Duke Energy Carolinas, LLC
Belews Creek, North Carolina Site
Early Site Permit Application

Part 1

Administrative Information

Revision 0

PART 1
ADMINISTRATIVE INFORMATION

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GLOSSARY

Term	Definition
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
DEC	Duke Energy Carolinas, LLC
DEP	Duke Energy Progress, LLC
EP	Emergency Plan
ER	Environmental Report
ESP	Early Site Permit
ESPA	Early Site Permit Application
FEMA	Federal Emergency Management Agency
ITAAC	Inspections, Tests, Analyses, and Acceptance Criteria
LLC	Limited Liability Company
LWA	Limited Work Authorization
LWR	light-water reactor
mi.	mile
MWe	megawatts electric
NC	North Carolina
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC Technical Report designation

Term	Definition
PAG	Protective Action Guide
PPE	plant parameter envelope
Project site	Belews Creek, NC site
QA	quality assurance
QAPD	Quality Assurance Program Description
RG	Regulatory Guide
RS	Review Standard
SC	South Carolina
SSAR	Site Safety Analysis Report
SSCs	structures, systems, and components
USEPA	U.S. Environmental Protection Agency

Section 1 Introduction and Purpose

1.1 INTRODUCTION

Duke Energy Carolinas, LLC (DEC), referred to herein as “Duke Energy,” a wholly-owned subsidiary of Duke Energy Corporation, is submitting this application for an Early Site Permit (ESP) to the United States Nuclear Regulatory Commission (NRC) in accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR), Part 52 (10 CFR 52) Subpart A, “Early Site Permits.” Duke Energy is the applicant for this ESP. Duke Energy Progress, LLC (DEP) an indirect subsidiary of Duke Energy Corporation, and DEC (together referred to as “the Companies”) combined make up the Carolinas service territory within the region of interest. Duke Energy requests that the NRC issue an ESP for the proposed site described in this application for 20 years from the date of issuance.

The Belews Creek, NC site (Project site) is located primarily in Sauratown Township, in the southeastern corner of Stokes County, North Carolina (NC), with a small portion in Belews Creek Township, Forsyth County, NC. The site is referred to as the Belews Creek, NC site or Project site throughout this application. A description of the Project site may be found in Part 2 of the application, Site Safety Analysis Report (SSAR), Section 1.2.

The Project site is owned by Duke Energy and is bounded on the north, east, and west by Belews Lake, a reservoir also owned by Duke Energy. Belews Lake was constructed in the early 1970s by Duke Energy as a cooling reservoir for the adjacent Belews Creek Steam Station, which is a two-unit, 2220-megawatts electric (MWe) fossil fuel plant. The Project site comprises approximately 1187 acres.

At this juncture, Duke Energy has not selected a reactor technology to be built at the Project site. Accordingly, this Early Site Permit Application (ESPA) was developed using the plant parameter envelope (PPE) approach. Technical information from various reactor vendors was used to establish bounding parameters that envelop the facility characteristics needed to evaluate the site's suitability for the future construction and operation of one or more of the reactor technologies. The PPE approach provides the NRC with the necessary information to assess the suitability of the Project site for the reactor technologies selected, while providing Duke Energy additional time to evaluate the technologies and select the technology best suited for the site and Duke Energy’s customers and increasing demand before proceeding with construction. The information in this application supports the issuance of an ESP.

The potential reactor deployment schedule for this ESPA is based on the 2023 Carolinas Resource Plan (CRP), which was submitted to the North Carolina Utilities Commission (NCUC) and Public Service Commission of South Carolina (PSCSC) in August 2023 and supplemented in January 2024. Most recently, the 2025 Carolinas Resource Plan was submitted to the NCUC and PSCSC in October and November 2025, respectively. The 2025 CRP projects the commercial on-line date for the initial 600 MWe of new nuclear generation in 2037. The early deployment date included in the 2023 CRP was used as the basis for the analysis supporting the ESPA. The delay in the on-line date described in the 2025 CRP has been evaluated and concluded that there is no material impact to the conclusions as the results of the analysis do not have a strong dependency on timing.

This ESPA has been divided into parts as follows:

Part 1 – Administrative Information

Part 2 – Site Safety Analysis Report (SSAR)

Part 3 – Environmental Report (ER)

Part 5 – Emergency Plan

Part 7 – Exemptions, Departures, and Variances

Part 8 – License Conditions; Inspections, Tests, Analyses and Acceptance Criteria

Part 9 – Withheld Information

Part 10 – Quality Assurance Program Description

Part 11 – Supplemental Information

1.2 PURPOSE OF AN EARLY SITE PERMIT APPLICATION

U.S. Nuclear Regulatory Commission (NRC) regulations allow an applicant to obtain site approval for a nuclear power plant before deciding to proceed with construction. According to 10 CFR 52.13, an ESP applies when "any person who may apply for a construction permit under 10 CFR Part 50, or for a combined license under 10 CFR Part 52, seeks an ESP from the Commission separately from an application for a construction permit or a combined license."

Prior to the introduction of the ESP application process, applicants had to commit significant resources well before resolving key environmental, site safety, and emergency planning issues. The ESP process allows these critical issues to be addressed early, before making substantial capital investments in nuclear power plant construction.

Environmental issues, site safety issues, and specific aspects of emergency preparedness are addressed as part of the ESP process. In those cases where the ESP applicant has not selected a particular reactor technology, the applicant may use the PPE approach as a surrogate for facility information to support required safety and environmental reviews. Under the PPE approach, the resulting ESP is applicable for a range of reactor designs.

To grant an ESP to Duke Energy for the Project site, the NRC must be assured, among other things, that a nuclear reactor (or reactors) with characteristics within the site parameters can be constructed and operated safely, without undue risk to the health and safety of the public. The specific issuance criteria are set forth in 10 CFR 52.24. This ESPA was prepared in accordance with 10 CFR Part 52, Subpart A.

Site safety issues, environmental issues, and major features of emergency preparedness are addressed as part of the ESP process. ESP licensing issues are resolved with a degree of finality during the ESP review process, subject to the exceptions specified in 10 CFR 52.39.

1.3 CONTACT INFORMATION

Any notices, questions, or correspondence in connection with this filing should be directed to:

Chris Nolan
Vice President New Nuclear Generation Strategy & Regulatory Engagement
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Huntersville, NC 28078

With copies to:

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525 S. Tryon St.
Charlotte, NC 28202

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Morgan, Lewis & Bockius LLP
1111 Pennsylvania Ave., N.W.
Washington, D.C. 20004

Section 2 Early Site Permit Application Format and Content

2.1 FORMAT AND CONTENT

Where applicable to the technologies being considered, this application contains the information required by 10 CFR 52.17, “Contents of applications; technical information,” for an ESP, and is submitted in accordance with NRC guidance on electronic submittals. Each part of the application is intended to stand alone to the extent practical. Information presented within one part may be referenced elsewhere within the same part to minimize duplication. However, if the same information is used in more than one part, that information may be replicated so that each part may be used without reliance on another part. Key references used in the development of the application are listed within the application documents. However, the inclusion of references in these lists does not imply full adherence to all criteria or guidance stated in each individual reference. The various reports and plans required for the ESPA were developed in accordance with applicable regulatory requirements and with consideration of available NRC guidance. A general description of the contents of this application is provided below.

Part 1 - Administrative Information

The Administrative Information section contains an overview of the ESPA, a general description of the format and content of the application, and general information required by 10 CFR 50.33(a) through (d) and (j).

Part 2 - Site Safety Analysis Report

The SSAR covers the site description, safety assessment, quality assurance (QA), and key design parameters for the Project site. It also evaluates site suitability, population profiles, and features that may influence the chosen design. The SSAR complies with the applicable portions of 10 CFR 52.17(a)(1). The SSAR provides a description and safety assessment of the proposed site, including any aspects of the plant that could affect the site and contribute to radiological consequences. The suitability of the site in relation to 10 CFR Part 100 is also described in the SSAR.

As noted earlier, a specific reactor design has not been selected for construction at the Project site. To provide sufficient design information for the NRC to assess the proposed site, a surrogate design has been included in the application. The surrogate plant consists of a set of bounding parameters, the PPE. The combination of PPE values and site characteristics forms the basis for the NRC's issuance of an ESP. Further details of the PPE approach are provided in Section 2.0 of the SSAR.

The SSAR also addresses the facility’s ability to withstand natural and man-made hazards that could affect the site. The emergency preparedness information includes an assessment of potential impediments to implementing an emergency plan (EP) at the Project site, as required by 10 CFR 52.17(b)(1). The QA program under which ESP-related activities are conducted is also provided.

Where practical, the SSAR section numbers align with those identified in NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light Water Reactor] Edition*. Consistent with that guidance, there are some intentional gaps in the numbering sequence. This approach is intended to facilitate subsequent integration

of the information from this ESPA into a construction permit application or a combined license application, in which the complete numbering sequence is used.

The regulatory basis for the SSAR includes:

- NRC Regulations – 10 CFR Part 20, 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100.
- NRC Regulatory Guide (RG) 1.70, *Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants*.
- NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition.*
- NRC RG 1.206, *Applications for Nuclear Power Plants*.
- Review Standard RS-002, *Processing Applications for Early Site Permits*.
- NRC RG 4.27, *Use of Plant Parameter Envelope in Early Site Permit Applications for Nuclear Power Plants* (NEI 10-01, *Industry Guideline for Developing a Plant Parameter Envelope in Support of an Early Site Permit)*.

The following provides a brief description of the individual chapters of the SSAR:

Chapter 1, *Introduction and General Description*, includes an overview of the Project site.

Chapter 2, *Site Characteristics*, addresses geography and demography; nearby industrial, transportation and military facilities; meteorology; hydrologic engineering; geology, seismology, and geotechnical engineering; and the PPE.

Chapter 3, *Design of Structures, Systems, Components, and Equipment*, contains a summary of the aircraft hazards analysis performed in Chapter 2.

Chapter 11, *Radioactive Waste Management*, provides information on liquid and gaseous radioactive releases.

Chapter 12, *Radiation Protection*, addresses doses to construction workers and the public from on-site sources of direct radiation; however, this chapter will not be included in the SSAR. This information is provided in ER Section 4.9 and SSAR Section 11.3.3, respectively.

Chapter 13, *Conduct of Operations*, provides an overview of emergency planning for the site and surrounding area in case of plant accidents and of the physical security provided for the site and plant sensitive areas.

Chapter 15, *Accident Analysis*, provides a discussion of radiological consequences of bounding plant accidents and conformance with applicable 10 CFR Part 100, Reactor Site Criteria, for the reactor technologies being considered.

Chapter 17*, Quality Assurance Program Description*, provides a description of the QA program under which the ESPA was prepared.

Part 3 – Environmental Report

This part presents information concerning site environmental issues, as required by 10 CFR 51.45 and 51.50. This part also satisfies the application content requirement of 10 CFR 52.17(a)(2). The ER focuses on the environmental impacts to the Project site from the construction and operation of multiple advanced reactors having characteristics that fall within the PPE. The ER discusses the existing environment surrounding the Project site and in the vicinity of the site, postulates environmental impacts of construction and operation, and considers appropriate mitigation measures where indicated; reviews the impacts of design basis and severe accidents; and presents the evaluation of alternative sites. This ER assesses impacts based on representative conditions developed from the facility designs included in the PPE; however, it does not postulate specific costs and benefits associated with construction or operation of any specific design option.

For evaluation purposes, the following categories of information regarding interfaces of the proposed site and facilities are reviewed:

- Comparison of the functional operational needs of the facility as they relate to the site's natural and environmental resources.
- Impact of the facility on the site's natural and environmental resources.

The regulatory bases for the ER include the following:

- National Environmental Policy Act
- NRC Regulations: 10 CFR Part 51 and 10 CFR Part 52
- NRC RGs:
  - RG 4.2, *Preparation of Environmental Reports for Nuclear Power Stations*
  - RG 4.7, *General Site Suitability Criteria for Nuclear Power Stations*
- NUREG-1555, Initial, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants*
- RS-002, *Processing Applications for Early Site Permits*
- Applicable federal, regional, state, and local environmental statutes

The following provides a brief description of the individual chapters of the ER:

- Chapter 1, *Introduction, d*iscusses the purpose and need for requesting an ESP.
- Chapter 2, *The Proposed Site and the Affected Environment*, examines current site use, the surrounding physical environment, and existing socioeconomic, demographic, historic, and community characteristics.

- Chapter 3, *Site Layout and Project Description*, describes the characteristics and parameters of the technologies considered that could impact the site, as well as the related construction activities.

- Chapter 4, *Environmental Impacts from Construction of the Proposed Project*, evaluates potential environmental impacts of constructing new nuclear plants at the Project site.

- Chapter 5, *Environmental Impacts from Operation of the Proposed Plant*, assesses potential environmental impacts of plant operation.

- Chapter 6, *Fuel Cycle, Transportation, and Decommissioning Impacts*, addresses the environmental impacts from the uranium fuel cycle and solid waste management, the transportation of radioactive material, and the decommissioning of the proposed nuclear plants at the Project site.

- Chapter 7, *Cumulative Impacts*, assesses any past, present, and reasonably foreseeable future actions in the geographic area of interest surrounding the site that would affect the same resources that would be affected by building and operation of the proposed project.

- Chapter 8, *Need for Power*, as specified in RG 1.206, *Applications for Nuclear Power Plants*, and directed by 10 CFR 51.50(b)(2), this chapter is not required nor included as part of the ER for this ESPA.

- Chapter 9, *Environmental Impacts of Alternatives*, reviews potential alternatives to constructing and operating new nuclear plants at the Project site.

- Chapter 10, *Conclusions*, summarizes the conclusions reached in the assessments of the environmental impacts of the proposed project as they support the suitability of the proposed site.

Part 4 – Technical Specifications

As specified in RG 1.206, *Applications for Nuclear Power Plants*, the submission of Technical Specifications is not required at the ESP phase.

Part 5 – Emergency Plan

The emergency planning information includes major features of the EP, as allowed by 10 CFR 52.17(b)(2)(i) using guidance provided in NUREG-0654/FEMA-REP-1, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants*.

The regulatory bases for the emergency planning information include consideration of the following:

- NRC Regulations – 10 CFR Part 50, 10 CFR Part 52, and 10 CFR 50.160

- Federal Emergency Management Agency (FEMA) Regulations - 44 CFR Part 350

- NRC/FEMA Memorandum of Understanding (58 Federal Register 47996)

- U.S. Environmental Protection Agency (USEPA), EPA-400/R-17/001, *PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents*
- NRC RG 1.101, *Emergency Response Planning and Preparedness for Nuclear Power Reactors*
- NRC RG 1.242, *Performance-Based Emergency Preparedness for Small Modular Reactors, Non-Light-Water Reactors, and Non-Power Production or Utilization Facilities*

The following briefly describes the contents of Part 5:

Part 5 outlines EP details, focusing on an Exposure Pathway Emergency Planning Zone specific to the reactor technologies under consideration. The EP establishes the concepts, evaluation and assessment criteria, and protective actions that are necessary to limit and mitigate the consequences of potential or actual radiological emergencies.

Part 6 – Security Plans

As specified in RG 1.206, the submission of Security Plans is not required at the ESP phase. As noted in ESPA Part 2 (SSAR Section 13.6), the characteristics of the Project site are such that adequate security plans and measures can be developed. Additional details regarding physical security will be provided during the construction permit or license application phase.

Part 7 – Exemptions, Departures, and Variances

The ESPA submitted herein has been reviewed, and it has been determined that no exemptions from the applicable requirements of 10 CFR are necessary for consideration by the NRC under the provisions of 10 CFR 52.7 and the exemption criteria set forth in 10 CFR 50.12. Variances under 10 CFR 52.93 and departures under 10 CFR 52.63 are not applicable to this ESPA. No NRC approval is required in this regard.

Part 8 – License Conditions; Inspections, Tests, Analyses and Acceptance Criteria

As specified in 10 CFR 52.17(b)(3), major features of an emergency plan may include proposed inspections, tests, analyses, and acceptance criteria (ITAAC). Part 5 of the ESPA (Emergency Plan) includes the major features of the proposed Emergency Plan for the Project site; however, it does not include any proposed ITAAC associated with those major features.

No License Conditions or Inspections, Tests, Analyses, and Acceptance Criteria are required for this ESPA.

Part 9 – Withheld Information

Part 9 contains the information redacted from other parts of the application due to the sensitive or proprietary nature of the information.

Part 10 – Quality Assurance Program Description

The Quality Assurance (QA) Program for safety-related activities is described in the Duke Energy Topical Report, *Quality Assurance Program Description Operating Fleet* (DUKE-QAPD-001, referred to as QAPD). The QAPD and associated procedures establish controls for

activities that could affect the quality of safety-related structures, systems, and components (SSCs) for the proposed advanced reactors at the Project site.

Part 11 – Supplemental Information

The ESP application submitted herein has been reviewed, and it has been determined that no supplemental information is currently needed to support the application.

2.2 LABELING CONVENTIONS

Each page of this application, except for title sheets, includes a header and footer indicating its corresponding section and current revision. Additional content identification is detailed in the following sections.

2.2.1 PAGINATION

Content pages are numbered to indicate their chapter and section, and page within a section. For example, page 3.5-1 is the first page in Chapter 3, Section 3.5. Tables, in a given chapter, are located at the end of the associated section and the figures, in a given chapter, are located at the end of the chapter. Both tables and figures are numbered by section and sheet number as appropriate. In addition, each chapter contains a Table of Contents, List of Tables, List of Figures, and a Glossary. The Table of Contents, List of Tables, List of Figures, and Glossary are sequentially numbered i, ii, etc., with the chapter number indicated. Page numbers are located in the page footer.

2.2.2 SECTION NUMBERING

Each part of the ESPA has multiple chapters, sections, and subsections. The term “Chapter” is applied to X-level material. The term “Section” is applied to X.Y-level content and further subsections, as necessary. Chapter numbering and titles for the SSAR are consistent, to the extent practicable, with NUREG-0800, and for the ER, consistent, to the extent practicable, with RG 4.2.

2.2.3 REFERENCES

Reference lists appear at the end of each chapter. For example, the references list for Part 3, Chapter 2 appears at the end of Chapter 2. In general, NRC regulations or guidance documents (i.e., CFRs, NUREGs, Regulatory Guides, etc.) are not included in the reference lists.

2.2.4 TABLES, FIGURES AND APPENDICES

Tables are generally located at the end of the associated X.Y section, and figures are located at the end of each chapter. Multi-page tables have “Sheet X of Y” in parentheses below table’s name on each page. Each figure has a title block to indicate the figure’s name, number and corresponding section. Multi-page figures have “Sheet X of Y” in parentheses after the figure number on each page. Tables and figures are numbered with their two-digit section number and a sequential number. For example, Figure 1.2-3 is the third figure for Section 1.2. If an appendix is required, it is included at the end of the associated chapter.

2.2.5 DOCUMENT REVISION LEVEL

The current revision level of the document is denoted in the footer on each page.

2.3 UNIT CONVENTION

In the ESPA, units used are those found in the source documents from which parameter information is drawn. In some cases, unit conversions are provided to facilitate comparison with other parameters. In general, English units are followed by metric units in parentheses, unless the source is in metric units, in which case an English unit equivalent is provided in parentheses.

Section 3 General Corporate Information

3.1 NAME OF APPLICANT AND OWNER

DEC, referred to herein as “Duke Energy,” a wholly-owned subsidiary of Duke Energy Corporation.

3.2 ADDRESS OF APPLICANT

Duke Energy Carolinas, LLC
525 S. Tryon St.
Charlotte, NC 28202

3.3 DESCRIPTION OF BUSINESS OF APPLICANT

DEC is the applicant for an ESP at the Project site. Headquartered in Charlotte, NC, Duke Energy is a regulated public utility focused on generating, transmitting, distributing, and selling electricity in parts of NC and South Carolina (SC). In filing this ESP application, the applicant is not acting as an agent or representative of any other entity.

Duke Energy Corporation is a Fortune 150 company and one of largest energy holding companies in America. The company’s electric utilities serve 8.6 million customers in several states including NC, SC, Florida, Indiana, Ohio, and Kentucky. The company’s electric utilities collectively own approximately 55,100 MWe of energy capacity. DEC and DEP operate eleven nuclear units at six sites in NC and SC with a generating capacity of 10,819 MWe. Duke Energy is executing an ambitious clean energy transition plan to achieve a goal of net-zero carbon emissions from electrical generation by 2050. The company is investing in major electric grid upgrades and cleaner generation, including expanded energy storage, renewables, natural gas, and nuclear generation.

DEC (the Applicant) is not owned, controlled, or dominated by an alien, a foreign corporation, or foreign government. The application does not contain Restricted Data or classified National Security Information.

3.4 DESCRIPTION OF ORGANIZATION AND MANAGEMENT OF APPLICANT

Duke Energy Corporation is currently governed by a 15-member Board of Directors (Board), with the Chair selected from among the members. The Board’s corporate governance framework is designed to enhance shareholder value and ensure timely responses to issues affecting the corporation’s compliance with Securities and Exchange Commission regulations. The Chief Executive Officer (CEO) is elected by the Board and is responsible for managing the Corporation’s affairs. The CEO performs all legally required duties and any additional responsibilities assigned by the Board. The CEO reports directly to the Board, while the Company’s Officers report to the CEO. All Directors, the CEO, and Officers are United States citizens.

The business address for all Board members is:

Duke Energy Corporation
DEP-101
PO BOX 1414
Charlotte, NC 28201

As of the date of this application, the names of the Board members are as follows:

Harry K. Sideris, President and Chief Executive Officer, Duke Energy Corporation
Derrick Burks
Annette K. Clayton
Theodore F. Craver, Jr., Independent Chair
Robert M. Davis
Caroline Dorsa
W. Roy Dunbar
Nicholas C. Fanandakis
Jeffrey B. Guldner
John T. Herron
Idalene F. Kesner
E. Marie McKee
Michael J. Pacilio
Thoms E. Skains
William E. Webster, Jr.

The business address for all Officers is:

Duke Energy Corporation
525 S. Tryon Street
Charlotte, NC 28202

As of the date of this application, the names (and titles) of the Directors and Principal Officers of the Applicant are as follows:

Capps, Steven D.	Senior Vice President, New Nuclear Development and Operations Support
Flippin, Nicole L.	Senior Vice President, Nuclear Operations
Ghartey-Tagoe, Kodwo	Executive Vice President, Chief Legal Officer and Secretary
Gibby, Shawn K.	Vice President, Nuclear Engineering
Glenn, R. Alexander	Executive Vice President
Haff, Thomas P.	Senior Vice President, Nuclear Operations
Henderson, Kelvin	Senior Vice President and Chief Nuclear Officer
Nader, Rounette K.	Vice President, New Nuclear Generation and License Renewal
Sideris, Harry K.	Chief Executive Officer

Duke Energy Carolinas, LLC

Belews Creek, North Carolina Site

Early Site Permit Application

Part 2

Site Safety Analysis Report

Revision 0

CHAPTER 1
INTRODUCTION AND GENERAL DESCRIPTION

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GLOSSARY

Term	Definition
ac.	acre
BWR	boiling-water reactor
CFR	Code of Federal Regulations
DEC	Duke Energy Carolinas, LLC
DEP	Duke Energy Progress, LLC
ER	Environmental Report
ESP	Early Site Permit
ESPA	Early Site Permit Application
GVH	GE Vernova Hitachi Nuclear Energy
ha	Hectare
HALEU	high-assay low-enriched uranium
Holtec	Holtec International
HTGR	high-temperature gas-cooled reactor
km	Kilometer
LLC	Limited Liability Company
LWR	light-water reactor
mi.	mile
MW	megawatt

Term	Definition
MWe	megawatts electric
MWt	megawatts thermal
NC	North Carolina
non-LWR	non-light-water reactor
NRC	U. S. Nuclear Regulatory Commission
NUREG	NRC Technical Report designation
NuScale	NuScale Power, LLC
PPE	plant parameter envelope
Project site	Belews Creek, NC site
PWR	pressurized-water reactor
RG	NRC Regulatory Guide
SC	South Carolina
SMR	small modular reactor
SRP	NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition*
SSAR	Site Safety Analysis Report
SSCs	structures, systems, and components
TerraPower	TerraPower, LLC
TRISO	TRi-structural ISOtropic

Term	Definition
UHS	ultimate heat sink
U.S.	United States
WEC	Westinghouse Electric Company, LLC
WSP	WSP USA
X-energy	X-energy, LLC

Chapter 1 Introduction and General Description

1.1 INTRODUCTION

Duke Energy Carolinas, LLC (DEC), referred to herein as “Duke Energy,” a wholly-owned subsidiary of Duke Energy Corporation, hereby submits this application for an Early Site Permit (ESP) to the United States Nuclear Regulatory Commission (NRC) in accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR), Part 52, (10 CFR 52) Subpart A, Early Site Permits. Duke Energy is the Applicant for this ESP. Duke Energy Progress, LLC (DEP) an indirect subsidiary of Duke Energy Corporation, and DEC (together referred to as “the Companies”) combined make up the Carolinas service territory within the region of interest. Duke Energy requests that the NRC issue an ESP for the proposed site described in this application for a period of 20 years from the date of issuance. The information in this application has been developed to support the issuance of that permit.

The Belews Creek, North Carolina (NC), site (Project site) is located primarily in Sauratown Township, in the southeastern corner of Stokes County, NC, with a small portion in Belews Creek Township, Forsyth County, NC. All proposed nuclear units will be in Stokes County. The Project site, located adjacent to Belews Lake, is approximately 14 miles (mi.) (23 kilometers [km]) northeast of Winston-Salem, NC, and approximately 19 mi. (31 km) northwest of Greensboro, NC.

The Project site is owned by Duke Energy and is bounded on the north, east, and west by Belews Lake, also owned by Duke Energy. Belews Lake was constructed in the early 1970s by Duke Energy as a cooling reservoir for the adjacent Belews Creek Steam Station, which is a two-unit, 2220-megawatt (MW) fossil fuel plant.

The Project site is comprised of a total area of approximately 1187 acres (ac.) (480 hectares [ha]). A specific reactor design has not been selected by Duke Energy to be constructed at the Project site. However, to facilitate the NRC's determination regarding suitability of the site for new nuclear units, Duke Energy has provided a set of bounding plant parameters, referred to as the plant parameter envelope (PPE). Technical information from various reactor designs was used to develop a set of bounding parameters that envelope the proposed facility characterization. This approach provides the NRC with information to assess the suitability of the Project site and allows Duke Energy to choose the best technology when a decision is made to proceed with construction. An overview of the reactor designs used to develop the PPE is provided in Section 1.11, and Section 2.0 identifies the PPE and site characteristic values, which may be used as a basis for the NRC’s determinations.

The Site Safety Analysis Report (SSAR) contains information describing the site characteristics, acceptability of the site for constructing and operating the proposed reactors, emergency preparedness, and quality assurance. Each chapter includes relevant regulatory considerations as necessary. The following paragraphs briefly describe the contents of the SSAR:

Chapter 1, Introduction and General Description, includes a general site description, an overview of reactor technologies considered in the development of the PPE, and a summary of SSAR compliance with regulations and regulatory guidance.

Chapter 2, Site Characteristics, includes a description of the PPE approach, the geography, demography, meteorology, hydrology, geology, and seismic characteristics of the site, and description of nearby industrial installations, military facilities, and transportation facilities.

Chapter 3, Design of Structures, Systems, Components, and Equipment, contains information on aircraft hazards in the vicinity of the Project site and references information on aircraft hazards provided in Section 2.2.

Chapter 11, Radioactive Waste Management, includes information concerning liquid and gaseous radioactive releases and associated doses during normal operations.

Chapter 13, Conduct of Operations, includes an overview of emergency planning and physical security for the site and plant sensitive areas.

Chapter 15, Accident Analysis, provides the radiological assessment required by 10 CFR 52.17(a)(1)(ix) to demonstrate compliance with the radiological dose criteria in 10 CFR Part 100. The assessment is based on information provided in the PPE.

Chapter 17, Quality Assurance Program Description, includes a description of the Quality Assurance Program under which the ESP application (ESPA) was prepared, as applied to activities related to the design, construction, and testing of the potential future facility.

The SSAR conforms with the applicable guidance contained in NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light Water Reactor] Edition* (SRP), except where explicitly indicated otherwise. Where possible, the SSAR section numbers correspond to the section numbers identified in NUREG-0800. Consistent with that guidance, there are some gaps in the numbering sequence. This is intentional; this approach is intended to facilitate subsequent integration of the information in this application with reactor design information in the construction permit or license application, in which the complete numbering sequence is used.

1.2 GENERAL SITE DESCRIPTION

1.2.1 SITE LOCATION

As discussed in Section 1.1, the Project site is primarily located in Sauratown Township, in the southeastern corner of Stokes County, NC, with a small portion in Belews Creek Township, Forsyth County, NC. All proposed nuclear units will be in Stokes County.

The Project site, adjacent to Belews Lake, is approximately 14 mi. (23 km) northeast of Winston-Salem, NC, and approximately 19 mi. (31 km) northwest of Greensboro, NC. The Project site comprises approximately 1187 ac. (480 ha) Figures 1.2-1 and 1.2-2 show the Project site location and the surrounding 6-mi.(10 km) and 50-mi. (80 km) region, respectively. A more detailed description of the Project site location is provided in Section 2.1.

1.2.2 SITE DEVELOPMENT

The Project site is owned by Duke Energy and is bounded on the north, east, and west by Belews Lake. Belews Lake was constructed in the early 1970s by Duke Energy as a cooling reservoir for the adjacent Belews Creek Steam Station, which is a two-unit, 2220-MW fossil fuel plant.

Duke Energy is seeking this ESP for optionality to construct up to three nuclear power Plant Complexes on the Project site (designated as the North, Middle, and South Plant Complexes) as shown in Figure 1.2-3. Each Plant Complex would be designed to house one or more advanced reactors, with the total number of reactors dependent on the specific technology selected. For the purposes of this application, advanced reactors include light-water small modular reactors (SMRs) and non-light water reactors (non-LWRs). Each reactor will have a thermal output of up to 1000 megawatts thermal (MWt). The Project site is planned to accommodate up to three nuclear power Plant Complexes, with a bounding gross electrical output of 2250 megawatts electric (MWe) and a maximum thermal output of 6250 MWt. The specific number of reactor units will depend on the technology selected. The specific reactor technology has not been selected; consequently, this ESPA was developed using the PPE approach. The PPE defines a set of bounding values that provide the bases for future site development at the Project site. Section 2.0 provides the PPE information selected for the Project site and further details concerning development of the PPE including information on the reactor technologies that were evaluated.

The Project site general arrangement is shown on Figure 1.2-3 including the site boundary, power blocks, cooling tower areas, and laydown areas. Because a technology or set of technologies has not yet been selected, Figure 1.2-3 provides a composite arrangement showing the power block areas, existing infrastructure in the area, and other site utilization characteristics.

1.3 COMPARISON WITH OTHER FACILITIES

This section is not applicable to an ESPA using the PPE approach.

1.4 IDENTIFICATION OF AGENTS AND CONTRACTORS

1.4.1 APPLICANT/PROGRAM MANAGER

Duke Energy is the Applicant for an ESP at the Project site. Duke Energy Corporation is a Fortune 150 company headquartered in Charlotte, NC. Duke Energy Corporation is one of the largest energy holding companies in America. The company's electric utilities serve 8.4 million customers in several states including NC, South Carolina (SC), Florida, Indiana, Ohio, and Kentucky. The company's electric utilities collectively own approximately 55,100 MW of energy capacity. The Companies operate 11 nuclear units at six sites in NC and SC with a generating capacity of approximately 10,819 MW. Duke Energy is executing an ambitious clean energy transition plan to achieve a goal of net-zero carbon emissions from electrical generation by 2050. The company is investing in major electric grid upgrades and cleaner generation, including expanded energy storage, renewables, natural gas, and nuclear generation.

1.4.2 PRINCIPAL CONTRACTORS AND PARTICIPANTS

1.4.2.1 Sargent & Lundy

Sargent & Lundy is a full-service architect-engineering firm with considerable nuclear plant expertise. The firm has demonstrated capabilities in the design and licensing of nuclear plants. Sargent & Lundy has engineered, designed, planned, evaluated, and managed large, complex nuclear projects. Sargent & Lundy is Duke Energy's primary contractor for the development of the Belews Creek, NC ESPA project, providing engineering, licensing, management, and consulting services. Responsibilities included the oversight and development of the SSAR, Environmental Report (ER), and Emergency Plan.

1.4.2.2 WSP USA (WSP)

WSP is a global leader in the energy market, providing a full range of services for the nuclear industry including technical and engineering assessments for new nuclear projects. Their services have included siting, licensing, commissioning, civil engineering, seismic design, and construction materials testing. For the Belews Creek, NC ESPA project, WSP is subcontracted to Sargent & Lundy. For the development of this ESPA, WSP provided expertise in the areas of hydrology, geology, seismology, and geotechnical engineering, including subsurface investigations. WSP was also responsible for preparation of significant portions of the ER.

1.4.2.3 Other Contractors and Participants

Sargent & Lundy and WSP established contractual relationships with specialized consulting firms to assist in the development of the Project site ESPA. These are briefly described in the following subsections.

1.4.2.3.1 GEOVision Geophysical Services

GEOVision Geophysical Services performed borehole geophysical testing.

1.4.2.3.2 University of Texas at Austin

The University of Texas at Austin assisted in performing seismic spectral analysis.

1.4.2.3.3 Coppersmith Consulting, Inc.

Coppersmith Consulting, Inc., provided expertise in probabilistic seismic hazard analysis, probabilistic fault displacement hazard analysis, seismic source characterization, and data collection methods.

1.4.2.3.4 Emergency Management Consulting, LLC

Emergency Management Consulting, LLC, provided expertise in emergency preparedness and developed the Emergency Plan provided in Part 5 of the ESPA.

1.5 REQUIREMENTS FOR ADDITIONAL TECHNICAL INFORMATION

No technical development programs remain to be performed to support this application.

1.6 MATERIAL REFERENCED

No material has been incorporated by reference in this application.

1.7 DRAWINGS AND OTHER DETAILED INFORMATION

No drawings or detailed information have been submitted separately as part of this application.

1.8 INTERFACES WITH STANDARD DESIGN

This section is not applicable to an ESPA using the PPE approach and is to be addressed, if applicable, in the construction permit or license application stage.

1.9 CONFORMANCE WITH REGULATORY CRITERIA

This section evaluates the conformance of the SSAR with relevant NRC guidance contained in NRC Regulatory Guides (RGs) and NUREG-0800.

The applicable NRC RGs were identified through a review of the applicable SRP sections. Table 1.9-1 lists the applicable RGs by number and title, along with the associated SSAR section numbers and conformance statements. Exceptions to conformance with a RG are noted with an explanation. RGs included are those identified in the applicable SRP sections.

Table 1.9-2 provides a listing of the SRP sections applicable to an ESPA, including conformance statements. An exception to conformance is noted when the SSAR does not meet regulatory guidance as stated, but the intent or objective is met using an acceptable alternative. Exceptions to conformance with the SRP are noted with an explanation.

Exemptions to NRC regulations required to support this ESPA are identified and described in ESPA Part 7.

Table 1.9-1
Conformance With Regulatory Guides
(Sheet 1 of 9)

Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.23	1	Meteorological Monitoring Programs for Nuclear Power Plants	2.3.2	Conforms	
			2.3.3	Conforms	
			2.3.4	Conforms	
			2.3.5	Conforms	
1.26	6	Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants	17.5	Conforms	
1.27	3	Ultimate Heat Sink (UHS) for Nuclear Power Plants	2.3.1	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.1	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.2	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.3	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.

Table 1.9-1
Conformance With Regulatory Guides
(Sheet 2 of 9)

Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.27	3	Ultimate Heat Sink (UHS) for Nuclear Power Plants	2.4.4	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.5	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.6	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.7	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.8	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.

Table 1.9-1
Conformance With Regulatory Guides
(Sheet 3 of 9)

Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.27	3	Ultimate Heat Sink (UHS) for Nuclear Power Plants	2.4.9	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.11	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.4.12	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
			2.5.4	NA	The technologies under consideration for use at the Project site use passive cooling for the UHS. As indicated in RG 1.27, Rev. 3, the guidance provided therein does not apply to plants that utilize a passive containment cooling system as their UHS.
1.28	6	Quality Assurance Program Criteria (Design and Construction)	2.5.4	Exception	Refer to SSAR Section 17.5.3 for a discussion of the exceptions taken to this regulatory guide.
			2.5.5		
			17.5		
1.29	6	Seismic Design Classification	2.4.1	Conforms	
			2.4.2	Conforms	
			2.4.3	Conforms	
			2.4.4	Conforms	

Table 1.9-1
Conformance With Regulatory Guides
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Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.29	6	Seismic Design Classification	2.4.5	Conforms	
			2.4.6	Conforms	
			2.4.7	Conforms	
			2.4.8	Conforms	
			2.4.9	Conforms	
			2.4.10	Conforms	
			2.4.11	Conforms	
			2.4.14	NA	The site grade is above the maximum flood height (the site is considered to be dry). Thus, no flooding protection for SSCs important to safety is required.
			17.5	Conforms	
1.59	2	Design-Basis Floods for Nuclear Power Plants	2.4.1	Conforms	
			2.4.2	Conforms	
			2.4.3	Conforms	
			2.4.4	Conforms	
			2.4.5	Conforms	
			2.4.6	Conforms	No tsunami-induced flooding hazards are expected at the site.
			2.4.7	Conforms	
			2.4.8	NA	The Project site contains a canal that bisects the property; however, this canal is not designated for safety-related cooling water use. Additionally, none of the reactor technologies under consideration require a safety-related water supply.
			2.4.9	Conforms	Channel diversions as a result of changes to the river basin, associated with the Project site, are not expected to cause flooding hazards at the site.

Table 1.9-1
Conformance With Regulatory Guides
(Sheet 5 of 9)

Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.59	2	Design-Basis Floods for Nuclear Power Plants	2.4.10	Conforms	The Project site is a dry site.
			2.4.14	Conforms	The Project site is a dry site.
1.60	2	Design Response Spectra for Seismic Design of Nuclear Power Plants	2.5.2	NA	A performance-based approach is used in accordance with NRC RG 1.208, Rev.0.
1.76	1	Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants	2.3.1	Conforms	
1.78	2	Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release	2.2.1–2.2.2	Conforms	
			2.2.3	Conforms	
			2.3.4	Conforms	
1.91	3	Evaluations of Explosions Postulated to Occur at Nearby Facilities and on Transportation Routes Near Nuclear Power Plants	2.2.1–2.2.2	Conforms	
			2.2.3	Conforms	
1.101	6	Emergency Response Planning and Preparedness for Nuclear Power Reactors	13.3	NA	An emergency action-level scheme will be adopted consistent with industry standards, including Regulatory Guide 1.242, Rev. 0, which specifically pertains to advanced reactor technologies.
1.102	1	Flood Protection for Nuclear Power Plants	2.4.1	Conforms	The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.2	Conforms	The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.

Table 1.9-1
Conformance With Regulatory Guides
(Sheet 6 of 9)

Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.102	1	Flood Protection for Nuclear Power Plants	2.4.3	Conforms	The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.4	Conforms	The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.5	Conforms	The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.6	Conforms	There are no tsunami-induced flood hazards at the Project site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.7	Conforms	There are no ice-induced flooding hazards at the Project site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.8	Conforms	The Project site contains a canal that bisects the property; however, this canal is not designated for safety-related cooling water use. Additionally, none of the reactor technologies under consideration require a safety-related water supply. The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.9	Conforms	Channel diversions are not expected to cause flooding at the Project site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.10	Conforms	The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.
			2.4.14	Conforms	The Project site is a dry site. Design and operational considerations are to be addressed in the construction permit or license application.

Table 1.9-1
Conformance With Regulatory Guides
(Sheet 7 of 9)

Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.109	1	Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I	2.3.5	Conforms	
			11.2.3	Conforms	
			11.3.3	Conforms	
1.111	1	Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors	2.3.5	Conforms	
			11.3.3	Conforms	
1.112	1	Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors	2.3.5	Conforms	
			11.2.3	NA	Information related to the effluent source term is based upon vendor-provided information in the PPE approach. In-plant controls are addressed in the construction permit or license application.
			11.3.3	NA	Information related to the effluent source term is based upon vendor-provided information in the PPE approach. In-plant controls are addressed in the construction permit or license application.
1.113	1	Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I	2.4.13	NA	Guidance is applicable only when calculating re-concentration in surface waters.
			11.2.3	Conforms	
1.115	2	Protection Against Turbine Missiles	3.5.1.3	Conforms	

Table 1.9-1
Conformance With Regulatory Guides
(Sheet 8 of 9)

Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.125	2	Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants	2.4.8	NA	The Project site contains a canal that bisects the property; however, this canal is not designated for safety-related cooling water use. Additionally, none of the reactor technologies under consideration require a safety-related water supply.
1.132	3	Geologic and Geotechnical Site Characterization Investigations for Nuclear Power Plants	2.5.2	Conforms	
			2.5.4	Conforms	
			2.5.5	Conforms	
1.138	3	Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants	2.5.2	Conforms	
			2.5.4	Conforms	
			2.5.5	Conforms	
1.145	1	Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants	2.3.4	Conforms	
1.183	1	Alternative Radiological Source Terms for Evaluating Design-Basis Accidents at Nuclear Power Reactors	15	NA	Accident source term is defined in the PPE. Vendor-specific source terms are addressed in the construction permit or license application.
1.198	0	Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites	2.5.2	Conforms	
			2.5.4	Conforms	
			2.5.5	Conforms	
1.208	0	A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion	2.5.1	Conforms	
			2.5.2	Conforms	
			2.5.3	Conforms	
			2.5.5	Conforms	
1.221	0	Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants	2.3.1	NA	Based on the hurricane data acquired for the site area, hurricane winds and missiles are not a concern for the site area.

Table 1.9-1
Conformance With Regulatory Guides
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Regulatory Guide	Rev.	Title	Applicable SSAR Section	Conformance	Comments
1.242	0	Performance-Based Emergency Preparedness for Small Modular Reactors, Non-Light-Water Reactors, and Non-Power Production or Utilization Facilities	13.3	Conforms	Due to the Site Boundary Emergency Planning Zone, RG. 1.242, Section C.8, Offsite Planning Activities are not applicable.
4.7	4	General Site Suitability Criteria for Nuclear Power Stations	2.1.3	Exception	Population densities averaged to 20 miles are expected to be greater than 500 persons per square mile through 2039. As noted in Figure 2.1-16, the population projections are not significantly above 500 persons per square mile and are considered acceptable given they are not well in excess of this value.
			2.5.1	Conforms	
			2.5.2	Conforms	
			2.5.3	Conforms	
			13.3	Conforms	
4.27	0	Use of Plant Parameter Envelope in Early Site Permit Applications for Nuclear Power Plants	2.0	Conforms	
5.71	1	Cyber Security Programs for Nuclear Power Reactors	2.3.3	Conforms	
			13.6	Conforms	
5.79	0	Protection of Safeguards Information	13.6	Conforms	

Key: NA = Not applicable

Table 1.9-2
Conformance with Standard Review Plan
(Sheet 1 of 3)

NUREG-0800 Section	Rev.	Title	Applicable SSAR Section(s)	Conformance	Comments
1.0	2	Introduction and Interfaces	1.1–1.11	Conforms	Supplementary information related to reactor design and construction is addressed in the construction permit or license application, when a technology vendor has been selected.
2.0	1	Site Characteristics and Site Parameters	2.0	Conforms	
2.1.1	3	Site Location and Description	2.1.1	Conforms	
2.1.2	3	Exclusion Area Authority and Control	2.1.2	Conforms	
2.1.3	3	Population Distribution	2.1.3	Conforms	
2.2.1–2.2.2	3	Identification of Potential Hazards in Site Vicinity	2.2.1–2.2.2	Conforms	
2.2.3	3	Evaluation of Potential Accidents	2.2.3	Conforms	The specific locations, quantities, and effects of chemicals to be stored on-site are addressed in the construction permit or license application. Evaluations of the impacts of toxic gases on main control room habitability are addressed in the construction permit or license application.
2.3.1	3	Regional Climatology	2.3.1	Conforms	
2.3.2	3	Local Meteorology	2.3.2	Conforms	
2.3.3	3	On-site Meteorological Measurements Programs	2.3.3	Conforms	
2.3.4	3	Short Term Dispersion Estimates for Accident Releases	2.3.4	Conforms	
2.3.5	3	Long-Term Atmospheric Dispersion Estimates for Routine Releases	2.3.5	Conforms	
2.4.1	3	Hydrologic Description	2.4.1	Conforms	The Dan River, including its tributary at the Belews Creek Reservoir, is a regulated and fully developed system. Surges, seiches, tsunami, flooding caused by landslides, and effects of ice formation are not credible for the Project site.
2.4.2	4	Floods	2.4.2	Conforms	The Dan River, including its tributary at the Belews Creek Reservoir, is a regulated and fully developed system. Surges, seiches, tsunami, flooding caused by landslides, and effects of ice formation are not credible for the Project site.

Table 1.9-2
Conformance with Standard Review Plan
(Sheet 2 of 3)

NUREG-0800 Section	Rev.	Title	Applicable SSAR Section(s)	Conformance	Comments
2.4.3	4	Probable Maximum Flood on Streams and Rivers	2.4.3	Conforms	
2.4.4	3	Potential Dam Failures	2.4.4	Conforms	
2.4.5	3	Probable Maximum Surge and Seiche Flooding	2.4.5	Conforms	Evaluations have demonstrated that surge and seiche flooding events are not credible for the site.
2.4.6	3	Probable Maximum Tsunami Hazards	2.4.6	Conforms	There are no tsunami-induced flooding hazards expected at the Project site. Because the conditions at the site are not conducive to the creation of a tsunami, no propagation model has been developed and wave runup, inundation, and drawdown are not separately addressed.
2.4.7	3	Ice Effects	2.4.7	Conforms	No safety-related SSC are subject to ice-induced forces or blockages from sheet or frazil ice.
2.4.8	3	Cooling Water Canals and Reservoirs	2.4.8	Conforms	The Project site contains a canal that bisects the property; however, this canal is not designated for safety-related cooling water use. Additionally, none of the reactor technologies under consideration require a safety-related water supply.
2.4.9	3	Channel Diversions	2.4.9	Conforms	It has been concluded that channel diversion is not a necessary design consideration for the Project site.
2.4.10	3	Flooding Protection Requirements	2.4.10	Conforms	Based upon grade elevation and maximum flooding height, the site is considered to be “dry;” however, the need for flood protections is addressed in the construction permit or license application when detailed grading and reactor design are available. Local probable maximum precipitation is addressed in the construction permit or license application, when detailed grading and reactor design are available.
2.4.11	3	Low Water Considerations	2.4.11	Conforms	
2.4.12	3	Groundwater	2.4.12	Conforms	Groundwater is not used for safety-related purposes. The need for dewatering systems is addressed in the construction permit or license application.

Table 1.9-2
Conformance with Standard Review Plan
(Sheet 3 of 3)

NUREG-0800 Section	Rev.	Title	Applicable SSAR Section(s)	Conformance	Comments
2.4.13	3	Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters	2.4.13	Conforms	
2.4.14	3	Technical Specifications and Emergency Operation Requirements	2.4.14	Conforms	The site is considered to be “dry” and does not require a safety-related source of water. By design, no emergency actions or Technical Specifications are required. Conformance with the general design criteria is not applicable to ESPAs.
2.5.1	5	Basic Geologic and Seismic Information	2.5.1	Conforms	
2.5.2	5	Vibratory Ground Motion	2.5.2	Conforms	
2.5.3	6	Surface Faulting	2.5.3	Conforms	
2.5.4	5	Stability of Subsurface Materials and Foundations	2.5.4	Conforms	
2.5.5	5	Stability of Slopes	2.5.5	Conforms	
3.5.1.6	4	Aircraft Hazards	3.5.1.6	Clarification	In lieu of using the aircraft crash frequency methodology offered in Sections III.2 and III.3 of this SRP, a U.S. Department of Energy methodology is used to evaluate the aircraft hazard impact frequency (DOE-STD-3014-2006). Refer to Section 2.2.2.7 for a discussion of the use of this methodology. The NRC accepted use of this methodology in the PSEG ESPA.
11.2	5	Liquid Waste Management System	11.2.3	Conforms	Information related to design is addressed in the construction permit or license application.
11.3	4	Gaseous Waste Management System	11.3.3	Conforms	Information related to design is addressed in the construction permit or license application.
13.3	3	Emergency Planning	13.3	Conforms	
13.6.3	2	Physical Security – Early Site Permit and Reactor Siting Criteria	13.6	Conforms	
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17.5	1	Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants	17.5	Conforms	

1.10 IMPACT OF CONSTRUCTION OF NEW NUCLEAR POWER PLANT UNITS ON OPERATING UNITS AT MULTI-UNIT SITES

This section is not applicable to this ESPA and is to be addressed during the construction permit or license application phase.

1.11 OVERVIEW OF REACTOR TYPES

Duke Energy is seeking this ESP for optionality to construct up to three nuclear power Plant Complexes on the Project site (designated as the North, Middle, and South Plant Complexes). Each Plant Complex would be designed to house one or more advanced reactors, with the total number of reactors dependent on the specific technology selected. For the purposes of this application, advanced reactors include light-water SMRs and non-LWRs. Since the specific reactor technology has not been selected, this ESPA was developed using the PPE approach. The PPE is based on a project site designed to accommodate up to three nuclear power Plant Complexes, with a bounding gross electrical output of 2250 MWe and a maximum thermal output of 6250 MWt, along with other site-specific considerations. Each reactor will have a thermal output of up to 1000 MWt. Refer to Section 1.11.3 for additional discussion concerning the application of this power level limit to the Holtec SMR-300 technology.

To support this approach, six advanced reactor designs were used to create a “surrogate plant.” As defined in NEI 10-01*, Industry Guideline for Developing a Plant Parameter Envelope in Support of an Early Site Permit* (Reference 1.11-1), the surrogate plant provides the basis for developing the site-related design parameter values listed in Table 2.0-2 of Chapter 2. A basis summary for each plant parameter is provided in the SSAR section referenced in Table 2.0-2.

The PPE defines a set of bounding values that provide the bases for future site development at the Project site. In development of the PPE, the following reactor technologies were evaluated:

- GVH BWRX-300
- NuScale VOYGR
- Holtec SMR-300
- WEC AP300
- TerraPower Natrium
- X-energy Xe-100

All six designs are advanced reactors, with four SMRs (i.e., BWRX-300, VOYGR, SMR-300, and AP300) and two non-LWRs (i.e., Natrium and Xe-100) incorporating enhanced safety features aimed at improving overall reactor safety compared to current operating reactors.

1.11.1 GVH BWRX-300

The GVH BWRX-300 is an advanced boiling-water reactor (BWR) that includes passive safety features. The BWRX-300 is an evolutionary design based on an NRC-licensed technology (Economic Simplified BWR). Each reactor generates 870 MWt, with an estimated electrical output of 315 MWe. The reactor design uses standard LWR fuel. Each BWRX-300 is enclosed by a containment structure. Up to six reactors would be placed on the Project site with a total thermal power output estimate of 5220 MWt.

1.11.2 NUSCALE VOYGR

The NuScale VOYGR is an advanced integral pressurized-water reactor (PWR) that includes passive safety features. Each reactor generates 250 MWt, with an estimated electrical power output of 77 MWe. The NuScale VOYGR uses standard LWR fuel with a shorter fuel assembly length. The reactor sits within a containment vessel, and up to 12 reactors can be housed in one below-grade shared pool.

One plant (12 total reactors) would be placed on the Project site with a total thermal power output estimate of 3000 MWt.

1.11.3 HOLTEC SMR-300

The Holtec SMR-300 is an advanced PWR that includes passive safety features. Each reactor generates approximately 1050 MWt, with an estimated electrical power output of approximately 320 MWe. Up to six SMR-300 reactors would be placed on the Project site with a total thermal power output of less than 6000 MWt. The Holtec SMR-300 uses standard LWR fuel. The reactor, steam generator, and spent fuel pool are located inside the containment structure, with the reactor situated below grade.

Duke Energy is only considering reactor technologies that meet the NRC definition of a SMR under 10 CFR 50.2, which limits the maximum thermal output of an SMR module to 1000 MWt. Duke Energy understands that with a maximum thermal output of 1050 MWt, the SMR-300 thermal power rating exceeds the 10 CFR 50.2 1000 MWt SMR power limit, and thus poses an obstacle for implementing a performance-based emergency plan in accordance with 10 CFR 50.160. Duke Energy is aware that Holtec is considering various options for resolution of the issue (Reference 1.11-2). Should Duke Energy select the Holtec SMR-300 technology, any additional information or measures needed to resolve the issue are to be addressed in the construction permit or license application.

1.11.4 WEC AP300

The WEC AP300 is an advanced PWR that includes passive safety features. Each reactor generates 990 MWt, with an estimated electrical power output of 330 MWe. The WEC AP300 uses standard LWR fuel. The reactor and steam generator are located inside the containment structure. Up to six AP300 reactors would be placed on the Project site with a total thermal power output estimate of 5940 MWt.

1.11.5 TERRAPOWER NATRIUM

The TerraPower Natrium reactor is a metal fueled, pool-type sodium fast reactor that contains a molten salt energy storage system, enabling the plant to vary its supply of energy to the grid. Each reactor generates 840 MWt with an estimated electrical power output of 345 MWe, while maintaining constant reactor power. The Natrium reactor uses high-assay low-enriched uranium (HALEU) metallic fuel. The reactor operates near atmospheric pressure, circulating sodium through its core with pumps. Up to two Natrium reactors would be placed on the Project site with a total thermal power output estimate of 1680 MWt.

1.11.6 X-ENERGY XE-100

The X-energy Xe-100 is an advanced high-temperature gas-cooled reactor (HTGR) that

includes passive safety features. Each reactor generates 200 MWt, with an estimated electrical power output of 80 MWe. The X-energy Xe-100 uses HALEU TRi-structural ISOtropic (TRISO) particle fuel. The reactor and steam generator are located inside the containment structure. The standard design is for a four-reactor plant. Up to 14 Xe-100 reactors would be placed on the Project site with a total thermal power output estimate of 2800 MWt.

1.12 REFERENCES

1.11-1 NEI 10-01*, Industry Guideline for Developing a Plant Parameter Envelope in Support of an Early Site Permit*, Revision 1, May 2012.

1.11-2 U.S. Nuclear Regulatory Commission, Letter from Victoria V. Huckabay, *U.S. Nuclear Regulatory Commission Staff Response to SMR, LLC (A Holtec International Company) Presentation on Using the 10 CFR 50.160 Emergency Preparedness Rule for the SMR-300 Design*, July 9, 2025 (Accession Number ML25153A579).

Figure 1.2-1
Belews Creek, NC Site Location & 6-Mile Surrounding Area

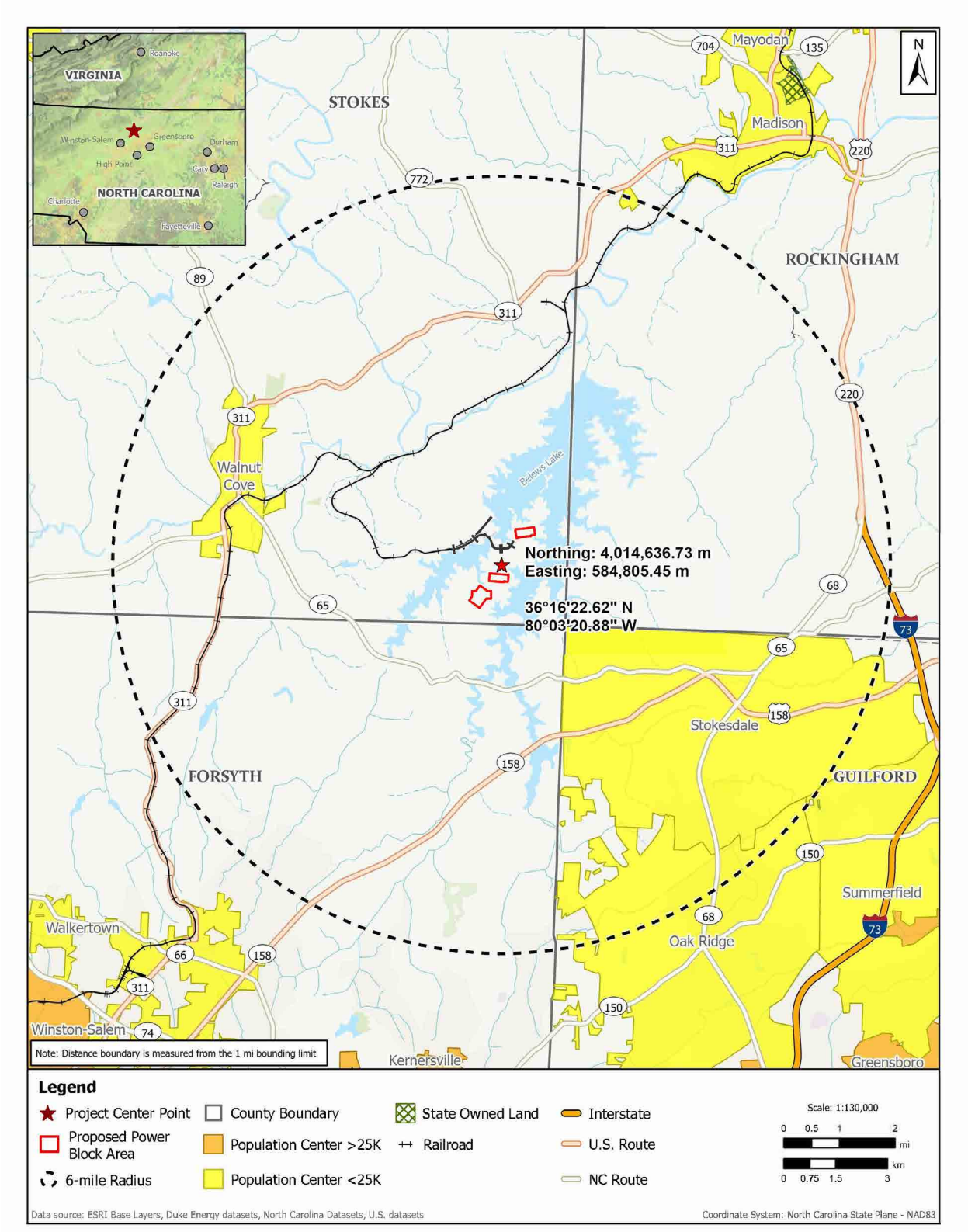


Figure 1.2-2
Belews Creek, NC Site Location & 50-Mile Surrounding Area

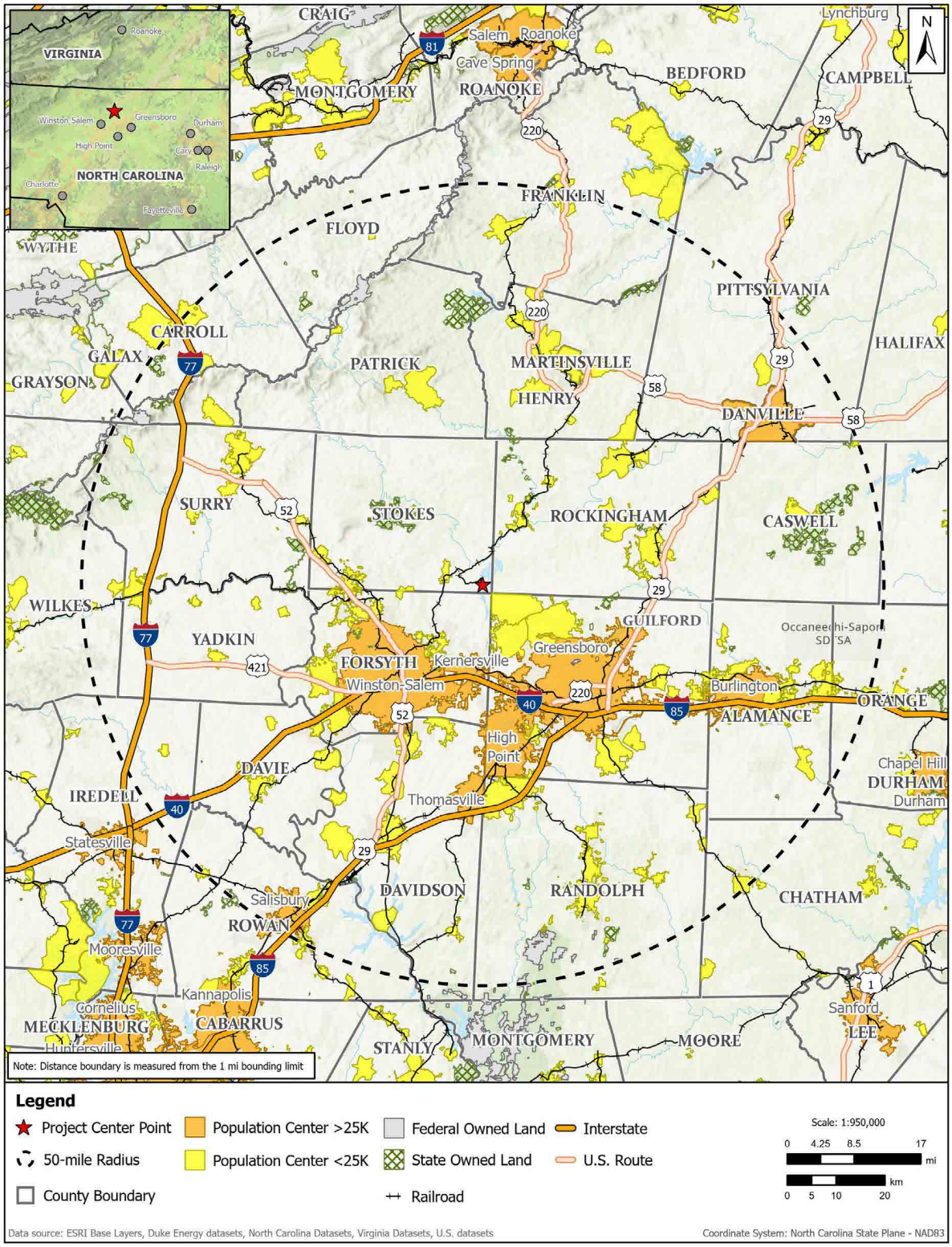
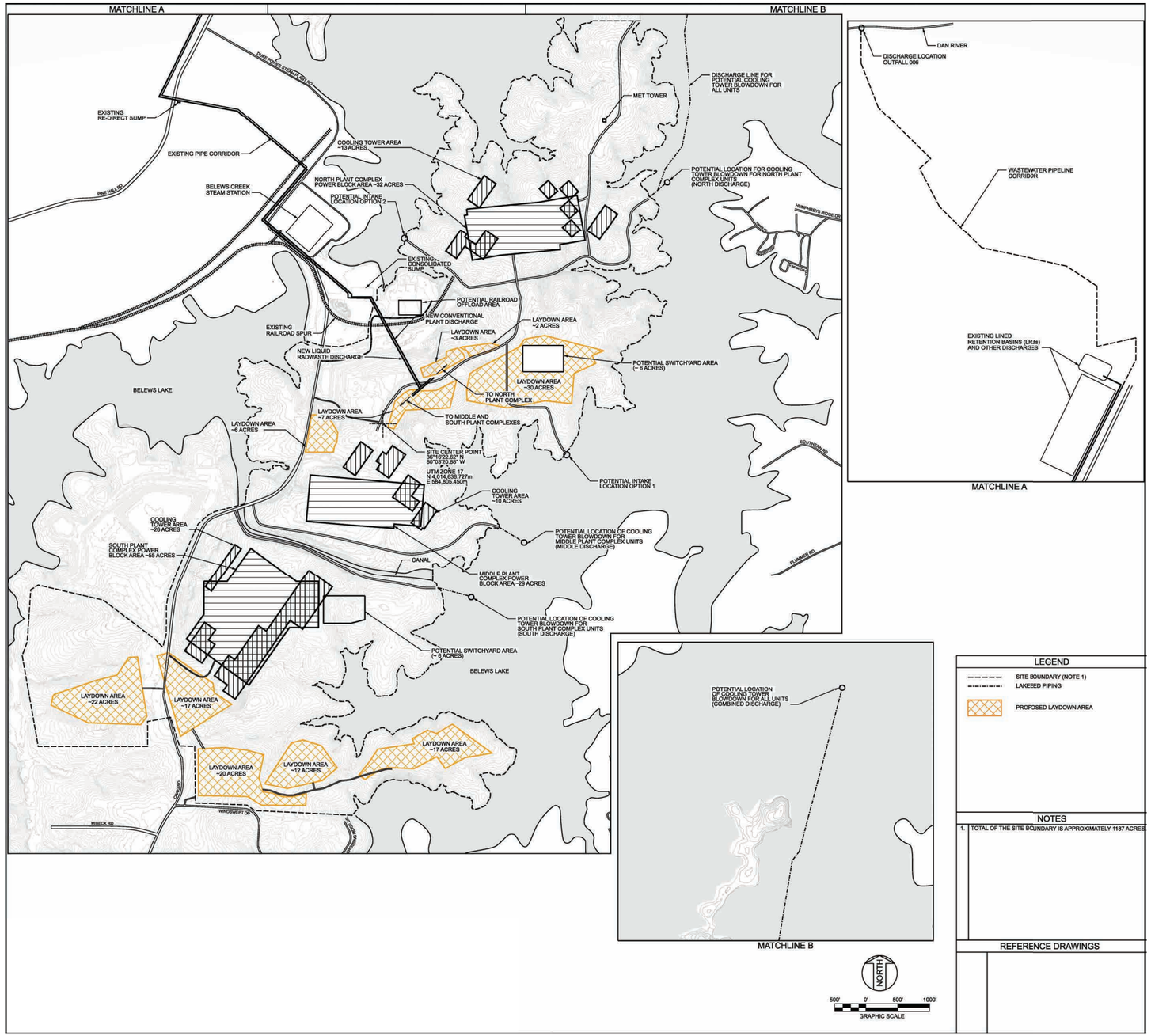


Figure 1.2-3
Belews Creek, NC Site General Arrangement



CHAPTER 2
SITE CHARACTERISTICS

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GLOSSARY

Term	Definition
2D	two-dimensional
40Ar/39Ar	argon-argon dating
°C	degrees Celsius
°F	degrees Fahrenheit
ac.	acre
ACES	Automated Coastal Engineering System
ac-ft	acre-foot
ACH	air changes per hour
AECL	Atomic Energy of Canda Limited
AFDD	accumulated freezing degree days
AFE	annual frequency of exceedance
AGL	above ground level
AHEX	Atlantic Highly Extended Crust
AHPS	Advanced Hydrologic Prediction Service
AL	approach and landing
ALOHA	Areal Locations of Hazardous Atmospheres

Term	Definition
AMSL	above mean sea level
ANS	American Nuclear Society
ANSI	American National Standards Institute
ANSS	Advanced National Seismic System Comprehensive Earthquake Catalog
APT	aquifer pumping test
ArcMap	ArcMap 10.8.2
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASTM	American Society of Testing and Materials
ATV	acoustic televiewer
BCSS	Belews Creek Steam Station
bgs	below ground surface
BLEVE	Boiling Liquid Expanding Vapor Explosion
BNL	Brookhaven National Laboratory
bpf	blows per foot
Bq	Becquerels (decays per second)

Term	Definition
BTOC	below top of casing
BTU	British Thermal Unit
c	cohesion
c'	effective cohesion
CAA	Clean Air Act
cal	calories
cal/s	calories per second
CAMP	Central Atlantic magmatic province
CAP	corrective action plan
CBR	center, body, and range
CEM	Coastal Engineering Manual
CENA	Central and Eastern North America
CEUS	Central and Eastern United States
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	Curie

Term	Definition
cm	centimeter
cm/yr	centimeters per year
CO	carbon monoxide
Co.	Company
CO_2	carbon dioxide
CO_2-eq	carbon dioxide equivalent
COV	coefficient of variation
COVID-19	coronavirus disease 2019
CP	Coastal Plain
CR	core recovery
CRREL	Cold Region Research and Engineering Laboratory
CSM	conceptual site model
CU	consolidated-undrained
CVSZ	Central Virginia Seismic Zone
CZbg	biotite gneiss and schist
CZfg	felsic mica gneiss

Term	Definition
D/Q	deposition factor
DBR	deep bedrock
DBT	dry bulb temperature
Delta-T	vertical temperature gradient
DEM	Digital Elevation Model
D_{min}	minimum damping
DOE	U.S. Department of Energy
DPT	dewpoint temperature
DPR	deepest bedrock
DRS	design response spectrum
DYFI	(USGS) Did you feel it?
E[M]	expected moment magnitude
EAB	exclusion area boundary
ECC-AM	Extended Continental Crust-Atlantic Margin
ECC-GC	Extended Continental Crust-Gulf Coast
ECL	effluent concentration limit

Term	Definition
EF Scale	Enhanced Fujita Scale
EL	elevation
ENE	east-northeast
EPRI	Electric Power Research Institute
ER	electrical resistivity
ERM	Eastern Rift Margin
ERM-N	Eastern Rift Margin-North
ERM-S	Eastern Rift Margin-South
ESC	Environmental Systems Corporation
ESE	east-southeast
ESP	Early Site Permit
ESPA	Early Site Permit Application
ESRI	Environmental Systems Research Institute
ETSZ	Eastern Tennessee Seismic Zone
FAA	Federal Aviation Administration
FDD	freezing degree days

Term	Definition
FEMA	U.S. Federal Emergency Management Agency
FERC	U.S. Federal Energy Regulatory Commission
FGD	flue gas desulfurization
FIRS	foundation input response spectrum
Fr-Fr	Free-Free
FS	factor of safety
ft.	feet
ft/day	feet per day
ft/ft	feet per foot
ft/s	feet per second
ft^2	square feet
ft^2/day	square feet per day
ft^2/lb	square feet per pound
ft^3	cubic feet
g	standard acceleration due to earth’s gravity
Ga	giga-annum (billion years)

Term	Definition
gal.	gallon
GCR	Gulf Coast Region
GHEX	Gulf Coast Highly Extended
GHG	greenhouse gases
GIS	geographic information system
G_{max}	maximum shear modulus
GMC	ground motion characterization
GMH	Great Meteor Hotspot
GMM	ground motion model
GMPE	ground motion prediction equation
GMRS	ground motion response spectrum
gpm	gallons per minute
GPS	Global Positioning System
Gt	gigaton
GVH	GE Vernova Hitachi Nuclear Energy
GWT	groundwater level

Term	Definition
H	horizontal
ha	hectare
ha-m	hectare-meter
HEC-RAS	Hydrologic Engineering Center River Analysis System
HHA	hierarchical hazard assessment
HMR	National Weather Service Hydrometeorological Reports
Holtec	Holtec International
hr.	hour
HW	hanging wall
IBEB	Illinois Basin Extended Basement
IEEE	Institute of Electrical and Electronic Engineers
I_h	horizontal hydraulic gradient
in.	inch
in/yr	inches per year
Inc.	incorporated
ISG	Interim Staff Guidance

Term	Definition
i_v	vertical hydraulic gradient
Jd	diabase dike
JFD	joint frequency distribution
K	hydraulic conductivity
K_d	solid/liquid partition coefficient
K_0	site attenuation parameter
kg	kilogram
KGS	Kansas Geological Survey
KGSO	National Weather Service Station at Piedmont Triad International Airport, Greensboro, NC
KINT	National Weather Service Station at Smith Reynolds Airport, Winston-Salem, NC
km	kilometer
km^2	square kilometer
kPa	kilopascal
kph	kilometer per hour
KRDU	National Weather Service Station at Raleigh/Durham International Airport, Raleigh, NC

Term	Definition
ksf	kips per square foot
kts	knots
kW	kilowatt
kyr	thousand year duration
L	horizontal projection of the flow path length
lb.	pound
LCD	local climatological data
LiDAR	Light Detection and Ranging
LIP	local intense precipitation
LMDCT	linear mechanical draft cooling towers
lpm	liters per minute
LPZ	low population zone
LTP	load transfer platform
LWR	light-water reactor
LWSP	local water supply plans
m	meter

Term	Definition
m/s	meters per second
m^2/kg	meters squared per kilogram
m^3	cubic meter
m^3/s	cubic meters per second
Ma	mega-annum (million years)
mb	millibar
MEL	Maximally Exposed Location
MESE	Mesozoic and younger extended crust
MESE-N	Mesozoic and younger extended crust-narrow
MESE-W	Mesozoic and younger extended crust-wide
MET tower	Belews Creek, NC site meteorological tower
mGal	milligal
mi.	mile
mi^2	square mile
MidC	Midcontinent-Craton
ml	milliliter

Term	Definition
ML	non-plastic silts
mld	million liters per day
mm	millimeter
mm/yr	millimeter per year
Mmax	maximum magnitude
MMI	Modified Mercalli Intensity
mo	month
MPa	megapascal
mph	miles per hour
mps	meter per second
MQ	Marquesas
MRI	mean return interval
MW	megawatt
MWe	megawatts electric
MWh	megawatt-hour
MWIS	makeup water intake structure

Term	Definition
MWSEL	Maximum Water Surface Elevations
my	million years
n	effective porosity
N	resistance
N*	NUREG-2115 methodology that adjusts earthquake counts to account for the uncertainty in the magnitude estimate
NAAQS	National Ambient Air Quality Standards
NAD 1983	North American Datum of 1983
NAP	Northern Appalachian
NAVD 88	North American Vertical Datum of 1988
NC	North Carolina
NCA	National Climate Assessment
NCCSR	North Carolina Climate Science Report
NCDC	National Climatological Data Center
NCDEQ	North Carolina Department of Environmental Quality
NCDWR	North Carolina Division of Water Resources
NCEI	National Centers for Environmental Information

Term	Definition
NCGS	North Carolina Geological Survey
NCOSBM	North Carolina Office of State Budget and Management
NEDB	National Earthquake Database of Canada
NEI	Nuclear Energy Institute
NGA	Next Generation Attenuation
NGVD 29	National Geodetic Vertical Datum of 1929
NID	National Inventory of Dams
NIST	National Institute of Standards and Technology
NLCD	National Land Cover Database
NM	Nautical Mile
NMESE	non-extended crust or crust where the most recent extension occurred before the Mesozoic
NMESE-N	non-extended crust or crust where the most recent extension occurred before the Mesozoic-Narrow
NMESE-W	non-extended crust or crust where the most recent extension occurred before the Mesozoic-Wide
NMFS	New Madrid Fault System
NNE	north-northeast

Term	Definition
NNW	north-northwest
NO_2	nitrogen dioxide
NOAA	U.S. National Oceanic and Atmospheric Administration
non-LWR	non-light-water reactor
NPDES	National Pollutant Discharge Elimination System
NPS	U.S. National Park Service
NRC	U.S. Nuclear Regulatory Commission
NS	Norfolk Southern
NSHM	National Seismic Hazard Map
nT	nanotesla
NUREG	NRC Technical Report designation
NUREG/CR	NRC Contractor Technical Report
NuScale	NuScale Power, LLC
NWI	National Wetland Inventory
NWS	National Weather Service
OB	overburden

Term	Definition
OSHA	U.S. Occupational Safety and Health Administration
PBIRS	performance-based interface response spectrum
pcf	pounds per cubic foot
PEZ-N	Paleozoic Extended Zone-Narrow
PEZ-W	Paleozoic Extended Zone-Wide
PGA	peak ground acceleration
pH	potential of hydrogen
PI	Plasticity Index
PIR	Potential Impact Radius
$PM_{2.5}$	particulate matter with a diameter of 2.5 microns or less
PM_{10}	particulate matter with a diameter of less than 10 microns
PMF	probable maximum flood
PMP	probable maximum precipitation
PMWP	probable maximum winter precipitation
PPBA	potential power block area
PPE	plant parameter envelope

Term	Definition
PPg	porphyritic granite
ppm	parts per million
PPRP	participatory peer review panel
Project site	Belews Creek, NC site
psf	pounds per square foot
PSHA	Probabilistic Seismic Hazard Analysis
psi	pound per square inch
psig	pounds per square inch gauge
PWR	partially weathered rock
PWS	public water supply
RCP	Representative Concentration Pathway
RCTS	Resonant Column Torsional Shear
Rd	road
RG	Regulatory Guide
RH	relative humidity
RLME	repeated large-magnitude earthquake

Term	Definition
RQD	rock quality designation
RR	Reelfoot Rift
RR-RCG	Reelfoot Rift with Rough Creek Graben
Rrup	distance to earthquake rupture
RSL	relative sea level rise
RTD	resistance temperature and detector
S	storage coefficient
s/m^3	seconds per cubic meter
SACTI2	Seasonal/Annual Cooling Tower Impact Prediction Code 2
SASW	Spectral Analysis of Surface Waves
SBR	shallow bedrock
SCRAM	Support Center for Regulatory Atmospheric Modeling
sec.	second
SLR	St. Lawrence Rift
SM	silty sands
SMR	small modular reactor

Term	Definition
SO_2	sulfur dioxide
SPT	Standard Penetration Test
sq.	square
sq. mi.	square mile
SRA	Site Response Analysis
SRP	Standard Review Plan
SSAR	Site Safety Analysis Report
SSC	seismic source characterization
SSCs	structures, systems, and components
SSE	south-southeast
SSHAC	Senior Seismic Hazard Analysis Committee
SSW	south-southwest
STUDY-R	Study Region
T	transmissivity
T_a	air temperature
TDIs	technically defensible interpretations

Term	Definition
TerraPower	TerraPower, LLC
t_i	ice thickness
TI Team	Technical Integration Team
TNT	Trinitrotoluene
TOC	top of casing
TOK	Texas-Oklahoma-Arkansas region
tsf	tons per square foot
U.S.	United States
UCS	unconfined compressive strength
UHRS	uniform hazard response spectrum
UHS	ultimate heat sink
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce

Term	Definition
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
UU	unconsolidated-undrained
V	vertical
V/H	vertical-to-horizontal
VA	Virginia
VDWR	Virginia Department of Wildlife Resources
V_p	compression wave velocity
V_S	shear wave velocity
WBT	Wet Bulb Temperature
WEC	Westinghouse Electric Company, LLC
WNW	west-northwest
WOTUS	Waters of the U.S.
WSEL	water surface elevation
WSW	west-southwest

Term	Definition
X-energy	X-energy, LLC
yr.	year
Δh	difference in hydraulic head
ΔT	temperature difference
µg	micrograms
χ/Q	atmospheric dispersion factor
φ	total stress friction angle
φ'	effective total stress friction angle

Chapter 2 Site Characteristics

Chapter 2 describes the key characteristics of the Belews Creek, North Carolina (NC) site (Project site), including the plant parameter envelope (PPE), and the geographical, demographical, geological, seismological, hydrological, and meteorological characteristics of the site and vicinity. Additionally, the chapter includes an assessment of nearby industrial, transportation, and military facilities to assess the potential for accidents that could compromise safe operations. Chapter 2 provides sufficient detail about the Project site location, attributes, and related design parameters to support a safety assessment. Chapter 2 is organized into the following sections:

Section 2.0: Plant Parameter Envelope

Section 2.1: Geography and Demography

Section 2.2: Nearby Industrial, Transportation, and Military Facilities

Section 2.3: Meteorology

Section 2.4: Hydrologic Engineering

Section 2.5: Geology, Seismology, and Geotechnical Engineering

2.0 PLANT PARAMETER ENVELOPE

Duke Energy is pursuing an Early Site Permit (ESP), utilizing a PPE for site evaluation approval, to support potential construction of multiple advanced reactors at the Project site. Advanced reactors include light water small modular reactors (SMRs) and non-light-water-reactors (non-LWRs). Each reactor will have a thermal output of up to 1000 megawatts thermal (MWt). These advanced reactors are planned across three areas at the site, referred to as the North Plant Complex, Middle Plant Complex, and the South Plant Complex (collectively referred to as Plant Complexes). The final number and type of advanced reactors will depend on the technology selected.

Because a technology has not yet been selected, a PPE has been developed. The PPE was prepared using the guidelines in Nuclear Energy Institute (NEI) 10-01, *Industry Guideline for Developing a Plant Parameter Envelope in support of an Early Site Permit* (Reference 2.0-1). The PPE uses information supplied by reactor vendors for the technologies under consideration to establish a surrogate plant.

The final technology selected for the Project site will be identified during the construction permit or license application phase, at which time it will be confirmed that the selected design is bounded by the PPE. Any parameters that are determined to be non-bounding will require a variance during the construction permit or license application phase, in accordance with Title 10 of the Code of Federal Regulations (CFR) Part 52, Section 52.39(d) (10 CFR 52.39(d)). This approach ensures site suitability for multiple reactor technologies without committing to a specific technology. A summary of the reactor designs considered in developing the PPE is

provided in Section 1.11, Overview of Reactor Types.

Tables 2.0-1 and 2.0-2 present the principal site characteristics and site-related design parameters for the Project site. This information is presented consistent with the guidance in the U.S. Nuclear Regulatory Commission (NRC) technical guidance document NUREG-0800, *Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,* Tables 2.0-3 through 2.0-6 are part of the PPE and provide isotopic source term information used to assess dose consequences from both routine releases and postulated accident scenarios.

Tables 2.0-4 and 2.0-6 provide the bounding annual normal release of gaseous and liquid radionuclide activity, respectively. The bounding release values in these tables were determined in the following manner:

- Two technologies were primarily used to identify the overall bounding values based largely on the conservative total activity for each radionuclide.
- A third technology was used when the two initial technologies' values were "zero."
- The fourth technology was used to replace extraordinarily low exponent values from the third technology.
- Where "negligible" was provided for radionuclide activity by one of the first two technologies, a value of 1.00E-05 curies per year (Ci/year) per reactor was used.
- The radionuclide activity considers the number of reactors of the specific technology proposed to be built at the Project site.

The site characteristics and design parameters presented below, and throughout the Site Safety Analysis Report (SSAR), establish the findings required by 10 CFR Part 52 and 10 CFR Part 100 regarding the suitability of the Project site.

Table 2.0-1
Site Characteristics
(Sheet 1 of 7)

Characteristic Parameter	Site-Specific Value/ Characteristic	Description	SSAR Section
Geography and Demography			
Exclusion Area Boundary (EAB)	Figure 2.1-5 shows the proposed EAB.	The area surrounding the reactors, in which the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property from the area.	2.1.3.3
Low Population Zone (LPZ)	Figure 2.1-5 shows the LPZ. For the reactor technologies under consideration, the LPZ and EAB are equivalent. There are no residents within the LPZ.	The area immediately surrounding the exclusion area such that there is a reasonable assurance that appropriate protective measures could be taken in the event of a serious accident.	2.1.3.3
Population Center Distance	7.7 mi. (12.4 km)	The distance from the Project site boundary to the nearest boundary of a densely populated center containing more than about 25,000 residents.	2.1.3.4

Table 2.0-1
Site Characteristics
(Sheet 2 of 7)

Characteristic Parameter	Site-Specific Value/ Characteristic	Description	SSAR Section
Meteorology and Hydrology			
Winter Precipitation		The highest ground-level weight among the: 1. 100-year return snowpack, 2. historical maximum snowpack, 3. 100-year return 2-day snowfall event, and 4. historical maximum 2-day snowfall event.	2.3.1.2.2.3
Normal Winter Precipitation Event	24.4 psf (119 kg/m^2)		
Extreme Frozen Winter Precipitation Event	15.8 psf (77.2 kg/m^2)	The highest ground-level weight between the: 1. 100-year return 2-day snowfall event, and 2. historical maximum 2-day snowfall event.	2.3.1.2.2.4
Extreme Liquid Winter Precipitation Event (48-hour Probable Maximum Winter Precipitation [PMWP])	23 in. (0.58 m)	The extreme liquid winter precipitation event is defined as the greatest depth of precipitation for a 48-hr period that is physically possible over a 25.9 square kilometer (10 square mile) area.	2.3.1.2.2.5
Maximum Rainfall Rate	18.8 in/hr (0.478 m/h) 6.2 in/5-min (0.158 m/5-min)	PMP for 1-hour and for 5-minute durations at the Project site.	2.4.2.3.1
Maximum Flood	747.86 ft. (227.95 m)	Maximum flood level from combined effects PMP and wind waves.	2.4.2.2

Table 2.0-1
Site Characteristics
(Sheet 3 of 7)

Characteristic Parameter	Site-Specific Value/ Characteristic	Description	SSAR Section
Maximum Groundwater	810 ft. (247 m)	Maximum groundwater level under foundation structures in power block area.	2.4.12.2.6
Travel Time for Groundwater Flow	Maximum – 28 years Minimum – 35 days	Groundwater travel time from power block area to potential receptor.	2.4.12.6
Travel Time for Radionuclide Transport in the Groundwater	Maximum – greater than 1000 years Minimum – 35 days	Radionuclide transport time in groundwater.	2.4.13.1
100-Year Return Period 3-Second Gust Wind Speed	93 mph (42 m/s)	100-Year Return Period 3-Second Gust Wind Speed.	2.3.1.2.1.2
Historical Maximum Wind Speeds	69 mph (111 km/h) 115 mph (185 km/h)	Maximum recorded win speed (non-thunderstorm). Maximum recorded wind speed (thunderstorm).	2.3.1.2.1.2
Design-Basis Hurricane Windspeed	160 mph (258 km/h)	The 3-second gust wind velocity at 33 ft (10 m) above ground level (AGL) in the site area, corresponding to a hurricane wind event with a 10^{-7} annual exceedance probability. The site-specific value is determined from the windspeed contour maps presented in Regulatory Guide (RG) 1.221.	2.3.1.2.1.5
Design Basis Tornado			2.3.1.2.1.4
Maximum Pressure Drop	1.2 psi (83 mb)	Decrease in ambient pressure from normal atmospheric pressure due to passage of a tornado.	

Table 2.0-1
Site Characteristics
(Sheet 4 of 7)

Characteristic Parameter	Site-Specific Value/ Characteristic	Description	SSAR Section
Maximum Rotational Speed	184 mph (82 m/s)	Rotation component of maximum wind speed due to passage of a tornado.	2.3.1.2.1.4
Maximum Translational Speed	46 mph (21 m/s)	Translation component of maximum wind speed due to the movement of a tornado across the ground.	2.3.1.2.1.4
Maximum Wind Speed	230 mph (103 m/s)	Sum of the maximum rotational and translational wind speed components due to passage of a tornado.	2.3.1.2.1.4
Radius of Maximum Rotational Speed	150 ft. (45.7 m)	Distance from the center of the tornado at which the maximum rotational wind speed occurs.	2.3.1.2.1.4
Maximum Rate of Pressure Drop	0.5 psi/s (37 mb/s)	Maximum rate of pressure drop at site due to passage of a tornado.	2.3.1.2.1.4
Site Characteristics Ambient Air Temperature Dry Bulb Temperature (DBT)		DBT parameters used in establishing design capacity and performance requirements for heat removal systems.	2.3.1.2.1.4
0.4% Annual Exceedance (Mean Coincident WBT)	92.4˚F (33.6˚C) 74.0˚F (23.3˚C)		
1% Annual Exceedance (Mean Coincident WBT)	90.3˚F (32.4˚C) 73.5˚F (23.1˚C)		
2% Annual Exceedance (Mean Coincident WBT)	88.2˚F (31.2˚C) 72.9˚F (22.7˚C)		
Mean	58.3˚F (14.6˚C)		
Minimum Mean	11.4˚F (-11.4˚C)		

Table 2.0-1
Site Characteristics
(Sheet 5 of 7)

Characteristic Parameter	Site-Specific Value/ Characteristic	Description	SSAR Section
Wet Bulb Temperature (WBT)		WBT parameters used in establishing design capacity and performance requirements for heat removal systems.	2.3.2.3
0.4% Annual Exceedance	77.0˚F (25.0˚C)		
1% Annual Exceedance	75.8˚F (24.3˚C)		
Mean	50.1˚F (10.1˚C)		
Minimum Mean	9.3˚F (-12.6˚C)		
Atmospheric Dispersion (χ/Q) (Accident)		Atmospheric dispersion coefficients used in safety analyses to estimate dose consequences of accident airborne releases. For the technologies under consideration, the EAB and LPZ boundaries are equivalent.	2.3.4
0-2 hr. @ EAB	1.78E-03 s/m^3		
0-8 hr. @ LPZ	1.33E-03 s/m^3		
8-24 hr. @ LPZ	1.15E-03 s/m^3		
1-4 day @ LPZ	8.42E-04 s/m^3		
4-30 day @ LPZ	5.37E-04 s/m^3		
Atmospheric Dispersion (χ/Q) (Annual Average)	Refer to Table 2.3-57 Table 2.3-58 Table 2.3-59 Table 2.3-60	Atmospheric dispersion coefficient used in the safety analysis for the dose consequences of normal airborne releases.	2.3.5
Gaseous Releases			
Dose Consequences			
Normal	10 CFR 20.1301(e) 10 CFR Part 20, App. B 10 CFR Part 50, App. I 40 CFR Part 190	Estimated radiological dose consequences due to gaseous releases from normal operation of the plant.	11.3.3
Post-Accident	10 CFR 52.17(a)(1)(ix)	Estimated radiological dose consequences due to gaseous releases from postulated accidents.	15.3
Minimum Distance from Release Point to EAB	725 ft. (221 m)	Minimum lateral distance from release point to EAB.	2.3.4

Table 2.0-1
Site Characteristics
(Sheet 6 of 7)

Characteristic Parameter	Site-Specific Value/ Characteristic	Description	SSAR Section
Liquid Releases			
Dose Consequences			
Normal	10 CFR 20.1301(e) 10 CFR Part 20, App. B 10 CFR Part 50, App. I 40 CFR Part 190	Estimated radiological dose consequences due to liquid releases from normal operation of the plant.	11.2.3
Post-Accident	10 CFR 20, Appendix B, Table 2, Column 2	Estimated radiological dose consequences due to liquid releases from postulated accidents.	2.4.13
Geology, Seismology, and Geotechnical Engineering			
Ground Motion Response Spectra	Refer to Table 2.5-42 Table 2.5-49	The design response spectra used to establish a plant's seismic design.	2.5.2.6
Capable Tectonic Structures or Sources	None	The assumption made in a plant design about the presence of capable faults or earthquake sources in the vicinity of the plant site.	2.5.3
Soil Properties			
Liquefaction	None	Liquefaction potential at the site.	2.5.4
Minimum Static Bearing Capacity	14.0 kips per square foot (ksf) (670 kPa) (safety-related structures) 8.9 ksf (426 kPa) (other structures)	Allowable load-bearing capacity of layer supporting plant structures.	2.5.4
Minimum Dynamic Bearing Capacity	35 ksf (1676 kPa)	Capacity of the foundation soil/rock to resist loads imposed by the structures in the event of an earthquake.	2.5.4

Table 2.0-1
Site Characteristics
(Sheet 7 of 7)

Characteristic Parameter	Site-Specific Value/ Characteristic	Description	SSAR Section
Minimum Shear Wave Velocity	1000 ft/s (305 m/s)	The assumed limiting propagation velocity of shear waves through the foundation materials used in the plant design.	2.5.4
Minimum Soil Angle of Internal Friction	35 degrees	Design assumption for the minimum value of the internal friction angle of foundation soils, fill soils, or excavation slopes that would provide a safe design of plant through soil structure interaction analyses including sliding along the base.	2.5.4
Maximum Settlement	4 in. (10.2 cm)	The greatest vertical displacement of a structure's foundation anticipated to occur under the combined effects of static, dynamic, and operational loading conditions.	2.5.4.10
Slope Failure Potential (Y/N)	N	The potential for critical slope failure under static, hydraulic, and dynamic conditions.	2.5.5
Lateral Soil Variability (Y/N)	Y	Site investigations have been conducted to characterize the spatial (lateral) variability of soil and rock properties across the site.	2.5.4.2

Table 2.0-2
Site-Related Design Parameters
(Sheet 1 of 4)

Characteristic Parameter	Site-Specific Value	Description	SSAR Section
Structure Height	176 ft. (53.6 m)	The height from finished grade to the top of the tallest power block structure, excluding stacks and cooling towers.	3.5.1.6
Structure Foundation Embedment	125 ft. (38.1 m)	The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure.	2.4.12.2 2.4.12.5.1 2.4.12.5.3
Minimum Site Grade	810 ft. (247 m) NAVD 88	Minimum finished ground elevation in the power block area.	2.4.4
Plant Megawatts Thermal (MWt)	6250 MWt	The combined maximum thermal power generated by the Project site.	1.11
Control room air changes per hour (ACH)	2.64/hr.	The control room air exchange rate (volume changes per hour) for evaluating toxic chemical releases from nearby facilities.	2.2.2.2
Condenser Design Duty	1.32E10 BTU/hr (3869 MW)	Design value for the waste heat rejected to the circulating water system across the condensers (site total).	-

Table 2.0-2
Site-Related Design Parameters
(Sheet 2 of 4)

Characteristic Parameter	Site-Specific Value	Description	SSAR Section
Cooling Water Flow Rate	1.4E06 gpm (88.33 m³/s)	Design value for the maximum flow rate of the circulating water system through the condenser tubes (site total).	-
Maximum Inlet Temperature to Condenser	100˚F (37.8˚C)	Design assumption for the maximum acceptable circulating water temperature at the inlet to the condenser or cooling water system heat exchangers.	-
Evaporation Rate for the Facility During Normal Operation	26,256 gpm (1.66 m³/s) – normal 32,580 gpm (2.06 m³/s) – maximum	The expected (and maximum) rate at which water is lost by evaporation from the cooling water systems (site total).	-
Gaseous Releases			
Source Term (Accident)	Refer to Table 2.0-3	Bounding design basis accident atmospheric release by post-accident interval.	15.2
Source Term (Routine)	Refer to Table 2.0-4	Annual activity, by radionuclide, contained in routine plant airborne effluent streams.	11.3.3.1

Table 2.0-2
Site-Related Design Parameters
(Sheet 3 of 4)

Characteristic Parameter	Site-Specific Value	Description	SSAR Section
Release Point Elevation			
Accident	Ground Level	The elevation above finished grade of the release point for releases due to an accident.	2.3.4.2
Normal	Ground Level	The elevation above finished grade of the release point for normal effluent releases.	2.3.5.2
Liquid Releases			
Source Term (Accident)	Refer to Table 2.0-5	The assumed activity, by radionuclide, contained in accidental liquid radwaste release from postulated tank failure.	2.4.13
Source Term (Routine)	Refer to Table 2.0-6	The annual activity, by radionuclide, contained in routine plant liquid effluent streams.	11.2.3

Table 2.0-2
Site-Related Design Parameters
(Sheet 4 of 4)

Characteristic Parameter	Site-Specific Value	Description	SSAR Section
Release Point Characteristics		Liquid release point characteristics (for routine and accident releases).	
Accident	A liquid accident release is assumed to occur at ground level. Section 2.4.13 describes the release point and underlying assumptions for an accidental liquid release.		2.4.13
Routine	Routine liquid releases are controlled, monitored, and processed to ensure compliance with regulatory limits and applicable standards. Section 11.2.3 describes the release points and assumptions associated with routine liquid discharges.		11.2.3

Table 2.0-3
Design Basis Accident Atmospheric Radioactive Release (Ci)
(Sheet 1 of 2)

Nuclide	Integrated Activity Released to the Environment as a Function of Time				
	2.0 hr.	8.0 hr.	24.0 hr.	72.0 hr.	78.0 hr.
I-131	4.60E+00	1.80E+01	5.50E+01	1.60E+02	1.70E+02
I-132	4.60E+01	1.80E+02	5.50E+02	1.60E+03	1.70E+03
I-133	3.40E+01	1.40E+02	4.10E+02	1.20E+03	1.20E+03
I-134	1.30E+02	5.40E+02	1.60E+03	4.80E+03	4.90E+03
I-135	6.70E+01	2.70E+02	8.00E+02	2.40E+03	2.50E+03
Rb-89	1.30E+00	5.40E+00	1.60E+01	4.80E+01	4.90E+01
Cs-134	1.90E-02	7.80E-02	2.30E-01	7.00E-01	7.20E-01
Cs-136	1.50E-02	6.10E-02	1.80E-01	5.50E-01	5.60E-01
Cs-137	3.00E-02	1.20E-01	3.60E-01	1.10E+00	1.10E+00
Cs-138	1.40E+00	5.80E+00	1.70E+01	5.20E+01	5.30E+01
Ba-137m	3.00E-02	1.20E-01	3.60E-01	1.10E+00	1.10E+00
H-3	9.90E-02	3.90E-01	1.20E+00	3.60E+00	3.60E+00
Na-24	2.90E-03	1.20E-02	3.50E-02	1.00E-01	1.10E-01
P-32	1.20E-04	4.70E-04	1.40E-03	4.20E-03	4.30E-03
Cr-51	2.80E-03	1.10E-02	3.40E-02	1.00E-01	1.00E-01
Mn-54	1.40E-03	5.60E-03	1.70E-02	5.10E-02	5.20E-02
Mn-56	5.30E-03	2.10E-02	6.30E-02	1.90E-01	2.00E-01
Fe-55	2.90E-03	1.20E-02	3.50E-02	1.10E-01	1.10E-01
Fe-59	7.70E-04	3.10E-03	9.30E-03	2.80E-02	2.90E-02
Co-58	6.70E-04	2.70E-03	8.00E-03	2.40E-02	2.50E-02
Co-60	1.30E-03	5.20E-03	1.60E-02	4.70E-02	4.80E-02
Ni-63	2.90E-06	1.20E-05	3.50E-05	1.10E-04	1.10E-04
Cu-64	1.40E-02	5.50E-02	1.60E-01	4.90E-01	5.10E-01
Zn-65	6.00E-04	2.40E-03	7.20E-03	2.20E-02	2.20E-02
Sr-89	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Sr-90	1.10E-04	4.40E-04	1.30E-03	3.90E-03	4.00E-03
Y-90	1.10E-04	4.40E-04	1.30E-03	3.90E-03	4.00E-03
Sr-91	1.30E+00	5.20E+00	1.60E+01	4.70E+01	4.80E+01
Sr-92	2.80E+00	1.10E+01	3.40E+01	1.00E+02	1.00E+02
Y-91	2.90E-02	1.10E-01	3.40E-01	1.00E+00	1.10E+00
Y-92	8.80E-01	3.50E+00	1.10E+01	3.20E+01	3.30E+01
Y-93	9.50E-02	3.80E-01	1.10E+00	3.40E+00	3.50E+00

Table 2.0-3
Design Basis Accident Atmospheric Radioactive Release (Ci)
(Sheet 2 of 2)

Nuclide	Integrated Activity Released to the Environment as a Function of Time				
	2.0 hr.	8.0 hr.	24.0 hr.	72.0 hr.	78.0 hr.
Zr-95	6.00E-02	2.40E-01	7.20E-01	2.20E+00	2.20E+00
Nb-95	6.00E-02	2.40E-01	7.20E-01	2.20E+00	2.20E+00
Mo-99	2.80E-01	1.10E+00	3.30E+00	1.00E+01	1.00E+01
Tc-99m	2.80E-01	1.10E+00	3.30E+00	1.00E+01	1.00E+01
Ru-103	1.40E-02	5.80E-02	1.70E-01	5.20E-01	5.30E-01
Rh-103m	1.40E-02	5.80E-02	1.70E-01	5.20E-01	5.30E-01
Ru-106	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Rh-106	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Ag-110m	2.90E-06	1.20E-05	3.50E-05	1.10E-04	1.10E-04
Te-129m	2.90E-02	1.10E-01	3.40E-01	1.00E+00	1.10E+00
Te-131m	3.90E-02	1.60E-01	4.70E-01	1.40E+00	1.40E+00
Te-132	6.70E-03	2.70E-02	8.00E-02	2.40E-01	2.50E-01
Ba-140	3.00E-01	1.20E+00	3.60E+00	1.10E+01	1.10E+01
La-140	3.00E-01	1.20E+00	3.60E+00	1.10E+01	1.10E+01
Ce-141	1.40E-02	5.80E-02	1.70E-01	5.20E-01	5.30E-01
Ce-144	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Pr-144	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
W-187	6.70E-04	2.70E-03	8.00E-03	2.40E-02	2.50E-02
Np-239	2.30E-01	9.20E-01	2.70E+00	8.20E+00	8.50E+00

Table 2.0-4
Bounding Normal Gaseous Radioactive Release (Ci/yr)

Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/year)
Ag-110	8.02E-05	I-135	7.52E-01	Sb-129	7.38E-09
Ag-110m	6.00E-05	Kr-83m	4.87E+01	Se-75	6.00E-05
Am-241	6.00E-05	Kr-85	3.62E+02	Sr-89	5.64E-05
Ar-41	2.04E+02	Kr-85m	5.37E+00	Sr-90	2.22E-05
As-76	6.00E-05	Kr-87	1.65E+01	Sr-91	2.73E-04
Ba-137m	4.98E-05	Kr-88	1.80E+01	Sr-92	1.66E-04
Ba-139	1.01E-07	Kr-89	7.71E+01	Tc-99	2.48E-09
Ba-140	1.15E-03	La-140	2.66E-04	Tc-99m	3.64E-05
Br-82	4.16E-06	La-141	3.12E-08	Te-125m	2.02E-07
Br-83	2.38E-05	La-142	1.49E-08	Te-127	2.70E-05
Br-84	1.10E-05	Mn-54	1.89E-03	Te-127m	7.70E-07
Br-85	1.32E-06	Mn-56	7.32E-05	Te-129	2.86E-06
C-14	6.51E+01	Mo-99	4.22E-04	Te-129m	1.36E-04
Ce-141	7.35E-05	Mo-101	4.22E-06	Te-131	3.08E-06
Ce-143	6.72E-08	Na-24	2.32E-04	Te-131m	2.44E-05
Ce-144	6.00E-05	Nb-95	2.89E-04	Te-132	6.00E-05
Co-57	4.92E-07	Ni-63	3.98E-06	Te-133m	3.82E-06
Co-58	8.46E-04	Np-239	2.86E-04	Te-134	5.42E-06
Co-60	1.77E-03	P-32	1.12E-04	W-187	8.53E-05
Cr-51	3.19E-03	Pr-143	8.72E-08	Xe-131m	5.40E+01
Cs-132	8.66E-08	Pr-144	1.36E-08	Xe-133	2.57E+02
Cs-134	1.07E-04	Pu-238	6.00E-05	Xe-133m	1.86E-01
Cs-135m	3.52E-07	Pu-239	6.00E-05	Xe-135	2.00E+02
Cs-136	5.95E-05	Rb-86	4.60E-06	Xe-135m	9.75E+01
Cs-137	1.67E-04	Rb-86m	4.90E-10	Xe-137	1.88E+01
Cs-138	1.79E-05	Rb-88	5.00E-04	Xe-138	1.91E+02
Cu-64	9.37E-04	Rb-89	7.17E-06	Y-90	1.43E-07
Fe-55	3.96E-03	Rh-103m	3.01E-07	Y-91	1.45E-04
Fe-59	9.39E-04	Rh-105	7.66E-08	Y-91m	1.04E-07
H-3	1.57E+02	Rh-106	1.67E-06	Y-92	6.70E-05
I-129	6.00E-05	Ru-103	7.31E-05	Y-93	2.12E-05
I-130	3.38E-05	Ru-105	3.52E-08	Zn-65	8.01E-04
I-131	8.48E-02	Ru-106	6.00E-05	Zr-95	3.05E-04
I-132	5.00E-01	Sb-124	6.00E-05	Zr-97	6.30E-08
I-133	3.92E-01	Sb-125	6.00E-05	**Total**	**1.77E+03**
I-134	1.41E+00	Sb-127	6.70E-09		

Table 2.0-5
Estimated Liquid Radwaste Activities by Technology
(Sheet 1 of 3)

TerraPower			
Isotope	**TerraPower Activity Bq**	**TerraPower Activity Ci (Concentration times 3200 gallons in tank)**	**TerraPower Effluent Concentration µCi/ml**
Am-241	1.77E+01	4.78E-10	3.95E-11
Ba-137m	2.80E+04	7.57E-07	6.25E-08
Ce-144	2.91E+03	7.87E-08	6.50E-09
Cs-134	1.41E+07	3.80E-04	3.14E-05
Cs-137	1.48E+08	4.00E-03	3.30E-04
I-129	6.27E+01	1.70E-09	1.40E-10
Pr-144	2.91E+03	7.87E-08	6.50E-09
Pr-144m	2.77E+01	7.50E-10	6.19E-11
Pu-238	9.14E+02	2.47E-08	2.04E-09
Pu-239	3.20E+02	8.66E-09	7.15E-10
Pu-240	1.27E+02	3.44E-09	2.84E-10
Pu-241	2.05E+03	5.54E-08	4.57E-09
Rh-106	2.48E+03	6.70E-08	5.53E-09
Ru-106	2.47E+03	6.69E-08	5.52E-09
Sb-125	6.81E+04	1.84E-06	1.52E-07
Sr-90	2.14E+04	5.79E-07	4.78E-08
Te-125m	9.55E+02	2.58E-08	2.13E-09
Te-129	3.82E-02	1.03E-12	8.53E-14
Te-129m	4.21E+01	1.14E-09	9.39E-11
Y-90	2.14E+04	5.79E-07	4.78E-08
X-energy			
Isotope	**X-energy Activity Bq**	**X-energy Activity Ci**	**X-energy Concentration Ci/ml (for 883 gallons)**
Ag-110m	9.13E+10	2.47E+00	7.38E-07
Ba-137m	7.24E+10	1.96E+00	5.85E-07
Ba-140	2.47E+09	6.68E-02	2.00E-08
Cs-134	1.67E+11	4.51E+00	1.35E-06
Cs-137	1.05E+11	2.84E+00	8.49E-07
I-131	1.08E+10	2.92E-01	8.73E-08
La-140	2.47E+09	6.68E-02	2.00E-08

Table 2.0-5
Estimated Liquid Radwaste Activities by Technology
(Sheet 2 of 3)

Westinghouse Electric Company (WEC)			
Isotope	**WEC Activity Bq**	**WEC Activity Ci**	**WEC Concentration Ci/ml (for 10,000 gallons)**
H-3	1.92E+12	5.20E+01	1.37E+00
Cr-51	2.49E+09	6.74E-02	1.78E-03
Mn-54	1.29E+09	3.49E-02	9.22E-04
Mn-56	3.27E+11	8.85E+00	2.34E-01
Fe-55	9.62E+08	2.60E-02	6.87E-04
Fe-59	2.49E+08	6.74E-03	1.78E-04
Co-58	3.66E+09	9.88E-02	2.61E-03
Co-60	4.22E+08	1.14E-02	3.01E-04
Br-83	2.95E+10	7.98E-01	2.11E-02
Br-84	1.57E+10	4.24E-01	1.12E-02
Br-85	1.85E+09	4.99E-02	1.32E-03
Rb-88	1.38E+12	3.74E+01	9.88E-01
Rb-89	6.36E+10	1.72E+00	4.54E-02
Sr-89	1.01E+09	2.74E-02	7.24E-04
Sr-90	4.55E+07	1.23E-03	3.25E-05
Sr-91	1.57E+09	4.24E-02	1.12E-03
Sr-92	3.77E+08	1.02E-02	2.69E-04
Y-90	1.20E+07	3.24E-04	8.56E-06
Y-91m	8.51E+08	2.30E-02	6.08E-04
Y-91	1.30E+08	3.50E-03	9.25E-05
Y-92	3.14E+08	8.49E-03	2.24E-04
Y-93	1.01E+08	2.74E-03	7.24E-05
Nb-95	1.48E+08	3.99E-03	1.05E-04
Mo-99	1.94E+11	5.25E+00	1.39E-01
Tc-99m	1.85E+11	4.99E+00	1.32E-01
Ru-103	1.30E+08	3.50E-03	9.25E-05
Rh-103m	1.30E+08	3.50E-03	9.25E-05
Rh-106	4.14E+07	1.12E-03	2.96E-05
Ag-110m	3.70E+08	9.99E-03	2.64E-04
Te-127m	6.99E+08	1.89E-02	4.99E-04
Te-129m	2.40E+09	6.49E-02	1.71E-03
Te-129	3.50E+09	9.47E-02	2.50E-03
Te-131m	6.18E+09	1.67E-01	4.41E-03
Te-131	3.96E+09	1.07E-01	2.83E-09

Table 2.0-5
Estimated Liquid Radwaste Activities by Technology
(Sheet 3 of 3)

Westinghouse Electric Company (WEC)			
Isotope	**WEC Activity Bq**	**WEC Activity Ci**	**WEC Concentration Ci/ml**
Te-132	7.29E+10	1.97E+00	5.20E-02
Te-134	1.01E+10	2.74E-01	7.24E-03
I-129	1.38E+04	3.74E-07	9.88E-09
I-130	1.01E+10	2.74E-01	7.24E-03
I-131	6.55E+11	1.77E+01	4.68E-01
I-132	8.70E+11	2.35E+01	6.21E-01
I-133	1.20E+12	3.24E+01	8.56E-01
I-134	2.04E+11	5.51E+00	1.46E-01
I-135	7.22E+11	1.95E+01	5.15E-01
Cs-134	6.36E+11	1.72E+01	4.54E-01
Cs-136	9.25E+11	2.50E+01	6.60E-01
Cs-137	4.63E+11	1.25E+01	3.30E-01
Cs-138	3.41E+11	9.21E+00	2.43E-01
Ba-137m	4.33E+11	1.17E+01	3.09E-01
Ba-140	9.25E+08	2.50E-02	6.60E-04
La-140	2.86E+08	7.72E-03	2.04E-04
Ce-141	1.48E+08	3.99E-03	1.05E-04
Ce-143	1.30E+08	3.50E-03	9.25E-05
Pr-143	1.38E+08	3.74E-03	9.88E-05
Ce-144	1.11E+08	3.00E-03	7.93E-05
Pr-144	1.11E+08	3.00E-03	7.93E-05
Zr-95	1.48E+08	3.99E-03	1.05E-04

Key: Ci = Curies; m = metastable isotope; 1 Bq = 2.7027E-11 Ci; µCi/ml = microCuries per milliliter

Table 2.0-6
Bounding Normal Liquid Release (Ci/yr)

Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)
Ag-110	1.20E-04	I-132	9.00E-04	Sb-124	6.00E-05
Ag-110m	9.00E-04	I-133	1.14E-02	Sb-125	6.00E-05
Am-241	6.00E-05	I-134	6.00E-05	Sb-127	5.84E-09
As-76	6.00E-05	I-135	5.16E-03	Sb-129	2.12E-07
Ba-137m	7.20E-04	La-140	1.20E-03	Se-75	6.00E-05
Ba-139	1.32E-03	La-141	1.26E-21	Sr-89	3.00E-04
Ba-140	2.94E-02	La-142	1.08E-03	Sr-90	6.00E-05
Br-82	1.57E-07	Mn-54	3.90E-02	Sr-91	1.20E-02
Br-83	4.02E-03	Mn-56	1.20E-03	Sr-92	2.88E-03
Br-84	6.00E-05	Mo-99	1.68E-02	Tc-99	1.16E-08
Br-85	1.41E-05	Mo-101	1.62E-04	Tc-99m	1.68E-02
C-14	6.00E-05	Na-24	1.14E-02	Te-123m	6.00E-05
Ce-141	1.98E-03	Nb-95	7.20E-03	Te-125m	8.38E-07
Ce-143	9.60E-04	Nb-98	6.00E-05	Te-127	3.30E-06
Ce-144	2.82E-03	Nd-147	2.40E-04	Te-127m	3.38E-06
Cm-242	6.00E-05	Ni-63	1.86E-02	Te-129	1.80E-04
Cm-244	6.00E-05	Ni-65	2.40E-04	Te-129m	3.00E-03
Co-57	6.00E-05	Np-239	1.26E-02	Te-131	1.26E-03
Co-58	2.04E-02	P-32	2.82E-03	Te-131m	1.20E-04
Co-60	3.96E-02	Pr-143	3.54E-03	Te-132	4.20E-04
Cr-51	7.20E-02	Pr-144	2.82E-03	Te-133m	1.50E-04
Cs-132	5.16E-06	Pu-238	6.00E-05	Te-134	2.07E-04
Cs-134	1.38E-02	Pu-239	6.00E-05	W-187	4.44E-03
Cs-135m	7.20E-07	Pu-240	6.00E-05	Y-90	3.00E-07
Cs-136	7.80E-03	Pu-241	6.00E-05	Y-91	4.02E-03
Cs-137	2.10E-02	Rb-86	5.76E-04	Y-91m	6.00E-05
Cs-138	1.78E-03	Rb-86m	5.66E-09	Y-92	9.00E-03
Cu-64	4.44E-02	Rb-88	6.00E-05	Y-93	9.60E-04
Fe-55	8.40E-02	Rb-89	2.44E-04	Zn-65	1.62E-02
Fe-59	2.10E-02	Rh-103m	4.62E-03	Zn-69m	2.52E-02
H-3	1.62E+03	Rh-105	6.30E-09	Zr-95	6.60E-03
Hf-181	6.00E-05	Rh-106	1.50E-03	Zr-97	1.20E-04
I-129	1.25E-10	Ru-103	4.62E-03		
I-130	1.76E-09	Ru-105	4.74E-03	**Total**	**1.62E+03**
I-131	6.60E-03	Ru-106	2.88E-03		

2.1 GEOGRAPHY AND DEMOGRAPHY

This section of the SSAR identifies the Project site location and describes the distribution of infrastructure, natural features, and population in the vicinity of the Project site. This section also identifies the proposed exclusion area boundary (EAB) for each Plant Complex planned for the Project site and establishes Duke Energy's authority to determine the activities within these areas. The discussion addresses the guidance in NUREG-0800.

2.1.1 SITE LOCATION AND DESCRIPTION

2.1.1.1 Specification of Site Location

As illustrated in Figure 2.1-1, the proposed Project site is located primarily in Sauratown Township, in the Southeastern corner of Stokes County, NC, with a small portion in Belews Creek Township, Forsyth County, NC. As discussed in Section 1.2.2, Duke Energy Carolinas, LLC (Duke Energy), a wholly-owned subsidiary of Duke Energy Corporation, proposes to construct and operate multiple advanced reactors on one to three Plant Complexes planned for the Project site. All proposed nuclear units (all three Plant Complexes) are to reside in Stokes County. The Project site, adjacent to Belews Lake, is approximately 14 miles (mi.) (23 kilometers [km]) northeast of Winston-Salem, NC, and approximately 19 mi. (31 km) northwest of Greensboro, NC. Political subdivisions and prominent natural and man-made features, including rivers, lakes, industrial, and transportation facilities in the vicinity of the site and surrounding area are illustrated in Figures 2.1-1 through 2.1-4. Figure 2.1-5 depicts the general layout of the Project site. The total site area is approximately 1187 acres (ac.) (480 hectares [ha]).

The Project site center point coordinates are:

Universal Transverse Mercator (UTM) Coordinates

UTM Zone	17N
Northing	4,014,636.73 meters (m)
Easting	584,805.45 m

Latitude/Longitude [Deg/Min/Sec]

Latitude	36° 16' 22.62" N
Longitude	80° 03' 20.88" W

The Project site is owned by Duke Energy and is bounded on the north, east, and west by Belews Lake, also owned by Duke Energy. Belews Lake was constructed in the early 1970s by Duke Energy as a cooling reservoir for the Belews Creek Steam Station (BCSS), a two-unit, 2220-megawatt (MW) fossil fuel plant located adjacent to the Project site that has been in operation since 1974. The BCSS cooling system is classified as closed-cycle and utilizes once-through cooling, with water supplied by and discharged back into Belews Lake during plant

operation. In 2020 and 2021, natural gas was added to the station to allow up to 50 percent natural gas co-firing on both units. An existing pumping station can transfer makeup water from the nearby Dan River into Belews Lake to maintain the reservoir level.

The BCSS is the only industrial facility within the immediate vicinity of the Project site. There are no significant commercial or recreational structures or features within the immediate vicinity of the Project site, with the exception of Belews Lake.

2.1.1.2 Site Area Description and Site Map

Figure 2.1-5 shows the general layout of the Project site. As discussed above, the Project site is separated into three Plant Complexes. The three Plant Complexes are designated as the North, Middle, and South Plant Complexes. The power block areas shown in the figure represent composite footprints based on the technologies and number of units being considered for each Plant Complex. The figure also shows the potential locations of the Project site switchyard, cooling towers, cooling tower makeup intake, and the planned discharge location of other station liquid effluents. The temporary laydown areas depicted may be repurposed following construction for site support buildings, material storage, parking areas, or be restored. The proposed EAB developed for each Plant Complex planned for the Project site are also shown on Figure 2.1-5. The distance from each plant feature to its respective EAB can be estimated using the graphic scale provided on the figure.

Figures 2.1-1 through 2.1-4 show the proximity of the site to highways, railroads, and waterways in the vicinity of the Project site. Figures 2.1-2 and 2.1-3 show the location of the Project site with respect to the surrounding municipalities within a 6-mi. (10-km) and 50-mi. (80-km) radius, respectively. Access to the project site is available by road using the Duke Power Steam Plant Road (Rd), via Pine Hall Rd, or using Craig Rd, via State Highway 65.

As discussed further in Section 2.2.2.6 and shown in Figure 2.1-2, there is a Norfolk Southern (NS) rail line that runs within approximately 1.5 mi. (2.4 km) of the site, with a spur that serves the BCSS and the proposed Project site. Figure 2.1-4 identifies the principal transportation means including major airports, highways, and railways in the Project site region. The area is served by the Smith Reynolds Airport (Winston-Salem, NC) and the Piedmont Triad International Airport (Greensboro, NC).

The Project site has nearby access to 230 kV transmission lines. Three double-circuit 230 kV transmission lines cross the Project site. Duke Energy Corporation owns and operates the lines.

2.1.2 EXCLUSION AREA AUTHORITY AND CONTROL

2.1.2.1 Authority

As discussed in Section 2.1.1.1 and shown in Figure 2.1-5, the Project site is approximately 1187 ac. (480 ha) and situated on a peninsula that extends into Belews Lake. As shown in Figure 2.1-6, Duke Energy, the applicant for the ESP, owns the Project site, Belews Lake, and all the land within and immediately adjacent to Belews Lake. That ownership also includes the

mineral rights to those properties. Figure 2.1-5 shows the proposed EAB for each Plant Complex proposed for the Project site. The proposed EABs reside, in their entirety, within the property owned and controlled by Duke Energy. Duke Energy grants shoreline access leases to property owners adjacent to Belews Lake to enable their access to the lake.

As shown in Figures 2.1-2 and 2.1-5, there are no public transportation routes traversing the Project site or exclusion areas.

There are no mineral resources, including oil and natural gas being exploited within or adjacent to the site.

Duke Energy holds existing easements for transmission lines and a natural gas pipeline that traverse the Project site. These easements are illustrated in Figure 2.1-1 of the Environmental Report. The transmission lines are owned and operated by Duke Energy, and the gas line is owned and operated by the Piedmont Natural Gas Company, a Duke Energy business unit. Accordingly, while these easements pass through the North Plant Complex EAB, they do not impact Duke Energy's authority to control access to the Project site and determine activities within any of the three Plant Complex exclusion areas.

2.1.2.2 Control of Activities Unrelated to Plant Operation

As shown in Figure 2.1-5, there are no residences or commercial activities within the proposed EABs. As owner of the land within the EABs, Duke Energy determines all activities within the exclusion areas and has the authority to exclude and remove personnel and property from the area and prohibit recreational activities within the areas. As discussed above, there are no public highways or active railroads that traverse the exclusion areas.

The owner-controlled area for the Project site will be determined during the development of the physical security plan in support of the construction permit or license application. The owner-controlled area will include physical barriers as needed to satisfy the physical protection program design requirements of 10 CFR 73.55(b). The owner-controlled area is to be clearly posted with "no trespassing" signs along its border over land. Where the EABs extend over Belews Lake, Duke Energy plans to install buoys or other suitable barriers to demarcate the EABs in this area and provide notification to recreational users of the lake that crossing the boundary is prohibited. All road access points to the Project site will be controlled. Once inside the owner-controlled area, access to the nuclear plant will be controlled with security checkpoints and barriers. The site's physical security plan contains information on actions to be taken by security force personnel in the event of unauthorized persons crossing an EAB by land or water. The permanent population distribution within the EAB is zero.

An existing historic cemetery located on the Project site within the Middle Plant Complex will require relocation to a suitable off-site location.

2.1.2.3 Arrangements for Traffic Control

Arrangements for control of traffic in the event of an emergency are not required in that no

publicly used transportation routes cross the EABs.

2.1.2.4 Abandonment or Relocation of Roads

There are no public roads within the exclusion area (see Figure 2.1-5).

2.1.3 POPULATION DISTRIBUTION

This section provides a description of the current and projected population distribution in and around the Project site. The current population distribution surrounding the Project site was estimated based on the year 2020 United States (U.S.) Census Bureau (USCB) decennial census data (Reference 2.1-4). Population projections were developed for 2024, 2030 (the estimated construction start date), 2034 (the estimated year of plant approval), 2039 (five years following plant approval), 2049, 2059, 2069, and 2079 by calculating annualized growth rates using county population projection estimates employing data from the North Carolina Office of State Budget and Management (NCOSBM) and the University of Virginia Weldon Cooper Center for Public Service as the base (References 2.1-2, 2.1-3).

As shown in Figure 2.1-7 and Figure 2.1-8, the population distribution is described for an area extending from a one (1) mile (mi.) site bounding limit – defined by a circle centered on the preliminary Project site center point with a radius of 5280 feet (ft.) (1609.34 meters [m]) or 1.0 mi. (1.2 km) – to a concentric circle with a 50-mi. (80.5-km) radius from the Project site bounding limit. The population is estimated in 15 concentric distance bands at incremental distances from the site bounding limit and in 16 wedge-shaped directional sectors, with each sector measuring 22.5 degrees. Table 2.1-1 and Table 2.1-2 summarize the distance bands and directional sectors utilized in estimating the population distribution. Figure 2.1-7 and Figure 2.1-8 present the distance bands and directional sectors surrounding the Project site.

2.1.3.1 Resident Population

The population distribution within 50 mi. (80 km) of the Project site was computed by overlaying the 2020 USCB block group data on the grid of segments shown in Figure 2.1-7 and Figure 2.1-8 and summing the population of the block group(s) within, or partially intersecting, each segment. The ArcGIS Pro geoprocessing tool “tabulate intersection” was used to calculate overlapping areas (Reference 2.1-1). To prepare for the tabulate intersection function, individual distance and direction segment and block group areas were first calculated in ArcGIS Pro. The tabulate intersection tool was used to calculate the overlapping area of each block group-segment intersection. This value was used to calculate the proportion of the USCB 2020 Census block group population within the individual segment, assuming block group populations are spread uniformly across the block group area. The block group populations in the segment were grouped and summed to calculate a total segment population. Calculations of the proportional value and the segment population calculations were performed in Microsoft Excel.

Population projections were produced for the 26 counties and two independent cities within NC and Virgina (VA) identified as wholly or partially intersecting the 50-mi. (80.5-km) radius surrounding the Project site bounding limit. Projected annual growth rates for the identified

counties and independent cities were calculated using county population estimates from the USCB 2020 Census as the base year and the projected population growth rates from the NCOSBM and the University of Virginia Weldon Cooper Center for Public Service datasets. The projected annual growth rates were then applied to the 2020 segment populations to project forward through the construction and operational licensing period of the Project site.

2.1.3.1.1 Resident Population within 20 Miles

Figure 2.1-7 shows the general locations of the municipalities and other features within 20 mi. (32.2 km) of the Project site. According to the 2020 Census, the City of Greensboro, with a population of 299,035, is the largest municipality within 20 mi. (32.2 km) of the site (Reference 2.1-4). The closest municipality to the site is Stokesdale, a community with a 2020 Census population of 5924, located approximately 1.6 mi. (2.6 km) southeast of the Project site (Reference 2.1-4).

In 2020, the residential population within 5 mi. (8.0 km), from 5 – 10 mi. (8 – 16.1 km), and from 10 – 20 mi. (16.1 – 32.2 km) of the Project site was 16,951, 74,442, and 675,829, respectively (Table 2.1-3). Figure 2.1-9 illustrates the 2020 population within 20 mi. (32.2 km). Population projections for the years 2024 through 2079 are summarized in Table 2.1-3. Distance and directional segment population estimates for 2020, 2024, 2030, 2034, 2039, and 2079 are included in Figures 2.1-9 through Figure 2.1-14.

2.1.3.1.2 Resident Population Between 20 and 50 Miles

As detailed in Section 2.1.3.1, the 50-mi. (80.5-km) radius around the Project site includes all or parts of 26 counties and two independent cities in NC and VA (Figure 2.1-8). Estimates of the 2020 resident population and projected populations for 2024, 2030, 2034, 2039, and 2079 for the area between 20 (32.2 km) and 50 mi. (80.5 km) from the Project site are shown in Figure 2.1-15 through Figure 2.1-20. The total area resident population and projections between zero and 50 mi. (80.5 km) are summarized in Table 2.1-4.

2.1.3.2 Transient Population

2.1.3.2.1 Transient Population within 20 Miles

While the Project site is in a relatively rural area, the 20 mi. (32.2 km) region surrounding the site contains a significant transient population associated with the Piedmont metropolitan area. The cities of Greensboro, High Point, and Winston-Salem anchor the Piedmont metropolitan area (Piedmont Triad). Data on significant transient population sources within 20 mi. (32.2 km) of the Project site were collected from a variety of public sources to estimate current and projected populations associated with major employers, schools, medical facilities, lodging facilities, and recreational areas and venues. The area's transient population also includes several regional airports and detention facilities.

Outdoor recreation is an important recreational pastime in the Piedmont Triad metropolitan area and a large draw for transient population into the region. The 20 mi. (32.2 km) area contains

multiple state and county parks, as well as community centers and historic places, athletic complexes, and other outdoor activities associated with the region's various lakes and rivers. Projects in development like Forsyth County's Belews Lake Park, Piedmont Land Conservancy's Shoebuckle Tract (recently acquired by the NC Forest Service and will be known by the Dan River Educational State Forest), and VA's Mayo State Park indicate that recreational land use, already widespread, is of increasing importance in the region.

The urban areas of Winston-Salem and Greensboro provide many opportunities for employment at large facilities. While many employees of these facilities are likely to be area residents, others are likely to commute from outside the region. Major regional medical facilities and multiple residential colleges and universities are also found in Winston-Salem and Greensboro.

Transient visitor data was gathered through publicly available information such as government and corporate websites, federal databases, tourism sites, and aggregators of service provider records for the region. Raw transient population estimates were weighted according to the length of time each population group was expected to be in the 20 mi. (32.2 km) area. Weighted transient population estimates were rounded to the nearest whole number to avoid estimating a fraction of a person. The transient population estimates were assumed to be reflective of 2020. Projected transient populations were computed with the same methodology used to develop the resident population projections.

Table 2.1-5 summarizes the unweighted and weighted transient population estimates by facility type within 20 mi. (32.2 km) of the site.

2.1.3.2.2 Transient Population Between 20 and 50 Miles

Airports, residential schools, detention facilities, hospitals, major recreation areas, and large events and venues are located between 20 and 50 mi. (32.2 to 80.5 km) from the Project site. Within the 20 to 50 mi. (32.2 to 80.5 km) area, there are 41 significant events and attractions identified that may contribute to over 700,000 daily visitors to the larger region. Notably, the Piedmont Triad metropolitan area hosts the Carolina Classic Fair, which averages 325,000 visitors each year (Reference 2.1-5). Significant sources of transient population in this area were noted but not added to segment populations in the 20 to 50 mi. (32.2 to 80.5 km) area. Table 2.1-6 details known transient facilities and attractions with their capacity and attendance estimates between the 20 and 50 mi. (32.2 and 80.5 km) area.

2.1.3.2.3 Total Resident and Transient Population

The estimated 2020 resident and weighted transient population values were combined and then projected to obtain an estimate of the total population surrounding the Project site. All estimates were rounded to the nearest whole number to avoid estimating a fraction of a person. Table 2.1-7 displays the combined resident and weighted transient population within 20 mi. (32.2 km) of the Project site for 2020 through 2079. Figure 2.1-9 through Figure 2.1-14 show the combined resident and weighted transient populations within 20 mi. (32.2 km) of the Project site for 2020, 2024, 2030, 2034, 2039, and 2079.

2.1.3.3 Exclusion Area and Low Population Zone

As discussed in Section 2.1.1.2, an EAB has been developed for each Plant Complex proposed for the Project site. An EAB has been developed based on the technologies being considered for each Plant Complex, and the associated number of units for each technology being considered for each Plant Complex. For the Project site, the EAB for each Plant Complex also represent the Low Population Zones (LPZs) established for each Plant Complex. Figure 2.1-5 shows the Plant Complexes, planned site features, and the EAB for each Plant Complex. As shown in Figure 2.1-5, there are no resident or transient populations existing within the EABs and LPZs. Desktop reconnaissance of aerial imagery confirmed that no housing structures are located within the EAB and LPZ. No facilities or other attractions, including schools, parks, hospitals, or prisons, were identified in the EAB and LPZ that would attract additional transient populations. The nearest transient facilities to the Project site within one (1) mi. (1.6 km) of the bounding limit include the Bella Collina Mansion (0.2 mi. [0.3 km] southeast), Humphrey's Ridge Family Marina (0.7 mi. [1.1 km] east-northeast), the NC Wildlife Resources Commission Pine Hall Public Boat Ramp (0.9 mi. [1.4 km] north), and the future Forsyth County Belews Lake Park (0.4 mi. [0.6 km] south).

2.1.3.4 Population Center

The nearest population center to the Project site with more than 25,000 residents is the Town of Kernersville, NC, with a 2020 population of 26,449 (Reference 2.1-4). The closest boundary of Kernersville is approximately 7.7 mi. (12.4 km) from the Project site bounding limit, exceeding the minimum distance specified by 10 CFR 100.11(a)(3).

Population projections from 2024 to 2079 using the same methods described in Section 2.1.3.1 were also calculated for all municipalities within 50 mi. (80.5 km) of the Project site. Table 2.1-8 presents the projected municipality populations.

2.1.3.5 Population Density

The NRC Regulatory Position C.4 in Regulatory Guide (RG) 4.7, Rev. 4, *General Site Suitability Criteria for Nuclear Power Stations*, and NUREG-0800 (Section 2.1.3,"Population Distribution") provide guidance on suitable population densities, including weighted transient population, for the area surrounding a nuclear power plant site. Given a construction start date of 2030 for the first unit, the first full year of commercial operations in 2034, and an operational period of 40 years, operations could extend until 2079. Figure 2.1-21 is a plot of estimated population density against radial distance from the plant. Population curves were plotted to illustrate the Project site vicinity population density in comparison to the regulatory guidance for population density. The population curves show the estimated cumulative 2024 population within 20 mi. (32.2 km) of the site and estimated cumulative populations for 2030, 2034, 2039, and 2079. On the same figure, for the same radial distances, regulatory guidance population curves are plotted for hypothetical densities of 500 persons per square mile (sq. mi.) and 1000 persons per sq. mi. This information is also presented in Table 2.1-9. Based on these projections, population densities, averaged over any radial distance out to 10 mi. (16.1 km) for 2024, 2030, 2034, and

2039, are expected to be less than 500 persons per sq. mi. over the lifetime of the new units. However, population densities averaged to 20 mi. (32.2 km) are expected to be greater than 500 persons per sq. mi. through 2039. As noted in Figure 2.1-21, the population projections are not significantly above 500 persons per sq. mi. and are considered acceptable given they are not well in excess of this value. Population densities averaged over any radial distance at the end of the Project site licensing period (2079) are expected to be less than 1000 persons per sq. mi. Therefore, the projected population distribution meets the intent of the regulatory guidance and is considered acceptable for site suitability.

As provided in Sections 2.1.2, 2.1.3, and 13.3, and as further supported by the analyses in Chapter 15, sufficient details have been provided regarding the site location, site area, surrounding population distribution, and emergency planning considerations to allow the staff to evaluate that the relevant requirements of 10 CFR 52.17(a)(1) and 10 CFR Part 100 have been met.

Table 2.1-1
Distance Bands

Distance from Project Site Center Point	Distance from Site Bounding Limit (Distance Band)		
	mi.	km	ft.
1.0 to 1.3 mi.	0 to 0.3	0.0 to 0.5	0 to 1584
1.3 to 2.0 mi.	0.3 to 1	0.5 to 1.6	1584 to 5280
2.0 to 3.0 mi.	1 to 2	1.6 to 3.2	5280 to 10,560
3.0 to 4.0 mi.	2 to 3	3.2 to 4.8	10,560 to 15,840
4.0 to 5.0 mi.	3 to 4	4.8 to 6.4	15,840 to 21,120
5.0 to 6.0 mi.	4 to 5	6.4 to 8.0	21,120 to 26,400
6.0 to 7.0 mi.	5 to 6	8.0 to 9.7	26,400 to 31,680
7.0 to 8.0 mi.	6 to 7	9.7 to 11.3	31,680 to 36,960
8.0 to 9.0 mi.	7 to 8	11.3 to 12.9	36,960 to 42,240
9.0 to 10.0 mi.	8 to 9	12.9 to 14.5	42,240 to 47,520
10.0 to 11.0 mi.	9 to 10	14.5 to 16.1	47,520 to 52,800
11.0 to 21.0 mi.	10 to 20	16.1 to 32.2	52,800 to 105,600
21.0 to 31.0 mi.	20 to 30	32.2 to 48.3	105,600 to 158,400
31.0 to 41.0 mi.	30 to 40	48.3 to 64.4	158,400 to 211,200
41.0 to 51.0 mi.	40 to 50	64.4 to 80.5	211,200 to 264,000

Key: feet = ft; mi. = mile

Table 2.1-2
Directional Sectors

Direction Name	Central Direction[(a)]	Symbol
North	0.0°	N
North-northeast	22.5°	NNE
Northeast	45.0°	NE
East-northeast	67.5°	ENE
East	90.0°	E
East-southeast	112.5°	ESE
Southeast	135.0°	SE
South-southeast	157.5°	SSE
South	180.0°	S
South-southwest	202.5°	SSW
Southwest	225.0°	SW
West-southwest	247.5°	WSW
West	270.0°	W
West-northwest	292.5°	WNW
Northwest	315.0°	NW
North-northwest	337.5°	NNW

Note:
(a) All directional sectors are 22.5° wide, or 11.25° on either side of the central direction.

Table 2.1-3
2020 – 2079 Resident Population within 20 Miles of the Project Site

Distance	2020	2024	2030	2034	2039	2049	2059	2069	2079
0 to 5 mi.	16,951	17,341	17,878	18,239	18,673	19,543	20,452	21,428	22,482
5 to 10 mi.	74,442	76,287	79,268	81,359	83,988	89,286	94,856	100,868	107,352
10 to 20 mi.	675,829	693,420	724,103	746,822	775,801	834,304	895,842	962,245	1,033,899
TOTAL	**767,222**	**787,048**	**821,249**	**846,420**	**878,462**	**943,133**	**1,011,150**	**1,084,541**	**1,163,733**

Key: mi. = mile

Table 2.1-4
2020 – 2079 Resident Population within 50 Miles of the Project Site

Distance	2020	2024	2030	2034	2039	2049	2059	2069	2079
0 to 50 mi.	2,032,605	2,080,534	2,153,450	2,206,012	2,272,833	2,409,017	2,552,893	2,708,937	2,878,110

Key: mi. = mile

Table 2.1-5
Estimated 2020 Transient Populations within 20 Miles of the Project Site by Facility Type

Total for All Facilities by Facility Type	Unweighted	Weighted
Airports	4867	390
Daycare Facilities	2855	767
Event Venues	2020	803
Jails and Detention Centers	2392	2392
Lodging Facilities	2129	2129
Major Employers	129,341	42,688
Medical and Nursing Facilities	3750	3750
Public Recreation Areas	13,034	4302
School Facilities	70,368	59,569
TOTAL	**230,756**	**116,790**

Key: mi. = mile

Table 2.1-6
Contributors to Transient Population within 20 to 50 Miles of the Project Site
(Sheet 1 of 3)

Recreation Event or Venue[(a)]	City	State	Capacity/ Attendance
Bowman Gray Stadium	Winston-Salem	NC	17,000
Reeve Stock Festival	Elkin	NC	4000
Floyd Fest Horizon	Check	VA	8500
RiverRun International Film Festival	Winston-Salem	NC	11,570
Carolina Classic Fair	Winston-Salem	NC	325,000
Piedmont Earth Day Fair	Piedmont	NC	8000
International Black Theatre Festival	Winston-Salem	NC	65,000
Cone denim Entertainment Center	Greensboro	NC	850
Martinsville Speedway (several different events)	Ridgeway	VA	65,000
Henry County Fair	Ridgeway	VA	4500
Danville-Pittsylvania Fairgrounds	Ringgold	VA	50,000
High Point University Nido & Marina Qubein Arena, Conference Center and Jana and Ken Kahn Hotel	High Point	NC	6500
High Point Willard Stadium	High Point	NC	2000
High Point Vert Stadium	High Point	NC	3000
First Horizon Coliseum (formally Greensboro Coliseum)	Greensboro	NC	22,000
University of North Carolina Greensboro Flemming Gym	Greensboro	NC	1800
University of North Carolina Greensboro Baseball Stadium	Greensboro	NC	3500
University of North Carolina Greensboro Softball Stadium	Greensboro	NC	1500
University of North Carolina Greensboro Soccer Stadium	Greensboro	NC	3540
Wake Forest University Allegacy Federal Credit Union Stadium	Winston-Salem	NC	31,500
Wake Forest University LJVM Coliseum	Winston-Salem	NC	14,665
Wake Forest University David F. Couch Ballpark	Winston-Salem	NC	3823
Wake Forest University Spry Stadium	Winston-Salem	NC	3000

Table 2.1-6
Contributors to Transient Population within 20 to 50 Miles of the Project Site
(Sheet 2 of 3)

Recreation Event or Venue[a]	City	State	Capacity/ Attendance
Wake Forest University Tennis Center	Winston-Salem	NC	n/a
Wake Forest University Kenter Stadium	Winston-Salem	NC	4000
Wake Forest University Arnold Palmer Golf Complex	Winston-Salem	NC	n/a
Truist Stadium (minor-league baseball park)	Winston-Salem	NC	5500
North Carolina Agricultural and Technical State University Truist Stadium	Greensboro	NC	21,000
North Carolina Agricultural and Technical State University World War Memorial Stadium	Greensboro	NC	7500
North Carolina Agricultural and Technical State University Corbett Sports Center	Greensboro	NC	5000
Davidson County Executive Airport[b][c]	Lexington	NC	295
Blue Ridge Airport[b][c]	Martinsville	VA	239
Mount Airy/Surry County Airport[b][c]	Mount Airy	NC	175
Burlington/Alamance Regional Airport[b][c]	Burlington	NC	757
Mid-Carolina Regional Airport[b][c]	Salisbury	NC	519
Hargrave Military Academy[d][e]	Chatham	VA	200
Averett University[d][e]	Danville	VA	1024
Elon University[d][e]	Elon	NC	7123
Ferrum College[d][e]	Ferrum	VA	869
Catawba College[d][e]	Salisbury	NC	1172
Livingstone College[d][e]	Salisbury	NC	839
Hood Theological Seminary[d][e]	Salisbury	NC	144
Guilford County Jail 2[f][g]	High Point	NC	274
Yadkin County Detention Center[f][g]	Yadkinville	NC	101
Davie County Correctional Facility[f][g]	Mocksville	NC	72
Rowan County Detention Center[f][g]	Salisbury	NC	210
Davidson County Detention Center[f][g]	Lexington	NC	283

Table 2.1-6
Contributors to Transient Population within 20 to 50 Miles of the Project Site
(Sheet 3 of 3)

Recreation Event or Venue[a]	City	State	Capacity/ Attendance
Randolph County Detention Center[f][g]	Asheboro	NC	367
Alamance County Detention Center[f][g]	Graham	NC	476
Caswell County Detention Center[f][g]	Yanceyville	NC	120
Surry County Jail[f][g]	Dobson	NC	125
Henry County Adult Detention Center[f][g]	Martinsville	VA	400
Franklin County Jail[f][g]	Rocky Mount	VA	177
Patrick County Jail[f][g]	Stuart	VA	28

Notes:
(a) Events and locations listed in this table are sourced from publicly available information and should not be considered a complete list.
(b) Airports with commercial carrier and/or air taxi service outside of the 20 mi. radius.
(c) Airport capacity estimated using information available from the Federal Aviation Administration.
(d) Residential schools outside of the 20 mi. radius.
(e) Student population.
(f) Detention facilities outside the 20 mi. radius.
(g) Estimated facility maximum capacity.
Key: mi. = mile; N/A = not applicable; NC = North Carolina; VA = Virginia

Table 2.1-7
2020 – 2079 Resident and Transient Populations within 20 Miles of the Project Site

Distance	2020	2024	2030	2034	2039	2049	2059	2069	2079
0 to 5 mi.	19,275	19,716	20,317	20,700	21,160	22,076	23,031	24,060	25,168
5 to 10 mi.	83,844	85,906	89,236	91,579	94,527	100,470	106,716	113,460	120,736
10 to 20 mi.	780,893	801,196	836,809	863,248	896,992	965,124	1,036,799	1,114,149	1,197,625
TOTAL	**884,012**	**906,818**	**946,362**	**975,527**	**1,012,679**	**1,087,670**	**1,166,546**	**1,251,669**	**1,343,529**

Key: mi. = mile; NC = North Carolina

Table 2.1-8
2020 – 2079 Population Centers within 50 Miles of the Project Site
(Sheet 1 of 7)

Name[a]	2020[b]	2024	2030	2034	2039	2049	2059	2069	2079
Advance CDP, NC	1499	1567	1665	1729	1810	1972	2142	2327	2528
Alamance Village, NC	988	1052	1131	1180	1241	1365	1495	1639	1796
Altamahaw CDP, NC	334	356	382	399	420	461	506	554	607
Archdale City, NC[c]	11,907	12,113	12,450	12,684	12,979	13,572	14,184	14,825	15,498
Asheboro City, NC	**27,156**	**27,616**	**28,335**	**28,816**	**29,420**	**30,626**	**31,863**	**33,150**	**34,489**
Bermuda Run Town, NC	3120	3262	3466	3600	3768	4104	4458	4843	5261
Bethania Town, NC	344	355	374	387	403	436	470	508	548
Boonville Town, NC	1185	1196	1203	1203	1203	1203	1203	1204	1204
Burlington City, NC[c]	**57,303**	**60,845**	**65,239**	**68,025**	**71,533**	**78,557**	**86,010**	**94,170**	**103,106**
Clemmons Village, NC	**21,163**	**21,851**	**22,987**	**23,785**	**24,793**	**26,816**	**28,941**	**31,235**	**33,711**
Cleveland Town, NC	846	874	906	927	957	1011	1071	1135	1202
Cooleemee Town, NC	940	983	1044	1085	1135	1236	1343	1459	1585
Danbury Town, NC	189	195	200	201	202	202	202	202	202
Denton Town, NC	1494	1563	1645	1695	1759	1886	2019	2161	2314
Dobson Town, NC	1462	1463	1464	1464	1464	1464	1464	1463	1463
East Bend Town, NC	634	640	644	644	644	644	644	644	644
East Spencer Town, NC	1567	1619	1679	1718	1772	1872	1984	2102	2227
Eden City, NC	15,421	15,507	15,528	15,528	15,528	15,528	15,529	15,530	15,531

Table 2.1-8
2020 – 2079 Population Centers within 50 Miles of the Project Site
(Sheet 2 of 7)

Name[a]	2020[b]	2024	2030	2034	2039	2049	2059	2069	2079
Efland CDP, NC	852	873	920	953	995	1079	1167	1263	1366
Elkin Town, NC[c]	4122	4127	4130	4131	4134	4139	4146	4152	4160
Elon Town, NC	11,336	12,074	12,973	13,536	14,243	15,657	17,158	18,804	20,606
Farmington CDP, NC	291	304	323	336	351	383	416	452	491
Flat Rock CDP, NC	1326	1327	1327	1327	1328	1327	1327	1327	1327
Forest Oaks CDP, NC	4209	4295	4478	4629	4826	5225	5647	6103	6596
Franklinville Town, NC	1197	1217	1249	1270	1297	1350	1404	1461	1520
Germanton CDP, NC[c]	790	816	847	862	880	915	951	990	1032
Gibsonville Town, NC[c]	8920	9259	9774	10,142	10,614	11,566	12,573	13,669	14,861
Glen Raven CDP, NC	3239	3450	3707	3868	4070	4474	4903	5373	5888
Graham City, NC	**17,157**	**18,274**	**19,635**	**20,486**	**21,557**	**23,697**	**25,969**	**28,459**	**31,188**
Granite Quarry Town, NC	2984	3084	3197	3271	3374	3565	3777	4002	4240
Green Level Town, NC	3152	3357	3607	3764	3960	4354	4771	5228	5730
Greensboro City, NC	**299,035**	**305,119**	**318,159**	**328,905**	**342,837**	**371,246**	**401,216**	**433,606**	**468,611**
Harmony Town, NC	543	598	684	740	810	952	1108	1289	1501
Haw River Town, NC	2252	2399	2577	2689	2829	3110	3409	3735	4094
High Point City, NC[c]	**114,059**	**116,506**	**121,527**	**125,608**	**130,890**	**141,651**	**152,999**	**165,258**	**178,501**
Jamestown Town, NC	3668	3743	3903	4034	4205	4554	4921	5319	5748
Jonesville Town, NC	2308	2330	2343	2343	2344	2344	2344	2344	2344
Kernersville Town, NC	**26,449**	**27,309**	**28,729**	**29,726**	**30,986**	**33,513**	**36,170**	**39,037**	**42,132**

Table 2.1-8
2020 – 2079 Population Centers within 50 Miles of the Project Site
(Sheet 3 of 7)

Name[a]	2020[b]	2024	2030	2034	2039	2049	2059	2069	2079
King City, NC[c]	7197	7435	7655	7719	7781	7883	7985	8096	8216
Lewisville Town, NC	13,381	13,816	14,534	15,039	15,676	16,955	18,299	19,750	21,315
Lexington City, NC	**19,632**	**20,541**	**21,611**	**22,277**	**23,112**	**24,784**	**26,531**	**28,401**	**30,403**
Liberty Town, NC	2655	2700	2770	2817	2876	2994	3115	3241	3372
Lowgap CDP, NC	267	267	267	267	267	267	267	267	267
McLeansville CDP, NC	1113	1136	1184	1224	1276	1382	1493	1614	1744
Madison Town, NC	2129	2141	2144	2144	2144	2144	2144	2144	2144
Mayodan Town, NC	2418	2431	2435	2435	2435	2435	2435	2435	2435
Mebane City, NC[c]	**17,797**	**18,772**	**20,077**	**20,914**	**21,965**	**24,068**	**26,296**	**28,732**	**31,394**
Midway Town, NC	4742	4962	5220	5381	5583	5986	6408	6860	7344
Milton Town, NC	155	150	146	144	140	134	127	121	115
Mocksville Town, NC	5900	6168	6554	6807	7125	7760	8430	9158	9948
Mount Airy City, NC	10,676	10,686	10,688	10,688	10,688	10,688	10,687	10687	10,686
Oak Ridge Town, NC	7474	7626	7952	8221	8569	9279	10,028	10837	11,712
Ossipee Town, NC	536	571	613	640	673	740	811	889	974
Pilot Mountain Town, NC	1440	1441	1442	1442	1442	1442	1442	1441	1441
Pinnacle CDP, NC	786	812	833	836	838	839	839	839	840
Pleasant Garden Town, NC	5000	5102	5320	5499	5732	6207	6709	7250	7835
Pleasant Hill CDP, NC	831	840	863	881	906	968	1040	1118	1201

Table 2.1-8
2020 – 2079 Population Centers within 50 Miles of the Project Site
(Sheet 4 of 7)

Name[a]	2020[b]	2024	2030	2034	2039	2049	2059	2069	2079
Ramseur Town, NC	1774	1804	1851	1882	1922	2001	2081	2166	2253
Randleman City, NC	4595	4673	4794	4876	4978	5182	5391	5609	5836
Reidsville City, NC	14,583	14,664	14,684	14,684	14,684	14,685	14,686	14,686	14,687
Ronda Town, NC	438	443	455	464	477	510	548	589	633
Ruffin CDP, NC	322	324	324	324	324	324	324	324	324
Rural Hall Town, NC	3351	3460	3640	3766	3926	4246	4583	4946	5338
Salisbury City, NC	**35,540**	**36,726**	**38,080**	**38,958**	**40,184**	**42,466**	**44,991**	**47,666**	**50,500**
Saxapahaw CDP, NC	1671	1780	1912	1995	2100	2308	2529	2772	3037
Sedalia Town, NC	676	690	719	744	775	839	907	980	1059
Siler City Town, NC	7702	8270	9076	9602	10,286	11,636	13,101	14,750	16,607
Smithtown CDP, NC	224	226	227	227	227	227	227	228	228
Southmont CDP, NC	1563	1635	1721	1774	1840	1973	2112	2261	2421
Spencer Town, NC	3308	3418	3544	3626	3740	3953	4188	4437	4700
Stanley Town, NC	3963	4030	4135	4205	4293	4469	4650	4838	5033
Stokesdale Town, NC	5924	6045	6303	6516	6792	7355	7948	8590	9283
Stoneville Town, NC	1308	1315	1317	1317	1317	1317	1317	1317	1317
Summerfield Town, NC	10,951	11,174	11,651	12,045	12,555	13,595	14,693	15,879	17,161
Swepsonville Town, NC	2445	2604	2798	2919	3072	3377	3701	4056	4444
Thomasville City, NC[c]	**27,183**	**28,429**	**29,897**	**30,811**	**31,959**	**34,255**	**36,654**	**39,222**	**41,970**
Toast CDP, NC	1423	1424	1425	1425	1425	1425	1425	1424	1424

Table 2.1-8
2020 – 2079 Population Centers within 50 Miles of the Project Site
(Sheet 5 of 7)

Name[a]	2020[b]	2024	2030	2034	2039	2049	2059	2069	2079
Tobaccoville Village, NC	2578	2662	2800	2896	3018	3262	3519	3796	4095
Trinity City, NC	7006	7125	7310	7434	7590	7901	8220	8552	8898
Tyro CDP, NC	3753	3927	4131	4259	4418	4738	5072	5429	5812
Walkertown Town, NC	5692	5877	6183	6397	6668	7212	7784	8401	9067
Wallburg Town, NC	3051	3192	3359	3462	3592	3852	4123	4414	4725
Walnut Cove Town, NC	1586	1639	1681	1688	1691	1693	1693	1694	1694
Welcome CDP, NC	4131	4322	4547	4688	4863	5215	5583	5976	6397
Wentworth Town, NC	2662	2677	2681	2681	2680	2681	2681	2681	2681
White Plains CDP, NC	1025	1026	1026	1026	1026	1026	1026	1026	1026
Whitsett Town, NC	584	596	621	642	670	725	784	847	915
Winston-Salem City, NC	**249,545**	**257,657**	**271,052**	**280,465**	**292,353**	**316,197**	**341,262**	**368,314**	**397,509**
Woodlawn CDP, NC	912	971	1044	1089	1146	1260	1380	1513	1658
Yadkin College CDP, NC	377	394	415	428	444	476	509	545	584
Yadkinville Town, NC	2995	3023	3040	3041	3041	3041	3042	3042	3042
Yanceyville Town, NC	1937	1880	1827	1794	1753	1669	1588	1511	1438
Bassett CDP, VA	1028	996	950	916	874	803	733	670	612

Table 2.1-8
2020 – 2079 Population Centers within 50 Miles of the Project Site
(Sheet 6 of 7)

Name[a]	2020[b]	2024	2030	2034	2039	2049	2059	2069	2079
Blairs CDP, VA	841	819	788	780	770	760	751	743	734
Cana CDP, VA	1243	1221	1188	1180	1170	1167	1165	1163	1161
Chatham Town, VA	1232	1200	1154	1142	1127	1113	1100	1088	1076
Chatmoss CDP, VA	1671	1619	1544	1489	1421	1305	1192	1089	995
Collinsville CDP, VA	7380	7149	6817	6576	6277	5762	5265	4810	4393
Danville City, VA	**42,590**	**42,159**	**41,521**	**40,123**	**38,383**	**35,417**	**32,555**	**29,914**	**27,487**
Fancy Gap CDP, VA	214	210	205	203	202	201	201	200	200
Ferrum CDP, VA	1827	1794	1745	1782	1829	1947	2069	2198	2335
Fieldale CDP, VA	852	825	787	759	725	665	608	555	507
Floyd Town, VA	448	448	447	454	462	484	508	532	558
Galax City, VA	6720	6551	6306	6246	6171	6103	6045	5987	5929
Henry Fork CDP, VA	1120	1100	1070	1093	1121	1193	1268	1347	1432
Hillsville Town, VA	2884	2832	2756	2738	2716	2707	2703	2698	2694
Horse Pasture CDP, VA	2058	1994	1901	1834	1750	1607	1468	1341	1225
Laurel Park CDP, VA	657	636	607	585	559	513	469	428	391
Martinsville City, VA	13,485	13,273	12,961	12,502	11,930	10,948	9999	9129	8335

Table 2.1-8
2020 – 2079 Population Centers within 50 Miles of the Project Site
(Sheet 7 of 7)

Name[a]	2020[b]	2024	2030	2034	2039	2049	2059	2069	2079
Meadows of Dan CDP, VA	72	70	67	66	63	59	56	52	49
Mount Hermon CDP, VA	4057	3952	3800	3761	3713	3666	3624	3583	3542
Oak Level CDP, VA	803	778	742	716	683	627	573	523	478
Patrick Springs CDP, VA	1813	1766	1697	1651	1593	1498	1406	1320	1239
Penhook CDP, VA	782	768	747	763	783	833	885	941	1000
Ridgeway Town, VA	752	732	704	685	661	621	583	548	514
Rocky Mount Town, VA	4903	4814	4684	4783	4908	5224	5552	5899	6267
Sandy Level CDP, VA	464	450	429	413	395	362	331	302	276
Stanleytown CDP, VA	1385	1342	1279	1234	1178	1081	988	903	824
Stuart Town, VA	1431	1394	1340	1303	1257	1182	1110	1042	978
Union Hall CDP, VA	1328	1304	1269	1296	1329	1415	1504	1598	1698
Villa Heights CDP, VA	638	618	589	569	543	498	455	416	380
Woodlawn CDP (Carroll County), VA	2045	2008	1954	1942	1926	1920	1916	1913	1910

Notes:
(a) Per the USCB, population centers are categorized as cities, towns, villages, or Census Designated Places (CDP).
(b) USCB 2020 Census Population Estimate, Redistricting Data Table P1.
(c) Nine North Carolina municipalities were discovered to cross county boundaries. Population growth rates were assigned based on the proportion of each municipality in its intersecting county.

Population centers identified by performing an intersection between North Carolina and Virginia municipalities and the project's 50 mi. radius in ArcGIS.
Projected populations were calculated using annual county population growth rates for 2020-2070 and applied to each intersecting population center. Highlighted rows (bold text) indicate population centers that are either greater than 25,000 people or will grow to greater than 25,000 during the lifetime of the proposed project.
Projected population center population calculation results abbreviated to key analysis years for presentation purposes.

Table 2.1-9
Project Site Cumulative Population and Population Density, 0 to 20 Miles, Compared to NRC Siting Criteria

Distance (mi.)	Cumulative Projected Population					NRC Siting Criteria Cumulative Population Density	
	2024	2030	2034	2039	2079	500 People per sq. mi.	1000 People per sq. mi.
0	0	0	0	0	0	0	0
2	3380	3470	3526	3590	4119	14,137	28,274
4	11,671	12,012	12,227	12,483	14,695	39,270	78,540
6	29,618	30,572	31,194	31,951	38,600	76,969	153,938
8	58,294	58,294	61,774	63,508	78,852	127,235	254,469
10	105,622	105,622	112,279	115,687	145,904	190,066	380,133
20	906,818	906,818	975,527	1,012,679	1,343,529	692,721	1,385,442

Distance (mi.)	Projected Population Densities (People per sq. mi.)					NRC Siting Criteria Population Densities	
	2024	2030	2034	2039	2079	500 People per sq. mi.	1000 People per sq. mi.
0	0	0	0	0	0	0	0
2	120	123	125	127	146	500	1000
4	149	153	156	159	187	500	1000
6	192	199	203	208	251	500	1000
8	229	237	243	250	310	500	1000
10	278	288	295	304	384	500	1000
20	655	683	704	731	970	500	1000

Key: mi. = mile; NC = North Carolina; NRC = U.S. Nuclear Regulatory Commission; sq. mi. = square mile

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

This section establishes whether the effects of potential accidents in the site vicinity from present and projected industrial, transportation, and military installations and operations should be used as design-basis events for plant design parameters related to the selected accidents. Facilities and activities within the 5-mi. (8-km) vicinity of the Project site are considered to meet the guidance in NUREG-0800. Facilities and activities at greater distances are included as appropriate based on their potential for affecting plant safety-related features.

2.2.1 LOCATIONS AND ROUTES

The proposed Project site is located in the southeastern corner of Stokes County, NC, just north of Belews Creek Township, NC, extending slightly into the northeastern corner of Forsyth County, NC, and adjacent to Belews Lake. The Project site is approximately 14 mi. (23 km) northeast of Winston-Salem, NC and approximately 19 mi. (31 km) northwest of Greensboro, NC. Potential hazardous facilities and routes within the 5 mi. (8 km) vicinity of the Project site, and airports within 20 mi. (32 km) of the site were identified along with facilities at a greater distance in accordance with the following:

RG 1.70, Rev. 3, *Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)*

RG 1.78, Rev. 2, *Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release*

RG 1.91, Rev. 3, *Evaluations of Explosions Postulated To Occur at Nearby Facilities and on Transportation Routes Near Nuclear Power Plants*

RG 1.206, Rev. 1, *Applications for Nuclear Power Plants*

RG 4.7, Rev. 4, *General Site Suitability Criteria for Nuclear Power Stations*

Relevant sections of 10 CFR Parts 50, 52, and 100

Major facilities and transportation routes identified are listed below along with the figure that shows their location relative to the Project site. Major facilities are those that store chemicals as identified on a Tier II report submitted under Sections 311 and 312 of the U.S. Environmental Protection Agency (USEPA) Emergency Planning and Community Right-to-Know Act that pose a hazard to the nuclear facility.

- Industrial facilities (Figure 2.2-1)
  - BCSS
  - Wieland Copper
  - Endura Products
  - Hall Oil and Propane

  - Parkdale Mills
  - Vulcan Materials Company
  - Oliver Diesel and Auto Repair
  - Mobil
  - Pure
- Roadways (Figure 2.2-2)
  - NC Highway 65 (NC-65)
  - U.S. Route 311 (US-311)
  - U.S. Route 158 (US-158)
- Railroads (Figure 2.2-2)
  - NS rail line
  - NS rail spur to BCSS
- Pipelines (Figures 2.2-3)
  - Piedmont Natural Gas Company (Co.) Incorporated (Inc.)

The following airfields, airports, and heliports (with Federal Aviation Administration [FAA] location identifiers) in the vicinity of the site are identified in Figure 2.2-4.

- Meadow Brook Field (N63)
- DS Butler Farm and Airfield (N83)
- Dusenbury Field (13NR)
- Lindsay (0NC7)
- Lewis Airstrip (7NC7)
- Meylor Field (9NC9)
- Robertson Field (NC63)
- Smith Reynolds (INT)
- Piedmont Triad International (GSO)
- Mountain View Aerodrome (NC37)
- Air Harbor (W88)

- Rockingham County NC Shiloh (SIF)
- Warf (NR33)
- Moorefield's Airstrip (VA27)
- NC Baptist Hospital Heliport (5NC7)

There are no military bases, oil wells, gas wells, underground gas storage facilities, or navigable waterways identified in the vicinity of the Project site

2.2.2 DESCRIPTIONS

Industrial, transportation, and military facilities located in the vicinity of the Project site are identified in Section 2.2.1 and are described in the subsequent sections.

2.2.2.1 Descriptions of Facilities

The following sections provide short descriptions of the industrial, transportation, and military facilities located within 5 mi. (8 km) of the Project site, based on available information. The facilities of interest are summarized in Table 2.2-1. The location of facilities within 5 mi. (8 km) of the Project site are shown on Figure 2.2-1. For the purpose of identifying nearby hazards, the Project site is represented as a 1 mi. (1.6 km) radius circle around the site center. This 1 mi. (1.6 km) radius circle defines the site bounding limit. A second 6-mi. (10-km) radius circle is drawn to identify any facilities that come within 5 mi. (8 km) of the 1-mi. (1.6-km) radius circle. Distances from the Project site are measured from the site bounding limit 1 mi. (1.6 km) circle for most hazards. Some hazards that are close to the Project site, or within the site bounding limit, required more refined distance measurements. There are three Plant Complexes within the Project site and each Plant Complex has a power block within it. Refined distances for nearby hazards are measured from the nearest Plant Complex power block. The Plant Complex power blocks are shown in Figure 1.2-3.

Facilities further than 5 mi. (8 km) from the Project site bounding limit do not present a credible hazard. For example, the Pine Needle liquified natural gas (LNG) facility located 5.5 mi. (8.9 km) southeast of the Project site was evaluated and determined not to present a credible hazard. The only significant facility outside of 5 mi. (8 km) is Vulcan Materials Co. since potentially hazardous materials are shipped to Vulcan Materials Co. via roadways within 5 mi. (8 km) of the Project site.

2.2.2.2 Descriptions of Products and Materials

Detailed information regarding hazardous and explosive chemicals in the vicinity of the Project site due to facilities or transportation routes (described in the sections below) is provided in Tables 2.2-2 through 2.2-5. Information provided includes toxicity and explosion limits, quantity, and shipment frequency (if available).

The tables only include chemicals which could pose a toxic or explosive hazard to the Project site. If a chemical presents neither a toxic nor explosive hazard, it is not presented in the tables.

Toxicity screenings were performed based on the guidance in RG 1.78, while explosivity screenings were performed based on a chemical's vapor pressure relative to its lower explosive limit (if applicable). RG 1.78 screenings for potential toxic hazards are based on chemical toxicity, quantity, vapor pressure, and number of shipments per year (for transported chemicals). Because a reactor technology has not been selected, the screening described in RG 1.78, Appendix A, based on distance from the Project site, chemical toxicity, weather, and control room parameters was performed using a bounding set of control room parameters from a survey of potential technologies. The bounding set of control room parameters yields 2.64 air changes per hour (ACH) for the control room envelope. If the selected technology has a safety-related control room, it will be confirmed that the control room envelope air change rate is less than or equal to 2.64 ACH or the habitability analysis will be updated accordingly.

2.2.2.2.1 Belews Creek Steam Station

BCSS is north of the Project site center and within the 1 mi. (1.6 km) bounding limit, as identified on Figure 2.2-1. The BCSS is a two-unit coal and natural gas-fired power plant. [[

]]^{SRI} There is a rail spur line that is used to transport coal and [[ ]]^{SRI} to the steam station as shown in Figure 2.2-2. Other toxic and explosive chemicals stored at the BCSS are included in Table 2.2-2. Toxic and explosive chemicals transported via truck and rail are included in Tables 2.2-4 and 2.2-5.

2.2.2.2.2 Wieland Copper

Wieland Copper is a copper supplier located 3.7 mi. (6 km) north of the Project site. Toxic and explosive chemicals stored at Wieland Copper are included in Table 2.2-2. Toxic and explosive chemicals transported via truck and rail are included in Tables 2.2-4 and 2.2-5.

2.2.2.2.3 Endura Products

Endura Products is a supplier of residential exterior door components located 4.9 mi. (7.9 km) east-southeast of the Project site. Toxic and explosive chemicals stored at Endura Products are included in Table 2.2-2. Toxic and explosive chemicals transported via truck and rail are included in Tables 2.2-4 and 2.2-5.

2.2.2.2.4 Hall Oil and Propane

Hall Oil and Propane is a propane supplier located 4.0 mi. (6.4 km) northwest of the Project site. Toxic and explosive chemicals stored at Hall Oil and Propane are included in Table 2.2-2. Toxic and explosive chemicals transported via truck and rail are included in Tables 2.2-4 and 2.2-5.

2.2.2.2.5 Parkdale Mills

Parkdale Mills is a small textile manufacturer located 3.6 mi. (5.8 km) northwest of the Project site. Toxic and explosive chemicals stored at Parkdale Mills are included in Table 2.2-2. Toxic and explosive chemicals transported via truck and rail are included in Tables 2.2-4 and 2.2-5.

2.2.2.2.6 Vulcan Materials Company

Vulcan Materials Co. is located 5.8 mi. (9.3 km) east-southeast from the Project site. Vulcan Materials Co. is a supplier and manufacturer of construction materials including gravel, sand, and crushed stone. This facility utilizes explosives for blasting operations at the quarry that are shipped via US-158 as indicated in Table 2.2-4.

2.2.2.2.7 Oliver Diesel and Auto Repair, Mobil, and Pure

There are gas stations and auto repair shops located within 5 mi. (8 km) of the Project site, specifically Oliver Diesel and Auto Repair, Mobil, and Pure. The potentially toxic and explosive chemicals stored at these facilities are listed in Table 2.2-2.

2.2.2.3 Description of Pipelines and Mining Operations

There is one pipeline within 5 mi. (8 km) of the Project site. The pipeline is operated by Piedmont Natural Gas Co., a Duke Energy business unit, and transports odorized natural gas to the BCSS. The distance of the pipeline from the Project site as well as the available data for design pressure, pipe size, and capacity, is presented in Table 2.2-3.

There are no mining operations identified within 5 mi. (8 km) of the Project site.

2.2.2.4 Description of Waterways

Waterways in the vicinity of the Project site include Belews Lake, Belews Creek, and the Dan River. There is no commercial freight traffic or navigable waterways where hazardous commodities would be shipped within 5 mi. (8 km) of the Project site.

2.2.2.5 Description of Highways

The survey of chemical hazards transported by truck considers those chemicals known to be stored or shipped in the vicinity of the Project site based on the stationary facility survey presented in Section 2.2.2.2.

There are three major roadways within 5 mi. (8 km) of the Project site: NC-65, US-311, and US-158 as shown in Figure 2.2-2. At their closest points, NC-65, US-311, and US-158 are approximately 1.1 mi. (1.8 km), 3.2 mi. (5.2 km), and 2.2 mi. (3.5 km) from a 1 mi. (1.6 km) radius circle surrounding the Project site center, respectively. A radius larger than 5 mi. (8 km) was considered when identifying chemical hazards stored near the site as these chemicals may be transported within 5 mi. (8 km) of the site along the nearby roadways. The survey identified several facilities farther than 5 mi. (8 km) from the site but located close to one or more of these roadways. Additionally, one of these facilities, Vulcan Materials Co., identified Orica, an explosives supplier that is not close to the site, which sometimes ships chemicals for blasting to Vulcan Materials Co. on a route that includes US-158.

Table 2.2-4 presents the identified toxic and explosive hazardous chemicals transported along the major roadways. Unless specific maximum transported quantities were provided by facilities

along the roadways, trucks are considered to contain 50,000 pounds (lb.) (22,700 kilograms [kg]) of chemical consistent with RG 1.91.

2.2.2.6 Description of Railroads

There is one NS rail line within 5 mi. (8 km) of the Project site. The NS line is northwest of the site coming within 1.5 mi. (2.4 km) of the Project site at its closest point. Additionally, there is a spur off this line leading to the BCSS which is less than 1 mi. (1.6 km) from the Project site center point. The railroad spur is approximately 0.4 mi. (0.6 km) from the nearest Plant Complex power block. Railways are shown in Figure 2.2-2.

The list of chemicals transported provided by the railroad operators was screened and reduced to the list of potentially hazardous chemicals presented in Table 2.2-5. Chemicals shipped fewer than 30 times per year (the RG 1.78 definition of frequent for rail traffic) are not identified as potential toxic hazards; however, these chemicals are evaluated as potential explosive hazards.

2.2.2.7 Description of Airports, Aircraft, and Airway Hazards

NUREG-0800 establishes that the risks as the result of aircraft hazards should be sufficiently low, in that it requires that aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) with a probability of occurrence greater than an order of magnitude of 10^{-7} per year should be considered in the design of the plant.

However, Section 3.5.1.6 of NUREG-0800 provides that 10 CFR 100.20, 10 CFR 100.21, and 10 CFR 52.17 requirements are met if the probability of aircraft accidents resulting in radiological consequences greater than the 10 CFR Part 100 exposure guidelines is less than an order of magnitude of 10^{-7} per year. Additionally, these guidelines provide that the probability is considered to be less than an order of magnitude of 10^{-7} per year by inspection if the distances from the plant meet all of the criteria listed below:

1. The plant-to-airport distance, D, is between 5 and 10 statute mi. (8 and 16 km), and the projected annual number of operations is less than 500 D^2, or the plant-to-airport distance, D, is greater than 10 statute mi. (16 km), and the projected annual number of operations is less than 1000 D^2.

2. The plant is at least 5 statute mi. (8 km) from the nearest edge of military training routes, including low-level training routes, except for those associated with usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.

3. The plant is at least 2 statute mi. (3.2 km) beyond the nearest edge of a federal airway, holding pattern, or approach pattern.

Therefore, utilizing the proximity criteria presented above, a screening analysis was first performed to establish whether the probability of aircraft accidents for the Project site is considered to be less than an order of magnitude of 10^{-7} per year by inspection. The screening

and analysis of airport and airway hazards uses distances measured from the hazard to the Project site boundary as defined in Figure 2.1-1.

2.2.2.7.1 Airports

There are two airfields within 5 statute mi. (8 km) of the Project site boundary: Meadow Brook Field (N63) and DS Butler Farm and Airfield (N83).

Meadow Brook Field is located 4.7 statute mi. (7.6 km) west-northwest of the Project site boundary. The most recent Meadow Brook Field FAA filing listed 12,050 total annual operations. Due to its proximity to the site, the airport owner was contacted. The owner confirmed that the current operations are accurate; however, the airport is installing two new airplane hangars and is hoping to expand to approximately 30,000 total operations annually.

DS Butler Farm and Airfield is located 5 statute mi. (8 km) south-southeast of the Project site boundary. The most recent DS Butler FAA filing listed 2100 total annual operations. Due to its proximity to the site, the airport owner was contacted. The owner confirmed that the reported annual operations are accurate and are not expected to grow.

There are four airports between 5 statute mi. (8 km) and 10 statute mi. (16 km) of the Project site boundary: Dusenbury Field (13NR), Lindsay (0NC7), Lewis Airstrip (7NC7), and Meylor Field (9NC9). There are eight airports between 10 statute mi. (16 km) and 20 statute mi. (32 km) of the site: Robertson Field (NC63), Smith Reynolds (INT), Piedmont Triad International (GSO), Mountain View Aerodrome (NC37), Air Harbor (W88), Warf (NR33), Rockingham County NC Shiloh (SIF), and Moorefield's Airstrip (VA27).

Although Piedmont Triad International (GSO) currently satisfies the screening criteria for allowable airport operations in NUREG-0800, Section 3.5.1.6, it is projected that this limit will be exceeded during the life of the plant. Because of this, all runways, approach patterns, and holding patterns for Piedmont Triad International (GSO) were evaluated to ensure the risks associated with operations into and out of GSO are properly quantified. One approach pattern, approach and landing (AL) 178 to Runway 14, lies within 2 statute mi. (3.2 km) of the Project site boundary. Because of this, Piedmont Triad International was contacted to better understand operations on this approach pattern. Per airport staff, there were 72,000 total operations at Piedmont Triad International (GSO) from March of 2023 to March of 2024. This value is slightly higher than what was reported on the most recent FAA filing.

Runway 14 is oriented 140 degrees from North and is the shortest runway at Piedmont Triad International (GSO) with a length of 6380 ft. In the timeframe from March 2023 to March 2024 there were only 220 landing operations on Runway 14. This value was doubled (i.e., 440 operations) to accurately quantify the total number of operations (takeoffs and landings) on Runway 14. Additionally, the total number of operations was scaled proportional to the total 2050 projected operations to conservatively maximize the associated probabilistic risk resulting in 834 total operations. All operations on this runway are assumed to utilize the portion of approach pattern AL-178 that comes within 2 statute mi. (3.2 km) of the Project site boundary.

In addition to the approach and holding patterns for Piedmont Triad International (GSO), the approach and holding patterns for Meadow Brook Field (N63) and Smith Reynolds (INT) were also evaluated. Other airports within 10 statute mi. (16 km) do not have holding or approach patterns. None of these holding or approach patterns come within 2 statute mi. (3.2 km) of the Project site boundary. Therefore, no further analysis is required for approach and holding patterns associated with Meadow Brook Field (N63) and Smith Reynolds (INT).

The airports discussed above are identified in Table 2.2-6 and shown in Figure 2.2-4. The table also includes information for Charlotte/Douglas International (CLT), the largest airport in NC. The table includes the distance from the Project site boundary, current annual operations categorized by type, projected future operations (where available), and the screening value for number of allowable operations below which further analysis is not required.

Based on the number of operations and proximity to the Project site boundary, the only airports requiring quantitative aircraft hazard evaluation are Meadow Brook Field (N63), DS Butler Farm and Airfield (N83), and Piedmont Triad International (GSO) Runway 14. NUREG-0800, Section 3.5.1.6, provides methodology for the evaluation of crash frequency for airport and non-airport operations; however, some specific information required to implement the methodology is not available (e.g., flight count on airway routes, methodology for computation of effective area of the plant, etc.). Therefore, an alternate methodology outlined in U.S. Department of Energy (DOE) Standard DOE-STD-3014-2006, herein referred to as the DOE standard, is used (Reference 2.2-13). Prior NRC acceptance of the DOE standard methodology is documented in the safety evaluation for Chapter 3 of the PSEG early site permit application (ESPA) (Reference 2.2-15).

The airport operation crash impact frequency evaluation is determined using the following four-factor formula:

$$F_j = N_j \cdot P_j \cdot f_j(x,y) \cdot A_j \qquad \text{(Equation 2.2-1)}$$

Where:

F_j = site crash frequency per year for aircraft class j

j = each aircraft class suggested in the DOE standard

N_j = expected number of flights per year for aircraft class j

P_j = aircraft takeoff and landing crash rates for aircraft class j

$f_j(x,y)$ = probability, given a crash, that the crash occurs in a 1 sq. mi. (2.6 sq. km) area surrounding the plant

A_j = effective plant area in sq. mi.

Table B-1 of the DOE standard provides P_j values for airport takeoffs and landings, while Tables B-4 and B-5 of the DOE standard provide $f_j(x,y)$ values for airport takeoffs and landings for

general aviation aircraft (Reference 2.2-13). Only the general aviation aircraft class data is needed since the airports requiring detailed evaluation only use general aviation aircraft.

The effective plant area depends on the length, width, and height of the new plant, as well as the aircraft's wingspan, skid distance, and impact angle as explained in Section B.4 of the DOE standard and below (Reference 2.2-13).

$$Aj = Afj + Asj \quad \text{(Equation 2.2-2)}$$

$$Af_j = H \cot(\Phi)_j (WS_j + R) + (2 L W WS) / R + L W \quad \text{(Equation 2.2-3)}$$

$$As_j = S_j (WS_j + R) \quad \text{(Equation 2.2-4)}$$

$$R = (L^2 + W^2)^{0.5} \quad \text{(Equation 2.2-5)}$$

Where:

A_j = effective plant area for aircraft class j.

Af_j = effective fly-in area for aircraft class j.

As_j = effective skid area for aircraft class j.

WS_j = aircraft wingspan for aircraft class j (Page B-28 of DOE standard).

R = length of the diagonal of the plant, reactor technology specific.

H = plant height, reactor technology specific.

$\cot(\Phi)_j$ = mean of the cotangent of the aircraft impact angle for aircraft class j (Page B-29 of DOE standard).

L = length of plant, reactor technology specific.

W = width of plant, reactor technology specific.

S_j = aircraft skid distance for aircraft class j (Page B-29 of DOE standard).

Meadow Brook Field uses only general aviation aircraft. The total crash frequency for general aviation aircraft is 4.33×10^{-6} crashes per year for takeoffs and landings at Meadow Brook Field.

DS Butler Farm and Airfield uses only general aviation aircraft. The total crash frequency for general aviation aircraft is 4.26×10^{-7} crashes per year for takeoffs and landings at DS Butler Farm and Airfield.

Approaches to Runway 14 of Piedmont Triad International may come within 2 mi. (3.2 km) of the Project site boundary and have a crash frequency of 4.51×10^{-8} crashes per year.

There is a single heliport located within 20 statute mi. (32 km) of the Project site boundary. NC Baptist Hospital heliport is located 16 statute mi. (26 km) from the Project site boundary and has

significantly less than the 256,000 operations per year screening limit.

2.2.2.7.2 Airways

Federal airways within 10 statute mi. (16 km) of the Project site boundary are identified and are shown in Figure 2.2-5. There are five airways within 10 statute mi. of the Project site boundary. The center of airway V-20/T-224 is located approximately 1.9 statute mi. (3.1 km) from the site boundary, the center of airway V-45 is located approximately 3.1 statute mi. (5 km) from the site boundary, the center of airway V-103 is located approximately 3.5 statute mi. (5.6 km) from the site boundary, the center of airway V-143 is located approximately 11 statute mi. (18 km) from the site boundary, and the center of airway IR-719 is located 13 statute mi. (21 km) from the site boundary. Commercial airways are generally 8 nautical miles (NM) (15 km) wide and military airway IR-719 is 10 NM (19 km) wide. Based on the proximities of airways V-20/T-224, V-45, and V-103 to the Project site, quantitative aircraft hazard evaluation for the airways is required.

The non-airport operations crash frequency evaluation is performed using the same four-factor formula presented in Equation 2.2-1 for airport operations. For the non-airport operations, Tables B-14 and B-15 of DOE Standard DOE-STD-3014-2006 (Reference 2.2-13) provide values for the product of N_j, P_j, and $f_j(x,y)$ applicable for specific DOE sites and for a general location in the continental U.S. Since none of the DOE sites are in the vicinity of the Project site, the values for a general U.S. location are used. The effective plant area is the same as that calculated for airport operations.

The total frequency of a crash for non-airport operations for air carrier, air taxi, large and small military, and general aviation aircraft is 3.23×10^{-6} crashes per year for airways.

2.2.2.7.3 Total Aircraft Risk

Combining the crash frequency due to the airports and airways results in a total crash frequency of 8.04×10^{-6} per year. The majority of the risk is from general aviation aircraft, which have a crash frequency of approximately 7.85×10^{-6} per year. Treating all traffic on Runway 14 of Piedmont Triad International as Air Carrier, the total crash frequency for Air Carrier is 6.03×10^{-8} per year, Air Taxi is 3.31×10^{-8} per year, Large Military is 7.02×10^{-9} per year, and Small Military is 8.67×10^{-8} per year. This breakdown by aircraft type is provided in Table 2.2-8. Since the total crash frequency exceeds the 10^{-7} per year screening criterion in NUREG-0800, Section 3.5.1.6, additional evaluation is required as discussed in SSAR Section 3.5.1.6.

2.2.2.8 Projections of Industrial Growth

Research was conducted to identify planned industrial facilities that, when completed, could become a potential hazard to the Project site. Economic development representatives in each of the four counties surrounding the site, Stokes, Forsyth, Rockingham, and Guilford, were contacted to collect information. There are several ongoing and upcoming industrial projects in the surrounding counties, but none within the immediate vicinity of the Project site. Since Stokes County, where the site is located, is primarily rural and lacks developed infrastructure and nearby interstate access, many these projects are likely to be located in other counties far

enough away so as to not present a hazard to the site. Additionally, many of these projects would not require a large chemical inventory. A summary of some of the larger projects in the surrounding counties in central NC, which include the cities of Greensboro, Winston-Salem, High Point, and Kernersville, is given in Table 2.2-7.

The locations of the future facilities listed in Table 2.2-7 are all farther than 5 mi. (8 km) from the Project site and none are located along the major roadways which come within 5 mi. (8 km) of the Project site. Therefore, it is unlikely that these facilities, once built, would be required to ship chemicals near the Project site, and these projects do not affect the hazard evaluation.

2.2.3 EVALUATION OF POTENTIAL ACCIDENTS

An evaluation of the information provided in Sections 2.2.1 and 2.2.2 was performed to determine potential accidents to be considered as design-basis events, and the potential effects of these accidents on the nuclear plant in terms of design parameters (e.g., overpressure, missile energies) or physical phenomena (e.g., concentration of flammable or toxic clouds outside building structures). The potential effects of these accidents on the nuclear plant were evaluated using guidance in RG 1.78, RG 1.91, RG 4.7, and RG 1.206.

2.2.3.1 Determination of Potential Accidents

NUREG-0800 states that design-basis events in the vicinity of the nuclear plant are defined as those accidents for which the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the 10 CFR 50.34(a)(1) as it relates to the requirements of 10 CFR Part 100 is estimated to exceed an order of magnitude of 10^{-7} per year. The following accident categories are considered in selecting design-basis events: explosions, flammable vapor clouds (delayed ignition), toxic chemicals, aircraft crashes, fires, collisions with the intake structure, and liquid spills.

There are two types of analyses described in this section: deterministic and probabilistic.

Deterministic analyses use a single set of worst-case, or near worst-case, conditions to show that a defined hazardous condition will not exist due to a failure external to the plant. Worst-case conditions typically include: an immediate full rupture of a tank or transportation source, worst-case weather conditions, and the closest possible location to the Project site.

RG 1.78 suggests that the weather conditions used should be the worst-case ones that are exceeded less than 5 percent of the time. In other words, a successful analysis shows that the acceptance criteria are met for more than 95 percent of weather conditions. Wind frequency data was developed at the Project site over the time period of February 7, 2024, through February 6, 2025. This data was tabulated into a joint frequency distribution (JFD) of Pasquill stability class, wind speed, and wind direction for use in gas dispersion analyses. For deterministic cases, the worst Pasquill stability class that occurs at least 5% of the time is Class F, as shown in Table 2.3-37 through 2.3-40. The minimum wind speed used in the deterministic analysis is 1.1 mph (0.5 m/s). In some deterministic cases, higher or lower wind speeds may be conservative. As a result, some deterministic analyses model several cases to show that

acceptance criteria are met for more than 95 percent of stability class and wind speed combinations.

As there is not a joint table including ambient temperature and stability class, a high analysis ambient temperature of 91 degrees Fahrenheit (°F) (33 degrees Celsius [°C]) is used. This temperature is higher than the 1 percent high cooling dry-bulb temperature at Piedmont Triad International Airport (Reference 2.2-1).

A probabilistic analysis determines the frequency of hazardous conditions using the results of many deterministic analyses. NUREG-0800 indicates that chemical sources are acceptable if the expected rate of occurrence of potential exposures resulting in radiological dose is on the order of magnitude of 10^{-7} per year. NUREG-0800 goes on to say that "an expected rate of occurrence of potential exposures resulting [in] radiological dose [on the] order of magnitude of 10^{-6} per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower." RG 1.91 states that if "estimates of explosion rate, frequency of shipment, and exposure distance are made on a realistic or best-estimate basis, an exposure rate less than $1x10^{-7}$ per year is sufficiently low. If conservative estimates are used, an exposure rate less than $1x10^{-6}$ per year is sufficiently low." For the analyses herein, the probabilistic requirement is that the frequency of hazardous conditions must be less than 10^{-6} events per year.

The general method for all probabilistic assessments comes from RG 1.91.

$$R = n \cdot f \cdot s = n1 \cdot n2 \cdot f \cdot s \qquad \text{(Equation 2.2-6)}$$

Where:

R = the exposure rate in hazardous conditions per year.

n = the rate of hazardous conditions per mi.

f = the frequency of the shipment per year.

s = the exposure distance in mi. per shipment. For fixed sources, n represents hazardous conditions per year.

For transportation hazards, the parameter n is broken up into n1, accidents per mi. for the transportation mode, and n2, hazardous conditions per accident. The values for n1, n2, f, and s are dependent on the weather conditions, chemical, storage or transportation conditions, method of transportation, transportation route or location of fixed sources, and the accident category being evaluated.

Probabilistic analyses also use the Project site joint wind speed, wind direction, and Pasquill stability class table. Similarly, the high analysis ambient temperature of 91 °F (33 °C) is used.

2.2.3.1.1 Explosions

Accidents involving detonations of explosives, munitions, chemicals, liquid fuels, and gaseous

fuels are considered for facilities and transportation routes in the vicinity of the Project site, where such materials are processed, stored, used, or transported in a sufficient quantity. Blast pressures from explosions from nearby sources were evaluated to determine if the explosion would have an adverse effect on plant operation or would prevent safe shutdown of the plant. As shown below, the explosions evaluated meet the acceptance criteria and are not design-basis hazards to the Project site.

The allowable and actual distances of hazardous chemicals transported or stored are evaluated in accordance with RG 1.91, which cites 1 pound per square inch (psi) (6.9 kilopascal [kPa]) as a conservative value of peak positive incident overpressure below which no significant damage would be expected. RG 1.91 provides the relationship between explosive energy and safe distance as:

$$R = k \cdot W^{(1/3)} \qquad \text{(Equation 2.2-7)}$$

Where:

R = the distance in ft. from the explosion.

W = the equivalent weight of trinitrotoluene (TNT) in lb.

k = the scaled distance for a given overpressure. For a 1 psi (6.9 kPa) overpressure, k is 45 $ft/lb^{1/3}$ (18 $m/kg^{1/3}$).

The method to determine the equivalent weight of TNT is dependent on the storage conditions of the chemical hazard. For gaseous and liquid chemicals, the equivalent weight of TNT is calculated by scaling the explosive chemical mass by the ratio between the heat of combustion of the explosive chemical with the heat of combustion of TNT, as shown in Equation 2.2-8.

$$W = \alpha \cdot \Delta H_c \cdot m / \Delta H_{TNT} \qquad \text{(Equation 2.2-8)}$$

Where:

α = the yield of the explosion.

ΔHc = the heat of combustion of the chemical.

m = the explosive mass of the chemical.

ΔH_{TNT} = the heat of combustion of TNT, 1900 British Thermal Unit (BTU)/lb (4500 KJ/kg) per RG 1.91.

For solid chemicals, RG 1.91 states that a minimum yield of 1 should be used (i.e., the mass of explosive material is used as the mass of TNT in Equation 2.2-7).

Additionally, boiling liquid expanding vapor explosions (BLEVE) are considered for chemicals that are gases at standard conditions but are stored as a liquid (e.g., ammonia). Overpressure due to a BLEVE is caused by the rapid expansion of a chemical from its storage conditions. The BLEVE expansion occurs isentropically and the energy release is calculated using the change

in internal energy before and after expansion.

$$x = (s_{stor} - s_f) / (s_v - s_f) \quad \text{(Equation 2.2-9)}$$

$$\Delta u = u_{stor} - (u_v \cdot x + u_f (1 - x)) \quad \text{(Equation 2.2-10)}$$

Where:

x = the fraction of the gas that flashes to vapor.

s = entropy, u is internal energy, the subscript ‘stor’ refers to the liquid storage conditions, the subscript v refers to the post-expansion vapor conditions, and the subscript f refers to the post-expansion liquid conditions. The change in internal energy is substituted into Equation 2.2-8 to determine the equivalent weight of TNT for the BLEVE as shown in Equation 2.2-11.

$$W = \Delta u \, m / \Delta H_{TNT} \quad \text{(Equation 2.2-11)}$$

Stationary explosions of [[ ]]SRI are modeled as both fully confined explosions and as semi-confined explosions. The [[ ]]SRI at the BCSS are housed in a partially open enclosure that has a greater volume than the individual storage tanks. Conservatively, the enclosure is treated as a fully confined explosion with the entire free volume filled with [[ ]]SRI at the upper explosive limit of 25 percent and an explosive yield of 100 percent. Since the explosive mass in this scenario is only a fraction of the total mass in the [[ ]]SRI, a BLEVE scenario is also evaluated. The [[ ]]SRI railcar is analyzed as a fully confined explosion with the railcar filled with gas at ambient pressure and an explosive yield of 100 percent. Finally, a conservative semi-confined explosion is analyzed that assumes the entire inventory of one railcar is released, vaporized, and ignited. The explosive yield for such semi-confined explosions is chemical dependent and set to 5 percent, 10 percent, or 15 percent per RG 1.91 and Factory Mutual Global guidelines (Reference 2.2-2). For [[ ]]SRI, a yield of 15 percent was used.

[[

]]SRI For these remaining hazards, the full inventory of the chemical is assumed released, vaporized, and ignited with an explosive yield of 100 percent.

The materials stored at nearby facilities (Table 2.2-2) and potentially transported along roadways (Table 2.2-4), railways (Table 2.2-5) and pipelines (Table 2.2-3) are evaluated to determine whether they have the potential to explode. The effects of these explosion events from external sources are described in the following sections relative to the release source.

2.2.3.1.1.1 Explosions at Nearby Facilities

The facilities listed in Table 2.2-1 were identified as facilities of concern with regard to storage of materials with the potential for explosion within the vicinity of the Project site. Each material stored at the identified offsite facilities was evaluated with respect to explosion potential. The potentially explosive materials are those with a lower explosive limit listed in Table 2.2-2. Each material was then assessed based on the identified physical properties of the material using the applicable methods from Section 2.2.3.1.1.

[[

]]SRI The tanks and supporting piping are housed beneath a roofed structure with open walls allowing ventilation to the environment. The area around the structure is unconfined. To support the stationary explosion evaluation for the [[

]]SRI At atmospheric conditions, [[ ]]SRI could be contained in this confined volume if a spill were to occur. Assuming 100 percent yield, a detonation of [[ ]]SRI gives a 1 psi (6.9 kPa) standoff distance of 333 ft (102 m), which is less than the distance to the Project site of 2100 ft. (640 m). Since the stationary explosion of [[ ]]SRI considered only the mass of confined vapor in the enclosure, a BLEVE scenario is also considered. The BLEVE assumed the catastrophic failure of one of the [[

]]SRI Approximately 20 percent of the [[ ]]SRI mass flashes to vapor which equates to an equivalent TNT mass of 78,900 lb. (35,800 kg). The BLEVE gives a 1 psi (6.9 kPa) standoff distance of 786 ft (240 m), which is less than the distance to the Project site of 2100 ft. (640 m).

The second hazard analyzed for the BCSS is 5 million lb. (2.3 million kg) of bituminous coal and bituminous coal dust. It is unlikely that this large outdoor pile of coal poses an explosion risk; however, it was conservatively assumed that 5 percent of the entire pile becomes aerosolized dust and explodes as TNT. Using this approach, the 1 psi (6.9 kPa) standoff distance is 2840 ft (866 m), which is less than the distance to the Project site of 3170 ft. (966 m).

Three explosive chemicals were analyzed for the Wieland Copper facility: gasoline, hydrogen, and odorized propane. For simplicity, each of these chemicals was analyzed by assuming the entire stored mass is released, vaporized, and detonated with a yield of 100 percent. Using this approach, the 1 psi (6.9 kPa) standoff distance for 13,200 lb. (6000 kg) of gasoline is 2280 ft. (695 m), the 1 psi (6.9 kPa) standoff distance for 2450 lb. (1110 kg) of hydrogen is 1800 ft. (549 m), and the 1 psi (6.9 kPa) standoff distance for 102,000 lb. (46,300 kg) of propane is 4590 ft. (1400 m). The standoff distance for each of these cases is substantially less than the distance to the Project site of 21,100 ft. (6430 m).

Two potentially explosive materials were identified for Endura Products: wood dust and Sherwin-Williams primer. Like the previously discussed coal dust, the wood dust was analyzed

assuming 5 percent of the mass becomes aerosolized dust and explodes as 2180 lb. (989 kg) TNT. This approach gives a 1 psi standoff distance of 583 ft. (178 m), which is significantly less than the distance to the Project site of 30,100 ft. (9170 m). The 3460 lb. (1570 kg) of Sherwin-Williams primer was not analyzed as it is bounded by nearer hazards with greater mass and heat of combustion.

Two explosive chemicals were analyzed for Hall Oil and Propane: gasoline and odorized propane. For simplicity, each of these chemicals was analyzed by assuming the entire stored mass is released, vaporized, and detonated with a yield of 100 percent. Using this approach, the 1 psi (6.9 kPa) standoff distance for 60,000 lb. (27,200 kg) of gasoline is 3780 ft. (1150 m) and the 1 psi (6.9 kPa) standoff distance for 150,000 lb. (68,100 kg) of propane is 5220 ft. (1590 m). The standoff distance for each of these cases is substantially less than the distance to the Project site of 25,900 ft. (7890 m).

One explosive chemical was analyzed for Parkdale Mills: odorized propane. For simplicity, the hazard was analyzed by assuming the entire stored mass is released, vaporized, and detonated with a yield of 100 percent. Using this approach, the 1 psi (6.9 kPa) standoff distance for 4850 lb. (2200 kg) of propane is 1660 ft. (506 m). The standoff distance is substantially less than the distance to the Project site of 22,700 ft. (6920 m).

One explosive chemical was analyzed for Oliver Diesel and Auto Repair: brake cleaner. The brake cleaner is primarily composed of acetone and was treated as acetone when performing the analysis. For simplicity, the hazard was analyzed by assuming the entire stored mass is released, vaporized, and detonated with a yield of 100 percent. Using this approach, the 1 psi (6.9 kPa) standoff distance for 404 lb. (183 kg) of acetone is 637 ft. (194 m). The standoff distance is substantially less than the distance to the Project site of 23,800 ft. (7250 m).

The Mobil and Pure gas stations each have underground gasoline storage tanks. These are minimal risk since overpressure from an explosion in the tank would be mitigated by the ground and a spill from the tanks would be released into the ground rather than into the air. For simplicity, each of these chemicals was analyzed by assuming the entire stored mass is released, vaporized, and detonated with a yield of 100 percent. Using this approach, the 1 psi (6.9 kPa) standoff distance for 12,000 gallons (gal.) (45.4 m^3) of gasoline at Mobil is 4070 ft. (1240 m). The 1 psi (6.9 kPa) standoff distance for the 4000 gal. (15.1 m^3) of gasoline at Pure is 2820 ft. (859 m). The standoff distances for each of these cases is substantially less than the actual distance from the Project site to Mobil of 23,800 ft. (7250 m) and Pure of 10,600 ft. (3230 m).

Therefore, damaging overpressures from an explosion of stored materials at each of the identified facilities would not adversely affect the operation or shutdown of units located within the Project site.

2.2.3.1.1.2 Explosions from Roadways and Railways

The materials listed in Tables 2.2-4 and 2.2-5 were identified as materials of concern with the potential for explosion on roadways and railways within the vicinity of the Project site. Each

material identified was evaluated with respect to explosion potential. The potentially explosive materials are those with a lower explosive limit listed in Tables 2.2-4 and 2.2-5. Each material was then assessed based on the identified physical properties of the material using the applicable methods from Section 2.2.3.1.1.

To simplify the evaluation, the mass of TNT that would yield a 1 psi (6.9 kPa) overpressure was determined at the shortest distance between the analyzed route and the Project site. This is defined as the allowable mass of TNT (W_{TNT} Allowable). As described in Section 2.2.2.5, the nearest major roadway is 1.1 mi. (1.8 km) from the site. The NS rail line is 1.5 mi. (2.4 km) from the Project site at its closest point per Section 2.2.2.6; however, the nearest approach of the NS rail line is 2.1 mi. (3.4 km) from the nearest of the three Plant Complex power block boundaries within the Project site. The NS rail spur off this line leading to the BCSS is 0.44 mi. (0.7 km) from the nearest of the three Plant Complex power block boundaries within the Project site. Utilizing these distances, the allowable mass of TNT for each transportation source is determined from Equation 2.2-7.

Route	Distance	W_{TNT} Allowable
Roadway	1.1 mi. (5810 ft.)	2,150,000 lb.
Railway	2.1 mi. (11,100 ft.)	14,900,000 lb.
Rail Spur	0.44 mi. (2320 ft.)	138,000 lb.

To determine acceptability of the roadway and railway hazards, the equivalent TNT was determined using Equation 2.2-8 for each postulated hazard scenario. The hazard is acceptable if the equivalent TNT is less than the allowable TNT for the applicable route.

For the roadways, the equivalent TNT was determined for each of the explosive chemicals described in Table 2.2-4. These include [[ ]]^{SRI}, gasoline, heptane, hydrogen, propane, and solid explosives. The equivalent TNT for all these postulated hazards is significantly below the allowable TNT mass of 2,150,000 lb. (975,000 kg).

For the railway, the equivalent TNT was determined for each of the explosive chemicals described in Table 2.2-5. These include acetic acid, acrylonitrile, butane, ethanol, gasoline, isopropyl alcohol, petroleum distillates, petroleum gases, propane, and xylenes. The equivalent TNT for all these postulated hazards is significantly below the allowable TNT mass of 14,900,000 lb. (6,760,000 kg).

For the rail spur, [[ ]]^{SRI} and coal dust are the only applicable explosive hazards. The [[ ]]^{SRI} railcar on the spur is analyzed two ways: as a fully confined explosion with the railcar filled with gas at ambient pressure and an explosive yield of 100 percent, and as a semi-confined explosion that assumes the entire inventory of one railcar is released, vaporized, and ignited with an explosive yield of 15 percent. The calculated equivalent TNT for the coal dust and both [[ ]]^{SRI} explosion cases is below the allowable of 138,000 lb. (62,600 kg). A BLEVE scenario was not analyzed for the [[ ]]^{SRI} railcar since the full railcar mass was used in the semi-confined explosion case and 15 percent of the heat of combustion is larger than the energy of expansion for [[ ]]^{SRI}

2.2.3.1.1.3 Explosions from Pipelines

There is one natural gas pipeline within the vicinity of the Project site as described in Table 2.2-3. A natural gas pipeline explosion occurring in the vicinity of the release point would be unconfined. A damaging detonation from an unconfined natural gas release is not credible according to the NRC safety evaluation report for a Hartsville, Tennessee, nuclear power plant (Reference 2.2-14). As such, the natural gas pipeline is not analyzed as a stationary explosion hazard. The natural gas pipeline is analyzed in subsequent sections as a source of flammable vapor clouds and jet fires.

The effects of pipeline missiles were considered consistent with methods discussed in the Indian Point pipeline hazards report (Reference 2.2-6) and the Dresden pipeline hazards report (Reference 2.2-7). The Indian Point report concluded that pipeline missiles are not a concern beyond 600 ft. (183 m) from the rupture location. The Dresden report noted that in most cases the travel distance of pipeline missiles is less than 50 percent of the potential impact radius (PIR) defined in 49 CFR 192.903. The PIR for the Piedmont pipeline is 524 ft. (160 m). Since the Piedmont pipeline is at least 790 ft. (241 m) from the nearest safety-related structures, pipeline missiles are not a concern.

2.2.3.1.1.4 Flammable Vapor Clouds

A flammable vapor cloud occurs when a flammable chemical source is released, and the vapor travels with the wind toward the site. The Plant Complex power block structures may provide confinement and ignition sources which could support a detonation that damages safety-related equipment. The acceptance criterion, therefore, is that the concentration of a chemical vapor cloud must be less than the lower explosive limit at Plant Complex power block structures where confinement and ignition sources exist.

A flammable vapor cloud analysis requires calculation of the mass release rate and downwind dispersion. The mass release rate for tanks (including fixed sources and sources transported by rail and road) uses methods from NUREG-0570 which have different release rate equations for chemicals that are gases at standard conditions but are stored as a pressurized liquid, or chemicals that are liquid at standard conditions. Chemicals stored as gases are considered released in a single puff. Chemicals that are gases at standard conditions but are stored as compressed liquids (e.g., propane), flash to vapor upon release. The remainder of the stored chemical that does not flash then boils from a pool on the ground. Lastly, chemicals that are liquids at standard conditions evaporate from pools on the ground. All analyses use the high ambient temperature of 91 °F (33 °C) to maximize the release rates.

For pipelines, the release rate is calculated using the Areal Locations of Hazardous Atmospheres (ALOHA) software (Reference 2.2-5), developed by the National Oceanic and Atmospheric Administration (NOAA) and the USEPA.

Pipeline break air-fuel mixing and dilution due to the rapid release of pressurized gases, using the methods from Lee (Reference 2.2-4), is only credited in the probabilistic evaluations of pipelines (further discussion in the pipeline section). Not crediting the energetic mixing in the

analysis of other compressed gases (hydrogen and propane) is a significant conservatism in the analysis.

Downwind dispersion is modeled using the methods from NUREG-0570, *Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release* and RG 1.145.

The analyses presented for flammable vapor clouds credit meander using the meander coefficients as defined in RG 1.145.

$$\frac{\chi}{Q} = \frac{1}{U \cdot \pi \cdot \Sigma_y \cdot \sigma_z} \qquad \text{(Equation 2.2-12)}$$

$$\Sigma_y = \begin{matrix} M \cdot \sigma_y \; if \; distance \leq 800\; m\; (2620\; ft) \\ or \\ (M-1)\sigma_{y,800m} + \sigma_y \; if \; distance > 800\; m\; (2620\; ft) \end{matrix}$$

Where:

χ = the chemical concentration in kg/m^3.

Q = the release rate in kg/s.

U = the wind speed in m/s.

σ_z = the vertical dispersion coefficient in m.

σ_y = the horizontal dispersion coefficient in m.

M = the meander coefficient from RG 1.145 which is based on wind speed and stability class. It is important to note that M is 1 for all wind speeds above 6 m/s (13 mph). As a result, worst-case analytical conditions often occur when the wind speed is 6 m/s (13 mph), however, the full range of wind speeds is evaluated.

Buoyancy driven plume rise is not credited in the analysis, which is a significant conservatism for large natural gas pipeline releases where the buoyant plume may rise above areas of confinement that could support a detonation.

Building wake is also not credited in any analysis. This is conservative for cases where the vapor cloud encounters structures prior to reaching one of the Plant Complex power blocks within the Project site.

2.2.3.1.1.4.1 Vapor Cloud Explosions from Nearby Facilities

The facilities within 5 mi. (8 km) of the Project site with chemicals that could form flammable vapor clouds are the BCSS, Wieland Copper, Hall Oil and Propane, Parkdale Mills, Oliver Diesel and Auto Repair, Mobil, and Pure. Table 2.2-9 shows the chemicals evaluated at these facilities. These facilities are described in Section 2.2.2.

The flammable vapor cloud analysis found that all the chemicals at stationary facilities are

acceptable. No chemical releases from nearby facilities result in flammable vapor clouds at the Project site using deterministic analyses with more than 95 percent of stability class and wind speed combinations.

2.2.3.1.1.4.2 Flammable Vapor Clouds from Roadways and Railways

All chemicals that are used in the vicinity of the Project site are considered to be transported on local roadways. The lower mass between 50,000 lb. (22,700 kg), based on RG 1.91, and the maximum used at any facility within 5 mi. (8 km) is used for each trucked chemical (aside from hydrogen, where the maximum mass that can fit on a truck is evaluated). The nearest roadway that would likely be used to transport chemicals in the vicinity of the Project site is highway NC-65. Chemicals analyzed on NC-65 are shown in Table 2.2-10.

The flammable vapor cloud analysis found that all the trucked chemicals are acceptable. The analysis shows that the lower explosive limit is not exceeded for stability class and wind speed combinations that occur more than 95 percent of the time.

The chemicals shipped on the NS rail line and NS rail spur that can produce a flammable vapor cloud are also identified on Table 2.2-10.

The flammable vapor cloud analysis found that all the chemicals on the NS rail line and NS rail spur are acceptable. The analysis shows that the lower explosive limit is not exceeded for stability class and wind speed combinations that occur more than 95 percent of the time.

2.2.3.1.1.4.3 Flammable Vapor Clouds from Pipelines

There is a single pipeline in the vicinity of the Project site as described in Section 2.2.2.3. To evaluate the delayed ignition vapor cloud explosion hazard for the pipeline, nine pipeline releases are evaluated. These are presented in Table 2.2-11.

The first six scenarios are full double-ended pipe ruptures of the 23-inch (in.) (58-centimeter [cm]) inner diameter pipeline. The six different scenarios are to address each of the Plant Complex power block locations. For each of the Plant Complex power block locations, the analysis is performed both with and without credit for dilution of the turbulent jet due to energetic mixing with air at the release point (Reference 2.2-4). This jet-dilution mixing is significant in that it reduces the concentration of methane at the release point prior to atmospheric dispersion to the Plant Complex power block. For all the full break cases, the release rate is determined using two ALOHA runs. Since the analyzed pipeline is a lateral that terminates at the BCSS, only one side of the break is fed by a constant pressure source, while the other side is a capped, depressurizing, pipe volume. One ALOHA model represents the pressurized side of the pipe, which is held at a constant 800 pounds per square inch gauge (psig) (5520 kPa) pressure. The second ALOHA model represents the capped, depressurizing pipe, side of the break. A pipe length of 5 mi. (8 km) is used in each model. This is reasonable since the total pipe length is approximately 10 mi. (16 km) and the Project site is near the capped end of the pipeline (see Figure 2.2-3). Using a longer length on the capped side of the break is conservative since it maximizes the blowdown volume and using a shorter length on the pressurized side of the

break is conservative since it minimizes friction losses between the fixed pressure and the break. The calculated break flow rates from these two ALOHA runs are summed to create a total transient break flow which is shown in Table 2.2-12.

The final three scenarios are leak scenarios from a 1-in. (2.5-cm) diameter hole in the pipe (Reference 2.2-12). ALOHA again is used to calculate the break flow assuming a fixed upstream pressure of 800 psig (5520 kPa). A constant break flow rate of 611 pounds per minute (lb/min) (4.62 kilogram per second [kg/s]) was calculated for these leak scenarios.

All pipeline scenarios are evaluated using Monte Carlo methods. The Monte Carlo analysis uses break location along the pipeline, wind speed, wind direction, and atmospheric stability class as randomly sampled variables. For each of the scenarios, 10,000 deterministic cases were analyzed with randomly sampled inputs. The analysis determined that none of the small leak scenarios resulted in an explosive concentration at the Plant Complex power blocks. The analysis also determined that when jet-dilution was credited, none of the full pipe break scenarios resulted in an explosive concentration at the Plant Complex power blocks. When jet-dilution is not credited, 235 of 10,000 cases resulted in an explosive concentration at the worst-case Plant Complex power block. This gives a conditional probability of an explosive cloud reaching a given Plant Complex power block of 0.026 for each release that is not ignited at the break location with 95 percent confidence.

The pipe rupture frequency used in the analysis is based on that cited in reports related to natural gas pipeline hazards near the Indian Point Nuclear Station (Reference 2.2-6) and the Dresden Nuclear Station (Reference 2.2-7). These reports cite a full pipe rupture frequency for pipelines greater than 20-in. (51-cm) diameter with a maximum operating pressure greater than 300 pound per square inch absolute (2070 kPa) of 2.4×10^{-5} ruptures/mi-yr (1.5×10^{-5} ruptures/km-yr). A failure frequency for small leaks was not required since the leak scenarios did not result in any explosive concentrations at a Plant Complex power block. Some additional conditional probabilities are used in the probabilistic analysis of the pipeline. First, although a majority of large pipe breaks are expected to remove soil covering the break resulting in an unobstructed turbulent jet, jet-dilution is credited for only 50 percent of the full pipe ruptures. Application of jet-dilution to only 50 percent of pipe ruptures accounts for less than full ruptures, which may not result in an unobstructed turbulent jet. Direct ignition at the release point is expected to occur 9 percent of the time (Reference 2.2-10) and the remaining 91 percent become unignited clouds that may drift to a Plant Complex power block. Further, the probability of a flammable cloud resulting in a detonation if above the lower flammable limit at the Plant Complex power block is 0.4 (Reference 2.2-10).

The length of pipeline within 5 mi. (8 km) of the nearest Plant Complex power block is 6.57 mi. (10.6 km). Using the above probabilities and pipeline length, the frequency of hazardous explosions is calculated to be 7.46×10^{-7} hazardous explosions per yr.

The pipeline hazard analysis is applicable to all reactor technologies with determined bounding building dimensions less than or equal to that for the analyzed plant (i.e., with a confined area footprint less than or equal to 1000 ft. [305 m] by 1000 ft. [305 m]). The bounding building

dimensions associated with the selected reactor technology will be confirmed at the time of the construction permit or license application.

2.2.3.1.1.5 Cumulative Explosion Hazard Frequency

The acceptance criterion is that the frequency of hazardous explosions must be less than 10^{-6} hazardous explosions per year. The analyses are described in Section 2.2.3.1.1 and summarized here.

For most explosive hazard sources, the risk is dispositioned deterministically, and probabilistic assessments are not used.

The analysis only uses probabilistic risk models for pipeline delayed ignition vapor cloud explosions (7.46×10^{-7} per year). The total risk to the Plant Complex power blocks within the Project site is, therefore, 7.46×10^{-7} hazardous explosions per year. This value includes significant conservatisms:

- All analyses use the site high analysis temperature of 91°F (33 °C). High temperatures are conservative for estimating flashing fractions and boiloff rates for compressed gases. High temperatures concurrent with the worst-case wind speed and stability class are not expected because more stable classes occur at night with low wind speeds.
- Gas buoyancy is not credited for the natural gas pipeline releases. For the large release rates modeled for full pipe breaks, significant plume rise is expected. Plume rise enhances the gas dispersion and may eliminate the possibility of a confined explosion in many cases.
- The pipeline is not considered to have any protection or isolation that would limit the release rate. Releases are modeled as continuing past the time when the peak concentration would reach the Plant Complex power blocks within the Project site.
- The calculated conditional probabilities of an explosive cloud given a release are 95 percent confidence estimates rather than point estimates.

Therefore, flammable vapor clouds meet the acceptance criterion and are not a design-basis hazard to the Plant Complex power blocks within the Project site.

2.2.3.1.2 Toxic Chemicals

Accidents involving the release of toxic or asphyxiating chemicals from nearby facilities and nearby transportation sources were considered. Toxic chemicals known to be present within the vicinity of the Project site, or to be frequently transported in the vicinity, were evaluated. The materials stored at nearby facilities (Table 2.2-2) and transported by pipeline (Table 2.2-3), along highways (Table 2.2-4) and by railway (Table 2.2-5) were evaluated to ascertain which chemicals should be analyzed with respect to their potential to form a toxic or asphyxiating vapor cloud following an accidental release.

Each identified chemical was evaluated based upon the chemical properties, quantities, and distance in relation to the Plant Complex power block, with consideration of plant control room envelope air exchange rate. As described in Section 2.2.2.2, a bounding air exchange rate of 2.64 ACH is used in the analysis. Additionally, the analysis conservatively uses the shortest distance between each hazard and a Plant Complex power block for the location of the control room air intake.

Chemicals were first evaluated using the screening process from RG 1.78, which determines an allowable weight of hazardous chemical at a given distance based on the toxicity, the distance to the control room air intakes, Pasquill stability class, and the control room air exchange rate. Chemical hazards failing this screening are retained for detailed dispersion analysis.

The atmospheric dispersion model was used to predict the chemical concentrations within a toxic or asphyxiating vapor cloud as it disperses downwind for all facilities and sources. The control room habitability analyses performed follows methodology for toxic chemical release and atmospheric dispersion as described in:

- RG 1.78, Rev. 2, *Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release*
- RG 1.145, Rev. 1, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*
- NUREG-0570, *Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release*, June 1979

The toxic limit used for odorized natural gas is 5000 parts per million (ppm), which is 10 percent of the lower explosive limit for methane. The toxicity limits for other analyzed chemicals are as listed in Tables 2.2-2, 2.2-4, and 2.2-5. As described in RG 1.78, trained operators are expected to don an available self-contained breathing apparatus within two minutes of detection of a toxic gas and nasal detection of toxic gases is credible. Failed scenarios are therefore those that exceed the toxic limit less than two minutes from the time the chemical is detected.

Deterministic analyses for each postulated toxicity event were evaluated under a spectrum of meteorological conditions. The spectrum of meteorological parameters was selected based on the Pasquill stability class and wind speed combinations for the Project site that occur greater than 95 percent of the time. For hazards that require a probabilistic analysis, meteorological conditions are randomly sampled from the site-specific joint frequency weather distribution.

2.2.3.1.2.1 Toxic Chemicals from Nearby Facilities

The facilities within 5 mi. (8 km) of the Project site with chemicals that could form toxic vapor clouds are the BCSS, Wieland Copper, Hall Oil and Propane, Parkdale Mills, Oliver Diesel and Auto Repair, Mobil, and Pure. These facilities are described in Section 2.2.2.

All chemicals at nearby facilities passed the RG 1.78 screening except for [[
]][SRI] and hydrochloric acid at the BCSS. Detailed dispersion analysis is required for

these two hazards.

The analysis of a release of 35,000 lb. (15,900 kg) of hydrochloric acid at the BCSS is acceptable because although the toxicity limit is exceeded, there will be greater than two minutes between the time of nasal detection and the time the toxic limit is exceeded.

The [[ ]]SRI at the BCSS was analyzed for both a catastrophic tank failure and a sustained leak through a 1-in. (2.5-cm) diameter opening. A constant break flow rate of 27.2 lb/s (12.3 kg/s) was calculated using ALOHA. The analysis of a release of 27.2 lb/s (12.3 kg/s) of [[ ]]SRI at the BCSS is acceptable because although the toxicity limit is exceeded, there will be greater than two minutes between the time of nasal detection and the time the toxic limit is exceeded.

The catastrophic rupture of an [[ ]]SRI tank at the BCSS is analyzed using probabilistic methods. The Monte Carlo analysis conservatively considers a catastrophic failure of one of the [[ ]]SRI
Only the wind speed, wind direction, and stability class are variables in the Monte Carlo model. The analysis was performed for each Plant Complex. The North Plant Complex, which is nearest the BCSS, was found to have the worst results of the Plant Complexes. The analysis shows 7540 out of 100,000 cases resulted in an uninhabitable control room at the North Plant Complex power block. The failure probability is 7.68×10^{-2} hazardous conditions per release with 95 percent confidence. Using methods presented in Equation 2.2-6, the rate of toxic vapor clouds of [[ ]]SRI reaching a Plant Complex power block is calculated. From quantitative risk assessment studies by the Dutch government (Reference 2.2-9), the rate of failure of single walled tanks is 5×10^{-6} per year. Using these inputs, the total risk of a hazardous condition at the North Plant Complex power block due to an [[ ]]SRI traveling vapor cloud is 2.3×10^{-6} per year. This is added to the total frequency for [[ ]]SRI toxicity for the North Plant Complex power block in Section 2.2.3.1.2.4.

Since the results for the North Plant Complex exceed 10^{-6} toxic control rooms/yr, the Middle Plant Complex is also analyzed. The Middle Plant Complex is nearer to the BCSS than the South Plant Complex and was found to have worse results than the South Plant Complex. The analysis shows 1960 out of 100,000 cases resulted in an uninhabitable control room at the Middle Plant Complex power block. The failure probability is 2.03×10^{-2} hazardous conditions per release with 95 percent confidence. Using methods presented in Equation 2.2-6, the rate of toxic vapor clouds of [[ ]]SRI reaching the Middle Plant Complex power block is calculated. Using the single wall tank failure rate, the total risk of a hazardous condition at the Middle Plant Complex power block due to an [[ ]]SRI traveling vapor cloud is 6.1×10^{-7} per year. This is added to the total frequency for [[ ]]SRI toxicity for the Middle Plant Complex power block in Section 2.2.3.1.2.4.

2.2.3.1.2.2 Toxic Chemicals from Roadways and Railways

All chemicals that are used in the vicinity of the Project site are considered to be transported on local roadways and railways as applicable. Those chemicals with toxic limits identified in Tables

2.2-4 and 2.2-5 are considered toxic hazards and are first evaluated using the RG 1.78 screening.

All identified hazards pass the RG 1.78 screening except: [[ ]]SRI railcar and truck deliveries at the BCSS, hydrogen and propane trucks on NC-65, and LPG and hydrochloric acid railcars on the NS railway.

The analysis of a release of 50,000 lb. (22,700 kg) of propane from a truck on NC-65 and 145,000 lb. (66,000 kg) of LPG from a railcar on the NS railway are acceptable. Using a variety of atmospheric conditions that cover more than 95 percent of stability class and wind speed combinations, the toxic limit is never reached in the control room. The remaining roadway and railway hazards are evaluated probabilistically.

Truck deliveries of [[ ]]SRI to the BCSS are analyzed using probabilistic methods. The Monte Carlo analysis considers a catastrophic failure of a truck of [[ ]]SRI Only the location on the roadway, wind speed, wind direction, and stability class are variables in the Monte Carlo model. The analysis shows a maximum of 176 out of 100,000 cases resulted in an uninhabitable control room at a Plant Complex power block. The failure probability is 1.98×10^{-3} hazardous conditions per release with 95 percent confidence. NUREG/CR-6624 summarizes accident rates and conditional spill probabilities from several sources. The most conservative data cited within NUREG/CR-6624 when considering both accident rate and spill probability is from the U.S. Atomic Energy WASH-1238, Commission *Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants* and is used in this analysis. The truck accident rate is 1.69×10^{-6} accidents per mile with a conditional spill probability of 0.18. This results in a hazardous spill rate for trucks of 3.04×10^{-7} ($1.69 \times 10^{-6} * 0.18$) accidents with spills per mile. Using methods presented in Equation 2.2-6, the allowable number of trips per year that would yield a total probability of 1×10^{-6} per year is 401 deliveries based on the exposure distance of 4.14 mi. (6.67 km) per delivery. The calculated allowable deliveries are greater than the current number of 14 deliveries per year. The risk from the current 14 deliveries per year is added to the total frequency for [[ ]]SRI toxicity in Section 2.2.3.1.2.4.

Truck shipments of hydrogen on NC-65 are analyzed using probabilistic methods. The Monte Carlo analysis considers a catastrophic failure of a truck of hydrogen, which releases 10,000 lb. (4540 kg) of hydrogen. Only the location along the roadway, wind speed, wind direction, and stability class are variables in the Monte Carlo model. The analysis shows a maximum of 25 out of 100,000 cases resulted in an uninhabitable control room at a Plant Complex power block. The failure probability is 3.32×10^{-4} hazardous conditions per release with 95 percent confidence. Using the hazardous spill rate for trucks of 3.04×10^{-7} accidents with spills per mi. and methods presented in Equation 2.2-6, the allowable number of trips per year that would yield a total probability of 1×10^{-6} per year is 819 deliveries based on the exposure distance of 12.0 mi. (19.3 km) per delivery. The calculated allowable shipments is greater than the current number of 183 shipments per year.

Deliveries of [[ ]]SRI on the NS rail spur to the BCSS are analyzed using

probabilistic methods. The Monte Carlo analysis considers a catastrophic failure of a railcar of [[ ]]SRI Only the location on the rail spur, wind speed, wind direction, and stability class are variables in the Monte Carlo model. The analysis shows 1340 out of 100,000 cases resulted in an uninhabitable control room at a Plant Complex power block. The failure probability is 1.4×10^{-2} hazardous conditions per release with 95 percent confidence. Rail spurs, also known as industrial/private sidings, have a different, higher accident rate than main lines due to the nature of sorting, unloading, and loading. Accident frequencies differ between the shunting yard part of the siding and the railway part of the siding (Reference 2.2-9). As a distinction in the Belews Creek spur could not be made, the accident frequency is conservatively taken as the higher of the two values. The accident frequency for the spur is treated as 1.77×10^{-6} accidents per railcar mi. (1.1×10^{-6} accidents per railcar km). Furthermore, the outflow probability for pressurized tank cars in a collision scenario is 0.01 (Reference 2.2-9). This results in a hazardous spill rate for railcars on the spur of 1.77×10^{-8} ($1.77 \times 10^{-6} * 0.01$) accidents with spills per mi. Using methods presented in Equation 2.2-6, the allowable number of trips per year that would yield a total probability of 1×10^{-6} per year is 840 deliveries based on the exposure distance of 4.79 mi. (7.71 km) per delivery. The calculated allowable deliveries are greater than the current number of 56 deliveries per year. The risk from the current 56 deliveries per year is added to the total frequency for [[ ]]SRI in Section 2.2.3.1.2.4.

Deliveries of hydrochloric acid on the NS railway are analyzed using probabilistic methods. The Monte Carlo analysis considers a catastrophic failure of a railcar of hydrochloric acid, which releases 235,000 lb. (107,000 kg) of hydrochloric acid. Only the location along the railway, wind speed, wind direction, and stability class are variables in the Monte Carlo model. The analysis shows 1260 out of 100,000 cases resulted in an uninhabitable control room at a Plant Complex power block. The failure probability is 1.32×10^{-2} hazardous conditions per release with 95 percent confidence. NUREG/CR-6624 summarizes train accident rates and spill probabilities from several sources using old data. Since the collection of this data, safety features and automation have improved in railroad transportation, making it safer over time. For this reason, a more current railroad accident rate was developed based on data from the Federal Railroad Administration (Reference 2.2-3) and U.S. Department of Transportation (Reference 2.2-8). Using the available data, the rate of railroad accidents with a hazmat release on main line track is 4.2×10^{-9} hazmat car releases per freight car mi. Based on methods presented in Equation 2.2-6, the allowable number of shipments per year that would yield a total probability of 1×10^{-6} per year is 2070 deliveries based on the exposure distance of 8.72 mi. (14.0 km) per delivery. The calculated allowable shipments are greater than the current number of 34 shipments per year.

2.2.3.1.2.3 Toxic Chemicals from Pipelines

There is a single pipeline in the vicinity of the Project site as described in Section 2.2.2.3. To evaluate the toxic vapor cloud hazard for the pipeline, both a full double-ended pipeline release and leak from a 1-in. (2.5-cm) diameter hole are evaluated for each Plant Complex.

For the analysis of the leak scenarios from a 1-in. (2.5-cm) diameter hole in the pipe (Reference

2.2-12), ALOHA was used to calculate the break flow assuming a fixed upstream pressure of 800 psig (5520 kPa). A constant break flow rate of 10.2 lb/s (4.63 kg/s) was calculated for these leak scenarios. Using a variety of atmospheric conditions that cover more than 95 percent of stability class and wind speed combinations, deterministic analyses show that operators have at least two minutes to don a self-contained breathing apparatus prior to reaching a toxic concentration in the control room for the 1-in. (2.5 cm) leak scenario.

The pipeline is also analyzed for a full double-ended rupture of the 23-in. (58-cm) inner diameter pipeline. The calculated release rate is consistent with that described in Section 2.2.3.1.1.4.3 and shown in Table 2.2-12. Conservatively, jet dilution mixing is not credited in the toxic vapor cloud analysis. The full rupture scenario is evaluated using Monte Carlo methods. The Monte Carlo analysis uses break location along the pipeline, wind speed, wind direction, and atmospheric stability class as randomly sampled variables. For each of the scenarios, 100,000 deterministic cases were analyzed with randomly sampled inputs. The analysis determined that 942 of 100,000 cases resulted in a toxic control room at the worst-case Plant Complex power block. This gives a conditional probability of an unacceptable control room environment of 9.92 x 10^{-3} for each release with 95 percent confidence. The pipe rupture frequency used in the analysis is 2.4 x 10^{-5} ruptures/mi.-yr (1.5 x 10^{-5} ruptures/km-yr) consistent with that described in Section 2.2.3.1.1.4.3. Pipe ruptures are ignited at the point of release 9% of the time resulting in a jet fire rather than a toxic gas plume (Reference 2.2-9). The length of pipeline within 5 mi. (8 km) of the nearest Plant Complex power block is 6.57 mi. (10.6 km). Using the above probabilities and pipeline length, the frequency of hazardous control room is calculated to be 1.42 x 10^{-6} hazards per year for the North Plant Complex power block.

Since the results for the North Plant Complex exceed 10^{-6} toxic control rooms/yr, the Middle Plant Complex is also analyzed. The Middle Plant Complex is nearer to the pipeline than the South Plant Complex and was found to have worse results than the South Plant Complex. The analysis shows 133 out of 100,000 cases resulted in an uninhabitable control room at the Middle Plant Complex power block. The failure probability is 1.52 x 10^{-3} hazardous conditions per release with 95 percent confidence. The length of pipeline within 5 mi. (8 km) of the Middle Plant Complex power block is 6.12 mi. (9.85 km). Using the failure data presented above for the North Plant Complex, the total risk of a hazardous condition at the Middle Plant Complex power block due to pipeline rupture traveling vapor cloud is 2.03 x 10^{-7} per year.

2.2.3.1.2.4 Cumulative Toxic Hazard Frequency

The acceptance criterion is that the frequency of a hazardous control room for each chemical hazard must be less than 10^{-6} hazardous environments per year. The analyses are described in Section 2.2.3.1.2 and summarized here.

For most toxic hazard sources, the risk is dispositioned deterministically and probabilistic assessments are not used.

The analysis uses probabilistic risk models for multiple different [[ ]]^{SRI} sources including storage, truck deliveries, and railcar deliveries to the BCSS. The total risk due to [[ ]]^{SRI}

is determined using the current estimated number of annual deliveries by truck (14/yr.) and railcar (56/yr.). The risk from stationary [[ ]]^{SRI} storage, truck deliveries, and railcar deliveries are summed to determine the total risk at both the North and Middle Plant Complexes as shown in Table 2.2-13. The total risk to the North Plant Complex power block control room from all [[ ]]^{SRI} sources exceeds 1.0×10^{-6} hazardous control rooms per year. The total risk to the Middle Plant Complex power block control room, which also bounds that of the South Plant Complex, from all [[ ]]^{SRI} sources is 7.11×10^{-7} hazardous control rooms per year.

The total risk to the North Plant Complex power block control room from natural gas also exceeds 1.0×10^{-6} hazardous control rooms per year. The total risk to the Middle Plant Complex power block control room, which also bounds that of the South Plant Complex, from all natural gas sources is 2.03×10^{-7} hazardous control rooms per year.

All other chemicals analyzed probabilistically have a total hazard frequency less than 1.0×10^{-6} hazardous control rooms per year.

This analysis of toxic gas clouds includes the following significant conservatisms:

- All analyses use the site high analysis temperature of 91°F (33 °C). For the [[ ]]^{SRI} analyses, this maximizes the mass of the initial puff release and maximizes the evaporation rate. High temperatures concurrent with the worst-case wind speed and stability class are not expected because more stable classes occur at night with low wind speeds.

- Gas buoyancy is not credited for the natural gas pipeline releases. For the large release rates modeled for full pipe breaks, significant plume rise is expected. Plume rise enhances the gas dispersion and may eliminate the possibility of a confined explosion in many cases.

- Jet dilution of pipeline releases is not credited for the toxic gas analysis.

- None of the pipelines are considered to have any protection or isolation. Releases are modeled as continuing indefinitely.

- The calculated conditional probabilities of a toxic control room given a release are 95 percent confidence estimates rather than point estimates.

[[

]]^{SRI} Analysis may be refined or mitigating features employed once a final reactor technology is selected. Additional information will be provided in the construction permit or license application to demonstrate acceptability for the North Plant Complex.

All toxic chemical clouds meet the acceptance criterion and are not a design-basis hazard for the Middle and South Plant Complex power blocks.

The analysis credits nasal detection and donning of a self-contained breathing apparatus for

the following chemicals: [[ ]]SRI, hydrochloric acid, and natural gas (odorized). If the selected reactor technology has a safety-related control room, operators will be required to be trained in nasal detection and use of a self-contained breathing apparatus.

2.2.3.1.3 Fires

Natural fires (e.g., vegetation) and chemical fires are evaluated for the Project site. In all cases, analysis is used to determine a heat load and fire duration. The results are then compared to heat load and duration limits for structural concrete from NUREG/CR-3330. From NUREG/CR-3330, concrete walls can withstand 15 Kilowatts (kW)/m^2 (79 BTU/min-ft^2) for 11.6 hr., 25 kW/m^2 (132 BTU/min-ft^2) for 8.1 hr., and 50 kW/m^2 (264 BTU/min-ft^2) for 4.95 hr.

Natural fires are dispositioned using a conservative estimation of the available fuel heat load. The land surrounding the Project site contains hardwood and evergreen trees. A simple evaluation of the surrounding land using heat loads derived from United States Forestry Service fire modeling guidelines (Reference 2.2-11) found that a worst-case fire would result in at most 22.6 kW/m^2 (119 BTU/min-ft^2) of incident heat flux for 4.5 hr, when wooded areas are at least 100 ft. (30 m) from safety-related buildings. This is well below the NUREG/CR-3330 acceptance criteria. It will be confirmed that wooded areas are at least 100 ft. (30 m) from safety-related buildings in the construction permit or license application.

Three types of off-site chemical fires are considered: jet fires from the pipeline in the vicinity of the site, pool fires following spills of tanks or railcars of liquid flammable chemicals, and BLEVEs of chemicals that are gases at standard conditions but are stored as pressurized liquids. A bounding hazard was selected for each hazard type based on the mass of chemical, the heat of combustion, and the distance of the hazard from the Plant Complex power blocks. The analyzed hazards are a BLEVE of a [[ ]]SRI, a 235,000 lb. (107,000 kg) heptane pool fire on the NS rail line, and a methane jet fire of the 23-in. (58-cm) inner diameter Piedmont Natural Gas Co. pipeline. All three hazards were evaluated using ALOHA (Reference 2.2-5). All three hazards were evaluated at a distance of 870 ft. (265 m), which is the closest approach of any chemical hazard to a Plant Complex power block.

The bounding BLEVE fireball for release of [[ ]]SRI has a heat load of 25.6 kW/m^2 (135 BTU/min-ft^2) at a distance of 870 ft. (265 m) and burns for 18 sec. From NUREG/CR-3330, a concrete wall can withstand a 50 kW/m^2 (264 BTU/min-ft^2) heat load for 4.95 hr.

A pool fire of heptane was analyzed as the bounding liquid chemical at ambient conditions. The worst-case pool fire of 235,000 lb. (107,000 kg) of heptane has a heat load of 36.3 kW/m^2 (192 BTU/min-ft^2) at a distance of 870 ft. (265 m) and burns for 35 seconds. Note that the conditions of the bounding pool fire, such as pool diameter, were selected to maximize the heat flux. From NUREG/CR-3330, a concrete wall can withstand a 50 kW/m^2 (264 BTU/min-ft^2) heat load for 4.95 hr.

The jet fire for the 23-in. (58-cm) inner diameter natural gas pipeline was modeled such that the break release rate bounds that of the maximum flow documented in Table 2.2-12. The methane

jet fire has a maximum heat load of 3.86 kW/m^2 (20.4 BTU/min-ft^2). From NUREG/CR-3330, a concrete wall can withstand a 15 kW/m^2 (79 BTU/min-ft^2) heat load for 11.6 hr.

The evaluated fires do not pose a risk of thermal damage to structures at the Plant Complex power blocks within the Project site.

2.2.3.1.4 Collisions with Intake Structure and Liquid Spills

The cooling and makeup water intake for the Project site is provided from Belews Lake and the Dan River, which are not waterways used for commercial shipping (see Section 2.2.2.4). Therefore, an evaluation that considers the probability and potential effects of collision or hazardous liquid spills affecting the plant intake structure is not warranted.

2.2.3.2 Effects of Design-Basis Accidents

Evaluations were performed of potential hazards near the Plant Complex power blocks within the Project site. These evaluations concluded that potential accidents involving off-site explosions, flammable vapor clouds, and fires do not pose a threat to the Plant Complex power blocks within the Project site. [[

]]^{SRI} Toxic vapor clouds are not a design-basis hazard for the Middle Plant Complex and South Plant Complex power blocks. The effects of chemical releases from on-site chemical storage will be evaluated in the construction permit or license application because the required chemicals and location of safety-related structures must be considered to determine there is no adverse effect from these hazards.

Table 2.2-1
Major Facilities Near the Project Site – Products and Materials

[[

]]SRI

Note:
(a) Distance from site is measured from the edge of a 1-mile radius circle centered at the Project site center point.

Key: BCSS = Belews Creek Steam Station; mi. = mile; NC = North Carolina

Table 2.2-2
Toxic and Explosive Chemicals at Facilities Near the Project Site

[[

]]SRI

Notes:

(a) Equivalent TNT computed assuming 5% of the total mass is aerosolized dust.

(b) The hazard is not applicable for the chemical where "---" is indicated.

Key: BCCC = Belews Creek Steam Station; gal. = gallon; lb. = pound; NC = North Carolina; ppm = parts per million

Table 2.2-3
Pipelines Near the Project Site

[[

]]SRI

Note:
(a) Pipeline is within the Project site boundary. Distance is to the nearest location that could contain nuclear plant safety-related structures.

Key: in. = inch; mi. = mile; NC = North Carolina; psig = pounds per square inch gauge

Table 2.2-4
Hazardous and Explosive Chemicals Transported via Truck
Near the Project Site

[[

]]SRI

Notes:
(a) Equivalent TNT computed assuming 5% of the total mass is aerosolized dust.
(b) The hazard is not applicable for the chemical where "---" is indicated.
(c) Solid explosive treated as 100% TNT.

Key: lb. = pound; NC = North Carolina; PETN = Pentaerythritol tetranitrate; ppm = parts per million; TNT =2,4,6-trinitrotoluene; US = United States

Table 2.2-5
Hazardous and Explosive Chemicals Transported via Rail Near the Project Site

[[

]]SRI

Notes:

(a) Frequency based on January 31, 2023, to January 31, 2024, data.

(b) There were 93 coal trains in 2023. The total number of train cars is unknown.

(c) Equivalent TNT computed assuming 5% of the total mass is aerosolized dust.

(d) The hazard is not applicable for the chemical where "---" is indicated.

Key: BCSS = Belews Creek Steam Station; NC = North Carolina; ppm = parts per million

Table 2.2-6
Airports and Heliports in the Vicinity of the Project Site
(Sheet 1 of 2)

Airport Name	Location ID	Distance from Project Site Boundary (mi.)	Operations per Year[a]	Projected 2050 Operations	Allowable Operations Screening Value[c]
Meadow Brook Field	N63	4.7	AC: 0 AT: 0 GA: 12,050 M: 0 S: 12,050 (30,000)[b]	-	N/A[d]
DS Butler Farm and Airfield	N83	5.0	AC: 0 AT: 0 GA: 2100 M: 0 S: 2100	-	N/A[d]
Dusenbury Field	13NR	> 5.0	0	-	12,500
Lindsay	0NC7	> 5.0	0	-	12,500
Lewis Airstrip	7NC7	> 7.5	0	-	28,125
Meylor Field	9NC9	> 9.0	0	-	40,500
Robertson Field	NC63	> 10.0	0	-	100,000
Smith Reynolds	INT	> 11.5	AC: 153 AT: 4459 GA: 32,731 M: 418 S: 37,761	53,103	132,250
Piedmont Triad International	GSO	> 11.5	AC: 16,351 AT: 11,381 GA: 35,676 M: 2524 S: 65,932 (72,000)[b]	124,912	132,250
Mountain View Aerodrome	NC37	> 12.5	0	-	156,250
Air Harbor	W88	> 14.5	AC: 0 AT: 0 GA: 3600 M: 0 S: 3600	-	210,250

Table 2.2-6
Airports and Heliports in the Vicinity of the Project Site
(Sheet 2 of 2)

Airport Name	Location ID	Distance from Project Site Boundary (mi.)	Operations per Year[(a)]	Projected 2050 Operations	Operations Screening Value[(c)]
Rockingham County NC Shiloh	SIF	> 15	AC: 0 AT: 0 GA: 24,000 M: 100 S: 24,100	24,100	225,000
Warf	NR33	> 18.5	AC: 0 AT: 0 GA: 1100 M: 0 S: 1100	-	342,250
Moorefield's Airstrip	VA27	> 19.5	0	-	380,250
Charlotte/Douglas International	CLT	> 86	AC: 410,364 AT: 62,885 GA: 27,180 M: 918 S: 501,347	890,402	7,396,000
NC Baptist Hospital	5NC7	> 16	3000[(b)]	-	256,000

Notes:
(a) Data based on 2021-2023, or latest Federal Aviation Administration (FAA) filing by airport as of 2024.
(b) Data obtained from direct communication with the airport that provided larger number of operations than the latest reports filed with the FAA.
(c) $500D^2$ operations per year for sites within 5 to 10 statute mi. and $1000D^2$ operations per year for sites outside 10 statute mi. where D is the distance from the Project site to the airport.
(d) Airports within 5 mi. cannot be screened and require detailed evaluation.
Key: AC = air carrier; AT = air taxi; GA = general aviation; M = military; mi. = mile; N/A = not applicable; NC = North Carolina; S = total

Table 2.2-7
Industrial Projects in the Counties Near the Project Site

Company	Location	Description
Boom Supersonic	Piedmont Triad International Airport	400,000 sq. ft. facility on 65-acre (ac.) campus. Manufacturing facility including assembly line, test facility, and customer delivery center for the Overture supersonic airliner. The facility is scheduled to begin production in 2024.
Marshall Aerospace	Piedmont Triad International Airport	Single hangar comprising six bays for aircraft maintenance and one additional paint bay. Start of operations planned for 2025.
ProKidney	Greensboro, NC	210,000 sq. ft. facility on 22 ac. of land. Manufacturing facility to support commercial manufacturing of its proprietary drug REACT®.
Honda Aircraft	Greensboro, NC	Production lines to manufacture the company's new HondaJet 2600.
DC Blox	Greensboro, NC	54,000 sq. ft., 10 MW Data center to serve businesses in the Piedmont Triad area.
ImpactData	Greensboro, NC	115,000 sq. ft. 10 MW colocation data center for commercial services and higher education support at North Carolina A&T State University.
Ecolab	High Point, NC	1 million sq. ft. customer care center warehouse on 113 ac.
Procter & Gamble	Greensboro, NC	80,000 sq. ft. manufacturing facility.
John Deere and John Deere Electric Power Trains	Kernersville, NC	115,000 sq. ft. manufacturing facility for Kreisel Electric products battery technology estimated to begin production in 2025.

Key: ac. = acre; MW = megawatt; NC = North Carolina; sq. ft. = square feet

Table 2.2-8
Total Crash Frequency for each Aircraft Class per Year

Air Carrier	Air Taxi	Large Military	Small Military	General Aviation
6.03×10^{-8}	3.31×10^{-8}	7.02×10^{-9}	8.67×10^{-8}	7.85×10^{-6}

Table 2.2-9
Chemicals Evaluated for Flammable Vapor Clouds at Nearby Facilities

[[

]]SRI

Key: gal = gallon; lb. = pound

Table 2.2-10
Chemicals Analyzed for Explosive Vapor Clouds on Nearby Transportation Routes

[[

]]SRI

Note:

(a) Also used as bounding chemical for liquified petroleum gases and petroleum distillates.

Key: lb. = pound; NC = North Carolina; NS = Norfolk Southern

Table 2.2-11
Pipeline Scenarios Evaluated

Pipeline Scenario	Scenario Description	Target Evaluated	Break Diameter (inches)
1	Double-Ended Break, With Jet-Dilution	North Plant Complex Power Block	23
2	Double-Ended Break, With Jet-Dilution	Middle Plant Complex Power Block	23
3	Double-Ended Break, With Jet-Dilution	South Plant Complex Power Block	23
4	Double-Ended Break, Without Jet-Dilution	North Plant Complex Power Block	23
5	Double-Ended Break, Without Jet-Dilution	Middle Plant Complex Power Block	23
6	Double-Ended Break, Without Jet-Dilution	South Plant Complex Power Block	23
7	Small Break, Without Jet-Dilution	North Plant Complex Power Block	1
8	Small Break, Without Jet-Dilution	Middle Plant Complex Power Block	1
9	Small Break, Without Jet-Dilution	South Plant Complex Power Block	1

Table 2.2-12
Pipeline Double-Ended Break Flow Rate

Time (min)	Back Flow from Closed End (lb/min)	Forward Flow from Pressurized End (lb/min)	Total Mass Release Rate (lb/min)
0	63,900	64,200	128,100
1	28,000	35,000	63,000
2	20,000	35,000	55,000
3	10,000	35,000	45,000
5	0	35,000	35,000
600	0	0	0

Key: lb/min = pounds per minute; min = minute

Table 2.2-13
Cumulative Toxic [[ ]]SRI Risk

[[

]]SRI

Key: yr = year

2.3 METEOROLOGY

This section addresses the local and regional climatology and meteorology, as well as air quality, in the vicinity of the Project site. The information evaluates meteorological impacts that could affect the safe design and siting of the plant. Section 2.3.1 describes characteristics of the regional climate. Section 2.3.2 describes local meteorology, including measurements from an on-site meteorological tower. Section 2.3.3 describes the on-site multi-level meteorological tower (MET tower) and the meteorological data collection program. Section 2.3.4 provides short-term atmospheric diffusion estimates. Section 2.3.5 provides long-term atmospheric diffusion estimates.

2.3.1 REGIONAL CLIMATOLOGY

Information about regional climatology conditions was obtained from the National Climatological Data Center (NCDC) Storm Events Database and Local Climatological Data (LCD) for the cities of Winston-Salem and Greensboro. The Project site is located within the NCDC's NC Northern Piedmont Climate Division, or Climate Division 3. The nearest National Weather Service (NWS) Station is the Piedmont Triad International Airport (KGSO), which is approximately 14 mi. [22 km] to the southeast of the Project site. Meteorological Data from the Smith Reynolds Airport NWS Station at Winston-Salem, NC (KINT), and the NWS Station at Raleigh/Durham International Airport (KRDU) were also utilized. KGSO is located in Guilford County and is a reliable station for collecting meteorological data. (References 2.3-26; 2.3-27; 2.3-39).

More specific information for the Project site was obtained from the MET tower collection period from February 7, 2024, through February 6, 2025.

2.3.1.1 General Climate

The Project site is located in north-central NC in the southeast portion of Stokes County and is bordered by Rockingham County to the east, Guilford County to the southeast, and Forsyth County to the south. The state of NC spans approximately 500 mi. (802 km) east to west and 186 mi. (301 km) north to south. The Project site is in the northern Piedmont region which is east of the Blue Ridge Mountain Range. The mountain range barriers affect temperature, precipitation, and wind. The Project site is in a humid subtropical climate zone. Figure 2.3-1 shows an aerial view of the Project site with a 50 mi. (80.5 km) radius around the site.

KGSO is in the west-central part of Guilford County, in the northern Piedmont section of NC. The location is approximately centrally located between the mountains to the west and the coastline to the east and south, which provides a temperate climate. The mountains block cold air masses moving eastward; therefore, few days in the winter are below 20 °F (-6.7 °C). KINT, located in Winston-Salem, NC, is within 50 mi. (80.5 km) of the Project site, and experiences warm and muggy summers and very cold winters with variable snowfall.

The average minimum extreme annual temperature at KGSO is 11.4 ˚F (-11.4 ˚C) and at KINT the average minimum extreme annual temperature is 12.4 ˚F (-10.9 ˚C) (see Table 2.3-1). Tropical air brings warm temperatures and high humidity to the area during the summer months.

During the summer, the average maximum annual temperatures at KGSO and KINT are 95.7 ˚F (35.4 ˚C) and 95.5 ˚F (35.3 ˚C), respectively.

Table 2.3-14 summarizes average, daily minimum, and daily maximum temperatures (dry bulb and wet bulb) recorded at the Project site during the collection period from 2024–2025. The highest daily maximum temperatures for the collection period occurred during the months of June and July. The lowest daily minimum temperatures occurred in December and January. The average dry bulb monthly temperatures range from the mid-30s (°F) (around 0 ˚C) in the winter to the upper 70s (°F) (around 25 ˚C). The extreme daily maximum recorded at the Project site was 97.3°F (July 2024), while the extreme daily minimum was 15.8 °F (January 2025).

Rainfall is fairly consistent throughout the year but varies significantly from year to year. July and August have the highest rainfall amounts, while October and November have the least. Summer rainfall is usually from thunderstorm activity that can also bring strong winds and hail.

Tornadoes, hurricanes, tropical storms, and depressions are infrequent in the area of the Project site (References 2.3-23; 2.3-26; 2.3-27; 2.3-40). See Sections 2.3.1.2.1.4 and 2.3.1.2.1.5 for additional information on the infrequency of these events.

2.3.1.2 Regional Meteorological Conditions for Design and Operating Basis

The regional meteorological conditions that are relevant to the design and operating basis for the Project site are discussed herein.

2.3.1.2.1 Severe Weather

Severe weather may require consideration in the design of safety-related structures, systems, and components (SSCs). Information about severe weather phenomena was obtained from the NCDC Storm Events Database that covers a 73-year period between 1950 through 2023. Additionally, LCD for the counties of Forsyth and Guilford were obtained.

Overall, severe storms are relatively infrequent in NC. The Project site is far enough inland that it is typically not affected by the brunt of intense tropical cyclones and hurricanes.

2.3.1.2.1.1 Thunderstorms, Hail, and Lightning

Thunderstorms and lightning mainly occur in the spring and summer months. Thunderstorms are occasionally accompanied by strong winds, heavy rain, and hail. Damaging thunderstorms are infrequent in the area of the Project site, according to the 75-year period reported on the KGSO and KRDU 2022 LCDs (References 2.3-26; 2.3-27). From 2002 to 2023 (8035 days), 174 severe thunderstorm warnings over 154 days were issued for the site center point of the facility. The percentage of days with a severe thunderstorm warning being issued for the site center is 1.92 percent during this period.

Hail has a diameter of five millimeters (mm) or greater and is always produced by convective clouds (Reference 2.3-5). Hail usually occurs coincident with thunderstorms in Forsyth County, Guilford County, Rockingham County, and Stokes County. A total of 553 hail events are

recorded in the National Centers for Environmental Information (NCEI) Storm Events Database from 1950 to 2023 in these counties. The largest size of hailstones reported were 2.25 in. (5.72 cm) in Stokes County, June 2002; 2.75 in. (6.99 cm) in Guilford County, April 1983; Rockingham County, June 1998; and Forsyth County, March 2005 (Reference 2.3-23).

In Forsyth County and Guilford County, severe hail (3/4 inch [in.] diameter or larger) has been reported 161 times during 1950 through 2023 (Reference 2.3-23). This corresponds to between 2 and 3 severe hail events per year.

2.3.1.2.1.2 Extreme Winds

The maximum strong wind recorded in Forsyth County, Guilford County, Rockingham County, or Stokes County was 50 knots (kts) (57.5 mph 92.6 kilometers per hour [kph]) which occurred in Stokes County, April 2003 (Reference 2.3-23). The maximum high wind recorded in those counties was 60 kts (69 mph [111 kph]), which occurred in February 2003 and March 2004 in Rockingham County and Stokes County (Reference 2.3-23). The thunderstorm wind maximum was 100 kts (115 mph [185 kph]) in Forsyth County in July 1962 (Reference 2.3-23). The database was queried from 1950 to 2023 for Forsyth County, Guilford County, Rockingham County, and Stokes County. The 100-year mean return interval (MRI) 3-second wind gust is 93 mph (42 meters per second [m/s]) (Reference 2.3-11).

The wind patterns are influenced by the local topography, which will affect the severe weather regionally. In the Piedmont region rainfall is modified by the mountain barrier, but to a lesser extent than in areas closer to the Appalachian Range. Shallow cold air masses from the W tend to be stopped or turned aside by the mountains, while deeper masses are lifted over the range, losing moisture, and warming during the passage. Summer precipitation is largely from thunderstorms, which signal an unstable atmosphere, mostly local in character. Damaging storms are infrequent in the Northern Piedmont area. The highest winds to occur have been associated with thunderstorms and are brief in duration.

2.3.1.2.1.3 Precipitation Extremes

Precipitation events were obtained from the NCEI Storm Events Database for Guilford County and Stokes County. Records indicate heavy rain is mostly associated with thunderstorms and tropical weather (hurricanes and tropical storms). The Storm Events Database defines heavy rain as an unusually large amount of rain which does not cause a Flash Flood or Flood event but causes damage. There are a total of three heavy rain (rain at a rate of accumulation exceeding the geographically dependent value [Reference 2.3-6]) events recorded in the NCEI Storm Events Database for Guilford County and Stokes County. The first was the rain event of February 3 – 4, 1998 when Goldsboro recorded 2.25 in. (5.72 cm), then on May 18, 2018, the NWS Cooperative Observer Program observer at King recorded 2.70 in. (6.86 cm) over a 24-hr. period which was the highest daily May rainfall at that station. More recently on February 6 – 7, 2020 the station at Danbury set a February two-day record with 4.89 in. (12.42 cm).

Floods are defined as the overflowing of the normal stream or body of water, or the accumulation of water over areas not normally submerged (Reference 2.3-7), whereas flash

floods are rapidly rising water levels in waterways, usually as a result of intense rainfall (Reference 2.3-8). The NCEI Storm Events Database recorded a total of 55 flood events and 254 flash flood events for the time period from 1950 to 2023 in Forsyth County, Guilford County, Rockingham County, and Stokes County for a total of 309 flooding events (Reference 2.3-23). This is an average of less than five flood events per year.

2.3.1.2.1.4 Tornadoes

Tornado intensity is classified according to the Enhanced Fujita Tornado Intensity Scale (EF Scale). This scale correlates wind speeds from a tornado event to the magnitude of observed damage according to 28 indicators. The EF Scale ranks tornadoes in categories EF-1 to EF-5. This updated scale uses more specific structural damage indicators than the original previously used tornado intensity classification scale, the Fujita Scale, which was established in 1971 (Reference 2.3-33).

Tornadoes infrequently occur around the Project site, with only 52 recorded in Guilford, Stokes, Rockingham, and Forsyth counties over 39 days from 1950 to 2023 (27,028 days). The percentage of days with a tornado occurring during this period is 0.14 percent. The strongest tornadoes recorded in the area (F3/EF-3) occurred during the months of March and May on the following dates and in these counties (Reference 2.3-23):

- May 1985 Forsyth County
- May 1989 Forsyth County
- March 1998 Rockingham County
- May 1998 Forsyth County
- May 2008 Forsyth County
- March 2010 Guilford County

Tornado Strike Probability

The probability of a tornado occurring at the Project site is low based on records from the NCDC Strom Events Database. Based on the tornado strike probability presented in NUREG/CR-4461, the number of tornado events from 1950 through August 2003 within a 2-degree box surrounding the Project site is 221, based on the latitude and longitude of the Project site (Figure 5-7 of Reference 2.3-37). This gives an annual average (221 tornadoes/53 years) of approximately 4 tornado events striking somewhere within the 2-degree box.

Based on the principle of geometric probability (Reference 2.3-41), the probability of a tornado striking any point in a 1-degree latitude by 1-degree longitude square may be calculated as follows:

$$P = \frac{zt}{A}$$ (Equation 2.3.1-1)

Where:

P = mean probability of a tornado striking a point in any year in a 1-degree square.

z = mean path area of a tornado (miles squared) = 0.314 mi. squared based on weight average from Table 2-14 of NUREG/CR-4461.

t = mean number of tornadoes per year from Figure 2-1 of NUREG/CR-4461.

= 38 tornadoes / 53.67 years = 0.71 tornadoes per year.

A = area (in miles squared) = approximately 3857 miles squared for the 1-degree square containing the Project site.

Therefore, the annual tornado probability for the 1-degree square containing the Project site (P, from Equation 2.3.1-1) = (0.314 x 0.71) / 3857 = 5.78×10^{-5} per year.

The inverse of tornado probability gives the mean recurrence interval (R) for a tornado striking a point within the 1-degree square.

$$R = \frac{1}{P}$$ (Equation 2.3.1-2)

Recurrence interval (R, from Equation 2.3.1-2) = 17,260 years

Design Basis Tornado Parameters

Site characteristic tornado parameters are based on guidance provided NRC RG 1.76, *Design Basis Tornado and Tornado Missiles for Nuclear Power Plants*. Based on RG 1.76, the Project site is in Region I. The characteristics applicable to SSCs important to safety at the Project site include the tornado maximum wind speed, translational speed, maximum rotational speed, radius of maximum rotational speed, pressure drop, and rate of pressure drop (from Table 1 of RG 1.76). The values of these parameters for the Project site are given in Table 2.3-2. Additionally in accordance with 10 CFR 50.34, SSCs that are important to safety are required to be designed to withstand natural weather phenomena without their safety function capability being compromised. Table 2.3-3 summarizes the design basis tornado missile spectrum and maximum horizontal speeds (from Table 2 of RG 1.76).

2.3.1.2.1.5 Hurricanes

Hurricanes, also known as tropical cyclones, have 1-minute average surface (10 m [32.8 ft]) winds exceeding 33 m/s (65 kts). Hurricanes originate from tropical depressions (winds up to 17 m/s [34 kts]), which can develop into tropical storms (winds 18 – 32 m/s [35 – 64 kts]) prior to being classified as a hurricane (Reference 2.3-2).

Twenty-two historical hurricane tracks are reported within 50 mi. of the site center point, by the

NOAA Historical Hurricane Tracks website. Of these, only an unnamed 1993 storm-maintained hurricane strength (Category 1) in the area, which is also confirmed by the NC State Climate Office (Reference 2.3-39). Additionally, four tropical storms were recorded from 1959 to 2023. Hurricanes and tropical storms can produce heavy rainfall, severe thunderstorms, hail, high winds, and flooding in the area. From 1859 to 2023, NOAA Atlantic Storm Totals climatology recorded 2950 total storms (hurricanes, tropical storms, and major hurricanes). The percentage of any Atlantic tropical system tracking within 50 mi. (80.5 km) of the site center point is 0.88 percent during this period.

Other storms impacted the area, but the centers of those storms did not pass through a 50 mi. radius of the site center point. The strongest hurricane which was within a 200 mi. (322 km) radius and had rains impacting Forsyth County and Guilford County was Hurricane Fran (September 5, 1996), a Category 3 hurricane (References 2.3-28; 2.3-23). Hurricane Floyd made landfall on NC's eastern coast and the hurricane-related rainfall (September 15, 1999) extended inland as far as Forsyth County and Guilford County (References 2.3-29; 2.3-23).

Design Basis Hurricane Wind Speed Parameter

The Project site design basis hurricane wind speed parameter is based on guidance provided in NRC RG 1.221, *Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants*. Based on RG 1.221, Figure 2, the Project site is located within wind speed contour band corresponding to 160 mph (258 km/h). This wind speed represents a 3-second gust wind velocity at 33 ft. (10 m) AGL in the site area, corresponding to a hurricane wind event with a 10^{-7} annual exceedance probability.

2.3.1.2.2 Winter Storm Events

Snow, sleet, glaze, and ice accumulation are rare during the winter months and short-lived when experienced. Snowfall amounts vary greatly, with some winters experiencing only trace snowfall amounts. Glazing is more common in the Piedmont area of NC (where the Project site is located) than the rest of the state but is usually not damaging.

Normal annual snowfall for the Project site is between 5.2 in. (13.2 cm) and 7.1 in. (18.0 cm). Maximum monthly snowfall ranges from 25.8 in. (65.5 cm) at KRDU, 22.9 in. (58.2 cm) at KGSO, and 21.3 in (54.1 cm) at KINT. The mountains to the W affect the winter temperatures and weather. This area experiences winter rain or snowfall amounts that are variable from year to year and rarely persist for more than a few days (References 2.3-26; 2.3-27).

2.3.1.2.2.1 Ice Storms

According to Tattelman and Gringorten's, "Estimated Ice and Wind Loads at the Earth's Surface for the Contiguous United States," ice thickness (t_i) greater than or equal to 2.5 cm (0.98 in.) occurred only two times in the state of NC during 50 years (Reference 2.3-40). From the Bennett 1959 study referenced in Tattelman and Gringorten's report, a total of 9 to 17 glaze storms, without regard to thickness. were observed. NC is in Region V in their report, five ice storms in 50 years with accumulation greater than or equal to 2.5 cm (0.98 in.) (Reference 2.3-

40).

Since Tattelman and Gringorten's 1973 publication, there have been multiple ice storms in the region. On December 4 – 5, 2002 a high-pressure system over the northeast U.S. created a system in the western Piedmont where snow fell for up to 8 hours in Greensboro before transitioning to sleet and freezing rain. The freezing rain lasted for more than 12 hours with up to an inch of ice accumulation in parts of the Piedmont. Back-to-back ice storms occurred in 2020. The February 12 – 13 storm had a quarter-inch of ice accumulation in the Greensboro area then the February 18 – 19 storm with areas along I-40 and US 421 between Burlington and Boone generally received around a quarter-inch of glaze.

2.3.1.2.2.2 Ground-Level Weights of Extreme Snowpacks and Snowfall Events

The snowpack, as defined in this section, is the depth of a layer of ice and snow on the ground surface measured routinely at manned weather observing stations. Maps of the weight of the 50-year mean recurrence interval snowpack are available in ASCE 7/16. The weight of the 50-year snowpack from Figure 7.2.1 in ASCE 7/16 is 20 pounds per square foot (psf) at the Project site (Reference 2.3-10). Using an adjustment factor of 1.22 presented in Section C7.3.3 of ASCE 7/16, the weight of the 100-year snowpack is 24.4 psf (24.4 psf = 20 psf x 1.22).

Note that ASCE changed its methodology for compiling snowpack information to design structures in its more recent ASCE 7/22. ASCE 7/22 compiled snowpack information to target a uniform structure reliability instead describing a uniform meteorological hazard (e.g., a 50-year return-interval snowpack) (Reference 2.3-11). ASCE 7/22 does not provide guidance on estimating 100-year snowpacks from snowpack information provided therein. Therefore, for purposes of estimating the weight of a 100-year snowpack in this report, guidance from ASCE 7/16 is used.

The maximum reported snow depth at KGSO is 15.0 in. (38.1 cm) which occurred in January 1966. The maximum reported snow depth at KRDU is 20.0 in. (50.8 cm) which occurred in January 2000 (References 2.3-26; 2.3-27).

The NRC's Interim Staff Guidance (ISG) on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures (NRC ISG DC/COL-ISG-07) (Reference 2.3-35), provides an algorithm (below) for converting historical maximum snowpack depth to a ground snow load:

$$L = 0.279D^{1.36} \quad \text{(Equation 2.3.1-3)}$$

Where:

D = the snowpack depth in inches.

L = the resulting snow loads in pounds per square foot (psf).

Using the higher of the two maximum observed snow depths at KGSO and KRDU (20.0 in. [50.8 cm] at KRDU) in Equation 2.3.1-3, the weight of the historical snowpack is 16.4 psf (16.4 psf = $0.279 \times 20.0^{1.36}$).

For purposes of applying guidance in NRC ISG DC/COL-ISG-07, two-day snowfalls are used to ensure that storms that persist for more than a one-day recording period are accurately captured. From the U.S. Department of Commerce (USDOC), 1998 the maximum two-day snowfall event at KRDU is 11.1 in. (28.2 cm) (Reference 2.3-44). In the four-county area around the Project site, (Stokes, Rockingham, Guilford, and Forsyth counties) the highest two-day, snowfall is 14.0 in. (35.6 cm) at Reidsville in Rockingham County, NC.

Other information regarding historical maximum snowfall events is available from KGSO and KRDU. The maximum observed 24-hour snowfall at KGSO is 14.3 in. (36.3 cm) in December 1930 (Reference 2.3-26). Digital records from KGSO are not available for December 1930 to determine a corresponding two-day snowfall. However, a cooperative weather observer in Greensboro, NC recorded a one-day snowfall of 14.0 in. (35.6 cm) on December 17, 1930 (Reference 2.3-24). This suggests that a maximum two-day snowfall at KGSO of 14.3 in. (36.3 cm) is reasonable. The maximum two-day snowfall at KRDU is 20.3 in. (51.6 cm) in January 24 – 25, 2000 (References 2.3-26; 2.3-25).

NRC ISG DC/COL-ISG-07 (Reference 2.3-35) provides an algorithm that converts a snowfall event to a ground snow load. The algorithm relates the snowfall depth in inches (S) to the resulting ground snow load (L) in psf:

$$L = (0.15)(S)(5.2) \qquad \text{(Equation 2.3.1-4)}$$

In Equation 2.3.1-4, the constant (0.15) represents the ratio of the volume of melt water derived from a snow sample and the constant (5.2) is the weight of 1 in. of water in psf. Using this algorithm with the highest observed two-day snowfall (20.3 in. [51.6 cm] at KRDU), the weight of the historical maximum two-day snowfall event is 15.8 psf (15.8 psf = 0.15 x 20.3 in. x 5.2).

The 100-year return period snowfall event is available from the U.S. Snow Climatology data (Reference 2.3-44). For purposes of applying guidance in NRC ISG DC/COL-ISG-07, two-day, 100-year snowfalls are used to ensure that storms that persist for more than a one-day recording period are accurately captured.

From USDOC (Reference 2.3-44), the maximum two-day, 100-year snowfall event at KRDU is 13.7 in. (34.8 cm). In the four-county area around the Project site, (Stokes, Rockingham, Guilford and Forsyth counties) the highest two-day, 100-year snowfall is 19.9 in. (50.5 cm) at Danbury 1 northwest (a cooperative observing station located approximately one mile [1.6 km] northwest of Danbury in Stokes County, NC). Thus, from available data the maximum two-day, 100-year snowfall event is 19.9 in. (50.5 cm). The weight of the highest two-day, 100-year snowfall event estimated from Equation 2.3.1-4 is 15.5 psf (15.5 psf = 0.15 x 5.2 x 19.9 in.).

The estimated weights of the 100-year snowpack, historical maximum snowpack, historical maximum two-day snowfall event, and the maximum 100-year return two-day snowfall event for

the Project site are summarized in Table 2.3-5.

2.3.1.2.2.3 Normal Winter Precipitation Event

The NRC ISG DC/COL-ISG-07 defines the Normal Winter Precipitation Event as the highest ground-level weight (in psf) among (1) the 100-year return period snowpack; (2) the historical maximum snowpack, (3) the 100-year return two-day snowfall event, or (4) the historical maximum two-day snowfall event. Thus, from the results above the Normal Winter Precipitation Event for the Project site is 24.4 psf.

2.3.1.2.2.4 Extreme Frozen Precipitation Event

The NRC ISG DC/COL-ISG-07 defines the Extreme Frozen Precipitation Event as the higher ground-level weight (in psf) between (1) the 100-year return (two-day) snowfall event and (2) the historical maximum (two-day) snowfall event (Reference 2.3-35). Thus, from the results above the Extreme Frozen Precipitation Event for the Project site is 15.8 psf.

2.3.1.2.2.5 Extreme Liquid Winter Precipitation Event

The Extreme Liquid Winter Precipitation Event is defined as the theoretically greatest depth of precipitation (in inches of water) for a 48-hour period that is physically possible over a 25.9-sq. km. (10 sq. mi.) area. Per NRC ISG DC/COL-ISG-07, the extreme liquid winter precipitation event is determined in accordance with the respective Hydrometeorological Reports (HMR) published by NOAA's Hydrometeorological Design Studies Center (Reference 2.3-45).

From USDOC (Reference 2.3-45), the 24-hour Probable Maximum Winter Precipitation (PMWP) (December – February) for a 10 sq. mi. area around the Project site is approximately 20 in. (50.8 cm). The corresponding 72-hour PMWP for a 10 sq. mi. area around the Project site is 26 in. (66.0 cm). Assuming a linear relationship between these values produces a 48-hour PMWP of approximately 23 in. (58.4 cm). Due to the warm climate of the Project site, most of the 48-hr. PMWP remains in liquid form and does not contribute to roof loading.

2.3.1.2.3 Atmospheric Stagnation

Air pollution episodes are typically the result of persistent surface high pressure systems that cause light and variable surface winds and stagnant meteorological conditions. The Bermuda High is a large area of semi-permanent high pressure, usually situated off the United States' southeastern Atlantic coast. Depending upon the position and strength of this weather system, the Bermuda High can lead to stagnant meteorological conditions in the region. The Bermuda High is strongest in July (Reference 2.3-53). This high-pressure system has a clockwise circulation, which puts the eastern United States in the position to receive south to southeast winds. These winds pump in heat and humid air from the Atlantic Ocean and Gulf of America over the Carolinas. It can often lead to many days or even weeks of hot and sticky weather, especially across the southeastern United States. Therefore, the Bermuda High is a unique controlling factor for air stagnation and stable atmospheric conditions over the eastern United States, besides the seasonal cycle of minimum wind in summer and maximum wind in winter.

Another unique feature of air stagnation in the eastern United States is its early onset in May, compared to the onset in June in the western and central United States. This results in a prolonged air stagnation season in the eastern United States.

Estimates

Estimates of the stagnation frequency are provided in Wang and Angell (Reference 2.3-53); Figures 1 and 2. Those estimates indicate that, on average, the Project site experiences approximately two to four cases of air stagnation per year. When stagnation occurs, stagnation lasts approximately five days.

2.3.1.3 Design Basis Dry- and Wet-Bulb Temperatures

This section provides ambient temperature and humidity statistics for use in establishing heat loads for the design of normal plant heat sink systems, post-accident containment heat removal systems, and plant heating, ventilating, and air conditions systems.

The mean dry bulb temperature (DBT) at KGSO is 58.3 °F (14.6 °C) with a mean maximum of 77.8 °F (25.4 °C) and mean minimum of 39.0 °F (3.9 °C). The mean wet bulb temperature (WBT) at KGSO is 50.1 °F (10.1 °C) with a mean maximum of 69.0 °F (20.6 °C) and mean minimum of 30.9 °F (-0.6 °C) (References 2.3-26; 2.3-27).

Design basis DBTs and WBTs were estimated for the Project site, using data from KGSO, KRDU, and KINT (Table 2.3-4 for items 1-17 and Table 2.3-1 for items 18 and 19). These include the following temperatures:

1. Normal DBT
2. Mean DBT
3. Mean WBT
4. Maximum Normal DBT
5. Maximum Mean DBT
6. Maximum Mean WBT
7. Minimum Normal DBT
8. Minimum Mean DBT
9. Minimum Mean WBT
10. DBT with Annual Exceedance Probability of 0.4 percent
11. Mean Coincident WBT with Annual Exceedance Probability of 0.4 percent
12. DBT with Annual Exceedance Probability of 1.0 percent

13. Mean Coincident WBT with Annual Exceedance Probability of 1.0 percent
14. DBT with Annual Exceedance Probability of 2.0 percent
15. Mean Coincident WBT with Annual Exceedance Probability of 2.0 percent
16. WBT (Non-Coincident) with Annual Exceedance Probability of 0.4 percent
17. WBT (Non-Coincident) with Annual Exceedance Probability of 1.0 percent
18. 100-year extreme maximum and minimum DBT
19. 100-year extreme maximum and minimum non-coincident WBT

The 100-year return interval extreme maximum and minimum DBT and WBT ([18] and [19] in the above list) are estimated using a technique described in American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) (Reference 2.3-12). This technique calculates the n-year return interval extreme maximum or minimum temperature using the average and standard deviation of a series of annual maximum and minimum temperatures with the following equation:

$$T_n = M + IF_s \qquad \text{(Equation 2.3.1-5)}$$

Where:

T_n = n-year return period value of the extreme temperature computed (years).

M = mean annual extreme temperature.

I = +1 if the maximum temperature is being computed, -1 if the minimum temperature is being computed.

S = standard deviation of the annual extreme temperature.

N = return period in years (e.g., n = 100 for a 100-year return interval).

$$F = -\sqrt{6}/\pi \{0.5772+\ln\{\ln[(n/(n-1)]\} \qquad \text{(Equation 2.3.1-6)}$$

Where:

F = a function that converts the standard deviation of annual extreme temperature parameters to a new variable that is linearly related to the n year return interval extreme temperature (T_n).

ASHRAE (Reference 2.3-12), provides the mean annual extreme maximum and mean annual extreme minimum temperature (M) and the corresponding standard deviation(s) used in Equation 2.3.1-5. The 100-year return minimum and maximum annual extreme DBT and non-coincident WBT are computed using Equations Equation 2.3.1-5 and Equation 2.3.1-6 for KGSO, KINT, and KRDU and are listed in Table 2.3-1.

Winter Storm Elliott presented a cold event in December 2022 with a minimum temperature of 5 ˚F (-15.0 °C) recorded at KGSO. An arctic cold front swept across the foothills and the Piedmont area of western NC during the morning of December 23, 2022, and introduced the coldest air mass in more than five years. Temperatures in the single digits and lower teens combined with 10 to 20 mph (16.1 – 32.2 kph) winds to produce wind chill values in the 0˚ to -15 ˚F (-18 to -26 ˚C) range from the evening of the December 23, 2022, through December 24, 2022. While winds abated through December 25, 2022, unseasonably cold weather persisted for the better part of four days. There were numerous reports of frozen and burst pipes along with mostly minor damage to infrastructure throughout the area. Using the 5 ˚F (-15.0 °C) minimum temperature in the ASHRAE calculation for return intervals, a return interval of nine years is computed.

2.3.1.4 Meteorological Data for Evaluating Ultimate Heat Sink

None of the advanced reactor designs being evaluated rely on an external water source as its ultimate heat sink (UHS). Therefore, meteorological parameters (dry and wet bulb temperature, ambient temperature, humidity, and degree-days below freezing) that characterize evaporation and drift loss of water, minimum water cooling, and the potential for water freezing in a UHS water storage facility are not applicable to the Project site.

2.3.1.5 Climate Changes

Historical long-term meteorological data are considered in the project's impact on the surroundings of the Project site. Though the impact of global climate change is uncertain, projected trends are discussed in this section. Consistent with NRC ISG NRC COL/ESP-ISG-026 (Reference 2.3-36), the normal project lifetime, decommissioning period, and resources that may be impacted by climate change are considered. The first unit at the Project site is estimated to be online in 2034 as the earliest possible commercial operation date, with a planned 12-month stagger between units for units 2 – 6 to come online. The initial operating license for each unit is for 40 years and license renewals could extend the operating period an additional 40 years. Thus with the initial license and renewals, the units could operate up to 80 years, with potential in the future to extend the operating life up to a total of 100 years.

The North Carolina Climate Science Report (NCCSR) (Reference 2.3-20) assesses historical climate trends and potential future climate change in NC under increased greenhouse gases (GHG) concentrations and provides projected changes for the climate of NC for two hypothetical climate futures: a higher scenario (Representative Concentration Pathway 8.5, or RCP8.5), in which GHG emissions continue to increase through the end of the century, and a lower scenario (RCP4.5), in which emissions increase at a slower rate, peak around the middle of the century, and then begin to decrease.

Sea level along the northeastern coast of NC has risen about twice as fast as along the southern half of the coast, averaging 1.8 in. (4.6 cm) per decade since 1978 at Duck, NC, and 0.9 in. (2.3 in.) per decade since 1935 at Wilmington, NC (Reference 2.3-20). A more recent study considered the effect of relative sea level rise (RSL) on historical water levels observed

along the NC coast and found that under the higher scenario (RCP8.5) after 2050, water levels that currently have a 10 percent probability of occurring each year would have nearly a 100 percent probability of occurring each year in Wilmington. Furthermore, water levels that currently have a 1 percent probability of occurring each year would have nearly a 60 percent probability of occurring each year from 2050 to 2100. Threats associated with these conditions would not have a direct effect on the Project site, due to its inland location.

The NCCSR projects that it is very likely that NC temperatures and extreme precipitation frequency and intensity will increase, and it is likely that the frequency and severity of inland flooding will increase (Reference 2.3-20).

The National Climate Assessment (NCA) Report provides detailed information related to the potential effects of climate change on the U.S. by region (Reference 2.3-52). The Project site is in the southeast region of the U.S. as defined by the report. In general, the NCA report states that the southeast region is vulnerable to sea level rise and coastal flooding, extreme heat events, hurricanes, and tropical cyclones, and increasing wildfire risk (Reference 2.3-52).

The NCA report found that heatwaves in the southeast region are happening more frequently and are occurring during a longer heat season, with some cities also showing increasing trends in heatwave duration and intensity.

The number of extreme warm days (above 95 °F [35 °C]) is expected to continue increasing with every increment of global warming. Further, there have been an increasing number of days that exceed 95 °F (35 °C) and nights that exceed 75 °F (24 °C) and a decrease in the number of “extremely cold” days since 1900. (Reference 2.3-52).

Temperatures have steadily increased across the southeast since the 1970s. Climate models agree that annual temperatures will continue to increase in the future, with an average annual increase of 3 – 5 °F (approximately 1.7 – 2.8 °C) by 2041 – 2070. Simulated temperature increases for winter and spring are between 2.5 – 5 °F (1.4 – 2.8 °C). For summer the simulated temperature increases from 3.5 – 6 °F (1.9 – 3.3 °C), and during the fall the increase is between 3 – 5 °F (1.7 – 2.8 °C) (Reference 2.3-43). These are probabilistic predictions; however, if these numbers are simply interpolated for the next 50 years, results indicate an approximate total increase of 2 °F (1.1 °C) to 4 °F (2.2 °C) during the operating lifetime of the Project site. The report also finds that days with maximum temperatures exceeding 95 °F (35 °C) are predicted to increase, with more than 35 additional days occurring in central Florida and 20 – 30 additional days across the rest of the region, and there is likely to be a decrease in days with freezing temperatures (Reference 2.3-52).

The NCA report states that the southeast region is more prone to extreme drought due to higher rates of evapotranspiration than other parts of the eastern United States. Longer-term droughts in the region appear to be increasing in severity but do not appear to be occurring more frequently (Reference 2.3-52).

The NCA report states that the southeast region has received increasing precipitation in the fall, but over the past few decades there has been a decreasing trend in rainfall in summer. Most

climate models forecast that the decrease in summer rainfall will continue with mean annual precipitation expected to decrease across the western portion of the southeast region. Extreme rainfall events have occurred more frequently across the southeast region in the past 20 years. Average annual precipitation from 2002 to 2021 was 5 percent to 15 percent higher relative to the 1901 – 1960 average in the central and eastern U.S. (Reference 2.3-52).

The NCA has investigated severe weather events including hurricanes, tropical storms, and tornadoes. The NCA report states that warmer temperature projections would result in a decrease in tropical storms globally, however, there has been a slight increase in the frequency of tropical storms in the Atlantic, and the number of major hurricanes (category 3 – 5) has increased over the past few decades (Reference 2.3-43). The Project site is located inland and not likely to experience the most severe impacts of hurricanes. However, extreme rain events are a risk with or without tropical systems. The study reports that the number of major tornadoes has increased in the past 50 years, however, there is "no statistically significant trend." The study indicates that the increase in the number of tornadoes reported may be attributable to expanded and better reporting of tornadoes (Reference 2.3-52).

Based on the NCA report, the greatest potential effects of climate change are increased temperatures and reduced water availability due to evapotranspiration and droughts for the Project site, and its surroundings. At the same time, stormwater from extreme precipitation events may increase. As the models used to develop these projections are based on future estimates of population growth, land use, energy consumption, emissions patterns, etc., there is a level of uncertainty associated with the events and meteorological conditions predicted. The Project site is required to continuously monitor meteorological and environmental conditions throughout the life cycle of the project to ensure it remains within its allowable licensed limits of operation. Details related to meteorological monitoring and water monitoring are covered in Duke Energy's Environmental Report Sections 2.7 and 4.2.4, respectively.

2.3.1.6 Regional Air Quality Conditions

The Project site is located within the Northern Piedmont Intrastate Air Quality Control Region. The Clean Air Act (CAA) was enacted in 1970 to protect public health and welfare and authorizes the USEPA to set National Ambient Air Quality Standards (NAAQS) for six common pollutants, called criteria pollutants. There are also provisions to regulate hazardous air pollutants, which are pollutants that are harmful to human health and/or the environment, as well as GHG, primarily carbon dioxide (CO_2) (42 U.S. Code 7401 et seq).

The CAA requires the USEPA to set NAAQS for pollutants considered to be harmful to public health and the environment. Primary NAAQS provide public health protection including protecting the health of sensitive populations (asthmatics, children, elderly, etc.). Secondary NAAQS provide public welfare protection against decreased visibility and damage to animals, crops, vegetation, and buildings (Reference 2.3-48).

On February 7, 2024, the USEPA issued its final rule reconsidering the particulate matter NAAQS (40 CFR Parts 50, 53, and 58). USEPA is revising the level of the primary (health-

based) annual standard for fine particles (particulate matter with a diameter of 2.5 micrometers or smaller, $PM_{2.5}$) from the current level of 12 micrograms (µg) per m^3 to 9 µg per m^3. The NAAQS are presented in Table 2.3-6. NC reached full attainment with all NAAQS across the entire state in 2015. The most recent pollutant to be redesignated was ozone. On July 28, 2015, the USEPA redesignated to attainment the NC portion of the Charlotte-Rock Hill, NC-SC, nonattainment area for the 2008, 8-hour ozone NAAQS, effective August 27, 2015.

2.3.1.6.1 Class I Areas

The CAA defines Class I areas as national parks greater than 6000 ac. (2428 ha), wilderness areas greater than 5000 ac., national memorial parks greater than 5000 ac. (2023 ha), and international parks that were in existence as of August 1977. These areas are potentially sensitive to visibility impairment. The USEPA states that a Class I visibility impact analysis is necessary for a major source within 100 km (62 mi.) of a Class I area (Reference 2.3-46).

The USEPA promulgated the Regional Haze Rule to Improve visibility in Class I areas in 1999 with the ultimate goal of restoring natural background visibility by 2064 (Reference 2.3-16). This rule was amended in 2005 to require certain industrial facilities to install emission controls to reduce emissions of air pollutants that reduce visibility (References 2.3-17; 2.3-49). These pollutants include particulate matter with $PM_{2.5}$ and compounds that contribute to $PM_{2.5}$ formation, such as nitrogen oxides, sulfur dioxide (SO_2), certain volatile organic compounds, and ammonia.

The closest Class I areas to the Project site area are Linville Gorge Wilderness Area, located in NC just over 100 mi. (roughly 168 km) to the southwest, Shenandoah National Park, located in VA approximately 143 mi. (230.5 km) to the north-northeast (NNE), and the Great Smoky Mountains National Park, located in NC and Tennessee approximately 174 mi. (280.3 km) to the southwest. There are no Class I areas within 100 km (62 mi.) of the Project site, therefore, no Class I areas are affected (Reference 2.3-49). The nearest state park is Mayo River State Park located approximately 10 mi. (16.1 km) to the northeast of the Project site.

2.3.1.6.2 Greenhouse Gas Emissions

Global net anthropogenic GHG emissions have been estimated to be 59 ± 6.6 gigaton CO_2-equivalent ($GtCO_2$-eq) in 2019, about 12 percent (6.5 $GtCO_2$-eq) higher than in 2010 and 54 percent (21 $GtCO_2$-eq) higher than in 1990, with the largest share and growth in gross GHG emissions occurring in CO_2 from fossil fuels combustion and industrial processes (Reference 2.3-19). At the national level, net GHG emissions in the U.S. in 2022 totaled 6343.2 million metric tons CO_2-eq after accounting for sequestration from the land sector (Reference 2.3-50). The increase in total GHG emissions was driven largely by an increase in CO_2 emissions from fossil fuel combustion.

In 2022, CO_2 emissions from fossil fuel combustion increased by 1 percent relative to the previous year. This increase in fossil fuel consumption emissions was from increased energy use, due in part to the continued rebound in economic activity after the height of the coronavirus disease 2019 (COVID-19) pandemic. GHG emissions in 2022 (after accounting for

sequestration from the land sector) were 17 percent below 2005 levels (Reference 2.3-50). At the state level, GHG emissions in NC are 115.6 million metric tons total CO_2 (Reference 2.3-15).

The impact of estimated GHG emissions resulting from the Project site on air quality is compared to state and national GHG emissions. The lifetime GHG emissions footprint from a generic 1000-megawatt electric (MWe) reactor is estimated to be 10.5 million metric ton (MT) CO_2eq. (Table A-3, Nuclear Power Plant Lifetime GHG Footprint, Reference 2.3-36). Using the emissions from the generic 1000 MWe reactor provides a conservative estimate. Lifetime GHG emissions from a new power plant are an estimated 9.1 percent of annual 2022 GHG emission in the state of NC (10.5 million to 115.6 million MTs) and 0.17 percent of the annual 2022 carbon equivalent emissions in the United States (10.5 million to 6343.5 million MTs).

2.3.1.6.3 Project Air Quality

Generation of electricity from the advanced reactors at the Project site would not be a source of criteria pollutants or other air toxic pollutants. However, supporting equipment such as cooling towers, auxiliary boilers, fire pump engines, and emergency or standby diesel generators would emit criteria pollutants. These supporting sources are not expected to be a significant source of criteria pollutant emissions or to significantly impact ambient air quality. If the Belews Creek facility were to emit criteria pollutants above significance thresholds, it would need to apply for a Prevention of Significant Deterioration permit prior to construction. The application for this permit would require a demonstration of compliance with applicable regulations and a demonstration that ambient air quality standards will not be threatened or exceeded as a result of the operation of this facility.

There may be some minor impacts on local air quality during construction. Construction impacts are mitigated using construction best management practices according to Duke Energy procedures and state air permits.

2.3.2 LOCAL METEOROLOGY

This section provides information concerning the local (e.g., on-site) meteorological parameters, the assessment of the potential influence of the proposed plant and its facilities on local meteorological conditions, and a topographical description of the site and its environment.

Short-term site-specific meteorological data, collected from MET tower during February 7, 2024 – February 6, 2025, are the primary basis for this dispersion meteorology analysis. In addition to on-site measurements, data representative of the site or indicative of site conditions were also obtained from LCDs recorded at the KGSO which is approximately 14 mi. (22.5 km) to the southeast of the Project site, KINT, and KRDU (References 2.3-26; 2.3-27; 2.3-39).

Meteorological measurements at the Project site were made using one on-site tower, as listed in Table 2.3-7, and further described in Section 2.3.3.1. Data from the on-site tower and regional towers were used to evaluate the impact of topography. The principal impact is on wind directions.

Topography around the site strongly influences the local climate. The Project site is located at an elevation of approximately 810 ft. (247 m) above mean sea level (AMSL) on a peninsula surrounded on three sides (west, north, and east sides) by Belews Lake. Most of the terrain in the vicinity of the Project site (Figure 2.3-1), is characterized by Belews Lake and the foothills of the Blue Ridge mountains to the northwest. Belews Lake was formed in the early 1970s from Belews Creek, a small tributary of the Dan River, under the authorization of the NC Department of Water and Air Resources specifically to provide cooling water to the BCSS. The location is at the southwest edge of the Dan River Basin. The Dan River runs parallel to the northwest boundaries of Belews Lake. The Dan River rises from springs on Belcher Mountain on the Blue Ridge Plateau in Patrick County, VA then flows 214 mi. (344 km) across the state border into Stokes County, NC. The lake sits in the North Central Piedmont of NC, and the land gradually rises to the Blue Ridge Mountains in the west and northwest. Outcroppings southeast of the Blue Ridge rise into peaks occasionally exceeding 2500 ft. (762 m). The Blue Ridge forms a northeast to southwest barrier about 50 mi. (80 km) from the Project site.

The Sauratown Mountains are located within Stokes and Surry counties and lie west-northwest (WNW) of the Project site. The range is home to two state parks located within a 25 mi. (40 km) radius of the Project site. Pilot Mountain State Park, which includes Pilot Mountain, peak elevation 2241 ft. (683 m), is approximately 24 mi. (39 km) west, and Hanging Rock State Park, peak elevation 2159 ft. (658 m), is approximately 14 mi. (23 km) northwest of the Project site.

Terrain in the vicinity of the Project site is characterized as alternating ridges and valleys oriented along a northeast to southwest axis. Nearby ridges reach an elevation of 1100 ft. (335 m) AMSL (approximately 300 ft. [91 m] above plant grade). The structures in all three areas (North, Middle, South) are located at a distance from the MET tower that would meet the offset requirement in RG 1.23, Rev.1, *Meteorological Monitoring Programs for Nuclear Power Plants,* that states the sensors should be located over level, open terrain at a distance of at least 10 times the height (10L) of any nearby obstruction. The MET tower is approximately 1218 ft. (371 m) ENE of the closest turbine and reactor building (the North Area). Since the turbine and reactor building is 120 ft. (37 m) tall, the tower would meet the 10:1 offset distance requirement for the North Area to minimize adverse effects of turbulence and building wake effects. This assumes that the maximum obstruction height is the turbine and reactor building, which is roughly 120 ft. above grade. The MET tower is approximately 1065 ft. (371 m) northeast of the closest cooling tower area (maximum height of 75 ft.) and meets the 10:1 offset distance requirement. In the area near the MET tower, trees with a vertical penetration within the 10L slope, or within 10 vertical ft. to the 10L surface have been cleared and removed.

A topographic map outlining a 5 mi. boundary from the Project site center point is shown in Figure 2.3-2. Figures 2.3-3 (Sheets 1 through 8) provide elevation profiles of the maximum elevation at the 16 compass directions radiating out from the Project site to 50 mi. (80.5 km). Figure 2.3-4 provides a topographic map of the elevation profile radials.

2.3.2.1 Normal and Extreme Values of Meteorological Parameters

Long-term temperature and precipitation records were examined to determine if data collected

at the Project site are consistent with regional conditions, both spatially and over time.

Meteorological data collected at nearby KGSO are presented and evaluated in the following sections in more detail. Table 2.3-8 summarizes annual meteorological parameters from KGSO, including normal temperature and relative humidity (RH), mean wind speed, prevailing wind direction, and normal precipitation for the time period of 1991 – 2020.

Comparisons of common measurements for the different data periods have been made to determine if site meteorological conditions are changing significantly over time. Common variables (except wind direction) can be compared directly, but wind direction is too dependent on topography for direct comparison particularly with off-site data. Comparing data from nearby off-site locations helps to determine if the Project site is consistent with regional conditions.

Comparison of the KGSO, KRDU, and KINT regional airport data to the Project site data summarized in Table 2.3-9, shows that there is generally good agreement between the Project site and off-site regional locations over different data periods. The differences fall within the normally expected variations. Therefore, it is concluded that meteorological characteristics for the Project site have not changed significantly over time. Additionally, data from the Project site appear to be consistent with overall meteorological conditions in the vicinity. This is characteristic of the controlling synoptic influences throughout the region.

2.3.2.1.1 Winds

From February 2024 to February 2025, 10 m wind data were collected by the MET tower at the Project site. The meteorological tower at the Project site meets the criteria for obtaining data representative of the atmospheric conditions on-site.

The following discussion considers the 10 m wind data from KGSO and the on-site MET tower as representative of potential ground-level releases for air dispersion modeling purposes. Local conditions are important in evaluating ground-level releases because maximum air concentrations from contaminants released into the atmosphere generally occur close to the release point.

2.3.2.1.1.1 Average Wind Direction and Wind Speed Conditions

JFDs of wind direction (unit vector approximation of scalar values), average (scalar) wind speed, and stability class from instruments at 10 m at the Project site are presented in Section 2.3.4. Wind roses for KGSO based on ten years of data (2013–2023), are presented in Figures 2.3-5 through 2.3-17. The Project site data are presented as wind roses at 10 m in Figures 2.3-18 through 2.3-30 and at 60 m in Figures 2.3-31 through 2.3-43.

Mean wind speeds recorded at KGSO for the 39-year period 1983 – 2022 (Table 2.3-10) were generally moderate with an average annual mean speed of 7.1 mph and prevailing wind direction from the SW. Wind gusts were recorded over a 27-year period, 1996 – 2022, with the maximum 2-minute wind speed recorded in May 2000 at 62 mph (100 kph). The maximum 3-second gust recorded was 82 mph (132 kph) on May 25, 2000, when Guilford and Alamance

counties were impacted by a severe storm with reports of property damage and tornado sightings (References 2.3-54; 2.3-55).

Wind speeds at the Project site during 2024–2025 were generally light with an average 10 m speed of 4.3 mph and prevailing wind direction from the WSW. The daily maximum 10 m (scalar) wind speed was 19.2 mph (Table 2.3-11).

The Project site and KGSO data indicate winds consistent with the southwest to northeast orientation of the terrain in the region (Figure 2.3-1). The geographic orientation of the local and regional terrain in the vicinity and region around the Project site aligns with the prevailing on-site and offsite winds from the southwest. The local wind patterns are influenced by the local terrain, with up-valley (southwest-WSW)/down-valley (northeast-ENE) flow patterns common on-site and stable conditions, with light to moderate winds frequently observed, especially during the summer and fall seasons.

2.3.2.1.1.2 Wind Direction Persistence

Generally, the longer the winds blow in the same direction, the lower the dilution potential because effluent is not dispersing significantly downwind. Wind direction persistence is an indicator of the duration of atmospheric transport from each direction. For the Project site (Table 2.3-12), the maximum persistence at 10 m is 27 hours from the SW.

The wind data for KGSO and the Project site show a consistent pattern of wind directions with predominant winds from the SW. There is moderate seasonal variation (Figures 2.3-44 through 2.3-51). Due to the combination of uniformly light to moderate wind speeds and surrounding terrain, there could often be minimal transport, with a potential for recirculation of gaseous effluent near the site.

2.3.2.1.2 Air Temperature

Table 2.3-13 summarizes normal maximum and minimum temperatures recorded at KGSO for the time period of 1991 – 2020. Maximum temperatures recorded for the 30-year period 1991 – 2020 usually occur between the months of June and September. Minimum temperatures for the 30-year period 1991 – 2020 usually occur from November through March. Mean monthly temperatures range from the lower 30s (°F) (around 0 ˚C) in the winter to the upper 80s (°F) (around 30 ˚C) in the summer.

The extreme maximum temperature recorded at KGSO for the 94-year period 1928 – 2020 was 103 °F (39.4 °C) in August 1988 and the extreme minimum temperature for the 94-year period was -8 °F (-22.2 °C) recorded in January 1985 (Reference 2.3-26).

Table 2.3-14 summarizes average, daily minimum, and daily maximum DBT and WBT recorded at the Project site during the collection period from 2024–2025. The highest daily maximum temperatures for the collection period occurred during the months of June and July. The lowest daily minimum temperatures occurred in December and January. The average monthly DBTs range from the mid-30s (°F) (around 0 ˚C) in January to the upper 70s (°F) (around 25 ˚C) in

July. The daily maxima recorded at the Project site was 97.3°F (36.3 °C) (July 2024), while the daily minimum was 15.8 °F (-9 °C) (January 2025).

2.3.2.1.3 Atmospheric Moisture

Long-term RH and WBTs for KGSO are presented in Table 2.3-15. The normal annual RH is 69 percent at KGSO and ranges from 61 percent in April to 77 percent in September. Normal mean annual WBT average is 50.1 °F (10.1 °C) at KGSO (Reference 2.3-26). Maximum monthly mean WBTs are 69.0 °F (20.6 °C) during July. Minimum monthly mean WBTs are recorded in January; 30.9 °F (-0.6 °C) (Reference 2.3-26).

Average humidity data for the Project site is summarized in Table 2.3-16. The average annual RH is 68 percent at the Project site and ranges from 53. percent in January to 80 percent in September. The average annual WBT is 54.7°F (12.6 °C). The highest daily maximum WBT is 71.8 °F (22.1 °C) during July. The lowest daily minimum WBT was recorded in January; 30.5 °F (-0.8 °C). The Project site data aligns with the long-term KGSO data.

2.3.2.1.4 Precipitation

2.3.2.1.4.1 Rain

Precipitation data from KGSO are presented in Table 2.3-17. Precipitation falls an average of about 116 days per year, and the normal annual precipitation is nearly 44 in. (112 centimeters [cm]). The maximum monthly rainfall in the 94-year period 1928 – 2022 was 13.26 in. in September 1947. The minimum monthly amounts in the 94-year period were trace amounts in September 1985 and June 1990. The maximum precipitation in 24 hours was 7.49 in. (19.02 cm) in September 1947. Except for late winter, which is slightly drier, precipitation is fairly uniformly distributed throughout the year. August and September are normally the wettest months of the year, and February is normally the driest.

Approximately 43 thunderstorms occur in a typical year (Table 2.3-17). Thunderstorm activity is greatest during the late spring and summer months, and the maximum frequency of thunderstorm days is normally in July.

The Belews Creek, NC precipitation data for the 2024-2025 data collection period (Table 2.3-18) indicate drier than normal precipitation. The annual precipitation was 38.07 in. (96.70 cm). The maximum monthly precipitation was recorded in September with 7.08 in. (17.98 cm). The maximum precipitation in 1 hour was 1.28 in. (3.25 cm) and the maximum precipitation in 24 hours was 4.23 in. (10.74 cm).

Maximum possible precipitation, estimated by statistical analysis of regional precipitation data, is given in Table 2.3-26 for return periods of one to 100 years and for rainfall durations from five minutes to ten days. Probable maximum precipitation (PMP), sometimes called maximum possible precipitation, for a given area and duration is the depth which can be reached but not exceeded under known meteorological conditions (Reference 2.3-42). This data was taken from the NOAA Atlas 14, Volume 2, Version 3 (Reference 2.3-21) and the NOAA Atlas 14 Point

Precipitation Frequency Estimates (Reference 2.3-22) for the area nearest the Project site. For the Project site, using a 100-year return period, the PMP for 6, 12, 24, and 48 hours is 5.1, 6.4, 7.8, and 8.8 in., respectively.

2.3.2.1.4.2 Precipitation Wind Roses

Table 2.3-19 shows composite precipitation data for the 2024-2025 collection period based on the Project site hourly precipitation and wind directions. The precipitation value used in the analysis is based on the amount that accumulated over the hour. Precipitation is most associated with wind direction from the W. There is a secondary maximum with wind direction from the WNW. The Project site composite precipitation and wind direction data are presented as precipitation wind roses at 10 m in Figures 2.3-52 through 2.3-68.

2.3.2.1.4.3 Snow

Appreciable snowfall is relatively infrequent in the area. Snowfall data are summarized in Table 2.3-20 for KGSO. Normal annual snowfall is about 7 in. (18 cm). Generally, significant snowfalls are limited to December through March. The 24 hour maximum snowfall was 14.3 in. (36.3 cm) in December 1930. Recorded maximum monthly snowfall was 22.9 in. (58.2 cm) in January 1966.

2.3.2.1.5 Fog

Fog is defined as water droplets suspended in the atmosphere in the vicinity of earth's surface that affect visibility. Fog reduces visibility below 1 km (0.62 mi.) (Reference 2.3-9). The number of days with heavy fog (visibility equal to or less than one-quarter mile) at the Project site, was determined based on data from the KGSO LCD and KRDU LCD (References 2.3-26; 2.3-27). Fog data for KGSO and KRDU is presented in Table 2.3-21. These data indicate that heavy fog occurs about 27 days per year, with the winter normally the foggiest season.

2.3.2.1.6 Atmospheric Stability

Atmospheric stability is based on the temperature difference (ΔT) between the 60 m and 10 m measurement levels. The Pasquill atmospheric stability classes (A – G) are described in Table 2.3-22 and the frequency occurrence of each class is presented in Table 2.3-23. While neutral lapse conditions (class D) occur most frequently (31.2 percent), stable lapse conditions (i.e., inversions) typically occur over 36.4 percent of the time. The most unstable class (class A) occurs 21.3 percent of the time, while the most stable class (class G) occurs 2.2 percent of the time.

Inversion Persistence

Tables 2.3-24 and 2.3-25 present a summary of on-site persistence data, with a breakdown by stability class, for the Project site for the 2024-2025 collection period. Inversion persistence is defined as two or more consecutive hours of a single stable class, or combination of stable classes (Stability Classes E through G). The longest contiguous period of inversion conditions (Stability Class E) was 19 hours.

Mixing Heights

Mixing heights for Greensboro, NC, were obtained from the USEPA Support Center for Regulatory Atmospheric Modeling (SCRAM). The USEPA data are more current than the traditional Holzworth reference that is often used. Mixing heights vary during the day, with the lowest average mixing heights (approximately 379 m [1243 ft]) generally recorded during the morning hours in the autumn and the highest readings (approximately 1609 m [5278 ft.]) recorded during the afternoon in the summer for the 7-year period of record (1984-1987 and 1989-1991) used by the USEPA in the SCRAM dataset (Reference 2.3-51). Approximate seasonal and annual estimates of mixing heights for the Project site are presented in Table 2.3-27.

2.3.2.2 Potential Influence of the Plant and Its Facilities on Local Meteorology

Larger structures on-site would influence wind conditions (wind speed, direction, and turbulence), although these effects are not expected to be significant beyond ten building/structure heights from the building or structure in question, per RG 1.23.

The only nearby feature which may have any noticeable effects on the local meteorology is the new on-site Ash Basin Landfill. The Ash Basin Landfill is planned to:

- Be located partially within the former footprint of the ash impoundment, called the Basin, at the BCSS, adjacent to Pine Hall Rd.
- Be approximately 90 ac.
- Be designed to contain approximately 14.1 million cubic yards of coal ash.
- Stand 168 ft. tall (from primary liner to top of final closure cap), rising approximately 125 ft. above Pine Hall Rd.

The new landfill is approximately 2 mi. (3.2 km) northwest of the Project site. While there could be some localized blockage and diversion of winds around the new landfill, the distance of the new landfill from the project is too far away to produce downstream effects at the Project site. Impacts on the proposed nuclear facility are expected to be minimal.

Project-related structures that may have noticeable effects on the local meteorology is the new cooling tower. The nearest cooling tower is in the North Area and is 1061 ft. (324 m) to the MET tower. If linear mechanical draft cooling towers (LMDCTs) are used, they are expected to produce elevated plumes that somewhat alter overall local frequencies of overhead clouds. LMDCTs are also expected to produce small increases of ground level fog, rime icing, and drift deposition as potential impacts. Ground fog events are defined to occur when a modeled plume contacts the ground and/or the plume is below the height of the cooling towers. No hours of fogging are predicted.

2.3.2.2.1 Cooling Tower Impact Modeling

The NRC has identified several plume-related codes as acceptable methodologies for modeling cooling tower impacts to the environment. A model in Carhart et al., 1992 is endorsed in NUREG-1555, Initial, *Standard Review Plans for Environmental Reviews for Power Plants*, Section 5.3.3.1. In NUREG-1555, the NRC accepts the conclusion of Carhart et al., 1992 that their model predicts plume rise within a factor of two approximately 75 percent of the time and visible plume length within a factor of 2.5 approximately 70 percent of the time. Their model is embedded into the Electric Power Research Institute's (EPRI) Seasonal/Annual Cooling Tower Impact Prediction Code (SACTI) in 1991 and later modified in 2015 in accordance with Carhart et al., 1992 and Policastro et al., 1994.

Evaluations of cooling tower impacts were performed assuming that LMDCT will be utilized. Salt deposition rates, as a function of distance and direction from the cooling towers, were calculated for a representative model of the LMDCT using the SACTI code. The current version of the SACTI plume modeling code, hereinafter referred to as SACTI2, was used to develop the model for the evaluation of potential plumes from LMDCTs on the Project site.

Significant levels of Chloride run-off can contribute to water quality degradation which can affect aquatic life. However, since the predicted salt deposition rates are relatively low and precipitation is relatively high and frequent at the Project site, deposited salts will be diluted quickly and therefore do not greatly impact Belews Lake and the surrounding area (SACTI2 does not predict the dilutive effects of precipitation on deposited solids). The highest modeled seasonal salt deposition rate (summer — 63.51 kg/km^2/mo) is located 300 m (984 ft.) ENE of the site center point. The maximum modeled seasonal salt deposition rate is in the very light range per guidance from the Institute of Electrical and Electronic Engineers (IEEE). The maximum modeled seasonal salt deposition rate is well below the 1000 – 2000 kg/km^2/mo range that could cause leaf damage in many species as noted in NUREG-1555. The maximum modeled annual deposition rate (41.57 kg/km^2/mo) is also located 300 m (984 ft.) ENE of the site center point within Duke property. This deposition rate is also well below the range that could cause leaf damage. Overall, salt drift deposition is not expected to be a significant concern. Results for these parameters are shown in Figures 2.3-69 and 2.3-70 and summarized in Table 2.3-28.

Water deposition, plume shadowing, plume length frequency, and plume height frequency were also determined for the LMDCTs and summarized in Tables 2.3-29 through 2.3-32. Table 2.3-29 shows the maximum modeled plume water deposition rate of 50,100 kg/km^2/mo occurred in summer. The maximum modeled cooling tower plume shadowing occurred in winter with a frequency of 137.0 hours in a northeast direction from the site center point (Table 2.3-30). The table shows that impacts are highest in winter and lowest in summer and fall. Table 2.3-31 shows the percentage of the time that plumes exceed a specified length. Modeled plumes are longest in the winter and shortest in the summer. Table 2.3-32 shows the percentage of time that plumes exceed a specified height. Modeled plume heights are typically 30 m (98.4 ft.) or less, as modeled seasonal plume heights exceed 50 m (164 ft.) and above less than 13 percent in winter (maximum seasonal value) and 6 percent annually.

2.3.2.3 Local Meteorological Conditions for Design and Operating Bases

The local meteorological conditions for the design and operational basis are provided in Section 2.3.1. The Design Basis Temperatures for KGSO, KRDU, and KINT are summarized in Table 2.

2.3.3 ON-SITE METEOROLOGICAL MEASUREMENTS PROGRAM

The following section provides information concerning the on-site meteorological monitoring program and the resulting data. The primary source of meteorological data during early site permitting through construction is a MET tower.

2.3.3.1 Meteorological Measurements History

Duke Energy installed a 60 m (196.9 ft.) on-site tower in late January 2024. The MET tower measures wind speed/direction, temperature, and RH with dewpoint temperature at 10 m AGL and wind speed/direction at 60 m AGL. The 60 – 10 m vertical DBT difference (Delta-T) is also measured. Precipitation is measured at ground level.

On-site meteorological monitoring data collection began in February 2024. The first full year of data was collected from February 7, 2024, through February 6, 2025. The joint data availability of 10 m (32.8 ft.) and 60 m (196.9 ft.) wind speed/direction, Delta-T between 10 m and 60 m, dewpoint, and RH during this period is 92.98 percent. This joint data availability exceeds the annual 90 percent data availability requirements in RG 1.23 and Reference 2.3-47.

2.3.3.2 Primary Meteorological Facility

The primary meteorological facility is a 197-ft. tall, open-lattice tower at the Project site equipped with various monitoring instruments and sensors (referred to as the “MET tower”). This Meteorological Monitoring system is designed to meet or exceed RG 1.23 requirements. Meteorological parameters measured or calculated at the on-site MET tower are listed below.

- Wind speed and direction – measured on an open-lattice tower at approximately 10 m (33 ft.) and 60 m (197 ft.) AGL.
- Sigma-theta, the standard deviation of wind direction. Calculated for both the 10 m (33 ft.) and 60 m (197 ft.) level wind direction.
- Ambient temperature – monitored at approximately 10 m (33 ft.) AGL. Temperature is also measured on the MET tower at the 60 m (197 ft.) level to determine the vertical temperature gradient and stability class.
- Vertical temperature gradient, Delta-T is used to determine the Pasquill atmospheric stability class for air dispersion modeling.
- Precipitation – measured near ground level near the base of the MET tower.
- Atmospheric moisture based on dewpoint temperature (DPT) and RH measured at 10 m (33 ft.) AGL.

Table 2.3-33 provides the specifications of the meteorological instruments installed on the MET tower comply with the guidance contained in RG 1.23. As discussed in Section 2.3.2, the sensors have been installed in open terrain at a distance of at least 10 times the height of any nearby obstruction.

Per RG 1.23, the tower is sited to provide representative measurements of the atmospheric conditions into which material may be released and transported. The MET tower is located at latitude 36˚ 17' 10.067" north and longitude 80˚ 2' 39.038" west and stands 197 ft. (60 m) AGL. The grade elevation of the tower is 810 ft. (247 m) and located at the approximate grade level of the plant. The location of the on-site tower is shown in Figure 2.3-1.

2.3.3.2.1 Instrument Description

Meteorological sensors meet or exceed specifications in RG 1.23 and are detailed in Table 2.3-33 and summarized below:

Sensor	Height (m)	Description
Wind Direction and Wind Speed	10 and 60	Balanced vane wind sensor with a 4-blade propeller
Temperature	10 and 60	Platinum wire resistance temperature and detector (RTD) sensor with aspirated radiation shield
RH with Dewpoint	10	RM Young humidity sensor that also calculates the dewpoint temperature
Rainfall	1	Tipping bucket rain gauge

2.3.3.2.2 Data Acquisition System

The data acquisition system consists of meteorological sensors, a data controller and various interface devices. These devices allow offsite access to the datalogger for downloading the meteorological data to a computer for validation and archiving.

2.3.3.2.3 System Accuracies

The meteorological data collection system is designed to meet or exceed specifications for accuracy and resolution in Table 2 of RG 1.23. The accuracies of the various sensors are provided in Table 2.3-33.

The joint annual data recovery for the 60 m wind speed/wind direction/Delta-T for the period February 7, 2024 – February 6, 2025, is 94.48 percent. The joint annual data recovery for the 10 m wind speed/wind direction/Delta-T for the period February 7, 2024 – February 6, 2025, is 96.07 percent. These data recovery rates exceed (better than) the requirement for annual 90 percent joint data availability in RG 1.23. Therefore, meteorological data meet or exceed data completion requirements RG 1.23.

2.3.3.2.4 Data Recording and Display

Data recording is controlled by an Environmental Systems Corporation (ESC) 8864 data logger that receives the output of each meteorological sensor in a specified time interval. Meteorological sensor outputs are measured every five seconds (720 measurements per hour), with exception of rainfall which is measured continuously as it occurs. Software within the data logger processes incoming data from the sensors to average one minute data into 1-hour averages, with the exception of precipitation (which is total amount per hour). Windspeed is scalar averaged, and the wind direction is a unit vector which approximates a scalar average.

Average wind direction, wind speed and Delta-T are used for meteorological air dispersion modeling applications. Tables 2.3-34 through 2.3-49 provide JFD tables of wind speed and wind direction by Atmospheric Stability Class.

Data is accessed by dialing into the BCNS datalogger which has a wireless modem and antenna for remote access. Data is validated and stored in a database by Duke Energy for reporting and archiving.

2.3.3.2.5 Equipment Servicing, Maintenance and Calibration

Personnel from the Duke Energy Environmental Services division and/or contractors maintain the meteorological data collection system (sensors, electronics, data logger, etc.). Maintenance includes field checks, calibration and/or replacement of components as necessary. Personnel follow procedures to maintain meteorological equipment and validate recorded data.

In accordance with RG 1.23, meteorological instrument calibration and maintenance procedures support meeting a data recovery rate of at least 90 percent on an annual basis for each meteorological variable and annual JFDs of wind speed, wind direction, and stability class. Meteorological data are available in real-time for analysis. Time average accuracies for digital systems meet the criteria listed in Table 2 of RG 1.23.

Calibration of instruments and maintenance of the MET tower is performed or overseen by Duke Energy. The MET tower instrumentation maintenance and service scheduling intended to support compliance with RG 1.23 are summarized below.

- Instrument maintenance and servicing schedules. Semi-annual calibrations, daily data review.
- Data reduction and compilation. The ESC 8864 data logger meets the digital sampling and display rate requirements.
- Guy wires are inspected annually, and the guy wire anchors are inspected once every three years.

2.3.3.3 Operational Meteorological Program

The meteorological monitoring program is designed to collect data that meets the 90 percent

joint data recoverability requirement for wind speed, wind direction and stability class in RG 1.23. The restoration of the data collection capability of the meteorological facility in the event of equipment failure or malfunction is accomplished by replacement or repair of affected equipment. An inventory of spare parts and equipment is maintained off-site at Duke Energy's Environmental Center to minimize periods of outages. Equipment malfunctions or outages are detected by data validation staff, environmental personnel, or contractors during routine or special checks. When an outage of one or more of the critical data items occurs, the appropriate environmental staff or contractor is notified to correct equipment problems and restore the meteorological monitoring system.

2.3.4 SHORT-TERM (ACCIDENT) DIFFUSION ESTIMATES

2.3.4.1 Purpose and Background

This section presents the methodology and results used to evaluate short-term atmospheric dispersion conditions applicable to a design-basis accident for the Project site. The evaluation supports demonstration of compliance with 10 CFR 100.21 and has been performed consistent with the guidance contained in NRC RG 1.145, and NUREG-0800, Section 2.3.4. Atmospheric dispersion consists of two components: (1) atmospheric transport, or the movement of gaseous effluents through the atmosphere; and (2) atmospheric diffusion, or the spread of gaseous effluents through the atmosphere. Atmospheric dispersion conditions are represented by relative air concentration (χ/Q) values at specified receptor distances, primarily at the Exclusion Area Boundary (EAB) and the outer boundary of the LPZ. The evaluations support the siting requirements by demonstrating that appropriate protective measures can be taken in response to a postulated accidental release.

2.3.4.2 Calculation Methodology and Assumptions

Atmospheric dispersion calculations were performed using the PAVAN computer program (NUREG/CR-2858), consistent with RG 1.145. PAVAN is designed to calculate relative air concentration (χ/Q) values using JFDs of wind direction, wind speed, and atmospheric stability class over a defined two-year meteorological data period.

Meteorological data are collected and processed in accordance with RG 1.23. Wind direction and speed data are measured at 10 m and 60 m AGL, and temperature data are collected at the 60 m and 10 m levels for determining atmospheric stability. JFDs are compiled into 16 compass sectors with wind speed and stability classifications. In accordance with RG 1.23, at least two consecutive years of site-specific meteorological data are recommended to ensure the data are representative of the site area meteorological conditions.

JFDs for each stability class, consistent with NUREG/CR-2858 and RG 1.23, are included as Tables 2.3-34 through 2.3-41, and 2.3-42 through 2.3-49, respectively, both using wind direction and wind speed data from 10 m AGL. Currently, only one year of site-specific data is available. When two years of site-specific meteorological data are available, Duke Energy will update the JFDs for the site and revise the short-term atmospheric dispersion calculation as indicated.

Dispersion factors are calculated for various time intervals post-accident, typically including 0–2 hours for the EAB and 0–8 hours and 4–30 days for the LPZ. The analysis uses a ground-level release assumption for conservatism, as defined by RG 1.145 and excludes credit for building wake effects.

For each receptor (EAB and LPZ), χ/Q values are calculated using both directionally dependent (maximum sector) and directionally independent (overall site) methods. The bounding χ/Q is the greater of the two values, consistent with RG 1.145 guidance. In the directionally dependent approach, χ/Q values are determined for each sector, and the 0.5 percent exceedance value is used. For the directionally independent approach, a site-wide cumulative distribution is compiled, and the 5 percent exceedance value is used.

Building wake effects are excluded (building height and cross-sectional area set to zero) for conservatism. Ground-level release is modeled since it results in the highest downwind concentrations. Plume meander is considered for neutral or stable conditions and wind speeds below 6 m/s. For higher wind speeds or unstable conditions, NUREG/CR-2858 states that the PAVAN computer program does not consider plume meander. For higher wind speeds or unstable conditions, NUREG/CR-2858 states that the PAVAN computer program does not consider plume meander.

Effluent release points are represented by a conservatively defined release boundary enclosing all potential sources within the plant's nuclear power block, determined using the aggregate power block footprint from all technologies being evaluated for implementation. The EAB is determined by assembling a composite of the EAB distances provided as inputs from the selected technologies to have the limiting EAB distance in every direction (limiting in this case meaning nearest to the potential release points). The outer boundary of the LPZ is assumed to be equivalent to the EAB for the purposes of the evaluation. Table 2.3-50 lists the minimum distances from the perimeter of the release envelope (the power block footprint) for each of the 16 downwind direction sectors for each Plant Complex.

2.3.4.3 Summary of Results and Conclusions

The PAVAN modeling results provide χ/Q values for use in accident dose consequence assessments as required by 10 CFR Part 100. The bounding EAB and LPZ χ/Q values for each Plant Complex are presented in Tables 2.3-51 through 2.3-53 The bounding χ/Q values for each Plant Complex are documented in Table 2.3-54.

2.3.5 LONG-TERM (ROUTINE) DIFFUSION ESTIMATES

2.3.5.1 Purpose and Background

This section presents the methodology and provides the atmospheric dispersion factors (χ/Qs) and deposition factors (D/Qs) for routine releases associated with the Project site. The analysis is prepared in accordance with the guidance provided in NRC RG 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors*, and uses site-specific meteorological data.

The χ/Q and D/Q factors are calculated at locations as a function of downwind distance from the Project site effluent release points that are located within the north, middle, and south power block areas. The χ/Q and D/Q locations include receptors on the EAB or property line (i.e., site boundary) for each Plant Complex in each of the 16 directional sectors and at two offsite locations, i.e., the nearest resident and nearest vegetable garden (greater than 50 m^2 [538 ft^2]). The minimum distance between the release point and the receptor on the unrestricted area boundary, i.e., the distance to the EAB or to the site boundary, is used as the distance in each sector for χ/Q and D/Q determination. The longest distance from the EAB or site boundary to the power block boundary is used to determine what unrestricted area boundary is used. In addition, general and segmented χ/Q and D/Q factors are calculated radially out to 50 mi. (80.5 km) from the Project site. For all the locations considered, the χ/Q factors are calculated as a ground level release considering the following scenarios: no depletion/no decay, no depletion/2.26-day half-life, and depletion/8-day half-life. The χ/Q and D/Q factors are calculated as average values over a period of one year.

2.3.5.2 Calculation Methodology and Assumptions

The site-specific meteorological data is collected and processed for a time period of one-year from February 7, 2024 to February 6, 2025 to evaluate routine releases at the Project site. RG 1.23 states that for an ESP a consecutive 24-month period of meteorological data that is defendable, representative and complete, but not older than 10 years from the date of the application is required at submittal. Currently, only one year of site-specific data is available. When two years of site-specific meteorological data are available, Duke Energy will update the JFDs for the site and revise the long-term atmospheric dispersion calculation as indicated.

The wind data consists of an hourly JFD of speed, direction, and Pasquill stability class derived from the meteorological tower located at the Project site.

The XOQDOQ code module of the NRCDose, version 2.3.10, computer code is used to calculate the χ/Q and D/Q factors. Using XOQDOQ module contained in the NRCDose computer code implements the assumptions outlined in Section C (excluding C.1.a and C.1.b) of RG 1.111.

The XOQDOQ code module of NRCDose is based on the theory that material released to the atmosphere will be normally distributed (Gaussian distribution) about the plume centerline. In predicting concentrations for longer time periods, the horizontal plume distribution is assumed to be evenly distributed within the directional sector. A straight-line trajectory is assumed between the point releases and all receptors in the models.

The XOQDOQ code uses the JFD to estimates the χ/Q and D/Q factors by default for each of the 16 sectors (22.5°), relative to the release location envelope, extending 50 mi. (80.5 km) radially outward at 22 radial distances for each sector. In the analysis, the release location envelope is at ground level over an area that covers the release point for each Plant Complex at the Project site. The unrestricted area boundary χ/Q and D/Q factors for the 16 sectors for each Plant Complex are conservatively estimated using the minimum distance from the power block boundary to the unrestricted area boundary. Figures 2.3-71 through 2.3-73 present the shortest

distances from the power block boundary to the unrestricted area boundary for each directional sector for the North, Middle, and South Plant Complexes, respectively. Table 2.3-55 presents the distances from the power block boundary to the unrestricted area boundary (i.e., EAB or site boundary) for each direction sector and each Plant Complex.

Many of the dose consequence analyses utilizing the χ/Q and D/Q factors determined in the analysis are prepared to address regulations applicable to the entire project site. Using the bounding χ/Q and D/Q factors for each Plant Complex is overly conservative because the bounding χ/Q and D/Q factors determined for each Plant Complex are not located at the same geological location. Therefore, it is reasonable to determine χ/Q and D/Q factors for each Plant Complex at an unrestricted area boundary Maximally Exposed Location (MEL) that provides less conservative combined χ/Q and D/Q factors than the combined bounding χ/Q and D/Q factors for each Plant Complex. The unrestricted area boundary MEL is a fixed point for a receptor and could be in different sectors for each Plant Complex.

A sensitivity analysis was performed to determine the unrestricted area boundary MEL that results in the maximum combined χ/Q and D/Q factors from each Plant Complex. The unrestricted area boundary MEL is determined to be located along the North Plant Complex EAB, in the northeast sector. The distances from the Middle and South Plant Complex power block boundary to the unrestricted area boundary MEL are shown in Table 2.3-55.

For conservatism, the MEL χ/Q factors for the Middle and South Plant Complex are those for the directional sector that provides the largest χ/Q factors at a distance equal to the MEL distance from the Middle and South Plant Complexes. As can be seen in Tables 2.3-57 through 2.3-60, the bounding χ/Q direction for distances of 0.25 mi. (0.40 km) and greater for the Project site is in the north directional sector. Therefore, the χ/Q factors for the Middle and South Plant Complexes are those in the north directional sector. The bounding D/Q direction for the Project site for distances 0.25 mi. (0.40 km) and greater is the northeast directional sector, which is the sector of the unrestricted area boundary MEL.

In addition, the χ/Q and D/Q factors are estimated for off-site receptor locations from the power block boundary of each Plant Complex. The off-site receptor locations are determined using the guidance from NUREG-1555. As such, per Section 5.4 of NUREG-1555, off-site receptors that are to be considered for evaluation up to 5 mi. (8 km) from the site include the nearest residence, milk animals, meat animals, and vegetable gardens larger than 50 m^2 (538 ft^2). These receptors (nearest resident and nearest vegetable garden) and the associated data are listed in Table 2.3-56. No milk animals or meat animals are identified within 5 mi. (8 km) of the Project site; therefore, locations of milk animals or meat animals are not evaluated.

In accordance with RG 1.111, radiological decay and dry deposition were considered. For conservative estimates of radioactive decay, an overall half-life of 2.26 days is acceptable for short-lived noble gases released to the atmosphere and an overall half-life of eight days is acceptable for iodines released to the atmosphere. In accordance with Regulatory Position 3.c of RG 1.111, wet deposition usually does not have a significant effect on the associated doses. Plume depletion via wet deposition is therefore not modeled in the analysis.

The maximum wind speed utilized in the analysis is 13 m/s (42.65 ft/s). The JFD information

provides the highest wind speed interval that is not closed, referring to any wind in excess of 8 m/s (26.25 ft/s) without specifying the maximum value. The XOQDOQ code requires the minimum and maximum values for the wind speed interval to be specified (closed interval). Per NUREG/CR-2919 (Reference 2.3-34), the maximum speed of an open interval can be assumed to be capped with a value that is 5 units greater than the largest specified interval limit. As such, use of 13 m/s (42.65 ft/s) is appropriate.

No building wake effect is credited in the XOQDOQ model (i.e., the building cross-sectional area for the dispersion analysis is assumed to be zero). Consistent with NUREG/CR-2919 (Reference 2.3-34) no credit for building wake reduces dispersion and is therefore conservative.

The XOQDOQ release model is developed assuming all routine effluent releases occur at ground level. No plume rise is calculated and no elevated terrain corrections are applied. This assumption is conservative because the receptors are located at the ground level, and the ground release model for this scenario provides the bounding values for the χ/Q and D/Q values. The following parameters are utilized in the XOQDOQ model for ground release:

- The vent average velocity is 0 m/s (0 ft/s), consistent with Table 2.1 of NUREG/CR-2919 (Reference 2.3-34) for ground release.
- The vent inside diameter is 0 m (0 ft.), consistent with Table 2.1 of NUREG/CR-2919 for ground release.
- The height of the vent release point is 10 m (32.81 ft.) above plant grade level because XOQDOQ treats a ground release as a release that is 10 m (32.81 ft.) AGL.
- The height of the vent's building is 10 m (32.81 ft.) above plant grade level, which is the same as the release height (for a ground release).
- The wind height used for the vent elevated release is 10 m (32.81 ft.) above plant grade level, consistent with Table 2.1 of NUREG/CR-2919 for ground release.
- The vent heat emission rate is 0 cal/s because this results in no additional plume rise due to buoyancy of the effluent.
- Default open terrain (e.g., recirculation) factors are utilized to represent plume recirculation in calm or light wind conditions.
- The option to correct χ/Q and D/Q values using standard correction factors for open terrain correction is used in the absence of site-specific diffusion test data. This is consistent with NUREG/CR-2919.

2.3.5.3 Summary of Results and Conclusions

The χ/Q and D/Q factors for the Project site unrestricted area boundary for each Plant Complex are provided in Tables 2.3-57 through 2.3-59. The Project site unrestricted area boundary χ/Q and D/Q factors at the MEL for each Plant Complex is provided in Table 2.3-60.

The χ/Q and D/Q factors will be used to determine the radiological consequences of routine airborne releases from the Project site. The offsite receptor χ/Q and D/Q factors for the nearest resident and nearest vegetable garden are provided in Tables 2.3-61 and 2.3-62, respectively.

The general χ/Q and D/Q factors as a function of distance from the release point for each Plant Complex, extending to a distance of 50 mi. (80.5 km), are provided in Table 2.3-63 through Table 2.3-66. The largest values for the χ/Q and D/Q, for all 16 sectors within 50 mi. (80.5 km) of the envelope, are in the north sector for χ/Q factors and in the northeast sector for D/Q factors. χ/Q and D/Q factors for segmented distances out to 50 mi. (80.5 km) from the Project site release envelope are provided in Tables 2.3-67 through 2.3-70.

Table 2.3-1
Computed 100-Year Return-Interval Extreme Temperatures

Airport NWS Station	Design Temperature	Means and Standard Deviations of Extreme Annual Temperatures (°F)				Computed 100-Year Return-Interval Extreme Temperatures (°F)	
		Mean		Std. Deviation			
		Min	Max	Min	Max	Min	Max
KGSO (1994 – 2019)	Dry Bulb	11.4	95.7	5.1	2.5	-4.6	103.5
	Wet Bulb (Non-Coincident)	9.3	78.3	4.5	1.4	-4.8	82.7
KINT (1994 – 2019)	Dry Bulb	12.4	95.5	5.1	2.6	-3.6	103.7
	Wet Bulb (Non-Coincident)	10.6	78.6	4.1	2.9	-2.3	87.7
KRDU (1994 – 2019)	Dry Bulb	12.3	99.0	5.3	3.0	-4.3	108.4
	Wet Bulb (Non-Coincident)	10.4	80.6	4.9	1.3	-5.0	84.7

Source: Reference 2.3-12
Key: °F = degrees Fahrenheit; min. = minimum; max = maximum; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC; KINT = Smith Reynolds Airport NWS Station, Winston-Salem, NC; KRDU = Raleigh/Durham International Airport NWS Station; NWS = National Weather Service; max = maximum; min = minimum; Std. Deviation = standard deviation

Table 2.3-2
Design-Basis Tornado Characteristics

Region	Maximum Wind Speed m/s (mph)	Translational Speed m/s (mph)	Maximum Rotational Speed m/s (mph)	Radius of Maximum Rotational Speed m (ft.)	Pressure Drop mb (psi)	Rate of Pressure Drop mb/s (psi/s)
I	103 (230)	21 (46)	82 (184)	45.7 (150)	83 (1.2)	37 (0.5)

Source: RG 1.76, Table 1

Key: ft. = feet; m = meter; mb = millibar; mph = mile per hour; m/s = meter per second; psi = pound per square inch; psi/s = pound per square inch per second

Table 2.3-3
Design-Basis Tornado Missile Spectrum and Maximum Horizonal Speeds

Missile Type	Schedule 40 Pipe	Automobile	Solid Steel Sphere
Dimensions	0.168 m diameter × 4.58 m long (6.625 in. diameter × 15 ft. long)	Region I and II 5 m × 2 m × 1.3 m (16.4 ft. x 6.6 ft. x 4.3 ft.)	2.54 cm diameter (1 in. diameter)
Mass	130 kg (287 lb.)	Region I and II 1810 kg (4000 lb.)	0.0669 kg (0.147 lb.)
C_DA/m	0.0043 m^2/kg (0.0212 ft^2/lb)	Region I and II 0.0070 m^2/kg (0.0343 ft^2/lb)	0.0034 m^2/kg (0.0166 ft^2/lb)
V_{Mh}^{max}	41 m/s (135 ft/s)	41 m/s (135 ft/s)	8 m/s (26 ft/s)

Source: RG 1.76, Table 2

Key: C_DA/m = drag coefficient * projected area/ mass; cm = centimeter; ft. = feet; ft^2/lb = square feet per pound; ft/s = feet per second; kg = kilogram; in. = inch; lb. = pound; m = meter; m^2/kg = meters squared per kilogram; m/s = meter per second; V_{Mh}^{max} = Horizontal velocity of missile, vertical velocity of missile

Table 2.3-4
Design-Basis Temperatures for KGSO, KRDU, and KINT

Temperature Variable	KGSO (˚F)	KRDU (˚F)	KINT (˚F)
Normal DBT	59.6	61.2	59.7
Mean DBT	58.3	60.0	58.0
Mean WBT	50.1	52.0	50.7
Maximum Normal DBT	69.8	72.0	NA
Maximum Mean DBT	95.7	99.0	95.5
Maximum Mean WBT	78.3	80.6	78.6
Minimum Normal DBT	49.4	50.5	NA
Minimum Mean DBT	11.4	12.3	12.4
Minimum Mean WBT	9.3	10.4	10.6
DBT with Annual Exceedance Probability of 0.4 %	92.4	95.0	92.2
Mean Coincident WBT With Annual Exceedance Probability of 0.4 %	74.0	75.6	73.5
DBT With Annual Exceedance Probability of 1.0 %	90.3	92.6	90.3
Mean Coincident WBT With Annual Exceedance Probability of 1.0 %	73.5	75.1	73.0
DBT With Annual Exceedance Probability of 2.0 %	88.2	90.3	88.3
Mean Coincident WBT With Annual Exceedance Probability of 2.0 %	72.9	74.5	72.4
WBT (Non-Coincidence) With Annual Exceedance Probability of 0.4 %	77.0	78.4	76.4
WBT (Non-Coincidence) With Annual Exceedance Probability of 1.0 %	75.8	77.4	75.3

Source: References 2.3-12; 2.3-26; 2.3-27; 2.3-39
Key: °F = degree Fahrenheit; DBT = Dry Bulb Temperature; KGSO = National Weather Service (NMW) Station at Piedmont Triad International Airport at Greensboro, NC; KINT = Smith Reynolds Airport NWS Station, Winston-Salem, NC; KRDU = Raleigh/Durham International Airport NWS Station; NA = not available; WBT = Wet Bulb Temperature

Table 2.3-5
Ground-Level Weights of Extreme Snowpacks and Snowfall Events

Parameter	Value (psf)	Notes
Weight of the 100-year snowpack	24.4	From the weight of a 50-year snowpack in ASCE 7/16 (20 psf.) multiplied by 1.22 to estimate the weight of a 100-year snowpack
Weight of historical maximum snowpack	16.4	Computed using Equation 2.3.1-3 with input from the higher of the two maximum observed snow depth (20.0 in. at KRDU)
Weight of the historical maximum two-day snowfall event	15.8	Computed using Equation 2.3.1-4 with input from the maximum observed two-day snowfall (20.3 in. at KRDU)
Weight of the maximum two-day, 100-year snowfall event	15.5	Computed using Equation 2.3.1-4 with the highest two-day, 100-year snowfall (19.9 in. at Danbury 1 NW)

Key: ASCE = American Society of Civil Engineers; in. = inch; KRDU = Raleigh/Durham International Airport National Weather Service Station; psf = pounds per square feet

Table 2.3-6
National Ambient Air Quality Standards

Pollutant	Primary/ Secondary Standard	Averaging Period	Level ($\mu g/m^3$)	Level (ppm)
CO[(a)]	Primary	1 hr.	--	35
CO[(a)]	Primary	8 hr.	--	9
Lead[(b)]	Primary and secondary	Rolling 3-month average	0.15	--
NO_2[(c)]	Primary	1 hr.	--	0.1
NO_2	Primary and secondary	Annual	--	0.053
Ozone[(d)]	Primary and secondary	8 hr.	--	0.070
$PM_{2.5}$[(e)]	Primary and secondary	24 hr.	35	--
$PM_{2.5}$	Primary	Annual	9.0	--
$PM_{2.5}$	Secondary	Annual	15.0	--
PM_{10}[(f)]	Primary and secondary	24 hr.	150	--
SO_2[(g)]	Primary	1 hr.	--	0.075
SO_2[(a)]	Secondary	3 hr.	--	0.5

Notes:
(a) Not to be exceeded more than once per year.
(b) In areas designated nonattainment for the Pb standards prior to promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have been submitted and approved, the previous standards (1.5 $\mu g/m^3$ calendar quarter average) also remain in effect.
(c) 98th percentile of 1-hr. daily maximum concentrations averaged over three years.
(d) Annual fourth-highest daily maximum 8-hr. concentration averaged over three years.
(e) 98th percentile averaged over three years.
(f) Not to be exceeded more than once per year on average over three years.
(g) 99th percentile of 1-hr. daily maximum concentrations averaged over three years.
Key: $\mu g/m^3$ = micrograms per cubic meter; CO = carbon monoxide; hr. = hour; NO_2 = nitrogen dioxide; ppm = parts per million; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; PM_{10} = particulate matter with a diameter of 10 microns or less; SO_2 = sulfur dioxide

Table 2.3-7
Meteorological Tower Specifications

Tower	Location	Measurement Levels	Data Collection Period
KGSO	Latitude: 36.09750 Longitude: -79.94361 Elevation: 925 ft. UTM: Zone 17 Northing: 260.82 km Easting: 524.63 km	10 m	Varies
KRDU	Latitude: 35.89223 Longitude: -78.78185 Elevation: 394 ft. UTM: Zone 17 Northing: 237.67 km Easting: 629.30 km	10 m	Varies
KINT	Latitude: 36.13333 Longitude: -80.22472 Elevation: 968 ft. UTM: Zone 17 Northing: 265.07 km Easting: 499.36 km	10 m	Varies
Project site	Latitude: 36.28613 Longitude: -80.044177 Elevation: 810 ft. UTM: Zone 17 Northing: 281.84 km Easting: 515.79 km	60 m, 10 m	February 7, 2024 – February 6, 2025

Source: References 2.3-30; 2.3-31; 2.3-32
Key: ft. = feet; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC; KINT = Smith Reynolds Airport NWS Station, Winston-Salem, NC; km = kilometer; KRDU = Raleigh/Durham International Airport NWS Station; m = meter; NC = North Carolina; UTM = Universal Transverse Mercator

Table 2.3-8
Summary of KGSO Annual Average Normals (1991-2020)

	Normal Dry Bulb Temp (˚F)	Normal RH (%)	Mean Wind Speed (mph)	Prevailing Wind Direction[(a)] (degrees)	Normal Liquid Precipitation (in.)
Annual (1991 – 2020)	59.6	69	7.1	220	43.95

Source: Reference 2.3-26
Note:
(a) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.
Key: °F = degree Fahrenheit; in. = inch; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC; mph = miles per hour; RH = relative humidity

Table 2.3-9
Annual Comparison of Meteorological Tower Measurements

	Measurement Level	Average Dry Bulb Temp (˚F)	Average RH (%)	Average Wind Speed (mph)	Prevailing Wind Direction[(a)] (degrees)	Total Liquid Precipitation (in.)
Project site (2024-2025)	10 m	61.0	67.9	4.3	247	38.07
	60 m	60.4	--	7.8	285	--
KGSO (2022)	10 m	59.6	66.0	7.1	220	47.79
KRDU (2022)	10 m	62.7	67.0	6.0	240	44.74
KINT (1964)	10 m	59.3	69.0	7.5	240	47.34

Source: Project site = Belews Creek MET tower measurements; Total precipitation data from Belews Creek Nuclear Site (future advanced reactors) Meteorological Data Recovery Document. Data Period: February 7, 2024–February 6, 2025
KGSO Source: Reference 2.3-26
KRDU Source: Reference 2.3-27
KINT Source: Reference 2.3-39
Note:
(a) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.
Key: °F = degree Fahrenheit; in. = inch; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC; KINT = Smith Reynolds Airport NWS Station, Winston-Salem, m = meter; km = kilometer; KRDU = Raleigh/Durham International Airport NWS Station; mph = miles per hour; RH = relative humidity

Table 2.3-10
Mean Wind Speeds and Prevailing Wind Direction Recorded at KGSO

Month	Mean Wind Speed[a] (mph)	Prevailing Wind Direction[b][d][f] (degrees)	Max 2-Minute Speed[c] (mph)	Wind Direction for Max 2-Minute Wind Speed[c][d][f] (degrees)	Max 3-Second Speed[c] (mph)	Wind Direction for Max 3-Second Wind Speed[c][d][f] (degrees)
January	7.6	220	41	190	54	60
February	8.0	220	43	260	54	230
March	8.5	220	49	300	61	290
April	8.6	220	43	160	62	280
May	7.4	220	62	270	82	260
June	6.7	240	47	290	60	290
July	6.3	230	53	290	74	290
August	5.8	230	40	120	59	280
September	6.2	30	46	260	60	250
October	6.2	30	40	180	51	180
November	6.7	220	38	20	48	240
December	7.0	220	39	290	53	300
Annual	7.1	220	62[e]	270[e]	82[e]	260[e]

Source: Reference 2.3-26
Notes:
(a) 1983 – 2022
(b) 1969 – 2022
(c) 1996 – 2022
(d) Direction from which the wind blows.
(e) Maximum Recorded May 2000
(f) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.
Key: KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC; mph =miles per hour; max = maximum

Table 2.3-11
Average Wind Speeds and Prevailing Wind Direction
Recorded at the Project Site (10 meters) (2024-2025)

Month	Average Wind Speed (mph)	Prevailing Wind Direction (degrees)[(a)]	Daily Maximum Wind Speed (mph)
January	5.1	287	13.9
February	4.9	246	16.0
March	4.6	170	14.6
April	5.4	227	15.7
May	3.7	219	11.1
June	4.0	209	9.3
July	4.1	210	9.5
August	3.4	261	19.2
September	3.8	81	17.3
October	3.4	320	9.8
November	4.2	284	11.9
December	4.5	317	17.1
Annual	4.3	247	19.2

Source: Belews Creek MET tower measurements. Data Period: February 7, 2024–February 6, 2025e
Note:
(a) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.

Key: mph = miles per hour

Table 2.3-12
Wind Direction Persistence Distribution (Hours) for the Project Site (10 meters) (2024-2025)

	Hours									
Direction	**1**	**2**	**3**	**4**	**5-6**	**7-8**	**9-10**	**11-12**	**13-14**	**>15**
N	128	39	15	9	9	3	0	1	0	0
NNE	150	37	16	0	5	0	1	0	0	0
NE	159	44	14	7	4	0	0	0	0	0
ENE	213	71	29	7	5	1	0	0	0	0
E	185	62	32	17	10	2	4	1	2	0
ESE	158	38	15	4	5	2	0	0	0	1
SE	118	26	3	1	1	0	0	0	0	0
SSE	147	48	16	6	5	2	1	0	0	0
S	231	86	38	9	16	5	1	0	0	0
SSW	305	86	44	17	14	8	0	2	1	0
SW	297	112	51	31	22	7	2	1	0	1
WSW	276	78	21	17	9	2	0	0	0	0
W	243	70	15	10	7	0	0	0	0	0
WNW	209	61	21	15	18	4	7	2	2	0
NW	179	55	16	14	13	4	4	0	0	0
NNW	141	30	17	6	2	1	0	0	0	0

Source: 2024–2025 composite based on Belews Creek hourly wind direction and speed.
Data Period: February 7, 2024–February 6, 2025
Key: E = east; ENE = east-northeast; ESE = east-southeast; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-13
Air Temperatures Recorded at KGSO

	Normal Daily Maximum (˚F)	Normal Dry Bulb (˚F)	Normal Daily Minimum (˚F)	Highest Daily Maximum (˚F)	Highest Daily Minimum (˚F)
Period of Record (Years)	30[(a)]	30[(a)]	30[(a)]	94[(d)]	94[(d)]
January	49.3	39.7	30.1	78	-8
February	53.3	43.0	32.7	81	-4
March	61.3	50.3	39.3	90	5
April	71.0	59.4	47.9	94	21
May	78.0	67.5	57.1	98	32
June	85.2	75.3	65.4	102	42
July	88.5	78.9	69.3	102	48
August	86.6	77.3	68.0	103	45
September	80.4	71.0	61.5	100	35
October	71.0	60.2	49.4	95	20
November	60.6	49.7	38.9	85	10
December	52.0	42.5	33.0	78	0
Annual	69.8	59.6	49.4	103[(b)]	-8[(c)]

Source: Reference 2.3-26
Notes:
(a) 1991 – 2020.
(b) August 1988.
(c) January 1985.
(d) 1928 – 2022.
Key: °F = degrees Fahrenheit; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC

Table 2.3-14
Air Temperatures Recorded at the Project Site (10 meters)
(2024-2025)

	Dry Bulb Temperature			Wet Bulb Temperature		
	Daily Average (˚F)	Daily Minimum (˚F)	Daily Maximum (˚F)	Daily Average (˚F)	Daily Minimum (˚F)	Daily Maximum (˚F)
January	36.1	15.8	66.7	30.5	12.6	59.9
February	48.7	29.3	72.9	42.3	24.0	61.5
March	54.4	32.7	80.4	46.6	27.1	60.5
April	61.9	38.3	84.9	53.7	32.9	66.9
May	68.6	51.8	85.6	62.7	47.9	71.5
June	76.6	54.5	94.1	68.2	54.2	78.0
July	78.8	61.7	97.3	71.8	57.4	77.8
August	76.1	60.6	93.9	70.6	60.3	78.2
September	70.7	56.5	84.9	66.2	51.4	76.5
October	62.0	42.1	79.3	56.0	39.0	71.3
November	55.0	30.7	80.6	49.6	25.8	69.4
December	42.8	23.4	66.7	38.9	19.9	61.7
Annual	61.0	15.8	97.3	54.8	12.6	78.2

Source: Belews Creek MET Tower measurements.
Data Period: February 7, 2024–February 6, 2025
Key: °F = degrees Fahrenheit

Table 2.3-15
Humidity Values Recorded at KGSO

	Mean DBT (°F)[a]	Mean Wet Bulb Temperature (°F)[b]	Mean Dewpoint Temperature (°F)[b]	Normal RH (%)	Mean Absolute Humidity (grams/cubic meter)
January	39.0	30.9	30.0	67	4
February	39.9	33.9	32.1	64	4
March	49.2	39.1	38.4	62	6
April	57.7	47.6	46.9	61	7
May	66.9	57.7	57.1	70	12
June	73.6	65.2	64.9	72	15
July	77.8	69.0	68.8	74	17
August	76.5	68.3	68.1	76	17
September	69.6	62.5	62.2	77	14
October	59.5	52.0	51.2	73	10
November	48.5	41.1	40.8	69	6
December	41.0	34.4	32.8	68	5
Annual	58.3	50.1	49.4	69	9

Source: Humidity from Reference 2.3-28**.** Temperatures and Dewpoints (°F) and Normal Relative Humidity from Reference 2.3-26.
Notes:
(a) Period of record = 120 years.
(b) Period of record = 38 years.
Key: °F = degrees Fahrenheit; DBT = Dry Bulb Temperature; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC

Table 2.3-16
Humidity Values Recorded at the Project Site (10 Meters) (2024 – 2025)[a]

	Daily Average DBT (°F)	Daily Average Wet Bulb Temperature (°F)	Daily Average Dewpoint Temperature (°F)	Daily Average RH (%)	Daily Average Absolute Humidity (grams/cubic meter)
January	36.1	30.5	19.0	53	3
February	48.7	42.3	33.4	59	5
March	54.4	46.6	36.7	58	6
April	61.9	53.7	46.3	60	9
May	68.6	62.7	58.9	75	13
June	76.6	68.2	63.8	67	15
July	78.8	71.8	68.5	73	18
August	76.1	70.6	68.0	78	18
September	70.7	66.2	63.7	80	15
October	62.0	56.0	51.3	71	10
November	55.0	49.6	43.9	69	8
December	42.8	38.9	32.5	70	5
Annual	61.0	54.7	48.8	68	9

Source: Humidity from Reference 2.3-38. Temperatures and Dewpoints (°F) and typical Relative Humidity based on 12 months of on-site data from Belews Creek MET Tower measurements.
Note:
(a) Data Period: February 7, 2024–February 6, 2025.
Key: °F = degrees Fahrenheit; DBT = Dry Bulb Temperature

Table 2.3-17
Historical Precipitation Data Recorded at KGSO

	Normal Monthly (in.)	Maximum Monthly (in.)	Minimum Monthly (in.)	Maximum in 24 Hours (in.)	Normal No. Days with Precipitation (≥ 0.01 in.)	Days with Thunderstorms
Period of Record (Years)	30[a]	94	94	94	30[a]	75
January	3.39	8.24	0.66	3.06	9.8	0.5
February	2.81	7.23	0.49	3.69	9.5	0.6
March	3.72	8.76	0.67	3.62	10.9	2.0
April	3.78	8.03	0.41	4.42	9.7	3.4
May	3.49	9.45	0.37	3.25	10.8	6.3
June	4.09	10.50	Trace[e][g]	4.91	10.6	7.7
July	4.18	12.72	0.98	4.43	11.3	10.1
August	4.36	12.53	0.71	5.14	10.2	7.8
September	4.59	13.26	Trace[f][g]	7.49[d]	8.3	3.1
October	3.10	12.59	0.26	6.24	7.5	1.0
November	3.27	8.26	0.24	3.56	8.2	0.5
December	3.17	6.99	0.33	3.60	9.2	0.3
Annual	43.95	13.26[b]	0.24[c]	7.49[d]	116.0	43.3

Source: Reference 2.3-26
Notes:
(a) 1991-2020.
(b) September 1947.
(c) November 2012.
(d) September 1947.
(e) June 1990.
(f) September 1985.
(g) Trace = Less than the smallest measurable amount, i.e., less than 0.01 inches.
Key: in. = inch; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC; No. = number

Table 2.3-18
Precipitation (Inches) Recorded at the Project Site (10 meters) (2024-2025)

	Monthly Total (in.)	Maximum in 1 Hour (in.)	Maximum in 24 Hours (in.)
January	1.74	0.31	1.06
February	1.82	0.29	1.13
March	4.64	0.28	1.09
April	2.27	0.77	1.47
May	5.15	0.52	1.64
June	1.87	0.96	1.3
July	2.89	1.28	1.79
August	5.98	0.83	4.23
September	7.08	0.60	3.11
October	0.45	0.15	0.25
November	1.35	0.23	0.87
December	2.83	0.17	1.36
Annual	38.07	1.28	4.23

Source: Belews Creek MET Tower measurements; Monthly and Annual Totals from Belews Creek Nuclear Site (future advanced reactors) Meteorological Data Recovery Document.
Data Period: February 7, 2024–February 6, 2025
Key: in. = inch

Table 2.3-19
Precipitation Frequency by Wind Direction for Project Site (10 Meters)
(2024 - 2025)[(a)(b)]

Project Site Wind Direction (blowing from)	Percent Occurrence of Belews Creek Precipitation						
	All Precipitation	Precipitation0 0.5 – 2.1 mm/hr	Precipitation 2.1 – 3.6 mm/hr	Precipitation 3.6 – 5.7 mm/hr	Precipitation 5.7 – 8.8 mm/hr	Precipitation 8.8 – 11.1 mm/hr	Precipitation > 11.1 mm/hr
N	0.48	0.24	0.07	0.09	0.05	0.01	0.02
NNE	0.47	0.28	0.01	0.13	0.02	0.00	0.03
NE	0.51	0.32	0.08	0.06	0.05	0.00	0.01
ENE	0.20	0.17	0.00	0.02	0.00	0.00	0.01
E	0.26	0.15	0.02	0.08	0.00	0.00	0.01
ESE	0.22	0.13	0.05	0.02	0.00	0.02	0.00
SE	0.10	0.07	0.01	0.02	0.00	0.00	0.00
SSE	0.09	0.05	0.01	0.01	0.00	0.01	0.01
S	0.34	0.24	0.05	0.02	0.00	0.00	0.03
SSW	0.33	0.21	0.05	0.05	0.01	0.01	0.01
SW	0.28	0.13	0.03	0.03	0.05	0.01	0.03
WSW	0.42	0.22	0.03	0.10	0.00	0.02	0.05
W	0.90	0.44	0.09	0.15	0.10	0.05	0.08
WNW	0.64	0.39	0.06	0.02	0.06	0.03	0.08
NW	0.18	0.10	0.02	0.02	0.01	0.00	0.02
NNW	0.17	0.15	0.01	0.01	0.00	0.00	0.00

Source: Belews Creek MET Tower measurements; Belews Creek Nuclear Site (future advanced reactors) Meteorological Data Recovery Document.
Notes:
(a) Data Period: February 7, 2024–February 6, 2025.
(b) Precipitation wind roses developed using WRPlot software are in mm/hr. The precipitation frequency displayed in WRPLOT represents the percentage of time that rain of a particular intensity occurred. During this data period, rain occurred 5.59% of the time.
Key: E = east; ENE = east-northeast; ESE = east-southeast; mm/hr = millimeters per hour; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-20
Historical Snowfall Data Recorded at KGSO

	Normal Monthly (in.)	Maximum Monthly (in.)	Maximum in 24 Hours (in.)	Maximum Snow Depth (in.)	Normal Number of Days with Snowfall ≥ 1.0 in.
Period of Record (Years)	30[a]	94	94	74	30[a]
January	2.9	22.9[b]	14.0	15[d]	0.8
February	2.0	16.3	9.3	13	0.7
March	0.9	21.3	11.1	14	0.3
April	0.0	Trace	Trace	0	0.0
May – October	0.0	Trace	Trace	0	0.0
November	0.1	5.9	5.0	4	0.0
December	1.2	14.3	14.3[c]	10	0.4
Annual	7.1	22.9[b]	14.3[c]	15[d]	2.2

Source: Reference 2.3-26
Notes:
(a) 1991 – 2020.
(b) January 1966.
(c) December 1930.
(d) January 1966.
Key: in. = inch; KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC

Table 2.3-21
Fog Occurrence Recorded at KGSO and KRDU

Month	Number of Days with Heavy Fog (Visibility ≤ 0.25 Miles)	
	KGSO	KRDU
January	3.8	3.2
February	2.8	2.6
March	2.4	1.9
April	1.3	1.3
May	1.5	1.6
June	1.2	1.2
July	1.3	1.9
August	1.8	2.4
September	2.3	2.3
October	2.3	2.4
November	2.6	2.6
December	3.3	3.1
Annual	26.6	26.5
Period of Record (Years)	59	59

Source: Reference 2.3-26
Key: KGSO = National Weather Service Station at Piedmont Triad International Airport at Greensboro, NC; KRDU = Raleigh/Durham International Airport NWS Station

Table 2.3-22
Classification of Pasquill Atmospheric Stability

Stability Classification	Pasquill Categories	Temperature Change with Height (°C/100 m)
Extremely unstable	A	$\Delta T \leq -1.9$
Moderately unstable	B	$-1.9 < \Delta T \leq -1.7$
Slightly unstable	C	$-1.7 < \Delta T \leq -1.5$
Neutral	D	$-1.5 < \Delta T \leq -0.5$
Slightly stable	E	$-0.5 < \Delta T \leq 1.5$
Moderately stable	F	$1.5 < \Delta T \leq 4.0$
Extremely stable	G	$\Delta T > 4.0$

Notes:
This table is listed as Table 1 in RG 1.23.
ΔT is the 60-10 m Delta-T. Actual DeltaT data must be normalized to a standard 100m vertical separation distance between instrument levels to compare to RG 1.23 ranges for determining stability categories. This may be referred to as the normalized lapse rate, derived from the DeltaT measurements.
Key: °C = degrees Celsius; m = meter

Table 2.3-23
Total Distribution in Each Stability Class for Project Site

Stability Class	Hours	Percentage
A	1799	21.3%
B	453	5.4%
C	485	5.7%
D	2630	31.2%
E	2318	27.5%
F	565	6.7%
G	189	2.2%
Unstable (Classes A-C)	2737	32.4%
Neutral (Class D)	2630	31.2%
Stable (Class E-G)	3072	36.4%

Source: Project site February 7, 2024 through February 6, 2025

Table 2.3-24
Frequency Distribution of Consecutive Hours in Each Stability Class for Project Site - Stability Class A through D

Persistence (Number of Consecutive Hours)	Number of Occurrences			
	A (ΔT ≤ -1.9)	B (-1.9 < ΔT ≤ -1.7)	C (-1.7 < ΔT ≤ -1.5)	D (-1.5 < ΔT ≤ -0.5)
2	15	49	47	113
3	6	16	24	55
4	11	9	14	56
5	8	5	7	36
6	9	2	6	25
7	17	3	0	31
8	23	1	0	41
9	33	0	0	19
10	30	1	0	15
11	24	1	0	11
12	15	0	0	3
13	13	0	0	3
14	1	0	0	4
15	1	0	0	7
16	2	0	0	5
17	0	0	0	1
18	0	0	0	1
19	0	0	0	0
20	2	0	0	2
21	1	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	2
25	0	0	0	1
26	0	0	0	1
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	1
32	0	0	0	0

Notes:
ΔT is the 60–10 m Delta-T.
This table shows the number of cases when each stability class persisted for two or more hours.
Data Period: Project site February 7, 2024 - February 6, 2025.

Table 2.3-25
Frequency Distribution of Consecutive Hours in Each Stability Class for Project Site - Stability Class E through G

Persistence (Number of Consecutive Hours)	Number of Occurrences			
	E (-0.5 < ΔT ≤ 1.5)	F (1.5<ΔT≤4.0)	G (ΔT>4.0)	All Inversion Conditions (E – G)
2	107	57	11	175
3	50	25	14	89
4	34	16	4	54
5	30	9	4	43
6	28	8	3	39
7	12	6	3	21
8	16	1	0	17
9	8	3	0	11
10	10	4	1	15
11	11	0	2	13
12	4	0	0	4
13	9	0	0	9
14	8	1	0	9
15	8	0	0	8
16	12	0	0	12
17	8	0	0	8
18	4	0	0	4
19	1	0	0	1
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0

Notes:
ΔT is the 60–10 m Delta-T.
This table shows the number of cases when each stability class persisted for two or more hours.
Data Period: Project site February 7, 2024 - February 6, 2025.

Table 2.3-26
Point Precipitation (Inches) by Recurrence Interval for Region

Duration	Recurrence Intervals (Years)						
	1	2	5	10	25	50	100
5 minutes	0.4	0.4	0.5	0.6	0.6	0.7	0.7
10 minutes	0.6	0.7	0.8	0.9	1.0	1.1	1.1
15 minutes	0.7	0.9	1.1	1.2	1.3	1.3	1.4
30 minutes	1.0	1.2	1.5	1.7	1.9	2.0	2.2
1 hour	1.3	1.5	1.9	2.2	2.5	2.7	3.0
2 hours	1.5	1.8	2.3	2.6	3.1	3.4	3.8
3 hours	1.6	2.0	2.5	2.8	3.3	3.7	4.1
6 hours	2.0	2.4	3.0	3.5	4.1	4.6	5.1
12 hours	2.4	2.9	3.6	4.2	5.0	5.7	6.4
24 hours	2.8	3.4	4.3	5.0	6.1	6.9	7.9
2 days	3.3	4.0	5.0	5.8	6.9	7.8	8.8
4 days	3.7	4.5	5.6	6.5	7.7	8.7	9.8
7 days	4.2	5.1	6.2	7.2	8.5	9.6	10.7
10 days	4.8	5.7	7.0	8.0	9.3	10.4	11.6

Source: Reference 2.3-22
Note:
Values were rounded to one decimal digit.

Table 2.3-27
Seasonal and Annual Average Mixing Heights at Greensboro, NC

	Morning		Afternoon	
Season[a,b]	**(m)**	**(ft.)**	**(m)**	**(ft.)**
Winter	465	1526	858	2816
Spring	476	1562	1538	5046
Summer	472	1547	1609	5278
Autumn	379	1243	1143	3749
Annual	448	1470	1299	4262

Source: Reference 2.3-50
Notes:
(a) POR 1984-1987 and 1989-1991 (SCRAM station #13723)
(b) The USEPA SCRAM data files were last modified Jan. 5, 2001, and the SCRAM description indicates they were originally created on July 7, 1992.
Key: ft. = feet; m = meter; NC = North Carolina

Table 2.3-28
Maximum Modeled Plume Drift Deposition (kg/km^2/mo)

Season	Salt deposition (kg/km^2/mo)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	51.77	300	ENE
Summer	63.51	300	ENE
Fall	45.11	200	NE
Winter	51.60	200	E
Annual	41.57	300	ENE

Source: SACTI2 Model from linear mechanical draft cooling towers (LMDCTs) from the Project site
Key: E = east; ENE = east-northeast; kg/km^2/mo = kilogram per square kilometer per month; m = meter; NE = northeast

Table 2.3-29
Maximum Modeled Plume Water Deposition (Kg/Km^2/Mo)

Season	Maximum Plume Water Deposition Rate (kg/km^2/mo)	Equivalent Monthly Precipitation (in.)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	43,400	0.0017	100	ENE
Summer	50,100	0.0020	100	ENE
Fall	41,100	0.0016	200	NE
Winter	47,700	0.0019	200	E
Annual	34,700	0.0014	100	ENE

Source: SACTI2 Modeling Files for the Project site
Data Period: February 7, 2024 - February 6, 2025
Key: E = east; ENE = east-northeast; in. = inch; kg/km^2/mo = kilograms per square kilometer per month; m = meter; NE = northeast

Table 2.3-30
Maximum Modeled Cooling Tower Plume Shadowing (Hours)

Season	Plume Shadowing (hours)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	111.7	200	SE
Summer	105.4	200	ESE
Fall	96.4	200	WNW
Winter	137.0	200	NE
Annual	380.9	200	SE

Source: SACTI2 Modeling Files for the Project site
Data Period: February 7, 2024 - February 6, 2025
Key: ESE = east-southeast; m = meter; NE = northeast; SE = southeast; WNW = west-northwest

Table 2.3-31
Maximum Modeled Plume Length Frequency (Percent)

Season/Distance	100 m	200 m	300 m	400 m	500 m	1.0 km	2.5 km	2.7 km	2.8 km
Spring	100.00	3.22	2.61	2.61	2.61	2.61	2.61	2.41	0.00
Summer	100.00	0.17	0.17	0.17	0.17	0.17	0.17	0.00	0.00
Fall	100.00	2.47	2.47	2.47	2.47	2.47	2.42	1.73	0.00
Winter	100.00	8.11	8.11	8.11	8.11	8.11	7.97	4.26	0.00
Annual	100.00	3.34	3.34	3.34	3.34	3.34	3.29	2.09	0.00

Source: SACTI2 Modeling Files for the Project site
Data Period: February 7, 2024 - February 6, 2025
Key: km = kilometer, m = meter

Table 2.3-32
Modeled Plume Height Frequency (Percent)

Season/Height from Towers	10 m	20 m	30 m	50 m	100 m	250 m	500 m	1.0 km
Spring	100.00	99.95	32.58	3.89	2.61	2.56	2.51	2.41
Summer	100.00	100.00	24.49	0.43	0.17	0.10	0.05	0.05
Fall	100.00	100.00	43.09	4.62	2.47	2.13	2.13	1.93
Winter	100.00	100.00	51.13	12.91	8.11	6.98	6.48	5.29
Annual	100.00	99.99	37.93	5.45	3.34	2.94	2.79	2.41

Source: SACTI2 Modeling Files for the Project site
Data Period: February 7, 2024 - February 6, 2025
Key: km = kilometer, m = meter

Table 2.3-33
Summary of Meteorological Equipment Used at the Project Site

Meteorological Equipment Upgrade	Specifications[c]	Measurement Levels (AGL)	Meets RG 1.23 Guidance	
			Yes	No
RM Young 05305V Wind Monitor-AQ (wind speed)	±0.2 m/s (±0.45 mph) or 5% of observed wind speed starting threshold < 0.4 m/s (0.89 mph)	60 m and 10 m	X	
RM Young 05305V Wind Monitor-AQ (wind direction)	±5 degree starting threshold < 0.4 m/s (0.89 mph)	60 m and 10 m	X[c]	
RM Young 41342VC Temperature Probe Delta[a]	±0.1 °C (±0.18 °F)	60 m and 10 m	X	
RM Young 41342VC Temperature Probe	±0.5 °C (±0.9 °F)	60 m and 10 m	X	
RM Young 52202-20 Rain Gauge	±10% for a volume equivalent to 2.54 mm (0.1 in.) of precipitation at a rate < 50 mm/hr (<2 in/hr)	Ground	X	
RM Young Aspirated Radiation Shield	Required for NIST	60 m and 10 m	X	
ESC 8864 Data Logger	N/A	N/A	X	
Sierra Wireless Modem – Duke Energy Approved	N/A	N/A	X	
RM Young Model 41382VC Relative Humidity / Temperature[b]	±4%	10 m	X	

Notes:
(a) Delta-T is derived from ambient temperature measurements between 60 m and 10 m. The two temperature probes are matched and calibrated together to achieve higher accuracy for Delta-T (i.e. ±0.1 °C or ±0.18 °F) than would be achievable from using individual temperature readings.
(b) For computation of the dewpoint temperature.
(c) The RM Young specs state that the starting threshold for the wind direction sensor (05305V) is 0.5 m/s at 10 degree displacement, but incorrectly states that 0.5 m/s would be equivalent to 1 mph (0.5 m/s =1.12 mph, so it does not completely meet RG 1.23 guidance for starting threshold). However, the RM Young wind direction does meet guidance in ANS-3.11-2024 for a starting threshold of 0.5 m/s (ref. section 3.1.2 in ANS-3.11-2024) and accuracy of 5 degrees. It would, however, meet the ANS-3.11-2024 guidance for accuracy and starting threshold.

Key: °C = degrees Celsius; °F = degrees Fahrenheit; AGL = above ground level; m = meter; mm = millimeter; mm/hr = millimeters per hour; mph = miles per hour; m/s = meters per second; N/A = not applicable; NIST = National Institute of Standards and Technology; RG = Regulatory Guide

Table 2.3-34
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class A (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	1	1	4	5	7	1	0	0	0	0	0	19
NNE		0	0	2	4	7	22	7	1	1	0	0	0	44
NE		0	0	1	6	12	28	19	2	1	0	0	0	69
ENE		0	2	2	11	27	94	45	1	1	0	0	0	183
E		0	0	3	14	41	82	70	3	0	0	0	0	213
ESE		0	1	5	8	11	41	28	2	0	0	0	0	96
SE		0	0	2	4	7	23	14	1	1	0	0	0	52
SSE		0	0	1	9	12	23	30	2	1	5	1	0	84
S		0	0	4	3	5	30	49	13	1	0	0	0	105
SSW		0	1	1	3	5	15	46	25	7	1	0	0	104
SW		0	2	5	4	7	33	105	68	20	8	1	0	253
WSW		0	0	3	6	10	26	88	50	18	0	0	0	201
W		0	2	3	7	5	20	38	27	8	10	1	0	121
WNW		0	1	3	8	10	14	46	46	22	21	4	0	175
NW		1	0	1	5	10	7	3	8	16	7	0	1	59
NNW		0	0	1	6	5	6	2	1	0	0	0	0	21
Total	0	1	10	38	102	179	471	591	250	97	52	7	1	1799

Source: Project site February 7, 2024 – February 6, 2025
Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-35
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class B (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	0	0	0	0	5	2	2	0	0	0	0	9
NNE		0	0	0	2	1	7	2	0	0	0	0	0	12
NE		0	0	0	3	4	6	6	0	0	0	0	0	19
ENE		2	1	5	3	6	13	16	0	0	0	0	0	46
E		0	0	8	15	14	39	11	2	0	0	0	0	89
ESE		0	1	3	3	6	7	8	0	0	0	0	0	28
SE		0	0	3	1	3	1	4	0	0	0	0	0	12
SSE		0	0	1	0	5	5	6	2	1	1	0	0	21
S		0	0	0	2	3	4	12	0	0	0	0	0	21
SSW		0	0	0	2	1	14	20	5	4	1	1	0	48
SW		0	1	4	2	2	6	19	6	4	1	1	0	46
WSW		0	1	3	1	0	3	9	3	1	0	0	0	21
W		0	0	3	3	2	4	12	1	0	0	0	0	25
WNW		0	0	2	2	2	5	5	4	1	1	0	0	22
NW		0	0	2	1	2	2	3	4	8	3	1	0	26
NNW		0	0	1	1	1	0	2	1	0	0	0	0	6
Total	2	2	4	35	41	52	121	137	30	19	7	3	0	453

Source: Project site February 7, 2024 – February 6, 2025
Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-36
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class C (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	0	1	2	1	7	6	1	0	0	0	0	18
NNE		0	0	0	2	2	9	5	0	0	0	0	0	18
NE		0	0	0	3	3	16	4	0	0	0	0	0	26
ENE		0	0	2	10	7	7	9	0	0	0	0	0	35
E		0	5	4	13	9	21	9	0	0	0	0	0	61
ESE		0	3	4	4	5	7	10	1	0	0	0	0	34
SE		0	0	1	1	3	2	2	0	0	0	0	0	9
SSE		0	0	1	0	2	2	5	1	1	1	0	0	13
S		0	0	0	1	3	13	14	2	1	1	0	0	35
SSW		0	0	0	2	2	15	24	13	3	1	0	0	60
SW		0	0	1	6	2	6	23	1	3	3	0	0	45
WSW		0	0	0	1	2	8	8	3	0	0	0	0	22
W		1	1	0	4	2	2	6	2	0	0	0	0	18
WNW		0	0	0	4	2	5	10	4	5	0	0	0	30
NW		1	0	0	4	0	5	10	13	8	2	3	0	46
NNW		0	0	0	0	1	8	4	0	1	0	0	0	14
Total	1	2	9	14	57	46	133	149	41	22	8	3	0	485

Source: Project site February 7, 2024 – February 6, 2025
Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-37
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class D (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	2	8	24	24	30	42	11	0	0	0	0	141
NNE		0	4	10	25	24	52	30	10	2	0	0	0	157
NE		0	7	10	20	21	73	21	1	0	0	0	0	153
ENE		1	7	19	35	43	66	11	0	0	0	0	0	182
E		1	6	13	19	28	60	28	1	0	0	0	0	156
ESE		3	8	9	19	11	28	26	9	1	4	2	0	120
SE		3	3	8	11	5	14	3	0	1	0	0	0	48
SSE		2	3	8	10	7	16	16	1	1	2	4	0	70
S		1	3	6	13	27	33	62	14	3	1	0	0	163
SSW		0	5	7	17	29	81	122	24	8	0	0	0	293
SW		2	7	14	16	16	63	138	28	7	0	0	0	291
WSW		2	10	15	17	21	20	78	22	4	1	0	0	190
W		2	7	16	9	12	24	27	38	7	0	0	0	142
WNW		2	8	9	11	14	36	61	44	30	2	0	0	217
NW		2	5	8	13	8	9	36	45	37	23	1	0	187
NNW		2	2	15	11	8	16	14	22	8	1	0	0	99
Total	21	23	87	175	270	298	621	715	270	109	34	7	0	2630

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-38
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class E (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		1	10	19	14	32	40	50	6	0	0	0	0	172
NNE		3	13	14	13	6	17	4	0	0	0	0	0	70
NE		6	10	12	15	10	8	2	0	0	0	0	0	63
ENE		3	12	6	13	7	10	0	0	0	0	0	0	51
E		1	9	14	15	13	28	8	0	0	0	0	0	88
ESE		2	10	12	7	9	16	12	3	0	0	0	0	71
SE		6	15	14	6	4	3	0	0	0	0	0	0	48
SSE		4	6	13	12	7	6	12	0	0	0	0	0	60
S		7	9	21	26	26	56	41	7	5	0	0	0	198
SSW		3	8	14	29	28	94	65	8	3	0	0	0	252
SW		3	20	19	28	29	85	88	23	5	0	0	0	300
WSW		2	18	24	23	19	33	38	6	1	0	0	0	164
W		3	14	20	24	11	41	48	11	3	0	0	0	175
WNW		3	15	18	12	9	32	86	32	6	5	0	0	218
NW		5	18	23	22	9	23	39	26	8	1	0	0	174
NNW		5	9	23	21	13	19	28	8	1	0	0	0	127
Total	87	57	196	266	280	232	511	521	130	32	6	0	0	2318

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-39
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class F (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		2	4	1	2	0	0	0	0	0	0	0	0	9
NNE		1	1	1	0	1	1	1	0	0	0	0	0	6
NE		3	1	2	0	0	0	0	0	0	0	0	0	6
ENE		2	1	3	1	0	0	0	0	0	0	0	0	7
E		1	6	1	1	0	0	0	0	0	0	0	0	9
ESE		1	9	0	2	0	1	0	0	0	0	0	0	13
SE		5	5	3	1	0	0	0	0	0	0	0	0	14
SSE		2	11	18	13	8	5	3	0	0	0	0	0	60
S		2	12	16	18	8	39	15	0	0	0	0	0	110
SSW		1	7	5	7	15	31	8	0	0	0	0	0	74
SW		2	9	5	14	12	19	9	0	0	0	0	0	70
WSW		0	4	4	4	6	4	1	0	0	0	0	0	23
W		0	8	4	3	0	3	6	0	0	0	0	0	24
WNW		0	12	12	5	1	2	0	0	0	0	0	0	32
NW		0	8	19	7	2	0	0	0	0	0	0	0	36
NNW		0	7	10	4	3	0	0	0	0	0	0	0	24
Total	48	22	105	104	82	56	105	43	0	0	0	0	0	565

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-40
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class G (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		1	3	1	0	0	0	0	0	0	0	0	0	5
NNE		0	1	0	0	0	0	0	0	0	0	0	0	1
NE		0	0	1	0	0	1	0	0	0	0	0	0	2
ENE		0	0	0	0	0	0	0	0	0	0	0	0	0
E		1	0	0	0	0	0	0	0	0	0	0	0	1
ESE		0	1	0	0	0	0	0	0	0	0	0	0	1
SE		0	2	3	0	0	0	0	0	0	0	0	0	5
SSE		2	11	11	17	8	8	1	0	0	0	0	0	58
S		3	7	13	11	5	6	5	0	0	0	0	0	50
SSW		0	5	4	6	0	2	1	1	0	0	0	0	19
SW		2	3	2	1	1	3	1	0	0	0	0	0	13
WSW		0	3	0	2	0	0	0	0	0	0	0	0	5
W		0	2	1	0	0	0	0	0	0	0	0	0	3
WNW		0	0	1	0	0	0	0	0	0	0	0	0	1
NW		1	1	2	1	0	0	0	0	0	0	0	0	5
NNW		0	2	1	0	0	0	0	0	0	0	0	0	3
Total	17	10	41	40	38	14	20	8	1	0	0	0	0	189

Source: Project site February 7, 2024 – February 6, 2025
Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-41
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class A through G (NUREG/CR-2858) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		4	20	31	46	62	89	101	20	0	0	0	0	373
NNE		4	19	27	46	41	108	49	11	3	0	0	0	308
NE		9	18	26	47	50	132	52	3	1	0	0	0	338
ENE		8	23	37	73	90	190	81	1	1	0	0	0	504
E		4	26	43	77	105	230	126	6	0	0	0	0	617
ESE		6	33	33	43	42	100	84	15	1	4	2	0	363
SE		14	25	34	24	22	43	23	1	2	0	0	0	188
SSE		10	31	53	61	49	65	73	6	4	9	5	0	366
S		13	31	60	74	77	181	198	36	10	2	0	0	682
SSW		4	26	31	66	80	252	286	76	25	3	1	0	850
SW		9	42	50	71	69	215	383	126	39	12	2	0	1018
WSW		4	36	49	54	58	94	222	84	24	1	0	0	626
W		6	34	47	50	32	94	137	79	18	10	1	0	508
WNW		5	36	45	42	38	94	208	130	64	29	4	0	695
NW		10	32	55	53	31	46	91	96	77	36	5	1	533
NNW		7	20	51	43	31	49	50	32	10	1	0	0	294
Total	176	117	452	672	870	877	1982	2164	722	279	107	20	1	8439

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-42
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class A (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)											
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		0	2	9	7	1	0	0	0	0	0	0	19
NNE		0	2	11	22	7	1	1	0	0	0	0	44
NE		0	1	18	28	19	2	1	0	0	0	0	69
ENE		0	4	38	94	45	1	1	0	0	0	0	183
E		0	3	55	82	70	3	0	0	0	0	0	213
ESE		0	6	19	41	28	2	0	0	0	0	0	96
SE		0	2	11	23	14	1	1	0	0	0	0	52
SSE		0	1	21	23	30	2	1	5	1	0	0	84
S		0	4	8	30	49	13	1	0	0	0	0	105
SSW		0	2	8	15	46	25	7	1	0	0	0	104
SW		0	7	11	33	105	68	20	8	1	0	0	253
WSW		0	3	16	26	88	50	18	0	0	0	0	201
W		0	5	12	20	38	27	8	10	1	0	0	121
WNW		0	4	18	14	46	46	22	21	4	0	0	175
NW		1	1	15	7	3	8	16	7	0	0	0	59
NNW		0	1	11	6	2	1	0	0	0	0	0	21
Total	0	1	48	281	471	591	250	97	52	7	1	0	1799

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-43
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class B (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		0	0	0	5	2	2	0	0	0	0	0	9
NNE		0	0	3	7	2	0	0	0	0	0	0	12
NE		0	0	7	6	6	0	0	0	0	0	0	19
ENE		2	6	9	13	16	0	0	0	0	0	0	46
E		0	8	29	39	11	2	0	0	0	0	0	89
ESE		0	4	9	7	8	0	0	0	0	0	0	28
SE		0	3	4	1	4	0	0	0	0	0	0	12
SSE		0	1	5	5	6	2	1	1	0	0	0	21
S		0	0	5	4	12	0	0	0	0	0	0	21
SSW		0	0	3	14	20	5	4	1	1	0	0	48
SW		0	5	4	6	19	6	4	1	1	0	0	46
WSW		0	4	1	3	9	3	1	0	0	0	0	21
W		0	3	5	4	12	1	0	0	0	0	0	25
WNW		0	2	4	5	5	4	1	1	0	0	0	22
NW		0	2	3	2	3	4	8	3	1	0	0	26
NNW		0	1	2	0	2	1	0	0	0	0	0	6
Total	2	2	39	93	121	137	30	19	7	3	0	0	453

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-44
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class C (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)											
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		0	1	3	7	6	1	0	0	0	0	0	18
NNE		0	0	4	9	5	0	0	0	0	0	0	18
NE		0	0	6	16	4	0	0	0	0	0	0	26
ENE		0	2	17	7	9	0	0	0	0	0	0	35
E		0	9	22	21	9	0	0	0	0	0	0	61
ESE		0	7	9	7	10	1	0	0	0	0	0	34
SE		0	1	4	2	2	0	0	0	0	0	0	9
SSE		0	1	2	2	5	1	1	1	0	0	0	13
S		0	0	4	13	14	2	1	1	0	0	0	35
SSW		0	0	4	15	24	13	3	1	0	0	0	60
SW		0	1	8	6	23	1	3	3	0	0	0	45
WSW		0	0	3	8	8	3	0	0	0	0	0	22
W		1	1	6	2	6	2	0	0	0	0	0	18
WNW		0	0	6	5	10	4	5	0	0	0	0	30
NW		1	0	4	5	10	13	8	2	3	0	0	46
NNW		0	0	1	8	4	0	1	0	0	0	0	14
Total	1	2	23	103	133	149	41	22	8	3	0	0	485

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-45
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class D (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)											
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		0	10	48	30	42	11	0	0	0	0	0	141
NNE		0	14	49	52	30	10	2	0	0	0	0	157
NE		0	17	41	73	21	1	0	0	0	0	0	153
ENE		1	26	78	66	11	0	0	0	0	0	0	182
E		1	19	47	60	28	1	0	0	0	0	0	156
ESE		3	17	30	28	26	9	1	4	2	0	0	120
SE		3	11	16	14	3	0	1	0	0	0	0	48
SSE		2	11	17	16	16	1	1	2	4	0	0	70
S		1	9	40	33	62	14	3	1	0	0	0	163
SSW		0	12	46	81	122	24	8	0	0	0	0	293
SW		2	21	32	63	138	28	7	0	0	0	0	291
WSW		2	25	38	20	78	22	4	1	0	0	0	190
W		2	23	21	24	27	38	7	0	0	0	0	142
WNW		2	17	25	36	61	44	30	2	0	0	0	217
NW		2	13	21	9	36	45	37	23	1	0	0	187
NNW		2	17	19	16	14	22	8	1	0	0	0	99
Total	21	23	262	568	621	715	270	109	34	7	0	0	2630

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-46
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class E (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		1	29	46	40	50	6	0	0	0	0	0	172
NNE		3	27	19	17	4	0	0	0	0	0	0	70
NE		6	22	25	8	2	0	0	0	0	0	0	63
ENE		3	18	20	10	0	0	0	0	0	0	0	51
E		1	23	28	28	8	0	0	0	0	0	0	88
ESE		2	22	16	16	12	3	0	0	0	0	0	71
SE		6	29	10	3	0	0	0	0	0	0	0	48
SSE		4	19	19	6	12	0	0	0	0	0	0	60
S		7	30	52	56	41	7	5	0	0	0	0	198
SSW		3	22	57	94	65	8	3	0	0	0	0	252
SW		3	39	57	85	88	23	5	0	0	0	0	300
WSW		2	42	42	33	38	6	1	0	0	0	0	164
W		3	34	35	41	48	11	3	0	0	0	0	175
WNW		3	33	21	32	86	32	6	5	0	0	0	218
NW		5	41	31	23	39	26	8	1	0	0	0	174
NNW		5	32	34	19	28	8	1	0	0	0	0	127
Total	87	57	462	512	511	521	130	32	6	0	0	0	2318

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-47
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class F (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		2	5	2	0	0	0	0	0	0	0	0	9
NNE		1	2	1	1	1	0	0	0	0	0	0	6
NE		3	3	0	0	0	0	0	0	0	0	0	6
ENE		2	4	1	0	0	0	0	0	0	0	0	7
E		1	7	1	0	0	0	0	0	0	0	0	9
ESE		1	9	2	1	0	0	0	0	0	0	0	13
SE		5	8	1	0	0	0	0	0	0	0	0	14
SSE		2	29	21	5	3	0	0	0	0	0	0	60
S		2	28	26	39	15	0	0	0	0	0	0	110
SSW		1	12	22	31	8	0	0	0	0	0	0	74
SW		2	14	26	19	9	0	0	0	0	0	0	70
WSW		0	8	10	4	1	0	0	0	0	0	0	23
W		0	12	3	3	6	0	0	0	0	0	0	24
WNW		0	24	6	2	0	0	0	0	0	0	0	32
NW		0	27	9	0	0	0	0	0	0	0	0	36
NNW		0	17	7	0	0	0	0	0	0	0	0	24
Total	48	22	209	138	105	43	0	0	0	0	0	0	565

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-48
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class G (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		1	4	0	0	0	0	0	0	0	0	0	5
NNE		0	1	0	0	0	0	0	0	0	0	0	1
NE		0	1	0	1	0	0	0	0	0	0	0	2
ENE		0	0	0	0	0	0	0	0	0	0	0	0
E		1	0	0	0	0	0	0	0	0	0	0	1
ESE		0	1	0	0	0	0	0	0	0	0	0	1
SE		0	5	0	0	0	0	0	0	0	0	0	5
SSE		2	22	25	8	1	0	0	0	0	0	0	58
S		3	20	16	6	5	0	0	0	0	0	0	50
SSW		0	9	6	2	1	1	0	0	0	0	0	19
SW		2	5	2	3	1	0	0	0	0	0	0	13
WSW		0	3	2	0	0	0	0	0	0	0	0	5
W		0	3	0	0	0	0	0	0	0	0	0	3
WNW		0	1	0	0	0	0	0	0	0	0	0	1
NW		1	3	1	0	0	0	0	0	0	0	0	5
NNW		0	3	0	0	0	0	0	0	0	0	0	3
Total	17	10	81	52	20	8	1	0	0	0	0	0	189

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-49
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class A through G (RG 1.23) 10 M AGL

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 – 1.00	1.00 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	8.00 – 10.00	>10.00	Total
N		4	51	108	89	101	20	0	0	0	0	0	373
NNE		4	46	87	108	49	11	3	0	0	0	0	308
NE		9	44	97	132	52	3	1	0	0	0	0	338
ENE		8	60	163	190	81	1	1	0	0	0	0	504
E		4	69	182	230	126	6	0	0	0	0	0	617
ESE		6	66	85	100	84	15	1	4	2	0	0	363
SE		14	59	46	43	23	1	2	0	0	0	0	188
SSE		10	84	110	65	73	6	4	9	5	0	0	366
S		13	91	151	181	198	36	10	2	0	0	0	682
SSW		4	57	146	252	286	76	25	3	1	0	0	850
SW		9	92	140	215	383	126	39	12	2	0	0	1018
WSW		4	85	112	94	222	84	24	1	0	0	0	626
W		6	81	82	94	137	79	18	10	1	0	0	508
WNW		5	81	80	94	208	130	64	29	4	0	0	695
NW		10	87	84	46	91	96	77	36	5	1	0	533
NNW		7	71	74	49	50	32	10	1	0	0	0	294
Total	176	117	1124	1747	1982	2164	722	279	107	20	1	0	8439

Source: Project site February 7, 2024 – February 6, 2025

Key: AGL = above ground level; E = east; ENE = east-northeast; ESE = east-southeast; m = meter; m/s = meters per second; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-50
Distances from Project Site Release Points to EAB/LPZ

Downwind Sector	Minimum Distance to EAB/LPZ (m)		
	South Plant Complex	Middle Plant Complex	North Plant Complex
N	339	409	377
NNE	343	385	361
NE	328	382	242
ENE	328	253	242
E	328	253	250
ESE	328	250	250
SE	322	250	329
SSE	249	355	394
S	221	425	452
SSW	221	468	447
SW	298	402	350
WSW	320	354	350
W	320	351	321
WNW	415	337	321
NW	415	337	362
NNW	339	438	409

Key: EAB = exclusion area boundary; E = east; ENE = east-northeast; ESE = east-southeast; LPZ = low population zone; m = meter; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-51
South Plant Complex Short-Term EAB/LPZ χ/Q Values

	Maximum Direction Dependent χ/Q		Direction Independent χ/Q
Time Period	**0.5% Max Sector**	**Sector**	**5% Overall Site Limit**
EAB, 0-2 Hours	1.52E-03	NNW	1.20E-03
LPZ, 0-8 Hours	1.04E-03	N	8.88E-04
LPZ, 8-24 Hours	8.80E-04	N	7.63E-04
LPZ, 1-4 Days	6.12E-04	N	5.48E-04
LPZ, 4-30 Days	3.62E-04	N	3.41E-04

Key: EAB = exclusion area boundary; LPZ = low population zone; max = maximum; N = north; NNW = north-northwest; χ/Q = atmospheric dispersion factor

Table 2.3-52
Middle Plant Complex Short-Term EAB/LPZ χ/Q Values

	Maximum Direction Dependent χ/Q		Direction Independent χ/Q
Time Period	**0.5% Max Sector**	**Sector**	**5% Overall Site Limit**
EAB, 0-2 Hours	1.68E-03	SE	1.09E-03
LPZ, 0-8 Hours	1.17E-03	SE	8.15E-04
LPZ, 8-24 Hours	9.73E-04	SE	7.03E-04
LPZ, 1-4 Days	6.54E-04	SE	5.11E-04
LPZ, 4-30 Days	3.70E-04	SE	3.23E-04

Key: EAB = exclusion area boundary; LPZ = low population zone; max = maximum; SE = southeast; χ/Q = atmospheric dispersion factor

Table 2.3-53
North Plant Complex Short-Term EAB/LPZ χ/Q Values

	Maximum Direction Dependent χ/Q		Direction Independent χ/Q
Time Period	**0.5% Max Sector**	**Sector**	**5% Overall Site Limit**
EAB, 0-2 Hours	1.78E-03	NE	1.18E-03
LPZ, 0-8 Hours	1.33E-03	NE	9.44E-04
LPZ, 8-24 Hours	1.15E-03	NE	8.45E-04
LPZ, 1-4 Days	8.42E-04	NE	6.65E-04
LPZ, 4-30 Days	5.37E-04	NE	4.72E-04

Key: EAB = exclusion area boundary; LPZ = low population zone; max = maximum; NNW = north-northwest; χ/Q = atmospheric dispersion factor

Table 2.3-54
Project Site Short-Term Limiting EAB/LPZ χ/Q Factors

Boundary, Time Period	Limiting χ/Q Factor (s/m^3)	Plant Complex	Site or Sector (Direction) Limit
EAB, 0-2 Hours	1.78E-03	North	Sector (NE)
LPZ, 0-8 Hours	1.33E-03	North	Sector (NE)
LPZ, 8-24 Hours	1.15E-03	North	Sector (NE)
LPZ, 1-4 Days	8.42E-04	North	Sector (NE)
LPZ, 4-30 Days	5.37E-04	North	Sector (NE)

Key: EAB = Exclusion Area Boundary; LPZ = Low Population Zone; max = maximum; NE = northeast; s/m^3 = seconds per cubic meter; χ/Q = atmospheric dispersion factor

Table 2.3-55
Distances from Project Site Plant Complex Release Points to Unrestricted Area Boundary

Sector	Boundary 1[(a)] (Degrees,°)	Boundary 2[(a)] (Degrees,°)	North Plant Complex[(b)]	Middle Plant Complex[(b)]	South Plant Complex[(b)]
			(ft.)	(ft.)	(ft.)
N	348.75	11.25	**1238**	2238	1262
NNE	11.25	33.75	2473	**1264**	3000
NE[(c)]	33.75	56.25	**797**	**1256** (5868)	2496 (8055)
ENE	56.25	78.75	**864**	**830**	1833
E	78.75	101.25	**820**	**834**	**1076**
ESE	101.25	123.75	**1082**	833	**1150**
SE	123.75	146.25	1984	**1165**	**1057**
SSE	146.25	168.75	2285	1753	2052
S	168.75	191.25	2679	1892	1454
SSW	191.25	213.75	3181	4084	1143
SW	213.75	236.25	**1148**	2499	1999
WSW	236.25	258.75	**1159**	**1163**	**1051**
W	258.75	281.25	**1053**	**1153**	**1461**
WNW	281.25	303.75	**1188**	**1107**	**1363**
NW	303.75	326.25	**1407**	1629	**1496**
NNW	326.25	348.75	**1343**	2112	**1115**

Notes:

(a) Sector boundaries are 22.5° apart and 0° is centered along the north direction.

(b) Bold values are distances to the Exclusion Area Boundary (EAB). Values that are not bold are distances to the site boundary.

(c) The values in parentheses are the distances to the composite EAB location.

Key: E = east; ENE = east-northeast; ESE = east-southeast; ft. = feet; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-56
Offsite Receptor Distances

Off-site Receptor No.	Receptor Description[(a)]	Distance from Site Boundary to Receptor (m)	Sector	Distance from North Plant Complex (m)	Distance from Middle Plant Complex (m)	Distance from South Plant Complex (m)
1	Nearest Residence	13	SSW	2228	1258	362
2	Nearest Vegetable Garden	521	SSW	2735	1766	870

Note: The offsite receptor locations were identified by the land use survey conducted in December 2024.
Key: m = meter; SSW = south-southwest

Table 2.3-57
North Plant Complex Long-Term Unrestricted Area Boundary χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q (1/m^2)
		No Decay	2.26-Day Decay	8-Day Decay	
		Undepleted	Undepleted	Depleted	
N	0.23	1.30E-04	1.30E-04	1.30E-04	2.10E-07
NNE	0.47	3.20E-05	3.20E-05	3.00E-05	8.80E-08
NE	0.15	**2.60E-04**	**2.60E-04**	**2.50E-04**	**6.00E-07**
ENE	0.16	1.30E-04	1.30E-04	1.20E-04	3.20E-07
E	0.16	1.30E-04	1.30E-04	1.20E-04	2.80E-07
ESE	0.20	9.20E-05	9.20E-05	8.80E-05	2.60E-07
SE	0.38	3.50E-05	3.50E-05	3.20E-05	8.00E-08
SSE	0.43	2.00E-05	2.00E-05	1.80E-05	3.60E-08
S	0.51	1.70E-05	1.70E-05	1.60E-05	3.40E-08
SSW	0.60	9.10E-06	9.10E-06	8.20E-06	2.20E-08
SW	0.22	6.80E-05	6.80E-05	6.50E-05	1.20E-07
WSW	0.22	6.70E-05	6.70E-05	6.40E-05	1.70E-07
W	0.20	8.30E-05	8.30E-05	7.90E-05	2.40E-07
WNW	0.22	5.30E-05	5.30E-05	5.00E-05	1.20E-07
NW	0.27	5.00E-05	5.00E-05	4.70E-05	5.30E-08
NNW	0.25	8.20E-05	8.10E-05	7.70E-05	1.00E-07

Note: Maxima values are in **bold font**.

Key: D/Q = Deposition Factor; E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; s/m^3 = seconds per cubic meter; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest ; χ/Q = atmospheric dispersion factor

Table 2.3-58
Middle Plant Complex Long-Term Unrestricted Area Boundary χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q (1/m^2)
		No Decay	2.26-Day Decay	8-Day Decay	
		Undepleted	Undepleted	Depleted	
N	0.42	5.10E-05	5.10E-05	4.70E-05	8.50E-08
NNE	0.24	1.00E-04	1.00E-04	9.60E-05	2.50E-07
NE	0.24	1.20E-04	1.20E-04	1.20E-04	3.10E-07
ENE	0.16	**1.40E-04**	**1.40E-04**	1.30E-04	3.40E-07
E	0.16	1.20E-04	1.20E-04	1.20E-04	2.80E-07
ESE	0.16	**1.40E-04**	**1.40E-04**	**1.40E-04**	**3.80E-07**
SE	0.22	8.50E-05	8.50E-05	8.10E-05	1.80E-07
SSE	0.33	3.10E-05	3.10E-05	2.90E-05	5.40E-08
S	0.36	3.10E-05	3.10E-05	2.90E-05	6.00E-08
SSW	0.77	5.80E-06	5.80E-06	5.10E-06	1.40E-08
SW	0.47	1.80E-05	1.80E-05	1.60E-05	3.60E-08
WSW	0.22	6.70E-05	6.70E-05	6.40E-05	1.70E-07
W	0.22	7.10E-05	7.10E-05	6.70E-05	2.10E-07
WNW	0.21	6.00E-05	6.00E-05	5.70E-06	1.30E-07
NW	0.31	3.90E-05	3.90E-05	3.60E-05	4.20E-08
NNW	0.40	3.90E-05	3.90E-05	3.60E-05	5.10E-08

Note: Maxima values are in **bold font**.

Key: D/Q = Deposition Factor; E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; s/m^3 = seconds per cubic meter; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-59
South Plant Complex Long-Term Unrestricted Area Boundary χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q (1/m^2)
		No Decay	2.26-Day Decay	8-Day Decay	
		Undepleted	Undepleted	Depleted	
N	0.24	**1.30E-04**	**1.30E-04**	**1.20E-04**	2.10E-07
NNE	0.57	2.30E-05	2.30E-05	2.10E-05	6.50E-08
NE	0.47	3.80E-05	3.80E-05	3.50E-05	1.00E-07
ENE	0.35	3.50E-05	3.50E-05	3.20E-05	1.00E-07
E	0.20	8.10E-05	8.10E-05	7.70E-05	1.90E-07
ESE	0.22	8.30E-05	8.30E-05	7.90E-05	**2.40E-07**
SE	0.20	1.00E-04	1.00E-04	9.50E-05	2.10E-07
SSE	0.39	2.40E-05	2.40E-05	2.20E-05	4.20E-08
S	0.28	4.80E-05	4.80E-05	4.60E-05	9.00E-08
SSW	0.22	5.30E-05	5.30E-05	5.10E-05	1.10E-07
SW	0.38	2.60E-05	2.60E-05	2.40E-05	5.10E-08
WSW	0.20	8.00E-05	8.00E-05	7.60E-05	2.00E-07
W	0.28	4.70E-05	4.60E-05	4.40E-05	1.50E-07
WNW	0.26	4.20E-05	4.20E-05	3.90E-05	9.70E-08
NW	0.28	4.50E-05	4.50E-05	4.20E-05	4.80E-08
NNW	0.21	1.10E-04	1.10E-04	1.00E-04	1.40E-07

Note: Maxima values are in **bold font**.

Key: D/Q = Deposition Factor; E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; s/m^3 = seconds per cubic meter; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-60
Project Site Long-Term Unrestricted Area Boundary MEL χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q (1/m^2)
		No Decay	2.26-Day Decay	8-Day Decay	
		Undepleted	Undepleted	Depleted	
North Plant Complex					
NE	0.15	**2.60E-04**	**2.60E-04**	**2.50E-04**	**6.00E-07**
Middle Plant Complex					
N	1.11	**7.20E-06**	**7.10E-06**	**6.20E-06**	1.20E-08
NE	1.11	6.30E-06	6.20E-06	5.50E-06	**1.80E-08**
South Plant Complex					
N	1.53	**3.40E-06**	**3.30E-06**	**2.90E-06**	5.50E-09
NE	1.53	3.00E-06	2.90E-06	2.50E-06	**8.10E-09**

Note: Maxima values are in **bold font**.

Key: D/Q = Deposition Factor; mi. = mile; N = north; NE = northeast; s/m^3 = seconds per cubic meter; χ/Q = atmospheric dispersion factor

Table 2.3-61
Nearest Resident Receptor χ/Q and D/Q Factors

Plant Complex	Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q (1/m^2)
			No Decay	2.26-Day Decay	8-Day Decay	
			Undepleted	Undepleted	Depleted	
South	SSW	0.22	5.00E-05	5.00E-05	4.70E-05	1.00E-07
Middle	SSW	0.78	5.60E-06	5.60E-06	5.00E-06	1.40E-08
North	SSW	1.38	1.30E-06	1.30E-06	1.10E-06	3.10E-09

Note: The nearest resident location was identified by the land use survey conducted in December 2024.
Key: D/Q = Deposition Factor; mi. = mile; s/m^3 = seconds per cubic meter; χ/Q = atmospheric dispersion factor

Table 2.3-62
Nearest Vegetable Garden Receptor χ/Q and D/Q Factors

Plant Complex	Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q (1/m^2)
			No Decay	2.26-Day Decay	8-Day Decay	
			Undepleted	Undepleted	Depleted	
South	SSW	0.54	1.10E-05	1.10E-05	1.00E-05	2.60E-08
Middle	SSW	1.10	2.40E-06	2.30E-06	2.10E-06	5.60E-09
North	SSW	1.70	8.40E-07	8.20E-07	7.00E-07	1.90E-09

Note: The nearest vegetable garden location was identified by the land use survey conducted in December 2024.
Key: D/Q = Deposition Factor; mi. = mile; s/m^3 = seconds per cubic meter; SSW = south-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-63
General χ/Q Factors for No-Decay, No-Depletion (s/m^3)

Sector	Distance from Facility (mi.)																				
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	5.692E-05	1.769E-05	8.839E-06	4.243E-06	1.601E-06	8.399E-07	5.219E-07	3.593E-07	2.648E-07	2.049E-07	1.643E-07	1.355E-07	6.891E-08	4.441E-08	2.532E-08	1.709E-08	1.263E-08	9.885E-09	8.040E-09	6.728E-09	5.752E-09	5.002E-09
SSW	4.153E-05	1.256E-05	6.241E-06	2.981E-06	1.116E-06	5.807E-07	3.584E-07	2.453E-07	1.798E-07	1.385E-07	1.106E-07	9.087E-08	4.550E-08	2.899E-08	1.626E-08	1.085E-08	7.947E-09	6.169E-09	4.986E-09	4.148E-09	3.529E-09	3.055E-09
SW	5.382E-05	1.634E-05	8.117E-06	3.880E-06	1.456E-06	7.600E-07	4.702E-07	3.226E-07	2.370E-07	1.828E-07	1.463E-07	1.204E-07	6.071E-08	3.889E-08	2.199E-08	1.476E-08	1.086E-08	8.461E-09	6.860E-09	5.724E-09	4.882E-09	4.236E-09
WSW	5.328E-05	1.555E-05	7.613E-06	3.615E-06	1.348E-06	6.996E-07	4.309E-07	2.944E-07	2.156E-07	1.659E-07	1.324E-07	1.088E-07	5.465E-08	3.492E-08	1.970E-08	1.322E-08	9.728E-09	7.585E-09	6.153E-09	5.138E-09	4.385E-09	3.808E-09
W	5.563E-05	1.623E-05	7.915E-06	3.752E-06	1.398E-06	7.262E-07	4.479E-07	3.065E-07	2.248E-07	1.732E-07	1.385E-07	1.140E-07	5.775E-08	3.716E-08	2.121E-08	1.439E-08	1.068E-08	8.386E-09	6.845E-09	5.747E-09	4.928E-09	4.298E-09
WNW	4.400E-05	1.312E-05	6.469E-06	3.081E-06	1.152E-06	5.995E-07	3.701E-07	2.534E-07	1.859E-07	1.432E-07	1.145E-07	9.413E-08	4.738E-08	3.032E-08	1.714E-08	1.152E-08	8.489E-09	6.625E-09	5.378E-09	4.493E-09	3.836E-09	3.332E-09
NW	5.536E-05	1.719E-05	8.568E-06	4.113E-06	1.557E-06	8.190E-07	5.103E-07	3.521E-07	2.601E-07	2.016E-07	1.620E-07	1.338E-07	6.846E-08	4.433E-08	2.544E-08	1.724E-08	1.278E-08	1.002E-08	8.170E-09	6.848E-09	5.864E-09	5.106E-09
NNW	8.371E-05	2.690E-05	1.345E-05	6.505E-06	2.495E-06	1.327E-06	8.345E-07	5.804E-07	4.317E-07	3.367E-07	2.720E-07	2.259E-07	1.180E-07	7.754E-08	4.550E-08	3.134E-08	2.353E-08	1.865E-08	1.534E-08	1.296E-08	1.118E-08	9.795E-09
N	**1.212E-04**	**3.846E-05**	**1.922E-05**	**9.268E-06**	**3.534E-06**	**1.870E-06**	**1.171E-06**	**8.115E-07**	**6.017E-07**	**4.680E-07**	**3.772E-07**	**3.125E-07**	**1.617E-07**	**1.056E-07**	**6.134E-08**	**4.197E-08**	**3.135E-08**	**2.474E-08**	**2.028E-08**	**1.708E-08**	**1.469E-08**	**1.284E-08**
NNE	9.385E-05	2.890E-05	1.439E-05	6.894E-06	2.597E-06	1.360E-06	8.441E-07	5.805E-07	4.276E-07	3.306E-07	2.650E-07	2.185E-07	1.110E-07	7.147E-08	4.074E-08	2.750E-08	2.033E-08	1.591E-08	1.294E-08	1.083E-08	9.262E-09	8.055E-09
NE	1.117E-04	3.433E-05	1.707E-05	8.181E-06	3.091E-06	1.623E-06	1.010E-06	6.956E-07	5.131E-07	3.973E-07	3.189E-07	2.633E-07	1.343E-07	8.683E-08	4.974E-08	3.369E-08	2.497E-08	1.958E-08	1.596E-08	1.338E-08	1.146E-08	9.978E-09
ENE	6.157E-05	1.852E-05	9.180E-06	4.385E-06	1.648E-06	8.606E-07	5.328E-07	3.656E-07	2.687E-07	2.074E-07	1.659E-07	1.366E-07	6.893E-08	4.418E-08	2.500E-08	1.678E-08	1.235E-08	9.627E-09	7.808E-09	6.517E-09	5.560E-09	4.825E-09
E	5.725E-05	1.734E-05	8.613E-06	4.113E-06	1.544E-06	8.062E-07	4.990E-07	3.424E-07	2.517E-07	1.942E-07	1.554E-07	1.280E-07	6.461E-08	4.142E-08	2.345E-08	1.575E-08	1.160E-08	9.042E-09	7.335E-09	6.123E-09	5.224E-09	4.534E-09
ESE	6.526E-05	1.973E-05	9.792E-06	4.678E-06	1.757E-06	9.174E-07	5.679E-07	3.897E-07	2.864E-07	2.210E-07	1.768E-07	1.456E-07	7.342E-08	4.704E-08	2.659E-08	1.784E-08	1.312E-08	1.022E-08	8.287E-09	6.913E-09	5.895E-09	5.114E-09
SE	6.898E-05	2.132E-05	1.063E-05	5.094E-06	1.920E-06	1.006E-06	6.244E-07	4.296E-07	3.165E-07	2.448E-07	1.963E-07	1.619E-07	8.225E-08	5.299E-08	3.021E-08	2.040E-08	1.508E-08	1.180E-08	9.600E-09	8.034E-09	6.870E-09	5.974E-09
SSE	5.038E-05	1.554E-05	7.766E-06	3.720E-06	1.400E-06	7.325E-07	4.543E-07	3.122E-07	2.297E-07	1.775E-07	1.422E-07	1.171E-07	5.923E-08	3.802E-08	2.154E-08	1.447E-08	1.065E-08	8.302E-09	6.732E-09	5.618E-09	4.791E-09	4.157E-09

Note: maxima values are in **bold font**.

Key: E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; s/m^3 = seconds per cubic meter; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-64
General χ/Q Factors for 2.26-Day-Decay, No-Depletion (s/m^3)

Sector	Distance from Facility (mi.)																						
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	5.679E-05	1.761E-05	8.778E-06	4.203E-06	1.579E-06	8.242E-07	5.096E-07	3.491E-07	2.561E-07	1.971E-07	1.573E-07	1.291E-07	6.405E-08	4.027E-08	2.186E-08	1.407E-08	9.920E-09	7.412E-09	5.765E-09	4.618E-09	3.784E-09	3.157E-09
SSW	4.144E-05	1.250E-05	6.198E-06	2.954E-06	1.100E-06	5.700E-07	3.501E-07	2.384E-07	1.740E-07	1.333E-07	1.060E-07	8.664E-08	4.235E-08	2.635E-08	1.410E-08	8.981E-09	6.287E-09	4.671E-09	3.617E-09	2.886E-09	2.357E-09	1.961E-09
SW	5.366E-05	1.624E-05	8.041E-06	3.831E-06	1.429E-06	7.409E-07	4.555E-07	3.104E-07	2.266E-07	1.737E-07	1.380E-07	1.129E-07	5.508E-08	3.415E-08	1.811E-08	1.142E-08	7.913E-09	5.816E-09	4.455E-09	3.518E-09	2.845E-09	2.344E-09
WSW	5.315E-05	1.547E-05	7.555E-06	3.578E-06	1.327E-06	6.851E-07	4.197E-07	2.853E-07	2.078E-07	1.590E-07	1.262E-07	1.032E-07	5.045E-08	3.139E-08	1.681E-08	1.072E-08	7.512E-09	5.585E-09	4.327E-09	3.456E-09	2.824E-09	2.352E-09
W	5.551E-05	1.616E-05	7.862E-06	3.718E-06	1.379E-06	7.130E-07	4.376E-07	2.980E-07	2.175E-07	1.668E-07	1.327E-07	1.087E-07	5.376E-08	3.377E-08	1.839E-08	1.192E-08	8.462E-09	6.365E-09	4.982E-09	4.016E-09	3.310E-09	2.778E-09
WNW	4.389E-05	1.306E-05	6.421E-06	3.051E-06	1.135E-06	5.877E-07	3.610E-07	2.459E-07	1.795E-07	1.376E-07	1.094E-07	8.957E-08	4.398E-08	2.747E-08	1.480E-08	9.502E-09	6.693E-09	5.000E-09	3.890E-09	3.117E-09	2.556E-09	2.134E-09
NW	5.514E-05	1.705E-05	8.466E-06	4.048E-06	1.520E-06	7.932E-07	4.903E-07	3.356E-07	2.459E-07	1.891E-07	1.507E-07	1.235E-07	6.076E-08	3.783E-08	2.010E-08	1.264E-08	8.713E-09	6.364E-09	4.840E-09	3.792E-09	3.041E-09	2.484E-09
NNW	8.348E-05	2.676E-05	1.334E-05	6.435E-06	2.455E-06	1.299E-06	8.122E-07	5.619E-07	4.157E-07	3.225E-07	2.592E-07	2.141E-07	1.089E-07	6.977E-08	3.893E-08	2.554E-08	1.829E-08	1.384E-08	1.088E-08	8.803E-09	7.274E-09	6.115E-09
N	**1.209E-04**	**3.827E-05**	**1.908E-05**	**9.177E-06**	**3.482E-06**	**1.833E-06**	**1.142E-06**	**7.876E-07**	**5.810E-07**	**4.496E-07**	**3.606E-07**	**2.972E-07**	**1.500E-07**	**9.559E-08**	**5.295E-08**	**3.459E-08**	**2.470E-08**	**1.866E-08**	**1.465E-08**	**1.184E-08**	**9.785E-09**	**8.226E-09**
NNE	9.370E-05	2.881E-05	1.432E-05	6.851E-06	2.573E-06	1.343E-06	8.308E-07	5.696E-07	4.181E-07	3.222E-07	2.575E-07	2.116E-07	1.058E-07	6.707E-08	3.705E-08	2.427E-08	1.741E-08	1.323E-08	1.046E-08	8.508E-09	7.077E-09	5.990E-09
NE	1.115E-04	3.419E-05	1.696E-05	8.112E-06	3.052E-06	1.595E-06	9.880E-07	6.778E-07	4.978E-07	3.837E-07	3.067E-07	2.520E-07	1.258E-07	7.956E-08	4.366E-08	2.836E-08	2.018E-08	1.521E-08	1.193E-08	9.638E-09	7.961E-09	6.693E-09
ENE	6.146E-05	1.846E-05	9.133E-06	4.355E-06	1.631E-06	8.488E-07	5.237E-07	3.581E-07	2.623E-07	2.017E-07	1.609E-07	1.320E-07	6.550E-08	4.129E-08	2.261E-08	1.470E-08	1.048E-08	7.922E-09	6.233E-09	5.049E-09	4.183E-09	3.527E-09
E	5.715E-05	1.728E-05	8.564E-06	4.082E-06	1.526E-06	7.940E-07	4.896E-07	3.347E-07	2.451E-07	1.884E-07	1.502E-07	1.232E-07	6.107E-08	3.845E-08	2.100E-08	1.362E-08	9.691E-09	7.308E-09	5.737E-09	4.637E-09	3.834E-09	3.226E-09
ESE	6.515E-05	1.966E-05	9.741E-06	4.645E-06	1.738E-06	9.046E-07	5.580E-07	3.816E-07	2.794E-07	2.149E-07	1.714E-07	1.406E-07	6.969E-08	4.390E-08	2.400E-08	1.559E-08	1.111E-08	8.389E-09	6.596E-09	5.341E-09	4.423E-09	3.728E-09
SE	6.883E-05	2.122E-05	1.056E-05	5.047E-06	1.893E-06	9.872E-07	6.100E-07	4.177E-07	3.063E-07	2.358E-07	1.882E-07	1.545E-07	7.667E-08	4.826E-08	2.629E-08	1.698E-08	1.202E-08	9.019E-09	7.041E-09	5.660E-09	4.653E-09	3.894E-09
SSE	5.027E-05	1.547E-05	7.712E-06	3.686E-06	1.381E-06	7.191E-07	4.439E-07	3.036E-07	2.224E-07	1.711E-07	1.364E-07	1.119E-07	5.532E-08	3.473E-08	1.884E-08	1.213E-08	8.570E-09	6.418E-09	5.004E-09	4.019E-09	3.302E-09	2.761E-09

Note: maxima values are in **bold font**.

Key: E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; s/m^3 = seconds per cubic meter; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-65
General χ/Q Factors for 8-Day-Decay, Depletion (s/m^3)

Sector	Distance from Facility (mi.)																					
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	5.383E-05	1.614E-05	7.862E-06	3.704E-06	1.355E-06	6.918E-07	4.199E-07	2.831E-07	2.047E-07	1.555E-07	1.227E-07	9.964E-08	4.756E-08	2.900E-08	1.508E-08	9.422E-09	6.501E-09	4.776E-09	3.665E-09	2.902E-09	2.355E-09	1.947E-09
SSW	3.928E-05	1.145E-05	5.551E-06	2.603E-06	9.439E-07	4.783E-07	2.884E-07	1.933E-07	1.390E-07	1.052E-07	8.260E-08	6.682E-08	3.142E-08	1.895E-08	9.699E-09	5.992E-09	4.100E-09	2.991E-09	2.282E-09	1.799E-09	1.453E-09	1.197E-09
SW	5.090E-05	1.490E-05	7.214E-06	3.384E-06	1.230E-06	6.248E-07	3.775E-07	2.534E-07	1.826E-07	1.383E-07	1.088E-07	8.811E-08	4.162E-08	2.516E-08	1.292E-08	7.989E-09	5.464E-09	3.983E-09	3.034E-09	2.386E-09	1.924E-09	1.582E-09
WSW	5.039E-05	1.418E-05	6.770E-06	3.155E-06	1.140E-06	5.758E-07	3.464E-07	2.318E-07	1.665E-07	1.258E-07	9.876E-08	7.989E-08	3.765E-08	2.275E-08	1.169E-08	7.255E-09	4.981E-09	3.645E-09	2.788E-09	2.203E-09	1.783E-09	1.472E-09
W	5.262E-05	1.480E-05	7.040E-06	3.276E-06	1.183E-06	5.982E-07	3.604E-07	2.415E-07	1.738E-07	1.315E-07	1.034E-07	8.382E-08	3.988E-08	2.428E-08	1.265E-08	7.946E-09	5.511E-09	4.068E-09	3.135E-09	2.494E-09	2.032E-09	1.687E-09
WNW	4.161E-05	1.196E-05	5.752E-06	2.689E-06	9.742E-07	4.936E-07	2.977E-07	1.996E-07	1.436E-07	1.087E-07	8.544E-08	6.918E-08	3.269E-08	1.980E-08	1.021E-08	6.357E-09	4.377E-09	3.211E-09	2.461E-09	1.948E-09	1.581E-09	1.307E-09
NW	5.233E-05	1.566E-05	7.610E-06	3.584E-06	1.313E-06	6.721E-07	4.087E-07	2.759E-07	1.997E-07	1.519E-07	1.200E-07	9.749E-08	4.664E-08	2.845E-08	1.477E-08	9.196E-09	6.317E-09	4.618E-09	3.525E-09	2.776E-09	2.240E-09	1.842E-09
NNW	7.916E-05	2.453E-05	1.196E-05	5.677E-06	2.110E-06	1.092E-06	6.708E-07	4.568E-07	3.332E-07	2.553E-07	2.029E-07	1.658E-07	8.128E-08	5.053E-08	2.703E-08	1.723E-08	1.208E-08	8.995E-09	6.980E-09	5.584E-09	4.572E-09	3.812E-09
N	**1.146E-04**	**3.507E-05**	**1.709E-05**	**8.090E-06**	**2.989E-06**	**1.540E-06**	**9.418E-07**	**6.391E-07**	**4.648E-07**	**3.552E-07**	**2.815E-07**	**2.296E-07**	**1.116E-07**	**6.891E-08**	**3.654E-08**	**2.315E-08**	**1.615E-08**	**1.198E-08**	**9.267E-09**	**7.393E-09**	**6.039E-09**	**5.025E-09**
NNE	8.878E-05	2.637E-05	1.281E-05	6.024E-06	2.200E-06	1.122E-06	6.807E-07	4.586E-07	3.315E-07	2.519E-07	1.987E-07	1.614E-07	7.717E-08	4.715E-08	2.464E-08	1.548E-08	1.075E-08	7.942E-09	6.129E-09	4.883E-09	3.985E-09	3.315E-09
NE	1.056E-04	3.131E-05	1.518E-05	7.144E-06	2.616E-06	1.337E-06	8.127E-07	5.485E-07	3.969E-07	3.020E-07	2.384E-07	1.938E-07	9.294E-08	5.688E-08	2.977E-08	1.869E-08	1.296E-08	9.562E-09	7.366E-09	5.856E-09	4.769E-09	3.958E-09
ENE	5.824E-05	1.690E-05	8.169E-06	3.831E-06	1.395E-06	7.098E-07	4.295E-07	2.887E-07	2.082E-07	1.579E-07	1.244E-07	1.008E-07	4.789E-08	2.911E-08	1.510E-08	9.430E-09	6.513E-09	4.795E-09	3.688E-09	2.929E-09	2.385E-09	1.979E-09
E	5.416E-05	1.582E-05	7.663E-06	3.593E-06	1.307E-06	6.647E-07	4.020E-07	2.702E-07	1.949E-07	1.478E-07	1.164E-07	9.436E-08	4.482E-08	2.724E-08	1.412E-08	8.816E-09	6.086E-09	4.477E-09	3.441E-09	2.731E-09	2.221E-09	1.842E-09
ESE	6.173E-05	1.800E-05	8.713E-06	4.087E-06	1.488E-06	7.566E-07	4.577E-07	3.077E-07	2.219E-07	1.683E-07	1.325E-07	1.074E-07	5.099E-08	3.098E-08	1.605E-08	1.002E-08	6.913E-09	5.085E-09	3.908E-09	3.102E-09	2.523E-09	2.093E-09
SE	6.525E-05	1.944E-05	9.455E-06	4.447E-06	1.624E-06	8.284E-07	5.025E-07	3.385E-07	2.447E-07	1.859E-07	1.466E-07	1.190E-07	5.682E-08	3.465E-08	1.804E-08	1.129E-08	7.800E-09	5.740E-09	4.411E-09	3.499E-09	2.843E-09	2.355E-09
SSE	4.765E-05	1.417E-05	6.907E-06	3.248E-06	1.184E-06	6.034E-07	3.656E-07	2.460E-07	1.776E-07	1.348E-07	1.062E-07	8.616E-08	4.095E-08	2.488E-08	1.288E-08	8.024E-09	5.526E-09	4.055E-09	3.109E-09	2.461E-09	1.997E-09	1.652E-09

Note: maxima values are in **bold font**.

Key: E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; s/m^3 = seconds per cubic meter; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-66
General D/Q Factors (1/m^2)

Sector	Distance from Facility (mi.)																						
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	1.045E-07	3.532E-08	1.814E-08	8.622E-09	3.097E-09	1.536E-09	9.043E-10	5.922E-10	4.167E-10	3.088E-10	2.380E-10	1.890E-10	8.398E-11	5.087E-11	2.571E-11	1.556E-11	1.043E-11	7.477E-12	5.614E-12	4.365E-12	3.487E-12	2.846E-12
SSW	8.638E-08	2.921E-08	1.500E-08	7.131E-09	2.561E-09	1.270E-09	7.479E-10	4.897E-10	3.446E-10	2.554E-10	1.968E-10	1.563E-10	6.945E-11	4.207E-11	2.127E-11	1.287E-11	8.630E-12	6.184E-12	4.643E-12	3.610E-12	2.884E-12	2.354E-12
SW	9.707E-08	3.283E-08	1.685E-08	8.013E-09	2.878E-09	1.427E-09	8.405E-10	5.503E-10	3.872E-10	2.870E-10	2.211E-10	1.757E-10	7.805E-11	4.728E-11	2.390E-11	1.446E-11	9.697E-12	6.949E-12	5.218E-12	4.057E-12	3.241E-12	2.645E-12
WSW	1.416E-07	4.787E-08	2.458E-08	1.169E-08	4.198E-09	2.082E-09	1.226E-09	8.026E-10	5.648E-10	4.185E-10	3.225E-10	2.562E-10	1.138E-10	6.895E-11	3.485E-11	2.109E-11	1.414E-11	1.013E-11	7.610E-12	5.917E-12	4.726E-12	3.858E-12
W	1.711E-07	5.785E-08	2.970E-08	1.412E-08	5.072E-09	2.515E-09	1.481E-09	9.698E-10	6.824E-10	5.057E-10	3.897E-10	3.096E-10	1.375E-10	8.332E-11	4.211E-11	2.549E-11	1.709E-11	1.225E-11	9.195E-12	7.149E-12	5.711E-12	4.661E-12
WNW	1.018E-07	3.443E-08	1.768E-08	8.404E-09	3.019E-09	1.497E-09	8.815E-10	5.772E-10	4.061E-10	3.010E-10	2.319E-10	1.843E-10	8.186E-11	4.959E-11	2.506E-11	1.517E-11	1.017E-11	7.288E-12	5.472E-12	4.255E-12	3.399E-12	2.774E-12
NW	5.785E-08	1.956E-08	1.005E-08	4.776E-09	1.715E-09	8.507E-10	5.009E-10	3.280E-10	2.308E-10	1.710E-10	1.318E-10	1.047E-10	4.652E-11	2.818E-11	1.424E-11	8.620E-12	5.780E-12	4.141E-12	3.110E-12	2.418E-12	1.931E-12	1.576E-12
NNW	1.048E-07	3.542E-08	1.819E-08	8.647E-09	3.106E-09	1.540E-09	9.070E-10	5.939E-10	4.179E-10	3.097E-10	2.387E-10	1.896E-10	8.422E-11	5.102E-11	2.579E-11	1.561E-11	1.046E-11	7.499E-12	5.631E-12	4.378E-12	3.497E-12	2.854E-12
N	1.930E-07	6.525E-08	3.350E-08	1.593E-08	5.721E-09	2.837E-09	1.671E-09	1.094E-09	7.697E-10	5.704E-10	4.396E-10	3.492E-10	1.551E-10	9.397E-11	4.750E-11	2.875E-11	1.928E-11	1.381E-11	1.037E-11	8.064E-12	6.442E-12	5.258E-12
NNE	2.351E-07	7.951E-08	4.083E-08	1.941E-08	6.972E-09	3.457E-09	2.036E-09	1.333E-09	9.380E-10	6.951E-10	5.357E-10	4.256E-10	1.891E-10	1.145E-10	5.788E-11	3.503E-11	2.349E-11	1.683E-11	1.264E-11	9.827E-12	7.850E-12	6.407E-12
NE	**2.833E-07**	**9.579E-08**	**4.918E-08**	**2.338E-08**	**8.399E-09**	**4.165E-09**	**2.453E-09**	**1.606E-09**	**1.130E-09**	**8.374E-10**	**6.454E-10**	**5.127E-10**	**2.278E-10**	**1.380E-10**	**6.973E-11**	**4.221E-11**	**2.830E-11**	**2.028E-11**	**1.523E-11**	**1.184E-11**	**9.457E-12**	**7.719E-12**
ENE	1.731E-07	5.855E-08	3.006E-08	1.429E-08	5.134E-09	2.546E-09	1.499E-09	9.816E-10	6.907E-10	5.119E-10	3.944E-10	3.134E-10	1.392E-10	8.433E-11	4.262E-11	2.580E-11	1.730E-11	1.239E-11	9.306E-12	7.236E-12	5.780E-12	4.718E-12
E	1.413E-07	4.779E-08	2.454E-08	1.166E-08	4.190E-09	2.078E-09	1.223E-09	8.011E-10	5.637E-10	4.178E-10	3.219E-10	2.558E-10	1.136E-10	6.882E-11	3.479E-11	2.106E-11	1.412E-11	1.012E-11	7.596E-12	5.906E-12	4.718E-12	3.851E-12
ESE	1.925E-07	6.509E-08	3.342E-08	1.589E-08	5.708E-09	2.830E-09	1.667E-09	1.091E-09	7.679E-10	5.691E-10	4.385E-10	3.484E-10	1.548E-10	9.375E-11	4.739E-11	2.868E-11	1.923E-11	1.378E-11	1.035E-11	8.045E-12	6.426E-12	5.245E-12
SE	1.495E-07	5.055E-08	2.595E-08	1.234E-08	4.432E-09	2.198E-09	1.294E-09	8.474E-10	5.963E-10	4.419E-10	3.405E-10	2.705E-10	1.202E-10	7.280E-11	3.680E-11	2.227E-11	1.493E-11	1.070E-11	8.035E-12	6.247E-12	4.990E-12	4.073E-12
SSE	8.328E-08	2.816E-08	1.446E-08	6.874E-09	2.469E-09	1.225E-09	7.211E-10	4.721E-10	3.322E-10	2.462E-10	1.897E-10	1.507E-10	6.696E-11	4.056E-11	2.050E-11	1.241E-11	8.320E-12	5.962E-12	4.476E-12	3.481E-12	2.780E-12	2.269E-12

Note: maxima values are in **bold font**.

Key: DQ = Deposition Factor; E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; s/m^3 = seconds per cubic meter; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 2.3-67
Segmented General χ/Q Factors for No-Decay, No-Depletion (s/m^3)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	8.764E-06	1.850E-06	5.416E-07	2.690E-07	1.657E-07	7.282E-08	2.591E-08	1.272E-08	8.067E-09	5.764E-09
SSW	6.196E-06	1.293E-06	3.725E-07	1.828E-07	1.116E-07	4.825E-08	1.669E-08	8.010E-09	5.005E-09	3.537E-09
SW	8.062E-06	1.685E-06	4.884E-07	2.408E-07	1.475E-07	6.428E-08	2.253E-08	1.094E-08	6.885E-09	4.892E-09
WSW	7.601E-06	1.564E-06	4.480E-07	2.192E-07	1.336E-07	5.792E-08	2.020E-08	9.801E-09	6.176E-09	4.394E-09
W	7.913E-06	1.623E-06	4.656E-07	2.285E-07	1.397E-07	6.109E-08	2.172E-08	1.075E-08	6.867E-09	4.937E-09
WNW	6.441E-06	1.335E-06	3.846E-07	1.889E-07	1.155E-07	5.019E-08	1.757E-08	8.552E-09	5.397E-09	3.844E-09
NW	8.504E-06	1.797E-06	5.293E-07	2.641E-07	1.633E-07	7.226E-08	2.599E-08	1.287E-08	8.196E-09	5.875E-09
NNW	1.335E-05	2.867E-06	8.642E-07	4.380E-07	2.741E-07	1.240E-07	4.632E-08	2.366E-08	1.538E-08	1.119E-08
N	1.907E-05	4.069E-06	1.214E-06	6.107E-07	3.801E-07	1.702E-07	6.256E-08	3.154E-08	2.033E-08	1.471E-08
NNE	1.428E-05	3.002E-06	8.763E-07	4.343E-07	2.672E-07	1.173E-07	4.169E-08	2.048E-08	1.299E-08	9.280E-09
NE	1.695E-05	3.570E-06	1.048E-06	5.212E-07	3.215E-07	1.419E-07	5.085E-08	2.514E-08	1.601E-08	1.148E-08
ENE	9.125E-06	1.906E-06	5.533E-07	2.730E-07	1.674E-07	7.297E-08	2.561E-08	1.244E-08	7.836E-09	5.571E-09
E	8.553E-06	1.787E-06	5.183E-07	2.557E-07	1.568E-07	6.838E-08	2.402E-08	1.168E-08	7.361E-09	5.234E-09
ESE	9.727E-06	2.033E-06	5.898E-07	2.910E-07	1.783E-07	7.772E-08	2.725E-08	1.322E-08	8.317E-09	5.907E-09
SE	1.054E-05	2.219E-06	6.482E-07	3.215E-07	1.979E-07	8.693E-08	3.091E-08	1.519E-08	9.632E-09	6.883E-09
SSE	7.696E-06	1.619E-06	4.716E-07	2.334E-07	1.433E-07	6.266E-08	2.206E-08	1.073E-08	6.756E-09	4.801E-09

Key: E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; s/m^3 = seconds per cubic meter; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-68
Segmented General χ/Q Factors for 2.26-Day-Decay, No-Depletion (s/m^3)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	8.708E-06	1.827E-06	5.293E-07	2.602E-07	1.587E-07	6.794E-08	2.249E-08	1.002E-08	5.799E-09	3.799E-09
SSW	6.157E-06	1.276E-06	3.641E-07	1.769E-07	1.069E-07	4.508E-08	1.454E-08	6.359E-09	3.640E-09	2.367E-09
SW	7.993E-06	1.657E-06	4.735E-07	2.304E-07	1.393E-07	5.862E-08	1.870E-08	8.011E-09	4.487E-09	2.859E-09
WSW	7.547E-06	1.542E-06	4.367E-07	2.114E-07	1.274E-07	5.370E-08	1.734E-08	7.597E-09	4.355E-09	2.836E-09
W	7.865E-06	1.603E-06	4.552E-07	2.212E-07	1.339E-07	5.709E-08	1.893E-08	8.545E-09	5.009E-09	3.322E-09
WNW	6.398E-06	1.317E-06	3.754E-07	1.825E-07	1.104E-07	4.677E-08	1.526E-08	6.765E-09	3.913E-09	2.566E-09
NW	8.411E-06	1.759E-06	5.092E-07	2.499E-07	1.520E-07	6.451E-08	2.073E-08	8.822E-09	4.876E-09	3.057E-09
NNW	1.325E-05	2.826E-06	8.418E-07	4.220E-07	2.613E-07	1.149E-07	3.983E-08	1.844E-08	1.094E-08	7.298E-09
N	1.894E-05	4.015E-06	1.185E-06	5.900E-07	3.635E-07	1.585E-07	5.427E-08	2.492E-08	1.473E-08	9.817E-09
NNE	1.422E-05	2.977E-06	8.629E-07	4.249E-07	2.597E-07	1.121E-07	3.804E-08	1.757E-08	1.051E-08	7.099E-09
NE	1.685E-05	3.529E-06	1.026E-06	5.058E-07	3.093E-07	1.333E-07	4.484E-08	2.038E-08	1.200E-08	7.988E-09
ENE	9.082E-06	1.889E-06	5.442E-07	2.666E-07	1.623E-07	6.952E-08	2.324E-08	1.058E-08	6.265E-09	4.197E-09
E	8.508E-06	1.769E-06	5.088E-07	2.491E-07	1.515E-07	6.483E-08	2.160E-08	9.786E-09	5.767E-09	3.847E-09
ESE	9.680E-06	2.014E-06	5.799E-07	2.840E-07	1.729E-07	7.398E-08	2.468E-08	1.122E-08	6.630E-09	4.438E-09
SE	1.048E-05	2.191E-06	6.337E-07	3.113E-07	1.898E-07	8.133E-08	2.704E-08	1.214E-08	7.080E-09	4.670E-09
SSE	7.646E-06	1.599E-06	4.612E-07	2.261E-07	1.376E-07	5.873E-08	1.939E-08	8.659E-09	5.033E-09	3.314E-09

Key: E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; s/m^3 = seconds per cubic meter; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-69
Segmented General χ/Q Factors for 8-Day-Decay, Depletion (s/m^3)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	7.852E-06	1.582E-06	4.377E-07	2.083E-07	1.239E-07	5.089E-08	1.566E-08	6.590E-09	3.692E-09	2.366E-09
SSW	5.552E-06	1.106E-06	3.010E-07	1.416E-07	8.344E-08	3.374E-08	1.011E-08	4.161E-09	2.301E-09	1.461E-09
SW	7.220E-06	1.440E-06	3.938E-07	1.860E-07	1.099E-07	4.464E-08	1.345E-08	5.545E-09	3.058E-09	1.934E-09
WSW	6.810E-06	1.337E-06	3.618E-07	1.697E-07	9.979E-08	4.041E-08	1.218E-08	5.053E-09	2.810E-09	1.792E-09
W	7.092E-06	1.388E-06	3.763E-07	1.770E-07	1.045E-07	4.271E-08	1.314E-08	5.583E-09	3.157E-09	2.041E-09
WNW	5.772E-06	1.142E-06	3.107E-07	1.463E-07	8.631E-08	3.507E-08	1.063E-08	4.439E-09	2.480E-09	1.588E-09
NW	7.610E-06	1.533E-06	4.258E-07	2.033E-07	1.211E-07	4.986E-08	1.533E-08	6.405E-09	3.552E-09	2.251E-09
NNW	1.196E-05	2.450E-06	6.976E-07	3.389E-07	2.047E-07	8.640E-08	2.790E-08	1.222E-08	7.024E-09	4.591E-09
N	1.709E-05	3.478E-06	9.802E-07	4.729E-07	2.841E-07	1.188E-07	3.778E-08	1.635E-08	9.328E-09	6.064E-09
NNE	1.281E-05	2.571E-06	7.096E-07	3.375E-07	2.007E-07	8.254E-08	2.557E-08	1.089E-08	6.172E-09	4.003E-09
NE	1.519E-05	3.054E-06	8.470E-07	4.041E-07	2.407E-07	9.933E-08	3.087E-08	1.313E-08	7.418E-09	4.791E-09
ENE	8.181E-06	1.632E-06	4.479E-07	2.121E-07	1.256E-07	5.131E-08	1.569E-08	6.604E-09	3.715E-09	2.396E-09
E	7.666E-06	1.530E-06	4.193E-07	1.985E-07	1.175E-07	4.801E-08	1.468E-08	6.171E-09	3.466E-09	2.232E-09
ESE	8.720E-06	1.740E-06	4.774E-07	2.260E-07	1.338E-07	5.464E-08	1.669E-08	7.009E-09	3.937E-09	2.535E-09
SE	9.449E-06	1.898E-06	5.238E-07	2.491E-07	1.481E-07	6.080E-08	1.873E-08	7.906E-09	4.443E-09	2.857E-09
SSE	6.895E-06	1.385E-06	3.812E-07	1.808E-07	1.073E-07	4.385E-08	1.339E-08	5.604E-09	3.132E-09	2.006E-09

Key: E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; s/m^3 = seconds per cubic meter; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest; χ/Q = atmospheric dispersion factor

Table 2.3-70
Segmented General D/Q Factors (1/m^2)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.773E-08	3.631E-09	9.479E-10	4.257E-10	2.408E-10	9.261E-11	2.679E-11	1.062E-11	5.671E-12	3.510E-12
SSW	1.466E-08	3.003E-09	7.839E-10	3.521E-10	1.992E-10	7.659E-11	2.216E-11	8.782E-12	4.690E-12	2.903E-12
SW	1.647E-08	3.374E-09	8.809E-10	3.956E-10	2.238E-10	8.607E-11	2.490E-11	9.869E-12	5.270E-12	3.262E-12
WSW	2.403E-08	4.921E-09	1.285E-09	5.770E-10	3.264E-10	1.255E-10	3.631E-11	1.439E-11	7.686E-12	4.757E-12
W	2.903E-08	5.947E-09	1.552E-09	6.972E-10	3.944E-10	1.517E-10	4.388E-11	1.739E-11	9.287E-12	5.748E-12
WNW	1.728E-08	3.539E-09	9.239E-10	4.150E-10	2.347E-10	9.027E-11	2.612E-11	1.035E-11	5.527E-12	3.421E-12
NW	9.818E-09	2.011E-09	5.250E-10	2.358E-10	1.334E-10	5.130E-11	1.484E-11	5.882E-12	3.141E-12	1.944E-12
NNW	1.778E-08	3.641E-09	9.506E-10	4.269E-10	2.415E-10	9.288E-11	2.687E-11	1.065E-11	5.687E-12	3.520E-12
N	3.275E-08	6.707E-09	1.751E-09	7.864E-10	4.449E-10	1.711E-10	4.949E-11	1.962E-11	1.048E-11	6.484E-12
NNE	3.990E-08	8.174E-09	2.134E-09	9.583E-10	5.421E-10	2.085E-10	6.031E-11	2.390E-11	1.277E-11	7.901E-12
NE	4.807E-08	9.847E-09	2.571E-09	1.155E-09	6.531E-10	2.512E-10	7.266E-11	2.880E-11	1.538E-11	9.519E-12
ENE	2.938E-08	6.019E-09	1.571E-09	7.057E-10	3.992E-10	1.535E-10	4.441E-11	1.760E-11	9.400E-12	5.818E-12
E	2.398E-08	4.912E-09	1.282E-09	5.759E-10	3.258E-10	1.253E-10	3.625E-11	1.437E-11	7.672E-12	4.749E-12
ESE	3.267E-08	6.691E-09	1.747E-09	7.846E-10	4.438E-10	1.707E-10	4.938E-11	1.957E-11	1.045E-11	6.469E-12
SE	2.537E-08	5.196E-09	1.356E-09	6.092E-10	3.446E-10	1.325E-10	3.834E-11	1.520E-11	8.115E-12	5.023E-12
SSE	1.413E-08	2.895E-09	7.558E-10	3.394E-10	1.920E-10	7.384E-11	2.136E-11	8.467E-12	4.521E-12	2.799E-12

Key: D/Q = Deposition Factor; E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

2.4 HYDROLOGIC ENGINEERING

2.4.1 HYDROLOGIC DESCRIPTION

This section describes the site and safety-related SSCs from the standpoint of hydrologic considerations and the project site interface with the hydrosphere.

2.4.1.1 Site and Facilities

The Project site is located at an elevation of approximately 810 ft. (247 m) in North American Vertical Datum of 1988 (NAVD 88) on a peninsula surrounded to the north, east, and west by Belews Lake. Most of the terrain in the vicinity of the Project site (Figure 2.4-1) is characterized by Belews Lake and the foothills of the Blue Ridge mountains to the northwest. Land uses in the vicinity of Belews Lake are primarily residential development, agriculture, and silviculture (timber or forest lands). Belews Lake was formed from Belews Creek, a tributary of the Dan River, under the authorization of the NC Department of Water and Air Resources specifically to provide cooling water to the BCSS. The location of Belews Lake is at the southwest edge of the Dan River Basin. The Dan River rises from springs on Belcher Mountain on the Blue Ridge Plateau in Patrick County, VA, then flows 200 mi. (322 km) across the state border into Stokes County, NC. The lake sits in the foothills of the Blue Ridge Mountains, and the land gradually rises to the northwest. Outcroppings southeast of the Blue Ridge rise into peaks occasionally exceeding 2500 ft. (762 m). The Blue Ridge forms a northeast to southwest barrier about 50 mi. (80 km) from the Project site.

The Sauratown Mountains are located within Stokes and Surry counties and lie west-northwest of the Project site. The range is home to two state parks located within a 25 mi. (40 km) radius of the Project site. Pilot Mountain State Park, which includes Pilot Mountain, peak elevation 2241 ft. (683 m), is approximately 24 mi. (39 km) west, and Hanging Rock State Park, peak elevation is Moore's Knob at 2579 ft. (786 m), is approximately 14 mi. (23 km) northwest of the Project site.

Terrain in the vicinity of the Project site is characterized as alternating ridges and valleys oriented along a northeast to southwest axis. Nearby ridges reach an elevation of 1100 ft. (335 m) AMSL (approximately 300 ft. [91.44 m] above plant grade).

The Project site is a peninsula owned by Duke Energy. It is bounded on the north, east, and west by Belews Lake. The Duke Energy BCSS, an existing dual-fuel coal and natural gas plant capable of generating 2220 MWs of electricity, is located adjacent to the Project site. Units 1 and 2 use once-through cooling in the condenser, with Belews Lake operating as a closed-cycle cooling reservoir. In 2020 and 2021 natural gas was added to the station to allow natural gas co-firing on both units. The station is authorized to pump makeup water from the Dan River into the Belews Lake to maintain the lake level. The proposed location of each Plant Complex is shown in Figure 2.4-1, with a total area of approximately 1187 ac. (480 ha). An existing NS Railroad track heads west from the site, passes the BCSS, and continues west where it intersects with a north-south track that follows the Dan River. These tracks may be used to transport freight to and from the BCSS. There is a short track (approx. 0.7 mi. [1.1 km]) that runs

between the BCSS and the coal pile. Figure 2.4-2 shows the plant grade at the Project site and topography of the surrounding area.

Additional waters located in the vicinity of the site include the Dan River, Belews Creek, and unnamed tributaries. The Dan River is located approximately 2.5 mi. (4.0 km) northwest and Belews Creek is located approximately 3.5 mi. (5.6 km) north-northeast of the Project Site Center Point.

The Project site is to be graded such that runoff is directed away from each proposed Plant Complex to the extent possible. The actual site grading plan will be based on the specific technology selected and the associated site layout plan; additional details will be provided as part of the construction permit or license application.

Flooding from several potential sources has been examined at the site. The potential flooding scenarios applicable and investigated for the site include the following: probable maximum flood (PMF) on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami, flooding due to ice effects, and potential flooding caused by channel diversions. Detailed descriptions of each of these flooding events and how they were estimated are found in Sections 2.4.2 through 2.4.7 and Section 2.4.9.

It is predicted that the highest flood levels at the safety-related structures would result from a local PMP event over the plant site as described in Section 2.4.2.3. Specific flood elevations at safety-related structures are described in Section 2.4.2 and Section 2.4.10. To ensure adequate flood protection, safety-related structures are located above the maximum postulated flood level.

2.4.1.2 Hydrosphere

The Project site is located within the Dan River Basin. The main hydrologic features include the Dan River, Belews Lake, Belews Creek, and the Belews Creek tributaries.

2.4.1.2.1 Dan River Basin

The Dan River rises on the eastern slope of the Blue Ridge Mountains in Patrick County, VA. From there it travels 200 mi. (322 km), passing through Stokes, Rockingham, Caswell, and Pittsylvania counties, before reaching Halifax County, VA, where it enters Kerr Reservoir near the town of South Boston. Along the way, it is fed by five main tributaries — the Smith, Mayo, Sandy, Hyco, and Banister rivers. The Dan River Watershed forms part of the headwaters of the Roanoke River, a major source of the Albemarle Sound in coastal NC, one of the largest estuaries in the U.S. The basin covers 3300 square miles (mi^2) (8547 square kilometers [km^2]), 11,123 linear stream mi. (17,901 km), and 25,042 lake ac. (10,134 ha) and comprises approximately one-third of the Roanoke River Basin.

The nearest stream gauge to the Project site is on the Dan River at Pine Hall, NC, (United States Geological Survey [USGS] 02069000) and is approximately 1.6 mi. (2.6 km) upstream from the confluence of the Dan River with Belews Creek. This gauge station is operated in

cooperation with North Carolina Department of Environmental Quality (NCDEQ). The drainage basin at the stream gauge is 501 mi^2 (1298 km^2) (Reference 2.4-47). There are no major tributaries to the Dan River west of the Project site and before USGS gauge number 02069000. Approximately 10 river mi. (16 km) downstream of Belews Creek is the confluence of the Dan River and the Mayo River. The gauge station Dan River near Wentworth (USGS 02071000) is approximately 8 river mi. (13 km) further downstream. The drainage basin at the Wentworth stream gauge is 1053 mi^2 (2727 km^2) (Reference 2.4-48).

The Dan River Basin is located in a climate region classified as humid subtropical and experiences warm and muggy summers and cold winters with variable snowfall. Rainfall is fairly consistent throughout the year but varies significantly from year to year. Normal annual precipitation in this region (based on data from the KGSO) is 43.95 in. [111.6 cm] July through September have the highest rainfall amounts, while October through December have the least. Summer rainfall is usually from thunderstorm activity that can also bring strong winds and hail. Snow, sleet, glaze, and ice accumulation are rare during the winter months and short-lived when experienced. Snowfall amounts vary greatly, with some winters experiencing only trace snowfall amounts. Glazing is more common in the Piedmont area of NC (where the Project site is located) than the rest of the state but is usually not damaging.

The Dan River and Belews Lake contribute to the water supply for the cooling system for the BCSS. Dan River and Belews Lake will be used as a source of cooling water for the proposed Plant Complexes.

Information on USGS-maintained stream flow gauge stations near the Project site is provided in Table 2.4-1. The information presented includes the location, drainage area, period of record, and the mean, minimum, and maximum average annual flow for the period of record. Streamflow gaging data collected in the basin sporadically since 1987 and data from the NOAA Advanced Hydrologic Prediction Service (AHPS) indicate that flooding events have occurred over the past two decades. Information on the USGS-maintained stream flow gauge station on the Dan River at Pine Hill (USGS stream gauge 02069000) near the Project site is provided in Table 2.4-2. This gauge is missing records for 1991 – 2008. Figure 2.4-3 depicts the location of stream gauges in the vicinity of the Project site.

Drought conditions prevailed across much of NC during 1998 – 2002, resulting in widespread record-low streamflow and groundwater levels in many areas. During this 4-year period, the drought was continuous in areas of western NC, although eastern areas of the state had some periods of relief from tropical storms in 1998 and 1999. New record-low daily mean discharges were set at two gaging stations on the Dan River, Dan River near Francisco (September 5, 1999) and Dan River near Wentworth (August 12, 2002.) (Reference 2.4-53). Table 2.4-3 presents the monthly mean flow data for USGS gauge on the Dan River at Wentworth, NC (02071000) from 1939 to 2024.

In 2007 – 2008, one of the worst droughts on record impacted NC. In 2007 conditions in the state went from no drought to record drought in less than one year. The year 2007 was recorded by the NWS as the driest year in more than 100 years in NC. Another record-breaking

drought occurred in 2010 – 2012 and in early 2016 much of NC was abnormally dry. While central and eastern NC received needed rains in late spring, western NC saw moderate drought begin by early May 2016. Conditions worsened with the western tip of NC reaching the Extreme Drought stage by October 18, 2016, and Exceptional Drought by November 8, 2016 (Reference 2.4-19). Recently, in 2021, NC experienced several periods with more than 80 percent of the state in conditions ranging from abnormally dry to severe drought. The mid-Atlantic started the year with no droughts, but moderate to severe drought developed by June. On December 28, 2021, approximately 87 percent of the state was in moderate to severe drought, with an additional 12 percent being classified as abnormally dry (Reference 2.4-18). These periods of drought are reflected in the monthly mean flows reported at stream gauges located in the region of the Project site (Table 2.4-2 and Table 2.4-3).

No low water records are available from the NWS AHPS for the Dan River at Pine Hall. The AHPS low water records for Dan River near Wentworth show a low of 0.39 ft. (11.9 cm) on August 12, 2002.

Details of flood history for the area are presented in Section 2.4.2. The largest flood on record on the Dan River near Wentworth, NC, occurred on June 22, 1972, as a result of Hurricane Agnes (Reference 2.4-29). The peak streamflow near Wentworth reached 54,200 cubic feet per second (cfs) (1535 cubic meters per second [m^3/s]), and the gauge station recorded a historical crest at 31.60 ft. (9.63 m). Tropical Depression Agnes produced less than 4 in. (100 mm) of rain while moving over the state of Georgia. The interaction with the low-pressure system over NC, however, caused a sharp increase in rainfall. The system produced approximately 150 – 250 mm (6 – 10 in.) of rain over that state with much higher amounts farther north. The record-breaking floods occurred in the Middle Atlantic States in late June and early July 1972. Many streams in the affected area experienced peak discharges several times the previous maxima of record (Reference 2.4-29).

Details of flood history for the area are presented in Section 2.4.2.

There are 11 reservoirs in the Belews Creek Basin in the vicinity of Belews Lake. Figure 2.4-4 shows the Belews Creek watershed upstream of the Belews Lake Dam and includes all the dams within this watershed. Table 2.4-4 provides detailed information for the 11 dams applicable to the site.

The Federal Emergency Management Agency (FEMA) Flood Insurance Study for Stokes County, NC, and Incorporated Areas reports the peak discharges for various flood frequencies on the Upper Dan River Basin and the Upper Yadkin River Basin. The flooding source of Belews Creek from the confluence with Dan River to U.S. Highway 158 was studied by limited detailed methods (Reference 2.4-9). These values are presented in Table 2.4-5. The FEMA 100-year flood inundation map, which represents flood inundation before construction of the Project site, is presented in Figure 2.4-5.

2.4.1.2.2 Belews Lake

Belews Lake is a cooling reservoir completed in 1973 by Duke Power. The reservoir has a

surface area of about 3864 ac. (1564 ha) and an 88 mi. (142 km) shoreline (water level 725.0 ft. [221.0 m]). Water levels in the reservoir vary with a [[
]][CEII] and minimum drawdown level at 720.0 ft. (219.5 m) for current BCSS operation. The reservoir has three main tributaries, West Belews Creek, Belews Creek, and East Belews Creek. The lake is impounded by an earthen dam with a concrete spillway.

Duke Energy has the ability to pump makeup water from the Dan River into Belews Lake to maintain the reservoir level. This pumping has been carried out five times, in Dec 2002 – Feb 2003, Jan 2008 – Mar 2008, Jan 2009 – Mar 2009, Dec 2011 – Mar 2012 and Aug 2012 – Dec 2012. The pumping system is authorized by the “BCSS” 2025 National Pollutant Discharge Elimination System (NPDES) permit “NC0024406” and “the Duke Power” 2009 United States Army Corps of Engineers (USACE) permit SAW-2009-01801. The Plant Complexes, are shown on Figure 2.4-2. The Circulating Water System and the cooling towers will obtain their source water from the Dan River and Belews Lake. Water for the nuclear power plant would be obtained via a new intake on the east side of the site or on the west side of the site, opposite the existing BCSS intake.

Duke Energy owns all the land within and immediately adjacent to Belews Lake. Duke Energy grants shoreline access leases to adjacent property owners for permission to access the reservoir across Duke Energy property. The Belews Creek Basin at its confluence with Dan River is shown in Figure 2.4-6.

2.4.1.2.2.1 Belews Lake Pumping Operations and Lake Elevation

Belews Lake has a makeup water intake structure (MWIS) that provides water from the Dan River, as needed, to maintain an operational level of water. The MWIS minimizes impingement and entrainment by having an approach velocity of less than 0.5 ft/s (0.15 m/s) at the inlet; it is also equipped with a 2 mm (0.08 in.) fine mesh travelling screen with a fish return system.

The drought conditions in the southeastern U.S. in 1998 – 2002, including the Carolinas, led to unprecedented lowering of Piedmont groundwater levels and stream base flows. Declining levels of cooling water in Belews Lake, combined with risks to future operability of BCSS, prompted Duke Energy to obtain regulatory approval to supplement the reservoir with water pumped from the nearby Dan River.

Duke Energy projected that if the surface elevation of Belews Lake dropped below 716.86 ft. (218.5 m) AMSL, BCSS would be unable to operate due to condenser cooling water pump cavitation. In early 2002, structures were added to the condenser cooling water inlets to suppress potential vortices, permitting the plant to operate to a surface elevation of 714.89 ft. (217.9 m) AMSL.

In January 2008 regulatory approval was granted for winter 2008 pumping of Dan River water to aid Belews Lake water management. Pumping from the Dan River commenced January 22, 2008, with the lake surface elevation at 721.78 ft. (220.0 m) AMSL, and terminated on March 31, 2008, with the surface elevation at 724.08 ft. (220.7 m) AMSL. Subsequent springtime tributary inflows further augmented Belews Lake storage volume, with the lake achieving full

pond at 725.07 ft. (221 m) AMSL by April 9, 2008. Pumping from the Dan River and coincident Belews Lake inflows supplied an estimated 8780 acre-feet (ac-ft) (1083 hectare-meters [ha-m]), or about 74% of the volume required to achieve full pond.

In 2012 regulatory approval was granted for pumping of Dan River water to aid Belews Lake water management under certain conditions, including:

- Pumping must not lower the flow in Dan River below 110 cfs (3.1 m^3/s), which is the Division of Water Resources target flow recommendation for this site. River flow at the pumping location must be checked at USGS Pine Hall gauge station (USGS 02069000) prior to each daily pumping event.
- Pumping may occur to a maximum water level in Belews Lake of 724.5 ft. (220.83 m) AMSL.
- Pumping must not occur from April 1 through June 30 of any year to avoid the fish spawning period.
- At least 80% of ambient flow as recorded at the new Pine Hall USGS gauge must be bypassed (i.e., withdraw no more than 20% of flow).

2.4.1.2.3 Belews Creek

There is one stream gauge on the Belews Creek upstream of the Belews Lake near Kernersville, NC (USGS 02069030) (Figure 2.4-3), which has a drainage area of 14.90 mi^2 (38.6 km^2) (Reference 2.4-49). The stream data available is limited to peak stream flow for water years 1954 through 1971. Information for this gauge station is provided in Table 2.4-6.

2.4.1.2.4 Belews Creek Watershed

2.4.1.2.4.1 Lakes

There are a series of small man-made lakes (maximum storage between 30 and 80 ac-ft [3.7 and 9.9 ha-m]) in the Belews Creek Watershed (Figure 2.4-6) (Reference 2.4-38). The associated dams are discussed in Section 2.4.1.2.1.

2.4.1.2.4.2 Streams

There are seven streams that feed into Belews Lake that include Belews Creek, Left Fork Belews Creek, Right Fork Belews Creek (Dean Creek), East Belews Creek, West Belews Creek (Little Belews Creek), Hartley Creek, and Kings Creek (Figure 2.4-6).

2.4.1.2.5 Wetlands

National Wetland Inventory (NWI) maps show that NC has 3.9 million ac. (1.6 million ha) of wetlands. Approximately 94 percent of the wetlands are east of the fall line based on a NC Division of Water Resources wetland program staff assessment (Reference 2.4-16).

Belews Lake is a NWI mapped Waters of the United States (WOTUS). WOTUS, including ponds, streams, and wetlands, are defined in 33 CFR 328.3, and are protected by Section 404 and other applicable sections of the Clean Water Act (CWA) (Title 33 of the U.S. Code 1344). The major drainage feature at the project site is Belews Lake, which is formed by the impoundment of Belews Creek. There are no public wetlands in the vicinity of the Project site (see Figure 2.4-7).

2.4.1.2.6 Water Supply and Canal System

The BCSS withdraws condenser cooling water from the down lake region of Belews Lake and discharges the heated effluent into the West Belews Creek Arm, which is connected to the Belews Creek Arm of the reservoir via a 0.93 mi. (1.50 km) long man-made canal. The man-made canal facilitates the return of heated condenser cooling water effluent from the West Belews Creek Arm to the Belews Creek Arm and back to the intake structure for reuse. Duke Energy constructed a MWIS in 2010. The MWIS withdraws water from the Dan River and Belews Creek and routes it directly to Belews Lake. The system complies with Section 316(b) of the CWA as it was designed to withdraw water via submerged intake pits and through a fine-mesh screen equipped with an aquatic organism return system. The MWIS is designed and permitted to include two 50 cfs (1.42 m^3/s) velocity caps and a four-pump pumping station with a capacity not to exceed 100 cfs (2.83 m^3/s).

The existing pumping station, existing outfall, and existing intake are shown in Figure 2.4-8. The proposed intake and outfall options for Project site are presented in Figures 2.4-9 and 2.4-10, respectively.

2.4.1.2.7 Surface Water Users

The NC Division of Environmental Quality (NCDEQ) maintains records of surface water withdrawals for the state of NC. The NCDEQ Division of Water Resources Water Supply Watersheds online mapping tool shows the Dan River (Madison) Watershed is classified as WS-IV (WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas). A review of the NCDEQ surface water database for the Dan River Water Supply Watershed identified Duke Energy is the only surface water user (Reference 2.4-17). North Carolina's Source Water Assessment Program records public water supply sources on NC OneMap. The Town of Madison and City of Eden are located upstream of the Dan River Combined Cycle Station and downstream of Belews Creek Steam Station. Surface water users and diversion amounts are listed in Table 2.4-7.

2.4.1.2.8 Groundwater and Groundwater Users

The local and regional groundwater characteristics and users are described in Section 2.4.12.

2.4.1.2.9 Climate Change

The first unit at the Project site is expected to be online in the first quarter of 2034, with Units 2 – 6 expected to come online during the period between January 1, 2035, and January 1, 2039

(12-month stagger). The initial operating license for each unit is for 40 years and license renewals could extend that by 40 to 60 years. Initial licensing and extensions could amount to 80 – 100 years of operating life. It is estimated that Unit 1 would be online fin the first quarter of 2034, with Units 2 – 6 expected to come online during the period between January 1, 2035, and January 1, 2039 (12-month stagger). Historical long-term meteorological and hydrological data are considered in the project's impact on the surroundings of the Project site. Though the impact of global climate change is uncertain, projected trends are discussed in this section. Consistent with NRC COL/ESP-ISG-026 (Reference 2.4-28), the normal project lifetime, decommissioning period, and resources that may be impacted by climate change are considered.

The NCCSR (Reference 2.4-14) assesses historical climate trends and potential future climate change in NC under increased greenhouse gas concentrations and provides projected changes for the climate of NC.

The NCCSR also addresses compound events including inland flooding. When analyzing long-term changes in inland flooding, changes in climate conditions, water management practices, and land use and land cover must be considered. Inland flooding in NC encompasses a range of scales, from local urban flooding to medium-size river basins, and a range of topography, from flat to mountainous. Flooding due to tropical cyclones can occur throughout NC. In 1916, 1940, and again in 2004, the remnants of tropical cyclones caused extreme flooding in Western NC, and in 1945 the Piedmont region experienced severe flooding due to a tropical cyclone. The NCCSR projects that it is very likely that NC temperatures and extreme precipitation frequency and intensity continue to increase, and it is likely that the frequency and severity of inland flooding increase statewide (Reference 2.4-14). According to NCCSR, annual average temperature increases relative to the recent climate (1996–2015) for NC are projected to be on the order of 2 – 5 degrees °F (1.1 – 2.8 °C) under a higher scenario (RCP8.5) and 2 – 4°F (1.1 – 2.2 °C) under a lower scenario (RCP4.5) by the middle of this century. By the end of this century, annual average temperature increases relative to the recent climate (1996–2015) for NC are projected to be on the order of 6 – 10°F (3.3 – 5.6 °C) under a higher scenario (RCP8.5) and 2°–6°F (1.1 – 3.3 °C) under a lower scenario (RCP4.5).

The NCSSR also predicts that in the future it is likely that major droughts in their multiple forms become more frequent and severe because of higher temperatures that increase evaporation rates (Reference 2.4-14).

The NCA Report provides detailed information related to the potential effects of climate change on the U.S. by region (Reference 2.4-46). The Project site is located in the southeast region as defined by the report. In general, the NCA report states that the southeast region is vulnerable to sea level rise and coastal flooding, extreme heat events, hurricanes, and tropical cyclones, and increasing wildfire risk (Reference 2.4-46).

The NCA report found that heatwaves in the southeast region are happening more frequently and are occurring during a longer heat season, with some cities also showing increasing trends in heatwave duration and intensity.

The number of extreme warm days (above 95 °F [35 °C]) is expected to continue increasing with every increment of global warming. Further, there have been an increasing number of days that exceed 95 °F (35 °C) and nights that exceed 75 °F (24 °C) and a decrease in the number of "extremely cold" days since 1900 (Reference 2.4-46).

Temperatures have steadily increased across the southeast region since the 1970s. Climate models agree that annual temperatures continue to increase in the future, with an average annual increase of 3 – 5 °F (approximately 1.7 – 2.8 °C) by 2041 – 2070 under higher scenario (RCP8.5). Simulated changes for winter and spring are between 2.5 – 5 °F (1.4 – 2.8 °C), 3.5 – 6 °F (1.9 – 3.3 °C) during the summer, and 3 – 5 °F (1.7 – 2.8 °C) during the fall (Reference 2.4-44). The report also finds that days with maximum temperatures exceeding 95 °F (35 °C) are predicted to increase, and there is likely to be a decrease in days with freezing temperatures (Reference 2.4-46).

The NCA report states that the southeast region is more prone to extreme drought due to higher rates of evapotranspiration than other parts of the eastern United States. Longer-term droughts in the region appear to be currently increasing in severity but do not appear to be occurring more frequently (Reference 2.4-46).

The NCA report states that the souteast region has received increasing precipitation in the fall, but over the past few decades there has been a decreasing trend in rainfall in summer. Most climate models forecast the decrease in summer rainfall to continue with mean annual precipitation expected to decrease across the western portion of the southeast region. Extreme rainfall events have occurred more frequently across the SE in the past 20 years. Average annual precipitation from 2002 to 2021 was 5 percent to 15 percent higher relative to the 1901 – 1960 average in the central and eastern U.S. (Reference 2.4-46).

The NCA has investigated severe weather events, including hurricanes, tropical storms, and tornadoes. The NCA report states that warmer temperature projections would result in a decrease in tropical storms globally, however, there has been a slight increase in the frequency of tropical storms in the Atlantic, and the number of major hurricanes (Category 3 – 5) has increased over the past few decades (Reference 2.4-44). The Project site is located inland and not likely to experience the most severe impacts of hurricanes. However, extreme rain events are a risk with or without tropical systems. The study reports that the number of major tornadoes has increased in the past 50 years, however, there is "no statistically significant trend." The study indicates that the increase in the number of tornadoes reported may be attributable to expanded and better reporting of tornadoes (Reference 2.4-46).

Based on the NCA report, the greatest potential effects of climate change are increased temperatures and reduced water availability for the Project site and its surroundings. At the same time, stormwater from extreme precipitation events may increase. As the models used to develop these projections are based on future estimates of population growth, land use, energy consumption, emissions patterns, etc., there is a level of uncertainty associated with the events and meteorological conditions predicted.

The USEPA climate and weather data maps (Reference 2.4-8) predict change in average annual precipitation under various cases. These projections are under the RCP8.5 scenario and run to 2060. The three cases are:

- Hot/Dry is based on the average of the five climate models that project hotter and drier conditions compared to the other model projections. Based on this case, the site will experience 0.4% annual reduction in precipitation.
- Central is based on the average of the five climate models that project changes in the middle of the distribution of projections. Based on this case, the site will experience 5% annual increase in precipitation.
- Warm/Wet is based on the average of the five climate models that project less warming but increased precipitation relative to other models. Based on this case, the site will experience 11.3% annual increase in precipitation.

While climate impacts are anticipated, they will be actively monitored. In line with established nuclear practices, the Project site will adopt proactive measures to monitor meteorological and environmental conditions throughout the project's life cycle, ensuring compliance with approved operational limits.

2.4.2 FLOODING

2.4.2.1 Flood History

The Project site is situated on a peninsula of Belews Lake, which is part of the larger Roanoke River Basin. The nearest city is Walnut Cove, approximately 4.5 mi. (7.24 km) west of the site (Figure 2.4-3). Belews Lake was constructed in the early 1970s by damming Belews Creek, a tributary to the Dan River. The North Carolina Department of Water and Air Resources authorized the creation of Belews Lake (Reference 2.4-20) specifically to provide cooling water to BCSS, which is owned and operated by Duke Energy. Once constructed, the lake was filled and reached full pond elevation in April 1973. A gated structural spillway [[ ]]^{CEII} and releases outflows to a rock-excavated outlet channel. The excavated channel flows into Belews Creek approximately 0.5 mi. (0.8 km) upstream of its confluence with the Dan River. [[ ]]^{CEII} A pond is located at the toe of the embankment with tailwater elevation of 590 ft. (179.83 m) NAVD 88.

Floods on Belews Creek occur primarily as a result of precipitation runoff over the watershed. However, since construction of the dam, flooding on Belews Creek has been controlled by the dam. Flooding from the Dan River is not applicable to the project site because the site is located at a higher elevation, approximately 220 ft. (67.06 m) above the Dan River.

Stage and streamflow from local gauges (Figure 2.4-3) have been analyzed to determine the intensity of the flood conditions around the site. There are no USGS high-water mark signs located near the site. All the high-water mark signs for NC are located closer to the coast. Only

one historical gauge (station ID 2069030) on Belews Creek was active before the creation of Belews Lake in 1973. Flooding conditions occurred in 1954 (water year 1955) and 1969 with gauge heights reaching 23.98 ft. (7.31 m) and 24.36 ft. (7.42 m), respectively. The average gauge height was 22.50 ft. (6.9 m) (Table 2.4-8). The peak streamflow on Belews Creek, measured in 1969, is 3600 cfs (102 m^3/s, see Figure 2.4-12).

The Dan River is downstream of the site and experiences increased flooding conditions compared to the site location upstream, next to Belews Lake. There are two USGS gauges (station IDs 2069000 and 2071000) on the Dan River close to the site. Although Dan River flooding is not applicable to the site, data from these gauges are presented because they have long periods of record. Dan River near Wentworth, NC (station ID 2071000), is the gauge with the longest period of record of the three gauges discussed in this section. Only the Dan River near Wentworth gauge receives regulated released flow from Belews Lake Dam. However, this released flow contributes only 1 percent of the Dan River's overall streamflow. Flooding conditions downstream of the Belews Lake Dam are more significant and frequent than the upstream flooding. Records are presented in Tables 2.4-9 and 2.4-10. Discharges are graphed and presented in Figures 2.4-13 and 2.4-14.

Flooding events of note that caused the peaks in streamflow data are the Flood of 1940, the "Homestead" Hurricane of 1945, Hurricane Agnes in 1972, Hurricane Florence in September 2018, the February 2020 flood event, and Hurricane Eta in November 2020. Hurricanes can cause intense rainfall in the surrounding areas. The years of the flooding events reflect the peak streamflow statistics from the USGS gauges.

All historical floods within the twentieth century were captured by the Dan River near Wentworth gauge, which has an 85-year period of record. Wentworth gauge data begins in 1908, pauses for 28 years, and resumes continuously in 1937. The gauge datum elevation from USGS 2071000 is 512.3 ft. (156.15 m) from vertical datum NAVD 88.

The average Dan River water depth is 20 ft. (elevation 532.3 ft. [162.25 m] NAVD 88) and average streamflow is 19,859 cfs for the period of record. The flood event with the highest peak stage was Hurricane Agnes in 1972 with a maximum water depth of 31.6 ft. (elevation 543.9 ft. [165.78 m] NAVD 88) and streamflow of 54,200 cfs (1535 m^3/s). This represents an increase of 2.7 times the average streamflow. Out of the five major historical flood events recorded by the USGS in NC's history, two occurred during the 1940s. The "Homestead" Hurricane of 1945 and the Flood of 1940 had peak discharges of 38,100 cfs (1079 m^3/s) and 34,700 cfs (983 m^3/s), respectively, recorded at the Dan River near Wentworth gauge.

Hurricane Florence caused high flows and water levels on the Dan River. Local property was inundated from high water levels, including the 311 Speedway, approximately 1.8 mi. (2.9 km) north of the Belews Lake Dam. The high streamflow was reflected by the Dan River gauges with flows peaking at 28,900 cfs (818 m^3/s) near Wentworth and 20,500 cfs (580 m^3/s) at Pine Hall in September 2018.

The wettest year on record in NC is 2020. Two intense rainfall events occurred in 2020 near the

site. In February of 2020, intense rainfall resulted in the highest streamflow statistics in recent history for both gauges on the Dan River. Hurricane Eta in November of 2020 reflects the second highest water depth and streamflow in recent history for both gauges on the Dan River. The streamflow reached highs of 40,900 cfs (1158 m^3/s) near Wentworth and 26,200 cfs (742 m^3/s) at Pine Hall in February, and 38,500 cfs (1090 m^3/s) near Wentworth and 25,800 cfs (730 m^3/s) at Pine Hall in November. Streamflow was 6.2 percent higher in February than November. Hurricane Agnes in 1972 remains the highest flow near Wentworth with 54,200 cfs (1535 m^3/s), 1.3 times higher than the 2020 flood event.

No historical data exist regarding flooding due to surges, seiches, tsunamis, dam failures, or landslides. River flooding is discussed in Section 2.4.3. Dam failures are discussed in Section 2.4.4. Surge and seiches are discussed in Section 2.4.5. Tsunamis are discussed in Section 2.4.6. Historical information related to icing and ice jams is provided in Section 2.4.7. Channel diversions are discussed in Section 2.4.9.

2.4.2.2 Flood Design Considerations

The types of events evaluated to determine the worst potential flood at the Project site included:

- PMP on the critical watersheds, including potential consequent dam failures, as discussed in Section 2.4.3.
- Cascading and instantaneous failure of all dams at their highest ponding elevation coincident with a 500-year flood event as discussed in Section 2.4.4.
- Local intense precipitation (LIP) as discussed in this section.
- Two-year coincident wind waves as discussed in Sections 2.4.3 and 2.4.4.

The potential events considered but not analyzed included:

- Flooding from Surges and Tsunamis - Specific analysis of Belews Lake flood levels resulting from ocean front surges and tsunamis was not required because of the inland location of the site.
- Flooding from Snow Melt and Ice Jam - Snow melt considerations were also unnecessary because of the temperate zone location of the plant. While there is the potential for ice jams on Belews Creek, based on the section geometry and site elevation at the Project site, an ice jam sufficient to cause Project site flooding is not credible. Further discussion of ice effects is found in Section 2.4.7.
- Flooding from Landslides - Flood waves from landslides into the lake required no specific analysis. A review of the borders of the Belews Lake indicate the absence of major elevation relief. Based on this review, the volume of material entering the lake from potential landslides is not significant compared to the available detention space in the lake. Any waves created from landslides would not result in site flooding due to the large difference in elevation between the normal pool elevation at the lake of 725 ft. (220.98 m) NAVD 88 and the Project site plan elevation of 810 ft. (247 m) NAVD 88.
- Flooding from Seiches - The occurrence of landslides in the area adjacent to Belews Lake is not considered possible due to the low relief of topographic features in the vicinity of the Project site. Therefore, potential seismic events and landslides are not expected to cause

seiches on Belews Lake and, therefore, cannot cause flooding at the Project site. Further discussion of seiches is included in Section 2.4.5.

- Flooding from Migration and Diversion - Belews Lake has been stable for many years with no indication of the potential for migration or diversion. Historical floods have not produced any major changes in the reservoir configuration, so specific analysis of channel diversion was not required. Further discussion of channel diversion is included in Section 2.4.9. As noted above, potential events were evaluated to determine the worst potential flood conditions at the site. The following is a summary of the events considered and their effects. More details for these events are provided in the referenced sections as appropriate.

The potential events considered and analyzed included:

- Flooding from Rivers and Streams - The condition producing the most critical flood level calculated at the Project site is the 10 mi^2 (26 km^2) PMP storm event over the entire Belews Creek watershed. This storm event produces a maximum flood level of 746.4 ft. (227.5 m) NAVD 88. Belews Lake Dam was assumed to not fail even though the dam embankments are overtopped. For more information see Section 2.4.3.
- Flooding from Combined Effects (PMP and Wind Waves) - Wind waves based on a calculated 2-year overwater wind speed of 42.9 miles per hour (mph) (69.0 kilometers per hour [kph]) were assumed to occur coincident with the flood peak. This creates maximum wind waves up to 1.49 ft. (0.45 m) high (trough to crest). When the effects of wind wave and runup were added, the maximum Belews Lake design PMF water level was established to be at elevation 747.86 ft. (227.95 m) NAVD 88. The PMP and wave effect are discussed in Sections 2.4.3.5 and 2.4.3.6.
- Flooding from Dam Breaches and Failures - The calculated water surface elevation (WSEL) at the site resulting from the combined simultaneous failure of all dams coincident with a 500-year flood event reaching its peak at the same time as the lake is [[ ]]^{CEII} NAVD 88 (see Section 2.4.4).
- Flooding from Combined Effects (Dam Failure and Wind Waves) - Wind waves based on a calculated 2-year overwater wind speed of 42.9 mph (69.0 kph) were assumed to occur coincident with the dam failure peak. This creates maximum wind waves up to 1.49 ft. (0.45 m) high (trough to crest). When the effects of wind wave and runup were added, the dam failure water level was established to be at elevation [[ ]]^{CEII} NAVD 88. The dam failure and wave effect are discussed in Sections 2.4.4.5 and 2.4.4.6.
- Local Intense Precipitation - Analysis of the general effects of LIP was also performed based on preliminary site plans. However, the detailed site grades and stormwater conveyance facilities will be designed at the construction permit or license application stage such that LIP does not flood the safety-related SSCs of the plant. For more information see Section 2.4.2.3.

The preliminary Project site plant grade is established at elevation 810 ft. (247 m) NAVD 88, well above the calculated maximum flood level, which is consistent with RG 1.59, Position 1 (see Section 2.4.2.3).

2.4.2.3 Effects of Local Intense Precipitation

The final maximum water levels at buildings expected to result from LIP will be confirmed at the

construction permit or license application stage. However, a preliminary calculation of the flood height resulting from LIP was performed.

Given the physical site topography and the location of the Project site, it is reasonable to expect that the PMP-driven (as described in Section 2.4.2.3.1) Belews Lake floodwater elevation at the locations adjacent to the power block area would be substantially less than that of the Project site plant grade elevation of 810 ft. (247 m) NAVD 88. Therefore, runoff from the Project site is not restrained by tailwater effects at the lake.

The final graded Project site can reasonably take full advantage of the current topography and provide more than adequate runoff capability to the east, west, north, and south with flow directed to Belews Lake. Belews Lake would be affected to a much lesser extent by local intense rainfall events than a PMF event for which the maximum elevation is 745.98 ft. (227.37 m) NAVD 88. The 64 ft. (19.5 m) elevation difference to the plant grade (810 ft. [247 m] NAVD 88) ensures that slopes and drainage systems can be designed to adequately convey LIP-event flows to Belews Lake.

Because Belews Lake is capable of accommodating Project site LIP-event flows without flooding the site, the potential and extent of flooding from a LIP event is dependent upon facility design and final grading and drainage system design. The final Project site drainage systems may employ several techniques, including grading slopes to efficiently convey runoff water, constructing additional drainage channels, etc. Given the existing topography, the Project site power block area is favorably located to allow design of a fully effective site drainage system. It is therefore reasonable to expect that a fully effective drainage system would be designed as part of the construction permit or license application stage.

2.4.2.3.1 Precipitation Distribution

Temporal LIP distribution for the plant was determined from guidance presented in Hydrometeorological Reports No. 51 and No. 52 (HMR-51 and HMR-52) (Reference 2.4-22 and Reference 2.4-23, respectively). The guidelines set forth in HMR-51 and HMR-52 were followed to form the rainfall hyetograph of the 1-hour (hr.), 1 mi^2 (2.6 km^2) PMP for the Project site. The estimated PMP depths presented in HMR-51 are for durations ranging from 6 to 72 hr. and for drainage areas ranging from 10 to 20,000 mi^2 (25 – 51,800 km^2). Using these depths, HMR-52 provides procedures to estimate short-duration point PMP depth (or 1 mi^2 [2.6 km^2]) for durations up to 1 hr.

Figures 24 and 36 in HMR-52 provide point PMP depths of 18.78 in. (477 mm) for a 1-hr. duration and 6.2 in. (157.48 mm) for a 5-minute duration. The 15-minute and 30-minute durations were estimated by applying the point ratios to 1-hr rainfall from Figures 37 and 38 in HMR-52, respectively. The 6-hr rainfall is from Figure 18 of HMR-52. The 15-minute, 30-minute, 60-minute, and 6-hr rainfall depths are 9.7 in. (246.38 mm), 14 in. (355.6 mm), 18.8 in. (477.52 mm), and 29.2 in. (741.68 mm), respectively. Table 2.4-11 presents the 1 mi^2 (2.6 km^2) PMP depths and intensities for various durations used in the analysis at the Project site. The PMP rainfall time series (see Figure 2.4-15) with a 5-minute interval was then constructed following

the guidelines in NRC *Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America* (NUREG/CR-7046), Appendix B:

- The first time step was set to the highest LIP depth, which is 6.2 in. (157.48 mm).
- The next two 5-minute time steps were set to an incremental precipitation depth of 1.75 in. ([9.7–- 6.2]/2 in.) (44.45 mm).
- Incremental precipitation depths for the subsequent time steps were determined from the cumulative LIP depths shown in Table 2.4-11.

2.4.2.3.2 Runoff Model

The advanced reactor technology and associated site layout and facilities at the Project site have not been finalized. A two-dimensional (2D) FLO-2D model is performed based on the general preliminary site layout as presented in Figure 2.1-5. The following assumptions are made:

1. Because no outside watershed is contributing to the LIP, site cover within the power blocks and laydown areas is assumed to maximize the water levels. High values for Manning's roughness coefficients from Table 2.4-12 are used in the model for the power blocks and areas downstream of the power blocks with the surface covers listed below. Low values from Table 2.4-12 are used for areas upstream of the power blocks. This maximizes the flow toward the power blocks and delays the discharge of flow from the power blocks, resulting in conservative flood levels.
    a. Power blocks: Gravel.
    b. Laydown areas at 840 ft. (256 m) elevation: Gravel cover to maximize tailwater condition.
    c. Laydown areas at 805 ft. (245 m) elevation: Grass cover to maximize tailwater condition.
    d. Laydown areas at 820 ft. (250 m) elevation: Pavement to maximize flow into the power block.
2. No evaporation was considered in the model. This is conservative because stormwater lost due to evaporation could reduce inundation depth and period of inundation.
3. Buildings within the watershed are considered to be solid and impervious. Stormwater must move around buildings and is not removed from the model by flowing into buildings. This assumption is conservative because all rainfall is contained within the model until it can flow out of the model on all sides to Belews Lake.
4. Details for the security barriers (delay barriers and Jersey barriers) are not provided and are not considered. This will be addressed during the construction permit or license application stage.

5. According to hierarchical hazard assessment (HHA) Case 3 of NUREG/CR-7046, all precipitation losses are ignored for all drainage areas. By eliminating the losses attributed to infiltration and initial abstraction, the peak runoff rate increases. This is a conservative assumption.

6. Wind wave analysis is not required for the site LIP calculation. Wind wave calculations are not required for this analysis because there is no flooding from the reservoir during the LIP event and localized ponding is not sufficient to create wind wave action. The configuration of the site structures in areas where ponding is likely also limits the fetch lengths or creates short, narrow fetches that diminish the potential for wind wave impact.

The site is modeled as a flat surface with buildings as obstructions. Three separate FLO-2D models are set up, one for each site boundary. The extent of the FLO-2D models is illustrated in Figure 2.4-17 through Figure 2.4-19. The model boundaries are placed at the edge of the finish grading area away from safety-related SSCs. The FLO-2D models cover an area of approximately 63 ac. (25.5 ha), 57 ac. (23.07 ha), 127 ac. (51.4 ha) for the specific site areas designated for North, Middle, and South Plant Complexes, respectively. In all model domains of this study, runoff is allowed to leave the FLO-2D model at all boundaries. Consequently, any water that reaches a boundary is allowed to flow out of the model in a natural manner by assigning outflow cells along the entire boundary. This reflects actual site conditions because the edge of the developed area is sloped away from the site toward Belews Lake (see Figure 2.1-5). Cell sizes of 10 ft. (3.0 m) were selected to properly identify footprints of the buildings. Fences do not constitute flooding barriers and are not considered in the analysis.

2.4.2.3.3 Flood Elevations

FLO-2D model results show that the maximum LIP flood WSEL in the vicinity of the buildings exceeds the assumed threshold by the amounts shown in Table 2.4-13. A threshold for all buildings and structures of 6 in. (0.15 m) is assumed. These results are based on preliminary site layout and grading. However, these results are considered conservative, as detailed site grades and stormwater conveyance facilities have not yet been developed. These features will be addressed during the construction permit or license application stage to ensure that a LIP does not impact safety-related SSCs.

2.4.2.3.4 Site Drainage System

The site layout and facilities at the Project site have not been finalized. Thus, the location and design of stormwater conveyance facilities have not been determined. These tasks are performed as part of detailed engineering at the construction permit or license application stage. Stormwater is carried away from the plant area by a stormwater collection system comprising appropriate combinations of swales and open channels or a subsurface system of catch basins, pipes and culverts. Runoff is routed to Belews Lake. The finished grade for the site slopes away from buildings and is designed such that the peak discharges from the LIP do not flood safety-related facilities if the subsurface drainage system is plugged.

2.4.3 PROBABLE MAXIMUM FLOOD ON STREAMS AND RIVERS

The design of nuclear power plants includes protection from the adverse effects of flooding. To assist in determining the potential for adverse flooding effects, the NRC provides guidance for estimating design basis floods in *Design Basis Floods for Nuclear Power Plants*, Rev. 2 (RG 1.59) and NUREG/CR-7046. One or an appropriate combination of several hydrometeorological, geoseismic, or structural-failure phenomena causes a design basis flood that results in a hazard to SSCs important to the safety of a nuclear power plant. The PMF due to PMP over the Belews Creek watershed is presented in this section.

American National Standards Institute and the American Nuclear Society (ANSI/ANS) document ANSI/ANS-2.8, Determining Design Basis Flooding at Power Reactor Sites (Reference 2.4-2), and NUREG/CR-7046 (Appendix H), provide three different alternatives for analysis of a flood caused by a precipitation event. They are as follows:

- **Alternative 1** – Combination of the following:
  - Mean monthly baseflow.
  - Median soil moisture.
  - Antecedent or subsequent rain: the lesser of (1) rainfall equal to 40 percent of PMP and (2) a 500-year rainfall PMP.
  - The PMP.
  - Waves induced by 2-year wind speed applied along the critical direction.
- **Alternative 2** – Combination of the following:
  - Mean monthly baseflow.
  - Probable maximum snowpack.
  - A 100-year, snow-season rainfall.
  - Waves induced by 2-year wind speed applied along the critical direction.
- **Alternative 3** – Combination of the following:
  - Mean monthly baseflow.
  - A 100-year snowpack.
  - Snow-season PMP.
  - Waves induced by 2-year wind speed applied along the critical direction.

Alternative 1 was used for this analysis as it is the most conservative and quantifiable. Based on air temperature (T_a) data, the occurrence of snow within the western NC basin and its effect on flood-producing phenomena indicated that snowmelt and antecedent snowpack are not critical factors in the production of floods at the Project site. Therefore, Alternatives 2 and 3 are not considered. Baseflow is not considered for Belews Creek as there are no active or historical gauges upstream of the creek branches for which adequate data were available. Instead,

conservative assumptions are used throughout the analysis to cover the impact of this assumption. To develop the most conservative case, no evaporation was considered in the model. This is conservative because stormwater lost due to evaporation could reduce inundation depth and period of inundation.

2.4.3.1 Watershed Characteristics

The Project site is located on a peninsula surrounded to the north, east, and west by Belews Lake. Belews Lake is formed upstream of Belews Lake Dam and is fed by Belews Creek. As depicted in Figure 2.4-20, the area of Belews Creek watershed upstream of the Belews Lake Dam is 69.33 mi^2 (179.59 km^2).

The hydrology of the Belews Creek watershed upstream of the Belews Lake Dam is characterized by a network of tributaries and streams that contribute to the Belews Lake reservoir in NC. The watershed encompasses a mix of forested, agricultural, and urban landscapes, influencing the flow and quality of water entering the lake. Precipitation is a significant driver of surface runoff and streamflow, with variability linked to seasonal weather patterns. The hydrologic system includes both surface water and subsurface contributions, with groundwater recharge and discharge playing a role in maintaining base flows during drier periods. The dam regulates outflow from Belews Lake, ensuring water availability for downstream uses, power generation, and ecological balance.

2.4.3.2 Probable Maximum Precipitation

Determination of design basis flood levels includes considering the most severe flood conditions that may be reasonably predicted to occur at a site as a result of severe hydrometeorological conditions. The NWS in HMR-51 (Reference 4.2-22) and HMR-52 (Reference 2.4-23) has defined, for the Project site, PMP events for the Belews Creek watershed. The storms defined by the NWS references provide either specific spatial rainfall patterns that reflect orographic effects or idealized elliptical isohyetal patterns with preferred orientation and orographic multipliers.

The stepwise process followed to distribute the storm-area averaged PMF from HMR-51 over the 69.33 mi^2 (179.56 km^2) watershed is described in HMR-52, Section 7. PMP depths for 10 mi^2 to 20,000 mi^2 (25 – 51,800 km^2) basins and durations from 6 hr. to 72 hr. are scaled from Figures 18 through 47 in HMR-51. Using this PMP depth data, curve fits are used to define the area versus precipitation depth relationships for 6-hr., 12-hr., 24-hr., 48-hr., and 72-hr. storm durations. Following the HHA approach from NUREG/CR-7046, instead of considering multiple storm centers and developing multiple PMPs, conservatively, the 10 mi^2 (26 km^2) PMP developed for the site is applied to the entire watershed. This is a conservative consideration because the direct contributing watershed upstream of the dam is 69.33 mi^2 (179.56 km^2) and not every part of the watershed receives the same rainfall at once.

The PMP storm is modeled as a nine-day event. A three-day antecedent storm was postulated to occur three days prior to the three-day PMP storm in the PMF determination. Antecedent storm rainfall depths applied were equivalent to 40 percent of the main storm with a uniform

areal distribution.

Temporal distribution patterns were then adopted based on a 72-hr. PMP distribution provided in HMR-52 (Reference 2.4-23). The distribution places the heaviest precipitation approximately in the end of the antecedent and main storms. The twelve 6-hr. rainfall increments of each 72-hr. storm were ordered from D1 (maximum depth) to D12 (minimum depth). The rainfall increments were applied in each 72-hr. duration in the following sequence: D12, D11, D10, D9 (first 24 hr.), D7, D6, D5, D3 (middle 24 hr.) and D1, D2, D4, D8 (last 24 hr.).

PMP estimations are presented in Table 2.4-14a through Table 2.4-14d. The 10 mi^2, 72-hr. precipitation is 44.2 in. over the watershed. The full PMP hyetograph is presented in Figure 2.4-21.

2.4.3.3 Precipitation Losses

Realistic site-specific Soil Conservation Service (SCS) curve numbers are calculated based on soil type, vegetation, and land use for watershed surfaces and a conservative, yet reasonable, curve number is applied to the watersheds.

The conterminous U.S. land cover (also known as the national land cover database [NLCD]) at a 30 m (98 ft.) spatial resolution with a 16-class legend based on a modified Anderson Level II classification system (Reference 2.4-21) is used. Land cover is further reclassified into four classes, agricultural, forest, medium residential, and water, as presented in Figure 2.4-20.

Soils are classified by the Natural Resource Conservation Service into four hydrologic soil groups based on the soil's runoff potential. The four hydrologic soil groups are A, B, C, and D. Soils classified as A generally have the smallest runoff potential and soils classified as D have the greatest. The Soil Survey Geographic Database is used in this analysis (Reference 2.4-45). Watershed hydrologic soil groups are presented in Figure 2.4-22.

The SCS curve number method is a standard, widely used, and efficient method for determining the amount of runoff from rainfall events. A combination of land use and hydrologic soil group are used to determine curve number. Table 2.4-15 shows the curve number for the corresponding soil group for each land use category. The dominant soil group and land use are B and forest, respectively (Figures 2.4-22 and 2.4-20). Curve numbers applied to the watershed are presented in Figure 2.4-23.

Sensitivity analysis showed that ignoring precipitation losses results in a WSEL 2.5 ft. higher than the scenario with realistic losses. Therefore, the results presented are those obtained by ignoring losses.

2.4.3.4 Runoff and Stream Course Model

A detailed, 2D flood routing model that is developed for the Belews Creek watershed upstream of the dam is used to establish flooding from PMF at the site. This model, Hydrologic Engineering Center River Analysis System (HEC-RAS) 2D, developed by the USACE (Reference 2.4-37), represents all the topographical and man-made features (i.e., buildings,

tanks, and hydraulic structures) that significantly affect runoff at the project site. The project site is represented by a preliminary layout from one of the technologies considered in this ESP.

In flood routing, it is assumed that the Belews Lake dam does not fail when overtopped. This is a conservative assumption as it maximizes the flood level near the site and in the lake by lowering the outflow. This is also a reasonable assumption, as short period of time and limited overtopping should not cause failure of the dam. Limited overtopping often lacks the prolonged hydraulic force necessary to cause significant erosion or undermine the dam's foundation. The duration and intensity of overtopping directly affect its potential to damage the structure. Historical case studies show that dams with robust construction and maintenance often endure short-duration overtopping without catastrophic failure. Failures typically occur when overtopping is sustained, intense, or exacerbated by pre-existing structural weaknesses (Reference 4.2-32). By using a 2D model, floodwater is routed in a natural manner without being "forced" to flow in predefined directions. This allows for a more accurate flood analysis than is possible with one-dimensional (1D) models.

2.4.3.4.1 Model Geometry and Terrain

The Belews Creek watershed is delineated at a point immediately downstream of the Belews Lake Dam, before it joins the Dan River (see Figure 2.4-24). The size of the watershed is 69.33 mi^2 (179.56 km^2). The 2018 1/3 Arc Second (i.e., 10 m [33 ft.]) USGS Light Detection and Ranging (LiDAR) data for NC (Reference 2.4-50) with vertical accuracy of 8 in. [20 cm] at a 95 percent confidence level is used in this analysis. The data were developed using a horizontal datum of North American Datum of 1983 and vertical datum of NAVD 88, both expressed in meters. The watershed topography (see Figure 2.4-25) ranges from 722 ft. (220 m) NAVD 88 at the lake to 1030 ft. (314 m) NAVD 88 at its most upstream point. This detailed LiDAR point data support the construction of a Digital Elevation Model (DEM) for the purposes of this analysis.

The DEM constructed for this analysis (Figure 2.4-26) has a cell size of 5 ft. x 5 ft. (1.5 m x 1.5 m). This cell size is adequate for this analysis because HEC-RAS 2D minimum cell sizes considered in this analysis are 100 ft. x 100 ft. (30.5 m x 30.5 m), with refined areas around the site and the man-made canal using cell sizes of 50 ft. x 50 ft. (15.2 m x 15.2 m). This requires the averaging of 100 or more DEM cells for the 50 ft. (15.2 m) HEC-RAS cell and 400 DEM cells for a 100 ft. (30.5 m) cell. Thus, any additional detail contained in a finer DEM is averaged out in the HEC-RAS grid and does not improve the model.

The extent of the HEC-RAS 2D model is illustrated in Figure 2.4-26. The model boundaries are set to the extent of the watershed to capture the rain on the grid feature of the HEC-RAS 2D. Boundaries are also away from the power block area and safety-related SSCs in order to prevent boundary conditions from affecting flood levels evaluated within the power block area and to ensure the stability of the model.

The HEC-RAS 2D model covers an area of approximately 69 mi^2 (179 km^2); about 13.5 mi. (21.7 km) in the north-south direction and about 6.5 mi. (10.5 m) in the east-west direction. The numerical grid was generated with the RAS Mapper module. The horizontal grid size was 100 ft.

x 100 ft. (30.5 m x 30.5 m) within the entire model domain. The model grid is refined to 50 ft. x 50 ft. (15.2 m x 15.2 m) on the site and in the vicinity of the man-made canal connecting the west part of the lake to the rest of the lake, edges of the embankments, and ditches around the site. The model has 204,696 cells (Figure 2.4-26). Sensitivity analysis on the size of the mesh was performed and confirmed that the selected cell size results in similar output as smaller cells. This is mainly due to the underlying features of HEC-RAS 2D, which considers:

- Volume rating curves of each cell based on detailed LiDAR data within the footprint of each cell.
- Profile along all faces of the cell based on detailed LiDAR data.

The computation interval is used in the unsteady flow calculations. This is probably one of the most important parameters entered into the model. Choosing this value was done with care and consideration as to how it may affect the simulation. The computation interval is based on several factors. First, the interval should be small enough to accurately describe the rise and fall of the hydrographs being routed. A general rule of thumb is to use a computation interval that is equal to or less than the time of rise of the hydrograph divided by 20 (Reference 2.4-37). A second way of computing the appropriate time step is by applying a numerical accuracy criterion called the Courant condition. The Courant condition criterion looks at cross section spacing and flood wave velocity. The basic premise is that the computational interval should be equal to or less than the time it takes water to travel from one cross section to the next. A detailed description of the Courant condition can be found under the Model Accuracy, Stability, and Sensitivity section of this chapter. Use of a time step based on the Courant condition gives the best numerical solution, but it may significantly increase the model's runtime. In this analysis, the sensitivity analysis showed that a 20-second computation interval results in a stable model and captures the hydraulics of the PMP hyetograph.

Model boundary conditions comprise the following:

- **Downstream:** Belews Lake Dam spillway discharge as determined in Section 2.4.3.4.2
- **Entire model domain**: Rain on grid as determined on Section 2.4.3.2.

2.4.3.4.2 Belews Lake Dam Discharge

The dam is an earthen embankment, 170 ft. (51.9 m) in height, constructed on Belews Creek in Rockingham County, approximately 2 mi. (3.2 km) northeast of the proposed plant site. A gated structural spillway, [[ ]]^{CEII} the normal pool at elevation 725 ft. (221 m) NAVD 88. The gate structure consists of two tainter gates 20 ft. (6 m) wide by 15 ft. (4.5 m) high. Each tainter gate is positioned on the [[ ]]^{CEII} The structural spillway releases outflows to a rock-excavated outlet channel. The excavated channel discharges flows into Belews Creek approximately 0.5 mi. (0.8 km) upstream of the confluence with the Dan River.

The gated spillway design of the Belews Lake Main Dam required the use of a hydraulic equation specific to the gated structure. A gate operation element must also be accounted for in the spillway rating curve. [[ ]]^{CEII},

which indicate two operating criteria during storm events. [[

]][CEII]

Accordingly, a spreadsheet developed by Reference 2.4-4 allows for input of gate opening dependent on reservoir WSEL. [[
]][CEII] the normal pool elevation of 725 ft. (221 m). [[

]][CEII]

To determine the spillway capacity, a hydraulic rating curve was developed for each spillway structure. The spillway flow equation, which can be found in the HEC-RAS software manual (Reference 2.4-36), was used to develop a rating curve for the radial crest gates. A weir coefficient of [[ ]][CEII] A weir coefficient of [[
]][CEII] The discharge coefficient for the tainter gate (C), trunnion height exponent (TE), gate opening exponent (BE), and head exponent (HE) values are typical values suggested in the HEC-RAS software manual. The exponent, GE, is a user developed exponent to determine the gate opening height based on the gate operating procedures described above that account for changes in WSEL. The rating curve assumes that the gates are [[
]][CEII] the normal pool elevation of 725 ft. (221 m). [[

]][CEII] Spillway capacity for the main dam is summarized in Tables 2.4-16a and 2.4-16b. Outflow varies from [[
]][CEII]

2.4.3.4.3 Roughness

Each cell in the model is assigned a Manning's roughness coefficient using land cover categories. Several sources report Manning's roughness coefficients for flow over various surfaces. The following three sources are used in this analysis.

- United States Department of Agriculture (USDA) Natural Resources Conservation Service Technical Release 55 (TR-55) (Reference 2.4-43).
- HEC-RAS Reference Manual (Reference 2.4-36).
- Open-Channel Hydraulics (Reference 2.4-6).

The references listed above provide a range of acceptable values for Manning's roughness coefficients (see Table 2.4-17 only presents roughness values for main features of the model). Manning's roughness values assigned to the entire model are presented in Figure 2.4-27. Roughness varies from 0.05 to 0.2. Sensitivity analysis was performed on roughness by assigning the minimum roughness value from the range provided by the HEC-RAS manual

(Reference 2.4-36). Sensitivity showed that the results are increased by only 6 in. (152 mm), which is bounded by the available margin.

2.4.3.4.4 Hydraulic Structures

Bridges were identified along Highway 158 and 65. Because these bridges are located upstream of the project sites, conservatively, they are assumed to be entirely open. The terrain is modified to simulate an entirely open section for the intersection of roads and Belews Creek.

2.4.3.5 Water Level Determinations

The PMF produces a water elevation of 746.4 ft. (227.5 m) NAVD 88 at the Project site. The maximum WSEL for the entire 2D model domain is presented in Figure 2.4-28. The component of the total vertical extent is 1.5 ft. (0.46 m) (see Table 2.4-22 and Table 2.4-23).

The total vertical extent of the PMF is 747.86 ft. NAVD 88 (Table 2.4-19). This elevation is significantly lower than the site grade elevation of 810 ft. (247 m) NAVD 88 and provides approximately 63 ft. (19 m) of margin. Therefore, it is concluded that safety-related SSCs are not impacted by the PMF and its associated combined effects.

2.4.3.6 Coincident Wind Wave Activity

Wind waves were computed using procedures from the USACE Coastal Engineering Manual (CEM) (Reference 2.4-39). In accordance with EM 1110-2-1614, Equation 2-2 (Reference 2.4-33), and ANSI/ANS-2.8 (Reference 2.4-2), the design wave height, also referred to herein as $H_{1\%}$ (the average wave height of the highest 1% of waves), used for wave runup has the following relationship to the significant wave height (H_s, average wave height of the highest 1/3 of the Waves) (see Equation 2.4.3-1).

$$H_{1\%} \approx 1.67\, H_s \qquad \text{Equation 2.4.3-1}$$

The 2-year mean recurrence interval annual extreme-mile wind speed at 30 ft. (9 m) above ground is 50 mph (80.5 kph) at the site location per Figure 1 of ANSI/ANS-2.8 (Reference 2.4-2) (Figure 2.4-29). The annual extreme-mile wind speed was converted to a 1-hr. duration wind speed using the USACE CEM, Figures II-2-1 and II-2-2 (Reference 2.4-39). The wind speeds were then converted to 10-, 15-, and 20-minute wind speed durations (as appropriate for wave generation for the applied fetches) using USACE CEM Figure II-2-1 (Reference 2.4-39). Calculations are presented in Tables 2.4-20a through 2.4-20e.

Wind-driven waves were calculated using the “Windspeed Adjustment and Wave Growth” module of the Automated Coastal Engineering System (ACES) in the Coastal Engineering Design & Analysis System Version 4.03 (Reference 2.4-40). The shallow restricted option was chosen because the waves are not expected to propagate under a deep-water condition for a significant duration, and the fetch is not unlimited for wave formation; selecting the shallow restricted option, therefore, yields more accurate results. Wind fetch geometry was determined using ArcGIS Pro Version 2.7.1 (Reference 2.4-13). The appropriate wind duration was

determined through an iterative process, as outlined below:

- Depending on fetch, an initial wind duration (10-minute, 15-minute, or 20-minute) was selected and input with the corresponding wind speed into ACES.
- The output wave period was used to calculate wavelength, celerity, and the time required for the wave to travel the fetch based on Dean and Dalrymple (Reference 2.4-7). Sample analyses are presented in Tables 2.4-21a and 2.4-21b.

The resulting time required to travel the fetch was rounded to the nearest five minutes and compared to the wind duration used in the ACES calculation. Five minutes was chosen as an appropriate rounding increment for the wind duration intervals based on the sensitivity and accuracy of the calculation; decreasing the increment to less than five minutes does not significantly change the results.

If the two values were the same, the resulting wave height, period, and wavelength were used. If the two values were different, the resulting time required to travel the fetch was used with the corresponding wind speed as input to the ACES calculation, and the calculation process was repeated. The geographical latitude of observation was input as 36.32 degrees north based on the location of the project site. In this analysis, a duration of 10 minutes with observed wind speed of 42.9 mph (69.0 kph) was selected.

The fetch geometry and average depth along the fetch were determined using the outputs of HEC-RAS 2D combined with the bathymetry of the lake. Average water depth along the fetches was calculated by obtaining the raster water depth information along the fetch line and then averaging these values. Geometry of the lake showed that one fetch is the longest, as shown on Figure 2.4-30. Any other fetch would be shorter than the one selected with shallower water depth. ACES output wave height is H_{mo}, the spectral significant wave height (see Table 2.4-22).

2.4.3.6.1 Wind Setup

Wind setup was calculated along the controlling fetch using U.S. Bureau of Reclamation ACER Technical Memorandum No. 2 (Reference 2.4-42). The calculated wind setup is 0.01 ft. (0.003 m) (Table 2.4-23).

2.4.3.6.2 Wave Runup

The theoretical wave runup was calculated using ACES (Reference 2.4-40) at the edges of the islands where reactor sites are located. Inputs for the runup calculations included design wave height, wave period, and embankment slope. The calculated average wave runup is 1.45 ft. (0.44 m) (Table 2.4-18).

2.4.4 POTENTIAL DAM FAILURES

2.4.4.1 Potential Dam Failure

This section examines the flooding design basis and evaluates the potential hazards to safety-related SSCs as a result of potential dam and on-site pond failures according to the procedure

described in the standard ANSI/ANS-2.8 (Reference 2.4-2), NRC *Guidance for Assessment of Flooding Hazards Due to Dam Failure* (JLD-ISG-2013-01) (Reference 2.4-26), and NUREG/CR-7046.

The Project site is located at an elevation of approximately 810 ft. (247 m) in NAVD 88 on a peninsula surrounded to the north, east, and west by Belews Lake. Most of the terrain in the vicinity of the Project site (Figure 2.4-1) is characterized by Belews Lake and the foothills of the Blue Ridge mountains to the northwest. The location of Belews Lake is at the southwest edge of the Dan River Basin. The Dan River rises from springs on Belcher Mountain on the Blue Ridge Plateau in Patrick County, VA, then flows 200 mi. (322 km) across the state border into Stokes County, NC. The lake sits in the foothills of the Blue Ridge Mountains and the land gradually rises to the northwest.

Upstream dams whose failure has the potential to cause problems at the plant were investigated to determine if their failure would endanger plant safety. Failure of the Belews Lake Dam downstream of the Project site would have no adverse impact on plant safety or shutdown capabilities, as none of the technologies considered require the lake as a safety-related cooling source.

2.4.4.2 Dam and Reservoir Description

There are a total of 10 dams in the Belews Creek watershed and its tributaries upstream of Belews Lake Dam with maximum combined storage capacity of 797 ac-ft. (98.3 ha-m). These dams and reservoirs are owned and operated by different entities for recreation or water supply purposes. Location of these reservoirs with respect to the Project site is shown in Figure 2.4-31. Specific information on these dams relevant to the flood risk assessment of the Project site is summarized in Table 2.4-24 based on data collected from the USACE National Inventory of Dams (NID) (Reference 2.4-38). All dams are earthen type. There are no on-site operational basins requiring analysis for potential dam failure.

There are no current plans to construct dams and reservoirs that could adversely affect flood levels at the Project site.

2.4.4.3 Dam Failure Permutations

Per NUREG/CR-7046, flooding from dam failure should capture the envelope of the following alternatives.

- **Alternative 1** – Combination of the following:
  - A 25-year flood.
  - A flood caused by dam failure resulting from a safe shutdown earthquake, and coincident with the peak of the 25-year flood antecedent or subsequent rain.
  - Waves induced by 2-year wind speed applied along the critical direction.
- **Alternative 2** – Combination of the following:

- The lesser of one-half of the PMF or the 500-year flood.
- A flood caused by dam failure resulting from an operating basis earthquake, coincident with peak flood conditions.
- Waves induced by 2-year wind speed applied along the critical direction.

The NRC has acknowledged that detailed evaluation of a large number of dams in a watershed is difficult and dam failure risk can potentially be evaluated more efficiently with a hierarchical approach. According to JLD-ISG-2013-01 (Reference 2.4-26), certain small dams can be eliminated from further consideration. However, due to the limited number of dams and their small size, screening is not performed in this analysis, and conservatively, all dams in the watershed are included.

According to NUREG/CR-7046, HHA is a progressively refined, stepwise estimation of site-specific hazards that evaluates the safety of SSCs with the most conservative plausible assumptions consistent with available data. The HHA process starts with the most conservative simplifying assumptions that maximize the hazards from the probable maximum event for each natural flood-causing phenomenon expected to occur in the vicinity of a proposed site.

Therefore, regardless of the region's seismic category or dam stability, Alternative 2 is used, which considers cascading failures of all upstream dams. Additionally, instead of seismic dam failure, overtopping dam failure with dams at their maximum storage is conservatively considered to maximize the dam failure impact. Overtopping occurs when a dam reaches its maximum storage capacity, leading to the release of maximum discharge from the structure.

Upon dam failure, the resulting discharge flows toward Belews Lake, over the spillway, and subsequently into the Dan River. This alternative considers the simultaneous failure of all dams while assuming that the downstream Belews Lake Dam remains intact. This assumption results in the highest water level at the Project site.

2.4.4.4 Unsteady Flow Analysis of Potential Dam Failures

In the conceptual dam break flood model, all the dams fail with their reservoir water level at or above the dam crest, thereby releasing the full dam storage. A simplified calculation approach was used to account for the NID volumes under failure conditions. A time to peak of 0.1 hr. was assumed, based on guidelines from the Federal Energy Regulatory Commission (FERC) for the estimation of the dam breach parameter (Reference 2.4-10). A Froehlich approach (Reference 2.4-12) was used to postulate the individual failure hydrograph peak flows. The breach section in the model was represented by a 1 vertical:1 horizontal side slope.

The individual hydrographs were then converted into a triangular hydrograph, ensuring that the entire NID volume was included in the failure flows. Several dams are located within one branch discharging into Belews Lake. These dams are clustered into one dam with the combined storage and average of their surface area used in estimating the breach hydrograph. This is compatible with the guideline provided in JLD-ISG-2013-01 (Reference 2.4-26). A total of two clusters are considered and, therefore, seven hydrographs are generated. Cluster

characteristics are provided in Table 2.4-25.

According to JLD-ISG-2013-01 (Reference 2.4-26), the location of hypothetical (i.e., clustered) dams should be at either the location of the most downstream dam in the cluster or further downstream toward the site. In this analysis, the location of all dams is moved further toward the site as presented in Figure 2.4-31. Breach hydrographs are presented in Figures 2.4-32a through 2.4-32d. Dam breach hydrograph properties and predicted peak discharge are presented in Table 2.4-26. [[

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A 500-year, 24-hr uniform rainfall of 10.5 in. (266.7 mm) (Reference 2.3-22) over the entire watershed is applied to represent the coincidental flow. The representative storm is Type II per Reference 2.4-43. To maximize dam failure flooding, the lake is assumed to be [[

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Hydrographs were then routed downstream toward Belews Lake using the unsteady, 2D flow option of USACE HEC-RAS version 6.4.1 (Reference 2.4-37).

The unsteady flow runoff and stream course models described in Section 2.4.3.3 were used to evaluate the site flood levels from a combined 500-year, 24-hour rainfall event involving dam failures above the plant.

2.4.4.5 Water Level at the Project Site

The unsteady flow analysis described in Section 2.4.4.4 was performed by applying the dam failure hydrographs (Figures 2.4-32a through 2.4-32d) combined with a 500-year, 24-hour rainfall event. The unsteady flow analysis provides the flow and peak still water levels at the Project site.

The resulting peak dam failure flow combined with the coincident 500-year flood at the location of maximum still water level is [[ ]]CEII (see Figure 2.4-33). The peak timing for the 500-year flood and dam failure hydrographs is matched through sensitivity analysis. The peak still WSEL is [[ ]]CEII NAVD 88. The maximum still WSEL for the entire 2D model domain is presented in Figure 2.4-34. Still water level varies from approximately [[ ]]CEII where the proposed reactor units at the Project site are located. Conservatively, the maximum is considered for all units.

A coincident 50 mph (80.5 kph) (adjusted wind speed, see Section 2.4.4.6) overwater wind was applied, resulting in a wave height of 1.49 ft. (0.45 m) from crest to trough. The maximum WSEL resulting from the combination of the controlling 500-year storm, coincident hydrologic dam failures and wind wave effects is [[ ]]CEII NAVD 88.

The impacts to the Project site from potential flood-causing mechanisms have been evaluated. The site finish grade is 810 ft. (247 m) NAVD 88. This provides approximately [[ ]]CEII Thus, there are no impacts to safety-related SSCs at the Project site.

2.4.4.6 Coincident Wind Wave

Wind waves were computed using procedures of the USACE Coast Engineering Manual (Reference 2.4-39). The calculated coincident design wave height and period are 1.49 ft. (0.45 m) and 1.72 sec., respectively. The wind setup and wave runup associated with an overwater wind speed of 50 mph (80.5 kph) (unadjusted), were 0.01 ft. (0.003 m) and 1.45 ft. (0.44 m), respectively. Calculation details are presented in Section 2.4.3.6.

2.4.4.7 Erosion and Deposition Effects

The effects of the potential movement of erodible material with respect to flood levels at the Project site are shown to be insignificant by taking a very conservative approach. According to EM 1110-2-2300 (Reference 2.4-34), the top width of earthen dams is between [[ ]]^{CEII} Conservatively, a top width of [[ ]]^{CEII} is used for the dams. A side slope of 1 vertical:3 horizontal is used to calculate the bottom width of the dam. The total volume of the material is then calculated as presented in Table 2.4-27. If all the earthen embankments to fail with the highest volume of breached material were to be completely eroded and deposited into the Belews Lake, the storage capacity of Belews Lake is reduced by about [[ ]]^{CEII} According to the elevation-volume curve of the lake (see Figure 2.4-35), this is equivalent to less than a foot rise in Belews Creek with headwater elevation at the peak elevation of [[ ]]^{CEII} NAVD 88. Based on the bounding dam failure results, a rise of less than a foot in Belews Lake is far short of the nearly [[ ]]^{CEII} of rise that would be required to reach the preliminary Project site plant grade.

2.4.5 PROBABLE MAXIMUM SURGE AND SEICHE FLOODING

2.4.5.1 Storm Surge

The Project site is located more than 2300 mi. (3701 km) inland from the Pacific Ocean, approximately 190 mi. (306 km) inland from the Atlantic Coast, and approximately 490 mi. (789 km) inland from the Gulf of America (Reference 2.4-51). The site is located adequately inland such that hurricanes and a Probable Maximum Hurricane are not a source of a potential flood hazard. Therefore, further consideration of storm surge flooding outlined in NRC *The Estimation of Very Low Probability Hurricane Storm Surges for Design and Licensing of Nuclear Power Plants in Coastal Areas*, (NUREG/CR-7134) and NRC *Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment* (JLD-ISG-2012-06) (Reference 2.4-27) is not applicable to the site.

Storm surge due to Probable Maximum Wind Storms and squall lines is also not applicable to the Project site because the site is not located on the Great Lakes, as discussed in ANSI/ANS-2.8 (Reference 2.4-2) and JLD-ISG-2012-06 (Reference 2.4-27). Therefore, according to JLD-ISG-2012-06 guidance, determination of hydrostatic and hydrodynamic forces, debris and water-borne projectiles, and effects of sediment erosion or deposition due to storm surge is not necessary because safety-related SSCs at the Project site are not affected by storm surge flood levels (Reference 2.4-27).

2.4.5.2 Seiche

A seiche is defined as “an oscillation of the water surface in an enclosed or semi-enclosed body of water initiated by an external cause” in NUREG/CR-7046. To account for the potential of a seiche due to meteorological effects, the seiche periods for the length and width of Belews Lake were computed. To compute the seiche periods, the lake was assumed to be a rectangular basin with an averaged depth of the lake, which follows the methodologies outlined by Dean and Dalrymple (Reference 2.4-7).

Using the Dean and Dalrymple methodology for seiche periods for Belews Lake, the resulting seiche periods computed were 10.4 minutes for the lake's length and 5.3 minutes for the width of the lake. Seiching at these periods could only occur if an oscillatory force (pressure or wind) excited lake oscillations at one of the seiche periods. The periods calculated for lake oscillation could not be continuously forced by changes in overall weather conditions because these conditions typically fluctuate at time scales of 1 hour or more (Reference 2.4-30). Therefore, seiches due to meteorological effects are dismissed as a source of flooding at the Project site.

Seiches can also occur due to seismic effects and landslides. The Project site is situated in an area of low seismic hazards, according to the American Society of Civil Engineers (ASCE) (Reference 2.4-3). The occurrence of landslides in the area adjacent to Belews Lake is not considered possible due to the low relief of topographic features in the vicinity of the Project site. Therefore, potential seismic events and landslide are not expected to cause seiches on Belews Lake and, therefore, cause flooding at the Project site. Additionally, according to JLD-ISG-2012-06 guidance, determination of hydrostatic and hydrodynamic forces, debris and water-borne projectiles, and the effects of sediment erosion or deposition due to seiche are not necessary because safety-related SSC at the Project site are not affected by seiche flood levels (Reference 2.4-27).

Faults and surface deformation in the vicinity of the Project site (within 25 mi. [40 km] of the site) and in the site region (within 200 mi. [322 km] of the site) are described in Sections 2.5.1 and 2.5.3. Because surge and seiche are not applicable flooding scenarios, the corresponding run-up is also not applicable.

2.4.6 PROBABLE MAXIMUM TSUNAMI HAZARDS

Following the guidance outlined in NRC *Tsunami Hazard Assessment at Nuclear Power Plant Sites in the United States of America – Final Report* (NUREG/CR-6966), and JLD-ISG-2012-06 (Reference 2.4-27), a review was conducted of the NOAA record of historical tsunamis that impacted the east coast of the U.S. and the Gulf of America. The maximum historical water levels due to historical tsunami run-up recorded along the east coast of the U.S. and the Gulf of America is 17.7 ft. (5.4 m), which occurred in Willets Point, New York in 1932 (Reference 2.4-24). Willets Point, New York, is approximately 451 mi. (726 km) from the Project site (Reference 2.4-51), and the closest shoreline that could be subjected to tsunami flooding is approximately 190 mi. (306 km) away. In addition, the Project site’s finish grade is 810 ft. (247 m) NAVD 88, which is significantly higher than the coastal elevations at Willets Point, NY. For these reasons,

the Project site is not subject to tsunami flood levels.

Faults and surface deformation in the vicinity of the Project site (within 25 mi. [40 km]) and in the region (within 200 mi. 322 km]) are described in Sections 2.5.1 and 2.5.3.

According to NUREG/CR-6966 indicates that if regional screening identifies that the site region is not subject to tsunamis, no further analysis for tsunami hazards is required. Additionally, according to JLD-ISG-2012-06 guidance (Reference 2.4-27), the determination of the hydrostatic and hydrodynamic forces, debris and water-borne projectiles, and the effects of sediment erosion and deposition are not considered because the safety-related SSCs of the Project site are not subject to tsunami flood levels (Reference 2.4-27).

2.4.7 ICE EFFECTS

The potential ice effects on the Project site are evaluated in this section. Because the site is located in a region of continental, humid subtropical climate, extreme ice conditions with potential adverse effects on safety-related and risk-significant SSCs are not typically present. Additionally, the advanced reactors under consideration for the Project site do not rely on an external, safety-related water source and therefore are not affected by any potential loss of water supply due to ice conditions in the region.

2.4.7.1 Historical Ice Accumulation

Historical ice accumulations in the site region are evaluated by examining the USACE Ice Jam Database, weather records maintained by NOAA, and other available sources.

The USACE Ice Jam Database, which contains records of ice jam events from 1780 to the access date of December 2024, documents no ice jam event on Belews Creek (Reference 2.4-41).

Records of icing near the Project site are limited. Historical weather data from the nearby airport station (see Figure 2.4-36) indicate that sub-freezing T_a can occur during the winter months in the area (Figure 2.4-37). NOAA NWS records for the North Carolina area, which begin in 1928, document an all-time lowest temperature of -7.96 °F (-22.2 °C) recorded on January 21, 1985 (Reference 2.4-25).

Based on the climatic condition of the area and historical evidence, it can be established that the potential for ice formation and accumulation, including ice jams, exists in the area of the Project site. However, an ice jam sufficient to cause flooding at the Project site is not credible. This is demonstrated by using conservative postulations that are not physically credible, consistent with the HHA approach, as presented below.

2.4.7.2 High and Low Water Levels

The T_a near the Project site have historically fallen below freezing in the winter seasons, as indicated by the mean daily temperatures measured at the Greensboro Piedmont Triad international airport station (Figure 2.4-36 and Figure 2.4-37). This introduces the possibility of

ice blockage of catch basins and drains, causing stormwater runoff to back up to the yard, creating a potential flood risk to the site. However, in evaluating the design basis flood hazard evaluation for the safety-related SSCs at the Project site, in particular the LIP flooding mechanism, it is assumed that all culverts, catch basins, and storm drains are blocked. With this assumption, the site is designed to pass the runoff from the LIP event without adversely impacting any safety-related facility, as presented in Section 2.4.2. The site finished grade at elevation 810 ft. (247 m) NAVD 88, which is above lake level, results in a positive gradient that allows stormwater runoff to gravity flow away from all safety-related SSCs and to prevent backwater flooding due to ice accumulation and ice jam formation in any of the natural water courses. Therefore, flooding of any safety-related SSCs as a result of LIP coincidental with ice formation is precluded.

The breach of an upstream ice dam is one of the considerations in the flood hazard evaluation for the Project site. The flood risk to the site in a breach event would be most critical when the ice jam is formed near the site, where Belews Creek Rd. passes over Belews Lake at three locations (Figure 2.4-42), maximizing the storage that can be impounded behind the jam. A conservative assumption for the height of the ice jam is made to derive a bounding estimate of the impoundment volume, consistent with the HHA approach. It is assumed that the ice jam builds up from the riverbed to 5 ft. (1.5 m) higher than the top of the bridges, which is the maximum dam height that hypothetically can form. The bounding impoundment volume behind the hypothetical ice jam is computed to be approximately 33,329 ac-ft (4111 ha-m). This volume is insignificant in comparison with the combined storage capacities of Belews Lake. Assuming the lake is at normal pool elevation of 725 ft. (221 m) NAVD 88 with an initial volume of 185,000 ac-ft (22,819 ha-m), the added volume from the jam results in an increase in lake level to elevation 734 ft. (224 m) NAVD 88. Combined with the higher available hydraulic heads for the flood waves during a breaching event of the upstream dams, it is concluded that the flooding impact on the Project site from the breach of any upstream ice dam is bounded by the impact from the most limiting dam failure described in Section 2.4.4.

For high water concerns due to backwater caused by ice jams formed downstream of the Project site, a hypothetical worst-case scenario, consistent with the HHA approach, was conservatively assumed with ice buildup to a maximum possible elevation on the Belews Lake Dam (Figure 2.4-36). By reviewing the natural landscape and manmade structures in the river system, it was determined that the worst-case and only backwater flooding at the site would occur when ice is built up at the Belews Lake Dam. The crest level of the dam is at elevation 743 ft. (226 m) NAVD 88. Assuming that an ice jam builds up to the top of the crest elevation, the backwater level behind the ice jam would be of the same order, i.e., approximately elevation 743 ft. (226 m) NAVD 88, which is 18 ft. (5.5 m) above the normal operating level of the lake of 725 ft. (221 m) NAVD 88. Because the site finish grade is at elevation 810 ft. (247 m) NAVD 88, more than 67 ft. (20 m) above the hypothetical maximum ice buildup elevation, it is concluded that no safety-related or risk-significant SSC is affected by the backwater effect of a downstream ice jam.

Low water conditions resulting from ice formation or accumulations that may cause interruption of stream flow in Belews Lake do not impact the site because the advanced reactors being

considered for the Project site do not rely on an external water source for safety-related and risk-significant water supply.

2.4.7.3 Ice Sheet Formation

The advanced reactors being considered for the Project site do not require external water sources for safety-related and risk-significant SSCs and do not rely on any open storage facilities or impoundments to supply or maintain the inventory for safety-related water use. Consequently, a reduction of stream flow in the river or storage volume in an impoundment due to ice sheet formation does not introduce any adverse impacts to safety-related or risk-significant SSCs.

The advanced reactors to be located at the Project site use cooling towers to dissipate the excess heat load from the main steam condensers. The main water structures in the cooling system that have hydrologic interfaces with ice sheet formation are the cooling tower basin at the base of each cooling tower, the Project site discharges, and the makeup water intake structure, located on Belews Lake, which supplies makeup water to the cooling water system.

Because subfreezing T_a can occur during the winter months, ice sheet formation is possible. The ice layer thickness was estimated to evaluate the impact of ice formation on the on-safety-related cooling tower basins and intake structure.

T_a data from the nearby Greensboro Piedmont Triad international airport meteorological station (see Figure 2.4-36 for station location and Figure 2.4-37 for data) was used for the t_i estimation (Reference 2.4-35). The airport meteorological station is located about 16 mi. (26 km) southeast of the site (Figure 2.4-36), and its temperature data is considered to be representative of the site and the nearby region. For this analysis, the station daily weather data from January 1, 1928, through December 9, 2024 (approximately 96 years of data), were used.

The examination of the daily average T_a from the meteorological station for the period of record from 1928 to 2024 (Figure 2.4-37) showed that there were several years in which the daily average temperature fell below freezing for consecutive days during the months of December through February. However, it appears that January and February were generally the months in which t_i reached its maximum (Table 2.4-28).

To predict the maximum t_i that can form at the Project site, an analysis of the temperature data was made to determine the maximum accumulated freezing degree-days (AFDD) for the period of record using the procedures in Reference 2.4-35.

Following the methodology in Reference 2.4-35, the freezing degree day (FDD) value for each day is determined by subtracting the daily average temperature from 32°F (0 °C). The AFDD is then determined by summing the FDD values for each day during the winter. A negative freezing degree day value represents a temperature warmer than freezing, and a positive freezing degree day represents temperatures below freezing. The FDD values for each day of the winter can be summed to determine the net AFDD. The AFDD point is reset to zero whenever the value becomes negative. The peak AFDD value for the period analyzed is 180.3

degree days, which occurred on February 8, 1977.

The t_i was then estimated using a conservative coefficient (C = 0.8), recommended for a windy lake with no snow condition (Reference 2.4-35). Figure 2.4-37 depicts the graph of T_a and AFDD for the period of record. Figure 2.4-38 depicts the temporal variation of the t_i. The maximum t_i was estimated to be approximately 11 in. (28 cm), occurring on February 8, 1977. Figure 2.4-39 shows the T_a and AFDD for the winter of 1976/1977. The estimated t_i over the winter of 1976/1977 is shown in Figure 2.4-40. The yearly maximum ice thickness for the approximate 96-year period is plotted in Figure 2.4-41 and provided in Table 2.4-28.

As demonstrated above, based on the worst winter on record (the winter of 1976-77), ice could build up to a maximum thickness of approximately 11 in. (28 cm) at the Project site and vicinity. Because it is located in a relatively mild climatic region, the plant is not typically subject to extreme ice conditions. Detailed design of the closed-cycle cooling tower and intake structure was not performed to support the ESPA; however, detailed design of the closed-cycle cooling tower and intake structure would consider ice effects, consistent with standard industry practice, to protect against unplanned interruption of the operation of the cooling system.

2.4.7.4 Ice-Induced Forces and Blockages

The advanced reactors being considered for the Project site do not include safety-related or risk-significant SSCs that are subject to ice-induced forces or blockages from either sheet ice or frazil ice. While non-safety-related components may be affected by ice-induced forces or blockages, standard design practices will mitigate the potential impacts of these events.

2.4.7.5 Consideration of Other Site-Related Evaluation Criteria

There is no additional site information that would indicate an icing scenario more severe than has been described above.

2.4.7.6 Consideration of Cold-Region Hydrology

The Project site is located in a region characterized as continental, humid subtropical climate; therefore, impacts associated with cold region hydrologic effects, including permafrost and significant frost, are not applicable to the site. The effect of rain-on-snow, ice and/or frozen soils is addressed, as applicable, in Section 2.4.2 for the LIP flooding evaluation and in Section 2.4.3 for the stream flooding evaluation.

2.4.7.7 Conclusion

Historical and postulated ice conditions applicable to the Project site are evaluated to determine their impact on the safety of the plant. Due to the relatively mild climatic condition at the Project site and the elevated design plant grade above natural drainages, in combination with the advanced reactor plant design that does not rely on external water sources for safety-related water use, it is concluded that ice effects do not cause flooding or water availability concerns for the safety-related and risk-significant SSCs.

2.4.8 COOLING WATER CANALS AND RESERVOIRS

The advanced reactors under consideration for the Project site do not rely on Belews Lake, the Dan River, or any other water source for a safety-related water supply, and the site will not include cooling water canals or new reservoirs to support nuclear generation. As discussed in Section 2.4.7, the Project site will use Belews Lake as the source of makeup water for non-safety-related normal plant cooling. Belews Lake has the ability to be supplemented with makeup water from the Dan River through an installed makeup water system.

2.4.9 CHANNEL DIVERSION

The Project site is located on a peninsula surrounded by Belews Lake. Belews Lake was constructed in the early 1970s by damming Belews Creek, a tributary to the Dan River. The North Carolina Department of Water and Air Resources authorized the creation of Belews Lake specifically to provide cooling water to BCSS, which is owned and operated by Duke Energy. Once constructed, the lake was filled and reached full pond elevation in April 1973. Belews Lake is located approximately 16 mi. (25.6 km) northeast of Winston-Salem in Stokes County, North Carolina. Belews Creek is regulated by the dam spillway, which eliminates the mechanisms by which erosion may cause meandering or encroachment into the intake structure.

Furthermore, the Project site does not rely on Belews Lake or the Dan River to support safety-related and risk-significant SSCs that provide emergency cooling water. However, as noted in Section 2.4.7, the lake is used as a water source for certain non-safety-related SSCs. Additionally, Dan River runs in a southwest-northeast direction downstream of the Belew Creek Dam. There is minimum of 165 ft. (50.3 m) (i.e., 725 ft. – 560 ft.) elevation difference between the Dan River and Belew Lake. Therefore, potential diversion of Dan River will not impact the site. Historical aerial photos of Dan River in the vicinity of pump station feeding Belews Lake from 1985 to 2024 were reviewed. No sign of meandering, erosion, or diversion is observed during the past 40 years. Dan River has experienced both flooding and draught conditions during this period. Therefore, it is highly unlikely that the pump station would be impacted by Channel Diversion. Even if the pump station were impacted, it would not affect site safety functions because the pump station provides no safety-related support functions.

No safety-related water sources are required for operation of the proposed advanced reactors. The lake is the primary source of water for the normal cooling system and water processing plant that feeds the demineralized water systems and liquid radwaste treatment system. Consequently, the safety of the plant is not compromised due to a loss of water supply even in the highly unlikely event of a channel diversion near the site.

It is concluded that a channel diversion is not a necessary design consideration for the Project site. In the unlikely event that channel diversions occur, there is no safety-related impact to the nuclear power plants at the Project site.

2.4.10 FLOOD PROTECTION REQUIREMENTS

Flood protection requirements are specified to protect safety-related and risk-significant SSCs

against postulated design basis external flooding events. The evaluations of the flood hazards applicable to the Project site are described in Sections 2.4.2 through 2.4.7 and Section 2.4.9. Design basis flooding scenarios are discussed in Section 2.4.3. Dam failure scenarios are discussed in Section 2.4.4. Surge and seiche events are discussed in Section 2.4.5. Tsunamis are discussed in Section 2.4.6. Historical information related to icing and ice jams is provided in Section 2.4.7. Channel diversions are discussed in Section 2.4.9. Section 2.4.2 summarizes the maximum flood levels for various flooding scenarios applicable to the Belews Creek Site.

The preliminary Project site grade is established at elevation 810 ft. (247 m) NAVD 88, well above the calculated maximum flood level of 747.86 ft. (227.95 m) NAVD 88 resulting from PMF. It is concluded that the functions of safety-related and risk-significant SSCs are not adversely impacted by the design basis external flooding events. Thus, for all flooding mechanisms other than LIP, no flood protection measures are required at the Project site, and the proposed plant conforms to Regulatory Position 1 of RG 1.59. LIP-specific measures are discussed in Section 2.4.10.2.

2.4.10.1 Flooding History

As detailed in Section 2.4.2.1, the Project site is situated on a peninsula of Belews Lake. Belews Lake was constructed in the early 1970s by damming Belews Creek, a tributary to the Dan River. The risk of floods on Belews Creek in the past was primarily associated with precipitation runoff over the watershed. However, since construction of the dam, flooding on Belews Creek has been controlled by the dam. Flooding from the Dan River does not adversely affect the site as the site is located approximately 250 ft (76.2 m) above the Dan River.

The wettest year on record in NC was 2020. Two intense rainfall events occurred in 2020 near the site. In February of 2020, intense rainfall resulted in one of the highest streamflow statistics in the recorded history for both gauges on the Dan River (see Figures 2.4-13 and 2.4-14). Hurricane Eta in November of 2020 reflects the second highest water depths and streamflow in recent history for both gauges on the Dan River. The streamflow reached highs of 40,900 cfs (1158 m^3/s) near Wentworth with water level of 540.3 ft. (164.7 m) NAVD 88 and 26,200 cfs (742 m^3/s) at Pine Hall in February, and 38,500 cfs (1090 m^3/s) near Wentworth and 25,800 cfs (730 m^3/s) at Pine Hall in November. Streamflow was 1.1 percent higher in February than November. The water levels reached 540.7 ft. (164.8 m) NAVD 88 near Wentworth and 591.2 ft. (180.2 m) NAVD 88 at Pine Hall in February, and 540.3 ft. (164.7 m) NAVD 88 near Wentworth and 590.9 ft. (180.1 m) NAVD 88 at Pine Hall in November.

Hurricane Agnes in 1972 remains the highest flow near Wentworth with 54,200 cfs (1535 m^3/s), 1.3 times higher than the 2020 flood event. Water levels are not available from the 1972 flood. However, scaling from 2020 event, it is estimated that the water level was in the range of 550 ft. (168 m) NAVD 88. The Pine Hall gauge was not in service during the 1972 timeframe.

2.4.10.2 Effects of Local Intense Precipitation

Because Belews Lake is capable of accommodating the water flows from Belews Creek, LIP events are not expected to flood the site. Additionally, in order to protect the Belews Lake Dam,

lake level is controlled procedurally by the dam spillway. The potential of flooding from a LIP event, as described in Section 2.4.2, is dependent upon facility design and final grading and drainage system design. Once the reactor technology has been selected, the site grading and drainage can be designed to prevent the LIP from impacting safety-related SSCs. It is therefore reasonable to expect that a fully effective drainage system is designed as part of the final licensed design.

2.4.11 LOW WATER CONSIDERATIONS

The Project site does not rely on Belews Lake or the Dan River to support safety-related and risk-significant SSCs that provides emergency cooling water. However, Belews Lake, combined with makeup water pumps from the Dan River, is used as a water source for non-safety-related SSCs. It primarily supplies the normal cooling system and the water processing plant that provides demineralized process water for downstream systems and the liquid radwaste treatment system. Figure 2.4-43 shows the location of the site in relation to Belews Lake and the Dan River.

The Project site is located on a peninsula in the middle of Belews Lake, and the supplemental makeup water pumps feeding the lake are located downstream of the Belews Lake Dam on the Dan River (see Figure 2.4-43). The lake was created in 1973 by Duke Energy to provide cooling water for the BCSS, a coal-burning and natural gas power plant currently situated on the lake.

The average withdrawal flow rate from the lake needed to support the nuclear facility at the Project site is estimated to be approximately 30,709 gpm (68.4 cfs, 1.94 m^3/s). The majority is used as makeup water to compensate for evaporation and blowdown losses from the closed-cycle mechanical draft cooling tower system that is used for normal cooling.

There would be return flow back to the lake or the Dan River based on operational needs, via a discharge structure, from cooling tower blowdown and effluents from downstream systems fed by the water processing plant and miscellaneous raw water users. The average discharge rate is estimated to be approximately 3467 gpm (7.72 cfs, 0.22 m^3/s). The net consumptive water use (withdrawal minus discharge) is therefore approximately 27,242 gpm (60.7 cfs, 1.72 m^3/s).

2.4.11.1 Low Flow in Rivers and Streams

The portion of the Dan River in the vicinity of Belews Lake Dam runs from southwest to northeast (Figure 2.4-44). The Dan River is a river of contrasts, originating high along the eastern slopes of the Blue Ridge Mountains in Patrick County, VA, and flowing east until it empties into the 50,000 ac. (20,234 ha) John H. Kerr Reservoir (Buggs Island Lake) near Clarksville, VA. The drainage area for the Dan River upstream of the makeup water pumping station is about 501 mi^2 (1298 km^2). The Belews Creek watershed upstream of Belews Lake Dam has a drainage area of about 69.33 mi^2 (179.59 km^2).

Historical Dan River flow data was gathered for both the 2001 – 2002 (i.e., extreme drought) and the 2011 – 2013 (i.e., typical) time periods from the USGS database (Reference 2.4-52). The typical period is reflective of 2011 – 2013, which were historically slightly drier than average

years, meaning they represent a conservative “typical” scenario. The typical scenario is also representative of normal condition while the extreme drought is a rare condition.

For the 2011 – 2013 period, data from the Pine Hall gauge was available for the entire period, reported in 15-minute intervals. For the 2001 – 2002 period, data from the Pine Hall gauge was not available. Instead, river flow data from the Wentworth gauge (located downstream in the Dan River from the Pine Hall gauge) was collected and flow data at the Pine Hall gauge was estimated. A correction factor was applied by comparing the flow at the two gauges when available for both. Gauge locations are shown in Figure 2.4-3. Streamflow data are presented in Figure 2.4-45.

2.4.11.1.1 Flow Release from Belews Lake Dam

The lake level is controlled by a set of spillway gates that are opened at points to release water. Belews Lake Dam Spillway Operation guidelines state that the lake level control-point (the lake height at which the spillways start releasing water) for winter/spring is 724.7 ft. NAVD 88 (221 m).

2.4.11.1.1.1 Belews Lake Inflows and Outflows

The main inflow contributions to Belews Lake include flow from Belews Creek and its branches, Dan River supplemental makeup flow, direct rainfall, and plant discharge back to the lake. Since the winter of 2002, pumping operations that withdraw supplemental makeup water from the nearby Dan River and deliver it to Belews Lake during periods of low lake level have occasionally occurred. NPDES Permit NC0024406 (Reference 2.4-15) allows for up to 100 cfs (2.83 m3/s) of pumping by the MWIS from the Dan River into Belews Lake. The number of pumps that can be operated at a time is dependent on the flow in the Dan River as well as other conditions. Per the NPDES Permit:

- Pumping from the Dan River must not lower the river flow below 110 cfs (3.11 m^3/s).
- At least 80 percent of the ambient flow must be bypassed (no more than 20 percent of the flow can be withdrawn).
- Pumping may occur to a maximum lake water level of 724.5 ft. (220.83 m) NAVD 88.
- Pumping must not occur from April 1st through June 30th of any year.
- The four-pump pumping station must not exceed a capacity of 100 cfs (2.83 m^3/s).

Outflows from the Belews Lake include primarily withdrawal for the nuclear plant and BCSS, normal spillway operation releases, and flood releases during high flow events. Scenarios are run with and without BCSS in operation. BCSS water demand in scenarios where BCSS is operating is set to the maximum plant usage of 2,257 cfs (1,013,200 gpm, 63.91 m^3/s).

Locations of intake and discharge points are presented in Figure 2.4-46. As there are multiple potential discharge locations, a bounding scenario is analyzed. Common discharge structure is the closest discharge location to the dam spillway and the farthest away from the intake.

Analyses using future plant intake and discharges use common discharge structure and the intake as the two points. This assumption is conservative because it would maximize the residence time of the heated discharge into the lake and thus maximize any related evaporation.

2.4.11.1.1.2 Lake Storage

To evaluate the surface water availability for the site non-safety-related SSCs, the depletion rate of the lake storage below the normal operating pool level was estimated using the stage-storage rating curve for Belews Lake (Table 2.4-30) in conjunction with conservative assumptions about the expected water demands and reservoir inflows and outflows. The scenario selected for evaluation is an extended period of severe drought when inflow to the lake is limited, but all existing users continue their withdrawals.

Since the creation of Belews Lake, sediment has settled at the bottom of the lake, affecting its bathymetry. Based on review of recent lake bathymetry survey against after lake construction bathymetry survey, it is conservatively assumed that, for current scenarios, the bottom 30 ft. (9.1 m) of the lake is filled. This reduces the storage volume of the lake by 1939 ac-ft (240 ha-m). For analysis of long-term scenarios, it is assumed the lakebed continues to experience sedimentation. An additional 10 ft. (3.0 m) is assumed to be filled for future long-term scenarios, equating to an additional 2995 ac-ft (370 ha-m) of volume being removed from the overall lake. This is based on the conservative sedimentation rate of 0.52 ac-ft per mi^2 (3.81 ha-m per km^2) per year (Reference 2.4-31), where the Belews Lake influence area is approximately 70 mi^2 (181 km^2) and the future operation period is 80 years.

2.4.11.1.1.3 Belews Lake Water Level

Belews Lake water levels were analyzed through two different periods: a period of extreme drought years and a period of typical years. The extreme drought period is reflective of 2001 – 2002, which saw the lowest lake levels out of the available 27 years of data.

In total, eight individual scenarios were analyzed using a dynamic water balance model built using the LakeT modeling program (developed by Sargent & Lundy). These analyses reflect four different cases in two different time periods (extreme drought and typical years).

- Extreme drought years (Figure 2.4-47)
  - Case 1: Baseline 1 (BCSS 100 percent, nuclear plant zero percent)
  - Case 2: Baseline 2 (BCSS zero percent, nuclear plant zero percent)
  - Case 3: Near-Term Operation (BCSS zero percent, nuclear plant 100 percent)
  - Case 4: Long-Term Operation (includes predictions for long-term future weather conditions and lake sedimentation, see below) (BCSS zero percent, nuclear plant 100 percent)
- Typical years (Figure 2.4-48)
  - Case 1: Baseline 1 (BCSS 100 percent, nuclear plant zero percent)

- Case 2: Baseline 2 (BCSS zero percent, nuclear plant zero percent)
- Case 3: Near-Term Operation (BCSS zero percent, nuclear plant 100 percent)
- Case 4: Long-Term Operation (includes predictions for long-term future weather conditions and lake sedimentation, see below) (BCSS zero percent, nuclear plant 100 percent)

Table 2.4-29 summarizes the primary differences between each of the four cases and the benchmarked models, with further explanation provided in this section. Predictions for long-term future weather conditions used in the Long-Term Operation case, modeled to the end of the century, show that future temperatures will be 8 °F (4.4 °C) higher, and future precipitation patterns will be 1 percent drier.

Baseline 2 (BCSS zero percent, Advanced Reactor zero percent) models a future lake, beyond advanced reactor operation, where there is no plant operation. As this is a future scenario, future weather conditions are used.

Analysis results for the four cases in typical years are presented in Figure 2.4-48. As shown, the lake level in a typical period follows the same general trend in all plant operation cases and oscillates between the pump trigger point and pump stopping point. Analysis results for the four cases in extreme drought years are presented in Figure 2.4-47. In an extreme drought period, the lake level is able to recover within the time period analyzed in the case with BCSS operation only (Case 1), but not in the cases including nuclear plant operation (Cases 3 and 4).

Differences between the Near-Term Operation models and the Long-Term Operation models are due to global climate change and future sedimentation in the lakebed. Compared to the Near-Term Operation results (Case 3), the Long-Term Operation (Case 4) results show minimal difference in the lowest lake elevation during a typical period (721.64 ft. [219.96 m] vs. 721.31 ft. [219.86 m], see Figure 2.4-48). However, during extreme drought years under future conditions, there is an additional drop of approximately 1.12 ft. in lake level (715.30 ft. [218.02 m] vs. 714.18 ft. [217.68 m], see Figure 2.4-47).

Comparing the lake level with the nuclear plant in operation (Case 3) to with the BCSS only (Case 1) in operation (reflecting current conditions), nuclear plant operation results in an additional approximate 4.4 ft. (1.3 m) drop in lake level during an extreme drought period (719.68 ft. [219.36 m] with BCSS vs. 715.30 ft. [218.02 m] with the nuclear plant, see Figure 2.4-47). In typical years the difference is less than 1 ft. [0.30 m] (722.21 ft. [220.13 m] with the BCSS vs. 721.64 ft. [219.96 m] with the nuclear plant, see Figure 2.4-48).

Additional analyses were performed to determine lake level trends with different pumping capacity. In the nuclear plant operation cases (Cases 3 and 4), the lake level difference is small between the four-pump and two-pump operation scenarios. In the extreme drought period, the difference in minimum lake level is less than 1 ft. (0.30 m) in the worst (Long-Term Operation) case (714.18 ft. [217.68 m] [four-pump] vs. 713.29 ft. [217.41 m] [two-pump]), whereas the lake level in the typical period recovers fully in both scenarios, with the two-pump operation taking slightly longer to reach the pump stopping point.

2.4.11.2 Low Water Resulting from Surges, Seiches, or Tsunamis

There is no safety impact on the Project site due to low water conditions generated by any mechanism because it does not rely on the Belews Lake or Dan River for its safety-related water use. The non-safety-related water supply is also not expected to be affected normally by low water conditions resulting from surges, seiches, tsunamis or other external events. As detailed in Section 2.4.5, there are no conceivable meteorological conditions that would produce a surge or seiche that would reach the Project site grade. It follows that the risk of any surge or seiche event that would cause significant low water concerns is low. Tsunamis are not considered a risk because there are no potential tsunamigenic sources that could affect the site, as indicated in Section 2.4.6.

Based on the evaluation in Section 2.4.7, low water conditions resulting from ice formation or accumulations could cause interruption of flow in Belews Lake under extreme conditions. However, no safety-related or risk-significant SSCs at the site would be impacted.

Similarly, the unlikely failures of the Belews Lake Dam would potentially create a low water condition at the site, but there would be no safety-related or risk-significant impacts.

2.4.11.3 Historical Belews Lake Low Water

Review of historical lake level recordings from 1996 to 2024 indicates that the drought of 2001 – 2002 was one of the worst in recorded Belews Lake history. The other drought of significance was that of 2007 – 2008. Lake water level was reduced to 717.21 ft. NAVD 88 (218.61 m) and 720.7 ft. NAVD 88 (219.67 m) for the 2001 – 2002 and 2007 – 2008 droughts, respectively. Water level variations for these two extreme years are presented in Figures 2.4-49 and 2.4-50.

2.4.11.4 Future Controls

The Project site does not rely upon Belews Lake or the Dan River for safety-related water use and, therefore, there would not be any safety impact as a result of future uses or controls in the lake. For non-safety-related water use, the storage capacity of Belews Lake is adequate to sustain the continuous supply of surface water to meet the needs of the site throughout a drought event equivalent to the drought of record, as discussed in Section 2.4.11.1. Any future water uses of Belews Lake would be controlled by Duke Energy, as the owner and operator, and any future agreements with water users would need to account for Project site water supply requirements. Thus, any future uses of Belews Lake are not expected to affect the water use at the Project site.

2.4.11.5 Plant Requirements

The capability of Belews Lake to maintain a sufficient water level during periods of drought is described in Section 2.4.11.1. The operating pool level at Belews Lake is monitored and maintained at a normal minimum at 724.7 ft. NAVD 88 (220.89 m) (for the winter season). As needed, reservoir operation management measures would be employed to ensure that sufficient water level is maintained in the lake to allow the Project site intake structure to operate.

2.4.11.6 Heat Sink Dependability Requirement

No technologies considered in this application rely on the Belews Lake or Dan River for UHS.

2.4.12 GROUNDWATER

This section was prepared to meet the requirements of NUREG-0800, Section 2.4.12 (Groundwater), and describes the hydrogeologic conditions near the Project site, and the effects of construction and operation of advanced reactors, including advanced reactors, on regional and local groundwater resources. It also summarizes the regional data for the physical and hydrologic characterization of these groundwater resources to evaluate effects on the aquifers of the area.

Regional and local surface water features are described in Section 2.4.1. A geologic overview is presented in Section 2.5.1, and a geotechnical description for plant construction is presented in Section 2.5.4. Note that elevations discussed in this section correspond with NAVD 88. In some cases, cited references may use a different datum.

2.4.12.1 Hydrogeologic Setting

This section describes regional physiography, geology, hydrogeology, groundwater sources and sinks, and sole-source aquifers.

2.4.12.1.1 Physiography and Geomorphology

The Project site is shown in Figure 2.4-51. It is located in southeast Stokes County and in a small portion of northern Forsyth County to the south. Rockingham County lies just to the east, and Guilford County is southeast. The Project site is located adjacent to the existing BCSS. It is 14 mi. (23 km) northeast of Winston-Salem, NC, and 19 mi. (31 km) northwest of Greensboro, NC. This Project site investigation focuses on three separate areas located on a southwest-northeast-trending peninsula that extends into the southwestern portion of Belews Lake. The three areas are referred to as the North Plant Complex, the Middle Plant Complex, and the South Plant Complex and are shown in Figure 2.4-51.

The Project site is in the Piedmont physiographic province, approximately 40 mi. (64 km) east of the Blue Ridge physiographic province (Figure 2.4-52) (Reference 2.4-54). The Piedmont physiographic province extends from Alabama to southern New York (approximately 1000 mi. [1600 km]) and is composed primarily of weathered metamorphic and igneous rocks. Metamorphic rocks include mostly schist and gneiss; igneous rocks are predominantly slightly metamorphosed granite. Structural basins (resulting from faulting) are filled with Mesozoic sediments (Reference 2.4-55).

The Blue Ridge physiographic province extends from Pennsylvania southwest to Georgia, and includes highly deformed metamorphic rocks, mostly Precambrian in age. The primary rock types are schist, gneiss, slate, and quartzite with numerous igneous intrusions (Reference 2.4-56).

The topography along the Project site peninsula is characterized by gently rolling hills and uplands dissected by steep-sided tributary valleys. A maximum elevation of more than 870 ft. (265 m) occurs in interbasinal areas, while the lowest elevations occur along the shoreline of Belews Lake at a typical elevation of 725 ft. (221 m). Prior to inundation, the peninsula was

bound by West Belews Creek to the north and Belews Creek to the south. The bottom elevation of these tributary valleys adjacent to the peninsula that are now flooded by Belews Lake is approximately 620 ft. (189 m), approximately 100 ft. (30 m) below current lake levels (Reference 2.4-57). Land use along the peninsula is predominately woodlands with industrial facilities, including landfills and basins associated with BCSS operations.

2.4.12.1.2 Regional Hydrology

The Project site drains locally into Belews Lake. Overflow from Belews Lake flows into Belews Creek and the Dan River. The Dan River originates along the eastern slopes of the Blue Ridge Mountains in Patrick County, Virginia, and flows east until emptying to the Roanoke River at the John H. Kerr Reservoir, near Clarksville, Virginia (Reference 2.4-58). The Roanoke River eventually drains into the Albemarle Sound of NC (Reference 2.4-59). Surface water bodies located within the Project Vicinity are depicted in Figure 2.4-53; these include the Dan River, Belews Creek, Belews Lake, and Town Fork Creek (Reference 2.4-60). The Dan River is the primary river in Stokes County, and it flows from southwest to northeast across the southeast portion of the county. Belews Lake flows into the Dan River via Belews Creek, just downstream of Belews Lake Dam in Rockingham County. Duke Energy created Belews Lake in 1973 as a cooling basin for the BCSS. The lake has a surface area of 3864 acres (1564 hectares) and reaches a maximum depth of 144 ft. (44 m) deep in the vicinity of the dam (Reference 2.4-61). Belews Lake has a supplemental pumping station that provides water from the Dan River during periods of low lake levels to maintain an operational level of water. During the life of the BCSS, pumping has been carried out four times: in 2002, 2008, 2009, and 2010 (Reference 2.4-62).

Additional discussion on hydrologic features on and near the Project site, surface water supply, and surface water users in the Project Vicinity is provided in Section 2.4.1.

2.4.12.1.3 Regional Geology

Three lithologic-tectonic belts or terranes are mapped within the Project Vicinity: the Milton Belt, Dan River basin, and the Sauratown Mountain Anticline. These features are shown in Figure 2.4-54 (Reference 2.4-63; Reference 2.4-64). The Project site is located within the Milton terrane, which is composed of late Precambrian massive to strongly foliated biotite gneiss and schist, amphibolite, felsic gneiss, and late Paleozoic granite intrusions. The rocks are metamorphosed to amphibolite facies and folded into shallowly plunging recumbent folds (Reference 2.4-65; Reference 2.4-66).

Figure 2.4-55 shows the geology of the Project Vicinity. Four main geologic formations are mapped beneath and adjacent to the Project site (Reference 2.4-63; Reference 2.4-67; Reference 2.4-68), including:

- CZbg - Biotite Gneiss and Schist (520 – 650 million years [my]) - highly metamorphosed and foliated biotite gneiss and schist underlie the Project site and are described as dark colored, medium to coarse grained to porphyroblastic, locally contains hornblende and is chiefly composed of biotite, quartz, potassium feldspar, muscovite, and hornblende. The CZbg formation is interlayered with mica schist and amphibolite and is locally intruded by pegmatite dikes.

- CZfg - Felsic Mica Gneiss (520 – 650 my) - interlayered biotite hornblende gneiss with graphitic mica schist and mica-garnet schist, commonly with kyanite. Underlies the northwest side of Belews Lake.

- PPg - Porphyritic Granite (265 – 325 my) - light gray, medium- to coarse-grained porphyritic granite, granodiorite, and quartz monzonite. Composed of microcline phenocrysts up to 5 inches (in.) (13 centimeters [cm]) in diameter in a matrix of quartz, oligoclase, and biotite. Underlies the area southwest and southeast of the Project site.

- Jd - Diabase Dike (265 – 325 my) - black to greenish dark gray, fine- to medium-grained, dense rock composed of plagioclase, augite, and olivine. Occur as dikes up to 200 ft. (61 m) wide and typically occur as spheroidal weathered boulders with a grayish-brown weathering rind. Diabase dikes typically trend northwest and north and are mapped east of the Project site.

Sedimentary rocks of the Triassic Dan River basin occur northwest of the Milton terrane and trend northeast toward Danville, Virginia. The Chatham Fault Zone separates the Triassic rocks from the metamorphic rocks of the Sauratown Mountain anticlinorium farther to the north and the Milton terrane to the south. The Pinehall Formation, Cow Branch Formation, and Stoneville Formations are mapped within the Triassic-age Dan River basin.

The Sauratown Mountain anticlinorium lies northwest of the Dan River basin. Four stacked thrust sheets or units of Middle Proterozoic basement rocks within the Sauratown Mountain anticlinorium have been pushed one on top of the other through the mountain-building processes that formed the Appalachian Mountains. The thrust sheets include the Forbush gneiss, Miller Creek Complex, Pilot Mountain gneiss, Grassy Creek gneiss, and Volunteer gneiss (Reference 2.4-69).

2.4.12.1.4 Regional Hydrogeology

Figure 2.4-56 shows the principal components of a typical groundwater system in the Piedmont province. The Piedmont groundwater system is characterized by a variably saturated sequence of interconnected and transitional strata (topsoil, residuum, saprolite, and partially weathered rock [PWR]) formed from in-situ weathering of the underlying bedrock parent material. These overlie metamorphic and igneous crystalline bedrock (Reference 2.4-70; Reference 2.4-71). Unconsolidated strata above PWR that primarily function as a porous media aquifer are called overburden (OB). In the boring logs, saprolite is not distinguished; all unconsolidated residual soil is identified as residuum. PWR marks the transition between residuum and unweathered bedrock and can behave as both a porous and fractured rock medium. PWR is designated as a separate hydrogeologic unit, as is fractured bedrock.

Residuum formed from felsic rock types common to the Milton terrane can produce a sandy soil texture. Quartz and muscovite, both common minerals in felsic gneiss and schists, are highly resistant to chemical weathering and remain in the residuum, giving it a sandy texture. Other common minerals such as feldspar, biotite, and amphibole, weather more readily to form silt-sized particles and hydrated clays. Residuum is generally thickest in upland areas and is thin to absent on steeper slopes adjacent to drainage basins (Reference 2.4-70; Reference 2.4-71). As residuum grades downward into PWR, both porous- and fracture-medium characteristics may exist because some of the textural features of the bedrock, including stratigraphic layering,

foliation, and fractures, are retained. With this grading, the degree of weathering decreases with depth (Reference 2.4-72; Reference 2.4-73).

2.4.12.1.5 Groundwater Sources, Sinks, and Recharge

Groundwater is present in the OB and PWR under unconfined or water table conditions and flows in much the same way that surface water runoff flows from topographically high areas to low areas. Groundwater generally travels short distances, discharging to nearby streams, springs, or surface water bodies such as Belews Lake. A portion of the groundwater in the OB flows vertically downward, recharging the underlying bedrock aquifer. In the underlying crystalline bedrock, groundwater is stored and subsequently flows within bedrock fractures. Flow is controlled by the frequency, orientation, and interconnectivity of these fractures, but for the most part, groundwater moves from surface water divides (recharge areas), toward areas of discharge at springs, tributary streams, and rivers or lakes.

Recharge from infiltrating rainfall continually replenishes groundwater. Most of the rainfall returns to the atmosphere by evaporation and transpiration from plants or flows overland to nearby streams. The remainder recharges underlying groundwater aquifers. The amount of water that recharges a groundwater system can be estimated by examining stream flow hydrographs and separating out the contribution from groundwater, called baseflow. It is assumed that over long periods of time, groundwater discharge in a basin in the form of stream baseflow equals groundwater recharge. Baseflow measurements and groundwater recharge estimates from various U.S. Geological Survey (USGS) stream-flow monitoring stations within the Dan River subbasin and in the Project Vicinity indicate an effective average groundwater recharge rate of 8.45 inches per year (in/yr) (21.5 centimeters per year [cm/yr]), or 630 gallons (2385 liters) per day per acre (Reference 2.4-74). Infiltrating groundwater is stored in the underlying residuum, PWR, and bedrock and flows through this aquifer material to eventually discharge to local and regional surface water bodies (Reference 2.4-70).

2.4.12.1.6 Sole-Source Aquifers

The USEPA data confirm no sole-source aquifers in the Project Vicinity. A sole-source aquifer is defined as the sole or principal source of drinking water that supplies 50 percent or more of drinking water for an area, with no reasonably available alternative source should the aquifer become contaminated. Figure 2.4-57 shows the location of sole-source aquifers in the eastern United States (Reference 2.4-75). There are no sole-source aquifers in NC at this time. In Virginia, the most prominent sole-source aquifer is the Columbia and Yorktown-Eastover Multi-aquifer System, which is located east of Chesapeake Bay and supplies drinking water to Accomack and Northampton counties in Maryland. In Maryland, the Piedmont Sole-Source Aquifer supplies drinking water to Montgomery, Howard, and Carroll counties.

2.4.12.2 Site-Specific Hydrogeology

Subsurface information was collected at three Plant Complexes from a total of 15 primary geotechnical borings plus additional offsets (nine of which were subject to geophysical testing), 33 well lithologic borings, 15 shallow monitoring wells, 12 deep monitoring wells, three aquifer pumping test (APT) wells, and 16 sentinel wells. Section 2.5.4 provides a detailed description of the geotechnical investigation, including the locations of borings, logs, and soil testing data. A summary of the field investigation activities related to groundwater characterization is presented below.

- Hydrogeologic cross sections were prepared using lithologic data from the geotechnical and well lithologic borings and groundwater data from monitoring wells. Stratigraphic layers and well screen placements depicted on the cross sections were determined based on field classification of OB, PWR, and bedrock using lithologic observations, Standard Penetration Test (SPT) N-values, and drilling characteristics. Section 2.4.12.2.1 describes development of hydrogeologic cross sections.

- Borehole geophysical logs: Acoustic televiewer (ATV) was completed at boring locations B-1, B-3, B-5, B-6, B-8, B-10, B-11, B-13, and B-15 and/or associated offsets to identify and characterize the orientation, density, and water-producing characteristics of bedrock fractures (Figure 2.4-58 provides boring locations). Fracture fabrics measured by the ATV logs were compared to mapped topographic lineament orientations to provide a better understanding of potential fracture-control and influences on groundwater flow at the Project site. Section 2.4.12.2.2 describes the results of the bedrock fracture fabric analysis, and Section 2.4.12.2.3 summarizes the results of the remote-sensing lineament analysis.

- Groundwater monitoring wells: Twenty-seven groundwater monitoring wells were installed at the three Plant Complexes. Fifteen of the monitoring wells (five at each complex; W-1 through W-15) are shallow wells designed to be screened across or near the water table. Twelve of the monitoring wells (four at each complex; DW-1 through DW-12) are deep monitoring wells screened at various depths within the crystalline bedrock (Figure 2.4-58 depicts well locations). The shallow monitoring wells have total depths ranging from 36 to 99 ft. (11 to 30 m); deep monitoring wells range from 135 to 198 ft. (41.1 to 60.4 m) in depth. Because the water table occurs at various stratigraphic depths across the Project site, shallow wells are screened partially in OB, PWR, and SBR, or a combination of these units. The deep monitoring wells are all screened in DBR. The wells were completed to various depths to provide adequate spatial distribution for determining horizontal and vertical groundwater flow directions and hydraulic gradients based on the encountered groundwater conditions. Sections 2.4.12.2.4, 2.4.12.2.5, and 2.4.12.2.6 describe groundwater flow directions, hydraulic gradients, and temporal groundwater level trends, respectively.

- Slug tests: Single-well field hydraulic conductivity tests (slug tests) were conducted in each of the 27 monitoring wells. Section 2.4.12.3.1 describes the results of the slug tests.

- Packer testing: Five packer tests were performed at three different boring locations. Packer test intervals were selected to target prominent fractures identified from the ATV logs. Section 2.4.12.3.2 describes results of the packer tests.

- APTs: Three APT well clusters were installed (one at each complex). Each cluster consists of one pumping well and several water level sentinel wells. Well clusters were installed in various aquifer depth zones including PWR (PW-2; Middle Plant Complex), the upper crystalline bedrock (PW-1; North Plant Complex), and the deep crystalline bedrock (PW-3; South Plant Complex) at total depths of 72.3 ft. (22.0 m), 90.3 ft.

(27.5 m), and 155.3 ft. (47.3 m), respectively. Section 2.4.12.3.3 describes the APTs. Figure 2.4-58 shows the APT well cluster locations.

Well installations described in this report began in May 2024 and were completed in September 2024. Figure 2.4-58 presents a map of all pumping wells, monitoring wells, sentinel wells, and borings, and Table 2.4-31 presents well construction details. The monitoring wells are segregated into four series based on well depth and well function as follows:

- "W" identifies shallow groundwater monitoring wells. W-1 through W-5 were installed at the North Plant Complex; W-6 through W-10 were installed at the Middle Plant Complex; and W-11 through W-15 were installed at the South Plant Complex. Due to significant topographic and hydrogeologic depth/elevation variability across the three Plant Complexes (including significant variability in depth to water table), the shallow wells were installed in multiple stratigraphic zones, including OB, PWR, and crystalline bedrock.

- "DW" identifies deep groundwater monitoring wells installed within the deeper portions of the crystalline bedrock. DW-1 through DW-4 were installed at the North Plant Complex; DW-5 through DW-8 were installed at the Middle Plant Complex; and DW-9 through DW-12 were installed at the South Plant Complex.

- "PW" identifies pumping wells associated with the three APTs. PW-1 (North Plant Complex) is screened in the shallow bedrock (SBR); PW-2 (Middle Plant Complex) is screened in the PWR; and PW-3 (South Plant Complex) is screened in the deep bedrock (DBR).

- "S" identifies sentinel wells. These wells serve as water level monitoring wells during APTs. Sentinel wells include wells screened in PWR and various depths within the crystalline bedrock.

The hydrogeologic investigation targeted water-bearing strata in the OB, PWR, and crystalline bedrock to characterize hydrogeologic conditions within the upper 200 ft. (61.0 m) below ground surface (bgs), nearly twice the depth of the maximum foundation embedment depth of 125 ft. (38.1 m) of the proposed reactor technologies.

2.4.12.2.1 Hydrogeologic Cross Sections

Hydrogeologic cross sections were prepared using lithologic data from the geotechnical and well lithologic borings, fracture data from the ATV logs, and groundwater data from monitoring wells. Surface profiles were generated using topographic data that included processed USGS LiDAR data. Hydrogeologic layers and well screen placements depicted on the cross sections were determined based on field classification of OB, PWR, and bedrock using lithologic observations, SPT N-values, and drilling characteristics. PWR is defined as residual material with SPT N-values exceeding 100 blows per ft. Top of bedrock is primarily determined from the rate of drilling penetration and other drilling characteristics such as the behavior of the drill rig upon approaching the top of bedrock. Figures 2.4-59 through 2.4-66 present the cross section location map and seven cross sections through the complexes (A-A′, B-B′, C-C′, D-D′, E-E′, F-F′, and G-G′).

Combined OB and PWR (depth to bedrock) thickness from wells and borings range from 14 to 86 ft. (4.3 to 26 m) thick and average 48 ft. (15 m). PWR thickness averages 13 ft. (4.0 m) and OB thickness averages 36 ft. (11 m). PWR is thickest across the northern and eastern portions of the North Plant Complex and is uniformly moderately thin at most other locations. OB is uniformly thick across all three Plant Complexes except in topographically low areas where it thins, likely due to erosion from incised streams. The top of bedrock surface is generally a subdued reflection of the land surface.

The OB consists of mostly moist, silty sand with lesser amounts of clays and sandy silt. Clay layers are more common within the soil profile in the upper 5 ft. (2 m). Trace amounts of gravel-sized rock fragments are commonly observed. PWR consists of silty sand with gravel. The relic rock structure of the parent rock material is commonly associated with PWR. Most of the crystalline bedrock encountered is gneiss and schist, with lesser amounts of granofels.

The water table generally occurs within the OB/PWR and upper 10 to 20 ft. (3.0 to 6.1 m) of the bedrock. In DBR wells, the potentiometric head rises substantially above the screen interval but generally remains within the fractured bedrock aquifer. Groundwater levels in DBR wells are typically at lower elevations than static groundwater elevations in nearby shallow wells, indicating that downward vertical hydraulic gradients prevail in the upland recharge areas of the peninsula.

2.4.12.2.2 Bedrock Fracture Fabric Analysis

An analysis of bedrock fracture fabrics was performed by reviewing the fracture data identified on ATV logs for boring locations B-1, B-3, B-5, B-6, B-8, B-10, B-11, B-13, and B-15 and/or associated offsets (Reference 2.4-76). Fracture density, orientation, and openness were evaluated from the 1,782 total ft. (543.1 m) of ATV logs from the nine borings. Fracture density is qualitatively assessed by observing fracture density in the ATV logs and quantified by calculating the number of fractures divided by the total length of core in each boring. Fracture density is presented in Table 2.4-32 as the identified number of fractures per 100 ft. (30.5 m) of core. The average fracture density for all the borings is 65 fractures per 100 ft. (30.5 m). Borings that intersect a relatively low density of fractures (i.e., 22 to 44 fractures per 100 ft. [30.5 m]) compared with the average fracture density include B-5, B-11, B-13, and B-15. Borings with a high density of fractures (i.e., 65 to 83 fractures per 100 ft. [30.5 m]) include B-1, B-3, B-6, B-8, and B-10.

Figure 2.4-67 shows fracture density and fracture aperture opening width with depth based on the ATV data. Fracture density with depth is keyed to boring depth: six borings are completed to 200 ft. (61.0 m), two borings are completed to 300 ft. (91.4 m), and one boring is completed to 600 ft. (183 m) bgs. Data from the borings drilled to 200 and 300 ft. (61.0 and 91.4 m) appear to indicate a higher fracture density from 60 to 180 ft. (18 to 54.9 m) bgs. Data from the 600 ft. (183 m) boring indicates increases in fracture density between 240 to 250 ft. (73.2 to 76.2 m) bgs and 470 to 530 ft. (143 to 162 m) bgs.

More than 1,150 fractures were identified in the ATV logs. Nearly all (more than 97 percent) of the identified fractures are described as filled or closed with no identified aperture opening. Less than 3 percent (31) of the fractures are identified as open or have open aperture values. Aperture widths range from 0.2 to 6.8 in. (5 to 172 mm), average 1.3 in. (32 mm), and have a median value of 0.9 in. (23 mm). Fractures with open apertures were only recorded in the upper 250 ft. (76.2 m) bgs, as illustrated on Figure 2.4-67. Open fractures identified from the ATV are shown on the hydrogeologic cross-sections.

The dominant fracture orientation identified in the ATV logs strike nearly east-west and dip at low angles toward the south. These sub-horizontal fractures are likely associated with mineralogical and lithological layering in the gneissic and schistose bedrock. Other fracture sets strike northwest and east-west and dip steeply toward the northeast, north, and southwest. These fractures are likely associated with subvertical joints that form perpendicular and oblique to regional geologic strike. The two fractures with the largest open apertures (identified in B-1 at 85 ft. [26 m] bgs and B-8 at 242 ft. [73.8 m] bgs) are sub-horizontal with shallow dips to the southeast and southwest, respectively (Reference 2.4-76).

Because groundwater is stored and transmitted along secondary fracture openings in bedrock aquifers, the density, orientation, and openness of these fractures help determine aquifer properties such as transmissivity (T), hydraulic conductivity (K), storage coefficient (S), yield capacity, fracture interconnectivity, and groundwater flow directions. Most fractures at the Project site are filled or closed or were likely identified by lithologic or mineralogical contrasts in the layering within the rock and are not necessarily fractures capable of conveying groundwater.

Project site data indicates that bedrock is mostly massive with low values of K, T, and S. Because most of the open transmissive fractures are sub-horizontal and occur within the upper 300 ft. (91.4 m), it is assumed that most groundwater flow and storage within the bedrock aquifer is moderately shallow and may be compartmentalized or confined provided there is not sufficient flow and interconnectivity within the bedrock fracture systems. Most groundwater flow likely occurs in the limited number of larger open fractures, which are more likely to be interconnected with regional fracture networks that discharge to available surface water bodies.

2.4.12.2.3 Remote-Sensing Lineament Analysis

Subsurface geologic features such as mineral segregations due to gneissic banding, fracture zones, geologic contacts, jointing, and faults often have ground surface expressions that can be detected through surficial or aerial remote-sensing analysis of photographic and topographic images. Fracture zones or lineaments are important hydrogeologic features because they represent potential areas of increased, localized fracture concentrations.

Fracture zones commonly have enhanced porosity and permeability and therefore represent important pathways for groundwater flow in bedrock. Because fracture zones are typically less resistant to weathering, they are often expressed as natural topographic lows, such as straight stream valley segments, swales, aligned depressions and gaps in ridges, or as linear tonal or vegetative alignments due to variations in soil thickness and moisture. These surface manifestations are referred to as fracture traces or lineaments and were identified for this project by remote-sensing techniques using topographic maps and shaded relief maps produced from digital elevation models (Reference 2.4-77).

A total of 1,408 lineaments were identified within the Project Vicinity and are shown on Figure 2.4-68. Mapped lineaments primarily correspond with tributary stream valleys and other linear topographic depressions. The lineament data were analyzed to display the dominant orientations of the lineaments. The prominent lineament orientations are centered on N30 – 40°W, N20 – 30°E, and N60 – 70°E. Lineament orientations are generally parallel or perpendicular to regional geologic strike (Reference 2.4-69; Reference 2.4-67). Variations are likely caused by changes in local geologic strike and the formation of conjugate fractures at small angles to the principal direction of stress.

The coincidence of the lineaments with known geologic structures and processes suggests that most of the mapped lineaments represent underlying fractures zones that may contribute to groundwater flow within the fractured bedrock aquifer. Lineaments oriented parallel to strike may result from less-resistant interlayered pelitic schist units and therefore may not represent preferential groundwater flow pathways. Across-strike (northwest-trending) lineaments are more likely to represent preferred flow pathways due to their kinematic formation (Reference 2.4-78).

2.4.12.2.4 Groundwater Flow Directions

Historical groundwater level data were evaluated from two nearby BCSS sites; the Craig Road Landfill and the Flue Gas Desulfurization (FGD) landfill. The Craig Road landfill is located approximately 500 ft. (152 m) west of the South Plant Complex. Groundwater flow during the July 2024 sampling event was generally west/northwest, partially radial from areas of high topographic elevation to low, toward Belews Lake. In the deep zone, there was an easterly component to groundwater flow in the eastern portion of the site, downhill, toward an unnamed stream that drains to the canal and Belews Lake. These flow directions are consistent with previous events dating back to 2016 (Reference 2.4-79).

The FGD landfill is located approximately 200 ft. (61.0 m) north of the Middle Plant Complex. Groundwater flow in both the shallow and deep zone during the November 2023 sampling event was generally west/northwest, from areas of high topographic elevation to low, toward Belews Lake. These flow directions are consistent with previous events dating back to 2016 (Reference 2.4-80).

Between May and September 2024, 27 groundwater monitoring wells were installed at the Project site. W-1 through W-15 are shallow monitoring wells screened at or just below the water table. DW-1 through DW-12 are deep monitoring wells screened at various depths within the crystalline bedrock. Five shallow wells and four deep wells were installed at each complex. A well and boring location map is presented as Figure 2.4-58; well construction details are provided in Table 2.4-31. The monitoring wells are used for water level monitoring and slug testing. Groundwater depth measurements were collected monthly for the 12-month period between July 15, 2024, and June 24, 2025, and converted to groundwater elevations after completion of as-built surveying. Groundwater elevation data are presented in Table 2.4-33.

Potentiometric surface maps were prepared that depict groundwater elevations and groundwater flow directions for the shallow and deep monitoring well zones. Depending on variability in site-specific depths to first groundwater, the shallow wells were screened within the unconsolidated OB, PWR, and SBR, or some combination of these units. Deep wells were screened at various depths within the DBR. Bedrock monitoring wells were selected, when possible, to screen more highly fractured intervals.

Figure 2.4-69 (Sheets 1 through 24) presents potentiometric surface maps constructed from water elevation data collected from the shallow and deep monitoring wells on a monthly basis between July 2024 and June 2025. In some cases, water levels did not return to static conditions until several weeks or months following the completion of well development or following a sampling event; these data are included in Table 2.4-33 but were not used for contouring potentiometric surfaces. This condition was observed at monitoring wells W-2, W-3, W-9, DW-3, DW-8, DW-10, DW-11, and DW-12.

The groundwater elevation in DW-8 is an extreme illustration of groundwater levels that likely have still not reached natural equilibrium in the monitoring well. Groundwater elevations gradually increased from approximately 665 to 677 ft. NAVD 88 (203 to 206 m) between September 2024 and June 2025 but remain at least 65 ft. (20 m) lower than other Middle Plant Complex deep monitoring well groundwater elevations. It is assumed that this well was screened within an extremely tight (low-yielding) portion of the crystalline bedrock, which accounts for the extended recovery period.

Groundwater flow direction among both shallow and deep potentiometric surfaces generally follows topography, with flow directions from areas of higher topographic elevations to lower elevations. At the South Plant Complex, groundwater flow is bilinear and radial, toward the northwest, northeast, and southeast toward Belews Lake and the cut-through channel/canal. At the Middle Plant Complex, groundwater flows mostly toward the west and southwest due to influence from the cut-through channel/canal, and in part, to more limited water level data. At the North Plant Complex, near the tip of the peninsula, flow is radial toward the northwest, north, and northeast because Belews Lake surrounds the area on these three sides. Groundwater elevations decrease from the South Plant Complex to the North Plant Complex as proximity to the lake (discharge sink) decreases. This results in a deeper depth to the water table at the North Plant Complex compared with the other two complexes.

2.4.12.2.5 Hydraulic Gradients

Potentiometric surface maps are used to estimate horizontal hydraulic gradients (i_h) at the Project site. For each map, i_h are calculated by drawing a flow line on the potentiometric surface map perpendicular to the contours and determining the difference in hydraulic head (Δh) between isocontour lines (upgradient and downgradient) over the horizontal projection of the flow path length (L) ($i_h = \Delta h/L$). These calculations are summarized in Table 2.4-34 and are presented on the respective potentiometric surface map for each event.

The shallow zone potentiometric map surfaces indicate i_h values range from 5.0×10^{-3} feet per foot (ft/ft) on August 19, 2024, at the North Plant Complex to 9.2×10^{-2} ft/ft on calculated for September 24, 2024, October 11, 2024, and January 8, 2025, at the South Plant Complex, with an overall average value of 3.8×10^{-2} ft/ft. The deep zone potentiometric map surfaces indicate i_h values range from 6.4×10^{-4} ft/ft (April 25, 2025, at the Middle Plant Complex) to 4.4×10^{-2} ft/ft (November 18, 2024, at the North Plant Complex), with an overall average value of 2.7×10^{-2} ft/ft.

Typically, the vertical hydraulic gradient (i_v) is calculated by comparing differences in water level elevations and screened interval depths from nested monitoring wells (i.e., co-located wells screened in different aquifers or aquifer zones). However, at this Project site, the shallow and deep monitoring wells are not co-located; therefore, i_v were modeled using interpolated potentiometric surfaces from the two zones (shallow and deep) and the mid-point of well screen elevation surfaces.

Figure 2.4-70 presents the modeled i_v values for February 7, 2025, because this is the first event with sufficient groundwater elevation data to generate potentiometric surfaces for all three Plant Complexes for both the shallow and deep zones. Modeled i_v results from all monthly water level monitoring events are summarized in Table 2.4-35.

Aquifer systems typically have a downward vertical gradient in groundwater recharge areas that transition to upward vertical gradients in groundwater discharge areas. Vertical gradients measuring greater than zero have a downward flow potential; vertical gradients less than zero have an upward flow potential. Vertical gradients equal to zero are considered flat (i.e., no upward or downward flow potential).

Based on the monthly water level data from the Project site, the following vertical gradient trends were observed:

- All but two vertical gradient calculations demonstrated downward vertical hydraulic gradients (i.e., had positive gradient values).
- Two vertical gradient calculations had upward vertical hydraulic gradients (i.e., had negative gradient values).
- Modeled i_v values ranged from -4.1×10^{-2} ft/ft to 0.64 ft/ft.
- The average modeled i_v value was 0.28 ft/ft.

2.4.12.2.6 Temporal Groundwater Level Trends

Figure 2.4-71 (Sheets 1 through 3) provides hydrographs for wells W-1 through W-15 and DW-1 through DW-12. The hydrographs include plots of groundwater elevation versus time, collected manually between July 15, 2024, and November 10, 2025, and recorded automatically using pressure transducers installed in each monitoring well between November 10, 2024, and November 13, 2025. Daily rainfall measurements from the nearby Dan River at the Pine Hall USGS gauging station (Reference 2.4-81) are also included on the hydrographs. Although not depicted on the hydrographs, lake levels in Belews Lake were collected between July and December 2024 and from July to October 2025. During these periods, lake levels were approximately 724 ft. (221 m).

2.4.12.2.6.1 North Plant Complex

At the North Plant Complex, groundwater elevations range from approximately 725 to 780 ft. NAVD 88 (221 to 238 m) among all monitoring wells, from approximately 746 to 780 ft. NAVD 88 (227 to 238 m) among shallow wells, and from approximately 725 to 769 ft. NAVD 88 (221 to 234 m) among deep wells. The following water level trends are observed in the North Plant Complex monitoring wells:

- Groundwater elevations are typically lower in the deep wells compared with nearby shallow wells indicating a downward hydraulic gradient (recharge area).
- There does not appear to be a direct relationship between rainfall and groundwater level trends.
- Water levels in shallow wells W-2, W-3, and W-5 are mostly flat over the year of hourly transducer measurements, except for episodic declines in water levels in W-2 and W-3 that is directly correlated with purging of these wells during quarterly water quality sampling events. The water levels took several weeks to months to recover after these sampling events.

- Wells W-1, W-4, and DW-4 show a slow steady increase in water levels over the past year and four months since the wells were installed, suggesting that the water levels may still be recovering from well drilling and development activities.

- Deep wells DW-1, DW-2, and DW-3 are the only wells that appear to show a seasonal trend with water levels rising gently through the winter and spring months when groundwater recharge typically occurs and declining water levels starting in May and continuing through the summer months when groundwater recharge typically is not occurring (Reference 2.4-70).

2.4.12.2.6.2 Middle Plant Complex

At the Middle Plant Complex, groundwater elevations range from approximately 750 to 788 ft. NAVD 88 (229 to 240 m) in the shallow monitoring wells, and 664 to 748 ft. NAVD 88 (202 to 228 m) in the deep monitoring wells. The following water level trends are observed in the Middle Plant Complex monitoring wells:

- Groundwater elevations are typically lower in the deep wells compared with nearby shallow wells indicating a downward hydraulic gradient and suggesting the Plant Complex is a groundwater recharge area.

- Most wells appear to show a consistent seasonal trend of declining groundwater levels through the summer months and into early winter, after which water levels level off and rise slightly through the winter and spring before starting to decline again in early summer.

- Episodic declines in water levels were observed in W-9 and appear to be related directly to purging of this well during quarterly water quality sampling events. The water levels took several weeks to months to recover after these sampling events.

- The stableness of the groundwater levels is attributed to the deep depth to groundwater and the stable elevation of the Belews Lake, the main discharge sink for groundwater.

- Groundwater elevations in deep well DW-8 are much lower than all other measured water levels at the Middle Plant Complex. Although water levels continue to show a slow and steady increase, the water levels are still significantly lower than the other Middle Plant Complex wells and suggest that DW-8 did not intersect any significant, connected water-bearing fractures.

2.4.12.2.6.3 South Plant Complex

Groundwater elevations range from approximately 764 to 810 ft. NAVD 88 (233 to 247 m) in the shallow monitoring wells, and 734 to 794 ft. NAVD 88 (224 to 242 m) in the deep monitoring wells. The following water level trends are observed in the South Plant Complex monitoring wells:

- Limited data are available for wells DW-10, DW-11, and DW-12 because these wells required several months to recover to static levels after well development, indicating these wells are in low-yielding fracture zones in the DBR.

- The water level in well W-13 appears not to have recovered after the last quarterly sampling event and remains below the bottom of the screen.

- Groundwater elevations are typically lower in the deep wells compared with nearby shallow wells indicating a downward hydraulic gradient and suggesting the Plant Complex is a groundwater recharge area.

- At the South Plant Complex, groundwater levels are stable showing level to slightly declining trends in essentially all monitoring wells over this period of measurement.

- A typical response to the hydrologic cycle observed at the Middle and North Plant Complexes is not observed at the South Plant Complex with the possible exception of W-15.

- The stableness of the groundwater levels is attributed to the deep depth to groundwater and the stable elevation of the Belews Lake, the main discharge sink for groundwater.

2.4.12.3 Aquifer Properties

The primary hydrogeological properties of interest at the Project site are K, and to a lesser extent, T, S, and effective porosity. The data obtained from the single-well slug tests and packer tests are used to evaluate K, while the multiple-well APTs are used to evaluate T, S, and K for each tested water-bearing zone.

Five packer tests were completed at three different boring locations. Packer test intervals targeted the open fractures identified from the ATV logs. Slug tests were conducted in 27 monitoring wells (15 in the shallow zone, and 12 in the deep zone).

Three APTs were performed between November and December 2024. One test was performed at each complex pumping well cluster. Each cluster consists of one pumping well and several water level sentinel wells. Well clusters were installed in various aquifer depth zones, including PWR (PW-2; Middle Plant Complex), the upper or shallow crystalline bedrock (PW-1; North Plant Complex), and the deep crystalline bedrock (PW-3; South Plant Complex) to total depths of 72.3 ft. (22.0 m), 90.3 ft. (27.5 m), and 155.3 ft. (47.3 m), respectively.

The following definitions are useful for a discussion of aquifer parameters measured from slug testing, packer testing, and APT results (Reference 2.4-70):

- Transmissivity (T) is the capacity of an aquifer to transmit water. It equals the hydraulic conductivity times the aquifer thickness.

- Storage coefficient (S) is the volume of water released from storage in a unit prism of an aquifer when the head is lowered a unit distance.

- Hydraulic conductivity (K) is the capacity of a unit cube of rock to transmit water under a unit gradient through a unit cross-sectional area of an aquifer.

2.4.12.3.1 Slug Test Analysis

K can be estimated from the slug test method, which evaluates the aquifer response to an instantaneous change in water level in the test well. A disadvantage of the slug test method is

that it measures K only in the immediate vicinity of the tested well. However, because the slug test requires minimal equipment and can be performed rapidly, slug testing can be readily performed in multiple wells across the Project site, offering an efficient determination of spatial variability in K.

Slug tests were conducted in 27 monitoring wells (15 in the shallow zone, and 12 in the deep zone). Slug test results based on Plant Complex and aquifer type are presented below and in Tables 2.4-36a – Table 2.4-36c. A summary of the overall sitewide results is provided below and in Table 2.4-37.

- North Plant Complex: The average K for the SBR is 3.31 feet per day (ft/day) (1.01 m/day) and the average K for the DBR is 0.451 ft/day (0.137 m/day). No wells were completed in OB/PWR in part due to the deeper depth of groundwater at the North Plant Complex.

- Middle Plant Complex: The average K for the OB/PWR is 9.07 ft/day (2.76 m/day). The average K for the SBR is 0.174 ft/day (5.30×10^{-2} m/day), and the average K for the DBR is 0.281 ft/day (8.56×10^{-2} m/day).

- South Plant Complex: The average K for the OB/PWR is 3.67 ft/day (1.12 m/day). The average K for the SBR is 0.270 ft/day (8.23×10^{-2} m/day) and 1.58×10^{-2} ft/day (4.82×10^{-3} m/day) for the DBR.

- Overall Project site: K for the OB/PWR ranges from 1.44 ft/day (0.439 m/day) to 16.7 ft/day (5.09 m/day) and averages 6.37 ft/day (1.94 m/day).

- Overall Project site: K for the SBR ranges from 7.09×10^{-4} ft/day (2.16×10^{-4} m/day) to 14.9 ft/day (4.54 m/day) and averages 1.63 ft/day (0.497 m/day). K for the DBR ranges from 5.03×10^{-6} ft/day (1.53×10^{-6} m/day) to 1.80 ft/day (0.549 m/day) and averages 0.249 ft/day (7.59×10^{-2} m/day). K for all bedrock ranges from 5.03×10^{-6} ft/day (1.53×10^{-6} m/day) to 14.9 ft/day (4.54 m/day) and averages 0.908 ft/day (0.277 m/day).

Three methods were used for slug test analysis: Hvorslev, Bouwer-Rice, and Kansas Geological Survey (KGS). Bouwer-Rice is a preferred method for unconfined aquifers, and Hvorslev is a preferred method for confined aquifers (Reference 2.4-82). The KGS method can handle more complex situations, including partial penetration, wellbore skin effects, anisotropy, and transient conditions (Reference 2.4-83). Although all three test methods were used to analyze the slug test data, only K values from the most appropriate methods for the known well and aquifer conditions are used to summarize representative K values in the right-hand column in Table 2.4-36. The Bouwer-Rice method was used as representative K values for clearly unconfined wells where the static water level was within or just above the screen interval and only rising head tests were analyzed due to the storage and gravity drainage effects of the well screen filter pack. The Hvorslev method was used as the representative K values for shallow wells where the water level was not within the well screen, and the KGS curve-matching method was used for the deep partially penetrating bedrock wells.

Table 2.4-37 presents sitewide average K values for each stratigraphic unit based on the slug test results. Figure 2.4-72 (2 Sheets) presents a distribution map of K values across the Project site from the shallow “W” wells and the deep “DW” wells. K values vary by several orders of

magnitude indicating heterogeneous and possibly anisotropic conditions. The low K values in some bedrock wells reflect screen intervals that were not placed adjacent to significant secondary fractures due to the low frequency of such water-bearing fractures and therefore represent the K of unfractured bedrock. Essentially, no groundwater flows through unfractured rock mass. Most groundwater flow occurs where fractures are present, open to transmit water, and interconnected with other fractures. The K distribution map for the shallow wells indicates areas of relatively high K values in central portions of the Plant Complexes that decrease outward toward the perimeter of the Plant Complexes. The K distribution in the deep wells indicates decreasing conductivity downward with depth.

2.4.12.3.2 Packer Test Analysis

Five packer tests were performed using the Lugeon test method at three different boring locations within the consolidated bedrock, one each at the North, Middle, and South Plant Complexes (two tests each were performed at borings B-3 and B-8, and one was performed at boring B-13). Packer test intervals targeted prominent fractures identified from the ATV logs. Packer test results are summarized in Table 2.4-38.

Three of the tested zones (B-3, B-8, and B-13) represented as Zone 1 did not allow significant water penetration, indicating the targeted fracture discontinuities selected were likely closed or filled. The estimated K values for these test intervals range from 2.22×10^{-3} to 9.58×10^{-2} ft/day (6.77×10^{-4} to 2.92×10^{-2} m/day), similar to the range of K values measured from slug testing for wells in consolidated bedrock. The remaining two test intervals required nearly 30 gallons per minute (gpm) (114 liters per minute [lpm]) during testing and had estimated K values of more than 2 ft/day (0.6 m/day). These fractures were open, through-going, and interconnected with other fractures, and may represent potentially significant groundwater flow pathways in an otherwise low permeability unfractured rock mass.

2.4.12.3.3 Aquifer Pumping Test Analysis

Three APT well clusters were installed for aquifer performance testing. Well locations are shown on Figure 2.4-58, and well construction details are provided in Table 2.4-31. These APT well clusters are located at the North, Middle, and South Plant Complexes and target three different aquifer zones as summarized below:

- OB/PWR (Middle Plant Complex): includes pumping well PW-2 and sentinel wells W-6 and S-6 through S-10. All wells are screened within OB/PWR to depths of approximately 70 to 75 ft. (21 to 23 m).

- SBR (North Plant Complex): includes pumping well PW-1 and sentinel wells W-1 and S-1 through S-5. All wells are screened within the SBR to depths of approximately 85 ft. (26 m).

- DBR (South Plant Complex): includes pumping well PW-3 and sentinel wells DW-9 and S-11 through S-16. S-16 is screened in the SBR; all other sentinel wells are screened in the DBR to depths of approximately 150 ft. (45.7 m).

The sentinel wells surrounding each pumping well are arranged in cruciform patterns at approximate distances of 20, 40, and 80 ft. (6.1, 12, and 24 m) away from the pumping well. The PW-2 cluster wells were spaced 15, 30, and 45 ft. (4.6, 9.1, and 14 m) apart. The cross-

shape cluster is oriented northeast-southwest or northwest-southeast, approximately parallel and perpendicular to regional geologic strike to better characterize potential preferred groundwater flow directions and anisotropy associated with bedrock fracture orientations. APT results are presented in Tables 2.4-39a – Table 2.4-39c and summarized below.

PW-2 (Middle Plant Complex, OB/PWR) was pumped at a rate of 3.5 gpm (13 lpm) for approximately 49 hours. The shape of a log-linear time-drawdown plot demonstrates an early-time reduced drawdown slope, which suggests possible gravity drainage effects typical of an unconfined aquifer. Approximately 400 minutes into the test, the drawdown curve steepens and plots as a straight line through the end of the test, indicating that the aquifer is behaving like a confined aquifer and can be analyzed using Theis and Theis recovery methods. These late-time data were analyzed for aquifer properties as being more representative of regional aquifer conditions. Based on the results presented in Table 2.4-39b, it is estimated that the OB/PWR at the Middle Plant Complex has an average T of 132 square feet per day (ft^2/day, 12.3 m^2/day), an average S of 1.99 x 10^{-2}, and an average K of 4.42 ft/day (1.35 m/day) assuming a tested aquifer thickness of 30 ft. (9.1 m) equal to screen length and saturated aquifer above the screen. The aquifer S values suggest the PWR is unconfined to partially confined.

PW-1 (North Plant Complex, SBR) was pumped at a rate of 0.06 gpm (0.2 lpm) for approximately 49 hours. The drawdown plot for the PW-1 APT is similar to the PW-2 APT in that it shows delayed effects of well bore storage and possible effects of limited gravity drainage, suggesting unconfined aquifer conditions. After several hundred minutes of pumping, the log-linear drawdown curve steepens and plots as a straight line through the end of the test. These late-time data were analyzed as confined aquifer conditions following early-time effects of borehole storage and gravity drainage. This portion of the time-drawdown curve is also considered to be more representative of regional aquifer conditions as the drawdown cone spreads away from the pumping well and encompasses greater portions of aquifer material. Distance-drawdown analyses demonstrate that the aquifer behaves heterogeneously with certain wells showing more drawdown than expected while others show less. This could be a function of fracture interconnectedness between the pumping well and certain sentinel wells within the cluster. The excessive drawdown in the pumping well suggests high head loss from turbulent flow likely due to tight fractures near the well interface, possible fracture dewatering, and head loss from cascading flow inside the pumping well. The average aquifer parameters estimated for the SBR aquifer from the test data include an average T of 8.89 ft^2/day (0.826 m^2/day), an average S of 1.06 x 10^{-2}, and an average K of 0.445 ft/day (0.136 m/day). The estimate of K assumes a saturated thickness of 20 ft. (6.1 m) equal to the length of the well screen.

PW-3 (South Plant Complex, DBR) was pumped at a rate of 0.8 gpm (3 lpm) for approximately 49 hours. The drawdown plot does not show evidence of unconfined gravity drainage conditions. After less than 400 minutes, the drawdown plot flattens slightly, indicating that leakage or recharge is occurring. This could be leakage from the overlying saturated OB material recharging bedrock fractures, or a recharge boundary from Belews Lake or the cut-through channel/canal for West Belews Creek. The recharge likely occurs as the drawdown cone expands away from the pumping well and intersects recharge from Belews Lake. Recharge could occur along an open interconnected sub-horizontal fracture(s) that intersects lake bottom sediments or is exposed to the bottom of the lake. Hantush and Theis methods were used to analyze the APT data. The estimated aquifer parameters indicate an average T of 1.40 ft^2/day (0.130 m^2/day), an average S of 1.54 x 10^{-3}, and an average K of 7.02 x 10^{-2} ft/day (2.14 x 10^{-2} m/day) assuming a saturated thickness of 20 ft. (6.1 m) equivalent to the screen

length. The distance-drawdown analysis, which may be more representative of the regional portion of the aquifer, provided a T of 4.29 ft^2/day (3.99x10^{-1} m/day) and K of 0.215 ft/day (6.55 x 10^{-2} m/day). The area of influence based on the distance-drawdown plot at the end of the pump test is slightly over 4000 ft. (1219 m) and covers all three Plant Complexes.

In summary, the following conclusions can be derived by analysis of the APT data.

- Based on the PW-2 test, the OB/PWR behaves as an unconfined to semi-confined aquifer with an average T of 132 ft^2/day (12.3 m^2/day), an average S of 1.99 x 10^{-2}, and an average K of 4.42 ft/day (1.35 m/day).

- Based on the PW-1 test, the SBR behaves as an unconfined to semi-confined aquifer with an average T of 8.89 ft^2/day (0.826 m^2/day), an average S of 1.06 x 10^{-2}, and an average K of 0.445 ft/day (0.136 m/day).

- Based on the PW-3 test, the DBR behaves as a leaky confined aquifer with an average T of 1.40 ft^2/day (0.130 m^2/day), an average S of 1.54 x 10^{-3}, and an average K of 7.02 x 10^{-2} ft/day (2.14 x 10^{-2} m/day). The distance-drawdown analysis, which may be more representative of the regional portion of the aquifer, resulted in a T of 4.29 ft^2/day (0.399 m^2/day) and a K of 0.215 ft/day (6.55 x 10^{-2} m/day).

2.4.12.3.4 Average Linear Groundwater Velocity

The average linear velocity of groundwater is estimated using Darcy's Law as shown below.

$V = K*i_h/\phi_e$

where

V = velocity (ft/day)

K = hydraulic conductivity (ft/day)

i_h = horizontal hydraulic gradient (ft/ft)

ϕ_e = effective porosity (unitless)

The average K from the slug tests and i_h from the monthly manual water levels were used to calculate the average linear velocity for the OB/PWR and the bedrock aquifers separately. Maximum linear velocities were calculated using the maximum i_h for the Project site. Only K values estimated from slug testing were considered in calculating average linear groundwater velocities because the data is more representative of sitewide conditions. Effective porosity values were estimated from reference documents based on grain size distribution and rock type in each stratigraphic unit (Reference 2.4-84; Reference 2.4-85). Average linear groundwater velocity results are summarized in Table 2.4-40.

Results indicate an average linear velocity of 1.2 ft/day (0.37 m/day) and a maximum linear velocity of 2.9 ft/day (0.88 m/day) in the OB/PWR aquifer, an average linear velocity of 3.3 ft/day (1.0 m/day) and a maximum linear velocity of 7.9 ft/day (2.4 m/day) in the SBR aquifer, and an average linear velocity of 0.35 ft/day (0.11 m/day) and a maximum velocity of 0.58 ft/day (0.18 m/day) in the DBR aquifer.

2.4.12.3.5 Hydrogeochemical Characteristics

Groundwater in the Piedmont aquifers typically has moderate mineralization, slightly acidic to neutral pH, and elevated hardness due to weathering of crystalline bedrock. Water quality is generally suitable for drinking, but localized issues include iron, manganese, radon, and occasional nitrate contamination from human activities. These water chemistry characteristics reflect rock-water interactions between infiltrating rainwater and the fractured crystalline rocks (granite, gneiss, schist). Within the Milton Belt, the major ions include calcium, magnesium, and bicarbonate (i.e., calcium-magnesium/bicarbonate type (Reference 2.4-86). Groundwater in the Mesozoic basins to the north of the Project site typically has higher total dissolved solids concentrations locally, and is harder and less acidic than groundwater from the crystalline bedrock aquifer (Reference 2.4-87).

2.4.12.3.6 Hydrogeologic Conceptual Site Model

A hydrogeologic conceptual site model (CSM) has been developed for the Project site from subsurface data collected from a total of 15 primary geotechnical borings plus additional offsets, borehole geophysical tests on 9 borings, 33 well lithologic borings, 15 shallow monitoring wells, 12 deep monitoring wells, three aquifer pumping test (APT) wells, and 16 sentinel wells, along with aquifer coefficient data obtained from 27 slug tests, 5 packer tests, and 3 aquifer pumping tests (one at each Plant Complex in each main hydrogeologic unit), and over one year of groundwater level, hydraulic gradient and groundwater flow direction data. The key aspects of the CSM are as follows:

- The hydrogeologic setting includes crystalline bedrock composed primarily of gneiss with lesser amounts of schist overlain by PWR and OB. The OB is composed of residual soil weathered in-place from the underlying bedrock and described primarily as a silty sand, with lesser occurrences of clay and sandy silt. PWR consists of silty sand with gravel and exhibits the relic rock structure of the parent rock material.

- More than 1,150 fractures were identified in the ATV logs. Based on the ATV logs, fracture density at the Project site ranges from 22 to 83 fractures per 100 ft. (30.5 m) and averages 65 fractures per 100 ft. (30.5 m) and generally declines with depth.

- Over 97 percent of the fractures identified in ATV logs are tight, closed, or filled and likely produce little water. Many of the identified fractures may also represent mineralogical or lithologic discontinuities and are not actually fractures.

- Less than 3 percent of the fractures identified were described as open or had a recorded open aperture width. Aperture widths range from 0.2 to 6.8 in. (5 to 172 mm) and average 1.3 in. (32 mm) with a median value of 0.9 in. (23 mm). Fractures with open apertures were only recorded in the upper 250 ft. (76.2 m) bgs.

- The dominant fracture orientation identified in the ATV logs strike nearly east-west and dip at low angles toward the south. These sub-horizontal fractures are likely associated with mineralogical and lithological layering in the gneissic and schistose bedrock. Other subordinate fracture sets identified in the ATV logs were subvertical and oriented generally northwest and east-west.

- Bedrock fracture orientations coincide reasonably well with more than 1,400 fracture trace lineaments identified within the Project Vicinity that may represent the surface manifestations of underlying subvertical fracture zones. Zones of increased bedrock fracture density may represent preferred pathways for groundwater flow.

- Project site data indicates that bedrock is mostly massive with low values of K, T, and S. Because most of the open transmissive fractures are sub-horizontal and occur within the upper 300 ft. (91.4 m), it is assumed that most groundwater flow and storage within the bedrock aquifer is moderately shallow and may be compartmentalized or confined. Most groundwater flow likely occurs in the largest open fractures, which are more likely interconnected with regional fracture networks and discharge to available surface water bodies.

- Groundwater recharge occurs as direct infiltration of rainfall at land surface that percolates through the unconsolidated OB/PWR into fractured bedrock. Bedrock generally has little primary porosity and permeability. Most groundwater is stored in and flows through a limited amount of secondary fractures with adequate aperture openings formed within the bedrock.

- Groundwater is present in the OB and PWR likely under unconfined or water table conditions and travels short distances, discharging to nearby tributary streams, springs, or surface water bodies such as Belews Lake.

- A portion of the groundwater flows vertically downward, recharging the underlying bedrock aquifer. In the underlying crystalline bedrock, groundwater continues to flow vertically downward and outward or away from topographic divides and toward areas of discharge into nearby creeks, seeps, and surface water bodies (e.g., Belews Lake).

- At the Project site, groundwater flow is bilinear along the spine of the peninsula away from the surface divide and toward Belews Lake and its tributaries. Radial flow occurs partially at all three Plant Complexes as groundwater flows toward Belews Lake and the cut-through channel/canal.

- Overall, groundwater elevations decrease from the South Plant Complex to the North Plant Complex as proximity to the lake decreases. This results in a deeper depth to the water table at the North Plant Complex compared with the other two complexes.

- Hydrographs of groundwater elevation data illustrate that water levels are essentially flat and do not fluctuate from episodic rainfall events or even seasonal changes in groundwater recharge. The stable nature of groundwater levels reflects the relatively deep unsaturated zone and the influence of stable lake levels surrounding the Project site.

- Some site monitoring wells demonstrate an expected seasonal trend with water levels rising gently through the winter and spring months when groundwater recharge typically occurs and declining water levels starting in May and continuing through the summer and fall when groundwater recharge typically is not occurring.

- K varies across the Project site by several orders of magnitude. The average K based on slug test results for OB/PWR is 6.37 ft/day (1.94 m/day) with a maximum of 16.7 ft/day (5.09 m/day). The SBR has an average K of 1.63 ft/day (0.497 m/day) and a maximum K of 14.9 ft/day (4.54 m/day). The K of the DBR is lower than that of the SBR with an average K of 0.249 ft/day (7.59 x 10^{-2} m/day) and a maximum K of 1.80 ft/day (0.549 m/day).

- Three aquifer pumping tests were performed at the Project site at PW-1 (SBR; average K of 0.445 ft/day (0.136 m/day) and average storativity, S, of 1.06 x10^{-2}), PW-2 (PWR; average K of 4.42 ft/day (1.35 m/day) and average S of 1.99 x10^{-2}), and PW-3 (DBR; average 7.02 x10^{-2} ft/day (2.14 x 10^{-2} m/day) and an average S of 1.54 x10^{-3}. Aquifer pump test results show similar but slightly lower K values reflecting the presence of silty sand OB/PWR and low fracture permeability in metamorphosed gneiss and schist bedrock. Storativity values indicate unconfined to semi-confined conditions persist in OB/PWR and SBR, and leaky confined conditions are present in the DBR unit.

- Horizontal groundwater flow velocities using average K values and average and maximum i_h values are highest in the SBR aquifer with an estimated average flow velocity of 3.3 ft/day (1.0 m/day) and a maximum linear velocity of 7.9 ft/day (2.4 m/day). The lowest groundwater flow velocities occur in the DBR aquifer with an average linear velocity of 0.35 ft/day (0.11 m/day) and a maximum velocity of 0.58 ft/day (0.18 m/day).

2.4.12.4 Groundwater Use

2.4.12.4.1 Vicinity Groundwater Use

Groundwater supplies most of the private and public drinking water in the Project Vicinity. Most of the groundwater supply wells are drilled into the underlying bedrock aquifer using air rotary rigs, are typically completed to depths of several hundred feet, and are constructed with 6-in. steel or polyvinyl chloride casing set and grouted into competent rock with the remainder of the borehole open to water-bearing fractures (Reference 2.4-69; Reference 2.4-67). Well yield for crystalline bedrock aquifers is generally low, typically yielding 5 to 35 gpm (20 to 130 lpm) within the fractured bedrock. Above the fractured bedrock, within the surficial aquifer, well yields can increase up to approximately 200 gpm (757 lpm) (Reference 2.4-88). Well yield for Early Mesozoic basins is typically low with an average 11 to 12 gpm (42 to 45 lpm) (Reference 2.4-89). Wells completed in the biotite gneiss and schist unit (CZbg) in the Project Vicinity range in yield from 2 to 93 gpm (8 to 350 lpm) with an average well yield of approximately 40 gpm (150 lpm). Well depths range from 46 to 1,504 ft. (14 to 458.4 m) deep and average approximately 295 ft. (89.9 m) (Reference 2.4-67).

The NC Department of Environmental Quality (NCDEQ) provides historical groundwater use data by category and county. Data are available from 1999 through 2022. The groundwater use categories are agricultural, energy, industrial, mining, public water supply (PWS), and recreational. Groundwater use data were reviewed for the four counties in the immediate Project Vicinity (Stokes, Rockingham, Guilford, and Forsyth). Table 2.4-41 presents the results from 2022 (Reference 2.4-64).

An average of 1.4 million gallons per day (mgd) (5.3 million liters per day [mld]) of groundwater was withdrawn among the four counties. Most of the groundwater withdrawals were for PWS (86 percent), followed by energy (7 percent), recreational (4 percent), and industrial (3 percent).

Groundwater use in Stokes County is relatively limited; 0.10 mgd (0.38 mld) for energy and 0.010 mgd (0.040 mld) for PWS for a total of 0.11 mgd (0.42 mld) for 2022. Between 2007 and 2021, the highest reported average daily groundwater use in Stokes County was 0.040 mgd (0.15 mld) in 2021 (Reference 2.4-88).

The NC Division of Water Resources (NCDWR) Local Water Supply Planning Database identifies three municipalities in the immediate Project Vicinity (Madison, Stokesdale, and Walnut Cove) that have local water supply plans (LWSP) for 2023. These LWSPs are designed to outline the current and projected water supply use and demand up to 2070 for surface water and groundwater.

The LWSP for Walnut Cove projects groundwater demand to increase from 0.31 mgd (1.2 mld) in 2023 to 0.32 mgd (1.2 mld) in 2070. This increase in demand correlates to an increase in overall projected population from 1757 in 2023 to 2000 in 2070. The Madison and Stokesdale LWSPs do not identify groundwater withdrawals for current water use and do not identify groundwater withdrawal use in their projections (Reference 2.4-91).

The NC OneMap, a collaborative geographic information system (GIS) website that presents data from local, state, and federal government agencies, was used to identify PWS near the Project site. OneMap classifies public water systems into three categories:

- Community water system: a public water system that supplies water to the same population year-round.
- Non-transient non-community water system: a public water system that regularly supplies water to at least 25 of the sample people at least 6 months per year (e.g., schools, factories, and hospitals).
- Transient non-community water system: a public water system that provides water in a place such as a gas station or compound where people do not remain for long periods of time.

The NC OneMap query identifies 47 community, 19 transient non-community, and 7 non-transient non-community PWS wells within a 7-mi. (11-km) radius of the Project site. Table 2.4-42 shows the identified PWS wells, and Figure 2.4-73 shows their locations.

Of the 73 identified PWS wells, 59 wells are installed in the Crystalline Rock aquifer, and 14 wells are installed within the Early Mesozoic basin aquifer. Well depths range from 103 to 1504 ft. (31.4 to 458.4 m) bgs in the Crystalline Rock aquifer and from 175 to 1230 ft. (53.3 to 374.9 m) bgs in the Early Mesozoic basin aquifer. Well yields range from 5 to 132 gpm (20 to 500 lpm) in the Crystalline Rock aquifer and from 2 to 200 gpm (8 to 757 lpm) within the Early Mesozoic basin aquifer (Reference 2.4-92).

A private well search of the Environmental Health Departments of the four surrounding counties (Forsyth, Guilford, Rockingham, and Stokes) yielded information from Guilford and Rockingham counties; however, private well information is not readily available from Forsyth and Stokes counties. Identified private water supply wells are presented in Figure 2.4-74. [[ ]]^{WI} private water supply wells within a 7-mi. (11-km) radius of the Project site are identified within Guilford County (Reference 2.4-93).

Private well data provided by Rockingham County identify [[ ]]WI private water supply wells within a 7-mi. (11-km) radius of the Project site. Limited information regarding well yields or depths is available. Based on the available data, well depths range from [[ ]]WI in the Crystalline Rock aquifer and [[ ]]WI in the Early Mesozoic basin aquifer. Well yields range from [[ ]]WI in the Crystalline Rock aquifer, and from [[ ]]WI in the Early Mesozoic basin aquifer (Reference 2.4-94).

The EPA Private Domestic Well online portal estimates the density of private water supply wells for domestic use in Forsyth, Stokes, Guilford, and Rockingham counties using land use data combined with housing units in the area to provide a well count estimate. Figure 2.4-75 shows estimated number of wells per square kilometer (km^2) (well density) for these counties. At the Project site, well density is estimated to be 0 to 25 wells per km^2 (Reference 2.4-95).

Based on the identified well yields and well distances from the Project site, groundwater withdrawals from surrounding areas do not have an influence at the Project site. Similarly, since groundwater is not used at the Project site, there is no impact to nearby groundwater supplies.

2.4.12.4.2 Current On-Site Groundwater Use

The BCSS does not use groundwater as a source for cooling water, potable water, or any other operational needs. Makeup water for the closed-cycle cooling system is derived from an existing surface water intake and conveyance pipeline from the Dan River. Potable water is derived from a local municipal water provider, Winston-Salem/Forsyth County Utilities. The public water is conveyed to BCSS through a water supply line located along the west side of Craig Road leading to the South Gate of the Project site. The only current groundwater pumping is for a groundwater corrective action plan (CAP) remediation system installed as part of ash basin closure activities. The CAP system is located approximately 2.2 mi. (3.5 km) northwest of the Project site and uses a series of 72 extraction wells and 64 clean water infiltration wells.

The total combined water withdrawal amounts for the 72 extraction wells operating as part of the full-scale CAP system are described below:

- Minimum system flow rate: 72 gpm (270 lpm)
- Maximum system flow rate: 98 gpm (370 lpm)
- Average system flow rate: 81 gpm (310 lpm)

Groundwater that is withdrawn is treated and re-infiltrated as clean water into 64 infiltration wells as part of the full-scale CAP system as follows:

- Minimum system infiltration rate: 63 gpm (240 lpm)
- Maximum system infiltration rate: 89 gpm (340 lpm)
- Average system infiltration rate: 75 gpm (280 lpm)

On average, the monthly CAP system withdrawal rate is approximately 3.5 million gallons (13 million liters), and the average monthly infiltration system rate is approximately 3.3 million gallons (12 million liters). Extraction and infiltration wells are screened in residuum and bedrock.

2.4.12.4.3 Projected On-Site Groundwater Use

2.4.12.4.3.1 Groundwater Needs to Support Construction

Even though the water table is moderately deep and the subsurface materials relatively low in permeability, groundwater withdrawal associated with temporary dewatering is expected during excavation and construction of the power block and/or other building foundations. The amount of dewatering required to support the construction of the new advanced reactor plant is unknown because the reactor technology has not been chosen. Because the Project site is surrounded by Belews Lake, impacts from dewatering are expected to be limited to the Project site area of the peninsula. Potential impacts of temporary dewatering are discussed in Section 2.4.12.5.

2.4.12.4.3.2 Groundwater Needs to Support New Plant Operations

Makeup water for reactor operations for closed-cycle cooling system will be sourced from Belews Lake and augmented from the Dan River during periods of low lake levels. Potable water supply needs are supplied by the Winston-Salem/Forsyth County Utilities. Other groundwater supplies are not required to support future advanced reactor plant operations.

2.4.12.5 Dewatering and Post-Construction Groundwater Conditions

2.4.12.5.1 Dewatering and Construction Activities

At this time, the specific reactor technology to be used on the Project site has not been identified; however, the foundation embedment will not exceed 125 ft. (38.1 m) in depth from the finished grade elevation of 810 ft. NAVD 88 (247 m). Based on preliminary site plans, the largest power block and containment structure will be a square roughly 400 by 400 ft. (122 by 122 m) for a total footprint of 160,000 ft^2 (14,864 m^2). The main power block area will be excavated and dewatered to facilitate construction. The dewatering system will likely consist of either DBR wells or sump pumping from a system of shallow excavations to collect groundwater and rainwater, which is then pumped to a discharge point away from the excavation.

The Dupuit equation for steady-state flow in an unconfined aquifer (Reference 2.4-96) is used to estimate dewatering needs based on the rate of groundwater inflow into the excavation. Using site-specific data and excluding recharge from precipitation and Belews Lake, the dewatering pumping rate is estimated to range from approximately 57 gpm (216 lpm) to 370 gpm (1,401 lpm). The radius of influence of the drawdown cone surrounding the foundation excavation is estimated using the modified Theis non-equilibrium equation (Reference 2.4-97; Reference 2.4-98). Based on pumping tests and estimates from this equation, the drawdown cone is predicted to extend up to 4000 ft. (1219 m) during peak dewatering operations. Figure 2.4-76 illustrates the maximum predicted radius of influence from construction dewatering at the three Plant Complexes. As shown, the radius of influence from the North Plant Complex extends across Belews Lake and includes an area of public and private water supply wells. One noncommunity transient public water supply well is located within the predicated radius of influence. The actual drawdown is expected to be reduced by groundwater recharge from precipitation and recharge boundary conditions from Belews Lake. No adverse impacts are

expected. In addition, drawdown from dewatering activities are temporary in nature. Normal groundwater levels are expected to return quickly after construction dewatering ceases.

2.4.12.5.2 Reliability of Groundwater System Used for Safety-Related Purposes

Safety-related systems will not rely on groundwater from the Project site.

2.4.12.5.3 Effects on Plant Foundations

The highest groundwater elevations in the central portion of the North, Middle, and South Plant Complexes are approximately 780 ft. NAVD 88 (238 m), 786 ft. NAVD 88 (240 m), and 810 ft. NAVD 88 (247 m), respectively from shallow monitoring wells W-2, W-8, and W-14. The deepest likely foundation excavation elevation is 685 ft. NAVD 88 (209 m) assuming a finish grade elevation of 810 ft. NAVD 88 (247 m) and maximum excavation depth of 125 ft. (38.1 m). This results in an estimated maximum hydrostatic pressure from groundwater on foundations equivalent to 95 to 125 ft. (29 to 38.1 m) of groundwater or 41 to 54 psi (282 to 372 kPa). Actual hydrostatic pressures on foundations will depend on the actual finished grade and the selected reactor technology.

2.4.12.5.4 Post-Construction Groundwater Conditions

Following decommissioning of the dewatering system, the groundwater will attempt to return to a natural condition. Pavement and structures will likely reduce groundwater recharge, potentially impacting groundwater baseflow discharge into nearby perennial creeks and Belews Lake. Unpaved areas covered by permeable gravel or fill may receive increased recharge, countering impacts of increased impermeable surfaces.

2.4.12.6 Groundwater Flow Model

A numerical groundwater flow model was developed to assist with interpretation of the subsurface hydrogeologic materials and to simulate steady-state groundwater flow conditions.

Due to the complexity of the aquifer system at the Project site, numerical modeling offers the best framework to assess advective flow transport of dissolved constituents within the aquifer and identify location(s) of potential exposure, along with estimating travel times from points of possible accidental release to potential receptors.

The finite-difference three-dimensional groundwater flow model code, MODFLOW-USG Transport (MODFLOW; Reference 2.4-99) was used for numerical modeling. MODFLOW is a standard of the groundwater modeling community and offers a wide range of boundary condition and solver options that satisfy the anticipated demands posed by the facility hydrogeologic setting. The graphical interface for modeling (Groundwater Vistas) was used to create MODFLOW input files and to process and display output data files.

MODFLOW offers a variety of packages for iteratively solving the array of algebraic equations representing the partial differential equations governing fluid flow in a porous medium. The Sparse Matrix Solver (SMS) package employs a nonlinear iterative algorithm to achieve convergence to closure criteria and eventually to observed conditions. SMS can work with the unstructured format of MODFLW-USG Transport, unlike previous solvers. Conservative convergence criteria are specified for SMS, with 0.001 ft. for the maximum absolute change in

head per outer iteration, 1E-05 ft. change per inner iteration, a maximum number of outer loop iterations of 200, and a maximum number of inner loop iterations of 300.

2.4.12.6.1 Model Construction

2.4.12.6.1.1 Model Cell Discretization and Property Conditions

The model domain covers a rectangular area of approximately 230 square miles (Figure 2.4-77) and consists of a parent grid with 165 rows, 95 columns, and 5 layers. The active area of the model is approximately 112 square miles. The parent grid is further subdivided using quadtree refinement into 655,950 total cells (615,265 active cells). Cell spacing ranges from 40 x 40 ft. near the three Plant Complexes to 640 x 640 ft. away from the Project site. The top surface of the model ranges from an elevation of 536 to 1,035 ft. NAVD 88 and is a combined topography-bathymetry surface. A USGS digital elevation model (DEM) was used to represent ground surface outside Belews Lake (Reference 2.4-100). Historical topographic surfaces were used to represent the Belews Lake bathymetry (Reference 2.4-101; Reference 2.4-102).

Five model layers were used to simulate hydrogeologic layers beneath the Project site, including OB, PWR, SBR, DBR, and deepest bedrock (DPR) and are shown in model cross sections (Figure 2.4-78). Note, the DPR layer is not shown in model cross sections. Each layer was assigned average hydraulic conductivity derived from Project site aquifer testing as initial parameter values in the groundwater model. Conductivity values were adjusted during the calibration process but remained within the range of site observed values. The final calibrated model input parameters for K ranges from 2.84 x 10^{-4} ft/day (8.66 x 10^{-3} m/day) to 42.4 ft/day (12.9 m/day).

Groundwater recharge is applied to the uppermost saturated layer present within the model. Recharge values were based on landcover classifications calibrated to a baseflow separation estimate of mean annual recharge for the Dan River Basin of 8.45 in/yr (Reference 2.4-74). Landcover classes thought to represent groundwater discharge areas (wetlands and open water) were set to zero recharge. Medium-intensity and high-intensity developed land was set initially to half and one quarter of the annual recharge estimate to account for impervious surfaces that would facilitate runoff. Recharge property values were adjusted during the calibration process. The final calibrated model input parameters for recharge ranges from 0 to 16.9 in/yr. The average recharge rate over the active model area is 5.84 in/yr. The lower recharge rate is attributed to the large portion of the model area covered by Belews Lake that has an input recharge value of 0 in/yr.

2.4.12.6.1.1.1 Boundary Conditions

Boundary conditions applied in the model include the River, Drain, and No-Flow (Figure 2.4-77). River cells are used to represent Belews Lake and Dan River and other larger perennial streams. River boundaries are head-dependent flux boundaries and can add or remove water from a model, depending on whether the simulated head in the model cell is above or below the assigned threshold value. Drain boundary conditions are used to simulate ephemeral and minor perennial features such as creeks, wetlands and small ponds. Drain boundaries can remove water from a model only. No Flow cells are used to represent inactive portions of the flow model. No Flow cells are set to approximate geographically realistic groundwater flow divides, such as topographic divides at the watershed boundaries. To the west, the Dan River represents a prime groundwater discharge area that would receive flow from both sides of the

river. Accordingly, no-flow cells were set on the west bank of the Dan River. To the north, several sub-catchments were included beyond the Belews Lake impoundment dam to capture any deep flow pathways that may circulate to the north. To limit model size, watersheds to the northeast were filtered to only include adjacent sub-catchments. In addition, the top, bottom and sides of the flow model are also implicit no-flow boundaries.

2.4.12.6.1.1.2 Steady State Conditions

The model is constructed to represent long-term steady-state hydraulic conditions. The available site-wide data set taken in February 2025 is used as a representative example of static conditions. Due to steady lake stages over time and a lack of significant nearby pumping, the assumption of steady-state conditions is likely to hold within the Project site. Other areas of the model domain undergoing construction or other anthropogenic modifications may exhibit temporal changes. However, the distance of potentially variable water levels from the Project site vicinity and dense spatial distribution of boundary conditions enhances the model's ability to meet the steady-state assumption.

2.4.12.6.1.1.3 Model Calibration

Model calibration is an iterative process where initial values of model input parameters are varied within hydrologically and geologically plausible ranges until model results align with constraining observations (i.e., water elevations collected in the field). The modeler, in adjusting parameter values, adheres to reasonable ranges of input parameters based on site-specific or literature values. In the process of adjusting these parameter values, the modeler determines which parameters more strongly affect model outputs. The main calibration targets for this model are water levels, groundwater flow directions, horizontal and vertical hydraulic gradients, and overall water balance.

Water level calibration targets were based on data collected in February 2025 from 24 monitoring wells. Given the range of the water levels, which spanned 83 ft. (25.2 m), a target of 10 percent or 8.30 ft. (2.52 m) was set as the average of the absolute value of the residuals. A match of observed hydraulic gradients and agreement of flow direction in the model compared to the interpreted flow directions from contouring of observed measurements is more important than precise matching of potentiometric target points.

Figure 2.4-79 depicts contoured model-simulated heads compared to interpreted potentiometric surface contours. The model-generated predicted head contours are consistent with measured data obtained across the site. In general, the model conforms to the conceptual site model in that flow directions radiate away from topographic high points on the Project site peninsula, towards Belews Lake, and that shallow unit heads are higher than those of deeper units indicating downward vertical flow gradients.

Figure 2.4-80 presents the residuals plot and a bubble plot of the computed heads versus the observed heads at the target locations. Residual statistics suggest a reasonable fit to the target data. The points lie close to a 1:1 slope line, indicating that the simulated water levels closely match observed water levels. The bubble plots show that positive and negative residuals are randomly distributed throughout the Project site area.

Final calibrated model input parameter values are presented in Table 2.4-44.

2.4.12.6.1.2 Model Water Balance

Details of the water balance for the model are summarized in Table 2.4-43. Water enters the flow model through recharge and river boundary conditions. Water leaves the model through river and drain boundary conditions. The overall internal water balance for inputs versus outputs as computed by MODFLOW is 0.00 percent, indicating a good closure of the model solver and no anomalous numerical behavior.

2.4.12.6.1.3 Model Sensitivity

During the manual adjustments of model input parameters, it became apparent that the most sensitive parameters are horizontal and vertical hydraulic conductivity and recharge for all zones immediately underlying and adjacent to site targets. This is due to the limited geographic extent of targets.

2.4.12.6.1.4 Particle Tracking

Particle tracking was conducted to assess potential groundwater flow pathways and travel times from the potential power block areas (PPBAs) to downgradient discharge areas. Particle tracking utilizes the three-dimensional calculated potentiometric flow field to estimate the path of individual water molecules from a given starting or ending location. This calculation emulates the process of groundwater advective flow. Particle tracks were run in forward mode to a maximum transit time of 10,000 years in the subsurface, or until the particle leaves the model by discharging into a surface water body. Starting locations were placed along the bounding perimeter and at the center of each PPBA. Starting particles were placed at the surface of the water table interface regardless of the layer that occurred.

Particle track simulation results are shown in plan view in Figure 2.4-81 and in cross section view in Figure 2.4-82. Tracks generally run from power blocks radially outward following the topographic and hydraulic gradient away from each PPBA. Some particles travel through shallow OB and/or PWR pathways directly to Belews Lake or ephemeral tributary streams that drain into Belews Lake. Other particles descend into shallow and deep bedrock before rising again to discharge to Belews Lake.

Minimum and median travel times were calculated from a dense particle tracking array with initial particles starting either along the perimeter or the center of the PPBA. Results indicate that the minimum travel times from the perimeter of the North, Middle and South Plant Complexes until discharging into Belews Lake or a tributary are 45.0, 35.3, and 95.6 days, respectively. The forward-tracked particles discharge directly into Belews Lake in the case of the North and Middle Plant Complexes and to an ephemeral tributary in the case of the South Plant Complex. The median simulated travel time from the perimeter of North, Middle, and South Plant Complexes to Belews Lake are 6.7, 8.1, and 7.7 years, respectively. The maximum simulated travel times are 11.3, 27.8, and 15.8 years from the perimeter of North, Middle, and South Plant Complexes to Belews Lake, respectively. The minimum travel times from the center of the North, Middle, and South Plant Complexes until discharging into Belews Lake are 75, 30, and 6.5 years, respectively. The median simulated travel time from the center of the North, Middle, and South Plant Complexes to Belews Lake are 1366, 260, and 72 years, respectively. Estimated minimum and median travel times from each Plant Complex are summarized in Table 2.4-45. Figure 2.4-83 illustrates a box and whisker distribution chart of the numerical groundwater flow model particle tracking results of travel times. Note that all travel times

presented represent saturated groundwater flow only and do not include travel time through the unsaturated vadose zone.

2.4.12.7 Monitoring or Safeguards Requirements

Groundwater level monitoring at the Project site uses the groundwater monitoring wells installed in 2024 for the subsurface investigation. As part of the evaluation for the early site permit (ESP), the groundwater monitoring wells and environmental monitoring program are evaluated with respect to the Nuclear Energy Institute Groundwater Protection Initiative (Reference 2.4-103) and 10 CFR 20.1406 to determine whether any modifications are required to adequately monitor plant effects on groundwater.

Some of the existing monitoring wells are expected to be removed from service before construction activities begin to avoid their inadvertent destruction. For long-term groundwater monitoring purposes, the remaining monitoring wells are evaluated to determine the need for replacement wells. The evaluation forms the basis for the groundwater monitoring program described in the following paragraphs. Considerations to revise the groundwater monitoring program include the following:

- Groundwater Monitoring: Periodic water level measurements in the shallow and deep zone monitoring wells and collection of geochemical samples for analysis are performed in selected monitoring wells. The water level monitoring program objective is to detect changes in flow patterns in the aquifer zones of interest that might affect accident analysis and track temporal trends in groundwater levels that might affect structural stability.

- Operational Monitoring: The process and effluent monitoring program and implementation schedule is described at the construction permit application stage.

Groundwater level measurements in the monitoring wells are collected during construction and after plant startup. The selection of monitoring wells to be included in the program is made before the start of operation. The selection process is based on well condition and position relative to the reactor and other monitoring wells to provide optimal spatial distribution for potentiometric map preparation and hydraulic gradient assessment. Additionally, the long-term viability of monitoring wells (i.e., the likelihood that the well survives construction activities) is considered in the selection process. Monitoring frequency and duration is determined during detailed design at the construction permit or license application stage.

Geochemical groundwater sampling and analysis is performed during construction and after startup. Analysis may include field parameters (e.g., potential of hydrogen [pH], temperature, specific conductance, oxidation-reduction potential, and dissolved oxygen), major cations, major anions, total dissolved solids, and silica. Sampling is performed in supply wells and selected monitoring wells. The monitoring wells to be sampled, the sampling frequency, and the sampling duration are determined later.

Safeguards minimize the potential for adverse impacts to groundwater from the construction and operation of the new reactors. These safeguards include the use of lined containment structures around storage tanks (where appropriate) and hazardous materials storage areas, emergency cleanup procedures to capture and remove surface contaminants, and other

measures deemed necessary to prevent or minimize adverse impacts to the groundwater beneath the Project site.

2.4.13 ACCIDENTAL RELEASES OF LIQUID EFFLUENTS TO GROUND AND SURFACE WATERS

2.4.13.1 Introduction and Release Scenario Description

This section describes a hypothetical liquid accidental release scenario of a volume of water containing radionuclides to groundwater and its subsequent migration to a specified receptor location. Complete design parameters for all technologies considered in this application have not yet been obtained. Specifically, one technology (GVH BWRX-300) has not yet provided a source term for the accidental liquid release scenario, while two of the other technologies (Holtec SMR-300 and NuScale VOYGR) have identified mitigating design features to preclude the release of tank inventories to the environment assuming a postulated failure of the storage tanks. Accordingly, analysis of the liquid effluents to ground and surface waters is limited here to the WEC AP300, X-energy Xe-100, and the TerraPower Natrium technologies. However, conservative assumptions expected to bound any single technology being considered were made in this evaluation. Section 2.4.13.6 summarizes the assumptions used in this analysis. Detailed computations quantifying groundwater conditions, flow direction, velocities, and travel times to potential receptors are described in Section 2.4.12, while potential accidental release parameters and fate of released constituents associated with the assessed technologies are described in this section.

The location(s) of, and travel times to, potential receptors have been determined by forward particle tracking simulating the movement of groundwater by means of the calibrated numerical groundwater flow model. Particles were seeded at the edges of the PPBAs and tracked to the nearest surface water body. Some particles travel through shallow saprolite and/or PWR pathways directly to Belews Lake or a tributary stream draining into Belews Lake. Other particles descend into shallow bedrock before rising again beneath Belews Lake to discharge. The resultant shortest particle travel times are 45.0, 35.3, and 95.6 days from the North, Middle and South Plant Complexes, respectively (Table 2.4-45). The tracked particles discharge directly into Belews Lake in the case of the North and Middle Plant Complexes and to an ephemeral tributary in the case of the South Plant Complex. For particles seeded near the centers of the PPBAs, the median simulated travel times from the North, Middle and South Plant Complexes to Belews Lake are 6.7, 8.1 and 7.7 years, respectively. It is improbable that near any of the Plant Complexes, PWR, or OB strata would be tapped for any reasonable groundwater use or that ephemeral streams would be tapped for surface water use (i.e., there are no potential receptors other than the nearest surface water).

Summaries of isotopes and activities associated with a potential accidental release are listed (by technology) in Table 2.0-5.

The envisioned conservative accidental release scenario includes the following assumptions:

- A worst-case release of liquid waste with composition as listed in Table 2.0-5 (for each technology) is introduced into groundwater. Volumes of potential release are shown in Table 2.4-47.

- The release would occur at the edge of the PPBA, which would be a shorter distance to a receptor location than if the release occurred interior to the PPBA.

- The liquid released is assumed to immediately enter groundwater and move with the groundwater toward a surface water discharge point.

- The released radionuclides move with the general groundwater flow while undergoing attenuation by sorption and radioactive decay. To be conservative, the additional attenuation mechanisms of dilution with groundwater, dispersion along the groundwater flow path, and eventual dilution with surface waters are not initially considered as a basis for comparison to later attenuation effects.

- Ephemeral streams or various points on Belews Lake or the cut-through channel/canal surface water feature between the South and Middle Plant Complexes (West Belews Creek) are the nearest potential receptors identified by the groundwater flow model for groundwater flowing beneath the Plant Complexes.

- Initially, no attenuation mechanisms are assessed as the most conservative scenario. Then, attenuation due to radioactive decay of the parent isotope (progeny decay products excluded) and retardation from sorption are considered (see Sections 2.4.13.2.1.1 and 2.4.13.2.1.2 for details on these attenuation factors).

The potential maximum activity release volume to groundwater varies with technologies and ranges between 883 and 10,000 gal.

Once a technology is selected and site utilization plan developed, further analysis will be conducted and incorporated into additional accidental release modeling and assessment for the construction permit or licensing application of the project.

2.4.13.2 Initial Assessment

The groundwater flow system downgradient of the hypothetical point of release was evaluated to identify potential exposure points and their distances from an accidental release of radionuclides to groundwater. Travel time is conservatively taken as the shortest particle tracking time along a flow path (vertical and horizontal flow) to discharge, which is 35.3 days.

Given the unattenuated travel time estimate of 35.3 days and ignoring both the attenuation of dissolved radionuclides by sorption to aquifer solids and nuclear decay as well as a more indirect path to surface water, this estimate of travel time does not rule out plausible transport and potential for exposure within realistic time periods. This is an overly conservative estimate because the potential release constituents of concern are radioactive and undergo decay, and almost all would be retarded in their transport by interactions with the aquifer solid matrix.

2.4.13.2.1 Attenuated Travel

Sorptive retardation and radioactive decay are attenuation factors affecting the potential release effects at receptor locations. Both factors attenuate (lessen) the potential exposure at receptor locations. Retardation slows the travel time allowing greater decay and spreads out the contaminant mass along the flow path leading to a smaller peak exposure, while radioactive

decay removes contaminants from the system, lessening the total amount of contaminant available and slowing arrival times and concentrations at receptor locations.

2.4.13.2.1.1 Retardation

Using the retardation factors derived from the element-specific solid/liquid partition coefficient (K_d) values for sand, the various retarded travel times for constituents are shown in Table 2.4-48. Site-specific partition coefficient samples are still under analysis and will be incorporated prior to submittal of the construction permit or license application. These retarded travel times are the conservative estimates of when the peak concentration of contaminant arrives at the potential receptor location. Because of element-specific variable spreading of the mass of contaminants in the flow path due to sorption, some of the contaminants arrive earlier than this peak time (but no sooner than the unretarded groundwater flow time [35.3 days]). Also, some of the contaminants arrive later than the peak time. The larger the retardation factor, the more the contaminant mass is spread along the flow path, relatively lessening the peak concentration for an isotope.

2.4.13.2.1.2 Radioactive Decay

Each identified isotope that may be potentially released has a distinct decay rate constant that describes how quickly that isotope's nucleus decays by a certain radioactive decay process. One of the common measures of this mechanism is an isotope's half-life. Half-life is the time needed for half of a given number of atoms to undergo a radioactive decay process and is a constant value under all practical conditions.

Half-life values depend on the isotope. An extensive, authoritative list of isotope half-lives is available from Brookhaven National Laboratory (BNL) (Reference 2.4-104). The half-lives used to determine isotopic concentrations due to groundwater transport were generally taken from this source. When not available from BNL, additional isotope information was obtained from MIRDspecs (Reference 2.4-105).

Given the retarded travel times and radioactive half-lives, the remaining percent of initial activities for individual isotopes of interest for each technology are shown in Table 2.4-48.

2.4.13.2.1.3 Assessment Using Attenuation Factors

The results (maximum remaining concentration) associated with including attenuation factors are shown in Table 2.4-48, and a summary of Unity Rule calculations by technology is provided in Table 2.4-49. Based on NRC standards, the sum of the fractions of the radionuclide concentration to the respective effluent concentration limit (ECL) value from 10 CFR Part 20, Appendix B, Table 2, column 2, should not exceed 1. Based on the Unity Rule calculations, the composition of the initial potential release materials result in sums that are above unity (i.e., exceed 1) for all assessed technologies and are predicted to exceed unity at the receptor location although at a much-reduced value.

2.4.13.3 Sensitivity Analysis

As a conservative measure, K_d values for sandy soils were obtained from AECL-10125 (Reference 2.4-106). In every case, the listed K_d value for sand is the lowest or second lowest value (and still within the same order of magnitude) listed for various soil types. Using these lower K_d values results in a smaller retardation factor and a faster estimated travel time between

an accidental release point and the potential receptor location. Use of any of the more restrictive (greater) retardation factors leads to a longer expected travel time and increased attenuation.

Because retarded travel time plays such a major part in determining the activity of a potential release once it has been transported to the potential receptor, three different travel times (based on particle tracking) were assessed: (1) shortest travel time overall (35.3 days); (2) shortest travel time from the central region of any PPBA (2369 days or 6.5 years); and (3) shortest median (50th percentile) travel time of points release in the central region of one of the three PPBAs (26,238 days or 72 years). Table 2.4-49 presents the effects of these three travel times on Unity Rule values based on the attenuation (retarded travel and radioactive decay).

There are some effects on the final interpretation of Unity Rule values based on the varying travel times. For the shortest overall travel (35.3 days), only X-energy is predicted to be below unity. For the shortest travel from the center of a PPBA (2369 days or 6.5 years), both X-energy and TerraPower are predicted to be below unity. With the median travel time from any PPBA (26,238 days or 72 years), WEC closely approaches unity but is still slightly in excess (1.01 E+00).

This analysis considers the maximum possible concentrations at the receptor (remaining activity divided by release volume) but does not consider the retardation factor's peak spreading, which would spread out the mass along the plume, generally decreasing the actual maximum activity at the reception location.

When both the reactor technology and final location are selected, it may be necessary to re-evaluate the potential impact of an accidental release to groundwater. Furthermore, it may be possible to better quantify greater attenuation due to dilution and/or dispersion. These factors will be affected by the final selected location of the hypothetical release and its flow path length to the nearest surface water.

2.4.13.4 Possible Alternative Conceptual Models

The current evaluation uses the accidental release scenario assumptions described in Section 2.4.13.1. Alternate models could assume the following:

- Different activities or identities of isotopes in accidentally released liquid waste could be considered (which could increase or decrease potential exposure).
- The release could occur elsewhere within the PPBA with or without additional mitigating factors for release control.
- The release could be contained, not mixed with groundwater, and not be transported to eventual release to surface water (which could decrease potential exposure).
- The release could be greatly diluted by mixing with groundwater and/or surface water (which could decrease potential exposure).
- Attenuation by sorption to aquifer matrix might be greater than assumed (site-specific sorption analyses still pending), leading to greater attenuation and reduction of activity at the receptor location (which could decrease potential exposure).

- The volume and/or composition and total activity of the release in the final design could be different (which could increase or decrease potential exposure).

2.4.13.5 Results

The results (maximum remaining concentration) associated with including attenuation factors are shown in Table 2.4-48, and a summary of Unity Rule calculations by technology is provided in Table 2.4-49. Based on NRC standards, the sum of the fractions of the radionuclide concentration to the respective ECL value from 10 CFR Part 20, Appendix B, Table 2, column 2 should not exceed 1.

Based on the Unity Rule calculations:

- The composition of the initial potential release materials yields a sum of ratios of concentrations to respective ECLs that are above unity (i.e., exceed 1) for all assessed technologies.

- WEC is predicted to exceed unity at the nearest receptor location after attenuated travel. TerraPower and X-energy technologies are not predicted to exceed unity at the receptor location after attenuated travel.

- For sensitivity analysis, at one-half the attenuated travel time, only X-energy technology is estimated to be below unity at the receptor location.

- For sensitivity analysis, at double the attenuated travel time, Both TerraPower and X-energy technologies are estimated to be below unity at the receptor location.

Future decisions on placement and choice of technologies may result in the modification of these results and will be incorporated into additional accidental release modeling and assessment for the construction permit or licensing application stage of the project, if necessary, including site-specific partition coefficients.

For some isotopes with short half-lives, the decrease in radioactivity with attenuated travel is substantial. However, such attenuation may not be sufficient in every case to achieve Unity Rule compliance. Unity Rule calculations for isotopes with long half-lives and great exceedances of unity after travel to a receptor location are still expected to exceed ECL acceptable values even when retardation, mixing with groundwater, dispersion, or mixing with the receiving water are considered.

Initially, potential exposure was assessed using no attenuation factors and a conservative (fast) estimate of travel time to assess activities at the surface water locations following an accidental release. Then, refinements, including conservative adsorption values and radioactive decay (crediting retardation), were added to the assessment. Of the radionuclides identified in Table 2.4-32, most have very short half-lives relative to travel time, leading to notable attenuation by radioactive decay. Many isotopes have sufficient time during travel to undergo numerous half-lives of decay time. Future choices of technology and plant placement may also reduce projected radioactivities at potential points of exposure. Additional analyses (including radioactivities of daughter-products produced during transport) will be necessary when final location and reactor technology are chosen.

2.4.13.6 Summary of Conservative Assumptions Employed in the Analysis

The shortest travel time to the closest potential receptor was estimated from particle tracking simulations based on the MODFLOW numerical groundwater flow model. Isotopes, volumes, and activities were obtained from the three technologies that provided these inputs: TerraPower, X-energy, and WEC. The concentration activity (µCi/ml) for each isotope for each technology was provided by the vendor or calculated from the supplied data at the point of potential release. Retardation factors of travel for individual elements' travel due to adsorptive retardation were based on linear sorption assumptions, and K_d values were taken from available literature values, assuming the sand-specific K_d to be least retarding. This retarded travel time was then applied to radioactive decay based on isotope-specific half-lives from literature values. Ignoring the peak-spreading of retarded travel of a solute slug and assuming the remaining radioactive solute would be released to the potential receptor at one time ("maximum possible activity concentration"), the initial release activity concentration was decayed based on the number of half-lives in the retarded travel time. Conservative aspects of these calculations include: (1) all released isotopes are immediately introduced into the groundwater flow regime for transport; (2) the generally least retarding matrix (K_d from sand) was used, leading to the shortest retarded travel time; (3) no peak activity concentration decrease during transport is expected except by radioactive decay (maximum concentration is expected to decrease with retarded travel while peak width increases); and (4) for exposure concentration aggregating (Unity Rule), all isotopes' peak activity concentration (after retarded travel and radioactive decay) are used, even though they will appear at the potential receptor at different times due to different retarded travel rates.

2.4.14 TECHNICAL SPECIFICATIONS AND EMERGENCY OPERATION REQUIREMENTS

Finished site grade is at an elevation of 810 ft. (247 m) NAVD 88. Sections 2.4.2, 2.4.3, 2.4.4, 2.4.5, 2.4.6, 2.4.7, 2.4.8, and 2.4.9 describe controlling hydrological events that may affect the Project site. Section 2.4.10 describes the flooding protection requirements for safety-related SSCs from design basis flood events. As described in Section 2.4.10, the plant will be designed and constructed to prevent flooding that could compromise any SSC in performing their intended safety function.

Accordingly, there are no requirements for emergency protective measures designed to minimize the impact of hydrology-related events on safety-related SSC, and none are incorporated into the technical specifications or emergency operating procedures. The need for such emergency protective measures will be reevaluated at the construction permit or license application stage.

Table 2.4-1
USGS Stream Gauges Near the Project Site

Gauge Number	Name	River	Latitude	Longitude	County	Drainage Area (mi^2)	Period of Record from Year	Years of Record[(a)]	Historical Monthly Mean Flow Rate (cfs)		
									Maximum	Minimum	Average
02069000[(a)]	Dan River at Pine Hall, NC	Dan River	36° 19' 09"	-80° 03' 01"	Stokes	501	1923[(a)]	88	1872[(c)]	135.5[(d)]	629
02069030[(b)]	Belews Creek near Kernersville, NC	Belews Creek	36° 12' 20"	-80° 04' 25"	Stokes	14.90	1954	17	NA	NA	NA

Notes:
(a) Not all years of complete data are available.
(b) Only station peak annual stream flow data available.
(c) Water year 2019
(d) Water year 1986
Key: mi^2 = square mile; cfs = cubic feet per second

Table 2.4-2
Monthly Mean Flows for Dan River at Pine Hall, NC, USGS 02069000
(Sheet 1 of 2)

Year	Monthly Mean in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1923	-	-	-	-	-	-	-	-	-	250	306.5	611.2
1924	845.9	611.7	644	722.5	583.2	531.4	947.7	462.5	953.2	571.5	329	648.9
1925	1030	698.9	523.8	403.2	605	240.2	219.6	169.5	182	168.3	303.2	253.6
1926	613.6	638.4	489.5	-	-	-	-	-	-	-	-	-
1986	-	-	-	349.5	272.6	167.6	135.5	251.2	246.5	188.3	314.1	587.1
1987	533.8	1000	1443	2901	1006	500.6	665.9	278.5	822.9	239.7	364.3	634.9
1988	631.4	502	412.9	477.6	337.8	235.8	272.6	205.1	221.2	211	325.2	262.6
1989	327.5	570.1	979.4	554	1138	1435	1246	797.5	871.1	1432	660.8	714.2
1990	1339	1894	1551	1159	1437	776.1	724.7	387.4	268	1696	716.7	-
2008	-	-	-	-	-	-	-	-	-	-	-	454.3
2009	567.4	249.5	678.8	623.1	816.3	1137	331.3	241	207.9	176.9	888.8	1262
2010	1567	1346	993.2	651.3	402.2	395.2	269.2	459.2	372.4	619.2	312	433.7
2011	302.8	306	947.2	719.6	530.6	286.2	198.4	154.2	260.2	232.3	455.6	790.5
2012	496.7	417.2	752.2	421.1	1044	479.5	290.8	257.5	358.7	269	216.2	317.9
2013	1305	742.3	664.9	707.2	973.5	836.5	1137	574.4	365.4	355.9	438.1	903.9
2014	998.9	872.9	794.2	1015	511.1	318	241.8	348.4	303.2	263.1	355.5	341.7
2015	433.4	389.6	522	792	312	288.1	247.5	253.3	570.5	816.7	984.9	1562
2016	948.5	1584	777.7	614.1	1258	371.1	352.3	734.9	240.2	284.5	216.4	270.8
2017	575.3	288.6	307.3	1574	1337	593.5	287	255.2	239.7	274.5	254.3	244.4
2018	282.8	817	596.9	837.4	1066	411.8	324.5	648.5	1236	1191	1267	1871

Table 2.4-2
Monthly Mean Flows for Dan River at Pine Hall, NC, USGS 02069000
(Sheet 2 of 2)

Year	Monthly Mean in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2019	1413	1872	1092	1041	677.5	1092	492.5	356.5	224.8	389.4	505.5	816.1
2020	883	2238	707.6	1001	2090	881.3	467.9	808.6	583.7	1079	2012	1400
2021	992	1627	1205	884.6	562.5	530.6	554.8	422.8	591.3	309.4	255.4	240.6
2022	411.5	841	702.8	548.2	753.5	371.9	379.6	363.2	415.1	292.7	538	783.9
2023	763.7	921.1	649.5	680.8	501.9	535.9	316.1	443.7	247.9	173.3	-	-
Mean of Monthly Discharge	785	929	792	849	828	564	459	403	445	499	546	700

Source: Reference 2.4-47.
Key: cfs = cubic feet per second, NC = North Carolina; USGS = U.S. Geological Survey

Table 2.4-3
Monthly Mean Flows for Dan River near Wentworth, NC, USGS 02071000
(Sheet 1 of 5)

Year	Monthly Mean in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1939	-	-	-	-	-	-	-	-	-	-	-	628.9
1940	707	1128	994.1	1361	1100	1038	1101	3067	767.3	526.1	1282	962.3
1941	980.4	771.2	910.8	1144	546	574	2188	610.5	672.9	334.5	408.4	670.6
1942	772.2	1184	1379	690.4	1839	1761	717.1	1656	1244	870.1	660	1226
1943	1594	1998	1932	1892	1063	1653	1853	668.1	469.3	450.1	474.9	559.9
1944	910.5	1632	2731	1766	952.5	695.2	868.4	483.6	1630	1712	826	1100
1945	1493	1698	1165	1130	1045	670.3	929.6	559.5	3292	853.5	1120	2238
1946	2332	1969	1385	1040	1751	923.6	915.6	628	604.1	652.8	754.4	675.7
1947	2212	862.9	1326	1587	977.9	1185	764.9	626.3	1115	1792	1614	862
1948	1081	2076	1963	2368	1486	1167	797.5	827.6	569.6	704.2	1489	2163
1949	1772	1615	1444	1788	2431	1397	2345	1998	1478	1223	1336	939.8
1950	1005	1292	1361	1009	2138	1150	868.8	819.9	865.4	767.7	646.3	1212
1951	752	1468	1402	2196	1000	920.1	653.8	624.4	362.7	320.3	537.1	1424
1952	1028	1365	3329	1664	1281	762.7	549.5	984.2	1006	466.1	628.1	694.6
1953	1470	2035	2652	1264	887.5	1093	576	386	289.6	237.5	297.4	717.1
1954	1962	901.3	1344	949.1	869.4	649.2	499.4	366.5	165.6	1341	790.9	1152
1955	652.5	1543	1480	2341	989.4	863.9	867	964.7	390.8	406.2	414.4	422
1956	392.3	1104	1046	1739	607.2	386.8	338.3	296.5	864	807	632.6	1144
1957	846.4	2146	1342	2424	817.3	1317	600.5	517.5	1789	1015	2963	1799
1958	1598	1576	1564	3279	2168	1170	841.4	931.8	463.4	534.6	538.3	1429

Table 2.4-3
Monthly Mean Flows for Dan River near Wentworth, NC, USGS 02071000
(Sheet 2 of 5)

Year	Monthly Mean in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1959	1098	875.1	1085	1690	806.7	586.2	613.4	615.3	1705	3676	1066	1646
1960	1698	4308	3019	2871	1935	1096	784.1	863.6	945.4	710.5	651.1	666.5
1961	1023	2165	2218	2127	1174	1501	795.7	960.9	562.3	444.3	557.8	1867
1962	1842	2246	1666	2219	1110	1997	1040	763.9	613.9	561.7	1774	1694
1963	1353	1205	3479	1014	983.1	722	573.5	353.6	459.9	343.4	596.2	511.5
1964	1741	1809	1292	1434	708.4	488.3	1479	926	935.3	2192	1093	1296
1965	1483	2359	2599	1571	1092	870.2	1034	841.6	505.4	894.5	548.5	489.1
1966	568.3	2600	1711	790.4	1070	545.8	346.4	532	520.2	725.4	571.4	677.1
1967	1034	1082	765	608	874.3	449.4	416.5	728	388.1	382	380.1	1531
1968	1557	910.8	1590	993.2	868.8	744.1	548.1	479.4	194.4	829.6	919.1	665.5
1969	775.8	1200	1556	1115	947.7	1716	762	1053	672.3	640.6	622.6	1251
1970	1054	1606	961.9	1158	1081	763.8	752.9	2523	464.3	917.9	1435	826.5
1971	1250	2404	1654	1356	2143	1078	872.3	851.3	648.4	1960	1625	1306
1972	1525	1893	1459	1875	3149	4220	1536	925.8	978.3	912.3	1960	2284
1973	1726	2499	2790	2555	1995	1427	1094	1167	648.2	749.7	721.1	2433
1974	2586	1821	1558	2948	1691	1242	982.4	1389	1554	575.2	520.3	1321
1975	2093	1753	5345	2002	1521	1640	1770	759.2	1400	1150	840.4	920.3
1976	1593	1181	1109	963.2	753.5	968.9	564.4	363.4	328.2	1852	922.4	1610
1977	818.5	799.8	1125	1443	598.7	449.7	331.7	280.8	412.5	947.6	1033	1226
1978	3274	1119	2424	1997	2358	1000	1469	1210	657.9	475.3	558.3	1320

Table 2.4-3
Monthly Mean Flows for Dan River near Wentworth, NC, USGS 02071000
(Sheet 3 of 5)

Year	Monthly Mean in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979	2966	3001	3021	2120	1530	1236	929.4	629.4	3667	2069	1469	1012
1980	1835	1004	2436	2986	1525	1053	899.5	548.4	465.3	559.8	642.4	587.1
1981	526.2	828.9	705.2	732.7	515.4	491	418.4	218.1	856.4	484	407.7	849.2
1982	1387	1817	1425	1199	1140	2250	680.7	572.6	369	483.5	703.9	1207
1983	776.2	2000	2233	3388	1375	1005	628.5	434.1	300.3	594.3	1101	1658
1984	1299	2322	2883	1835	2214	945.5	1589	909.6	500.7	569.1	582.8	583.7
1985	840.1	1480	661.4	591.7	718.1	473.4	607.8	2249	503.3	620.3	2383	1200
1986	705.5	908.4	1063	637.9	535.9	332.7	267.5	481.5	528.7	366.6	620.6	1242
1987	1096	1824	3467	4951	1689	896.5	1388	531.6	1790	541.9	774.7	1106
1988	1159	937.6	770.8	951.3	672.5	479.4	545.4	382.9	462.2	418.6	711.2	529.6
1989	660.7	1149	1984	1058	2105	2387	2056	1189	1561	2506	1057	1233
1990	2187	3204	2360	1868	2522	1152	1276	615.5	492.6	2854	1151	1875
1991	2365	1314	3277	2170	1773	1177	959.3	787.9	605.1	455.6	512.5	825.1
1992	1354	972.7	1065	1876	1099	1657	628.4	803.8	678.8	638	1619	1117
1993	2397	1342	4273	2506	1497	1017	1027	653.4	664.5	452.9	631.7	1009
1994	1475	1772	3893	1456	873.8	778.5	1396	1162	694	594.6	687	775.3
1995	1553	1158	1253	667.4	851.1	1234	873.1	502.3	401.6	904.8	1054	650.7
1996	2173	1634	1277	1038	1413	1729	665.2	1246	2639	1467	1199	2458
1997	1436	1835	2510	2418	1384	1283	786.2	554.6	516.7	522.6	599.8	686.1
1998	2321	2467	1845	2477	1795	943.8	584.7	544.2	348.4	360.3	395.2	646.5

Table 2.4-3
Monthly Mean Flows for Dan River near Wentworth, NC, USGS 02071000
(Sheet 4 of 5)

Year	Monthly Mean in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	1032	797.4	824.7	862.4	1088	426.3	548.3	296.3	665.8	571.1	498.3	712.7
2000	859	932.5	1023	1343	684.9	557.2	351.5	376.2	856.8	336	371	417
2001	630.2	583.1	1177	894.5	686.7	486.8	373.1	522.6	283.3	219.2	231.4	398
2002	598.8	517.9	810.5	520.3	411.4	232.7	202.1	101.7	231.9	425	1048	1262
2003	728.2	1728	3319	3227	1721	2960	1796	2500	1815	991.7	1188	1706
2004	1115	1773	1015	1409	952.1	1226	831.8	910.3	2399	1217	1483	1519
2005	1484	1261	1874	1403	1043	958.3	1402	953.5	480.5	1131	840.7	1396
2006	1693	1018	775	732.3	616.3	757.3	714	462.6	1087	684.2	1695	1018
2007	2751	1124	1972	1320	729.1	633.2	563	285	474	533.1	415.9	622.5
2008	628.3	791.1	808.5	1362	1212	427.2	290.5	330.6	393.8	343.4	414	941.3
2009	1186	613.2	1302	1222	1245	1741	551.2	425.8	398.8	408.7	2112	2298
2010	2781	2442	1915	1361	968.9	677.5	473.1	822.6	799.8	1351	628.6	878.4
2011	652.1	657.8	1795	1400	1105	600.3	420.4	260	501.1	496.7	1011	1406
2012	968.7	800.4	1446	839	1518	820.3	574.1	448.6	612.7	482.2	384.9	593.5
2013	2484	1391	1257	1355	1813	1573	1727	1026	649.5	651.3	806.5	1584
2014	1794	1576	1511	1852	970.4	622.2	448.3	648.5	592.6	530.5	683.2	703.2
2015	809.5	755.6	989.1	1465	644.5	598.8	486.3	409.8	1371	1747	1893	2889
2016	1816	2953	1447	1196	2275	826.6	780.1	1202	472.6	650.6	410.3	495.4
2017	1169	634.2	656.8	2971	2696	1589	621.2	528	510.2	507	457.7	445.5
2018	509.8	1471	1131	1562	1942	721.1	716.9	1508	2883	2693	2788	3935

Table 2.4-3
Monthly Mean Flows for Dan River near Wentworth, NC, USGS 02071000
(Sheet 5 of 5)

Year	Monthly Mean in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	3002	3743	2340	2119	1315	2105	988.7	699.4	443.4	782.7	1024	1594
2020	1756	4478	1408	1886	5040	1939	1038	1597	1183	2059	3927	2978
2021	2074	3347	2486	1776	1102	1031	1140	808.4	1005	577.5	522.6	504.3
2022	918.8	1610	1451	1090	1547	680.3	693.5	845.1	863.1	571.3	1073	1556
2023	1549	1892	1291	1450	1046	1160	623.8	857.8	526.1	373.7	425.5	1220
2024	3368	1427	1834	-	-	-	-	-	-	-	-	-
Mean of Monthly Discharge	1440	1620	1770	1640	1340	1080	864	815	859	878	958	1200

Source: Reference 2.4-48

Key: cfs = cubic feet per second; NC = North Carolina; USGS = U.S. Geological Survey

Table 2.4-4
Belews Creek Watershed Dams

NAT ID	Dam Name	County	Latitude (degrees)	Longitude (degrees)	Year (Inspection)	Dam Height (ft.)	Dam Length (ft.)	Max Storage (ac-ft)	Emergency Spillway	Crest Elevation (ft. NGVD 29)	Type
NC05942	Belews Lake Dam	Rockingham	36.3200	-80.0244	2021	170	3200	263,490	No	743	Earth
NC03882	Williams Lake Dam	Rockingham	36.2819	-80.0167	2014	26.4	195	31	No	-	Earth
NC02748	Beaman Farm Lake Dam	Guilford	36.2530	-80.0280	2014	27.8	235	64	No	-	Earth
NC01595	Merchants Lake Dam Upper	Guilford	36.2400	-80.0100	2022	29.3	253	45	No	-	Earth
NC01596	Merchants Lake Dam Lower	Guilford	36.2380	-80.0130	2014	26.2	333	35	No	-	Earth
NC01581	Honkers Hollow Dam	Guilford	36.2330	-79.9920	2015	25.1	242	40	No	-	Earth
NC01594	Thompson Lake Dam	Guilford	36.2190	-80.0260	2014	32.2	308	64	No	-	Earth
NC01593	Pope Lake Dam	Guilford	36.2140	-80.0020	2022	34.7	221	83	No	-	Earth
NC00429	Tandon Lake Dam	Forsyth	36.1956	-80.0531	2014	22	400	55	No	-	Earth
NC00315	Kernersville Water Supply Dam	Forsyth	36.1545	-80.1006	2021	20	650	300	No	-	Earth
NC00314	Walker Lake Dam	Forsyth	36.1440	-80.0750	2020	35	300	70	No	-	Earth

Source: Reference 2.4-38
Key: ft. = feet; ac-ft = acre-feet; NGVD 29 = National Geodetic Vertical Datum of 1929

Table 2.4-5
Belews Creek River Frequency Peak Discharges

Flooding Source and Location	Drainage Area (mi^2)	Peak Discharges (cfs)			
		10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Belews Creek					
Approximately 500 ft. upstream of confluence of West Belews Creek	50.49	-	-	8642	-
Confluence of Belews Creek Tributary 2	46.65	-	-	8226	-
Approximately 0.6 mi. upstream of confluence with Belews Creek Tributary 2	46.38	-	-	8196	-
Approximately 0.9 mi. upstream of confluence with Belews Creek Tributary 2	45.89	-	-	8142	-
Confluence with Belews Creek Tributary 3	42.62	-	-	7774	-
Approximately 750 ft. upstream of confluence of Belews Creek Tributary 3	42.54	-	-	7766	-
Approximately 0.6 mi. downstream of Forsyth / Stokes County Boundary	42.06	-	-	7710	-
Approximately 120 ft. upstream of Forsyth / Stokes County Boundary	40.52	-	-	7532	-
Approximately 1550 ft. upstream of Forsyth / Stokes County Boundary	40.12	-	-	7486	-
Belews Creek Tributary 1 of Tributary 3					
Confluence with Belews Creek Tributary 3	2.00	-	-	1143	-
Belews Creek Tributary 2					
Confluence with Belews Creek	3.15	-	-	1527	-
Approximately 660 ft. downstream of Rockingham / Stokes County Boundary	3.05	-	-	1494	-

Source: Reference 2.4-9

Key: mi^2 = square mile; cfs = cubic feet per second; ft. = feet; mi. = mile

Table 2.4-6
Belews Creek Near Kernersville, NC, Peak Streamflow

Water Year	Date	Gauge Height (ft.)	Streamflow (cfs)
1969	1969-08-16	24.36	3600
1955	1954-10-15	23.98	2500
1959	1959-09-07	23.75	2050
1965	1964-10-18	23.40	1500
1963	1962-12-04	23.16	1180
1970	1970-08-10	22.91	950
1961	1961-06-21	22.88	860
1956	1956-09-00	22.76	780
1954	1954-01-00	22.71	760
1960	1960-02-18	22.69	740
1971	1971-05-13	22.64	710
1951	1957-02-00	22.61	700
1958	1958-04-28	22.50	630
1966	1966-02-28	22.44	600
1962	1962-01-06	22.18	460
1964	1964-01-25	21.97	430
1968	1968-07-12	22.01	400

Source: Reference 2.4-49
Key: ft. = feet; cfs = cubic feet per second; NC = North Carolina

Table 2.4-7
Surface Water Users

Facility ID	Facility Name	Owner Name	Latitude (degrees)	Longitude (degrees)	River Basin	Stream Name	Divert Amount (mgd)	Divert Amount (ac-ft per year)	Use	Priority Date	County
0057-0013	Belews Creek Steam Station	Duke Energy Carolinas, LLC	36.3	-80.1	Roanoke River (14-1)	Belews Creek Reservoir	1292	1,448,185	Industrial (Energy)	2022	Stokes
0057-0022	Dan River Combined Cycle Station	Duke Energy Carolinas, LLC	36.5	-79.72	Roanoke River (14-1)	Dan River	3.633	4072	Industrial (Energy)	2022	Rockingham
02-79-030	Town of Madison	Town of Madison, NC	36.3	-80.0	Roanoke River	Dan River	1.5	1,681	Drinking	1972	Rockingham
02-79-010	City of Eden	City of Eden, NC	36.49	-79.76	Roanoke River	Dan River	5.0	5,604	Drinking	1950	Rockingham

Source: Reference 2.4-17

Key: mgd = million gallons per day; ac-ft = acre-feet

Table 2.4-8
Annual Peak Discharges and Water Level in Belews Creek Near Kernersville, NC, USGS 2069030

Water Year	Date	Peak Discharges (cfs)	Gauge Height (ft.)
1954	1/1/1954	760	22.71
1955	10/15/1954	2500	23.98
1956	9/1/1956	780	22.76
1957	2/1/1957	700	22.61
1958	4/28/1958	630	22.50
1959	9/7/1959	2050	23.75
1960	2/18/1960	740	22.69
1961	6/21/1961	860	22.88
1962	1/6/1962	460	22.18
1963	12/4/1962	1180	23.16
1964	1/25/1964	430	21.97
1965	10/18/1964	1500	23.40
1966	2/28/1966	600	22.44
1968	7/12/1968	400	22.01
1969	8/16/1969	3600	24.36
1970	8/10/1970	950	22.91
1971	5/13/1971	710	22.64

Key: cfs = cubic feet per second; ft. = feet; NC = North Carolina; USGS = U.S. Geological Survey

Table 2.4-9
Annual Peak Discharges and Water Level in the Dan River at Pine Hall, NC, USGS 2069000

Water Year	Date	Peak Discharges (cfs)	Water Level (ft.)
1987	3/1/1987	20,700	24.53
1988	1/20/1988	3370	8.39
1989	5/6/1989	13,000	18.59
1990	10/2/1989	10,700	-
2009	1/7/2009	10,700	17.35
2010	1/25/2010	27,800	25.77
2011	10/28/2010	11,900	18.29
2012	5/14/2012	11,100	17.58
2013	1/18/2013	13,000	21.03
2014	1/11/2014	11,400	17.84
2015	4/20/2015	13,700	21.42
2016	12/24/2015	13,800	20.73
2017	4/24/2017	16,700	22.66
2018	9/17/2018	20,500	24.91
2019	10/12/2018	-	25.52
2019	2/24/2019	18,300	23.64
2020	2/7/2020	26,200	27.94
2021	11/12/2020	25,800	27.76
2022	5/27/2022	9240	16.42
2023	8/28/2023	8920	16.10

Note: Gauge height is 563.3 ft. NAVD 88.

Key: cfs = cubic feet per second; ft. = feet; NAVD 88 = North American Vertical Datum of 1988; NC = North Carolina; USGS = U.S. Geological Survey

Table 2.4-10
Annual Peak Discharges in the Dan River Near Wentworth, NC, USGS 2071000
(Sheet 1 of 5)

Water Year	Date	Peak Discharge (cfs)	Water Level (ft.)
1908	1908	-	34.90
1937	1937	-	29.80
1940	8/15/1940	34700	26.90
1941	7/17/1941	17000	19.20
1942	5/22/1942	18600	20.04
1943	4/20/1943	18100	19.76
1944	3/30/1944	13100	16.63
1945	9/18/1945	38100	27.78
1946	1/8/1946	12800	16.45
1947	9/25/1947	16000	18.56
1948	10/10/1947	20000	21.47
1949	7/12/1949	16000	18.93
1950	10/31/1949	10600	15.00
1951	2/8/1951	12200	16.44
1952	12/22/1951	16400	19.09
1953	3/24/1953	19600	20.47
1954	1/23/1954	19700	20.75
1955	10/16/1954	26500	22.79
1956	4/16/1956	14800	18.18
1957	9/18/1957	21500	22.38
1958	11/20/1957	18200	20.90

Table 2.4-10
Annual Peak Discharges in the Dan River Near Wentworth, NC, USGS 2071000
(Sheet 2 of 5)

Water Year	Date	Peak Discharge (cfs)	Water Level (ft.)
1959	12/29/1958	19900	20.90
1960	10/1/1959	22500	21.72
1961	3/9/1961	14500	-
1962	6/13/1962	15900	19.69
1963	3/13/1963	26400	24.20
1964	1/25/1964	15100	19.22
1965	10/17/1964	21000	22.20
1966	2/14/1966	17000	19.59
1967	10/19/1966	6910	-
1967	8/24/1967	-	11.44
1968	3/13/1968	11600	16.63
1969	10/20/1968	13600	18.20
1970	8/11/1970	28300	24.82
1971	10/31/1970	20900	22.16
1972	6/22/1972	54200	31.60
1973	2/3/1973	18100	20.38
1974	4/5/1974	19300	21.09
1975	3/30/1975	27600	24.61
1976	1/1/1976	9330	13.73
1977	10/10/1976	17700	20.12
1978	1/26/1978	23700	23.07

Table 2.4-10
Annual Peak Discharges in the Dan River Near Wentworth, NC, USGS 2071000
(Sheet 3 of 5)

Water Year	Date	Peak Discharge (cfs)	Water Level (ft.)
1979	9/23/1979	39400	28.12
1980	4/10/1980	20200	21.58
1981	9/7/1981	8790	13.17
1982	6/14/1982	12700	16.13
1983	4/10/1983	17800	20.13
1984	3/29/1984	16700	19.39
1985	8/19/1985	30800	25.56
1986	11/5/1985	22100	22.31
1987	3/2/1987	34000	26.58
1988	1/20/1988	5980	9.32
1989	7/6/1989	16800	19.50
1990	10/2/1989	23100	22.77
1991	3/30/1991	27400	24.44
1992	4/22/1992	19500	21.03
1993	3/4/1993	21500	22.01
1994	3/28/1994	21400	21.98
1995	1/15/1995	14400	17.58
1996	9/6/1996	21400	21.96
1997	4/29/1997	16800	19.45
1998	4/18/1998	18100	20.14
1999	5/14/1999	11000	14.47

Table 2.4-10
Annual Peak Discharges in the Dan River Near Wentworth, NC, USGS 2071000
(Sheet 4 of 5)

Water Year	Date	Peak Discharge (cfs)	Water Level (ft.)
2000	3/21/2000	7390	10.88
2001	3/30/2001	10000	13.53
2002	3/18/2002	4740	7.80
2003	3/21/2003	35200	26.91
2004	9/29/2004	27200	24.42
2005	7/8/2005	13000	16.17
2006	10/8/2005	12200	14.75
2007	1/1/2007	24600	22.78
2008	5/9/2008	15400	17.30
2009	1/7/2009	15100	17.08
2010	1/26/2010	28900	24.68
2011	10/28/2010	16000	17.72
2012	3/25/2012	12200	14.76
2013	1/18/2013	19700	20.12
2014	1/12/2014	15100	17.05
2015	9/30/2015	21400	21.71
2016	12/25/2015	18300	20.05
2017	4/25/2017	24200	23.14
2018	9/18/2018	28900	24.88
2019	10/12/2018	27100	24.27
2020	2/7/2020	40900	28.39

Table 2.4-10
Annual Peak Discharges in the Dan River Near Wentworth, NC, USGS 2071000
(Sheet 5 of 5)

Water Year	Date	Peak Discharge (cfs)	Water Level (ft.)
2021	11/13/2020	38500	27.62
2022	5/27/2022	12200	14.93
2023	12/23/2022	12600	15.39

Note: Gauge height is 512.3 ft. NAVD 88.

Key: cfs = cubic feet per second; ft. = feet; NAVD 88 = North American Vertical Datum of 1988; NC = North Carolina; USGS = U.S. Geologic Survey

Table 2.4-11
Project Site Short Duration Local PMP Depths

Duration	Area (mi^2)	Multiplier	Applied to	PMP Depth (in.)
6 hr.	10	NA	NA	29.2 (HMR-51 Figure 18)
1 hr.	1	NA	NA	18.8 (HMR-52 Figure 24)
30 minute	1	0.744 (HMR-52 Figure 38)	1-hr., 1-mi^2 PMP	14.0
15 minute	1	0.518 (HMR-52 Figure 37)	1-hr., 1-mi^2 PMP	9.7
5 minute	1	0.328 (HMR-52 Figure 36)	1-hr., 1-mi^2 PMP	6.2

Key: mi^2 = square mile; PMP = probable maximum precipitation; in. = inch; hr. = hour

Table 2.4-12
Manning's Roughness Coefficients

Manning's Roughness Category	Manning's Roughness Coefficient		
	High[a]	Medium[a]	Low[a]
Grass	0.4[b]	0.2[b]	0.03[c]
Gravel	0.1[b]	0.04[b]	0.02[d]
Pavement	0.05[b]	0.02[b]	0.011[e]

Source: From ADWR's State Standard for Identification of and Development Within Sheet Flow Areas (Reference 2.4-1).From USDA TR-55 (Reference 2.4-43).

Notes:

(a) The categories "high," "medium," and "low" reflect the range of guidance for Manning's roughness coefficients for each land cover type.

(b) From the FLO-2D Reference Manual (Reference 2.4-11).

(c) From Open-Channel Hydraulics (Reference 2.4-6).

Table 2.4-13
Project Site FLO-2D Result Summary

Models	Max. MWSEL (ft. NAVD 88)[(a)]	Site Finish Grade (ft. NAVD 88)	Building Finish Grade (ft. NAVD 88)[(b)]	Max. Flood Depth (ft.)[(c)]
Column ID	**A**	**B**	**C**	**D**
North Plant Complex	811.04	810	810.5	0.54
Middle Plant Complex	811.69	810	810.5	1.20
South Plant Complex	811.17	810	810.5	0.67

Notes:

(a) Maximum water surface elevations (MWSEL) are representative of the majority of the site. There are spots with higher elevations. A detailed study during COLA will identify elevations near safety-related doors of safety-related building(s).

(b) It is assumed that the building finish grades are 6 in. higher than the site finish grade. (COL C = COL B + 6")

(c) Flood depth is calculated by subtracting max water surface elevation from building finish grade. (COL D = COL A – COL C)

Key: MWSEL = maximum water surface elevations; ft. = feet; NAVD 88 = North American Vertical Datum of 1988

Table 2.4-14a
All-Season PMP Precipitation Depths in Inches for the Basin with Storm Center at Watershed Center

Basin Size (mi^2)	6 hr.	12 hr.	24 hr.	48 hr.	72 hr.
10	29.2	34.5	38.8	42.7	44.2

Key: mi^2 = square mile; hr. = hour; PMP = probable max precipitation

Table 2.4-14b
Depth-Duration Precipitation Values for Envelope Basins in Inches with Storm Center at Watershed Center

6-hr. Time Period	6 hr.	12 hr.	18 hr.	24 hr.	30 hr.	36 hr.	42 hr.	48 hr.	54 hr.	60 hr.	66 hr.	72 hr.
10 mi^2 Cumulative (in.)	29.2	34.5	36.7	38.8	39.8	40.8	41.7	42.7	43.1	43.4	43.8	44.2
10 mi^2 Incremental (in.)	29.2	5.3	2.2	2.1	1	1	0.9	1	0.4	0.3	0.4	0.4
10 mi^2 Incremental (in/hr)	4.87	0.88	0.37	0.35	0.17	0.17	0.15	0.17	0.07	0.05	0.07	0.07

Key: hr. = hour; mi^2 = square mile(s); in. = inch

Table 2.4-14c
Depth-Duration Precipitation Values for Envelope Basins in Inches with Storm Center at Watershed Center for 40% PMP

6-hr. Time Period	6 hr.	12 hr.	18 hr.	24 hr.	30 hr.	36 hr.	42 hr.	48 hr.	54 hr.	60 hr.	66 hr.	72 hr.
10 mi^2 Cumulative (in.)	11.7	13.8	14.7	15.5	15.9	16.3	16.7	17.1	17.2	17.4	17.5	17.7
10 mi^2 Incremental (in.)	11.7	2.12	0.88	0.84	0.4	0.4	0.36	0.4	0.16	0.12	0.16	0.16
10 mi^2 Incremental (in/hr)	1.95	0.35	0.15	0.14	0.07	0.07	0.06	0.07	0.03	0.02	0.03	0.03

Key: hr. = hour; mi^2 = square mile; in. = inch(es); PMP = probable maximum precipitation

Table 2.4-14d
Precipitation Depths in Inches for Each Realigned 6-Hour Time Period According to the Standardized Temporal Distribution from HMR-52

6-hr. Increment Number	12	11	10	9	7	6	5	3	1	2	4	8
6-hr. Time Period from Table 2.4-14c	72	66	60	54	42	36	30	18	6	12	24	48
Time Period	0-6 hr.	6-12 hr.	12-18 hr.	18-24 hr.	24-30 hr.	30-36 hr.	36-42 hr.	42-48 hr.	48-54 hr.	54-60 hr.	60-66 hr.	66-72 hr.
10 mi^2 Incremental PMP (in.)	0.3	0.4	0.4	0.4	1.0	1.0	1.0	2.2	29.2	5.3	2.1	0.9
10 mi^2 Incremental PMP (in/hr)	0.07	0.07	0.05	0.07	0.15	0.17	0.17	0.37	4.87	0.88	0.35	0.17

Key: hr. = hour; in. = inch; mi^2 = square mile; PMP = probable maximum precipitation

Table 2.4-15
Curve Number Combinations

Land Use Description	Hydrologic Soil Group			
	A	B	C	D
Water	100	100	100	100
Medium Residential	57	72	81	86
Forest	30	58	71	78
Agricultural	67	77	83	87

Source: Reference 2.4-32

Table 2.4-16a
Belews Lake Dam Spillway Characteristics

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Key: ft. = feet

Table 2.4-16b
Belews Lake Dam Gated Spillway Flow Estimation

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Key: WSEL = water surface elevation; ft. = feet; NAVD 88 = North American Vertical Datum of 1988; cfs = cubic feet per second

Table 2.4-17
Manning's Roughness Coefficients

Manning's Roughness Category	Manning's Roughness Coefficient		
	High	Medium	Low
Cultivated Crop	0.05	0.035	0.02
Hay/Pasture/ Grassland	0.05	0.027	0.025
Pavement and Buildings	0.05	0.03	0.011
Water	0.05	0.038	0.025

Sources: Reference 2.4-43; Reference 2.4-36; Reference 2.4-6

Table 2.4-18
Wind Runup Calculation

Case: Belews Creek Irregular Wave Runup on Smooth Slope Linear		
Item	**Value**	**Units**
Deepwater significant wave height:	1.49	ft.
Peak energy wave period:	1.72	sec.
Cotangent of beach slope:	2.75	ft/ft
Maximum wave runup:	3.87	ft.
Runup exceeded by 2% of runups:	3.08	ft.
Average of highest 1/10 of runups:	2.81	ft.
Average of highest 1/3 of runups:	2.28	ft.
Average wave runup:	1.45	ft.

Key: ft. = feet; ft/ft = feet per foot; sec. = second

Table 2.4-19
Calculation of Total Water Surface Elevation Due to PMF

Point of Interest	Average Depth Along Fetch (ft.)	Fetch Length (ft.)	Design Wind Speed (mph)	Wind Speed Duration (minute)	H_{mo} (ft.)	T_p (sec.)	Wave length (ft.)	Wind Setup (ft.)	H1% (ft.)	Wave Runup (ft.)	PMF WSEL (ft. NAVD 88)	Total Water Level (ft. NAVD 88)[(a)]
Slopes around the Plant	126.5	9370	50	10	0.89	1.72	15.2	0.01	1.49	1.45	746.4	747.86

Note:

(a) Total Water Level = PMF WSEL + Wave Runup + H1%

Key: ft. = feet; mph = miles per hour; NAVD 88 = North American Vertical Datum of 1988; PMF = probable maximum flood; sec. = second; WSEL = water surface elevation

Table 2.4-20a
2-Year Wind Speed Conversion to 1 Hour

Input		
Fastest-Mile Windspeed (U_f), mph:		50
Calculation		
Time to Travel One Mile (t) = 3600/U_f, sec.:		72
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.22
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	N/A
Result		
One-Hour Average Windspeed [$U_{3600} = U_f/U_t/U_{3600}$), mph:		40.9

Source: Figure II-2-1 from Reference 2.4-33

Notes:

(a) U_f = Fastest-Mile Windspeed.

(b) U_{3600} = One-hour Averaged Windspeed.

(c) U_t = t-hour Averaged windspeed.

Key: mph = miles per hour; N/A = Not Applicable; sec. = second

Table 2.4-20b
2-Year Wind Speed Conversion to 5 Minutes

Input		
Known Windspeed (U_{one}), mph:		40.9
Duration of Known Windspeed, min:		60
Duration of Windspeed of Interest (x), min:		5
Calculation		
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.00
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	1
One-Hour Average Windspeed [$U_{3600} = U_f/(U_t/U_{3600})$, mph:		40.9
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.09
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	N/A
One-Hour Average Windspeed [$U_t = U_{3600}(U_t/U_{3600})$, mph:		44.6
Result		
Windspeed of Interest ($U_t = U_{3600(t)}$ [U_t/U_{3600}]), mph:		44.6

Source: Figure II-2-1 from Reference 2.4-33

Notes:

(a) Uf = Fastest-Mile Windspeed

(b) U3600 = One-hour Averaged Windspeed

(c) Ut = t-hour Averaged Windspeed

Key: mph = miles per hour; N/A = Not Apllicable; sec. = second

Table 2.4-20c
2-Year Wind Speed Conversion to 10 Minutes

Input		
Known Windspeed (U_{one}), mph:		40.9
Duration of Known Windspeed, min:		60
Duration of Windspeed of Interest (x), min:		10
Calculation		
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.00
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	1
One-Hour Average Windspeed [$U_{3600} = U_f/(U_t/U_{3600})$, mph:		40.9
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.05
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	N/A
One-Hour Average Windspeed [$U_t = U_{3600}(U_t/U_{3600})$, mph:		42.9
Result		
Windspeed of Interest ($U_t = U_{3600(t)}$ [U_t/U_{3600}], mph:		42.9

Source: Figure II-2-1 from Reference 2.4-33

Notes:

(a) U_f = Fastest-Mile Windspeed.

(b) U_{3600} = One-hour Averaged Windspeed.

(c) U_t = t-hour Averaged Windspeed.

Key: mph = miles per hour; N/A = Not Applicable; sec. = second

Table 2.4-20d
2-Year Wind Speed Conversion to 15 Minutes

Input		
Known Windspeed (U_{one}), mph:		40.9
Duration of Known Windspeed, min:		60
Duration of Windspeed of Interest (x), min:		15
Calculation		
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.00
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	1
One-Hour Average Windspeed [$U_{3600} = U_f/(U_t/U_{3600})$, mph:		40.9
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.03
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	N/A
One-Hour Average Windspeed [$U_t = U_{3600}(U_t/U_{3600})$, mph:		42.2
Result		
Windspeed of Interest ($U_t = U_{3600(t)}$ [U_t/U_{3600}], mph:		42.2

Source: Figure II-2-1 from Reference 2.4-33

Notes:

(a) U_f = Fastest-Mile Windspeed

(b) U_{3600} = One-hour Averaged Windspeed

(c) U_t = t-hour Averaged Windspeed

Key: mph = miles per hour; N/A = Not Applicable; sec. = second

Table 2.4-20e
2-Year Wind Speed Conversion to 20 Minutes

Input		
Known Windspeed (U_{one}), mph:		40.9
Duration of Known Windspeed, min:		60
Duration of Windspeed of Interest (t), min:		20
Calculation		
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.00
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	1
One-Hour Average Windspeed [$U_{3600} = U_f/(U_t/U_{3600})$, mph:		40.9
U_t/U_{3600} (Figure II-2-1)	For 1 < t < 3600 sec. U_t/U_{3600} = 1.277 + 0.296 tanh[0.9 log(45/t)]	1.02
	For 3600 < t < 36000 sec. U_t/U_{3600} = -0.15 log t + 1.5334	N/A
One-Hour Average Windspeed [$U_t = U_{3600}(U_t/U_{3600})$, mph:		
Result		
Windspeed of Interest ($U_t = U_{3600(t)}$ [U_t/U_{3600}], mph:		41.8

Notes:
(a) U_f = Fastest-Mile Windspeed.
(b) U_{3600} = One-hour Averaged Windspeed.
(c) U_t = t-hour Averaged Windspeed.
Key: mph = miles per hour; N/A = Not Applicable; sec. = second

Table 2.4-21a
Windspeed Duration Adjustment – ACES

General		
Wind observation type	Shore (windward)	
Wind fetch options	Deep restricted	
Breaking criteria	0.780	
Item	**Value**	**Units**
Elevation of observed wind (Zobs)	30.00	ft.
Observed wind speed (Uobs)	42.90	mph
Air sea temperature difference (dT)	0.00	deg F
Duration of observed wind (DurO)	10.00	minute
Duration of final wind (DurF)		minute
Latitude of observation (LAT)	36.32	deg
Restricted fetch geometry		
Number	**Fetch angle (deg)**	**Fetch length (ft.)**
1	0.00	9370.00
2	10.00	9370.00
Results		
Wind fetch length (F)	6871.33	ft.
Wind direction (WDIR)	10.00	deg
Eq. neutral wind speed (Ue)	38.98	mph
Adjusted wind speed (Ua)	53.97	mph
Mean wave direction (THETA)	7.00	deg
Wave height (Hmo)	0.89	ft.
Wave period (Tp)	1.72	sec.
Wave growth: Deep		

Key: ACES = Automated Coastal Engineering System; deg = degrees; F = Fahrenheit; ft. = feet; mph = miles per hour; sec. = second

Table 2.4-21b
Windspeed Duration Adjustment – Check

	Input	
	Wave Period, T (sec):	1.72
	g (ft/sec^2):	32.2
	Water Depth, h (ft):	126.5
	Fetch Length (ft):	6871.33
	Estimate of Wave Length, L (ft):	15.16
	Calculations	
Equation 3.36	$L = g/(2\Omega)T^2\tanh(2\Pi h/L)$	15.16
	Error (%)	0.00
	Output	
	Celerity, C (ft/sec)	8.81
	Time to Travel Fetch (min)	12.99

Key: ft. = feet; sec. = second

Table 2.4-22
Significant Design Wave Height

Input	
From ACES	H_{mo} = 0.89 ft.
From Dean & Dalrymple	L_p =15.2 ft.
Calculation	
$\varepsilon = 0.25\ H_{mo} / L_p$	0.01 (Equation applicable)
$H_{1/3} = H_{mo}$	0.89 ft.
Design Wave Height $H_{1\%} = 1.67\ H_{1/3}$	**1.49**

Notes:
Spreadsheet calculates the H1% from H_{mo}.
Conversion from H_{mo} to $H_{1/3}$ uses guidance from CETN I-45 (3/91).
Conversion from $H_{1/3}$ to H1% uses guidance from EM 1110-2-1614.
Key: ACES = Automated Coastal Engineering System; ft. = feet; sec. = second

Table 2.4-23
Wind Setup Calculation

Input	
Design Wind Velocity, U (mph)	42.9
Wind Fetch, F (ft)	6871.33
Average Water Depth, D (ft)	126.5
Calculations	
Convert Wind Fetch to Miles	1.30
$S = U^2F/(1400D)$	0.01
Result	
Wind Setup, ft	0.01

Key: ft. = feet; mph = miles per hour

Table 2.4-24
Belews Creek Watershed Dam Characteristics

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Key: ac. = acre; ac-ft = acre-feet; ft. = feet; NID = National Inventory of Dams

Table 2.4-25
Dam Failure Cluster Characteristics

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Key: ac. = acre; ac-ft = acre-feet; ft. = feet; NID = National Inventory of Dams

Table 2.4-26
Dam Breach Hydrograph Properties

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Keys: cfs = cubic feet per second; ft. = feet; hr. = hour; NID = National Inventory of Dams

Table 2.4-27
Dam Volume Calculation

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Key: ac. = acre; ac-ft = acre-feet; ft. = feet; NID = National Inventory of Dams

Table 2.4-28
Estimated Maximum Ice Thickness for Approximate 96-Year Period of Record

Year	Date	t_i (in.)	Year	Date	t_i (in.)	Year	Date	t_i (in.)
1928	26-Nov	1.70	**1971**	10-Feb	5.82	**2014**	30-Jan	5.50
1929	4-Dec	5.16	**1972**	17-Jan	5.09	**2015**	21-Feb	6.64
1930	31-Dec	7.28	**1973**	14-Jan	7.27	**2016**	23-Jan	4.41
1931	1-Jan	7.48	**1974**	14-Jan	2.77	**2017**	9-Jan	5.05
1932	21-Dec	4.11	**1975**	25-Dec	3.66	**2018**	8-Jan	7.84
1933	12-Feb	4.34	**1976**	10-Jan	4.68	**2019**	22-Jan	2.97
1934	1-Mar	5.16	**1977**	8-Feb	10.74	**2020**	26-Dec	2.31
1935	31-Dec	9.73	**1978**	11-Feb	9.09	**2021**	29-Jan	0.96
1936	12-Feb	10.68	**1979**	20-Feb	5.95	**2022**	26-Dec	4.73
1937	14-Dec	4.59	**1980**	13-Feb	7.09	**2023**	4-Feb	0.76
1938	28-Jan	4.57	**1981**	13-Jan	7.12	**2024**	21-Jan	3.51
1939	28-Jan	2.28	**1982**	27-Jan	8.21			
1940	3-Feb	10.41	**1983**	31-Dec	6.94			
1941	7-Jan	3.09	**1984**	2-Jan	7.07			
1942	12-Jan	7.57	**1985**	29-Jan	6.74			
1943	16-Feb	4.80	**1986**	29-Jan	4.55			
1944	16-Jan	3.62	**1987**	29-Jan	5.41			
1945	25-Dec	6.92	**1988**	16-Jan	7.74			
1946	3-Jan	4.12	**1989**	27-Dec	7.92			
1947	3-Mar	4.56	**1990**	1-Jan	5.21			
1948	2-Feb	6.38	**1991**	16-Feb	2.99			
1949	31-Jan	1.95	**1992**	16-Jan	1.95			
1950	22-Dec	4.60	**1993**	15-Mar	3.82			
1951	20-Dec	4.56	**1994**	21-Jan	7.94			
1952	31-Jan	3.16	**1995**	9-Feb	4.97			
1953	19-Dec	3.88	**1996**	6-Feb	6.60			
1954	14-Jan	4.07	**1997**	19-Jan	5.96			
1955	14-Feb	4.08	**1998**	1-Jan	3.01			
1956	25-Nov	2.94	**1999**	6-Jan	4.29			
1957	19-Jan	4.78	**2000**	2-Feb	7.07			
1958	21-Feb	7.85	**2001**	4-Jan	6.75			
1959	12-Jan	4.94	**2002**	6-Jan	3.76			
1960	14-Mar	7.31	**2003**	27-Jan	4.60			
1961	6-Feb	6.70	**2004**	28-Jan	4.00			
1962	15-Dec	6.45	**2005**	24-Jan	5.27			
1963	24-Dec	6.75	**2006**	9-Dec	1.87			
1964	1-Jan	6.38	**2007**	6-Feb	2.34			
1965	19-Jan	5.35	**2008**	22-Jan	2.99			
1966	6-Feb	8.95	**2009**	21-Jan	4.30			
1967	26-Feb	4.27	**2010**	13-Jan	5.79			
1968	15-Jan	6.12	**2011**	14-Jan	4.57			
1969	7-Jan	4.70	**2012**	4-Jan	2.39			
1970	11-Jan	6.64	**2013**	26-Jan	3.20			

Key: t_i = ice thickness | in. = inch(es)

Table 2.4-29
Benchmarked Model Changes for Each Case

LakeT Case	Change from Benchmark Model						
	Weather	**Intake / Discharge Location**	**Lake Volume / Effectiveness**	**Dam Location**	**Water Usage**	**Dan River Pumping**	**Belews Creek Flow**
Benchmark: BCSS historical data, no nuclear plant operating	*Actual*	*Actual*	*Actual/Calculated*	*Actual*	*Actual*	*Actual*	*Bench*
Case 1: Baseline 1 (BCSS 100%, nuclear plant 0%)	No change	No change	No change	No change	Plant flow set to a constant, maximum flow of 2257 cfs	Utilized according to established requirements	No change
Case 2: Baseline 2 (BCSS 0%, nuclear plant 0%)	Temperature increased by 8°F, precipitation decreased by 1%	N/A	2995 ac-ft of volume removed	No change	No input for plant flow, blowdown flow, or temperature rise through plant	No pumping from the river	Flow amounts reduced by the same as precipitation (1%)
Case 3: Near-Term Operation (BCSS 0%, nuclear plant 100%)	No change	Intake/discharges in new locations, new distance between them used	Volume remains the same, effectiveness recalculated based on new intake/discharge locations	New distance from discharge to dam used	Inlet flow is set to 68.4 cfs, discharge flow is set to 7.72 cfs with a temperature of 95°F	Utilized according to established requirements	No change
Case 4: Long-Term Operation (BCSS 0%, nuclear plant 100%)	Temperature increased by 8°F, precipitation decreased by 1%	Intake/discharges in new locations, new distance between them used	2995 ac-ft of volume removed, effectiveness recalculated based on new intake/discharge locations	New distance from discharge to dam used	Inlet flow is set to 68.4 cfs, discharge flow is set to 7.72 cfs with a temperature of 95°F	Utilized according to established requirements (Dan River flowrate reduced by 1%)	Flow amounts reduced by the same as precipitation (1%)

Key: °F = degrees Fahrenheit; ac-ft = acre-feet; BCSS = Belews Creek Steam Station; cfs = cubic feet per second

Table 2.4-30
Belews Lake Area/Volume Drawdown Curve

Water Surface Elevation (ft.)	Surface Area (ac.)	Storage Volume (ac-ft)
735	4325	226,544
730	4156	205,344
725	3863	185,299
720	3408	167,124
715	3096	150,864
710	2834	136,039
705	2679	122,259
700	2525	109,248
690	2125	85,996
680	1770	66,519
670	1500	50,167
660	1228	36,525
650	1000	25,383
640	760	16,581
630	575	9909
620	384	4934
610	215	1939
600	73	497
590	13	65
580	0	0

Key: ac. = acre; ac-ft. = acre-feet; ft. = feet

Table 2.4-31
Well Construction Details
(Sheet 1 of 3)

Well Identification	Well Description	Northing[(a)]	Easting[(a)]	Ground Surface Elevation[(a)]	Top of Casing Elevation[(a)]	Well Diameter (in.)	Well Depth (ft. bgs)	Top of Screen (ft. bgs)	Bottom of Screen (ft. bgs)	Top of Screen (ft. NAVD 88)	Bottom of Screen (ft. NAVD 88)	Top of PWR (ft. bgs)	Top of PWR (ft. NAVD 88)	Top of Rock (ft. bgs)	Top of Rock (ft. NAVD 88)
W-1	North (Shallow)	923696.4	1690333.1	803.4	805.92	2	82.3	60.0	80.0	743.4	723.4	2.3	801.1	33.8	769.6
W-2		923203.1	1690472.0	830.3	832.97	2	97.3	72.0	92.0	758.3	738.3	19.0	811.3	26.0	804.3
W-3		923213.0	1691824.9	820.7	823.14	2	74.3	52.0	72.0	768.7	748.7	NP	NP	44.0	776.7
W-4		922868.5	1691399.6	826.1	828.74	2	66.3	54.0	64.0	772.1	762.1	25.4	800.7	35.6	790.5
W-5		922702.3	1690494.9	836.4	839.19	2	88.3	66.0	86.0	770.4	750.4	NP	NP	35.5	800.9
DW-1	North (Deep)	923477.7	1691108.2	837.1	840.02	2	175.3	150.0	170.0	687.1	667.1	32.5	804.6	51.2	785.9
DW-2		923271.7	1692373.9	801.2	804.16	2	158.3	133.0	153.0	668.2	648.2	37.2	764.0	47.9	753.3
DW-3		922852.6	1689834.3	811.7	814.41	2	195.3	170.0	190.0	641.7	621.7	15.5	796.2	48.6	763.1
DW-4		922675.4	1690992.0	831.3	833.86	2	142.3	117.0	137.0	714.3	694.3	48.9	782.4	67.9	763.4
W-6	Middle (Shallow)	919044.7	1687926.2	798.6	801.51	2	64.3	44.0	59.0	754.6	739.6	35.5	763.1	58.7	739.9
W-7		919062.9	1688467.8	816.5	819.04	2	65.3	45.0	60.0	771.5	756.5	40.5	776.0	60.5	756.0
W-8		918586.5	1688768.2	812.1	815.30	2	36.3	21.0	31.0	791.1	781.1	10.0	802.1	26.5	785.6
W-9		918526.4	1687708.0	823.7	826.37	2	99.3	77.0	97.0	746.7	726.7	NP	NP	46.8	776.9
W-10		918328.9	1688247.8	810.5	813.35	2	49.3	34.0	44.0	776.5	766.5	33.5	777.0	40.5	770.0
DW-5	Middle (Deep)	919682.3	1688451.1	813.5	815.99	2	195.3	170.0	190.0	643.5	623.5	NP	NP	30.3	783.2
DW-6		919108.1	1689199.4	819.7	822.15	2	160.3	135.0	155.0	684.7	664.7	37.6	782.1	38.9	780.8
DW-7		918852.9	1687677.4	804.3	807.04	2	175.3	150.0	170.0	654.3	634.3	NP	NP	31.8	772.5
DW-8		918177.5	1687754.3	803.3	806.01	2	150.3	125.0	145.0	678.3	658.3	42.0	761.3	48.5	754.8

Table 2.4-31
Well Construction Details
(Sheet 2 of 3)

Well Identification	Well Description	Northing[(a)]	Easting[(a)]	Ground Surface Elevation[(a)]	Top of Casing Elevation[(a)]	Well Diameter (in.)	Well Depth (ft. bgs)	Top of Screen (ft. bgs)	Bottom of Screen (ft. bgs)	Top of Screen (ft. NAVD 88)	Bottom of Screen (ft. NAVD 88)	Top of PWR (ft. bgs)	Top of PWR (ft. NAVD 88)	Top of Rock (ft. bgs)	Top of Rock (ft. NAVD 88)
W-11	South (Shallow)	917690.1	1687055.8	817.4	820.21	2	70.8	55.5	65.5	761.9	751.9	50.3	767.1	65.5	751.9
W-12		917656.0	1686355.0	798.1	801.12	2	50.3	35.0	45.0	763.1	753.1	35.5	762.6	40.5	757.6
W-13		917097.0	1686912.4	842.9	846.15	2	59.3	44.0	54.0	798.9	788.9	40.5	802.4	49.2	793.7
W-14		916538.5	1686198.0	850.4	853.09	2	62.3	42.0	57.0	808.4	793.4	42.0	808.4	42.6	807.8
W-15		916307.9	1686738.4	774.9	778.02	2	41.3	29.0	39.0	745.9	735.9	43.0	731.9	48.5	726.4
DW-9	South (Deep)	917989.0	1686787.4	800.0	802.46	2	152.3	127.0	147.0	673.0	653.0	31.9	768.1	35.1	764.9
DW-10		916888.6	1687619.0	815.2	817.59	2	135.3	110.0	130.0	705.2	685.2	47.0	768.2	66.2	749.0
DW-11		916007.6	1685551.6	852.9	855.78	2	198.3	173.0	193.0	679.9	659.9	54.5	798.4	54.5	798.4
DW-12		915587.5	1686799.4	825.8	828.55	2	163.3	138.0	158.0	687.8	667.8	33.5	792.3	34.4	791.4
PW-1 (SBR)	North (Pumping Well)	923684.9	1690316.8	803.6	806.25	4	90.3	65.0	85.0	738.6	718.6	NR	NR	NR	NR
PW-2 (PWR)	Middle (Pumping Well)	919056.2	1687916.2	797.1	799.66	4	72.3	47.0	67.0	750.1	730.1	NR	NR	NR	NR
PW-3 (DBR)	South (Pumping Well)	917974.8	1686773.6	799.7	801.98	4	155.3	130.0	150.0	669.7	649.7	NR	NR	NR	NR
S-1	North (Sentinel Wells)	923750.8	1690271.1	799.2	801.66	2	85.2	60.0	80.0	739.2	719.2	26.7	772.5	55.6	743.6
S-2		923717.5	1690293.7	801.7	804.35	2	90.2	65.0	85.0	736.7	716.7	NR	NR	NR	NR
S-3		923701.1	1690304.9	802.2	804.94	2	90.2	65.0	85.0	737.2	717.2	NR	NR	NR	NR
S-4		923668.2	1690328.5	804.8	807.29	2	85.2	60.0	80.0	744.8	724.8	NR	NR	NR	NR
S-5		923673.4	1690300.7	804.2	806.71	2	90.2	65.0	85.0	739.2	719.2	5.3	798.9	48.6	755.6

Table 2.4-31
Well Construction Details
(Sheet 3 of 3)

Well Identification	Well Description	Northing[(a)]	Easting[(a)]	Ground Surface Elevation[(a)]	Top of Casing Elevation[(a)]	Well Diameter (in.)	Well Depth (ft. bgs)	Top of Screen (ft. bgs)	Bottom of Screen (ft. bgs)	Top of Screen (ft. NAVD 88)	Bottom of Screen (ft. NAVD 88)	Top of PWR (ft. bgs)	Top of PWR (ft. NAVD 88)	Top of Rock (ft. bgs)	Top of Rock (ft. NAVD 88)
S-6	Middle (Sentinel Wells)	919046.4	1687904.8	796.2	799.21	2	73.2	48.0	68.0	748.2	728.2	NR	NR	NR	NR
S-7		919067.1	1687906.7	795.8	798.26	2	76.2	51.0	71.0	744.8	724.8	46.8	749.0	68.5	727.3
S-8		919066.1	1687927.6	797.5	800.27	2	77.2	52.0	72.0	745.5	725.5	NR	NR	NR	NR
S-9		919076.0	1687938.8	797.5	800.26	2	80.2	55.0	75.0	742.5	722.5	NR	NR	NR	NR
S-10		919086.0	1687949.9	797.2	799.96	2	81.3	56.0	76.0	741.2	721.2	71.8	725.4	74.2	723.0
S-11	South (Sentinel Wells)	918031.1	1686716.5	795.2	797.83	2	150.2	125.0	145.0	670.2	650.2	NP	NP	44.3	750.9
S-12		918003.3	1686744.8	797.5	800.02	2	150.2	125.0	145.0	672.5	652.5	NR	NR	NR	NR
S-13		917988.6	1686759.4	798.6	801.19	2	155.2	130.0	150.0	668.6	648.6	NR	NR	NR	NR
S-14		917960.9	1686787.3	800.6	803.58	2	155.2	130.0	150.0	670.6	650.6	NR	NR	NR	NR
S-15		917960.4	1686759.7	799.1	801.73	2	155.2	130.0	150.0	669.1	649.1	31.7	767.4	38.7	760.4
S-16		917973.5	1686753.9	798.2	801.20	2	113.2	88.0	108.0	710.2	690.2	NR	NR	NR	NR

Note:

(a) Coordinates are North Carolina State Plane (United States ft) which is based on North American Datum of 1983 (NAD83); elevations are based on North American Vertical Datum of 1988 (NAVD 88)

Key: bgs = below ground surface; ft. = feet; in. = inches; NP = not present; NR = Not recorded; lithology data collected from three borings (two borings near sentinel wells and one near a shallow or deep well) at each Aquifer Pumping Test (APT) location

Table 2.4-32
Bedrock Fracture Fabric Analysis

Boring Location	Start Depth (ft. bgs)	End Depth (ft. bgs)	Core Length (ft.)	Total # of Fractures	Fracture Density (per 100 ft.)
B-1	85	199	114	92	81
B-3	78	291	213	138	65
B-5	70	189	119	48	40
B-6	47	199	152	115	76
B-8	39	598	559	460	82
B-10	29	199	170	141	83
B-11	57	177	120	26	22
B-13	49	284	235	89	38
B-15	59	159	100	44	44
Total			**1,782**	**1,153**	
Average					**65**

Notes:

(a) Percent of fractures that are filled or closed >97%.

(b) Percent of fractures that are open <3%.

(c) Measured open aperture ranges from 5 to 172 mm, average 32 mm.

(d) Measured open aperture ranges from 0.2 to 6.8 in., average 1.3 in.

Key: bgs = below ground surface; ft = feet; in. = inch; mm = millimeter

Table 2.4-33
Groundwater Elevation Data
(Sheet 1 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
W-1 (North Plant Complex)	6/12/2024	7/15/2024	805.92	62.14	743.78
		8/19/2024		62.58	743.34
		9/22/2024		62.58	743.34
		10/11/2024		62.20	743.72
		11/10/2024		62.18	743.74
		12/7/2024		62.19	743.73
		1/8/2025		61.89	744.03
		2/7/2025		61.68	744.24
		3/7/2025		60.72	745.20
		4/14/2025		60.31	745.61
		5/15/2025		59.95	745.97
		6/24/2025		59.00	746.92
W-2 (North Plant Complex)	9/19/2024	7/15/2024	832.97	NM	NM
		8/19/2024		NM	NM
		9/22/2024		71.84[(a)]	761.13[(a)]
		10/11/2024		57.89[(a)]	775.08[(a)]
		11/10/2024		54.76	778.21
		12/7/2024		53.46	779.51
		1/8/2025		53.17	779.80
		1/28/2025		53.02	779.95
		2/7/2025		59.83[(a)]	773.14[(a)]
		3/7/2025		53.78	779.19
		4/14/2025		52.95	780.02
		5/15/2025		54.35	778.62
		6/24/2025		53.12	779.85
W-3 (North Plant Complex)	6/21/2024	7/15/2024	823.14	58.70	764.44
		8/19/2024		57.78	765.36
		9/22/2024		57.91	765.23
		10/11/2024		58.36	764.78
		11/10/2024		57.96	765.18
		12/7/2024		58.01	765.13
		1/8/2025		59.55	763.59
		1/29/2025		60.65	762.49
		2/7/2025		64.66[(a)]	758.48[(a)]
		3/7/2025		64.34[(a)]	758.80[(a)]
		4/15/2025		64.94[(a)]	758.20[(a)]
		5/15/2025		67.41[(a)]	755.73[(a)]
		6/24/2025		66.65[(a)]	756.49[(a)]

Table 2.4-33
Groundwater Elevation Data
(Sheet 2 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
W-4 (North Plant Complex)	6/24/2024	7/15/2024	828.74	60.15	768.59
		8/19/2024		60.12	768.62
		9/22/2024		60.16	768.58
		10/11/2024		60.17	768.57
		11/10/2024		60.07	768.67
		12/7/2024		59.86	768.88
		1/8/2025		59.62	769.12
		2/7/2025		59.51	769.23
		3/7/2025		59.41	769.33
		4/16/2025		59.27	769.47
		5/15/2025		59.08	769.66
		6/24/2025		58.81	769.93
W-5 (North Plant Complex)	6/18/2024	7/15/2024	839.19	67.59	771.60
		8/19/2024		67.58	771.61
		9/22/2024		66.41	772.78
		10/11/2024		67.26	771.93
		11/10/2024		67.63	771.56
		12/7/2024		67.76	771.43
		1/8/2025		67.81	771.38
		2/7/2025		67.88	771.31
		3/7/2025		67.73	771.46
		4/16/2025		67.67	771.52
		5/15/2025		67.55	771.64
		6/24/2025		67.45	771.74
W-6 (Middle Plant Complex)	6/13/2024	7/15/2024	801.51	47.80	753.71
		8/19/2024		48.81	752.70
		9/22/2024		49.75	751.76
		10/11/2024		50.03	751.48
		11/10/2024		50.52	750.99
		12/7/2024		51.06	750.45
		1/8/2025		51.36	750.15
		2/7/2025		51.64	749.87
		3/7/2025		51.12	750.39
		4/16/2025		50.78	750.73
		5/15/2025		50.53	750.98
		6/24/2025		50.55	750.96

Table 2.4-33
Groundwater Elevation Data
(Sheet 3 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
W-7 (Middle Plant Complex)	6/14/2024	7/15/2024	819.04	37.18	781.86
		8/19/2024		37.78	781.26
		9/22/2024		38.33	780.71
		10/11/2024		37.53	781.51
		11/10/2024		38.70	780.34
		12/7/2024		39.06	779.98
		1/8/2025		39.30	779.74
		2/7/2025		39.57	779.47
		3/7/2025		38.90	780.14
		4/15/2025		38.82	780.22
		5/15/2025		38.71	780.33
		6/24/2025		38.63	780.41
W-8 (Middle Plant Complex)	6/26/2024	7/15/2024	815.30	28.60	786.70
		8/19/2024		28.95	786.35
		9/22/2024		29.45	785.85
		10/11/2024		29.46	785.84
		11/10/2024		29.79	785.51
		12/7/2024		30.08	785.22
		1/8/2025		30.25	785.05
		2/7/2025		30.36	784.94
		3/7/2025		29.71	785.59
		4/16/2025		29.45	785.85
		5/15/2025		29.51	785.79
		6/24/2025		29.47	785.83
W-9 (Middle Plant Complex)	9/19/2024	7/15/2024	826.37	NM	NM
		8/19/2024		54.24[(a)]	772.13[(a)]
		9/22/2024		87.62[(a)]	738.75[(a)]
		10/11/2024		74.12[(a)]	752.25[(a)]
		11/10/2024		55.79	770.58
		12/7/2024		50.81	775.56
		1/8/2025		50.40	775.97
		1/28/2025		50.41	775.96
		2/7/2025		57.34[(a)]	769.03[(a)]
		3/7/2025		50.99	775.38
		4/15/2025		50.48	775.89
		5/15/2025		51.31	775.06
		6/24/2025		50.78	775.59

Table 2.4-33
Groundwater Elevation Data
(Sheet 4 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
W-10 (Middle Plant Complex)	6/15/2024	7/15/2024	813.35	36.70	776.65
		8/19/2024		36.85	776.50
		9/22/2024		37.33	776.02
		10/11/2024		37.63	775.72
		11/10/2024		38.16	775.19
		12/7/2024		38.62	774.73
		1/8/2025		39.05	774.30
		2/7/2025		39.45	773.90
		3/7/2025		38.65	774.70
		4/15/2025		38.19	775.16
		5/15/2025		37.93	775.42
		6/24/2025		37.03	776.32
W-11 (South Plant Complex)	6/8/2024	7/15/2024	820.21	38.56	781.65
		8/19/2024		38.95	781.26
		9/22/2024		39.31	780.90
		10/11/2024		39.56	780.65
		11/10/2024		39.83	780.38
		12/7/2024		39.95	780.26
		1/8/2025		40.11	780.10
		2/7/2025		40.32	779.89
		3/7/2025		40.36	779.85
		4/14/2025		40.26	779.95
		5/15/2025		40.00	780.21
		6/24/2025		38.86	781.35
W-12 (South Plant Complex)	6/13/2024	7/15/2024	801.12	37.40	763.72
		8/19/2024		37.05	764.07
		9/22/2024		37.07	764.05
		10/11/2024		37.26	763.86
		11/10/2024		37.50	763.62
		12/7/2024		37.66	763.46
		1/8/2025		37.94	763.18
		2/7/2025		38.27	762.85
		3/7/2025		38.42	762.70
		4/14/2025		38.59	762.53
		5/15/2025		38.58	762.54
		6/24/2025		38.55	762.57

Table 2.4-33
Groundwater Elevation Data
(Sheet 5 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
W-13 (South Plant Complex)	6/26/2024	7/15/2024	846.15	56.63	789.52
		8/19/2024		56.39	789.76
		9/22/2024		56.36	789.79
		10/11/2024		56.55	789.60
		11/10/2024		56.61	789.54
		12/7/2024		56.64	789.51
		1/8/2025		56.74	789.41
		2/7/2025		56.93	789.22
		3/7/2025		57.06	789.09
		4/14/2025		57.00	789.15
		5/15/2025		62.12	784.03
		6/24/2025		62.15	784.00
W-14 (South Plant Complex)	6/11/2024	7/15/2024	853.09	42.93	810.16
		8/19/2024		42.81	810.28
		9/22/2024		42.89	810.20
		10/11/2024		43.09	810.00
		11/10/2024		43.21	809.88
		12/7/2024		43.28	809.81
		1/8/2025		43.49	809.60
		2/7/2025		43.78	809.31
		3/7/2025		43.97	809.12
		4/15/2025		44.15	808.94
		5/15/2025		44.18	808.91
		6/24/2025		44.24	808.85
W-15 (South Plant Complex)	6/9/2024	7/15/2024	778.02	11.33	766.69
		8/19/2024		10.85	767.17
		9/22/2024		11.49	766.53
		10/11/2024		11.44	766.58
		11/10/2024		11.71	766.31
		12/7/2024		11.75	766.27
		1/8/2025		11.67	766.35
		2/7/2025		11.63	766.39
		3/7/2025		11.23	766.79
		4/15/2025		10.98	767.04
		5/15/2025		11.53	766.49
		6/24/2025		11.77	766.25

Table 2.4-33
Groundwater Elevation Data
(Sheet 6 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
DW-1 (North Plant Complex)	7/18/2024	7/15/2024	840.02	NM	NM
		8/19/2024		97.40	742.62
		9/22/2024		100.43	739.59
		10/11/2024		100.70	739.32
		11/10/2024		101.54	738.48
		12/7/2024		101.47	738.55
		1/8/2025		101.13	738.89
		2/7/2025		100.77	739.25
		3/7/2025		100.61	739.41
		4/15/2025		100.26	739.76
		5/15/2025		100.29	739.73
		6/24/2025		100.40	739.62
DW-2(North Plant Complex)	7/11/2024	7/15/2024	804.16	77.85	726.31
		8/19/2024		77.98	726.18
		9/22/2024		77.88	726.28
		10/11/2024		77.91	726.25
		11/10/2024		78.18	725.98
		12/7/2024		78.19	725.97
		1/8/2025		78.00	726.16
		2/7/2025		77.84	726.32
		3/7/2025		77.71	726.45
		4/14/2025		77.63	726.53
		5/15/2025		77.66	726.50
		6/24/2025		77.75	726.41
DW-3 (North Plant Complex)	9/19/2024	7/15/2024	814.41	NM	NM
		8/19/2024		NM	NM
		9/22/2024		182.80[(a)]	631.61[(a)]
		10/11/2024		112.69[(a)]	701.72[(a)]
		11/10/2024		89.09	725.32
		12/7/2024		87.78	726.63
		1/8/2025		87.02	727.39
		2/7/2025		86.56	727.85
		3/7/2025		86.18	728.23
		4/14/2025		85.92	728.49
		5/15/2025		85.75	728.66
		6/24/2025		85.78	728.63

Table 2.4-33
Groundwater Elevation Data
(Sheet 7 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
DW-4 (North Plant Complex)	8/21/2024	7/15/2024	833.86	NM	NM
		8/19/2024		NM	NM
		9/22/2024		65.84	768.02
		10/11/2024		65.82	768.04
		11/10/2024		65.65	768.21
		12/7/2024		65.27	768.59
		1/8/2025		64.99	768.87
		2/7/2025		64.85	769.01
		3/7/2025		64.68	769.18
		4/14/2025		64.44	769.42
		5/15/2025		64.26	769.60
		6/24/2025		64.02	769.84
DW-5 (Middle Plant Complex)	7/3/2024	7/15/2024	815.99	69.83	746.16
		8/19/2024		71.00	744.99
		9/22/2024		70.91	745.08
		10/11/2024		71.20	744.79
		11/10/2024		71.21	744.78
		12/7/2024		71.66	744.33
		1/8/2025		71.67	744.32
		2/7/2025		71.75	744.24
		3/7/2025		71.55	744.44
		4/15/2025		71.70	744.29
		5/15/2025		71.77	744.22
		6/24/2025		72.03	743.96
DW-6 (Middle Plant Complex)	6/20/2024	7/15/2024	822.15	74.36	747.79
		8/19/2024		75.89	746.26
		9/22/2024		76.40	745.75
		10/11/2024		76.55	745.60
		11/10/2024		76.12	746.03
		12/7/2024		77.38	744.77
		1/8/2025		77.49	744.66
		2/7/2025		77.68	744.47
		3/7/2025		77.62	744.53
		4/15/2025		77.66	744.49
		5/15/2025		77.74	744.41
		6/24/2025		77.93	744.22

Table 2.4-33
Groundwater Elevation Data
(Sheet 8 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
DW-7 (Middle Plant Complex)	7/9/2024	7/15/2024	807.04	60.79	746.25
		8/19/2024		62.38	744.66
		9/22/2024		63.71	743.33
		10/11/2024		63.68	743.36
		11/10/2024		63.40	743.64
		12/7/2024		64.59	742.45
		1/8/2025		64.49	742.55
		2/7/2025		64.45	742.59
		3/7/2025		63.89	743.15
		4/15/2025		63.58	743.46
		5/15/2025		63.67	743.37
		6/24/2025		63.84	743.20
DW-8 (Middle Plant Complex)	9/19/2024	7/15/2024	806.01	NM	NM
		8/19/2024		NM	NM
		9/22/2024		140.80[(a)]	665.21[(a)]
		10/11/2024		139.58[(a)]	666.43[(a)]
		11/10/2024		137.80[(a)]	668.21[(a)]
		12/7/2024		136.40[(a)]	669.61[(a)]
		1/8/2025		134.84[(a)]	671.17[(a)]
		2/7/2025		133.52[(a)]	672.49[(a)]
		3/7/2025		132.25[(a)]	673.76[(a)]
		4/15/2025		130.86[(a)]	675.15[(a)]
		5/15/2025		129.89[(a)]	676.12[(a)]
		6/24/2025		128.02[(a)]	677.99[(a)]
DW-9 (South Plant Complex)	7/14/2024	7/15/2024	802.46	68.40	734.06
		8/19/2024		68.16	734.30
		9/22/2024		68.24	734.22
		10/11/2024		68.16	734.30
		11/10/2024		68.60	733.86
		12/7/2024		68.59	733.87
		1/8/2025		68.58	733.88
		2/7/2025		68.46	734.00
		3/7/2025		67.86	734.60
		4/14/2025		67.68	734.78
		5/15/2025		67.83	734.63
		6/24/2025		67.92	734.54

Table 2.4-33
Groundwater Elevation Data
(Sheet 9 of 10)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft. NAVD 88)	Depth to Groundwater (ft. BTOC)	Groundwater Elevation (ft. NAVD 88)
DW-10 (South Plant Complex)	9/19/2024	7/15/2024	817.59	NM	NM
		8/19/2024		NM	NM
		9/22/2024		125.50[(a)]	692.09[(a)]
		10/11/2024		118.36[(a)]	699.23[(a)]
		11/10/2024		102.99[(a)]	714.60[(a)]
		12/7/2024		88.25[(a)]	729.34[(a)]
		1/8/2025		81.76[(a)]	735.83[(a)]
		2/7/2025		78.70[(a)]	738.89[(a)]
		3/7/2025		77.10[(a)]	740.49[(a)]
		4/14/2025		76.26	741.33
		5/15/2025		76.00	741.59
		6/24/2025		75.95	741.64
DW-11 (South Plant Complex)	9/19/2024	7/15/2024	855.78	NM	NM
		8/19/2024		NM	NM
		9/22/2024		126.13[(a)]	729.65[(a)]
		10/11/2024		62.88	792.90
		11/10/2024		62.18	793.60
		12/7/2024		62.48	793.30
		1/8/2025		62.48	793.30
		2/7/2025		62.58	793.20
		3/7/2025		62.53	793.25
		4/14/2025		62.59	793.19
		5/15/2025		62.64	793.14
		6/24/2025		62.74	793.04
DW-12 (South Plant Complex)	10/8/2024	7/15/2024	828.55	NM	NM
		8/19/2024		NM	NM
		9/22/2024		NM	NM
		10/11/2024		156.55[(a)]	672.00[(a)]
		11/10/2024		145.77[(a)]	682.78[(a)]
		12/7/2024		130.61[(a)]	697.94[(a)]
		1/8/2025		108.82[(a)]	719.73[(a)]
		2/7/2025		94.70[(a)]	733.85[(a)]
		3/7/2025		85.81[(a)]	742.74[(a)]
		4/14/2025		78.81[(a)]	749.74[(a)]
		5/15/2025		75.41[(a)]	753.14[(a)]
		6/24/2025		73.02[(a)]	755.53[(a)]

Table 2.4-33
Groundwater Elevation Data
(Sheet 10 of 10)

Note:

(a) Indicates pre-development water level, or post-development or post-sampling water level that had not returned to static conditions; data not used in contouring.

Key: BTOC = below top of casing; ft. = feet; NAVD 88 = North American Vertical Datum 1988; NM = Not measured (well had not been installed and/or developed at time of measuring event); TOC = top of casing

Table 2.4-34
Horizontal Hydraulic Gradient Calculations
(Sheet 1 of 5)

				Gradient Calculations				
Date	**Depth Zone**	**Plant Complex**	**Flow Direction**	**Δh (ft)**	**L (ft)**	**i_h (ft/ft)**	**Average i_h (ft/ft)**	**Maximum i_h (ft/ft)**
7/15/2024	Shallow Bedrock	North	SSE to NNW (western flow line)	25	760	3.3E-02	1.9E-02	3.3E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	5	870	5.7E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	25	590	4.2E-02	2.9E-02	4.2E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	10	580	1.7E-02		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	5	170	2.9E-02		
	Shallow Bedrock	South	SSE to NNW (northern flow line)	35	620	5.6E-02	5.0E-02	7.6E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,290	1.9E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	460	7.6E-02		
	Deep Bedrock	North	Insufficient data; not calculated	NC	NC	NC	NC	NC
	Deep Bedrock	Middle	NE to SW	1	610	1.6E-03	1.6E-03	1.6E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC
8/19/2024	Shallow Bedrock	North	SSE to NNW (western flow line)	25	780	3.2E-02	1.9E-02	3.2E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	5	1,010	5.0E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	15	460	3.3E-02	2.8E-02	3.3E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	10	440	2.3E-02		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	5	180	2.8E-02		
	Shallow Bedrock	South	S to N (northern flow line)	35	730	4.8E-02	5.0E-02	8.5E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,380	1.8E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	410	8.5E-02		
	Deep Bedrock	North	Insufficient data; not calculated	NC	NC	NC	NC	NC
	Deep Bedrock	Middle	SE to NW	1	650	1.5E-03	1.5E-03	1.5E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC
9/22/2024	Shallow Bedrock	North	SSE to NNW (western flow line)	25	790	3.2E-02	2.0E-02	3.2E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	5	690	7.2E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	25	610	4.1E-02	3.3E-02	4.1E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	30	880	3.4E-02		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	5	220	2.3E-02		
	Shallow Bedrock	South	S to N (northern flow line)	40	880	4.5E-02	5.2E-02	9.2E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	30	1,490	2.0E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	380	9.2E-02		
	Deep Bedrock	North	S to N (western flow line)	25	620	4.0E-02	3.8E-02	4.0E-02
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,010	3.5E-02		
	Deep Bedrock	Middle	E to W	2	1,190	1.7E-03	1.7E-03	1.7E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC

Table 2.4-34
Horizontal Hydraulic Gradient Calculations
(Sheet 2 of 5)

				Gradient Calculations				
Date	**Depth Zone**	**Plant Complex**	**Flow Direction**	**Δh (ft)**	**L (ft)**	**i_h (ft/ft)**	**Average i_h (ft/ft)**	**Maximum i_h (ft/ft)**
10/11/2024	Shallow Bedrock	North	SSE to NNW (western flow line)	25	340	7.4E-02	4.0E-02	7.4E-02
	Shallow Bedrock	North	W to E (eastern flow line)	5	790	6.3E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	20	670	3.0E-02	2.8E-02	3.6E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	30	830	3.6E-02		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	10	530	1.9E-02		
	Shallow Bedrock	South	S to N (northern flow line)	40	840	4.8E-02	5.3E-02	9.2E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,220	2.0E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	380	9.2E-02		
	Deep Bedrock	North	S to N (western flow line)	25	670	3.7E-02	3.4E-02	3.7E-02
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,140	3.1E-02		
	Deep Bedrock	Middle	E to W	2	1,380	1.4E-03	1.4E-03	1.4E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC
11/10/2024	Shallow Bedrock	North	SSE to NNW (western flow line)	30	390	7.7E-02	4.3E-02	7.7E-02
	Shallow Bedrock	North	W to E (eastern flow line)	10	1,120	8.9E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	25	700	3.6E-02	2.5E-02	3.6E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	15	1,070	1.4E-02		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	10	420	2.4E-02		
	Shallow Bedrock	South	S to N (northern flow line)	40	890	4.5E-02	3.8E-02	4.9E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,270	2.0E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	720	4.9E-02		
	Deep Bedrock	North	SE to NW (western flow line)	35	790	4.4E-02	3.7E-02	4.4E-02
	Deep Bedrock	North	S to N (middle flow line)	25	670	3.7E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	40	1,280	3.1E-02		
	Deep Bedrock	Middle	E to W	2	1,220	1.6E-03	1.6E-03	1.6E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC
12/7/2024	Shallow Bedrock	North	SSE to NNW (western flow line)	30	360	8.3E-02	4.6E-02	8.3E-02
	Shallow Bedrock	North	W to E (eastern flow line)	10	1,080	9.3E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	25	660	3.8E-02	2.6E-02	3.8E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	10	1,090	9.2E-03		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	10	310	3.2E-02		
	Shallow Bedrock	South	S to N (northern flow line)	40	770	5.2E-02	5.3E-02	8.8E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,230	2.0E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	400	8.8E-02		
	Deep Bedrock	North	SE to NW (western flow line)	35	810	4.3E-02	3.8E-02	4.3E-02
	Deep Bedrock	North	S to N (middle flow line)	25	660	3.8E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,090	3.2E-02		
	Deep Bedrock	Middle	E to W	2	960	2.1E-03	2.1E-03	2.1E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC

Table 2.4-34
Horizontal Hydraulic Gradient Calculations
(Sheet 3 of 5)

Date	Depth Zone	Plant Complex	Flow Direction	Gradient Calculations				
				Δh (ft)	L (ft)	ih (ft/ft)	Average ih (ft/ft)	Maximum ih (ft/ft)
1/8/2025	Shallow Bedrock	North	SSE to NNW (western flow line)	30	430	7.0E-02	3.9E-02	7.0E-02
	Shallow Bedrock	North	WNW to ESE (eastern flow line)	10	1,120	8.9E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	15	600	2.5E-02	2.2E-02	3.1E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	10	1,070	9.3E-03		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	10	320	3.1E-02		
	Shallow Bedrock	South	S to N (northern flow line)	40	880	4.5E-02	5.2E-02	9.2E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,320	1.9E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	380	9.2E-02		
	Deep Bedrock	North	SE to NW (western flow line)	35	820	4.3E-02	3.7E-02	4.3E-02
	Deep Bedrock	North	S to N (middle flow line)	30	790	3.8E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,130	3.1E-02		
	Deep Bedrock	Middle	NE to SW	2	1,370	1.5E-03	1.5E-03	1.5E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC
2/7/2025	Shallow Bedrock	North	SSE to NNW (western flow line)	30	420	7.1E-02	4.0E-02	7.1E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	10	1,030	9.7E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	30	370	8.1E-02	4.1E-02	8.1E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	5	770	6.5E-03		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	5	140	3.6E-02		
	Shallow Bedrock	South	S to N (northern flow line)	40	640	6.3E-02	5.5E-02	8.1E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,140	2.2E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	430	8.1E-02		
	Deep Bedrock	North	SE to NW (western flow line)	30	730	4.1E-02	4.0E-02	4.2E-02
	Deep Bedrock	North	S to N (middle flow line)	25	590	4.2E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	30	830	3.6E-02		
	Deep Bedrock	Middle	NE to SW	1	660	1.5E-03	1.5E-03	1.5E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC
3/7/2025	Shallow Bedrock	North	SSE to NNW (western flow line)	30	400	7.5E-02	4.4E-02	7.5E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	10	760	1.3E-02		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	30	340	8.8E-02	4.8E-02	8.8E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	5	630	7.9E-03		
	Shallow Bedrock	South	S to N (northern flow line)	35	800	4.4E-02	4.7E-02	8.0E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,370	1.8E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	440	8.0E-02		
	Deep Bedrock	North	SE to NW (western flow line)	35	880	4.0E-02	3.5E-02	4.0E-02
	Deep Bedrock	North	S to N (middle flow line)	25	700	3.6E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,230	2.8E-02		
	Deep Bedrock	Middle	NE to SW	1	840	1.2E-03	1.2E-03	1.2E-03
	Deep Bedrock	South	Insufficient data; not calculated	NC	NC	NC	NC	NC

Table 2.4-34
Horizontal Hydraulic Gradient Calculations
(Sheet 4 of 5)

				Gradient Calculations				
Date	**Depth Zone**	**Plant Complex**	**Flow Direction**	**Δh (ft)**	**L (ft)**	**i_h (ft/ft)**	**Average i_h (ft/ft)**	**Maximum i_h (ft/ft)**
4/14/2025	Shallow Bedrock	North	SSE to NNW (western flow line)	25	370	6.8E-02	4.8E-02	6.8E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	20	730	2.7E-02		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	30	770	3.9E-02	2.7E-02	3.9E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	10	1,060	9.4E-03		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	5	150	3.3E-02		
	Shallow Bedrock	South	S to N (northern flow line)	35	840	4.2E-02	4.5E-02	7.5E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	25	1,410	1.8E-02		
	Shallow Bedrock	South	NW to SE (eastern flow line)	30	400	7.5E-02		
	Deep Bedrock	North	SE to NW (western flow line)	35	880	4.0E-02	3.6E-02	4.0E-02
	Deep Bedrock	North	S to N (middle flow line)	25	660	3.8E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,170	3.0E-02		
	Deep Bedrock	Middle	NE to SW	0.5	780	6.4E-04	6.4E-04	6.4E-04
	Deep Bedrock	South	S to N (western flow line)	25	760	3.3E-02	2.7E-02	3.3E-02
	Deep Bedrock	South	SW to NE (middle flow line)	50	2,000	2.5E-02		
	Deep Bedrock	South	NW to SE (eastern flow line)	45	1,860	2.4E-02		
5/15/2025	Shallow Bedrock	North	SSE to NNW (western flow line)	25	430	5.8E-02	3.2E-02	5.8E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	5	870	5.7E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	20	710	2.8E-02	2.0E-02	2.8E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	10	960	1.0E-02		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	5	240	2.1E-02		
	Shallow Bedrock	South	S to N (northern flow line)	30	750	4.0E-02	4.6E-02	8.1E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	20	1,250	1.6E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	30	370	8.1E-02		
	Deep Bedrock	North	SE to NW (western flow line)	35	900	3.9E-02	3.6E-02	3.9E-02
	Deep Bedrock	North	S to N (middle flow line)	25	660	3.8E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,120	3.1E-02		
	Deep Bedrock	Middle	NE to SW	0.5	740	6.8E-04	6.8E-04	6.8E-04
	Deep Bedrock	South	S to N (western flow line)	40	960	4.2E-02	3.9E-02	4.2E-02
	Deep Bedrock	South	SW to NE (middle flow line)	45	1,110	4.1E-02		
	Deep Bedrock	South	NW to SE (eastern flow line)	40	1,140	3.5E-02		

Table 2.4-34
Horizontal Hydraulic Gradient Calculations
(Sheet 5 of 5)

Date	Depth Zone	Plant Complex	Flow Direction	Gradient Calculations				
				Δh (ft)	**L (ft)**	**i_h (ft/ft)**	**Average i_h (ft/ft)**	**Maximum i_h (ft/ft)**
6/24/2025	Shallow Bedrock	North	SSE to NNW (western flow line)	25	380	6.6E-02	3.7E-02	6.6E-02
	Shallow Bedrock	North	WSW to ENE (eastern flow line)	5	700	7.1E-03		
	Shallow Bedrock	Middle	SE to NW (northern flow line)	20	690	2.9E-02	2.1E-02	2.9E-02
	Shallow Bedrock	Middle	E to W (middle flow line)	10	1,010	1.0E-02		
	Shallow Bedrock	Middle	NE to SW (southern flow line)	5	210	2.4E-02		
	Shallow Bedrock	South	S to N (northern flow line)	35	880	4.0E-02	4.8E-02	8.5E-02
	Shallow Bedrock	South	SW to NE (middle flow line)	20	1,020	2.0E-02		
	Shallow Bedrock	South	NW to SE (southern flow line)	35	410	8.5E-02		
	Deep Bedrock	North	SE to NW (western flow line)	35	860	4.1E-02	3.5E-02	4.1E-02
	Deep Bedrock	North	S to N (middle flow line)	25	740	3.4E-02		
	Deep Bedrock	North	SW to NE (eastern flow line)	35	1,130	3.1E-02		
	Deep Bedrock	Middle	NE to SW	0.5	710	7.0E-04	7.0E-04	7.0E-04
	Deep Bedrock	South	S to N (western flow line)	50	1,430	3.5E-02	2.7E-02	3.5E-02
	Deep Bedrock	South	SW to NE (middle flow line)	50	2,250	2.2E-02		
	Deep Bedrock	South	NW to SE (eastern flow line)	40	1,720	2.3E-02		

Overall Average (Shallow) =	**3.8E-02**
Overall Minimum (Shallow) =	**5.0E-03**
Overall Maximum (Shallow) =	**9.2E-02**
Overall Average (Deep) =	**2.7E-02**
Overall Minimum (Deep) =	**6.4E-04**
Overall Maximum (Deep) =	**4.4E-02**

Note:

(a) Δh and L values were obtained from the potentiometric surface maps for the July 2024 through June 2025 events.

Key: ft. = feet; ft/ft = feet per foot; i_h = Horizontal hydraulic gradient; calculated by the formula $i_h = \Delta h/L$; Δh = Difference in hydraulic head between contour lines used to calculate i_h; L = Horizontal distance between contour lines used to calculate i_h; L measured in ArcMap to the nearest 10-ft increment; NC = not calculated

Table 2.4-35
Vertical Hydraulic Gradient Calculations
(Sheet 1 of 2)

Date	Plant Complex	Screen Mid-Point Approach		
		Minimum i_v (ft/ft)	Maximum i_v (ft/ft)	Average i_v (ft/ft)
	North	NA	NA	NA
7/15/2024	Middle	0.018	0.36	0.24
	South	NA	NA	NA
	North	NA	NA	NA
8/19/2024	Middle	0.13	0.37	0.27
	South	NA	NA	NA
	North	0.054	0.33	0.21
9/22/2024	Middle	0.091	0.39	0.27
	South	NA	NA	NA
	North	**-0.041**	0.43	0.24
10/11/2024	Middle	0.093	0.39	0.28
	South	NA	NA	NA
	North	0.048	0.50	0.34
11/10/2024	Middle	0.082	0.39	0.29
	South	NA	NA	NA
	North	0.049	0.51	0.34
12/7/2024	Middle	0.12	0.43	0.32
	South	NA	NA	NA
	North	0.040	0.50	0.32
1/8/2025	Middle	0.084	0.43	0.31
	South	NA	NA	NA
	North	0.086	0.34	0.24
2/7/2025	Middle	0.052	0.36	0.26
	South	0.060	0.58	0.28
3/7/2025	North	0.065	0.51	0.33
	Middle	0.046	0.39	0.29
	South	NA	NA	NA
4/14/2025	North	0.059	0.48	0.30
	Middle	0.048	0.42	0.29
	South	0.054	0.62	0.23
5/15/2025	North	0.066	0.48	0.30
	Middle	0.083	0.42	0.30
	South	0.065	0.59	0.24

Table 2.4-35
Vertical Hydraulic Gradient Calculations
(Sheet 2 of 2)

Date	Plant Complex	Screen Mid-Point Approach		
		Minimum i_v (ft/ft)	**Maximum i_v (ft/ft)**	**Average i_v (ft/ft)**
6/24/2025	North	0.080	0.48	0.32
	Middle	0.076	0.48	0.31
	South	**-0.029**	0.64	0.19
Overall Minimum i_v = **-0.041**				
Overall Maximum i_v = 0.58				
Overall Average i_v = 0.28				

Notes:

i_v Vertical hydraulic gradient (feet per foot [ft/ft]); positive value represents downward gradient, negative values (**in bold**) represent an upward gradient.

i_v was calculated in ArcMap as: shallow potentiometric surface - deep potentiometric surface/shallow well screen mid-point elevation surface - deep well screen mid-point elevation surface.

Potentiometric and screen elevation surfaces were generated in ArcMap on a six ft by six ft grid for each Plant Complex. Vertical hydraulic gradients are measured at each of the grid nodes from these surfaces.

Key: NA = not available, insufficient data.

Table 2.4-36a
Summary of Slug Test Results, North Plant Complex
(Sheet 1 of 2)

Well ID	Aquifer Zone	Date	Test	Hydraulic Conductivity (ft/day)			Specific Storage (ft^{-1})	Selected Method	Representative Hydraulic Conductivity (ft/day)
				Hvorslev	Bouwer-Rice	KGS	KGS		
W-1	SBR	10/14/2024	Falling	14.1[(a)]	10.1	17.4	5.63E-04	Hvorslev (averaged)	14.9
			Rising	15.6[(a)]	10.6	30.1	1.82E-08		
W-2	SBR	10/21/2024	Falling	-[(a)]	-	-	-	Hvorslev (rising)	9.15E-04
			Rising	9.15E-04[(a)]	6.14E-04	5.07E-04	9.18E-06		
W-3	SBR	10/14/2024	Falling	-	-[(a)]	-	-	Bouwer-Rice (rising)	1.64
			Rising	2.51	1.64[(a)]	7.65E-01	4.99E-03		
W-4	SBR	10/21/2024	Falling	-	-[(a)]	-	-	Bouwer-Rice (rising)	1.38E-02
			Rising	1.68E-02	1.38E-02[(a)]	-	-		
W-5	SBR	10/21/2024	Falling	6.91E-03[(a)]	4.78E-03	1.00E-02	2.19E-08	Hvorslev (averaged)	4.30E-03
			Rising	1.68E-03[(a)]	1.54E-03	-	-		
DW-1	DBR	10/22/2024	Falling	6.78E-03	4.56E-03	1.08E-02[(a)]	3.24E-12	KGS (averaged)	5.57E-03
			Rising	4.58E-04	3.29E-04	3.33E-04[(a)]	1.62E-03		
DW-2	DBR	10/30/2024	Falling (pneumatic)	2.60	1.83	2.48[(a)]	2.04E-04	KGS (averaged)	1.80
			Rising (pneumatic)	2.15	1.67	2.17[(a)]	1.05E-04		
		11/9/2024	Falling	1.46	1.09	1.38[(a)]	5.14E-05		
			Rising	1.16	1.00	1.18[(a)]	1.73E-04		
DW-3	DBR	11/4/2024	Falling	-	-	-[(a)]	-	KGS (rising)	5.03E-06
			Rising	9.19E-05	6.72E-05	5.03E-06[(a)]	1.05E-03		
DW-4	DBR	11/4/2024	Falling	2.32E-04	1.69E-04	8.66E-05[(a)]	8.17E-05	KGS (averaged)	4.50E-05
			Rising	8.90E-05	6.46E-05	3.42E-06[(a)]	3.14E-03		

Table 2.4-36a
Summary of Slug Test Results, North Plant Complex
(Sheet 2 of 2)

Average (North Plant Complex - SBR)	**3.31**
Average (North Plant Complex - DBR)	**4.51E-01**

Note:

(a) Indicates representative hydraulic conductivity value due to analysis method (see report text for additional information).

Key: "-" Not analyzed because water levels were still recovering or method was inappropriate, i.e., falling head in unconfined well screen; ft. = feet; ft/day = feet per day; DBR = deep bedrock (analyzed from DW wells); KGS = Kansas Geological Survey, does not include skin effects; SBR = shallow bedrock (analyzed from W wells)

Table 2.4-36b
Summary of Slug Test Results, Middle Plant Complex
(Sheet 1 of 2)

Well ID	Aquifer Zone	Date	Test	Hydraulic Conductivity (ft/day)			Specific Storage (ft^{-1})	Selected Method	Representative Hydraulic Conductivity (ft/day)
				Hvorslev	Bouwer-Rice	KGS	KGS		
W-6	OB/PWR	10/13/2024	Falling	-	-[(a)]	-	-	Bouwer-Rice (rising)	16.7
			Rising	22.3	16.7[(a)]	85.0	5.24E-12		
W-7	OB/PWR	11/8/2024	Falling	1.26[(a)]	1.06	1.28	1.59E-05	Hvorslev (averaged)	1.44
			Rising	1.62[(a)]	9.24E-01	1.29	4.33E-05		
W-8	SBR	10/28/2024	Falling	-	-[(a)]	-	-	Bouwer-Rice (rising)	1.72E-02
		10/29/2024	Rising	2.77E-02	1.72E-02[(a)]	-	-		
W-9	SBR	-	Falling	-[(a)]	-	-	-	Hvorslev (rising)	7.09E-04
		11/5/2024	Rising	7.09E-04[(a)]	5.31E-04	7.48E-04	1.07E-06		
W-10	SBR	11/5/2024	Falling	-	-[(a)]	-	-	Bouwer-Rice (rising)	5.04E-01
			Rising	7.49E-01	5.04E-01[(a)]	3.93E-02	6.33E-03		
DW-5	DBR	10/22/2024	Falling	8.25E-02	5.87E-02	9.70E-02[(a)]	1.10E-06	KGS (averaged)	9.29E-02
			Rising	6.98E-02	5.57E-02	8.88E-02[(a)]	1.47E-06		
DW-6	DBR	10/26/2024	Falling (pneumatic)	1.20	8.98E-01	1.28[(a)]	4.01E-05	KGS (averaged)	9.85E-01
			Rising (pneumatic)	1.10	9.77E-01	1.21[(a)]	4.97E-04		
		11/9/2024	Falling	6.51E-01	5.89E-01	7.51E-01[(a)]	9.19E-05	KGS (averaged)	
			Rising	6.75E-01	5.41E-01	6.97E-01[(a)]	1.27E-04		
DW-7	DBR	11/4/2024	Falling	3.94E-02	3.04E-02	7.05E-02[(a)]	2.59E-11	KGS (averaged)	4.63E-02
			Rising	2.54E-02	1.83E-02	2.21E-02[(a)]	7.36E-06		
DW-8	DBR	10/28/2024	Falling	-	-	-[(a)]	-	KGS (rising)	1.21E-04
			Rising	2.54E-04	1.34E-04	1.21E-04[(a)]	6.62E-03		

Table 2.4-36b
Summary of Slug Test Results, Middle Plant Complex
(Sheet 2 of 2)

Average (Middle Plant Complex - OB/PWR)	**9.07**
Average (Middle Plant Complex - SBR)	**1.74E-01**
Average (Middle Plant Complex - DBR)	**2.81E-01**

Note:

(a) Indicates representative hydraulic conductivity value due to analysis method (see report text for additional information).

Key: "-" = Not analyzed because water levels were still recovering or method was inappropriate, i.e., falling head in unconfined well screen; DBR = Deep Bedrock (analyzed from DW wells); ft = feet; ft/day = feet per day; KGS = Kansas Geological Survey, does not include skin effects; OB = Overburden; PWR = Partially weathered rock; SBR = Shallow Bedrock (analyzed from W wells)

Table 2.4-36c
Summary of Slug Test Results, South Plant Complex
(Sheet 1 of 2)

Well ID	Aquifer Zone	Date	Test	Hydraulic Conductivity (ft/day)			Specific Storage (ft^{-1})	Selected Method	Representative Hydraulic Conductivity (ft/day)
				Hvorslev	Bouwer-Rice	KGS	KGS		
W-11	OB/PWR	11/8/2024	Falling	2.36[(a)]	1.96	4.50E-01	7.37E-06	Hvorslev (averaged)	2.38
			Rising	2.40[(a)]	1.95	4.33E-01	3.86E-05		
W-12	SBR	10/16/2024	Falling	5.68E-01	3.93E-01[(a)]	1.38E-02	5.81E-03	Bouwer-Rice (averaged)	2.11E-01
			Rising	4.11E-02	2.95E-02[(a)]	-	-		
W-13	SBR	10/28/2024	Falling	-	-	-	-	Bouwer-Rice (rising)	3.48E-01
			Rising	4.69E-01	3.48E-01[(a)]	2.38E-02	1.28E-02		
W-14	SBR	10/24/2024	Falling	5.29E-01	4.28E-01[(a)]	5.77E-01	4.31E-03	Bouwer-Rice (averaged)	2.47E-01
			Rising	8.51E-02	6.61E-02[(a)]	4.72E-01	4.31E-03		
W-15	OB/PWR	10/15/2024	Falling (pneumatic)	6.03[(a)]	4.99	7.42	1.92E-04	Hvorslev (averaged)	4.95
			Rising (pneumatic)	6.19[(a)]	5.86	7.61	2.98E-04		
		11/7/2024	Falling	3.59[(a)]	3.44	4.09	2.35E-04		
			Rising	4.00[(a)]	3.66	4.23	2.43E-04		
DW-9	DBR	11/7/2024	Falling	8.16E-02	5.97E-02	7.60E-02[(a)]	1.94E-05	KGS (averaged)	6.01E-02
			Rising	5.84E-02	4.27E-02	4.41E-02[(a)]	2.32E-04		
DW-10	DBR	10/14/2024	Falling	-	-	-	-	KGS (rising)	1.03E-04
			Rising	1.35E-03	8.87E-04	1.03E-04[(a)]	4.61E-03		
DW-11	DBR	10/28/2024	Falling	2.02E-04	1.46E-04	3.61E-04[(a)]	3.20E-12	KGS (averaged)	1.82E-04
		10/29/2024	Rising	9.79E-05	7.08E-05	2.60E-06[(a)]	3.17E-03		
DW-12	DBR	10/28/2024	Falling	-	-	-	-	KGS (rising)	3.00E-03
		10/29/2024	Rising	1.62E-03	8.35E-04	3.00E-03[(a)]	6.54E-12		

Table 2.4-36c
Summary of Slug Test Results, South Plant Complex
(Sheet 2 of 2)

Average (South Plant Complex - OB/PWR)	**3.67**
Average (South Plant Complex - SBR)	**2.70E-01**
Average (South Plant Complex - DBR)	**1.58E-02**

Note:

(a) Indicates representative hydraulic conductivity value due to analysis method (see report text for additional information).

Key: "-" = Not analyzed because water levels were still recovering or method was inappropriate, i.e., falling head in unconfined well screen; DBR = deep bedrock (analyzed from DW wells); ft. = feet; ft/day = feet per day; KGS = Kansas Geological Survey, does not include skin effects; OB = overburden; PWR = partially weathered rock; SBR = shallow bedrock (analyzed from W wells)

Table 2.4-37
Summary of Sitewide Hydraulic Conductivity Values

Stratigraphic Unit	Hydraulic Conductivity (K) (ft/day)[(a)]			Wells Tested
	Minimum	Maximum	Average	
OB/PWR Wells	1.44	16.7	6.37	4
All Bedrock Wells	5.03E-06	14.9	9.08E-01	23
SBR Wells	7.09E-04	14.9	1.63	11
DBR Wells	5.03E-06	1.80	2.49E-01	12

Note:

(a) K values from slug tests (Table 2.4.36).

Key: DBR = deep bedrock (analyzed from DW wells); ft/day = feet per day; OB = overburden; PWR = partially weathered rock; SBR = shallow bedrock (analyzed from W wells)

Table 2.4-38
Summary of Lugeon Packer Test Results

Boring Location	Test Interval (ft. bgs)	Average Hydraulic Conductivity (K) (ft/day)	Average Flow (gpm)	Fracture Aperture (in.)
B-3 (North Plant Complex)	Zone 1 (148.4 – 159.6)	4.56E-03	0.06	1.18
	Zone 2 248.4 – 259.6	2.06	27.69	0[(a)]
B-8 (Middle Plant Complex)	Zone 1 165.4 – 176.6	9.58E-02	1.12	1.11
	Zone 2 236.4 – 247.6	2.67	29.56	6.11
B-13 (South Plant Complex)	Zone 1 61.4 – 72.6	2.22E-03	0.01	0.20
Zone 1 Average		**3.42E-02**	**0.4**	**0.83**
Zone 2 Average		**2.37**	**28.63**	**3.06**

Note:

(a) Aperture width was 0, however there are ten fractures shown by acoustic televiewer (ATV) within this test interval; two of the fractures listed as open but had no measured aperture width.

Key: bgs = below ground surface; ft. = feet; ft/day = feet per day; gpm = gallons per minute; in. = inch

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Table 2.4-39a
Summary of Aquifer Pumping Test Results, North Plant Complex

Well Identification	Distance from PW-1 (ft.)	Maximum Drawdown (ft.)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[(a)] (ft/day)	Storativity
PW-1 (0.06 gpm)	0.00	9.98	SBR	Theis	-	-	-
				Theis (Recovery)	-	-	-
S-1	80.2 NW	0.00	SBR	Theis	No observable connection		
				Theis (Recovery)			
S-2	39.9 NW	0.30	SBR	Theis	7.23	3.62E-01	4.32E-03
				Theis (Recovery)	4.02	2.01E-01	5.19E-03
S-3	20.1 NW	1.50	SBR	Theis	2.04	1.02E-01	9.28E-04
				Theis (Recovery)	2.01	1.01E-01	9.56E-04
S-4	20.4 SE	0.31	SBR	Theis	6.94	3.47E-01	2.08E-02
				Theis (Recovery)	2.68	1.34E-01	2.39E-02
S-5	19.8 SW	0.33	SBR	Theis	9.10	4.55E-01	7.16E-03
				Theis (Recovery)	8.75	4.38E-01	7.16E-03
W-1	19.9 NE	0.31	SBR	Theis	2.91	1.46E-01	2.28E-02
				Theis (Recovery)	2.88	1.44E-01	2.31E-02
Distance-Drawdown			SBR	Theis	49.2	2.46	6.80E-07
		Average (SBR)			**8.89**	**4.45E-01**	**1.06E-02**

Note:

(a) K=T/b where K=hydraulic conductivity, T=Transmissivity, and b=saturated aquifer thickness (assumed to be 20 ft equal to screen length).

Key: ft = feet; ft^2/day = square feet per day; ft/day = feet per day; gpm = gallons per minute (pumping rate in pumping well); PW = pumping well; SBR = Shallow Bedrock

Table 2.4-39b
Summary of Aquifer Pumping Test Results, Middle Plant Complex

Well Identification	Distance from PW-2 (ft.)	Maximum Drawdown (ft.)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[(a)] (ft/day)	Storativity
PW-2 (3.5 gpm)	0.00	8.42	OB/PWR	Theis	-	-	-
				Theis (Recovery)	113	3.77	-
S-6	15 SW	2.75	OB/PWR	Theis	96.2	3.21	3.18E-02
				Theis (Recovery)	103	3.43	3.23E-02
S-7	14.5 NW	2.88	OB/PWR	Theis	117	3.90	8.43E-03
				Theis (Recovery)	132	4.40	1.11E-02
S-8	15.1 NE	6.25	OB/PWR	Theis	57.2	1.91	3.37E-03
				Theis (Recovery)	105	3.50	2.93E-03
S-9	30.1 NE	2.25	OB/PWR	Theis	128	4.27	3.93E-03
				Theis (Recovery)	165	5.50	4.54E-03
S-10	45 NE	0.92	OB/PWR	Theis	199	6.63	1.75E-02
				Theis (Recovery)	347	11.6	4.22E-02
W-6	15.2 SE	2.85	OB/PWR	Theis	89.3	2.98	5.45E-02
				Theis (Recovery)	85.3	2.84	4.04E-02
Distance-Drawdown			OB/PWR	Theis	117	3.90	5.38E-03
Average (OB/PWR)					**132**	**4.42**	**1.99E-02**

Note:

(a) K=T/b where K=hydraulic conductivity, T=Transmissivity, and b=saturated aquifer thickness (assumed to be 30 ft equal to screen length and saturated aquifer above the screen).

Key: ft = feet; ft^2/day = square feet per day; ft/day = feet per day; gpm = gallons per minute (pumping rate in pumping well); PW = pumping well; OB = Overburden; PWR = Partially weathered rock

Table 2.4-39c
Summary of Aquifer Pumping Test Results, South Plant Complex
(Sheet 1 of 2)

Well Identification	Distance from PW-3 (ft.)	Maximum Drawdown (ft.)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[(a)] (ft/day)	Storativity
PW-3 (0.8 gpm)	0.00	0.00	DBR	Theis	-	-	-
				Hantush	-	-	-
				Theis (Recovery)	1.20	6.00E-02	-
S-11	80.2 NW	19.34	DBR	Theis	1.09	5.45E-02	6.36E-05
				Hantush	0.625	3.13E-02	6.47E-05
				Theis (Recovery)	1.34	6.70E-02	2.55E-05
S-12	40.5 NW	25.83	DBR	Theis	0.579	2.90E-02	1.57E-04
				Hantush	0.565	2.83E-02	1.09E-04
				Theis (Recovery)	0.730	3.65E-02	3.39E-05
S-13	19.7 NW	26.48	DBR	Theis	1.57	7.85E-02	2.23E-04
				Hantush	1.33	6.65E-02	2.39E-04
				Theis (Recovery)	1.78	8.90E-02	9.57E-05
S-14	19.5 SE	28.66	DBR	Theis	0.784	3.92E-02	7.72E-04
				Hantush	0.484	2.42E-02	6.72E-04
				Theis (Recovery)	0.866	4.33E-02	3.32E-04
S-15	20.0 SW	51.19	DBR	Theis	1.49	7.45E-02	1.40E-05
				Hantush	1.21	6.05E-02	2.39E-05
				Theis (Recovery)	1.16	5.80E-02	3.06E-06
S-16	19.8 W	6.92	DBR	Theis	2.26	1.13E-01	9.27E-03
				Hantush	1.90	9.50E-02	9.74E-03
				Theis (Recovery)	2.87	1.44E-01	1.17E-02
DW-9	19.8 NE	30.96	DBR	Theis	1.43	7.15E-02	1.30E-04
				Hantush	1.23	6.15E-02	1.53E-04
				Theis (Recovery)	1.50	7.50E-02	4.51E-05

Table 2.4-39c
Summary of Aquifer Pumping Test Results, South Plant Complex
(Sheet 2 of 2)

Well Identification	Distance from PW-3 (ft.)	Maximum Drawdown (ft.)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[a] (ft/day)	Storativity
Distance-Drawdown			DBR	Hantush	4.29	2.15E-01	2.49E-06
		Average (DBR)			**1.40**	**7.02E-02**	**1.54E-03**

Note:

(a) K=T/b where K=hydraulic conductivity, T=Transmissivity, and b=saturated aquifer thickness (assumed to be 20 ft equal to screen length).

Key: ft – feet; ft^2/day - square feet per day; ft/day - feet per day; gpm - gallons per minute (pumping rate in pumping well); PW - pumping well; DBR - Deep Bedrock

Table 2.4-40
Average Linear Groundwater Velocity Calculations

Stratigraphic Unit	Hydraulic Conductivity (K)[a] (ft/day)	Average Horizontal Hydraulic Gradient[c] (i_h) (ft/ft)	Maximum Horizontal Hydraulic Gradient[c] (i_h) (ft/ft)	Specific Yield (Effective Porosity, n)	Average Horizontal Flow Velocity[d] (V_{avg}) (ft/day)	Maximum Horizontal Flow Velocity[d] (V_{max}) (ft/day)
Overburden/Partially Weathered Rock (OB/PWR)[b]	6.37	3.8E-02	9.2E-02	0.20	1.2	2.9
Shallow Bedrock (SBR)[b]	1.63	3.8E-02	9.2E-02	0.019	3.3	7.9
Deep Bedrock (DBR)[b]	2.49E-01	2.7E-02	4.4E-02	0.019	0.35	0.58

Notes:

(a) Average K values from slug tests for each stratigraphic unit (Table 2.4.12-7).

(b) K values for SBR and DBR from all three Plant Complexes; K values for OB/PWR from Middle and South Plant Complex only.

(c) Represents average or maximum ih for each stratigraphic unit (Table 2.4.12-4).

(d) Vavg and Vmax calculated using Darcy's Law: V = K*ih/n; Vavg uses average K and average ih and Vmax uses average K and maximum ih.

Key: ft/day - feet per day; ft/ft - feet per foot

Table 2.4-41
Historical Groundwater Use (Vicinity)

County	Recreational	Energy	Industrial	Mining/ Agriculture	Public Water Supply	Total
Forsyth	--	--	--	--	0.22	0.22
Guilford	0.050	-	0.040	--	0.86	0.95
Rockingham	--	--	--	--	0.10	0.10
Stokes	--	0.10	-	--	0.01	0.11
Total (mgd)	**0.050**	**0.10**	**0.040**	**--**	**1.2**	**1.4**
Portion of Overall Use (%)	**4**	**7**	**3**		**86**	

Notes:
Values shown in million gallons per day (mgd) for 2022.
Key: "—" = no water use reported

Table 2.4-42
Vicinity Public Water System Wells
(Sheet 1 of 4)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft bgs)	System Name	System Address	System City
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234 139	Community	FORSYTH	WELL #3	55	250	PINE KNOLLS WATER SUPPLY	–	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234 192	Community	FORSYTH	WELL #2	11	300	DEERPATH S/D	PINEY GROVE RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234 192	Community	FORSYTH	WELL #3	30	405	DEERPATH S/D	PINEY GROVE RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234 193	Community	FORSYTH	WELL #1	73	300	MIKKOLA DOWNS S/D	–	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234 193	Community	FORSYTH	WELL #2	18	300	MIKKOLA DOWNS S/D	–	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 197	Community	GUILFORD	WELL #1	18	505	SMOKE RIDGE ESTATES	9100 SMOKE HOLLOW RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 197	Community	GUILFORD	WELL #2	18	525	SMOKE RIDGE ESTATES	9100 SMOKE HOLLOW RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 200	Community	GUILFORD	WELL #1	45	320	DORSETT DOWNS S/D	5 DORSETT DOWNS DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 203	Community	GUILFORD	WELL #2	41	-	RIVER OAKS S/D	NC 68	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 203	Community	GUILFORD	WELL #3	65	345	RIVER OAKS S/D	NC 68	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 206	Community	GUILFORD	WELL #1	60	280	WEATHERSTONE S/D	8107 BARTONSHIRE DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 206	Community	GUILFORD	WELL #2	10	700	WEATHERSTONE S/D	8107 BARTONSHIRE DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 207	Community	GUILFORD	WELL #1	55	358	MEADOW RIDGE S/D	7626 ANTHONY RD	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 207	Community	GUILFORD	WELL #2	71	385	MEADOW RIDGE S/D	7626 ANTHONY RD	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 217	Community	GUILFORD	WELL #1	37	400	HUNTCLIFF S/D	KRISTEN DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241 217	Community	GUILFORD	WELL #2	37	400	HUNTCLIFF S/D	KRISTEN DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279 118	Community	ROCKINGHAM	WELL #1	18	225	RICHWOOD ACRES	–	MADISON
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279 118	Community	ROCKINGHAM	WELL #2	10	300	RICHWOOD ACRES	–	MADISON
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279 151	Community	ROCKINGHAM	WELL #1	15	225	QUAIL OAKS	123 FORREST DR	MADISON

Table 2.4-42
Vicinity Public Water System Wells
(Sheet 2 of 4)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft bgs)	System Name	System Address	System City
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279176	Community	ROCKINGHAM	WELL #1	93	315	CEDAR HOLLOW S/D	109 SHETLAND CT	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279176	Community	ROCKINGHAM	WELL #4	92	605	CEDAR HOLLOW S/D	109 SHETLAND CT	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3034012	Community	FORSYTH	WELL #1	31	500	BLUE WATER COVE S/D	EASTSHORE CIRCLE	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041009	Community	GUILFORD	WELL #1	73	245	PROVIDENCE NORTH S/D	PROVIDENCE NORTH DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041010	Community	GUILFORD	WELL #1	62	585	HUNTING RIDGE S/D	–	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041011	Community	GUILFORD	WELL #1	25	500	SPRINGDALE S/D	8100 SPRINGBIRCH DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041011	Community	GUILFORD	WELL #2	66	300	SPRINGDALE S/D	8100 SPRINGBIRCH DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041039	Community	GUILFORD	WELL #1	7.5	800	ARBOR RUN/CHARLES PLACE S/D	7599 TREBBIANO DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041039	Community	GUILFORD	WELL #2	132	355	ARBOR RUN/CHARLES PLACE S/D	7599 TREBBIANO DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041039	Community	GUILFORD	WELL #4	50	500	ARBOR RUN/CHARLES PLACE S/D	7599 TREBBIANO DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041043	Community	GUILFORD	WELL #1	56	425	LINVILLE OAKS S/D	8504 CRESTED OAK COURT	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041058	Community	GUILFORD	WELL #1	40	500	PEARMAN ESTATES	7512 BROADUS COURT	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3079023	Community	ROCKINGHAM	WELL #2	60	320	BELEWS LANDING S/D	301 CROWS NEST DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3079023	Community	ROCKINGHAM	WELL #3	60	300	BELEWS LANDING S/D	301 CROWS NEST DR	STOKESDALE
Crystalline-Rock	BETHEL UMC_0241697	NC0241697	Non-Community Transient	GUILFORD	WELL #1	40	330	BETHEL UMC	8424 HAW RIVER RD	OAK RIDGE
Crystalline-Rock	ELLISBORO BAPT CH_279468	NC0279468	Non-Community Transient	ROCKINGHAM	WELL #1	40	–	ELLISBORO BAPTIST CHURCH	1604 ELLISBORO ROAD	MADISON
Crystalline-Rock	FULP MORAVIAN CHURCH_285416	NC0285416	Non-Community Transient	STOKES	WELL #1	40	–	FULP MORAVIAN CHURCH	1556 US HWY 311	WALNUT COVE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279168	Non-Community Transient	ROCKINGHAM	WELL #1	50	–	HUMPHREYS RIDGE CAMPGROUND NO 2	–	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279169	Non-Community Transient	ROCKINGHAM	WELL #2	20	300	HUMPHREYS RIDGE CAMPGROUND NO 3	435 HUMPHREYS RIDGE DR.	STOKESDALE

Table 2.4-42
Vicinity Public Water System Wells
(Sheet 3 of 4)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft bgs)	System Name	System Address	System City
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279169	Non-Community Transient	ROCKINGHAM	WELL #3	50	–	HUMPHREYS RIDGE CAMPGROUND NO 3	435 HUMPHREYS RIDGE DR.	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279695	Non-Community Transient	ROCKINGHAM	WELL #1	50	–	HUMPHREY`S RIDGE CAMPGROUND NO 1	435 HUMPREYS RIDGE DR	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279695	Non-Community Transient	ROCKINGHAM	WELL #2	50	–	HUMPHREY`S RIDGE CAMPGROUND NO 1	435 HUMPREYS RIDGE DR	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279750	Non-Community Transient	ROCKINGHAM	WELL #2	6	500	HUMPHREY`S GRILL	435 HUMPHREYS RIDGE RD	STOKESDALE
Crystalline-Rock	JARVIS, ROSANNE	NC0285515	Non-Community Transient	STOKES	WELL #1	13	103	HILLBILLY HIDE AWAY	4335 PINE HALL RD	WALNUT COVE
Crystalline-Rock	JOYNER, JERRY	NC0241553	Non-Community Transient	GUILFORD	WELL #1	40	–	PARKERS RESTAURANT	6903 HWY 158 EAST	STOKESDALE
Crystalline-Rock	MT ZION METHODIST CHURCH_279415	NC0279415	Non-Community Transient	ROCKINGHAM	WELL #1	40	–	MT ZION METHODIST CHURCH	3708 ELLISBORO RD	STOKESDALE
Crystalline-Rock	OAK LEVEL BAPTIST CHURCH-ROCKINGHAM CO	NC3079008	Non-Transient, Non-Community	ROCKINGHAM	WELL #1	5	1504	OAK LEVEL BAPTIST ACADEMY-ROCKINGHAM CO	1569 OAK LEVEL CHURCH RD	STOKESDALE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041060	Community	GUILFORD	WELL #1	24	420	RACHEL`S LANDING	8531 BELEWS CREEK RD	STOKESDALE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041101	Community	GUILFORD	WELL #3	60	600	KNIGHT`S LANDING S/D	8515 PARKCHESTER PLACE	OAK RIDGE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041101	Community	GUILFORD	WELL #2	25	700	KNIGHT`S LANDING S/D	8515 PARKCHESTER PLACE	OAK RIDGE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041104	Community	GUILFORD	WELL #9	33	660	SHILOH SUBDIVISION	7635 MONTY DRIVE	KERNERSVILLE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041104	Community	GUILFORD	WELL #10	80	600	SHILOH SUBDIVISION	7635 MONTY DRIVE	KERNERSVILLE
Crystalline-Rock	PARKSIDE INVESTMENTS LLC	NC0285483	Non-Community Transient	STOKES	WELL #1	50	-	PARKSIDE INVESTMENTS LLC	4547 PINE HALL RD	WALNUT COVE
Crystalline-Rock	PATTEN, JIM	NC0279406	Non-Community Transient	ROCKINGHAM	WELL #1	30	225	CAROLINA CAMPING & MARINA	–	STOKESDALE
Crystalline-Rock	PATTEN, JIM	NC0279406	Non-Community Transient	ROCKINGHAM	WELL #2	25	225	CAROLINA CAMPING & MARINA	–	STOKESDALE
Crystalline-Rock	PATTEN, JIM	NC0279406	Non-Community Transient	ROCKINGHAM	WELL #3	35	300	CAROLINA CAMPING & MARINA	–	STOKESDALE

Table 2.4-42
Vicinity Public Water System Wells
(Sheet 4 of 4)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft bgs)	System Name	System Address	System City
Crystalline-Rock	SIMAAN QUAIL ACRES, LLC	NC02791 57	Community	ROCKINGHAM	WELL #3	29	505	QUAIL ACRES MHP	152 TURFWOOD CIRCLE	STOKESDALE
Crystalline-Rock	SIMAAN QUAIL ACRES, LLC	NC02791 57	Community	ROCKINGHAM	WELL #5	21	505	QUAIL ACRES MHP	152 TURFWOOD CIRCLE	STOKESDALE
Crystalline-Rock	SMITH-STACEY, LYNN	NC02855 21	Non-Community Transient	STOKES	WELL #1	10	168	SMITHS GROCERY & GRILL	2294 PINE HALL ROAD	PINE HALL
Crystalline-Rock	THALMAN, JOHN	NC02796 92	Community	ROCKINGHAM	WELL #1	70	160	GIDEON GROVE TP NO 1	WEST OF 145 BERNICE DRIVE	STOKESDALE
Early Mesozoic basin	BAILEYTOWN CHRISTIAN CHURCH	NC30850 05	Non-Community Transient	STOKES	WELL #1	10	265	BAILEYTOWN CHRISTIAN CHURCH	1163 BAILEYTOWN CH RD	WALNUT COVE
Early Mesozoic basin	EDEN UNITED METHODIST CHURCH_279413	NC02794 13	Non-Community Transient	ROCKINGHAM	WELL #1	2	500	EDEN UNITED METHODIST CH	844 EDEN CHURCH RD	MADISON
Early Mesozoic basin	STOKES COUNTY SCHOOLS	NC02854 28	Non-Transient, Non-Community	STOKES	WELL #1	50	175	PINE HALL ELEM SCHOOL	1400 PINE HALL ROAD	PINE HALL
Early Mesozoic basin	WALNUT COVE, TOWN OF	NC02850 15	Community	STOKES	WELL #1-FIRE STATION	140	1230	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic basin	WALNUT COVE, TOWN OF	NC02850 15	Community	STOKES	WELL #2 - FOWLER PARK	95	1150	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic basin	WALNUT COVE, TOWN OF	NC02850 15	Community	STOKES	WELL #3	35	600	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic basin	WALNUT COVE, TOWN OF	NC02850 15	Community	STOKES	WELL #4-CLUB STREET	55	805	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic basin	WALNUT COVE, TOWN OF	NC02850 15	Community	STOKES	WELL #5-HWY 311	36	605	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic basin	WALNUT COVE, TOWN OF	NC02850 15	Community	STOKES	WELL #6-BICYCLES WELL	40	903	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic basin	WIELAND COPPER PRODUCTS LLC	NC02854 73	Non-Transient, Non-Community	STOKES	WELL #1	100	465	WIELAND COPPER PRODUCTS LLC	3990 US 311 HWY NORTH	PINE HALL
Early Mesozoic basin	WIELAND COPPER PRODUCTS LLC	NC02854 73	Non-Transient, Non-Community	STOKES	WELL #5	195	312	WIELAND COPPER PRODUCTS LLC	3990 US 311 HWY NORTH	PINE HALL
Early Mesozoic basin	WIELAND COPPER PRODUCTS LLC	NC02854 73	Non-Transient, Non-Community	STOKES	WELL #6	200	268	WIELAND COPPER PRODUCTS LLC	3990 US 311 HWY NORTH	PINE HALL
Early Mesozoic basin	WIELAND COPPER PRODUCTS LLC	NC02854 73	Non-Transient, Non-Community	STOKES	WELL #7	85	300	WIELAND COPPER PRODUCTS LLC	3990 US 311 HWY NORTH	PINE HALL
Early Mesozoic basin	PINE HALL	NC02854 73	Non-Transient, Non-Community	STOKES	WELL #8	125	400	WIELAND COPPER PRODUCTS LLC	3990 US 311 HWY NORTH	

Source: Reference 2.4-92

Key: "-" = data was not reported; bgs = below ground surface; ft. = feet; gpm = gallons per minute; PWS = public water supply

Table 2.4-43
Numerical Model Simulated Water Balance

Model Feature	Cumulative Inflow (mgd)	Cumulative Outflow (mgd)
Drains	0.00	279.6
River Leakage	69.9	101.7
Recharge	314.4	0.00
Total Flow	381.3	381.3
Inflow - Outflow	0.00	0.00
Percent Discrepancy	0.00%	0.00%

Key: mgd = million gallons per day

Table 2.4-44
Final Calibrated Model Input Parameters
(Sheet 1 of 3)

Layer	Zone / Reach	Zone Type	Parameter	Calibrated Estimate	Parameter Unit
1 - Overburden (OB)	1	Silty to clayey sandy saprolite	Kxy	3.76	ft/day
	2	Sandy clay saprolite	Kxy	35.2	ft/day
	3	Silty Sand saprolite	Kxy	7.53	ft/day
2 - Partially Weathered Rock (PWR)	4	Silty to clayey sandy PWR	Kxy	0.109	ft/day
	5	Sandy clay PWR	Kxy	1.81	ft/day
	6	Silty Sand PWR	Kxy	42.4	ft/day
3 - Shallow Bedrock (SBR)	7	Biotite gneiss and schist (shallow bedrock)	Kxy	0.0144	ft/day
	8	Felsic mica gneiss (shallow bedrock)	Kxy	2.89	ft/day
	9	Metagraywacke and muscovite-biotite schist (shallow bedrock)	Kxy	1.15	ft/day
	10	Mudstone (shallow bedrock)	Kxy	0.317	ft/day
	11	Sandstone, mudstone, and conglomerate (shallow bedrock)	Kxy	0.454	ft/day
	12	Granite (shallow bedrock)	Kxy	0.104	ft/day
	13	Dike (shallow bedrock)	Kxy	0.478	ft/day
4 - Deep Bedrock (DBR)	14	Biotite gneiss and schist (deep bedrock)	Kxy	0.00604	ft/day
	15	Felsic mica gneiss (deep bedrock)	Kxy	0.426	ft/day
	16	Metagraywacke and muscovite-biotite schist (deep bedrock)	Kxy	0.702	ft/day
	17	Mudstone (deep bedrock)	Kxy	0.0479	ft/day
	18	Sandstone, mudstone, and conglomerate (deep bedrock)	Kxy	0.120	ft/day
	19	Granite (deep bedrock)	Kxy	0.0217	ft/day
	20	Dike (deep bedrock)	Kxy	0.465	ft/day
5 - Deepest Bedrock (DPR)	21	Biotite gneiss and schist (deepest bedrock)	Kxy	0.000284	ft/day
	22	Felsic mica gneiss (deepest bedrock)	Kxy	0.0408	ft/day
	23	Metagraywacke and muscovite-biotite schist (deepest bedrock)	Kxy	0.334	ft/day
	24	Mudstone (deepest bedrock)	Kxy	0.0524	ft/day
	25	Sandstone, mudstone, and conglomerate (deepest bedrock)	Kxy	0.116	ft/day
	26	Granite (deepest bedrock)	Kxy	0.245	ft/day
	27	Dike (deepest bedrock)	Kxy	0.0376	ft/day

Table 2.4-44
Final Calibrated Model Input Parameters
(Sheet 2 of 3)

Layer	Zone / Reach	Zone Type	Parameter	Calibrated Estimate	Parameter Unit
1 - Overburden (OB)	1	Silty to clayey sandy saprolite	Kz	4.10	ft/day
	2	Sandy clay saprolite	Kz	0.0919	ft/day
	3	Silty Sand saprolite	Kz	0.409	ft/day
2 - Partially Weathered Rock (PWR)	4	Silty to clayey sandy PWR	Kz	3.68	ft/day
	5	Sandy clay PWR	Kz	0.621	ft/day
	6	Silty Sand PWR	Kz	2.01	ft/day
3 - Shallow Bedrock (SBR)	7	Biotite gneiss and schist (shallow bedrock)	Kz	0.437	ft/day
	8	Felsic mica gneiss (shallow bedrock)	Kz	0.00845	ft/day
	9	Metagraywacke and muscovite-biotite schist (shallow bedrock)	Kz	0.0127	ft/day
	10	Mudstone (shallow bedrock)	Kz	0.0265	ft/day
	11	Sandstone, mudstone, and conglomerate (shallow bedrock)	Kz	0.199	ft/day
	12	Granite (shallow bedrock)	Kz	0.204	ft/day
	13	Dike (shallow bedrock)	Kz	0.0329	ft/day
4 - Deep Bedrock (DBR)	14	Biotite gneiss and schist (deep bedrock)	Kz	0.000386	ft/day
	15	Felsic mica gneiss (deep bedrock)	Kz	0.00133	ft/day
	16	Metagraywacke and muscovite-biotite schist (deep bedrock)	Kz	0.00497	ft/day
	17	Mudstone (deep bedrock)	Kz	0.00161	ft/day
	18	Sandstone, mudstone, and conglomerate (deep bedrock)	Kz	0.0127	ft/day
	19	Granite (deep bedrock)	Kz	0.0105	ft/day
	20	Dike (deep bedrock)	Kz	0.00708	ft/day
5 - Deepest Bedrock (DPR)	21	Biotite gneiss and schist (deepest bedrock)	Kz	0.0130	ft/day
	22	Felsic mica gneiss (deepest bedrock)	Kz	0.00862	ft/day
	23	Metagraywacke and muscovite-biotite schist (deepest bedrock)	Kz	0.00441	ft/day
	24	Mudstone (deepest bedrock)	Kz	0.00540	ft/day
	25	Sandstone, mudstone, and conglomerate (deepest bedrock)	Kz	0.00137	ft/day
	26	Granite (deepest bedrock)	Kz	0.0220	ft/day
	27	Dike (deepest bedrock)	Kz	0.00644	ft/day

Table 2.4-44
Final Calibrated Model Input Parameters
(Sheet 3 of 3)

Layer	Zone / Reach	Zone Type	Parameter	Calibrated Estimate	Parameter Unit
1 - Overburden (OB)	1	Open water	Recharge	0	in/yr
	2	Developed, open space	Recharge	0.964	in/yr
	3	Developed, low intensity	Recharge	0.845	in/yr
	4	Developed, medium intensity	Recharge	0.420	in/yr
	5	Developed, high intensity	Recharge	0.255	in/yr
	6	Barren land	Recharge	16.9	in/yr
	7	Deciduous forest	Recharge	2.45	in/yr
	8	Evergreen forest	Recharge	3.87	in/yr
	9	Mixed forest	Recharge	5.86	in/yr
	10	Shrub/Scrub	Recharge	16.9	in/yr
	11	Grassland/herbaceous	Recharge	16.9	in/yr
	12	Pasture/Hay	Recharge	16.9	in/yr
	13	Cultivated crops	Recharge	5.99	in/yr
	14	Woody wetlands	Recharge	0	in/yr
	15	Emergent herbaceous wetlands	Recharge	0	in/yr

Notes:

Hydraulic properties (Kxy, Kz, and Recharge) are represented by zones. Boundary conditions (drains and rivers) are represented by reaches.

All recharge zones and boundary conditions apply to layer 1.

All values rounded to three significant digits.

Key: ft. = feet; in. = inches; yr. = year; Kxy = horizontal hydraulic conductivity; Kz = vertical hydraulic conductivity

Table 2.4-45
Estimated Minimum and Median Particle Travel Times[(a)]

Site	Particle Starting Position	Minimum Particle Tracking Travel Time In Days (Years)	Median Particle Tracking Travel Time In Days (Years)
North Plant Complex	PPBA Perimeter	45.0 (0.12)	2,452 (6.7)
Middle Plant Complex	PPBA Perimeter	35.3 (0.10)	2,961 (8.1)
South Plant Complex	PPBA Perimeter	95.6 (0.26)	2,821 (7.7)
North Plant Complex	PPBA Center	27,253 (75)	498,514 (1,366)
Middle Plant Complex	PPBA Center	10,018 (30)	95,005 (260)
South Plant Complex	PPBA Center	2,369 (6.5)	26,238 (72)

Note:

(a) Based on particle tracking results from the 3D Numerical Groundwater Flow Model.

Table 2.4-46

Not Used

Table 2.4-46
Not Used

Table 2.4-46
Not Used

Table 2.4-47
Accidental Release Volumes

TerraPower Tank Volume	3200	gallons	1.211E+07	ml
WEC Volume	10,000	gallons	3.785E+07	ml
X-energy Volume	883	gallons	3.343E+06	ml

Key: ml = milliliter

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 1 of 12)

Shortest Travel (Perimeter PPBAs) 35.3 Days									
Isotope	**TerraPower Activity Ci**	**Half-life (days)**	**Kd (sand) l/kg**	**Retardation Factor**	**Retarded Travel Time Days**	**Number of Half-lives**	**Activity Remaining Ci**	**Percent of Original Activity Remaining**	**Maximum Remaining Concentration (µCi/ml)**
Am-241	4.78E-10	158003.7752	1900	15106	533242	3.4	4.61E-11	9.6%	3.81E-12
Ba-137m	7.57E-07	0.001772222	Missing	1	35	19918.5	0.00E+00	0.0%	0.00E+00
Ce-144	7.87E-08	284.91	500	3976	140353	492.6	4.00E-156	0.0%	3.30E-157
Cs-134	3.80E-04	754.2981889	280	2227	78613	104.2	1.61E-35	0.0%	1.33E-36
Cs-137	4.00E-03	10986.48534	280	2227	78613	7.2	2.80E-05	0.7%	2.31E-06
I-129	1.70E-09	5734302521	1	8.95	316	0.0	1.70E-09	100.0%	1.40E-10
Pr-144	7.87E-08	0.012	Missing	1	35	2941.7	0.00E+00	0.0%	0.00E+00
Pr-144m	7.50E-10	0.005	Missing	1	35	7060.0	0.00E+00	0.0%	0.00E+00
Pu-238	2.47E-08	32031.74083	550	4373.5	154385	4.8	8.75E-10	3.5%	7.22E-11
Pu-239	8.66E-09	8805989.413	550	4373.5	154385	0.0	8.56E-09	98.8%	7.06E-10
Pu-240	3.44E-09	2396354.066	550	4373.5	154385	0.1	3.29E-09	95.6%	2.72E-10
Pu-241	5.54E-08	5233.555466	550	4373.5	154385	29.5	7.30E-17	0.0%	6.02E-18
Rh-106	6.70E-08	0.000348032	Missing	1	35	101427.3	0.00E+00	0.0%	0.00E+00
Ru-106	6.69E-08	371.8	55	438.25	15470	41.6	1.99E-20	0.0%	1.65E-21
Sb-125	1.84E-06	1007.54252	45	358.75	12664	12.6	3.03E-10	0.0%	2.50E-11
Sr-90	5.79E-07	10559.15197	15	120.25	4245	0.4	4.38E-07	75.7%	3.62E-08
Te-125m	2.58E-08	57.4	125	994.75	35115	611.8	1.80E-192	0.0%	1.49E-193
Te-129	1.03E-12	0.048333333	125	994.75	35115	726510.5	0.00E+00	0.0%	0.00E+00
Te-129m	1.14E-09	33.6	125	994.75	35115	1045.1	0.00E+00	0.0%	0.00E+00
Y-90	5.79E-07	2.66875	170	1352.5	47743	17889.7	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 2 of 12)

X-energy									
Isotope	**X-energy activity Ci**	**Half-life (days)**	**Kd (sand) l/kg**	**Retardation Factor**	**Retarded Travel Time Days**	**Number of Half-lives**	**Activity Remaining Ci**	**Percent of Original Activity Remaining**	**Maximum Remaining Concentration (µCi/ml)**
Ag-110m	2.47E+00	249.86	90	716.5	25292	101.2	8.32E-31	0.0%	2.49E-37
Ba-137m	1.96E+00	0.001772222	Missing	1	35	19918.5	0.00E+00	0.0%	0.00E+00
Ba-140	6.68E-02	12.751	Missing	1	35	2.8	9.80E-03	14.7%	2.93E-09
Cs-134	4.51E+00	754.2981889	280	2227	78613	104.2	1.91E-31	0.0%	5.72E-38
Cs-137	2.84E+00	10986.48534	280	2227	78613	7.2	1.99E-02	0.7%	5.96E-09
I-131	2.92E-01	8.0252	1	8.95	316	39.4	4.11E-13	0.0%	1.23E-19
La-140	6.68E-02	1.67858	Missing	1	35	21.0	3.12E-08	0.0%	9.33E-15
Xe-133	0.00E+00	5.2475	Missing	1	35	6.7	0.00E+00	0.0%	0.00E+00
WEC									
Isotope	**WEC Activity Ci**	**Half-life (days)**	**Kd (sand) l/kg**	**Retardation Factor**	**Retarded Travel Time Days**	**Number of Half-lives**	**Activity Remaining Ci**	**Percent of Original Activity Remaining**	**Maximum Remaining Concentration (µCi/ml)**
H-3	5.20E+01	4499.783889	0.1	1.795	63	0.0	5.15E+01	99.0%	1.36E+00
Cr-51	6.74E-02	27.704	70	557.5	19680	710.4	9.77E-216	0.0%	2.58E-217
Mn-54	3.49E-02	312.2	50	398.5	14067	45.1	9.53E-16	0.0%	2.52E-17
Mn-56	8.85E+00	0.107454167	50	398.5	14067	130912.1	0.00E+00	0.0%	0.00E+00
Fe-55	2.60E-02	1002.224593	220	1750	61775	61.6	7.25E-21	0.0%	1.91E-22
Fe-59	6.74E-03	44.49	220	1750	61775	1388.5	0.00E+00	0.0%	0.00E+00
Co-58	9.88E-02	70.86	60	478	16873	238.1	2.05E-73	0.0%	5.43E-75
Co-60	1.14E-02	1925.28	60	478	16873	8.8	2.62E-05	0.2%	6.93E-07
Br-83	7.98E-01	0.098916667	15	120.25	4245	42913.1	0.00E+00	0.0%	0.00E+00
Br-84	4.24E-01	0.022055556	15	120.25	4245	192460.6	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 3 of 12)

Isotope	WEC Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Br-85	4.99E-02	0.002013889	15	120.25	4245	2107775.2	0.00E+00	0.0%	0.00E+00
Rb-88	3.74E+01	0.012342361	55	438.25	15470	1253425.1	0.00E+00	0.0%	0.00E+00
Rb-89	1.72E+00	0.010638889	55	438.25	15470	1454120.4	0.00E+00	0.0%	0.00E+00
Sr-89	2.74E-02	50.563	15	120.25	4245	84.0	1.47E-27	0.0%	3.87E-29
Sr-90	1.23E-03	10559.15197	15	120.25	4245	0.4	9.31E-04	75.7%	2.46E-05
Sr-91	4.24E-02	0.402083333	15	120.25	4245	10557.1	0.00E+00	0.0%	0.00E+00
Sr-92	1.02E-02	0.108791667	15	120.25	4245	39017.9	0.00E+00	0.0%	0.00E+00
Y-90	3.24E-04	2.66875	Missing	1	35	13.2	3.38E-08	0.0%	8.93E-10
Y-91m	2.30E-02	0.034520833	Missing	1	35	1022.6	0.00E+00	0.0%	0.00E+00
Y-91	3.50E-03	58.51	Missing	1	35	0.6	2.30E-03	65.8%	6.09E-05
Y-92	8.49E-03	0.1475	Missing	1	35	239.3	7.69E-75	0.0%	2.03E-76
Y-93	2.74E-03	0.424166667	Missing	1	35	83.2	2.43E-28	0.0%	6.42E-30
Nb-95	3.99E-03	34.991	160	1273	44937	1284.2	0.00E+00	0.0%	0.00E+00
Mo-99	5.25E+00	2.746833333	10	80.5	2842	1034.5	0.00E+00	0.0%	0.00E+00
Tc-99m	4.99E+00	0.2503	0.1	1.795	63	253.2	3.11E-76	0.0%	8.21E-78
Ru-103	3.50E-03	39.247	55	438.25	15470	394.2	7.68E-122	0.0%	2.03E-123
Rh-103m	3.50E-03	0.038968056	Missing	1	35	905.9	7.08E-276	0.0%	1.87E-277
Rh-106	1.12E-03	0.000348032	Missing	1	35	101427.3	0.00E+00	0.0%	0.00E+00
Ag-110m	9.99E-03	249.86	90	716.5	25292	101.2	3.37E-33	0.0%	8.90E-35
Te-127m	1.89E-02	106.1	125	994.75	35115	331.0	4.45E-102	0.0%	1.17E-103
Te-129m	6.49E-02	33.6	125	994.75	35115	1045.1	0.00E+00	0.0%	0.00E+00
Te-129	9.47E-02	0.048333333	125	994.75	35115	726510.5	0.00E+00	0.0%	0.00E+00
Te-131m	1.67E-01	1.385416667	125	994.75	35115	25345.9	0.00E+00	0.0%	0.00E+00
Te-131	1.07E-01	0.017361111	125	994.75	35115	2022605.3	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 4 of 12)

Isotope	WEC Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Te-132	1.97E+00	3.204	125	994.75	35115	10959.6	0.00E+00	0.0%	0.00E+00
Te-134	2.74E-01	0.029027778	125	994.75	35115	1209692.2	0.00E+00	0.0%	0.00E+00
I-129	3.74E-07	5734302521	1	8.95	316	0.0	3.74E-07	100.0%	9.88E-09
I-130	2.74E-01	0.515	1	8.95	316	613.5	5.84E-186	0.0%	1.54E-187
I-131	1.77E+01	8.0252	1	8.95	316	39.4	2.49E-11	0.0%	6.59E-13
I-132	2.35E+01	0.095625	1	8.95	316	3303.9	0.00E+00	0.0%	0.00E+00
I-133	3.24E+01	0.867916667	1	8.95	316	364.0	8.53E-109	0.0%	2.25E-110
I-134	5.51E+00	0.036458333	1	8.95	316	8665.6	0.00E+00	0.0%	0.00E+00
I-135	1.95E+01	0.274166667	1	8.95	316	1152.3	0.00E+00	0.0%	0.00E+00
Cs-134	1.72E+01	754.2981889	280	2227	78613	104.2	7.28E-31	0.0%	1.92E-32
Cs-136	2.50E+01	13.01	280	2227	78613	6042.5	0.00E+00	0.0%	0.00E+00
Cs-137	1.25E+01	10986.48534	280	2227	78613	7.2	8.77E-02	0.7%	2.32E-03
Cs-138	9.21E+00	0.022569444	280	2227	78613	3483165.0	0.00E+00	0.0%	0.00E+00
Ba-137m	1.17E+01	0.001772222	Missing	1	35	19918.5	0.00E+00	0.0%	0.00E+00
Ba-140	2.50E-02	12.751	Missing	1	35	2.8	3.67E-03	14.7%	9.69E-05
La-140	7.72E-03	1.67858	Missing	1	35	21.0	3.61E-09	0.0%	9.53E-11
Ce-141	3.99E-03	32.504	500	3976	140353	4318.0	0.00E+00	0.0%	0.00E+00
Ce-143	3.50E-03	1.376625	500	3976	140353	101954.3	0.00E+00	0.0%	0.00E+00
Pr-143	3.74E-03	13.57	Missing	1	35	2.6	6.16E-04	16.5%	1.63E-05
Ce-144	3.00E-03	284.91	500	3976	140353	492.6	1.52E-151	0.0%	4.03E-153
Pr-144	3.00E-03	0.012	Missing	1	35	2941.7	0.00E+00	0.0%	0.00E+00
Zr-95	3.99E-03	64.032	600	4771	168416	2630.2	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 5 of 12)

Shortest Travel Time (Center PPBAs) 2369 Days									
TerraPower									
Isotope	TerraPower Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Am-241	4.78E-10	158003.7752	1900	15106	35846538	226.9	2.43E-78	0.0%	2.00E-79
Ba-137m	7.57E-07	0.001772222	Missing	1	2369	1338996.9	0.00E+00	0.0%	0.00E+00
Ce-144	7.87E-08	284.91	500	3976	9435048	33115.9	0.00E+00	0.0%	0.00E+00
Cs-134	3.80E-04	754.2981889	280	2227	5284671	7006.1	0.00E+00	0.0%	0.00E+00
Cs-137	4.00E-03	10986.48534	280	2227	5284671	481.0	6.33E-148	0.0%	5.23E-149
I-129	1.70E-09	5734302521	1	8.95	21238	0.0	1.70E-09	100.0%	1.40E-10
Pr-144	7.87E-08	0.012	Missing	1	2369	197750.0	0.00E+00	0.0%	0.00E+00
Pr-144m	7.50E-10	0.005	Missing	1	2369	474600.0	0.00E+00	0.0%	0.00E+00
Pu-238	2.47E-08	32031.74083	550	4373.5	10378316	324.0	7.23E-106	0.0%	5.97E-107
Pu-239	8.66E-09	8805989.413	550	4373.5	10378316	1.2	3.83E-09	44.2%	3.16E-10
Pu-240	3.44E-09	2396354.066	550	4373.5	10378316	4.3	1.71E-10	5.0%	1.41E-11
Pu-241	5.54E-08	5233.555466	550	4373.5	10378316	1983.0	0.00E+00	0.0%	0.00E+00
Rh-106	6.70E-08	0.000348032	Missing	1	2369	6818330.6	0.00E+00	0.0%	0.00E+00
Ru-106	6.69E-08	371.8	55	438.25	1039967	2797.1	0.00E+00	0.0%	0.00E+00
Sb-125	1.84E-06	1007.54252	45	358.75	851314	844.9	8.18E-261	0.0%	6.75E-262
Sr-90	5.79E-07	10559.15197	15	120.25	285353	27.0	4.24E-15	0.0%	3.50E-16
Te-125m	2.58E-08	57.4	125	994.75	2360542	41124.4	0.00E+00	0.0%	0.00E+00
Te-129	1.03E-12	0.048333333	125	994.75	2360542	48838794.8	0.00E+00	0.0%	0.00E+00
Te-129m	1.14E-09	33.6	125	994.75	2360542	70254.2	0.00E+00	0.0%	0.00E+00
Y-90	5.79E-07	2.66875	170	1352.5	3209483	1202616.4	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 6 of 12)

X-energy									
Isotope	**X-energy activity Ci**	**Half-life (days)**	**Kd (sand) l/kg**	**Retardation Factor**	**Retarded Travel Time Days**	**Number of Half-lives**	**Activity Remaining Ci**	**Percent of Original Activity Remaining**	**Maximum Remaining Concentration (µCi/ml)**
Ag-110m	2.47E+00	249.86	90	716.5	1700255	6804.8	0.00E+00	0.0%	0.00E+00
Ba-137m	1.96E+00	0.001772222	Missing	1	2369	1338996.9	0.00E+00	0.0%	0.00E+00
Ba-140	6.68E-02	12.751	Missing	1	2369	186.1	6.34E-58	0.0%	1.90E-64
Cs-134	4.51E+00	754.2981889	280	2227	5284671	7006.1	0.00E+00	0.0%	0.00E+00
Cs-137	2.84E+00	10986.48534	280	2227	5284671	481.0	4.50E-145	0.0%	1.35E-151
I-131	2.92E-01	8.0252	1	8.95	21238	2646.5	0.00E+00	0.0%	0.00E+00
La-140	6.68E-02	1.67858	Missing	1	2369	1413.7	0.00E+00	0.0%	0.00E+00
Xe-133	0.00E+00	5.2475	Missing	1	2369	452.2	0.00E+00	0.0%	0.00E+00
WEC									
Isotope	**WEC Activity Ci**	**half-life (days)**	**Kd (sand) l/kg**	**Retardation Factor**	**Retarded Travel Time Days**	**Number of Half-lives**	**Activity Remaining Ci**	**Percent of Original Activity Remaining**	**Maximum Remaining Concentration (µCi/ml)**
H-3	5.20E+01	4499.783889	0.1	1.795	4260	0.9	2.70E+01	51.9%	7.13E-01
Cr-51	6.74E-02	27.704	70	557.5	1322948	47752.9	0.00E+00	0.0%	0.00E+00
Mn-54	3.49E-02	312.2	50	398.5	945641	3029.0	0.00E+00	0.0%	0.00E+00
Mn-56	8.85E+00	0.107454167	50	398.5	945641	8800407.9	0.00E+00	0.0%	0.00E+00
Fe-55	2.60E-02	1002.224593	220	1750	4152750	4143.5	0.00E+00	0.0%	0.00E+00
Fe-59	6.74E-03	44.49	220	1750	4152750	93341.2	0.00E+00	0.0%	0.00E+00
Co-58	9.88E-02	70.86	60	478	1134294	16007.5	0.00E+00	0.0%	0.00E+00
Co-60	1.14E-02	1925.28	60	478	1134294	589.2	5.04E-180	0.0%	1.33E-181
Br-83	7.98E-01	0.098916667	15	120.25	285353	2884784.3	0.00E+00	0.0%	0.00E+00
Br-84	4.24E-01	0.022055556	15	120.25	285353	12937930.7	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 7 of 12)

Isotope	WEC Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Br-85	4.99E-02	0.002013889	15	120.25	285353	141692648.3	0.00E+00	0.0%	0.00E+00
Rb-88	3.74E+01	0.012342361	55	438.25	1039967	84259992.1	0.00E+00	0.0%	0.00E+00
Rb-89	1.72E+00	0.010638889	55	438.25	1039967	97751490.9	0.00E+00	0.0%	0.00E+00
Sr-89	2.74E-02	50.563	15	120.25	285353	5643.5	0.00E+00	0.0%	0.00E+00
Sr-90	1.23E-03	10559.15197	15	120.25	285353	27.0	9.01E-12	0.0%	2.38E-13
Sr-91	4.24E-02	0.402083333	15	120.25	285353	709686.8	0.00E+00	0.0%	0.00E+00
Sr-92	1.02E-02	0.108791667	15	120.25	285353	2622933.0	0.00E+00	0.0%	0.00E+00
Y-90	3.24E-04	2.66875	Missing	1	2369	889.2	6.93E-272	0.0%	1.83E-273
Y-91m	2.30E-02	0.034520833	Missing	1	2369	68741.1	0.00E+00	0.0%	0.00E+00
Y-91	3.50E-03	58.51	Missing	1	2369	40.6	2.16E-15	0.0%	5.72E-17
Y-92	8.49E-03	0.1475	Missing	1	2369	16088.1	0.00E+00	0.0%	0.00E+00
Y-93	2.74E-03	0.424166667	Missing	1	2369	5594.5	0.00E+00	0.0%	0.00E+00
Nb-95	3.99E-03	34.991	160	1273	3020829	86331.6	0.00E+00	0.0%	0.00E+00
Mo-99	5.25E+00	2.746833333	10	80.5	191027	69544.3	0.00E+00	0.0%	0.00E+00
Tc-99m	4.99E+00	0.2503	0.1	1.795	4260	17017.7	0.00E+00	0.0%	0.00E+00
Ru-103	3.50E-03	39.247	55	438.25	1039967	26498.0	0.00E+00	0.0%	0.00E+00
Rh-103m	3.50E-03	0.038968056	Missing	1	2369	60896.0	0.00E+00	0.0%	0.00E+00
Rh-106	1.12E-03	0.000348032	Missing	1	2369	6818330.6	0.00E+00	0.0%	0.00E+00
Ag-110m	9.99E-03	249.86	90	716.5	1700255	6804.8	0.00E+00	0.0%	0.00E+00
Te-127m	1.89E-02	106.1	125	994.75	2360542	22248.3	0.00E+00	0.0%	0.00E+00
Te-129m	6.49E-02	33.6	125	994.75	2360542	70254.2	0.00E+00	0.0%	0.00E+00
Te-129	9.47E-02	0.048333333	125	994.75	2360542	48838794.8	0.00E+00	0.0%	0.00E+00
Te-131m	1.67E-01	1.385416667	125	994.75	2360542	1703849.7	0.00E+00	0.0%	0.00E+00
Te-131	1.07E-01	0.017361111	125	994.75	2360542	135967204.8	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 8 of 12)

Isotope	WEC Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Te-132	1.97E+00	3.204	125	994.75	2360542	736748.4	0.00E+00	0.0%	0.00E+00
Te-134	2.74E-01	0.029027778	125	994.75	2360542	81320098.6	0.00E+00	0.0%	0.00E+00
I-129	3.74E-07	5734302521	1	8.95	21238	0.0	3.74E-07	100.0%	9.88E-09
I-130	2.74E-01	0.515	1	8.95	21238	41239.5	0.00E+00	0.0%	0.00E+00
I-131	1.77E+01	8.0252	1	8.95	21238	2646.5	0.00E+00	0.0%	0.00E+00
I-132	2.35E+01	0.095625	1	8.95	21238	222100.4	0.00E+00	0.0%	0.00E+00
I-133	3.24E+01	0.867916667	1	8.95	21238	24470.5	0.00E+00	0.0%	0.00E+00
I-134	5.51E+00	0.036458333	1	8.95	21238	582537.6	0.00E+00	0.0%	0.00E+00
I-135	1.95E+01	0.274166667	1	8.95	21238	77465.1	0.00E+00	0.0%	0.00E+00
Cs-134	1.72E+01	754.2981889	280	2227	5284671	7006.1	0.00E+00	0.0%	0.00E+00
Cs-136	2.50E+01	13.01	280	2227	5284671	406200.7	0.00E+00	0.0%	0.00E+00
Cs-137	1.25E+01	10986.48534	280	2227	5284671	481.0	1.98E-144	0.0%	5.23E-146
Cs-138	9.21E+00	0.022569444	280	2227	5284671	234151576.6	0.00E+00	0.0%	0.00E+00
Ba-137m	1.17E+01	0.001772222	Missing	1	2369	1338996.9	0.00E+00	0.0%	0.00E+00
Ba-140	2.50E-02	12.751	Missing	1	2369	186.1	2.37E-58	0.0%	6.27E-60
La-140	7.72E-03	1.67858	Missing	1	2369	1413.7	0.00E+00	0.0%	0.00E+00
Ce-141	3.99E-03	32.504	500	3976	9435048	290273.4	0.00E+00	0.0%	0.00E+00
Ce-143	3.50E-03	1.376625	500	3976	9435048	6853753.2	0.00E+00	0.0%	0.00E+00
Pr-143	3.74E-03	13.57	Missing	1	2369	174.9	8.54E-56	0.0%	2.26E-57
Ce-144	3.00E-03	284.91	500	3976	9435048	33115.9	0.00E+00	0.0%	0.00E+00
Pr-144	3.00E-03	0.012	Missing	1	2369	197750.0	0.00E+00	0.0%	0.00E+00
Zr-95	3.99E-03	64.032	600	4771	11321583	176811.3	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 9 of 12)

Median Travel Time (Center PPBAs) 26,280 Days									
TerraPower									
Isotope	TerraPower Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Am-241	4.78E-10	158003.7752	1900	15106	396985680	2512.5	0.00E+00	0.0%	0.00E+00
Ba-137m	7.57E-07	0.001772222	Missing	1	26238	14828840.1	0.00E+00	0.0%	0.00E+00
Ce-144	7.87E-08	284.91	500	3976	104489280	366744.9	0.00E+00	0.0%	0.00E+00
Cs-134	3.80E-04	754.2981889	280	2227	58525560	77589.4	0.00E+00	0.0%	0.00E+00
Cs-137	4.00E-03	10986.48534	280	2227	58525560	5327.1	0.00E+00	0.0%	0.00E+00
I-129	1.70E-09	5734302521	1	8.95	235206	0.0	1.70E-09	100.0%	1.40E-10
Pr-144	7.87E-08	0.012	Missing	1	26238	2190000.0	0.00E+00	0.0%	0.00E+00
Pr-144m	7.50E-10	0.005	Missing	1	26238	5256000.0	0.00E+00	0.0%	0.00E+00
Pu-238	2.47E-08	32031.74083	550	4373.5	114935580	3588.2	0.00E+00	0.0%	0.00E+00
Pu-239	8.66E-09	8805989.413	550	4373.5	114935580	13.1	1.02E-12	0.0%	8.42E-14
Pu-240	3.44E-09	2396354.066	550	4373.5	114935580	48.0	1.25E-23	0.0%	1.04E-24
Pu-241	5.54E-08	5233.555466	550	4373.5	114935580	21961.3	0.00E+00	0.0%	0.00E+00
Rh-106	6.70E-08	0.000348032	Missing	1	26238	75510209.5	0.00E+00	0.0%	0.00E+00
Ru-106	6.69E-08	371.8	55	438.25	11517210	30976.9	0.00E+00	0.0%	0.00E+00
Sb-125	1.84E-06	1007.54252	45	358.75	9427950	9357.4	0.00E+00	0.0%	0.00E+00
Sr-90	5.79E-07	10559.15197	15	120.25	3160170	299.3	4.67E-97	0.0%	3.86E-98
Te-125m	2.58E-08	57.4	125	994.75	26142030	455436.1	0.00E+00	0.0%	0.00E+00
Te-129	1.03E-12	0.048333333	125	994.75	26142030	540869586.2	0.00E+00	0.0%	0.00E+00
Te-129m	1.14E-09	33.6	125	994.75	26142030	778036.6	0.00E+00	0.0%	0.00E+00
Y-90	5.79E-07	2.66875	170	1352.5	35543700	13318482.4	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 10 of 12)

X-energy									
Isotope	**X-energy activity Ci**	**Half-life (days)**	**Kd (sand) l/kg**	**Retardation Factor**	**Retarded Travel Time Days**	**Number of Half-lives**	**Activity Remaining Ci**	**Percent of Original Activity Remaining**	**Maximum Remaining Concentration (µCi/ml)**
Ag-110m	2.47E+00	249.86	90	716.5	18829620	75360.7	0.00E+00	0.0%	0.00E+00
Ba-137m	1.96E+00	0.001772222	Missing	1	26238	14828840.1	0.00E+00	0.0%	0.00E+00
Ba-140	6.68E-02	12.751	Missing	1	26238	2061.0	0.00E+00	0.0%	0.00E+00
Cs-134	4.51E+00	754.2981889	280	2227	58525560	77589.4	0.00E+00	0.0%	0.00E+00
Cs-137	2.84E+00	10986.48534	280	2227	58525560	5327.1	0.00E+00	0.0%	0.00E+00
I-131	2.92E-01	8.0252	1	8.95	235206	29308.4	0.00E+00	0.0%	0.00E+00
La-140	6.68E-02	1.67858	Missing	1	26238	15656.1	0.00E+00	0.0%	0.00E+00
Xe-133	0.00E+00	5.2475	Missing	1	26238	5008.1	0.00E+00	0.0%	0.00E+00
WEC									
Isotope	**WEC Activity Ci**	**Half-life (days)**	**Kd (sand) l/kg**	**Retardation Factor**	**Retarded Travel Time Days**	**Number of Half-lives**	**Activity Remaining Ci**	**Percent of Original Activity Remaining**	**Maximum Remaining Concentration (µCi/ml)**
H-3	5.20E+01	4499.783889	0.1	1.795	47173	10.5	3.63E-02	0.1%	9.60E-04
Cr-51	6.74E-02	27.704	70	557.5	14651100	528844.2	0.00E+00	0.0%	0.00E+00
Mn-54	3.49E-02	312.2	50	398.5	10472580	33544.5	0.00E+00	0.0%	0.00E+00
Mn-56	8.85E+00	0.107454167	50	398.5	10472580	97460901.9	0.00E+00	0.0%	0.00E+00
Fe-55	2.60E-02	1002.224593	220	1750	45990000	45887.9	0.00E+00	0.0%	0.00E+00
Fe-59	6.74E-03	44.49	220	1750	45990000	1033715.4	0.00E+00	0.0%	0.00E+00
Co-58	9.88E-02	70.86	60	478	12561840	177276.9	0.00E+00	0.0%	0.00E+00
Co-60	1.14E-02	1925.28	60	478	12561840	6524.7	0.00E+00	0.0%	0.00E+00
Br-83	7.98E-01	0.098916667	15	120.25	3160170	31947801.2	0.00E+00	0.0%	0.00E+00
Br-84	4.24E-01	0.022055556	15	120.25	3160170	143282267.0	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 11 of 12)

Isotope	WEC Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Br-85	4.99E-02	0.002013889	15	120.25	3160170	1569187862.1	0.00E+00	0.0%	0.00E+00
Rb-88	3.74E+01	0.012342361	55	438.25	11517210	933144792.7	0.00E+00	0.0%	0.00E+00
Rb-89	1.72E+00	0.010638889	55	438.25	11517210	1082557597.9	0.00E+00	0.0%	0.00E+00
Sr-89	2.74E-02	50.563	15	120.25	3160170	62499.7	0.00E+00	0.0%	0.00E+00
Sr-90	1.23E-03	10559.15197	15	120.25	3160170	299.3	9.93E-94	0.0%	2.62E-95
Sr-91	4.24E-02	0.402083333	15	120.25	3160170	7859490.2	0.00E+00	0.0%	0.00E+00
Sr-92	1.02E-02	0.108791667	15	120.25	3160170	29047905.0	0.00E+00	0.0%	0.00E+00
Y-90	3.24E-04	2.66875	Missing	1	26238	9847.3	0.00E+00	0.0%	0.00E+00
Y-91m	2.30E-02	0.034520833	Missing	1	26238	761279.4	0.00E+00	0.0%	0.00E+00
Y-91	3.50E-03	58.51	Missing	1	26238	449.2	2.16E-138	0.0%	5.72E-140
Y-92	8.49E-03	0.1475	Missing	1	26238	178169.5	0.00E+00	0.0%	0.00E+00
Y-93	2.74E-03	0.424166667	Missing	1	26238	61956.8	0.00E+00	0.0%	0.00E+00
Nb-95	3.99E-03	34.991	160	1273	33454440	956087.0	0.00E+00	0.0%	0.00E+00
Mo-99	5.25E+00	2.746833333	10	80.5	2115540	770174.1	0.00E+00	0.0%	0.00E+00
Tc-99m	4.99E+00	0.2503	0.1	1.795	47173	188464.2	0.00E+00	0.0%	0.00E+00
Ru-103	3.50E-03	39.247	55	438.25	11517210	293454.5	0.00E+00	0.0%	0.00E+00
Rh-103m	3.50E-03	0.038968056	Missing	1	26238	674398.5	0.00E+00	0.0%	0.00E+00
Rh-106	1.12E-03	0.000348032	Missing	1	26238	75510209.5	0.00E+00	0.0%	0.00E+00
Ag-110m	9.99E-03	249.86	90	716.5	18829620	75360.7	0.00E+00	0.0%	0.00E+00
Te-127m	1.89E-02	106.1	125	994.75	26142030	246390.5	0.00E+00	0.0%	0.00E+00
Te-129m	6.49E-02	33.6	125	994.75	26142030	778036.6	0.00E+00	0.0%	0.00E+00
Te-129	9.47E-02	0.048333333	125	994.75	26142030	540869586.2	0.00E+00	0.0%	0.00E+00
Te-131m	1.67E-01	1.385416667	125	994.75	26142030	18869435.2	0.00E+00	0.0%	0.00E+00
Te-131	1.07E-01	0.017361111	125	994.75	26142030	1505780928.0	0.00E+00	0.0%	0.00E+00

Table 2.4-48
Results of Sorption and Radioactive Decay Attenuation
(Sheet 12 of 12)

Isotope	WEC Activity Ci	Half-life (days)	Kd (sand) l/kg	Retardation Factor	Retarded Travel Time Days	Number of Half-lives	Activity Remaining Ci	Percent of Original Activity Remaining	Maximum Remaining Concentration (µCi/ml)
Te-132	1.97E+00	3.204	125	994.75	26142030	8159185.4	0.00E+00	0.0%	0.00E+00
Te-134	2.74E-01	0.029027778	125	994.75	26142030	900586679.4	0.00E+00	0.0%	0.00E+00
I-129	3.74E-07	5734302521	1	8.95	235206	0.0	3.74E-07	100.0%	9.88E-09
I-130	2.74E-01	0.515	1	8.95	235206	456710.7	0.00E+00	0.0%	0.00E+00
I-131	1.77E+01	8.0252	1	8.95	235206	29308.4	0.00E+00	0.0%	0.00E+00
I-132	2.35E+01	0.095625	1	8.95	235206	2459670.6	0.00E+00	0.0%	0.00E+00
I-133	3.24E+01	0.867916667	1	8.95	235206	271000.7	0.00E+00	0.0%	0.00E+00
I-134	5.51E+00	0.036458333	1	8.95	235206	6451364.6	0.00E+00	0.0%	0.00E+00
I-135	1.95E+01	0.274166667	1	8.95	235206	857894.2	0.00E+00	0.0%	0.00E+00
Cs-134	1.72E+01	754.2981889	280	2227	58525560	77589.4	0.00E+00	0.0%	0.00E+00
Cs-136	2.50E+01	13.01	280	2227	58525560	4498505.8	0.00E+00	0.0%	0.00E+00
Cs-137	1.25E+01	10986.48534	280	2227	58525560	5327.1	0.00E+00	0.0%	0.00E+00
Cs-138	9.21E+00	0.022569444	280	2227	58525560	2593132504.6	0.00E+00	0.0%	0.00E+00
Ba-137m	1.17E+01	0.001772222	Missing	1	26238	14828840.1	0.00E+00	0.0%	0.00E+00
Ba-140	2.50E-02	12.751	Missing	1	26238	2061.0	0.00E+00	0.0%	0.00E+00
La-140	7.72E-03	1.67858	Missing	1	26238	15656.1	0.00E+00	0.0%	0.00E+00
Ce-141	3.99E-03	32.504	500	3976	104489280	3214659.1	0.00E+00	0.0%	0.00E+00
Ce-143	3.50E-03	1.376625	500	3976	104489280	75902500.7	0.00E+00	0.0%	0.00E+00
Pr-143	3.74E-03	13.57	Missing	1	26238	1936.6	0.00E+00	0.0%	0.00E+00
Ce-144	3.00E-03	284.91	500	3976	104489280	366744.9	0.00E+00	0.0%	0.00E+00
Pr-144	3.00E-03	0.012	Missing	1	26238	2190000.0	0.00E+00	0.0%	0.00E+00
Zr-95	3.99E-03	64.032	600	4771	125381880	1958112.8	0.00E+00	0.0%	0.00E+00

Key: µCi/ml = microCuries per milliliter; Ci = Curies; K_d = solid/liquid partition coefficient; l/kg = liters per kilogram

Table 2.4-49
Summary of Results of Unity Rule Calculations by Technology

Particle Type	Travel Time (Days)	Technology	Unity Value
Shortest Travel (Perimeter PPBAs)	35.3	TerraPower	2.44E+00
		X-energy	6.32E-03[(a)]
		WEC	3.75E+03
Shortest Travel Time (Center PPBAs)	2369	TerraPower	1.72E-02[(a)]
		X-energy	2.37E-59[(a)]
		WEC	7.13E+02
Median Travel Time (Center PPBAs)	26238	TerraPower	7.04E-04[(a)]
		X-energy	0.00E+00[(a)]
		WEC	1.01E+00

Note:

(a) Values are less than unity (1.0).

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

This section describes the geology, seismology, and geotechnical engineering characteristics from the Site Region to the Site Location level of detail. As described in Section 2.0, the Project site can accommodate up to three Plant Complexes, each considered for siting a nuclear power facility. A specific technology has not been selected; therefore, a PPE is assigned to the grouping of the three locations.

The following NRC regulatory guidance was used for this section: NRC RG 1.206, *Combined License Applications for Nuclear Power Plants (LWR Edition)*, RG 1.208, *A Performance-Based Approach to Define The Site-Specific Earthquake Ground Motion*, and RG 1.70*, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition, Rev. 3).* NRC Technical Report (NUREG) 0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition*, provides guidance for development of Section 2.5.1.

These guidance documents provide the principal seismic and geologic considerations for potential nuclear power plant sites. RG 1.208 stipulates that investigations are performed at four geographic levels: the Site Region (200 miles [mi.] [320 kilometers {km}]), Site Vicinity (25 mi. [40 km]), Site Area (5 mi. [8 km]), and Site Location (0.6 mi. [1 km]) radii. (Table 2.5-1). These distances were measured from the Project site boundary that was defined as the combined North, Middle, and South Plant Complex area. The terms are used in Sections 2.5.1 through 2.5.3 to describe the specific locations of investigation and characterization.

Section 2.5.1 describes the basic geologic and seismic information. Section 2.5.2 describes the vibratory ground motion at the Project site, including an updated seismicity catalog, and seismic sources. Section 2.5.3 describes the potential for surface faulting and deformation in the Site Area and Sections 2.5.4 and 2.5.5 describe the stability of subsurface materials, foundations, and slope stability at the Project site.

A field investigation and laboratory testing program and a literature review of relevant geologic and seismic literature were conducted. The investigations and literature review have not identified geologic or seismic hazards that would screen out the site from consideration for building a nuclear power plant.

2.5.1 GEOLOGIC CHARACTERIZATION INFORMATION

The geologic and seismologic information presented in this section was developed through a review of published scientific literature, interpretation of available scientific figures, a review of other peer-reviewed publications, and analysis of site-specific data. This section demonstrates compliance with the requirements of 10 CFR 100.23(c).

Section 2.5.1 describes the geological and seismological characteristics of the Site Region (200 mi. [320 km]), Site Vicinity (25 mi. [40 km]), Site Area (5 mi. [8 km]), and Site Location (0.6 mi. [1 km]) radii. Section 2.5.1.1 describes the physiographic, geologic, and tectonic characteristics of the Site Region. Section 2.5.1.2 describes the physiographic, geologic, and tectonic characteristics of the Site Vicinity, Site Area, and Site Location. The geological and

seismological information presented in this section was developed in accordance with NRC RG 1.206, RG 1.208, and NUREG-0800.

2.5.1.1 Regional Geology

This section discusses the regional geologic and seismic characteristics within a 200-mi. (320-km) radius of the Project site as captured in Figure 2.5-1. The physiography and geomorphology, geologic setting, stratigraphy, and tectonic setting are described below. The information provided summarizes this broad and complex area and is supported by numerous referenced sources. The Site Region includes the majority of NC, South Carolina, Virginia, and West Virginia, as well as small portions of northeast Georgia, eastern Kentucky, and eastern Tennessee.

2.5.1.1.1 Regional Physiography and Geomorphology

The Site Region is plotted in Figure 2.5-1 with respect to the physiographic provinces and sections as defined by Reference 2.5-1. It comprises the Appalachian Highlands and Atlantic Plain divisions of the United States. The Appalachian Highlands division comprises seven physiographic provinces, four of which are within the Site Region: the Appalachian Plateau, Valley and Ridge, Blue Ridge, and Piedmont provinces. Specifically, the Project site is within the Piedmont Uplands section of the Piedmont province. The southeastern portion of the Site Region encompasses the Coastal Plain province of the Atlantic Plain division, which is oriented parallel to the Atlantic coast shoreline (Figure 2.5-1). The major physiographic provinces are strongly controlled by geologic strata and structures (Reference 2.5-2). As a result, these physiographic provinces provide the basis for organizing the descriptions of geologic features in this section. Descriptions are organized geographically west to east as they are encountered in the Site Region.

2.5.1.1.1.1 Physiography and Topography of the Appalachian Plateaus Province

The Appalachian Plateau physiographic province extends over a length of 960 mi. (1540 km) and laterally extends over 220 mi. (350 km) in places, making it the largest province of the Appalachian Highlands division. It is a synclinal foreland basin that formed during Late Paleozoic time from erosion of a folded crystalline mountain range present to the east. The western portion of the province is underlain by Permian rocks with moderate topographic relief. The eastern margin is a high rim, extending from New York state to northern Alabama that is underlain by thick sequences of sandstone and conglomerate rocks interbedded with shale that are more resistant than the Permian rocks to the west forming higher ridges with more topographic relief. Sedimentary rock sequences are underlain by Precambrian crystalline basement rocks, generally thicken from west to east within the province and range in thickness from approximately 2800 feet (ft.) (850 meters [m]) in the western extent (outside the Site Area) to 25,000 ft. (7620 m) at the Allegheny Structural front (Reference 2.5-3).

Topographically, the province increases in ruggedness gradually from west to east. Topographic relief in Ohio ranges from approximately 295 to 490 ft. (90 to 150 m), while it ranges from 980 to 2950 ft. (300 to 900 m) in the eastern portions of West Virginia. The relief is the result of large rivers dissecting the resistant sandstone caps to form deep gorges, such as the New River Gorge in West Virginia along with several smaller gorges along the West Branch of the Susquehanna River, the Monongahela River, and Tennessee River. The areas surrounding the rivers are characterized by gentle slopes in the base of narrow valleys, with flat, plateau-like

areas restricted to the crests of hills or mountains. The southern reaches of the province in Tennessee and Alabama are more prototypically plateau-like with gently sloping land in the upland sections (Reference 2.5-4).

2.5.1.1.1.2 Physiography and Topography of the Valley and Ridge Province

The Valley and Ridge province is a narrow band east of the Appalachian Plateau that extends more than 1180 mi. (1900 km) from New York state to central Alabama. The province coincides with the outcrop of the folded and faulted rocks of the Appalachian system that were deposited without contemporaneous volcanism. The province is typified by broad valleys underlain by carbonates and shale, while the adjacent ridges are underlain by Silurian to Pennsylvania sandstones with thin shale sequences (Reference 2.5-4).

The entire southeastern edge of the province is an open valley generally termed the Great Valley, or locally called the Shenandoah Valley, the Cumberland Valley, and the Lebanon Valley, among several others. The northwestern edge of the province, particularly from Pennsylvania to southern Virginia, is characterized by high ridges separated by narrow valleys that extend up to 60 mi. (100 km) without being dissected by a stream (Reference 2.5-4).

Fenneman divides the Valley and Ridge province into three distinct sections: the Hudson-Champlain section, which is outside the Site Region, and the central and Tennessee sections within the Site Region (Reference 2.5-5). The central section is up to 80 mi. (130 km) wide and contains a broad sequence of sandstone-cored ridges separated by narrow valleys. Moving south within the central section, the province is more typified by ridges and narrow valleys. The Tennessee section extends from Wytheville, Virginia, to near Tuscaloosa, Alabama. The ridges here were obscured by low angle thrust sheets across Tennessee but reemerge in Alabama until they plunge beneath the Coastal Plain (Reference 2.5-4).

2.5.1.1.1.3 Physiography and Topography of the Blue Ridge Province

The Blue Ridge province is an elongated mountain range extending from Pennsylvania to northern Georgia. Fenneman (Reference 2.5-5) further subdivides the province into two distinctive sections separated by a broad and low gap near Roanoke, Virginia; the Site Region encompasses portions of both sections. The northern section is approximately 250 mi. (400 km) long with an average width of only 9 mi. (15 km) and drains primarily to the Atlantic Ocean. The southern section extends over 350 mi. (560 km), has an average width of approximately 75 mi. (120 km), and drains to the Gulf of America (Reference 2.5-4).

The northern Blue Ridge province occurs on the northwest flank of an anticlinorium with the underlying geology comprising: (1) a thick sequence of quartzite and phyllite rocks; (2) a massive, slightly metamorphosed basalt; and (3) coarse granodiorite. The ridge that extends from Pennsylvania to Roanoke, Virginia, is held up by one or more of the aforementioned rock masses. The anticlinorium core along the southeast face of the Blue Ridge consists primarily of igneous rocks of granitic composition that underlie isolated uplands associated with the adjacent Piedmont province (Reference 2.5-4).

The southern Blue Ridge section transitions from a plateau-like area in the northern portion with an average elevation of about 3000 ft. (910 m) to a more mountainous area in the southern reaches with altitudes of 4920 to 6560 ft. (1500 to 2000 m). The plateau-like reaches are underlain by slaty rocks that are less resistant to erosion than rocks in higher altitudes. The

mountainous areas in the south, such as the Great Smoky Mountains, are underlain by more resistant conglomerate and sandstone rocks. In the high areas of the southern Blue Ridge, long, narrow, steep-sided valleys resemble large trenches. Commonly, but not everywhere, these features crosscut the structural trends of the rocks. One crosscutting trench valley north of Asheville trends east and west for 37 mi. (60 km), crossing two low drainage divides (Reference 2.5-4).

2.5.1.1.1.4 Physiography and Topography of the Piedmont Province

The Piedmont province is between the Atlantic Plain division and the Blue Ridge province, extending from New Jersey to Alabama (Reference 2.5-1). The Project site occurs within the Piedmont province. Near the border with the Blue Ridge province, foothills within the Piedmont rise to an elevation of 2300 ft. (700 m), but the topography is generally gently rolling with an elevation ranging from 980 ft. (300 m) in the northern reaches, to 1500 ft. (450 m) in the southern extent. The Piedmont province slopes eastward to almost sea level in northern Jersey to approximately 790 ft. (240 m) at the most eastern extent in Georgia at the boundary with the Coastal Plain province (Reference 2.5-4).

The Piedmont is characterized by two contrasting terrain types. The bulk of the Piedmont province is underlain by Precambrian to Late Paleozoic igneous and metamorphic rocks and is morphologically characterized by monotonous ridges and ravines dissected in a dendritic pattern. The underlying rocks are mostly weathered to saprolite, a process that preserves the original rock character except the rock strength. Secondarily, from NC northward, several down-faulted Triassic- to Jurassic-aged basins bisect the Precambrian rocks. These Mesozoic basins generally have lower relief than the surrounding Piedmont (Reference 2.5-4). The closest example of this to the Project site is the Dan River basin, approximately 2 mi. (3.2 km) to the northwest. It is a topographic and structural rift basin filled with approximately 5000 ft. (1524 m) of Triassic sediments dipping 30 degrees to the west (Reference 2.5-6).

Most rivers in the Piedmont flow to the southeast, except the Delaware, Susquehanna, Potomac, James, Roanoke, and Coosa. Rivers traversing the Piedmont originate in the Piedmont itself or in the Blue Ridge province. Rivers in the Piedmont typically have narrow drainage basins for their size (Reference 2.5-4).

2.5.1.1.1.5 Physiography and Topography of the Coastal Plain Province

Within the U.S., the Coastal Plain province crosses 19 states to extend from Martha's Vineyard in Massachusetts, south along the Atlantic coast to Florida and west along the Gulf of America to the U.S. – Mexico border (Reference 2.5-1). The Site Region encompasses two of the six sections within the Coastal Plain province: the Embayed section and Sea Island section. The Cape Fear Arch separates the two sections (Reference 2.5-7).

The Coastal Plain is a region of broad, relatively flat terraces of primarily unconsolidated sediments overlying a crystalline basement that dips steeply toward the Atlantic Ocean. Sediments are predominantly siliciclastic and are derived from the erosion of the Piedmont, the Blue Ridge, and Appalachian Mountains. However, a band of Eocene and Oligocene carbonate rocks crop out in south-central NC. Sediments in the Coastal Plain thicken from tens of feet at the Fall Zone to more than 9843 ft. (3000 m) beneath Cape Hatteras, NC. Multiple marine transgressions and regressions since the Cretaceous were preserved as fluvial to marine

sediments. Surficial units are nearly flat-lying in most areas and are generally Miocene or younger in age (Reference 2.5-8).

Drainage within the Coastal Plain is generally toward the Atlantic Ocean and somewhat gentle due to low local relief (less than 99 ft. [30 m]). In the Site Region, drainage patterns are generally northwest to southeast. However, in the vicinity of the Cape Fear Arch to the southeast, the drainage patterns are characterized by deeply incised rivers with non-parallel terraces that resulted from long-term uplift and incision of the Cape Fear Arch river terraces (Reference 2.5-7).

2.5.1.1.2 Regional Geologic History

The geology of the Site Region has been studied intensively, particularly by Reference 2.5-9, Reference 2.5-10, and Reference 2.5-11. The region has experienced multiple phases of tectonic uplift and subsidence, resulting in a complex geological evolution. Numerous mountain-building periods (orogenies) and at least three continental separation events (rifts) have occurred within the region. In addition, other precursor tectonic events affected Laurentia that was initially a separate piece of ancestral North America. Whitmeyer et al. (Reference 2.5-11) describe the early geological events, beginning with the Hadean Eon that dates to at least 4 billion years ago (giga-annum [Ga]) involving the landmass of Laurentia. The oldest rocks of the Early Archean that occur within Laurentia have age ranges from 3.8 to 2.6 Ga. At this early time in the earth's evolution, the magmatic and subduction process of plate tectonics dominated. Whitmeyer et al. (Reference 2.5-11) developed a graphic, captured in Figure 2.5-2, to illustrate the progression of geological events in the development of Laurentia and ultimately the geological characteristics of southeastern North America and the region surrounding the Project site.

Reference 2.5-12 notes five stages of the earth's approximately 4.8 Ga evolution:

1. In the first few tens of millions of years, accretionary processes lead to the formation of the planet and subsequently the core and mantle system

2. Formation of a crustal layer in a pre-plate-tectonic regime until 3.0 Ga

3. High temperature subduction and shallow slab breakoff during an initial plate-tectonic regime from 3.0 to 1.7 Ga

4. Environmental, evolutionary, and lithospheric stability from 1.7 to 0.75 Ga

5. Modern era cold subduction regime from 0.75 Ga to present

During stages three, four, and five, there have been multiple cycles of supercontinent formation and fragmentation, and reassembly.

During the Early Proterozoic, beginning at approximately 2.5 Ga, the protocontinents that either existed or had developed during the Archean began to experience rifting and dispersion. These processes created new ocean crust and developed passive margins. The Grenville orogeny is the earliest orogeny to record geological events within the Appalachians. Prior to the Grenville orogeny, the Trans-Hudson orogeny had occurred farther west and the convergence of landmasses created the supercontinent Nuna/Columbia. The Mesoproterozoic Era, beginning at 1.6 Ga, included the reorganization of Nuna/Columbia and the gradual amalgamation of the

landmass Rodinia by way of the Grenville orogeny, which occurred along the eastern and southern margins of Laurentia (Reference 2.5-11). Swanson-Hysell et al. describe the amalgamation of Laurentia's Archean provinces approximately 1830 million years ago (mega-annum [Ma]). Following was approximately 700 million years (my) of accretionary orogenesis along the active southeastern margin. The accretionary orogenesis was characterized by the subduction of oceanic lithosphere, formation of volcanic arcs and back-arcs, and episodic continental accretion. This period spanned from the Late Paleoproterozoic and Mesoproterozoic Era. The result was n significant accretionary growth of the present-day North American crust. The closure of the Unimos Ocean ended the period of accretion (Reference 2.5-13).

The Grenville orogeny was a major mountain-building event both in physical size of the orogen and the duration of activity, which occurred from approximately 1090 to 980 Ma (Reference 2.5-13). Within the Grenville orogen, the Grenville orogeny caused ductile thrusting, nappe formation, and crustal imbrication associated with high-grade metamorphic conditions. The scale of crustal shortening within the Grenville orogen is indicated by the northwestern extent of deformation, which cuts across the approximately 746-mi.-wide (1200-km-wide) Great Proterozoic accretionary orogen from southwest to northeast at the Grenville Front (Reference 2.5-13).

Figure 2.5-3 shows the position of geological elements resulting from the Grenville orogeny relative to the present-day southeastern U.S. During the Grenville orogeny from 1090 to 980 Ma, the accreted Proterozoic crust was reworked and a large orogenic plateau later experienced extensional collapse prior to the formation of the Grenville Front tectonic zone (Reference 2.5-13). The last major contraction to occur in the Grenville orogeny was the Rigolet phase, which lasted from approximately 1010 to 980 Ma. This phase resulted in the development of the Grenville Front and the parautochthonous belt.

For approximately 200 my after the Grenville orogeny (circa 980 to 780 Ma), Laurentia experienced relative tectonic stability (Reference 2.5-13) until rifting and the emplacement of the associated Gunbarrel large igneous province (circa 778 Ma). After the 778 Ma event, progressive rifting of continents from Rodinia margins continued until the end of the Neoproterozoic Era. The exposed highlands, which developed after the Grenville orogeny, were eroded to sea level by the beginning of the Cambrian. Fault block basins to the north, northwest, and southeast were filled with clastic sediments from the erosion of higher elevation rocks. Sedimentation began as the Grenville highlands were eroded and block fault basins were filled with clastic sediments from the highlands located toward the west, northwest, and southeast (Reference 2.5-9). The Ouachita belt formed as a result of the closure of the Rheic Ocean, followed by the development of the Alleghanian orogen. The Rheic Ocean closure also caused the burial of the Laurentian platform by thick Pennsylvanian clastic wedges that increased in thickness westward (Reference 2.5-14). The Middle Proterozoic granulite terrane was uplifted and eroded due to the initiation of continental rifting at about 700 Ma along trends that eventually became Appalachian structural trends (Reference 2.5-15).

The evolution of the Appalachian region continued with the breakup of the Rodinia supercontinent during the Neoproterozoic at 1.0 Ga. Geologic activity during the Early Neoproterozoic included isolated basin development, which was then followed by large igneous provinces and rifted margins. Stratigraphic analyses have indicated that rifting and volcanism were heterogeneous and diachronous (Reference 2.5-11). The Iapetan margin experienced rifting and the Iapetus Ocean formed at approximately 690 to 570 Ma (Reference 2.5-9). Swanson-Hysell et al. note that a period of approximately 700 my of accretionary orogenesis

occurred along the active southeastern margin of Laurentia (Reference 2.5-13). Processes during this period included the subduction of oceanic lithosphere, the formation of volcanic arcs and back-arcs, and the episodic accretion of continents. During this period, major accretionary crustal growth occurred from active-margin tectonics.

The rifting of Laurentia along its margins during the Neoproterozoic through the Cambrian and the assembly of Gondwana was studied by van Staal and Zagorevski (Reference 2.5-16). The final assembly of Gondwana during the Cambrian was followed by global tectonic plate reorganization that resulted in the beginning of subduction that involved Laurentia, West Gondwana, and Baltica. The accretion of arc terranes along the Appalachian-Caledonian margin of the Iapetus Ocean began at the end of the Cambrian Period (515 to 505 Ma) during the Taconic orogenic cycle, which continued until the onset of the collision of Laurentia, Baltica, Ganderia, and East Avalonia at approximately 430 to 426 Ma. This collision created the Laurussian continent and caused the closure of the Iapetus Ocean. The closure of the Iapetus Ocean in the Appalachians was followed by the Acadian and Neoacadian orogenic cycles that were a result of the accretion of West Avalonia, Meguma, and the Suwanee terranes with Laurentia. The convergence of Laurentia with Baltica and Avalonia continued during the Devonian Period (Reference 2.5-16).

The Cherokee orogeny, a lesser-known orogenic event, has been described by Hibbard et al. (2013) (Reference 2.5-17) and Hibbard et al. (2010) (Reference 2.5-18) as a thermo-tectonic event that affected the Carolina terrane and Carolina. The effects of the Cherokee orogeny are most prominent in central NC with indications also found in Laurentian rocks. The Cherokee orogeny appears to have been contemporaneous with the Salinic orogeny in the northern Appalachians. Age dating using 40Ar/39Ar isotopes places this activity at 450 Ma (Late Ordovician), which is approximately the time of other events such as the Cherokee unconformity on the Laurentian margin at approximately 444 Ma, the supra-subduction zone magmatism in peri-Laurentian rocks at approximately 460 to 430 Ma, and the metamorphic events in peri-Laurentian rocks at approximately 430 Ma. The cause of the orogeny is hypothesized to be a result of the accretion of Carolinia to Laurentia.

The Paleozoic Era hosted the Silurian Salinic orogeny and the Devonian – Carboniferous Acadian and Neoacadian orogenies. The Salinic orogeny was prominent in the northern Appalachians and the Acadian-Neoacadian orogenies were more influential in the central and southern Appalachians. The eastern margin of Laurentia developed into the Appalachian-Caledonian orogenic belts as Laurentia converged with the landmasses of Baltica and West Gondwana. The result was the accretion of the Pangea supercontinent (Reference 2.5-11) and the closure of the Rheic Ocean (Reference 2.5-16). Figure 2.5-4 illustrates the paleogeography at the time of the Alleghanian orogeny prior to the separation that formed the Atlantic Ocean (Reference 2.5-16).

As continental separation occurred, the oceanic crust of the Iapetus Ocean formed. Continental margin and shelf sediments were deposited on the edge of the craton near the beginning of the Cambrian. Crustal compression that preceded the formation of the Appalachian orogen included the amalgamation of exotic (suspect) terranes during the Penobscottian orogeny at approximately 550 to 490 Ma; the Taconian orogeny from approximately 470 to 440 Ma, which included the closing of the Iapetus Ocean and the accretion of previously amalgamated terranes and possibly other terranes to Laurentia; the Acadian orogeny occurring primarily in New England from approximately 400 to 380 Ma; and the Alleghanian orogeny occurring approximately from 330 to 270 Ma in which the accretion of the easternmost terranes, collision

with Gondwana, and westward thrusting of terranes onto autochthonous North America (Reference 2.5-19). The timing and sequence of accreting terranes to Laurentia is illustrated in Figures 2.5-5 and 2.5-6 (Reference 2.5-10).

Reference 2.5-20 describes the aftermath of the Pangea breakup and the fragmentation of eastern North America. The fragmentation created the North American rift system during the Triassic and Jurassic Periods. This rift system consists of a series of exposed and buried basins that range from northern Florida to the Grand Banks of Canada and is divided into three segments: northern, central, and southern. Figure 2.5-7 shows the distribution of the basins and the positioning of the segments.

The basins are typically asymmetric and form a half-graben that is bounded by border faults that involve basement rock. Figure 2.5-8 shows a cross section through the Danville basin, which is proximate to the Project site. The Danville basin actively formed from the Late Triassic through the Middle Jurassic Periods (Reference 2.5-20). Rifting in the southern Appalachians had stopped before the igneous activity and formation of the Central Atlantic Magmatic Province (CAMP) (Reference 2.5-21). The stratigraphy of the Dan River basin, which lies at the southern-most extent of the Danville basin and is approximately 4.5 mi. (7.2 km) east-northeast of the Project site, consists of organic-rich, thermally mature rocks. The rocks include coal, organic mudstone intercalated with siltstone, black organic beds, and siltstone that indicated hydrocarbon outgassing (Reference 2.5-22).

A massive rift zone developed within the Pangean supercontinent, during early Mesozoic time. The rift zone resulted in fragments of Pangea that are separated and preserved on the passive margins of eastern North America, northwestern Africa, and Europe. The fragment on the North American margin, the eastern North American rift system, comprises a series of exposed and buried rift basins extending from northern Florida to the eastern Grand Banks of Canada (Reference 2.5-20).

The eastern North American rift system is divided into three geographic segments: the southern segment encompasses the southeastern United States, the central segment encompasses the northeastern United States and southeastern Canada, and the northern segment encompasses the eastern Grand Banks of Canada. The boundary between the southern and central segments passes through Virginia and Maryland as a diffuse zone. The boundary between the central and northern segments follows the northern faulted margins of the Fundy and Orpheus basins and the Newfoundland fracture zone as a well-defined zone that trends west-southwest to east-northeast. Figure 2.5-7 shows these segments and the rift basins that formed, while Figure 2.5-8 depicts cross sections of the rift basins (Reference 2.5-20).

The presence of growth strata within the rift basin aid in determining the timing of rifting. In general, Late Triassic strata coarsen abruptly near rift basin border faults, which is interpreted to indicate a local source of topographic relief adjacent to the border faults during deposition. Ages of the preserved synrift strata in the three segments of the eastern North American rift system vary. In general, only Late Triassic strata are present in the southern segment, while Late Triassic- to Early Jurassic-aged strata are present in the central segment, and Late Triassic to Early Cretaceous strata are present in the northern segment (Reference 2.5-20).

The vertical sequence of climate-sensitive facies within individual basins indicate as Pangea drifted northward, facies changed as the basins passed from one climate zone to another. The transition from Carnian through Norian-age strata is characterized by apparent drying in eastern

North America (Reference 2.5-20). Figure 2.5-5 from Reference 2.5-10 summarizes the historical timeline of major tectonic events (excluding the Cherokee orogeny).

Whitmeyer et al. summarize the events from the Mesozoic to the present-day (Reference 2.5-23). After the early Mesozoic rift basins formed and faulting occurred in the Proterozoic to Paleozoic rocks of the Piedmont province, mafic dikes intruded in the Piedmont and Blue Ridge, and to a lesser degree, in the Valley and Ridge provinces during the Jurassic. Topographic gaps within the Blue Ridge are indicative of high-angle, northwest-striking faults that crosscut predominantly northeast-trending fabrics throughout the region. Within the Shenandoah River system, subparallel northwest-striking joint sets are frequent and tend to parallel the bends in the river. Also occurring are northeast-trending faults that may be reactivated Paleozoic structures. Whitmeyer et al. note that late overprinting features may be indications of crustal extension related to the breakup of the Pangea supercontinent and the opening of the Atlantic Ocean during the Mesozoic (Reference 2.5-23).

The result of the orogenies is captured in a model cross section, Figure 2.5-9, illustrating the complexity of the regional geological structure and stratigraphy (Reference 2.5-24).

2.5.1.1.3 Regional Stratigraphy

As described in Section 2.5.1.1.2, the Site Region has undergone a complicated geologic history that has been recorded in a complex assemblage of igneous, metamorphic, and sedimentary rocks and their structural relations. Figure 2.5-10 shows the geologic units within a 200-mi. (320 km) radius. The units tend to be distributed in parallel-sided zones that trend northeast to southwest throughout the Site Region. A comparison of the physiographic province map presented in Figure 2.5-1 and the bedrock geology map provided in 2.5-10 suggest that the linear physiographic provinces that trend northeast to southwest have similar stratigraphy, indicating that the provinces have similar geologic histories within each zone. As such, the physiographic regions provide a basis for the discussion of regional stratigraphy in this section.

The stratigraphy is described from west to east across the Site Region. Due to the complex nature of the subsurface geology in the Site Region, the main discussion focuses on the stratigraphy of NC and the geologic terranes recognized in the state, as captured in Figure 2.5-11. These geologic belts have similar rock types and geologic histories in the parts of the Site Region that lie in the adjacent states of Virginia, West Virginia, Kentucky, Tennessee, and South Carolina.

2.5.1.1.3.1 Stratigraphy of the Appalachian Plateaus Province

Rocks of the Appalachian Plateau occur approximately 90 mi. (145 km) northwest of the Project site in eastern Kentucky and the southern portion of West Virginia (Figure 2.5-10). Within the Site Region, the rocks are a thick sequence of Paleozoic sedimentary rocks ranging in age from the Cambrian to the Permian overlying Grenville basement rocks. The sedimentary package ranges in thickness from approximately 13,000 ft. (3962 m) at the northwestern edge of the Site Region to more than 26,000 ft. (7925 m) at the boundary with the Valley and Ridge province in southeastern West Virginia (Reference 2.5-3). In general, sedimentary strata in the western portion of the Appalachian Plateau province are flat lying, while thin-skinned deformation with large-scale thrust faults is recorded in rocks near the Valley and Ridge province (Reference 2.5-3).

The Cambrian to Ordovician rocks underlying the Site Region are primarily a sequence of dolomite and limestone with interbedded siliclastic sequences and lesser amounts of shale (Reference 2.5-3). The main Cambrian formations of the Conasauga Group include the Rome Formation, Pumpkin Valley Shale, Rutledge Limestone, and Rogersville Shale within Kentucky and equivalent formations in West Virginia. The Upper Cambrian comprises the Copper Ridge Dolomite overlain by the Rose Run Sandstone. The Ordovician strata are dominated by the Beekmantown Dolomite overlain by the Trenton-Black River group. In some areas, especially in Kentucky, the St. Peter Sandstone separates the Beekmantown from the overlying Trenton-Black River group. The upper Ordovician is composed of the Reedsville Shale and Juniata Formation (Reference 2.5-3; Reference 2.5-25).

The Silurian strata are predominantly a series of interbedded sandstone, carbonate, and shale rocks. The Lower Silurian is marked by the Tuscarora Sandstone that is pervasive in the Site Region. The Rose Hill Formation, comprising several shale beds, overlies the Tuscorara Sandstone. The Upper Silurian is dominated by carbonate beds of the McKenzie Limestone, Salina group, which is a series of interbedded anhydrites in places, and the Keyser Limestone (Reference 2.5-3; Reference 2.5-25).

The Devonian Rocks in the Site Region are predominantly thick shale with interbeds of shale and, to a lesser extent, limestone. The Helderberg Limestone and the overlying Oriskany Sandstone were deposited during the early Devonian and are overlain by the Onondaga Limestone and the Marcellus Shale within the Middle Devonian. The Upper Devonian is composed of the Brallier Shale, which can locally be subdivided based on organic content in the Rhinestreet Shale, the Hava Formation, and the Ohio Shale. The Brallier Shale is overlain by the Berea Sandstone at the end of the Devonian (Reference 2.5-3; Reference 2.5-25).

Ascending into the Mississippian, the Sunbury Shale is the basal unit marking the beginning of the Early Carboniferous of the Mississippian sequence. Above this shale are at least 30 separate beds that are undifferentiated farther east in the Slade and Borden Formations (Reference 2.5-25). The Late Carboniferous of the Pennsylvanian contains the Breathitt Group in Eastern Kentucky that is equivalent to the Pocohontas Group in West Virginia. The Conemaugh and Conemaugh/Monongahela overlie the Breathitt Group that marks the end of the Late Carboniferous in this area (Reference 2.5-3; Reference 2.5-25).

The lower portion of the Pennsylvanian primarily consists of thick, pebbly to conglomeratic quartzose sandstones of the Kanawha Formation and Pottsville equivalents but becomes more shaley to the east indicating a deep marine depositional setting. The Middle to Upper Pennsylvanian is predominately sequences of siltstone and shale, graywacke, and coal of the Conemaugh and Monongahela (Reference 2.5-26; Reference 2.5-25).

During the entire Permian, only the Elliot County igneous peridotite intrusion was emplaced in the Middle to potentially Upper Permian. Stratigraphically, rocks recording the Triassic, Jurassic, and Lower to Middle Cretaceous are missing in Kentucky. Rocks of the Upper Cretaceous, Paleocene, Eocene, Oligocene, Miocene, and Pliocene are absent in eastern Kentucky. Within the Holocene (last 11,700 years), most of the alluvial floodplain sediments are less than 10,000 years old (Reference 2.5-25).

2.5.1.1.3.2 Stratigraphy of the Valley and Ridge Province

The Valley and Ridge province is captured in Figure 2.5-10 as a series of linear, northeast-trending parallel ridges and valleys. The strata are similar to the Appalachian Plateau in age and lithology; however, the rocks are folded (Reference 2.5-3). Haynes et al. (Reference 2.5-27) presented a general overview of the structural geology and stratigraphy of the Valley and Ridge province, and this narrative is derived from their work.

Within the Valley and Ridge province, the prominent ridges are composed of highly resistant rocks, most often the Tuscarora Sandstone. In some instances, lower elevation ridges are capped by the Devonian Oriskany Sandstone, the Devonian Hampshire Formation, or the Devonian – Mississippian Price Formation. The valleys are typically underlain by rocks susceptible to physical weathering and erosion such as shales, or those susceptible to chemical weathering and erosion such as carbonates. The main valley-forming sequences within the Site Region are the Ordovician Reedsville Shale and the Devonian Marcellus Shale and Mahantango Formation. The main valley-forming carbonate sequences are the Cambro-Ordovician sequences of the Waynesboro and Beekmantown Formations, the Silurian and Devonian carbonate sequences (e.g., the Tonoloway and Helderberg Group), and the Mississipian carbonate sequence (e.g., the Greenbrier Limestone) (Reference 2.5-28).

2.5.1.1.3.3 Stratigraphy of the Blue Ridge Province

Terranes and belts consisting of primarily metamorphic rocks and igneous intrusions make up the Blue Ridge of eastern North America. Tectonostratigraphic terranes are defined as fault-bounded geologic areas that are of regional extent and are characterized by an internally homogeneous stratigraphy and geologic history that is different from that of adjacent terranes (Reference 2.5-15). The Appalachian Mountains have distinct terranes that were accreted to Laurentia at different times by the convergence of tectonic plates. The terranes typically preserve an imprint of past geologic events that have involved compressional, extensional, and translational tectonic forces (Reference 2.5-15). The physiographic province boundaries do not correspond one-to-one with the current understanding of terrane boundaries, and some terranes from the Blue Ridge extend into the Piedmont province.

Hatcher et al. identify the terranes and describe the characteristics of each (Reference 2.5-10). Figure 2.5-11 shows the locations of the terranes for the southern and central Appalachians.

2.5.1.1.3.3.1 Western Blue Ridge (Laurentia)

The Western Blue Ridge is a geologically complicated area and likely composed of several geologic terranes (Reference 2.5-29) including the Trimont Ridge Massif and the Mars Hill Terrane (Reference 2.5-10). The Western Blue Ridge is considered to be part of Laurentia and composed of gneisses that are over 1 Ga and overlain by younger sedimentary rocks (Reference 2.5-15).

2.5.1.1.3.3.2 Central Blue Ridge Terranes

The Central Blue Ridge terranes are similarly complicated to the Western Blue Ridge and are composed of several geologic terranes (Reference 2.5-29), including the Cowrock and Cartoogechaye (Reference 2.5-10). The Cowrock terrane is predominately metasandstone, schists with minor mafic and ultramafic rocks (Reference 2.5-10). The Cartoogechaye terrane is

predominantly metasandstone and ultramafic rocks with Grenville basement that were metamorphosed up to a granulite facies (Reference 2.5-10). The origin of these lithologic assemblages is debated, but Hatcher et al. infer that they were an assemblage of oceanic crust and mantle that was subsequently overlain by oceanic sediments (Reference 2.5-10).

2.5.1.1.3.4 Stratigraphy of the Piedmont Province

Similar to the rocks of the Blue Ridge province to the west, the Piedmont province comprises terranes and belts of primarily metamorphic rocks and igneous intrusions (Reference 2.5-29). Horton et al. (Reference 2.5-15) describe the tectonostratigraphic terranes of the central and southern Appalachians, and Hatcher et al. (Reference 2.5-10) further refined these descriptions. Terrane locations for the southern and central Appalachians are captured in Figure 2.5-11. The following narratives, unless otherwise noted, are primarily based on Horton et al. (Reference 2.5-15).

2.5.1.1.3.4.1 Inner Piedmont Composite Terrane

The Inner Piedmont composite terrane is a stack thrust sheet thought to contain several disrupted terranes of metamorphic rocks, primarily schists, gneisses, amphibolites, and few ultramafic bodies. A more recent study by Merschat and Hatcher (Reference 2.5-30) describes the Inner Piedmont as a composite terrane of the Tugaloo and Cat Square terranes that is highly metamorphosed and extends approximately from the NC – Virginia state line to central Alabama (Figure 2.5-11).

The presence of charnockitic gneiss in NC is interpreted to potentially be Grenville-age basement rock. Other terranes indicate the present of oceanic crust, such as the ultramafic Soapstone Ridge body near Atlanta, Georgia, and the mafic-ultramafic Hammett Grove metaigneous suite in South Carolina. The South Mountains of NC and the Clairmont Formation near Atlanta, Georgia, are diamictite gneisses that may represent metamorphosed mélange complexes. Other parts of the Inner Piedmont have a coherent stratigraphy of metasedimentary and metavolcanic gneisses and schists (Reference 2.5-15).

The Brevard fault zone separates the Inner Piedmont terrane from the Jefferson terrane and is considered a major crustal boundary. The Henderson Gneiss is southeast of the Brevard fault zone and is of the Late Proterozoic or Cambrian age, spanning approximately 74.56 mi. (120 km). There is no indication of the Henderson Gneiss within the Jefferson terrane northwest of the Brevard fault zone. A low-grade metamorphic body, the Chauga belt, at the northwest side of the Inner Piedmont terrane provides a juxtaposition between the Inner Piedmont terrane and the Jefferson terrane in Georgia, NC, and South Carolina (Reference 2.5-15).

The mylonitized Henderson Gneiss in the Brevard fault zone contains zircons that indicate a Uranium-Lead (U-Pb) age of 456 Ma, which has been interpreted as representing the age of mylonite formation during the Taconian orogeny. Granitic gneisses subject to regional metamorphism have indicated a Rubidium-Strontium (Rb-Sr) whole-rock ages of 460 ± 9 Ma, 431 ± 22 Ma, 429 ± 22 Ma, and 427 ± 9 Ma. The onset of Inner Piedmont terrane accretion is placed at approximately 460 Ma within the Middle to Late Ordovician and within the age of the Taconic orogeny in the northern Appalachians. Plutonism associated with the Taconic orogeny carried into the Silurian. Additionally, there is an indication that Acadian metamorphism is dated by 40Ar/39Ar hornblende ages to range from 358 to 333 Ma in the higher-grade metamorphic rock of the Alto allochthon, and ranges from 368 to 327 Ma in the Inner Piedmont terrane and in

lower grade metamorphic rock of the Chauga belt. Researchers disagree about whether the Brevard fault zone is a suture or terrane boundary, but it is possible that the Brevard fault could be a terrane boundary that structurally separates a terrane under the Alto allochthon and the Jefferson terrane (Reference 2.5-15).

2.5.1.1.3.4.2 Smith River Allochthon

The Smith River terrane in NC and Virginia (Figure 2.5-11) primarily comprises two major rock units. The Basset Formation is the lower unit, and it contains fragments from ultramafic and mafic rocks and is interpreted to contain an ophiolitic mélange similar to the Potomac and Jefferson. The upper part of the Bassett is an amphibolite overlain by schist and gneiss of the Fork Mountain Formation. The gneiss unit in the Fork Mountain Formation contains mélange that is similar to mélange in the Potomac terrane (Reference 2.5-15).

The Smith River rocks maintain a characteristic metamorphism that is high prograde, retrograde to greenschist facies, and a secondary prograde to staurolite grade. The metamorphic sequence is similar to that of the Peters Creek Schist of the Potomac terrane. The Bassett and Fork Mountain formations have been intruded by the Martinsville igneous complex, which includes the Leatherwood granite, the Rich Acres Formation (gabbro-diorite), and norite. The Leatherwood granite was dated using U-Pb age dating and Rb-Sr whole-rock dating as Middle Ordovician. The regional amphibolite-facies metamorphism in the Smith River terrane pre-dates the Leatherwood granite and is interpreted as Taconian (Reference 2.5-15).

The Smith River terrane is a fault-bounded synform situated within the Jefferson terrane, northwest of the Sauratown terrane. The Ridgeway thrust bounds the terrane on the west, while the Bowens Creek fault bounds the terrane to the east. However, the synform becomes more compact southeastward, and the bounding faults converge into the Brevard fault zone where the terrane pinches out. Younger rocks of the Martinsville igneous complex are truncated by the Ridgeway thrust, but the thrust is older than the Chatham fault. The Chatham fault divides the Ridgeway fault and juxtaposes the northern end of the Smith River terrane against upper Triassic rocks of the Dan River-Danville basin (Reference 2.5-15).

The Smith River terrane may be infolded and terminate within the Potomac composite terrane, or it may be another thrust slice of the terrane. Smith River terrane rocks may or may not correlate with those in the Inner Piedmont terrane. On aeromagnetic maps, the Smith River terrane appears similar to the Potomac terrane and distinctly different from the Inner Piedmont and Milton terranes. The age of the Smith River terrane metamorphism indicates it was amalgamated with its surrounding terranes during the Taconian orogeny (Reference 2.5-15).

2.5.1.1.3.4.3 Sauratown Mountains Anticlinorium

The Sauratown terrane of NC and Virginia is an elongated foliation dome (Sauratown Mountains) that trends north – northeast and was exposed in an opening of the Jefferson terrane during the Forbush thrust (Figure 2.5-11). The eastern portion of the terrane terminates at the Chatham fault that marks the western edge of the Triassic Dan River-Danville basin. The Chatham fault is interpreted to be coincident with an older ductile shear zone and connect to either the Forbush thrust or the Yadkin fault. The Sauratown Mountains represent the northeastern end of the Brevard fault zone, a linear feature the extends southwest to the Coastal Plain overlap and perhaps farther, which is a distance of more than 373 mi. (600 km) (Reference 2.5-15).

The terrane consists of a Grenville-age continental basement complex and a nonfossiliferous metasedimentary cover. Approximately half of the basement core is biotite gneiss (paragneiss) and schist. In the northern part of the terrane, granitic migmatite of possible Grenville-age is complexly interlayered with the biotite gneiss and schist. South and west of the Sauratown Mountains, the biotite gneiss and schist are typically thin-layered, contain no granitic rock, and are ambiguously related to the basement massif. The basement orthogneisses are 1.17 Ga and correlate to the Blue Ridge orthogneisses to the northwest. Sauratown terrane basement rocks were intruded by Late Proterozoic granites and felsic dikes. The dikes are similar to the Late Proterozoic Crossnore Complex of the Blue Ridge, which is related to Iapetan rifting (Reference 2.5-15).

Cross-bedded muscovitic quartzite that is at least 246 ft. (75 m) thick outcrops for approximately 15 mi. (24 km) along the middle of the Sauratown terrane. Its structural and stratigraphic relationship to the surrounding basement rocks and granite of the Crossnore Complex are possibly part of the cover sequence that may correlate to the Chilhowee Group. The Ashe Formation, which is a gritty biotite-muscovite gneiss containing blue quartz clasts outcrops at one location along the north side of the Sauratown terrane, is interpreted to be unconformably above the Grenville basement. The Ashe Formation is hypothesized to be in thrust contact with the Grenville-age basement rock (Reference 2.5-15).

2.5.1.1.3.4.4 Cat Square Terrane

The Cat Square terrane is bounded by the younger-over-older Brindle Creek fault to the west and the Central Piedmont suture to the east (Figure 2.5-11). It is noted to consist of a sequence of Silurian to Devonian metapsammite and pelitic schist that was intruded by Devonian to Mississippian granitoids that include the Toluca Granite at approximately 378 Ma and the Walker Top Granite at approximately 366 or 407 Ma. Rare mafic and ultramafic rocks occur in the eastern Cat Square terrane. The minimum sediment thickness is estimated at 13,123 ft. (4,000 m). Detrital zircons indicate that Cat Square terrane rocks have a maximum age of approximately 430 Ma, with both Laurentian (2.8, 1.8, 1.4, 1.1 Ga) and peri-Gondwanan (600, 500 Ma) affinities. Deposits on the oceanic crust indicate there are numerous mafic and ultramafic bodies; there is no continental basement in the Cat Square terrane. The Cat Square terrane is interpreted as a remnant ocean basin between Laurentia and the converging Carolina superterrane of peri-Gondwana that lasted for approximately 25 Ma. It was then subducted beneath Laurentia and migrated southward toward the southern Appalachians. The location and southwest migration of a clastic wedge and its structural patterns in the Inner Piedmont indicate that the collision direction was toward the northwest and the basin closed from the northeast to the southwest (Reference 2.5-30).

2.5.1.1.3.4.5 Milton Terrane

The Milton terrane of NC and Virginia has a strongly developed foliation with interlayered felsic and mafic gneisses and minor pelitic schist (Figure 2.5-11). Previously, the rocks had been described as part of the Charlotte belt and that the rocks are higher-grade equivalents of rocks in the Carolina slate belt of the Carolina terrane. The Milton terrane has also been compared to the Inner Piedmont composite terrane based on lithologies, deformational style, and chronology of Paleozoic folding, metamorphism, and igneous activity. Horton et al. note that while the Milton terrane has a similar aeromagnetic character to the Inner Piedmont terrane, the rocks are lithologically distinct from the Carolina slate belt of the Carolina terrane, but it remains a

possibility that a suture zone coincides with the steep metamorphic gradient between the two terranes (Reference 2.5-15).

The northern portion of the Milton terrane is predominantly composed of mafic and felsic metavolcanic rocks, the Shelton Granite Gneiss, and other unnamed biotite gneiss units. A U-Pb crystallization age of approximately 458 Ma from two sources of a meta-rhyolite indicates the presence of Ordovician volcanic rocks in the northern portion of the Milton terrane. In addition to these ages and combined with an age of 450 ± 1.8 Ma from the Old Mill granitic gneiss and the 424 ± 3 and 463 ± 14 Ma ages from the Shelton granite support the Ordovician age for the Milton terrane (Reference 2.5-31).

The rocks from the Milton terrane indicate the involvement of ancient continental crust in the production of these rocks. The presence of Mesoproterozoic xenocrystic zircon documented in the northern portion of the Milton terrane infers a crustal provenance. Additionally, the Chopawamsic terrane rocks have similar trace element concentrations as Milton terrane rocks and are indicative of a volcanic-arc setting. The similarity in rock mineral assemblages, timing of magmatism, and elemental compositions of the Milton and Chopawamsic terranes support the interpretation that they are correlative and were part of an Ordovician arc system built on Iapetan continental crust between 470 and 440 Ma (Reference 2.5-31).

The Milton terrane is structurally characterized by a nearly recumbent antiformal nappe rooted west of the boundary with the Carolina terrane. The Shelton Formation is a leucocratic granitic gneiss that occurs as sill-like bodies throughout the terrane. The sills were emplaced as intrusions either during or after nappe emplacement. The Rb-Sr whole-rock age is 429 ± 7 Ma and indicates that nappe emplacement was probably no later than early Silurian and no later than Taconian. The Milton terrane is bounded to the west by the Chatham fault and to the north by the Brookneal shear zone. To the east, a steep metamorphic gradient marks the transition to the Carolina terrane (Reference 2.5-15).

2.5.1.1.3.4.6 Chopawamsic Terrane

The Chopawamsic terrane includes the Chopawamsic Formation and Ta River Metamorphic Suite in Virginia, the rocks of the Central Virginia volcanic-plutonic belt, and the James Run Formation in Maryland (Figure 2.5-11). The Chopawamsic Formation in Virginia consists of felsic to mafic metavolcanic rocks, interbedded with metagraywacke, phyllite, or schist, and locally intruded by small bodies of plagiogranite and trondhjemite. The Ta River Metamorphic Suite is composed of amphibolite and interlayered biotite schist and gneiss (Reference 2.5-15). The James Run Formation is outside the Site Region.

The Chopawamsic Formation is age-constrained based on U-Pb analyses to approximately 550 Ma (Reference 2.5-31). Rare earth and trace element geochemical characteristics of rocks within the formation are consistent with a tholeiitic island arc suite with some calc-alkaline components. The Ta River Metamorphic Suite has rare earth and trace element characteristics of oceanic tholeiites that indicate the Ta River Formation is a more oceanward facies of the volcanic arc (Reference 2.5-15). The Ellisville and Lahore plutons that have intruded the northern Chopawamsic terrane indicate U-Pb zircon crystallization ages of 440 Ma and 450 Ma for the Ellisville and Lahore plutons, respectively. Other U-Pb ion microprobe analyses from the northern portion of the Chopawamsic Formation yielded Ordovician dates from 445 to 469 Ma (Reference 2.5-31).

To the west, the Chopawamsic terrane has been thrust onto the Potomac terrane along the Chopawamsic fault, and both terranes were subsequently intruded by the Occoquan Granite, which is age-dated at 494 ± 14 Ma. The Chopawamsic and Potomac terranes are interpreted to have amalgamated before the Late Cambrian Penobscottian orogeny. In northern Virginia, the Chopawamsic Formation overlies a sedimentary mélange of the Potomac composite terrane and has the character of the terrane fragments within the Potomac terrane. The Goochland terrane was overthrust onto the Chopawamsic terrane along the Spotsylvania fault in Virginia (Reference 2.5-15).

The middle and upper Ordovician Arvonia Slate and Quantico Formation unconformably overlie the Chopawamsic Formation. Because the Arvonia Slate and Quantico Formation are post-Taconian, the Chopawamsic terrane is overlapped. Mapping has indicated that the Arvonia Slate is very close to overlapping the Milton terrane. The Chopawamsic terrane is interpreted to have amalgamated with the Bel Air-Rising Sun and Potomac terranes in the Penobscottian event of the Late Cambrian. This combined terrane package was overthrust by the Baltimore terrane during the Taconian orogeny (Reference 2.5-15).

2.5.1.1.3.4.7 Carolina Superterrane – Carolina Terrane, Charlotte Terrane

The Carolina terrane is thought to be a composite terrane that includes rocks of the Carolina slate belt and the Charlotte belt (Figure 2.5-11). Additionally included are the Kiokee belt, the Belair belt, and the Battleground Formation of the Kings Mountain belt. Tectonic models indicate that this terrane originated in a volcanic-arc setting; however, there are various hypotheses concerning the direction of subduction, the number of arcs, the crustal type, and the timing (Reference 2.5-15).

The Carolina terrane contains at least two types of volcanic-sedimentary assemblage. The oldest assemblage is a Late Proterozoic andesitic assemblage between Chapel Hill, NC, and the NC – Virginia state line. This assemblage has calc-alkaline differentiation trends within mineral assemblages and is inferred to have formed by subduction along a continental margin. The younger assemblage is Late Proterozoic to Middle Cambrian and consists mostly of interbedded felsic metatuffs and fine-grained marine metasedimentary rocks that formed in a tectonic setting with both continental and oceanic features (Reference 2.5-15).

A potential orogenic event referred to as the Virgilina deformation was interpreted near the Virginia – NC border. The deformation is late Precambrian and Early Cambrian, characterized by folding and faulting, and lacks regional metamorphism. Other studies propose the existence of a major unconformity, referred to as the Virgilina unconformity, in central NC that separated Late Proterozoic rocks affected by the Virgilina deformation from the younger, Late Proterozoic to Middle Cambrian rock sequence occurring to the south. An unnamed fault cuts the Virgilina synclinorium but is crosscut by the 575 ± 20 Ma Roxboro metagranite (Reference 2.5-15).

Multiple lines of evidence support the hypothesis that at least part of the Carolina terrane was accreted to Laurentia during the Taconian orogeny. Earlier tectonic studies that equate the Carolina terrane with Avalonian terranes of the northern Appalachians inferred a Devonian (Acadian) accretion of the Carolina terrane, but this is no longer the predominant understanding. More recent studies measuring whole-rock K-Ar ages for low-grade slates of the Albemarle Group and 40Ar/39Ar whole-rock ages for slates of the Tillery Formation in NC are consistent with a Late Ordovician Metamorphic event. Paleomagnetic studies of the Albermarle Group indicate a paleolatitude of 22 degrees south, which is consistent with a Late Ordovician

timeframe. Higher-grade metamorphic rocks from the Charlotte belt have 40Ar/39Ar ages, consistent with an Ordovician (Taconian) event (Reference 2.5-15).

Calc-alkaline granitoids occur throughout the Carolina terrane, which is common in the Milford-Dedham zone of southeastern New England and Avalon terrane of Newfoundland. The southeastern New England granitoids span 650 to 600 Ma, while Avalon granitoids span 620 to 580 Ma, placing their formation in the Late Proterozoic. The plutons of the Dedham zone and Avalon terrane intrude older metamorphic rocks, but the Carolina terrane does not have a basement identified. The Carolina terrane granitoids lack Lower Cambrian strata overlying the Dedham zone granitoids non-conformably; they also do not have Lower Cambrian red beds overlying them that typify the Avalon terrane (Reference 2.5-15).

The Belair belt is located along the southeastern edge of the Kiokee belt near the Georgia – South Carolina state line (Figure 2.5-11). Belair rocks are composed of greenschist-facies metavolcanic and metasedimentary rocks, whereas Kiokee rocks are an amphibolite facies. The stratigraphic sequences, metamorphic grade, and polyphase structural history of the Belair belt are similar to the Carolina slate belt and are considered part of the Carolina terrane (Reference 2.5-15).

2.5.1.1.3.4.8 Raleigh-Goochland Terrane

The Goochland terrane is located in east-central Virginia (Figure 2.5-11; Reference 2.5-15). More recently, it has been referred to as the Raleigh-Goochland terrane by Hatcher et al. (Reference 2.5-10). It includes the State Farm Gneiss that has a Rb/Sr whole-rock age of 1031 Ma, but with a large uncertainty of ±94 Ma. The State Farm Gneiss is overlain by the Sabot Amphibolite and Maidens Gneiss, which show evidence of a relict granulite-facies metamorphism along with the State Farm Gneiss. Anorthosite intrudes all of these units, which are exposed in three en-echelon, doubleplunging antiforms. The Maidens Gneiss is interpreted to be equivalent to the Po River Metamorphic Suite in northern Virginia and Raleigh gneiss in NC. The Goochland terrane has been traced northward beneath the Coastal Plain into Maryland based on coincident Bouger gravity and magnetic anomalies that were confirmed with a deep well on the Potomac River. A similar Bouger gravity anomaly that extends from the Eastern Shore of Maryland into Delaware and New Jersey has been interpreted as an offset extension of the Goochland terrane.

The Spotsylvania fault separates the Goochland terrane from the Chopawamsic terrane to the west, while the Late Paleozoic Hylas fault zone separates it from the Roanoke Rapids terrane to the east. An interpreted southern extension of the Goochland terrane is overlain by volcanogenic Spring Hope terrane rocks; the boundary between the terrane is a premetamorphic thrust within the Raleigh metamorphic belt. The Goochland terrane is not interpreted to be a piece of Laurentia, but it is considered an exotic accreted terrane (Reference 2.5-15).

2.5.1.1.3.4.9 Brunswick (Charleston) Terrane

The Charleston terrane is equivalent to the older terminologies "Charleston magnetic terrane" and "Brunswick terrane" with some boundary differences (Figure 2.5-11). Also, the Charleston terrane should not be confused with the "Charleston block," which is now generally known as the South Georgia basin. The Charleston terrane is partly covered by overlapping Mesozoic strata of the South Georgia basin and is completely covered by Coastal Plain sediments.

Interpretations of the terrane are entirely limited to subsurface samples obtained during drilling or geophysical data (Reference 2.5-15).

Rock samples obtained from within the terrane are predominantly greenschist-facies metasedimentary and metavolcanic rocks; these samples are interpreted to be similar to the rocks of the Carolina, Spring Hope, and Roanoke Rapids terranes. Short-wavelength circular magnetic and gravity anomalies are interpreted to be both mafic and granitic plutons. A well-known example is the Springfield pluton, which was investigated through a corehole within a circular gravity low. The broad-wavelength magnetic signature in the area of the Charleston terrane is attributed to the eastward dampening of magnetic anomalies caused by the increasing thickness of the non-magnetic Coastal Plain cover to the southeast. The Charleston terrane produces a magnetically high domain that is significantly greater than that of the adjacent Carolina terrane. The high magnetic signature is caused by depth variations to the Moho and is attributed to the nature at the middle to upper levels of the crust. The magnetic and gravity anomalies together show that there is a large volume of mafic plutons and foliated mafic rocks (Reference 2.5-15).

The northwestern boundary of the Charleston terrane is poorly constrained on aeromagnetic data. However, a terrane-bounding suture was interpreted on Consortium for Continental Reflection Profiling (COCORP) seismic reflection data at the continental margin north and southwest of Hatteras. The southeastern boundary of the Charleston terrane is interpreted as south-dipping reflectors penetrating deep into the crust along the Brunswick magnetic anomaly. Three seismic reflection lines at locations in southwestern Georgia confirmed the COCORP interpretations. Observations from shallow drill holes confirmed the suture can be traced from the northern flank of the Brunswick anomaly in Alabama and western Georgia but diverges off the anomaly trend more than 15.5 mi. (25 km) northward in eastern Georgia (Reference 2.5-15).

2.5.1.1.3.4.10 Spring Hope–Roanoke Rapids Terrane

The Spring Hope terrane consists of greenschist-facies felsic to mafic metavolcanic and volcanogenic metasedimentary rocks and their amphibolite-facies equivalents in the Raleigh metamorphic belt (Figure 2.5-11). The terrane is characterized by sequences of metamorphosed mudstone, siltstone, graywacke, and minor conglomerate that are interpreted to be turbidites or reworked pyroclastic-epiclastic deposits. Metavolcanic rocks include felsic crystal and lapilli metatuffs and greenstone-metabasalt, while metagabbro and metadiorite occur as local intrusives. Chemical analyses of terrane rocks indicate a low-potassium tholeiitic suite that is interpreted to mean the Spring Hope terrane formed in a volcanic-arc environment on oceanic crust, but perhaps on a very thin continental crust (Reference 2.5-15).

The age of rocks within the Spring Hope terrane is poorly constrained. Rb-Sr whole-rock ages of metavolcanic rocks are 365 ± 4 Ma and 386 ± 27 Ma, indicating the age is no younger than Devonian. However, high initial Rb/Sr ratios suggest the ages were reset by a Devonian regional metamorphic episode, most likely the Acadian. Metavolcanic rocks within the Carolina superterrane to the west have Rb-Sr whole-rock ages that date them as Ordovician (Taconian) or older (Reference 2.5-15).

The Roanoke Rapids terrane of NC and Virginia is interpreted to be equivalent to the Roanoke Rapids structural block, containing mainly greenschist-facies and epidote-amphibolite-facies metavolcanic and volcanogenic metasedimentary rocks (Figure 2.5-11). The ages of the Roanoke Rapids terrane rocks is poorly constrained. The Fountain pluton in NC contains

granites with Rb-Sr whole-rock ages of 531 ± 60 Ma. It is unknown if pluton intrusion within the surrounding volcanogenic sequence are contemporaneous, but the rocks are at least Cambrian aged, if not older (Reference 2.5-15).

The Fountain pluton has a silicic per-alkalic composition, consistent with rift-related magmatism. Based on the composition and the Rb-Sr age, the Fountain granite compares similarly to the Crossnore Complex in the Sauratown terrane and in the Laurentian terranes of the Blue Ridge tectonic province. Subsequently, the Fountain granite and the Crossnore Complex were possibly emplaced with the late Precambrian and early Paleozoic rifting that formed at the edge of the North American continent (Reference 2.5-15).

2.5.1.1.3.4.11 Mesozoic Rift Basins

During the breakup of Pangea and subsequent opening of the Atlantic Ocean, a series of rift basins, oriented from northeast to southwest, formed in eastern North America (Reference 2.5-32; Reference 2.5-33). The basin closest to the Project site is the Dan River-Danville basin, while the Deep River basin is approximately 60 mi. (96.5 km) southeast of the Project site (Figure 2.5-11). The Dan River-Danville basin is a half-graben that is fault-bounded on the west side and filled with Triassic-Jurassic sediments (Reference 2.5-22).

Strata within the Dan River-Danville basin are reported to be up to 5000 ft. (1524 m) thick (Reference 2.5-6) and are primarily composed of five formations that overlie a dark green to gray-green metamorphic rock that is likely metavolcanic (Reference 2.5-22). From oldest to youngest, the formations are the Pine Hall Formation, Walnut Cove Formation, Dry Fork Formation, Cow Branch Formation, and Stoneville Formation (Reference 2.5-22). The Pine Hall Formation contains mainly fining-upward sequences of medium- to coarse-grained sandstones. Interbedded within the sandstones are several red siltstones and black, organic-rich mudstones with locally persistent coal beds. The overlying Walnut Cove Formation is mainly a dark gray-black organic lacustrine deposit of mudstone, siltstone, and coal. The Dry Form Formation is mostly gray to dark gray siltstone and very fine-grained sandstone (Reference 2.5-22). The Cow Branch Formation is mainly lacustrine, organic-rich rocks of gray to black shale, and the Stoneville Formation is primarily clastics with some lacustrine deposits (Reference 2.5-6).

2.5.1.1.3.4.12 Mesozoic Dikes

Mesozoic Era features in the Site Region include Early Jurassic diabase dikes that occur in a series of dense swarms with systematic, divergent trends throughout the Appalachian Mountains and indicate regional variations in magnetic and chemical characteristics (Figure 2.5-12). The dikes coincide with the Appalachian gravity high and almost exclusively occur east of the Brevard fault zone. The dikes in some areas are overlain by Coastal Plain deposits and are identified by magnetic anomalies. Anomalies have the highest amplitude over the igneous intrusions in the Carolinas and are attributed to a stronger magnetization (Reference 2.5-34).

Burt et al. studied diabase dikes that occur predominately in the eastern Piedmont province of NC (Reference 2.5-35). The dikes tend to be north-trending, up to 37 mi. (60 km) long, and continuous. Two major trends occur from N10°W to N30°W (northwest-trending) and east-trending, and a third, less prominent, group generally trends from east to northeast. The dikes appear more readily in aeromagnetic mapping, but the magnetic signatures are variable, and the highest magnitude signatures are associated with the north-trending dikes. Dikes are narrow and dip steeply, and they are typically emplaced in pre-Triassic crystalline rocks and in

sedimentary rocks in the Triassic basins. The occurrence of dike sills is restricted to Triassic sediments. Dike widths range up to approximately 200 ft. (61 m) with metamorphic contact zones more than 439.40 ft. (12 m) wide. In sedimentary rocks, the contact zones are less than 30 ft. (9 m) wide. The diabase dikes cut cleanly across all structures and may indicate intrusion into tensile fractures. Mineral assemblages of the separate diabase dikes are similar, and most include a chilled border and may or may not show a baked zone or contact aureole (Reference 2.5-35).

The northwest-trending dikes are most common in the sedimentary rocks in the Durham, Deep River, and Wadesboro Triassic basins and north of the Wadesboro basin. A large concentration of north-trending dikes occurs in a zone extending from the South Carolina – NC state line to the NC – Virginia state line. The north-trending dikes are more closely spaced in the south where they are sharply discordant to the northwest-trending dikes and tend to fan out to the east and west as the dikes trend northward. The less prominent dikes that trend east-northeast are located within the Triassic basins, along the basin borders or may be scattered. The north-trending dikes tend to be longer than the dikes that trend northwest or east-northeast. These dikes are typically 0.5 to 15 mi. (0.8 to 24 km) long; none appear to have an uninterrupted length longer than approximately 37 mi (59.5 km). An interrupted dike was found to be more than 100 mi. (161 km) long. The longer dikes are irregularly sinuous with many dikes in the basins terminating into crystalline rock at the basin border or within a short distance of it. As a population, the dikes are not evenly distributed, and large concentrations are present in the central part of the Wadesboro Triassic basin and the Deep River Triassic basin, while areas such as Chatham County have no known dikes. The closest dike to the Site Location is approximately 4 mi. (6.4 km) (Reference 2.5-35; Figure 2.5-16).

2.5.1.1.3.5 Stratigraphy of the Coastal Plain Province

The Coastal Plain strata in the Site Region extend east from the fall line along the boundary with the Piedmont to the Atlantic Ocean (Figure 2.5-10) within Virginia, NC, and South Carolina. Comparing Willoughby et al. (Reference 2.5-36) and Meng and Harsh (Reference 2.5-37) with Weems et al. (Reference 2.5-38) reveals that the Coastal Plain stratigraphy descriptions presented for NC within the Site Region apply to the Coastal Plain of Virginia and South Carolina. Figure 2.5-13 presents a simplified geologic cross section through the coastal plan in Virginia, which is considered to represent the typical wedge-shaped, eastward-thickening Coastal Plain stratigraphy of Cretaceous to Quaternary sediments overlying crystalline basement rocks. The sediments within the Coastal Plain province thicken to a maximum thickness of approximately 9843 ft. (3000 m) at Cape Hatteras (Reference 2.5-8).

The strata of the Atlantic Coastal Plain are divided into five regional supergroups that are currently separated into groups, formations, and members based on stratigraphic relationships. The oldest supergroup that occurs in the NC Coastal Plain is the Cretaceous Minden Supergroup, which is divided into three informal fining-upward sequences. Lack of available fossil data make correlation difficult within the Minden Supergroup, but the units extend from offshore, westward and terminate at a growth fault in Pamlico Sound west of Cape Hatteras. Lower Cretaceous and basal Upper Cretaceous sediments make up the Marquesas (MQ) Supergroup that contains 10 sequences numbered oldest to youngest from MQ-1 to MQ-10. The westward extent of each MQ unit is interpreted to be controlled by a series of growth faults in underlying Paleozoic sediments (Reference 2.5-38).

The Upper Cretaceous, Paleocene, and lower Eocene units consist predominantly of marine siliciclastic sediments that make up the Ancora Supergroup. The middle Eocene through Oligocene units that form the Trent Supergroup are predominantly carbonates. The Nomini Supergroup, which predominantly comprises siliciclastic Miocene to recent sediments and rocks, includes phosphate deposits within the Pungo River Formation. In the Late Cretaceous, sediments of the Clubhouse Formation overstepped all older Coastal Plain deposits toward the northwest to within 50 mi. (80.4 km) of the fall line. The Clubhouse Formation contains calcareous nannofossils and marginal marine dinocysts that indicate marine conditions had extended nearly the entire breadth of the Coastal Plain in northern NC. Middle and upper Miocene strata are locally discontinuous as indicated by the occurrence of anomalously old dinocysts within test boreholes, which reflect reworking of scoured older Miocene sediments into basal Pliocene sediment that began filling the region scoured during the Miocene (Reference 2.5-38).

2.5.1.1.4 Principal Regional Tectonic Structures

The Site Region is characterized by tectonic structures that are the result of multiple Wilson cycles. The region contains orogenies and extensional features resulting from the opening and closing of ocean basins.

2.5.1.1.4.1 Precambrian Tectonic Structures in the Site Region

In the Site Region, the most prominent signature of the assembly of the super continent Rodinia is the New York – Alabama lineament (Reference 2.5-39). The lineament is a magnetic feature interpreted to have been a continental transform fault during the assembly of Rodinia, approximately 1200 Ma (Reference 2.5-39).

Rifting of the supercontinent Rodinia into Laurentia, Baltica, and Amazonia between 700 and 550 Ma led to the formation of the Iapetus Ocean (Reference 2.5-134). Iapetan-age transform and rift faults are mapped in a zone subparallel to the modern Atlantic coastline of the United States (Reference 2.5-39; Figure 2.5-14). Transform faults strike northwest and offset northeast-striking rifts (Reference 2.5-40). In the earliest Cambrian, the rift margin from the Alabama to the New York promontory transitioned to a passive margin. The Rough Creek Graben, Rome trough, and Birmingham Graben also formed at this time as a late synrift extension inward of the rifted margin (Reference 2.5-39).

2.5.1.1.4.2 Paleozoic Tectonic Structures in the Site Region

In the Site Region, the Paleozoic is characterized by three orogenies: the Taconian (Ordovician), Acadian/Neoacadian (Devonian-Mississippian), and Alleghanian (Pennsylvanian-Permian) (Reference 2.5-41; Reference 2.5-204). The Taconian orogeny occurred in the Middle to Late Ordovician and possibly into the Silurian (Reference 2.5-42). Convergence generally progressed northeast with the collision of small plates, islands, and back arc basins, resulting in folds, thrust faults, and nappes (Reference 2.5-42). The Acadian is represented in the region by the Gold Hill fault zone, a Devonian-dextral shear zone that may also have been active in the Late Ordovician with sinistral transpression, possibly related to the accretion of the Carolina zone (Reference 2.5-43).

A series of Paleozoic faults that trend northeast – southwest pass west of the Project site, north through the Central Virginia Seismic Zone (CVSZ). After the 2011 earthquake in Mineral,

Virginia, two of these faults, the Lakeside fault and the Little Fork Church fault, were investigated with ground-penetrating radar and trenched, but no evidence of modern or prehistoric faulting was interpreted. The faults are interpreted to have been reactivated as normal faults during the Mesozoic (Reference 2.5-44).

The Central Piedmont shear zone is interpreted to be a Carboniferous to Permian Alleghanian thrust (Reference 2.5-45). It forms the boundary between the metamorphic rocks of the Piedmont zone and the metaigneous and metasedimentary volcanic-arc rocks of the Carolina zone (Reference 2.5-45).

The Brevard mylonite zone is an up to 3.7-mi.-wide (6-km-wide) zone of mylonitic rocks that contains the up to 0.9-mi.-wide (1.5-km-wide) brittle Brevard fault zone. The Brevard fault zone is interpreted to have formed during the Taconic or Acadian orogenies (Reference 2.5-46). In the modern setting, the Brevard fault strikes northeast – southwest from Alabama to Virginia at the boundary of the Blue Ridge and Piedmont provinces (Reference 2.5-47).

2.5.1.1.4.3 Mesozoic Structures

During the Middle to Late Triassic, Pangea began to break apart. During the breakup and the opening of the Atlantic Ocean, a series of approximately northeast – southwest-oriented rift basins opened (Reference 2.5-32; Reference 2.5-33). The rift basins generally are asymmetric half- grabens (Reference 2.5-33). The basin closest to the Project site is the Dan River-Danville basin. The Chatham fault zone is the primary fault of the half-graben; it trends along the northwest edge of the basin. The fault dips approximately 45° southeast. Smaller, normal faults are also present in the basin (Figure 2.5-15) (Reference 2.5-48). The surface trace of the fault lies approximately 6.2 mi. (10 km) from the Project site (Figure 2.5-15).

The Stony Ridge fault is located approximately 12.4 mi. (20 km) northwest of the Project site and was mapped as forming during the Mesozoic reactivation of the Brevard fault (Reference 2.5-49; Reference 2.5-50; Reference 2.5-51). However, subsequent mapping has been unable to demonstrate measurable displacement on the fault, and the cataclastite associated with the fault may have formed due to hydrothermal alteration (Reference 2.5-49) (Figure 2.5-16).

2.5.1.1.4.4 Cenozoic Structures

2.5.1.1.4.4.1 Fall Lines

Fall lines are zones of increased gradient in rivers that align in a curvilinear trend with similar features in adjacent stream and rivers (Reference 2.5-52). The traditional fall line is the head of tide of navigable rivers, although other fall lines have been identified upstream (Reference 2.5-52). The traditional fall line is mapped as the Coastal Plain-Piedmont boundary (Reference 2.5-53). There are three hypotheses (described below) for the formation of fall lines in the coastal region of Virginia and the Carolinas; these mechanisms may work separately or together (Reference 2.5-52).

1. Differential erosion across linear belts of rock of different hardnesses

2. Climatically driven changes in hydraulic gradient that alter the stream profiles

3. Cenozoic neotectonic uplift

2.5.1.1.4.4.2 Arches

The East Coast of the U.S. is composed of a series of large-scale troughs and rises called arches and embayments (Reference 2.5-54; Figure 2.5-17). The closest feature to the Project site is the Cape Fear Arch, which is a post-rift structural high that trends approximately southeast-northwest across the Coastal Plain and continental shelf of NC (Reference 2.5-55). The axis of the arch runs approximately along the Cape Fear River Valley, and the northeastern flank is steeper than the southwestern flank (Reference 2.5-55). The Cape Fear Arch is interpreted to have experienced intermittent uplift from the Late Cretaceous through apparently the present (Reference 2.5-55). Late Holocene average uplift rates over the last 4000 years are estimated to be 0.24 ± 0.15 mm/yr (0.009 ± 0.006 in/yr) (Reference 2.5-56). The arch was a positive feature during the Cenozoic, and it influenced middle Eocene and Miocene sedimentation patterns (Reference 2.5-57). The U.S. Geological Survey (USGS) Quaternary Fault and Fold Database, last reviewed by USGS in 2002, classifies the Cape Fear Arch as Class C because much of the evidence favors regional warping rather than a narrow zone of near-surface faulting (Reference 2.5-58).

There is no scientific consensus for how the Cape Fear Arch formed. Proposed processes are described below (Reference 2.5-55):

- An ocean fracture zone formed during the opening of the Atlantic.
- A horst between the Cape Fear and Neuse faults.
- Uplift between the Faison and Neuse faults.
- Upwarped dome along the Fountains Creek fault.
- Topography related to the passing of the Bermuda Hotspot.
- Topography related to ongoing mantle upwelling.
- Topography related to delamination of the mantle beneath the arch.

2.5.1.1.4.4.3 Quaternary and Potentially Capable Tectonic Sources

The Site Region contains or connects with two fault sources from the 2023 USGS National Seismic Hazard Map (NSHM) – the CVSZ and the Charleston sources (Figure 2.5-18; Reference 2.5-59). The Site Region additionally intersects or contains three other zones of historical seismic activity that were reviewed for the Senior Seismic Hazard Analysis Committee (SSHAC) Level 2 study performed for the Project site: the Giles County Seismic Zone, the Little River fault, and the Eastern Tennessee Seismic Zone (ETSZ). Additionally, the New Madrid Seismic Zone is discussed because of its regional significance.

2.1.1.4.4.5.3.1 Charleston

On August 31, 1886, an expected moment magnitude (E[**M**]) 6.9 earthquake occurred in the region near Charleston, South Carolina. This earthquake is the largest historical earthquake in the southeastern United States. Paleoliquefaction evidence indicates pre-1886 earthquakes occurred in the same region (Reference 2.5-117, Chapter 6). Multiple faults are identified in the

region; however, there is no scientific consensus on the location of the 1886 rupture (Reference 2.5-61). The Charleston earthquake is included as a source in both the Central and Eastern United States (CEUS) seismic source characterization (SSC) model and the USGS NSHM 2023 (Reference 2.5-117, Chapter 6; Reference 2.5-59; Reference 2.5-62).

Several recent studies have aimed to identify the fault source of the 1886 earthquake and other active faults in the region. Pratt et al. analyzed reprocessed seismic reflection and aeromagnetic data and new ground-penetrating radar data to interpret faults deforming Cretaceous and younger sedimentary units. The faults mapped in their study trend mostly northeast – southwest (Reference 2.5-61). Chapman et al. interpreted a fault striking N6°E with a dip of 43° to the west, based on the occurrence of earthquakes from 2011 to 2012. They interpret the observed seismicity to be aftershocks of the 1886 event on the same fault plane (Reference 2.5-63).

Several recent articles reanalyze historical data related to the 1886 Charleston earthquake (Reference 2.5-64; Reference 2.5-65; Reference 2.5-66; Reference 2.5-67). Hough and Bilham reassess historical accounts of the 1886 earthquake from the near and far field and calculate 1297 Modified Mercalli Intensity (MMI) values and more than 200 not-felt locations (Reference 2.5-67). Using these data and the ground motion models from the Next Generation Attenuation (NGA)-East project, they calculate a M 7.3 for the 1886 event based on the source developed in Bilham and Hough (2023) (Reference 2.5-64). Bilham and Hough (2024) (Reference 2.5-65) reexamined post-1886 earthquake photographs of rail line deformation and concluded the deformation is from dynamic deformation (deformation due to ground motion) instead of the previously interpreted static deformation (coseismic surface deformation). They do not interpret any evidence for faulting in 1886 south of the Ashley River at Rantowles, and they reinterpret the rail line deformation there as the effects of dynamic deformation. Previous studies have interpreted photographs of rail line deformation at Rantowles as evidence for static deformation from shallow strike-slip and thrust faults. Pratt et al. (Reference 2.5-68) wrote a comment on Bilham and Hough (2023) (Reference 2.5-64), taking issue with their proposed location of the 1886 earthquake and interpretation of lack of faulting south of the Ashley River.

2.1.1.4.4.5.3.2 New Madrid

The New Madrid region is the source of the 1811–1812 New Madrid earthquake sequence, which includes the three largest earthquakes in the CEUS in historical time (Reference 2.5-117, Chapter 6). Seismicity is located within a reactivated Precambrian rift zone, the Reelfoot Rift (Reference 2.5-69). A series of three M 7-8 earthquakes occurred in the zone from 1811 to 1812 (Reference 2.5-117, Chapter 6; Reference 2.5-69), and similarly large clusters of earthquakes are interpreted from paleoseismic evidence to have occurred in the Holocene (Reference 2.5-70). The New Madrid region is interpreted to include predominantly strike-slip faults that trend mainly northeast – southwest (Reference 2.5-69; Reference 2.5-59). Although the faults are outside the 200 mi. (320 km) Site Region, following regulatory guidance of NUREG-0800, the historical large magnitude earthquakes in the New Madrid region prompted their inclusion in the review of seismic sources and the inclusion of New Madrid faults as sources in the seismic hazard model (Section 2.5.2).

2.1.1.4.4.5.3.3 Central Virginia Seismic Zone

The CVSZ is a region of higher seismicity rate and includes the 2011 E[**M**] 5.72 Mineral, Virginia, earthquake. Other large historical events include the 1758 E[**M**] 4.95, the 1774 E[**M**]

4.38, and the 1875 E[**M**] 4.77 events. No historical events in the zone are interpreted to be above a E[**M**] 6 (Reference 2.5-71).

Tuttle et al. (Reference 2.5-71; Reference 2.5-72; Reference 2.5-73) documented evidence for paleoliquefaction in the CVSZ. Consistent with previous studies, Tuttle et al. (Reference 2.5-72) found two generations of features, one set historical and one set between 3450 and 2450 years before present. They conclude the younger set of historical features are related to M 5.0–5.5 events, likely the 1758, 1774, and 1875 events, while the older features are likely related to one M 6.5-6.75 event. Tuttle et al. (Reference 2.5-73) give the alternative of the older generation of liquefaction features either being generated by two M 6.25–6.5 or one M 6.5–6.75. There is no conclusive evidence for repeated M 6.5+ earthquakes in the CVSZ.

2.1.1.4.4.5.3.4 East Tennessee Seismic Zone

The ETSZ is a region of elevated historical seismicity in the Valley and Ridge province of Tennessee. Four general explanations have been proposed for the higher rates of earthquakes in the region: (1) the ETSZ is a long-lived aftershock sequence from a prehistoric event; (2) the ETSZ is in a phase of strain release, but the location of strain release (earthquakes) can change; (3) the ETSZ is a zone of weakness that experiences higher strain rates and/or earthquakes; and (4) the seismicity in the ETSZ is the result of the sum of local and regional stresses, resulting in a higher magnitude deviatoric stress tensor (Reference 2.5-74). Stress inversions indicate oblique extension in the ETSZ and long-term deformation (Reference 2.5-74. Historical earthquakes in the region generally have hypocenters between 3 and 16 mi. (5 and 26 km) deep, and magnitudes smaller than M 5 (Reference 2.5-75). The largest instrumental events in the ETSZ are the 1973 E[**M**] 4.01 Alcoa, Tennessee, earthquake and the 2003 E[**M**] 4.57 Fort Payne, Alabama, earthquake (Reference 2.5-76).

Cox et al. (2022) (Reference 2.5-76) summarized recent paleoseismic work in the ETSZ. They interpret a 110-km (68-mi.)-long, northeast-trending corridor, termed the Dandridge-Vonore fault corridor, as a region of Quaternary faulting. Near Alcoa, Tennessee, they interpret sedimentary features in an outcrop as evidence for two thrust-faulting events between 15,000 and 10,000 years ago and two events within 40 thousand years (kyr) were interpreted near Dandridge. Cox et al. (2022) (Reference 2.5-76) conclude there is evidence from outcrop mapping and trenching for at least two, $M_W \geq 6.5$ earthquakes in the last 40 kyr.

Thompson Jobe et al. (Reference 2.5-75) examined the site near Alcoa analyzed in Cox et al. (2018; 2022) (References 2.5-77 and 2.5-76) and the lineaments in the ETSZ. They conclude the outcrops that Cox et al. (2022) (Reference 2.5-76) interpret as coseismic offset are better explained as the result of fluvial deposition. They also reviewed sites near Oak Ridge without firm conclusions, hypothesizing that either fluvial or Quaternary faulting processes could explain the observed scarps and lineaments. Thompson Jobe et al. (Reference 2.5-75) also analyzed light detection and ranging (LiDAR) data and identified lineaments that trend east–west and correlate with other mapped Cenozoic faults. They conclude the faults have apparent left-lateral offset, which agrees with modern earthquake focal mechanisms. The study does not identify any clear evidence for Quaternary surface deformation.

2.1.1.4.4.5.3.5 Giles County Seismic Zone

The Giles County seismic zone is a region of elevated seismicity in southwestern Virginia. The largest historical earthquake in the region is the E[**M**] 5.91 Giles County earthquake that

occurred on May 31, 1897, with a maximum MMI of VIII. The effects of the earthquake included broken chimneys and local landslides (Reference 2.5-78).

Bollinger and Wheeler (1988) (Reference 2.5-79) conclude Giles County seismicity most likely occurs on reactivated Iapetan normal faults. Geologic evidence indicates potential left-lateral faulting, but geophysical and stress analysis indicate oblique-thrust-fault mechanisms in the region of the Giles County seismic zone (Reference 2.5-80).

The Pembroke faults are mapped along an anticlinal trend in the terrace deposits of the New River in the Giles County seismic zone. Extensional cracks in probable Quaternary-age terrace deposits are alternatively interpreted as caused by either subsurface faulting or as the result of dissolution of underlying layers (Reference 2.5-81). These cracks are assigned Class B in the USGS Quaternary Fault and Fold Database (Reference 2.5-82), which is defined as “Geologic evidence demonstrates the existence of Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.”

2.1.1.4.4.5.3.6 Little River Fault

The Little River fault is a recently mapped fault considered to be associated with surface rupture from the 2020 M 5.1 Sparta earthquake in NC (Reference 2.5-83). The fault is located approximately 57 mi. (92 km) west-northwest of the Project site. The Sparta earthquake ruptured an oblique strike-slip fault. The moderate magnitude earthquake occurred at shallow depth (2 km [1.2 mi.]) with a northwest-southeast fault strike based on focal mechanism analysis, perpendicular to the regional structural orientation of the Appalachian Mountains. The earthquake occurred near the town of Sparta, NC, where there is relatively sparse historical seismicity. Geodetic markers and focal mechanism data indicate that the earthquake ruptured on a left-lateral fault at depth with a reverse component near and at the surface (Reference 2.5-83).

Paleoseismic trenches were dug and mapped across the fault scarp. Late Pleistocene surface ruptures with similar displacements to the 2020 earthquake have been interpreted, suggesting similar magnitudes and locations for older events (Reference 2.5-83). Preliminary geochronology and soil horizon analysis by the same authors suggests three earthquake events in the last 40 kyr, indicating an average recurrence interval of 13.3 kyr. Vertical deformation is approximately 3.3 ft. (1 m) in the last 50 kyr, suggesting an approximate vertical slip rate of 0.02 mm/yr during that timeframe (Reference 2.5-83).

2.5.1.1.4.5 Present-Day Tectonic Stress

The Site Region is located within a mid-plate compressive stress province that characterizes the CEUS and extends into Canada and the western North Atlantic basin (Reference 2.5-84). The principal horizontal stress is predominately east – northeast, while the faulting style is predominately compressive, although it transitions to strike-slip in eastern Tennessee (Reference 2.5-85). The cause of the principle horizontal stress direction in the eastern United States is poorly understood as the direction diverges from the plate trajectory. Lundstern and Zoback (Reference 2.5-85) suggest that the stress direction is controlled by sediment loading and flexure along the continental margin.

2.5.1.1.4.6 Regional Gravity and Magnetic Data

Kucks (Reference 2.5-86) provided the primary gravity data reviewed for this application. The data over land were free-air corrected, and a complete Bouguer correction was implemented by removing a gravity reference field within 103.6 mi. (166.7 km) of the measurement location. Figure 2.5-19 presents the Bouguer gravity map for the Site Region. A small portion of the 199-mi. (320 km) Site Region extends offshore into the Atlantic Ocean; that portion of the data was subjected to free-air correction (Reference 2.5-86).

The Magnetic Anomaly Map of North America from Bankey et al. (Reference 2.5-87) provided the primary magnetic data reviewed for this application. Figure 2.5-20 presents the magnetic anomaly map for the Site Region. Details of the specific processing method are presented in Reference 2.5-87. In general, the map is a compilation of digital and analog maps from aeromagnetic surveys completed from 1949 to 2001. For each survey, the definitive magnetic reference field for the survey date was removed, and the data were mathematically processed to an equivalent flight elevation of 1001 ft. (305 m) above terrain, merged, and then filtered (Reference 2.5-87).

2.5.1.1.4.6.1 Gravity Data

Figure 2.5-19 shows Bouguer gravity anomaly data within and surrounding the Site Region. Interpretation of gravity data is complex; general guidelines to interpret gravity patterns are presented below:

- Gravity differences due to subsurface variation in density generally span only a few hundred milligals (mGal) (Reference 2.5-88).
- Lateral variations in rock density give rise to gravity anomalies, but vertical variation in rock density in a flat and layered earth do not produce an anomaly (Reference 2.5-88).
- For igneous rocks, density usually increases with decreasing silica content. For sedimentary rocks, age, depth of burial, and mineral composition are the most important factors for density (Reference 2.5-89).

Figure 2.5-19 identifies key gravity anomalies and/or trends and are described below:

A. A high-gravity anomaly trending northeast to southwest (ranging from approximately -30 to -40 mGal) at the eastern edge of the Cumberland Plateau and Allegheny Mountains. Hatcher et al. (Reference 2.5-90) note that area as underlain by a mafic complex, mainly gabbro, which is denser than the surrounding rocks to the east. The eastern boundary approximately corresponds to the New York–Alabama lineament of Reference 2.5-91.

B. The Appalachian gravity gradient, sometimes referred to as the Piedmont gravity gradient, which is an elongate gravity high that trends northeast to southwest and separates the low (-90 to -70 mGal) gravity anomaly regions from the adjacent high Bouguer (~0 to 25 mGal) gravity in the Piedmont and Coastal Plain. Hatcher et al. infer that the Appalachian gravity gradient most likely represents the eastward thinning of autochthonous continental crust to a buried Iapetus suture (Reference 2.5-90).

C. A gravity low associated with the Triassic Dunbarton basin. Cumbest et al. (Reference 2.5-92) completed extensive research at the Savannah River site southwest of the Project site. The authors interpreted from borehole data and gravity modeling that the gravity low was attributed to granitic plutons bounded to the southeast by corresponding gravity/magnetic highs attributed to mafic intrusive complexes.

D. A gravity low associated with the Lumberton plutonic intrusion as presented in Rankin et al. (Reference 2.5-93). Pratt (Reference 2.5-94) completed a detailed geophysical and coring study in which the gravity low anomaly corresponded to a thick, granite intrusion.

E. The gravity low anomaly studied by Daniels and correlated to a mapped granitic pluton. Adjacent gravity high anomalies corresponded to mafic intrusions (Reference 2.5-95).

F. A gravity low anomaly with unknown origin due to lack of borehole data, but by analogous interpretation to anomalies C-E, it is interpreted to represent a granitic pluton intrusion.

2.5.1.1.4.6.2 Magnetic Interpretations

Figure 2.5-20 presents magnetic anomaly data encompassing the Site Region and surrounding area. The data are a compilation of aeromagnetic surveys published by Bankey et al. (Reference 2.5-87). Similar to gravity data, interpretation of magnetic anomaly data is complex; several guiding principles are presented below:

- The nanotesla (nT) is the standard unit of measure for processing and interpreting magnetic anomaly data (Reference 2.5-96).
- High amplitude anomalies typically reflect lithologic contacts, while anomalies related to structures are more subtle (Reference 2.5-96).
- Magnetic anomalies are caused by lateral changes in the magnetic mineral content of rocks, and so reflect lateral changes in lithology (Reference 2.5-88).

The North American magnetic anomaly map reveals the overall northeast – southwest structural features of the Appalachians. Several large-scale magnetic anomalies in the eastern United States form lineaments that have been associated with seismic zones or basement structures. Figure 2.5-20 identifies key magnetic anomalies and/or trends that are described below:

A. The New York–Alabama lineament occurs on the west side of the Appalachian gravity low. On the northwest side of the lineament, gravity anomalies are north-trending, while on the southeast side of the lineament gravity anomalies are northeast-trending (Reference 2.5-91). Further work by Steltenpohl et al. constrains the southern terminus of the lineament and indicates the feature represents a crustal scale, right-lateral strike-slip fault (Reference 2.5-97).

B. The Clingman lineament lies east of the New York–Alabama lineament and is a magnetic anomaly produced by deep-seated basement structures. These two lineaments, along with the Ocoee lineament that trends between them, are interpreted to be the bounds of the ETSZ (Reference 2.5-97).

C. The Brevard fault zone is also visible in these data. It is interpreted as an aeromagnetic lineament that corresponds with the mapped surface trace of the Brevard fault zone that extends from western NC through eastern Alabama. The aeromagnetic signature continues to the southwest beneath the Coastal Plain in Alabama (Reference 2.5-97).

D. The East Coast Magnetic Anomaly is outside the Site Region, but noteworthy because it marks the present continental/oceanic crustal transition and the Late Paleozoic suture between North America and Africa (Reference 2.5-98).

While not seen on the magnetic anomaly map, multiple prominent, high-frequency magnetic anomalies occur along the eastern portion of the Piedmont and into the Coastal Plain provinces. The magnetic anomalies within the Piedmont are attributed to the presence of an extensive eastern Piedmont fault system that extends southwest into Georgia (Reference 2.5-99; Reference 2.5-100). The series of linear- to arcuate-magnetic anomalies in the Coastal Plain province near the fall line are inferred to represent mafic intrusions on the perimeter of granitic plutons (Reference 2.5-100). Additionally, a similar anomaly is seen farther southwest near the Dunbarton Basin where Cumbest et al. correlated linear magnetic anomalies to mafic intrusions (Reference 2.5-92).

2.5.1.1.5 Regional Geologic Hazards

2.5.1.1.5.1 Karst

In the Site Region, karst and karst-like processes are mainly located in two broad bands. To the east of the Project site, carbonate rocks are located in the Coastal Plain. The Site Region is classified as humid, which results in carbonate bedrock and calcareous sediments at or near the surface as typically being karstic. To the west of the Project site, Weary and Doctor (Reference 2.5-101) mapped the potential for marble in the Sauratown Mountains region. More widespread evidence is available for carbonate units at or near the surface to the northeast of the Project site in the Valley and Ridge province where a band of Cambrian and Ordovician limestones and dolomites follow the general northeast – southwest structural trend (Reference 2.5-51; Reference 2.5-101). Evaporite rocks are not mapped as large-scale units in the Site Region (Reference 2.5-101). Units under the Project site are mapped as quartz-feldspar gneiss (Reference 2.5-51).

2.5.1.1.5.2 Landslide

Most of the mapped landslides in NC are in the Blue Ridge Mountains in the western portion of the state (Reference 2.5-102). Most mapped landslides correspond with the impacts from tropical cyclones or periods of higher rainfall. Landslides also occur more frequently where slopes have been modified by human activities (Reference 2.5-102). Debris flows dominate landslide processes in the southern Appalachian Highlands (Reference 2.5-103). The NC Geologic Survey has not mapped landslides in the counties closest to the Project site (Forsyth, Guilford, Rockingham, and Stokes) from 1990 to 2016 (Reference 2.5-102).

Mirus et al. (Reference 2.5-104) calculated the four counties surrounding the Project site as having a high percentage of landslide-susceptible terrain (66 to 100 percent) but a low rate of mapped landslides (less than 0.01 per km^2). The Coastal Plain region of the Site Region has a low rate of susceptible terrain (less than 33 percent) and a low rate of mapped landslides (less than 0.01 per km^2). The Blue Ridge Mountains have both a high percentage of susceptible

terrain (66 to 100 percent) and a high occurrence of mapped landslides (0.01 to more than 0.1 per km^2).

2.5.1.1.5.3 Volcanic

Prior to the breakup of Pangea, the CAMP, a large igneous province, formed (Reference 2.5-105; Reference 2.5-106). In the Site Vicinity, the CAMP is represented by a series of dikes that trend approximately north to south. Peak activity for the CAMP has been dated to the Triassic-Jurassic boundary, approximately 200 Ma (Reference 2.5-106).

The youngest igneous features within the Site Region are Eocene volcanic dikes, sills, plugs, and diatremes near the West Virginia – Virginia border (Reference 2.5-105), more than 125 mi. (200 km) from the Project site. These features are interpreted to be the result of asthenosphere upwelling related to lithospheric delamination, although other hypotheses are proposed, including plume magmatism and changes in the regional stress field (Reference 2.5-105).

Volcanism is typically associated with plate boundaries and mantle hotspots. Neither setting is present in the Site Region, and there are no mapped Quaternary active volcanoes (Reference 2.5-107; Reference 2.5-108; Reference 2.5-109). There are no Quaternary volcanoes in the Site Region (200 mi. [320 km]) or mapped Quaternary volcanic deposits within Site Vicinity (25 mi. [40 km]) (Reference 2.5-109). Therefore, based on RG 4.26, which specifies if no Quaternary active volcanoes are identified in the Site Region, or Quaternary pyroclastic deposits are located within the Site Vicinity, the volcanic hazard can be screened out from further analysis.

2.5.1.2 Local Geology

The following sections provide a summary of geologic conditions in the Site Vicinity (25 mi. [40 km radius]), Site Area (5 mi. [8 km] radius) and Site Location (0.6 mi. [1 km]) radius. Specifically, the sections present information concerning the physiography, geologic history, stratigraphy, structural geology, non-seismic geologic hazards, and engineering geology. This information is based on a review of geologic literature and geotechnical/hydrogeological field investigations conducted at the Project site.

2.5.1.2.1 Local Physiography

Figure 2.5-21 shows the Site Vicinity and Site Area. The Project site is located in southeast Stokes County, adjacent to the Belews Creek Steam Station (BCSS), near the intersection of four counties: Rockingham County to the east, Guilford County to the southeast, and Forsyth County to the south. The Project site is approximately 14 mi. (23 km) northeast of Winston-Salem and approximately 19 mi. (31 km) northwest from Greensboro, NC. The Project site specifically focuses on three separate sites located on a peninsula that trends southwest – northeast and extends into the southwestern portion of Belews Lake. The three sites are referred to as the North Plant Complex, the Middle Plant Complex, and the South Plant Complex, and they are within the Project site captured in Figure 2.5-21.

The entire Site Vicinity is within the Piedmont physiographic province, approximately 40 mi. (64 km) east of the Blue Ridge physiographic province (Figure 2.5-1). As discussed in Section 2.5.1.1.1, the Piedmont physiographic province extends from New Jersey to Alabama (approximately 994 mi. [1600 km]). Rocks within the Site Vicinity are primarily composed of weathered metamorphic and igneous rocks. Metamorphic rocks include mostly schist and

gneiss; igneous rocks are predominantly slightly metamorphosed granite. Structural basins (resulting from faulting) are filled with Mesozoic sediments (Reference 2.5-4).

The Site Vicinity is within the Yadkin-Pee Dee, Cape Fear, and Roanoke River basins, while the entire Site Area is within the Roanoke River basin. The Yadkin-Pee Dee Rivers flow through west-central NC into South Carolina before emptying into the Atlantic Ocean at Winyah Bay (Reference 2.5-109). The Cape Fear River originates in the northern Piedmont by the confluence of the Haw and Deep Rivers, flows southeast, and then empties into the Atlantic Ocean near Southport, NC (Reference 2.5-110). The Site Area drains locally into Belews Lake, which flows into Belews Creek and the Dan River. The Dan River is part of the Roanoke River basin; which originates along the eastern slopes of the Blue Ridge Mountains in Virginia and flows southeast through Virginia and NC before emptying into the Albemarle Sound of NC (Reference 2.5-111). Average elevations within the Roanoke River basin range from approximately 1000 ft. above sea level near the Dan River in Stokes County to sea level at the mouth of the Roanoke River (Reference 2.5-111). The terrain in the Dan River basin is characterized as rolling and hilly.

2.5.1.2.2 Local Geologic History

The major tectonic events that affected the Site Vicinity are characterized as the Appalachian Wilson Cycle. The sequence of events are outlined by Hatcher et al. (Reference 2.5-10) as follows:

- Formation of Rodinia from 1.2 to 1.0 Ga during the Grenville orogeny
- Rifting of Rodinia ~ 750 Ma
- Failed rifting of Rodinia ~735 Ma
- Rifting of Rodinia ~565 Ma and formation of Pangea
- Taconic orogeny 480-420 Ma
- Neoacadian orogeny 380-355 Ma
- Alleghenian orogeny 325-265 Ma
- Rifting of Pangea

See Section 2.5.1.1.2 for a more detailed discussion of the Site Vicinity tectonic history.

2.5.1.2.3 Local Stratigraphy

Six tectonostratigraphic terranes are mapped within the Site Vicinity: Tugaloo (West of Brevard Zone), Smith River, Sauratown Mountain, Milton, Carolina, and Charlotte. The Mesozoic Dan River basin is approximately 2 mi. (3.2 km) west of the Project site (Figure 2.5-11; 2.5-22). While not depicted on the map, the correlative terranes extend into Virginia as summarized by Bailey (Reference 2.5-112). Section 2.5.1.1.3.4 describes the general rock types and stratigraphy of the aforementioned Piedmont rocks.

At the Site Area level of detail, two lithologic-tectonic belts or terranes are mapped: the Milton Belt and Dan River basin. Figure 2.5-22 shows the tectonostratigraphic boundaries, and Figure 2.5-23 presents the Site Area bedrock geology. The Site Area is located within the Milton terrane, which comprises late Precambrian massive to strongly foliated biotite gneiss and schist, amphibolite, felsic gneiss, and Late Paleozoic granite intrusions. The rocks are metamorphosed to amphibolite facies and folded into shallowly plunging recumbent folds (Reference 2.5-113; Reference 2.5-114).

Four main geologic formations are mapped beneath and adjacent to the Site Area within the Milton terrane (Reference 2.5-115; Reference 2.5-116; Reference 2.5-117). Unit abbreviations are from Figure 2.5-23. Units in parentheses are from Figure 2.5-16:

- CZbg (bc) – Biotite Gneiss and Schist (520 – 650 my) – highly metamorphosed and foliated biotite gneiss and schist underlie the Project site and are described as dark colored, medium to coarse-grained to porphyroblastic, locally contains hornblende and is chiefly composed of biotite, quartz, potassium feldspar, muscovite, and hornblende. The CZbg formation is interlayered with mica schist and amphibolite and is locally intruded by pegmatite dikes.

- CZfg (qgc) – Felsic Mica Gneiss (520 – 650 my) – interlayered biotite hornblende gneiss with graphitic mica schist and mica-garnet schist, commonly with kyanite. Underlies the northwest side of Belews Lake.

- PPg (Pzc) – Porphyritic Granite (265 – 325 my) – light gray, medium- to coarse-grained porphyritic granite, granodiorite, and quartz monzonite. Composed of microcline phenocrysts up to 5 inches (13 centimeters) in diameter in a matrix of quartz, oligoclase, and biotite. Underlies the area southwest and southeast of the Project site.

- TRds, TRdc, TRdp (Trs) Clastic sedimentary rocks of the Dan River Basin

- (TRd) – Diabase Dike (265 – 325 my) – black to greenish dark gray, fine- to medium-grained, dense rock composed of plagioclase, augite, and olivine. Occurs as dikes up to 200 ft. (61 m) wide and typically occurs as spheroidal weathered boulders with a grayish-brown weathering rind. Diabase dikes typically trend northwest and north and are mapped east of the Project site.

Sedimentary rocks of the Triassic Dan River basin occur northwest of the Milton terrane and trend northeast toward Danville, Virginia. The Chatham fault zone separates the Triassic rocks from the metamorphic rocks of the Sauratown Mountain anticlinorium farther to the north and the Milton terrane to the south. The sedimentary rocks within the Dan River basin are mapped as the Pine Hall Formation, Cow Branch Formation, and Stoneville Formations (Reference 2.5-115; Reference 2.5-118); however, Reid and Taylor further subdivide the Pine Hall Formation into the Walnut Cove Formation and Dry Fork Formation (Reference 2.5-6). There is a Mesozoic dike approximately 4 mi. (6.4 km) northwest of the Site Location (Figure 2.5-16).

At the Site Location level, the subsurface was investigated through an exploration program including geotechnical drilling/coring, borehole and surface geophysics, groundwater well installation and aquifer testing, and laboratory analysis of soil/rock samples. Section 2.5.4 presents a detailed description of the exploration program.

Sixteen locations at each of the 3 Plant Complexes were targeted for exploration for a planned total of 48 geotechnical borings. In some instances, 1 to 3 offsets were completed at each location, resulting in 84 geotechnical boreholes. Lithologies were identified in the field and through laboratory testing on samples retrieved using standard penetration testing (SPT), rock coring, sonic drilling, and intact and bulk soil sampling techniques at the locations.

Cross sections were generated as part of an overall effort to understand the Site Location hydrogeologic and subsurface geologic conditions. The cross sections were prepared using lithologic data from the geotechnical and well lithologic borings, fracture data from the acoustic televiewer geophysical logs, and groundwater data from offset monitoring wells. Surface profiles were generated using topographic data that included processed USGS LiDAR data. The lithologic layers and well screen placements depicted on the cross sections were determined based on field classification of overburden; partially weathered rock (PWR); and bedrock using lithologic observations, SPT N-values (the total number of blows required for the 140-pound hammer to drive the sampler the remaining 1 foot [300 mm] depth), and drilling characteristics. PWR is defined as residual material with SPT N-values exceeding 100 blows per foot. Top-of-bedrock is primarily determined from the rate of drilling penetration and other drilling characteristics such as the behavior of the drill rig upon approaching the top of bedrock.

Figures 2.5-24 through 2.5-25 present the cross section location map and seven cross sections through the Plant Complexes (A-A′, B-B′, C-C′, D-D′, E-E′, F-F′, and G-G′).

Combined overburden and PWR (depth to bedrock) thickness from wells and borings range from 14 to 85 ft. (4.3 to 26 m) thick and average 49 ft. (15 m). PWR thickness averages 13 ft. (4.0 m) and overburden thickness averages 36 ft. (11 m). From the cross sections, PWR is interpreted to be thickest at the North Plant Complex and thins south and east within all three Plant Complexes. The top-of-bedrock surface is generally a subdued reflection of the present-day land surface.

The overburden consists of mostly moist, silty sand with lesser amounts of clay and sandy silt. Clay layers are more common within the soil profile in the upper 7 ft. (2 m). Trace amounts of gravel-sized rock fragments are commonly observed. PWR consists of silty sand with gravel. The relict rock structure of the parent rock material is commonly associated with PWR, such as foliations and schistose structures.

2.5.1.2.4 Site Local Structural Geology

2.5.1.2.4.1 Sauratown Mountains Window

The Sauratown Mountains window is northwest of the Project site at the boundary of the Blue Ridge and Piedmont provinces (Reference 2.5-119) and is an exposure of parautochthonous basement through the overlying thrust sheets (Reference 2.5-120; Figure 2.5-26).

A splay of the Brevard fault system terminates to the southwest of the zone (Figure 2.5-26). The window exposes four imbricate, stacked thrust sheets of Middle Proterozoic basement and Late Proterozoic to possibly Early Cambrian metamorphic rocks. Ages of strontium isotopes indicate reequilibrium of basement rocks occurred during the Grenville orogeny but structural textures formed after that time. Five stages of folding are interpreted in the window along with a later stage of brittle deformation that may indicate the reactivation of the Shacktown fault during Mesozoic rifting (Reference 2.5-119).

The following phases of deformation led to the formation of the Sauratown Mountains window (Reference 2.5-49):

- Late Proterozoic margin sedimentation of the Hogan Creek and Sauratown Formations
- Deep burial, metamorphism, and isoclinal folding
- Taconic age faulting along the Forbush thrust
- Taconic age suturing of the Carolina Terrane to North America
- Possibly Alleghanian-age overthrusting along the Danbury thrust
- Formation of the anticlinorium possibly related to duplexing of platform rocks beneath the Blue Ridge and Piedmont thrust sheet
- Mesozoic dike emplacement and hydrothermal activity

2.5.1.2.4.2 Stony Ridge Fault

The Stony Ridge fault is a discontinuous feature that trends northeast – southwest between the Sauratown Mountain window and the Dan River basin (Reference 2.5-51; Figure 2.5-26). The feature had previously been mapped as a fault; however, Hatcher (1988) (Reference 2.5-49) interpreted little to no displacement. Hatcher (1988) (Reference 2.5-49) interpreted the Stony Ridge fault as a Triassic and Jurassic fissure that had been silicified through hydrothermal processes associated with diabase dike emplacement.

2.5.1.2.4.3 Central Piedmont Suture

The Central Piedmont suture separates the rocks of North America from the allochthonous rocks of the Carolina Belt (terrane) (Reference 2.5-49). It is mapped as a terrane boundary from south-central Virginia to west-central Georgia (Reference 2.5-122). In north central NC, the suture is mapped as the Hyco shear zone and the boundary between the Milton and Carolina terrane. The Hyco shear zone is interpreted to be between 335 ± 2 Ma and 320 ± 1 Ma (U-Pb zircon ages) (Reference 2.5-122). The Hyco shear zone has interpreted dextral strike-slip and reverse motion. Hatcher (Reference 2.5-49) interprets the Shacktown fault to the south of the Sauratown Mountain window as the Central Piedmont suture near the Project site (Figure 2.5-26).

2.5.1.2.4.4 The Dan River-Danville Basin

The Dan River-Danville basin is an asymmetric graben (Figure 2.5-26) bounded to the north by the Chatham fault. The Shacktown fault follows the same trend as the Chatham fault, and some interpret the Chatham fault as the northeast extension of the Shacktown fault (Reference 2.5-119). The Dan River basin is one of a series of continental rift basins that formed during the breakup of Pangea from the Permian to the Early Jurassic (Reference 2.5-123). The southeastern boundary of the Dan River basin is bound by onlap via an unconformity, although some short (<1.8 mi. [3 km]) faults are mapped along this boundary (Reference 2.5-123; Reference 2.5-50). CAMP dikes that cross the Dan River basin have not been dated but if assumed to be the same age as other CAMP intrusives they were emplaced around 201 Ma

(Reference 2.5-123). Some dikes cross the Chatham fault and do not appear to be displaced, indicating tectonic subsidence on the fault ceased before dike emplacement (Reference 2.5-123).

2.5.1.2.5 Local Non-Seismic Geologic Hazards

2.5.1.2.5.1 Karst

In the Site Vicinity, rocks of the Sauratown Mountain Anticlinorium (Figure 2.5-22) are considered prone to karst formation, specifically geologic unit CZmg, which is less than a mile from the northwestern edge of the Site Area (Figure 2.5-23). The mapped CZmg unit is a metamorphic graywacke and muscovite-biotite schist with minor amounts of marble (Reference 2.5-115). The presence of marble (a carbonate rock) at or near the land surface, coupled with average annual precipitation of more than 30 in. (76 cm), is the reason the unit is classified as susceptible to karst (Reference 2.5-101). However, there are no known occurrences of karst in the rocks of the Sauratown Mountain Anticline. Additionally, there are no known fissures, tubes, caves, or units such as basalts that can contain tubes and tunnels and behave like karst within the Site Vicinity (Reference 2.5-101).

In the Site Area, no geologic units near the surface are mapped as carbonates or evaporites (Figure 2.5-23). Furthermore, as discussed in Section 2.5.1.2.3, geotechnical borings were advanced at the North, Middle, and South Plant Complexes as part of the subsurface exploration program. The maximum depth of exploration was approximately 299 ft. (91 m) at the North and South Plant Complexes and approximately 600 ft. (183 m) at the Middle Plant Complex. Bedrock at the site is gneiss and schist, which is consistent with the mapped units presented in Figure 2.5-23. Considering the lack of carbonate units within the upper 600 ft. (183 m) at the Site Location, karst is screened out as a site hazard.

2.5.1.2.5.2 Landslides

As discussed in Section 2.5.1.1.5, the area near the site is mapped as susceptible to landslides but with few mapped landslides (Reference 2.5-104). Belair et al. (Reference 2.5-124) developed a landslide susceptibility map for the continental United States (Figure 2.5-27). Slope and 328-ft. (100-m) relief were calculated on 1/3 arc-second digital elevation models (DEMs). Each 295-ft.(90-m) cell is given a rank of 0 to 81 representing how many 32-ft. × 32-ft. (10-m × 10-m) cells within the 90 m cell were calculated to contain landslide-susceptible terrain. In the Site Vicinity, landslide-susceptible terrain increases from southeast to northwest. In general, the terrain formed by the Dan River basin is less susceptible to landslides than the Sauratown Mountains window.

LiDAR DEM data in the Site Area were reviewed for geomorphic features associated with landslides. Typically, landslides can be identified as semi-circular steep scarps, hummocky terrain, and thickened toe-slopes adjacent to areas of higher topographic relief on LiDAR data (Reference 2.5-125). LiDAR data were hill-shaded at multiple angles and examined at various scales. Potential features were compared to an underlying aerial photograph that was used to identify cultural features that caused any anomalous features, such as cut/fill features associated with houses/buildings. No landslides were identified within the Site Area using this method.

2.5.1.2.5.3 Volcanism

As discussed in Section 2.5.1.1.5, volcanic hazards can be screened out due to lack of evidence for Quaternary volcanism in the Site Region (200 mi. [320 km]).

2.5.1.2.6 Site Engineering Geology Evaluation

2.5.1.2.6.1 Engineering Soil Properties and Behavior of Foundation Materials

Engineering soil properties, including index properties, static and dynamic strength, and compressibility were investigated through a detailed geologic, hydrogeologic, and geophysical investigation and are discussed in Section 2.5.4.

2.5.1.2.6.2 Zones of Alteration, Weathering, and Structural Weakness

Section 2.5.4.2 presents a detailed description of the site investigation to identify zones of alteration, weathering, and structural weakness.

In general, the engineering geological stratigraphy at the Project site generally consists of overburden residual soils weathered in place from the parent rock, underlain by PWR and largely unweathered crystalline rock (fractured and sound rock). The intensity of weathering in the residual soils and PWR is highly variable. The upper portion of the rock is fractured to varying degrees and followed at depth by sound rock.

Analysis of core samples collected at the Project site indicates that the recovery and rock quality designation (RQD) values at the site ranged between 0 and 100. The data indicate that the upper portion of the crystalline rock layer is variably fractured as defined by rocks with RQD less than 50. Overall, the thickness varies between borings, with a minimum thickness of 0 ft. and a maximum thickness of 51.3 ft. (15.6 m). At the North Plant Complex, the mean thickness of the stratum identified as fractured rock (see Section 2.5.4.2.2.3) was 14.0 ft. (4.3 m). At the Middle Plant Complex, the mean thickness of the fractured rock stratum was 5.2 ft. (1.6 m). At the South Plant Complex, the mean thickness of the fractured rock stratum was 6.2 ft. (1.9 m).

2.5.1.2.6.3 Deformational Zones

Section 2.5.3.6 presents a detailed analysis of deformational zones within the Site Area. The analysis compares interpretations from the site-specific geotechnical investigation to interpretations from published geologic maps, aerial photography, and a lineament analysis. The borehole data document metamorphic fabrics, folding, and intrusive relationships that are characteristic of Paleozoic to Precambrian tectonism. No evidence of Quaternary or other recent deformation is observed in the core descriptions, geophysical logs, or stratigraphic profiles developed as part of the site investigations.

Fracture and foliation orientations from borehole logging exhibit generally consistent structural patterns across the Site Area. Most boreholes show a dominant northeast – southwest (N30 – 50°E) azimuth fracture orientation with a secondary northwest – southeast (N20 – 40°W) azimuth–orientation, broadly consistent with conjugate fracture sets observed in Piedmont metamorphic rocks. Open and filled fractures were seen in several on-site boreholes, clustering tightly within these primary and secondary fracture orientation modes, whereas others record more dispersed populations that retain a preferred northeast – southwest fracture trend. As

discussed in Section 2.4.12, more than 97 percent of fractures were calculated to be filled or closed based on acoustic televiewer (ATV) logs.

Cross-hole comparisons show that boreholes express one or both of the principal fracture orientations, indicating that the Site Area-scale fracture geometry can likely be attributed to the regional, Site Vicinity, and Region-scale structural grain of the Milton terrane and Charlotte belt. These borehole-scale results correspond directly to the lineament analysis presented in Section 2.5.3.5, which identify prominent lineament orientations centered at N30 – 40°E, N20 – 30°W, and N60 – 70°E. The agreement between borehole fracture orientations and regional lineament trends supports the interpretation that deformation at the Project site reflects inherited Paleozoic – Mesozoic tectonic fabrics, with no evidence of anomalous Quaternary structural trends or through-going fault zones at the Site Location.

In summary, while the Site Area is located within a tectonically complex Piedmont terrane that records multiple Paleozoic and Mesozoic deformation events, none of the mapped structures in the Site Area show evidence of Quaternary reactivation. These structures are not interpreted to be genetically related to the active tectonic sources that define seismicity in the broader CEUS. Subsurface investigations confirm that the Project site is underlain entirely by Cambrian biotite gneiss and schist, with borehole logging documenting consistent fracture and foliation orientations across multiple boreholes. The dominant northeast – southwest and secondary northwest – southeast fracture sets are broadly consistent with Piedmont fabrics and the regional structural grain, indicating that observed fracture geometry reflects inherited tectonic fabrics. The prevalence of mineral-filled fractures further supports the interpretation that these features are ancient and not the result of recent tectonic activity. No evidence of Quaternary-capable faults, anomalous structural orientations, or recent deformation features were identified in borehole core, geophysical logs, or geomorphic datasets. This conclusion aligns with the summary of regional structure ages presented in Section 2.5.1.1.2.

2.5.1.2.6.4 Prior Earthquake Effects

The most recent widely felt earthquake in the Site Region was the 2020 E[**M**] 5.1 Sparta, NC, earthquake. The USGS Did You Feel It? (DYFI) database compiles voluntary submissions of MMI data and aggregates it at the zip code level for events in the United States (Reference 2.5-126). The Project site is located within the Belews Creek (27009) zip code (Table 2.5-2). Based on the DYFI data for the Sparta event, the Belews Creek zip code experienced MMI III effects from the earthquake based on 14 responses. Nearby zip codes also had aggregate DYFI information: zip code 27357 (Stokesdale) MMI III (50 responses), and zip code 27052 (Walnut Cove) MMI IV (53 responses). MMI III to IV is classified as weak to light shaking (Reference 2.5-126). An MMI III is defined as felt indoors, but many do not recognize it as an earthquake. An MMI IV is defined as felt by many indoors and by few people outdoors. Dishes, windows and doors are disturbed (Reference 2.5-127).

The largest recent event in the Site Region was the 2011 E[**M**] 5.72 Mineral, Virginia, earthquake. The USGS DYFI database had an aggregate MMI V in the Belews Creek zip code, which is a moderate shaking intensity with the potential for very light damage – slightly higher than the MMI III from the 2020 Sparta earthquake. Both the Stokesdale and Walnut Cove zip codes were MMI IV based on responses from the Mineral, Virginia, event (Reference 2.5-128).

The Site Vicinity (25 mi. [40 km]) does not include evidence for liquefaction in the paleoseismology database regional data sets compiled for the CEUS SSC Project (Reference 2.5-117, Appendix E).

2.5.1.2.6.5 Effects of Human Activities

Searching public databases for information on oil and gas production, mining, groundwater use, underground fluid injection, and geothermal development yielded the following effects of human activities in the Site Area:

- There have been 129 petroleum exploration holes drilled in NC, with the most recent being drilling to investigate the total petroleum system of the Dan River basin (Reference 2.5-22). There is currently no oil/gas (petroleum) production from any well in NC (Reference 2.5-129; Reference 2.5-130).

- A detailed analysis of the location of mines and mine-like features is presented in Section 2.5.3.6.1.1. Eight mapped features are within the Site Area (5 mi. [8 km]). Six are classified as clay pits, and two are classified as quarries. No underground mining features are mapped in the Site Area. The closest feature is a quarry that is 2.9 mi. (4.6 km) to the northwest of the Project site across the Dan River.

- An evaluation of groundwater use is presented in Section 2.4.12.4.1. The evaluation concludes that groundwater withdrawals do not have an influence at the Project site, and the Project site does not influence nearby groundwater supplies.

- An evaluation of groundwater use at the BCSS is presented in Section 2.4.12.4.2. A series of 72 extraction and 64 clean water injection wells are used for a groundwater system setup as part of the corrective action plan for the ash basin closure. On average, the monthly groundwater system withdrawal rate is approximately 3.4 million gallons (13 million liters), and the average monthly infiltration system rate is approximately 3.3 million gallons (12 million liters). Extraction and infiltration wells are screened in residuum and bedrock.

No commercial geothermal energy plants are located within the Site Area. There are two domestic injection water only geothermal source heat pump sources:

  - 332 Leeward Drive, Stokesdale, NC (Reference 2.5-131).

  - 6375 Carter Farm Road, Belews Creek, NC (Reference 2.5-131).

2.5.2 VIBRATORY GROUND MOTION

This section describes the vibratory ground motion assessments conducted for the Project site.

The NRC considers the CEUS SSC model (Reference 2.5-60), published as NUREG-2115, as an acceptable starting point for seismic analyses at sites in the CEUS. NRC staff evaluated the companion ground motion model (GMM), known as the Next Generation Attenuation (NGA)-East model (Reference 2.5-135), and agree that it provides an appropriate characterization of median ground motion for use in seismic hazard analyses for Central Eastern North America (CENA) sites. Both CEUS SSC and NGA-East models resulted from projects conducted as

Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 studies, ensuring a high level of regulatory compliance. RG 1.208 specifies that the adequacy of the inputs into a seismic hazard analysis must be evaluated considering any new data and interpretations. Following the recommendations in NUREG-2213, a SSHAC Level 2 study is appropriate for the revision (i.e., the modification of one or more components) of models obtained in SSHAC Level 3 studies, such as the CEUS SSC and NGA-East models. A Level 2 study is also appropriate for the application of a regional model to site-specific conditions and is consistent with recommendations in Rodriguez-Marek et al. (Reference 2.5-136) for site response analysis (SRA).

Duke Energy sponsored a SSHAC Level 2 Probabilistic Seismic Hazard Analysis (PSHA) and SRA study for the Project site. The SSHAC Level 2 report forms the basis of the documentation provided in this section of the Site Safety Analysis Report (SSAR). An overview of the study is provided below.

The goal of the SSHAC Level 2 study was to quantify the site-specific vibratory ground motion hazard for the Project site. The study comprised (1) an evaluation and update of the CEUS SSC and NGA-East models to obtain reference rock seismic hazard results; (2) an evaluation of site data and SRA; and (3) calculation of site-specific seismic hazard results. Figure 2.5-28 shows the workflow of the SSHAC Level 2 study. The evaluation and update of the CEUS SSC and NGA-East models are captured on the left side of the diagram (PSHA path, in red). This phase of work occurred while geotechnical and geophysical data were being collected at the site. As the data became available, the SRA part of the study began (SRA path, in blue, on the right side of the diagram). The two paths joined in the site-specific seismic hazard analysis are shown at the bottom of the diagram. As required by SSHAC, the PSHA and SRA parts of the study included (1) an evaluation phase and an integration phase; (2) the generation of databases collecting data, models, and methods; (3) interviews with resource and proponent experts; (4) documentation of analyses and activities. Duke Energy established a participatory peer review panel (PPRP) that was involved for the duration of the study. The PPRP reviewed the SSHAC Level 2 work plan, actively participated in three meetings with the Technical Integration (TI) Team, observed interactions between the TI Team and the resource and proponent experts, and reviewed the draft and final reports.

In the PSHA part of the SSHAC Level 2 study, the TI Team had to determine whether new data, models, and methods post-dating the publication of the CEUS SSC and NGA-East models warranted an update. NUREG-2213 identifies six decision factors to determine whether a model developed as a SSHAC Level 3 study needs to be updated and, if so, what type of update is required. The six factors are:

1. Changes in data, models, or methods
2. Changes in inputs to the hazard analysis
3. Changes in mean hazard results
4. Changes in technical bases
5. Comparisons of calculated mean hazard with current design bases
6. Comparison of risk or performance to target goals

The degree to which new data, models, and methods lead to changes in the input to the hazard analysis and to the hazard results are used to determine whether the study can be used, or whether it needs to be revised, replaced, refined, or corrected. NUREG-2213 defines these terms as follows:

- To “revise” a model means to modify part of it by incorporating new information that only affects that portion of the model.
- To “replace” means to completely abandon a model and develop a new one.
- To “refine” the model means to adapt a regional study to a site by adding information specific to that site.
- To “correct” a model means to rectify the documentation to fix non-technical errors.

As discussed in Section 6.2 of NUREG-2117, the decision to update (or not) a model resulting from a SSHAC Level 3 study is determined by first conducting a careful evaluation of the data, models, and methods that were available at the time the study was conducted. Second, the new data, models, and methods published since the study was completed are evaluated to determine their hazard significance. The criteria for deciding whether an update is necessary involve (1) establishing whether new data, models, and methods would change the center, body, and range (CBR) of technically defensible interpretations (TDIs) and (2) quantifying the changes in seismic hazard results and their importance.

Section 9.4.3 of NUREG-2115 (Reference 2.5-60) provides quantitative criteria to determine whether changes in model parameters are hazard significant. The criteria (provided below) are based on an assessment of the precision of hazard analyses from previous studies to determine minimum estimates of hazard uncertainty.

- Changes of more than 25 percent (absolute value) in mean annual frequency of exceedance (AFE) at the ground motion level corresponding to AFE 1E-4 are significant.
- Changes of more than 35 percent (absolute value) in mean annual frequency of exceedance at the ground motion level corresponding to AFE 1E-6 are significant.

NUREG-2117 also notes that the most important assessment is the confidence that the model captures the CBR of the TDIs, regardless of the effect on the hazard estimates (i.e., even if the change in hazard estimates is small).

The TI Team considered the guidance in NUREG-2117, NUREG-2213, and NUREG-2115 in evaluating the need to update CEUS SSC and NGA-East models based on the availability of data, models, and methods published after the completion of the two studies to determine whether updates were necessary.

The process began with a review of the CEUS SSC and NGA-East documentation to understand what information (data, models, and methods) was available at the time the models were developed and the reasons for modeling choices. As part of the SSHAC Level 2 evaluation phase, the TI Team contacted members of the CEUS SSC and NGA-East teams as resource experts and identified hazard-significant model components during a set of preliminary calculations. The TI Team then explored the key hazard issues by collecting and evaluating new data, models, and methods that became available since the publication of CEUS SSC and

NGA-East. The TI Team identified and contacted resource and proponent experts to clarify the applicability and limitations of new data, models, and methods.

These activities allowed the TI Team to assess the new information against the criteria discussed in the three NUREGs listed above. First, the TI Team considered if the new information determines changes to the CBR of the TDI. To assess new information against this criterion, the TI Team considered all the information (data, models, and methods) available at the time the CEUS SSC and NGA-East models were developed and information that became available after the publication of the models. Considering all the information and using the same criteria that were adopted to develop the CEUS SSC and NGA-East models, the TI Team evaluated whether the data would support different modeling choices that were not considered possible at the time the models were developed.

The TI Team also evaluated the significance of the differences in hazard estimates. If new data, models, and methods determined differences in AFE above the thresholds documented in Chapter 9.3.4 of Reference 2.5-60 listed above, then a refinement is warranted, and the model requires updating for application at the Project site. To use the criteria in Chapter 9 of Reference 2.5-60, the first step is to compute the mean hazard with the model as is. The TI Team was provided with a set of hazard calculations conducted with the CEUS SSC model and NGA-East model. The mean hazard curves were interpolated to obtain the ground motion levels corresponding to AFEs of 1E-4 and 1E-6 (in the following: GM_{1e-4} and GM_{1e-6}). The TI Team then conducted a new set of seismic hazard calculations, changing a model or parameter, and the resulting mean hazard curves were interpolated to find the AFE corresponding to GM_{1e-4} and GM_{1e-6}. Percent differences in AFE between the original model and the updated model were computed and compared to the criteria in Chapter 9 of Reference 2.5-60.

If the changes do not change the hazard results at the Project site and do not modify the CBR of the TDI, they are not implemented but are fully documented in this report.

The TI Team assessments and analyses conducted for the SSHAC Level 2 PSHA and SRA study are used to discuss the following aspects of vibratory ground motion, consistent with NUREG-0800:

- Seismicity (Section 2.5.2.1).
- Geologic and tectonic characteristics of the Site Region (Section 2.5.2.2).
- Correlation of earthquake activity with seismic sources (Section 2.5.2.3).
- PSHA and controlling earthquakes (Section 2.5.2.4).
- Seismic wave transmission characteristics of the site (Section 2.5.2.5).
- Ground motion response spectra (Section 2.5.2.6).

2.5.2.1 Seismicity

The assessment of earthquake recurrence for distributed seismicity zones (area zones) in CEUS relies on a catalog of observed earthquakes. The CEUS SSC project (i.e., NUREG-2115) followed a rigorous SSHAC Level 3 process to compile the earthquake catalog, which was

extensively reviewed. To date, no other compilations of CEUS earthquakes developed for seismic hazard analyses can provide the same level of regulatory assurance. The catalog terminates at the end of 2008; therefore, for the SSHAC Level 2 study, the TI Team assessed if regional earthquake patterns and seismicity parameters required updating. The following sections describe the CEUS SSC earthquake catalog and the update conducted for the SSHAC Level 2 study, provide information on significant earthquakes in the Site Region (200 mi. [320 km]), and discuss human-induced earthquakes.

2.5.2.1.1 CEUS SSC Earthquake Catalog

The CEUS SSC catalog contains records of earthquakes from the earliest available (AD 1534) to the end of 2008 (December 31, 2008) located within the portion of eastern North America that extends from the foothills of the Rocky Mountains at longitude 105°W, to a region of at least 200 mi. (320 km) from the U.S. – Canada border in the north and from the coastline in the south and east.

Earthquake records were collected from publicly available continental-scale catalogs, such as the USGS earthquake catalog or the earthquake catalog from the Geologic Survey of Canada; regional catalogs, such as those developed by local agencies like the southeastern U.S. Seismic Network; and published studies of specific earthquakes in limited geographic areas. The combined records were carefully reviewed to remove duplicate entries, false entries, and nontectonic events. A uniform process was adopted to convert all available magnitudes to the expected moment magnitude (E[**M**]), which considers the uncertainty associated with the magnitude conversion process, as well as statistical errors in magnitude estimation. Equations 3.3.1-9 and 3.3.1-10 of NUREG-2115, reproduced below as Equations 2.5.2-1 and 2.5.2-2 are used to compute E[**M**] and its associated aleatory variability.

$$\mathrm{E}\left[\mathbf{M} \mid \hat{\mathbf{X}}\right] = \left\{ \sum_i \frac{\sigma^2\left[\mathbf{M} \mid \hat{\mathbf{X}}\right]}{\sigma^2\left[\mathbf{M} \mid \hat{X}_i\right]} \cdot E\left[\mathbf{M} \mid \hat{X}_i\right] \right\} + (R-1)\beta\sigma^2\left[\mathbf{M} \mid \hat{\mathbf{X}}\right] \qquad \text{(Equation 2.5.2-1)}$$

$$\sigma^2\left[\mathbf{M} \mid \hat{\mathbf{X}}\right] = \left\{ \sum_i \frac{1}{\sigma^2\left[\mathbf{M} \mid \hat{X}_i\right]} \right\}^{-1} \qquad \text{(Equation 2.5.2-2)}$$

Where:

- $\hat{\mathbf{X}}$ is a vector of observed size measures $\hat{X}_i$
- *R* is the number of observed independent size measures
- *β* is the slope of the magnitude-frequency distribution in natural-log units (*β*=*b*ln(10))
- $\sigma\left[\boldsymbol{M} \mid \hat{X}_i\right]$ is the standard deviation of the statistical uncertainty in the estimate of E[**M**] given the observed size measurement $\hat{X}_i$

For records that have moment magnitudes computed directly from the seismic moment, the expected value of the true moment magnitude obtained from the observed moment magnitude ($E[\boldsymbol{M}|\widehat{\boldsymbol{M}}]$) given its uncertainty $\sigma[\mathbf{M}|\hat{\mathbf{M}}]$ is calculated using Equation 2.5.2-3, which is based on Equation 3.3.1-5 of NUREG-2115.

$$E[\boldsymbol{M}|\widehat{\boldsymbol{M}}] = \widehat{\boldsymbol{M}} - \beta\sigma^2[\boldsymbol{M}|\widehat{\boldsymbol{M}}] \quad \text{(Equation 2.5.2-3)}$$

NUREG-2115 developed a methodology to obtain unbiased earthquake parameters, referred to as the N* approach. The methodology adjusts earthquake counts to account for the uncertainty in the magnitude estimate. By performing statistical tests, EPRI, DOE, and NRC (Reference 2.5-60) showed that the N* approach performs better than the approach previously adopted (e.g., Reference 2.5-137), when the catalog has varying levels of completeness, as is the case for the CEUS SSC catalog. The N* parameter, i.e., the adjusted earthquake count is computed using Equation 3.3.1-12 from NUREG-2115, reproduced below as Equation 2.5.2-4.

$$N^* = exp\{\beta^2\sigma^2[|\boldsymbol{M}|\widehat{\boldsymbol{M}}]/2\}$$
or
$$N^* = exp\{\beta^2\sigma^2[|\boldsymbol{M}|X]/2\} \quad \text{(Equation 2.5.2-4)}$$

Where:

- $\hat{\mathbf{M}}$ is the observed moment magnitude calculated from seismic moment
- X represents a vector of moment magnitudes resulting from conversion of other magnitude types.

2.5.2.1.2 Earthquake Catalog Update

RG 1.208 specifies that the geological and seismological investigations should be conducted within a radius of 200 mi. (320 km) from the site, and NUREG-0800 states that the site PSHA should consider including more distant sources that have a potential for earthquakes large enough to affect the total site hazard. The SSHAC Level 2 study extended the region for updating the earthquake catalog beyond 400 mi. (640 km) of the site center point for two reasons: (1) to capture the concentration of seismicity in the ETSZ; and (2) to account for the low rate of ground motion in the CENA, which causes earthquakes to be felt over wide areas. Earthquake records with reported magnitudes as low as 2.0 were included in the catalog update for consistency with the CEUS SSC. This magnitude threshold is lower than the minimum magnitude of 3.0 or an MMI greater than or equal to IV prescribed in NUREG-0800.

The TI Team followed the methodology outlined in Reference 2.5-60 to update the CEUS SSC catalog in the Site Region. Earthquake records were obtained from the following sources:

- Advanced National Seismic System Comprehensive Earthquake Catalog (ANSS)
- National Earthquake Database of Canada (NEDB)

- Global Centroid Moment Tensor catalog
- Catalog of Moment Tensors for Parts of North America
- New Madrid Earthquake Catalog (Center for Earthquake Research and Information)
- New England Seismic Network
- Ohio Seismic Network
- Pennsylvania State Seismic Network
- South Carolina Seismic Network
- Daniels and Peng (2023) (Reference 2.5-138), catalog of seismicity in the ETSZ.

Duplicate entries (i.e., records of the same earthquake reported by different agencies) are introduced when records from multiple agencies are combined. In these cases, only one record is selected to represent the time and location of the event, while preserving all possible magnitude estimates that are not identical. This approach is consistent with the processing of the CEUS SSC catalog, in which the national catalogs (ANSS and NEDB) are preferred over regional catalogs, and ANSS records are preferred for earthquakes located south of the U.S.-Canada border, while NEDB records are preferred for those earthquakes that occur north of the border.

Table 2.5-3 shows the types of magnitudes present in the earthquake catalog update, the number of occurrences for each, and the magnitude range. The table also shows the equations used to convert these magnitudes, which are obtained from Table 3.3-1 of NUREG-2115 (Reference 2.5-60). The magnitudes for all earthquake records are converted to E[**M**] using Equations 2.5.2-1 to 2.5.2-3 and have a value of N* calculated with Equation 2.5.2-4.

The catalog in E[**M**] is declustered using the process adopted in NUREG-2115. Two versions of the catalog are obtained: one in which only natural (tectonic) events are included (no human-induced or nontectonic events); the other in which natural (tectonic) events and human-induced events are included. Table 2.5-4 lists the mainshocks with E[**M**] ≥ 2.9 reported to have occurred through April 30, 2024, in the region extending to 400 mi. (640 km) of the Project site. Only earthquakes of tectonic origin are included in Table 2.5-4. Table 2.5-5 contains events with E[**M**] ≥ 2.9 identified as potentially human-induced, reported to have occurred through April 30, 2024, in the region extending to 400 mi. (640 km) of the Project site. Section 2.5.2.1.4 describes the identification of human-induced and nontectonic events.

2.5.2.1.3 Significant Earthquakes in the Site Region (200 Mi. [320 Km] Radius)

Most of the seismicity occurring in the Site Region is located along the Appalachian Mountains to the west of the site, and in the CVSZ to the northeast of the site (Figure 2.5-29). As Figure 2.5-30 shows, only four small-magnitude earthquakes are reported to have occurred within 50 mi. (80 km) of the Project site. The closest of these earthquakes occurred on September 25, 1886, at 2:00 a.m. local time and shows an E[**M**] 2.98 computed from felt area. The figure does not include earthquakes identified as nontectonic or human-induced.

Eight earthquakes with E[**M**] ≥ 5.0 are reported within 200 mi. (320 km) of the Project site. The events are described below, from the largest to the smallest.

May 31, 1897, E[**M**] 5.91, Giles County, Virginia. Widespread damage was reported and felt over an area extending from Georgia to Pennsylvania and from the Atlantic coast to Indiana and Kentucky. In the town of Narrows, Virginia, which is approximately 80.7 mi. (130 km) to the north – northwest of the Project site, surface deformation, mudding of waters, and changes in the flow of springs were observed (Reference 2.5-139).

August 23, 2011, E[**M**] 5.72, Mineral, Virginia. The earthquake occurred on a shallow, northeast-striking reverse fault, within the CVSZ (Reference 2.5-140). It was felt from central Georgia to southeast Canada and as far west as Chicago, Illinois (Reference 2.5-140). The strong motion acceleration system at the North Anna Nuclear Power Plant, located approximately 14 mi. (23 km) northeast of the epicenter (Reference 2.5-141), was triggered and registered a peak acceleration of 0.26 g, peak velocity of 13.8 centimeters per second and cumulative absolute velocity of 0.17 g-sec., with duration of the strongest shaking of about 2 to 3 sec. on the north – south horizontal component (Reference 2.5-142).

August 31, 1861, E[**M**] 5.63, near Wilkesboro, Wilkes County, NC. Caused damage to the epicentral area, described as bricks shaken from chimneys, doors jammed open, and stopped clocks (Reference 2.5-139). The earthquake was felt along the Atlantic coast from Washington, D.C., to Charleston, South Carolina, and westward to Tennessee and Kentucky (Reference 2.5-139).

April 29, 1852, E[**M**] 5.21, near Wytheville, Wythe County, Virginia. This severe earthquake affected a large area in southwest Virginia. Damage in the epicentral area included collapsed chimney tops and fallen bricks. The earthquake was felt as far as the District of Columbia, Maryland, New York, Ohio, and Pennsylvania (Reference 2.5-139).

May 2, 1853, E[**M**] 5.16. The earthquake occurred on the border between Virginia and West Virginia. The only available information on this earthquake is a reported MMI of V and felt area of 61,390 mi^2 (159,000 km^2) as reported in Stover and Coffman (Reference 2.5-139).

August 9, 2020, E[**M**] 5.15, Sparta, NC. This earthquake occurred in the Blue Ridge province, which is characterized by prevailing northeast-southwest–trending structures, and west-northwest or east-west lineaments that cross the prevailing structural fabric (Reference 2.5-143). Figueiredo et al. (2022) (Reference 2.5-83) report observing features associated with the co-seismic rupture to the south and southeast of Sparta, stretching for approximately 1.2 mi. (2 km). They observed straight, ~N110° (west-northwest) trending ground ruptures extending ten to hundreds of meters and a co-seismic topographic step associated with a reverse scarp, 8 to 10 cm (3.1 to 3.9 in.) (maximum 9.8 in. [~25 cm]) high. Relocated aftershocks suggest possibly a complex event, with a primary rupture along the southwest-dipping Little River reverse fault that co-seismically ruptured to the surface (Reference 2.5-143). The second structure is interpreted as a sub-vertical fault with left-lateral strike-slip kinematics that had a blind rupture during the mainshock.

The earthquake was felt along the Atlantic coast and westward into Tennessee and Kentucky. In the epicentral area, roads, utility lines, and masonry structures were damaged, including the collapse of walls and chimneys and the cracking and shifting of foundations (Reference 2.5-83).

February 21, 1916, E[**M**] 5.13, near Waynesville, Haywood County, NC. This event was felt over a wide area of the Atlantic coast and westward to Tennessee and Kentucky. Bricks were shaken from chimneys in the epicentral area and as far as 43.5 mi. (70 km) in the northwest direction (Sevierville, Tennessee), according to Stover and Coffman (Reference 2.5-139). Minor damage was also reported in western Tennessee and Virginia. Changes to spring water quality and flow were reported in Wear Cove, Tennessee.

March 10, 1828, E[**M**] 5.08, south of Roanoke, Virginia. This earthquake occurred approximately 43.5 mi. (70 km) south of Roanoke, Virginia. The earthquake has a reported MMI of V and felt area of 189,190 mi^2 (490,000 km^2) according to Stover and Coffman (Reference 2.5-139). No additional information is available about this earthquake.

Consistent with NUREG-0800 requirements, large-magnitude earthquakes that occurred outside the Site Region (i.e., at distances of more than 200 mi. [320 km]) are discussed below. These earthquakes are the New Madrid, Missouri, earthquake sequence of 1811–1812 (approximately 497 mi. [800 km] west of the site) and the Charleston, South Carolina, earthquake of 1886 (approximately 224 mi. [360 km] southeast of the site).

December 16, 1811, E[**M**] 7.17, January 23, 1812, E[**M**] 7.50, and February 7, 1812, E[**M**] 7.80, New Madrid, Missouri. The three earthquakes in the 1811–1812 sequence are the largest earthquakes to have occurred in historical time in the CEUS (Reference 2.5-60). The earthquakes caused extensive ground deformation, including cratering thousands of acres of farmland and covering the surface with ejected sand, subsidence, uplift, and landslides, and opening fissures. Hundreds of thousands of acres of timber were destroyed, and more than 90 percent of the boats near New Madrid were sunk by a river tsunami (Reference 2.5-144). The damage area covered 231,661 mi^2 (600,000 km^2), and the felt area was more than 1,930,510 mi^2 (5,000,000 km^2) (Reference 2.5-139).

September 1, 1886, E[**M**] 6.9, Charleston, South Carolina. The earthquake is one of the most damaging earthquakes to occur in the southeastern United States, causing an estimated $5-6 million in property damage (Reference 2.5-139). Stover and Coffman (Reference 2.5-139) assign an MMI of X and list a felt area of more than 772,000 mi^2 (2,000,000 km^2) based on observations that structural damage was experienced in locations as far as central Ohio, central Alabama, eastern Kentucky, southern Virginia, and western West Virginia, with long period effects reported at locations more than 621 mi. (1000 km) away from the epicentral area. Surface deformation included damaged train tracks, fissures as wide as 3.3 ft. (1 m), cracks, and sand blows. The effects of the earthquake were documented by photographs; among the most famous are those depicting displacements of railroad tracks of the South Carolina Railroad. The aftershock sequence continued through 1889 (Reference 2.5-145), delineating a large aftershock zone extending about 155 mi. (250 km) toward Appalachia.

2.5.2.1.4 Seismicity Associated with Human Activities

The CEUS SSC project identified and removed non-tectonic events from the earthquake catalog. Non-tectonic events include mining and quarrying related blasts, explosions, and rock bursts; reservoir-induced seismicity; chemical explosions; and sonic booms. At the time the CEUS SSC catalog was compiled, earthquakes associated with enhanced oil and gas recovery operations were known to occur; however, the catalog end date (December 31, 2008) precedes the significant seismicity rate increase in the CEUS that began in 2009 with the expansion of recovery operations.

The region covered by the SSHAC Level 2 catalog update includes areas of active surface and underground mining, particularly in West Virginia, Maryland, and Pennsylvania, and areas of active stimulation of hydrocarbon plays, particularly in eastern Ohio and into central West Virginia. Three types of earthquake records are present in the SSHAC Level 2 catalog update: (1) tectonic (natural) earthquakes, including mainshocks and aftershocks; (2) non-tectonic events, such as mine and quarry blasts; and (3) human-induced events, e.g., those associated with hydrocarbon extraction activities.

In the northern Appalachian basin, hydraulic fracturing began in 2009 with targets in the Marcellus Shale. Beginning in 2011, the stratigraphically lower Utica formation was also targeted. A significant increase in seismicity was linked to wastewater disposal and hydraulic fracturing (Reference 2.5-146. Studies conducted by Schultz et al. (Reference 2.5-147) and Brudzinski and Kozlowska (Reference 2.5-146) show that induced seismicity clusters in Appalachia illuminate a set of pre-existing, critically stressed faults that are optimally oriented in the regional stress field.

Figure 2.5-31 is a map of the Appalachian basin showing the depth interval between the stimulated formation and the crystalline basement. Stars indicate known induced seismic sequences. According to Skoumal et al. (Reference 2.5-148), most of the confirmed induced seismic events occurred when the distance between the target shale and the basement is less than 0.6 mi. (1 km). However, it is not the distance itself that controls the occurrence of induced seismicity, rather it is the proximity to favorably oriented, critically stressed, pre-existing faults. In the Appalachian basin, the Precambrian basement satisfies this condition. A possible explanation for the relatively higher frequency of induced earthquakes in Ohio compared to Pennsylvania or West Virginia is the deepening of the Precambrian basement toward the east, such that wells in Pennsylvania and West Virginia target the shallower Marcellus formation instead of the deeper Utica formation. As captured in Figure 2.5-31, evaporites of the Salina Group underlay the Marcellus Shale and could be a barrier to fluid migration toward pre-existing basement faults, thus impeding the transmission of elevated pore-fluid pressures and stress transmission to the faults (Reference 2.5-148).

2.5.2.1.4.1 Induced Seismicity Clusters

This section describes confirmed induced seismicity clusters in Ohio and West Virginia that have occurred since the early 2010s. The clusters are described in chronological order.

A cluster of eight, small-magnitude earthquakes occurred within a few kilometers of an active wastewater injection well in Braxton County, West Virginia, between April and July 2010. The largest earthquake recorded had a magnitude of 3.4. After this cluster, the rate of injection was reduced, until a magnitude 2.8 earthquake occurred in 2012, prompting a reduction in the volume of injection. In 2013, a second magnitude 3.4 earthquake was observed, and the well was shut-in. In total, fifty-four earthquakes were detected between 2010 and 2013; these earthquakes appear to be aligned in a northeast to southwest direction, consistent with the focal mechanism of the largest event (Reference 2.5-148). During the same period, a sequence of small-magnitude earthquakes classified as “probably induced” occurred within 6.2 mi. (10 km) of active wastewater injection wells in Washington County, Ohio (Reference 2.5-149; Reference 2.5-150). The rise in seismicity appears to correlate with increased activity in the Long Run-1 well, located about 3.1 mi. (5 km) from the earthquake epicenters.

In 2011–2012, fluid injection into a deep well near Youngstown, Ohio, produced an earthquake sequence of 109 small events, the largest of which (M_W 3.9) occurred on December 31, 2011 (Reference 2.5-151). The seismicity aligned on an east-northeast to west-southwest trend, consistent with the focal mechanism of the main shock, and helped to identify a subsurface fault close to the injection point (Reference 2.5-151). According to Morris et al. (Reference 2.5-152), the volume of wastewater injection into the Northstar 1 well, combined with the original stress state and a highly anisotropic permeability structure, can reactivate basement structures.

Between July and August 2013, a cluster of 161 small-magnitude earthquakes (up to magnitude 2.7) were reported in Gilmer County, West Virginia. According to Skoumal et al. (Reference 2.5-148), the seismic activity began soon after hydraulic fracturing started and ended soon after the completion of the horizontal wells.

Harrison County, Ohio, experienced a sequence of small-magnitude earthquakes in October 2013. Earthquake epicenters relocated by Friberg et al. (Reference 2.5-153) show a vertical east-west–trending fault in the Precambrian basement directly beneath the Ryser-2, Ryser-3, and Ryser-4 horizontal wells. Using spatial and temporal correlation of the seismicity with the operations in the Ryser wells and the similarity of waveforms of all recorded earthquakes, Friberg et al. (Reference 2.5-153) conclude that the seismic activity was induced by hydraulic fracturing in the Ryser wells.

In 2014, Poland Township, Ohio, experienced 77 small-magnitude earthquakes (M_L up to 3), closely related spatially and temporarily to active hydraulic fracturing operations (Reference 2.5-154). The focal mechanism of the main event and the depth of the seismicity (approximately 1.9 mi. [3 km]) are consistent with the Youngstown, Ohio, sequence.

A sequence of small-magnitude earthquakes was reported in May 2014 near the Kirkwood well pad, near the border of Belmont and Guernsey counties, Ohio (Reference 2.5-146). The sequence was followed in August 2016 by a M_L 2.3 earthquake a few kilometers to the southeast.

In August 2014, a M_L 2.1 event was located within 0.6 mi. (1 km) of two wells in Trumbull County, Ohio. The wells were injecting water into Silurian strata (shallower well) and into sediments approximately 49 ft. (15 m) above the Precambrian basement (deeper well). Earthquake clusters formed an east-northeast to west – southwest trend and north – northeast to south – southwest trend, and the focal mechanism of the largest events (M_L 2.1) indicated a strike-slip mechanism with a north–south fault plane (Reference 2.5-146). Once the injection was halted in both wells, the seismicity stopped. Brudzinski and Kozlowska (Reference 2.5-146) note that the seismicity did not resume after the shallower well returned to operations, indicating a correlation of the earthquakes to the deep well injection.

Between May 2013 and July 2015, 23 earthquakes occurred within 1.9 mi. (3 km) of the Long Run-1 well in Washington County, Ohio. Currie et al. (Reference 2.5-150) identified an additional 319 similar events with magnitudes up to M_L 2.1 and correlated the rate of seismicity with the rate of injection. The seismicity clusters align in the northeast-to-southwest direction, consistent with the trend of low-amplitude folds in Paleozoic rocks overlying the area being stimulated. These folds are interpreted to be generated by basement-involved fault systems that might have provided a path for fluid pressure increases. The earthquakes occurred at depths between 1.9 and 2.7 mi. (3.1 and 4.3 km) in the Cambrian sedimentary strata and in the underlying Precambrian crystalline basement.

Between December 2016 and spring 2017, several small-magnitude earthquakes were reported in Monroe County, Ohio, associated with hydraulic fracturing on the Donato well pad and the nearby Gary Green and Jacobs well pads (Reference 2.5-146).

In June 2017, Noble County, Ohio, experienced two earthquakes, the largest with M_L 2.4, directly below an active horizontal well, followed a few weeks later by a M_L 3.7 earthquake (Reference 2.5-146). The focal mechanism of this earthquake shows an east-west–trending fault plane.

2.5.2.1.4.2 Identification of Human-Induced and Non-Tectonic Events in the Updated Catalog

The TI Team identified non-tectonic events (e.g., explosions, acoustic noise, anthropogenic events, collapses, chemical explosions, rock bursts, induced earthquakes, avalanches, landslides, mine blasts, sonic booms, cryoseisms) from publicly available catalogs and publications, satellite imagery, and databases of active mining operations in various states.

Similarly, the TI Team used maps in published literature and imagery to locate the wells. Earthquakes reported within 1.2 to 1.9 mi. (2 to 3 km) of known hydraulic fracturing or wastewater disposal wells, or that occurred in areas of previously identified induced seismicity clusters and have focal depths consistent with depth of induction, were flagged as probably human-induced.

Figure 2.5-32 compares the focal depth distribution of groups of events identified in the catalog update: tectonic (natural) earthquakes (mainshocks and aftershocks); human-induced earthquakes (i.e., those associated with oil and gas extraction activities); and non-tectonic events (e.g., mine and quarry blasts). Focal depths are used as they appear in the source catalogs, disregarding the quality of the solution. Human-induced earthquakes (red) are concentrated within the top 3.7 mi. (6 km), particularly between 0 and 0.6 mi. (0 and 1 km) and between 2.5 and 3.1 mi. (4 and 5 km). The distribution is truncated at 3.7 mi. (6 km) by choice, following the work of various authors (Reference 2.5-150; Reference 2.5-148) and the approximate depth of the Precambrian basement. Non-tectonic events (black) occur predominantly at very shallow depths (0 to 0.6 mi. [0 to 1 km]), consistent with predominant mining and quarry blasts. Tectonic earthquakes range in depth from very shallow (0 to 0.6 mi. [0 to 1 km]) to deep (24.8 mi. [40 km]). Two peaks, 0 to 0.6 mi. (0 to 1 km) and 2.5 to 3.1 mi. (4 to 5 km), suggest that some human-induced earthquakes may remain in the catalog, and that for many earthquakes, the depth is poorly determined and fixed at 3.1 mi. (5 km).

To evaluate the contamination of the catalog with mining/quarry blasts, the TI Team plotted the time of day when the events are recorded. Figure 2.5-33 compares the local time at which various types of events have occurred: time is converted from Universal Standard Time to Eastern Standard Time or Eastern Daylight Time, depending on the month of the year, and is presented in one-hour intervals. Non-tectonic events occur during daylight hours from about 6:00 a.m. to 6:00 p.m. with maximum frequency in the central part of the working day. Human-induced earthquakes have a similar pattern, while tectonic events are almost evenly distributed between daytime and nighttime. The TI Team noted that the distribution of earthquake occurrence in time (hour of day) seems to indicate that there might still be some contamination of non-tectonic events in the catalog, but tests described in Section 2.5.2.2.2.1 show that the potential contamination does not affect the analysis.

2.5.2.2 Geologic and Tectonic Characteristics of the Site and Region

The CEUS SSC model is the most recent regional SSC model available for the CEUS and is an acceptable starting point for PSHA analyses of sites in the region. Section 2.5.2.2.1 summarizes the CEUS SSC model, describing the logic and salient characteristics of the seismic sources that are used to compute seismic hazard at the Project site. The process of evaluating new information is described in Section 2.5.2.2.2.

Section 2.5.2.2.2 describes new information regarding seismic source zones and seismic fault sources, respectively, and the TI Team evaluation of their effect on seismic hazard. Section 2.5.2.4. summarizes the adopted SSC model for the seismic hazard evaluation of the Project site, informed by the evaluations described in the preceding sections.

2.5.2.2.1 Summary of CEUS SSC Model

The CEUS SSC model covers the portion of central and eastern North America that extends from the foothills of the Rocky Mountains (set at longitude 105°W) in the west, to at least 200 mi. (320 km) from the U.S.-Canada border in the north and from the coastline in the east and south.

The CEUS SSC model includes two types of seismic sources: (1) repeated large-magnitude earthquake (RLME) sources, and (2) distributed seismicity sources, or what are called “background” source zones in Chapter 4 of Reference 2.5-60. RLME sources are used to represent the location of repeated (more than one), large (magnitude **M** ≥ 6.5) earthquakes as inferred from the historical and paleoseismic record (Reference 2.5-60). As discussed in Chapter 1 of Reference 2.5-60, the threshold magnitude **M** 6.5 was chosen because it is usually possible to identify the effects of such earthquakes in the paleoseismological record. Distributed seismicity sources identify regions of diffuse seismicity within which the RLME sources are located.

The CEUS SSC model uses logic trees to represent alternative approaches and conceptual models, and their relative weights. Logic trees are evaluated from left to right, with the left-most nodes (first-order level of the tree) addressing basic conceptual models, followed by subsequent levels that represent the uncertainties in the implementation of each approach. Discrete alternative models or parameters for each level (or node) of the logic tree, are represented by branches and are assigned weights representing their relative credibility.

Figure 2.5-34 shows the CEUS SSC master logic tree: the first (left-most) node is the choice between the models used to define the spatial and temporal distribution of future seismicity in the background sources, respectively Mmax (maximum magnitude) zones and seismotectonic zones. Mmax zones are based on differences in the prior distributions used for assessing maximum magnitude using the Bayesian approach, while seismotectonic zones are delineated using differences in the expected characteristics of future earthquakes beyond Mmax, such as differences in rupture orientation, style of faulting, and focal depth.

RLME sources are tectonic features identified based on clear evidence for Late Quaternary or Holocene RLMEs. RLME sources have (1) the potential to localize future large magnitude (**M** ≥ 6.5) earthquakes; and (2) evidence of recurrence of such earthquakes that differs from that of their host background zone. For these reasons, RLME sources are always included in the model, regardless of how background (diffused) seismicity is represented.

Seismic hazard calculations require recurrence rates of earthquakes associated with each seismic source and the Mmax that each source can produce. A truncated exponential magnitude distribution, defined by rates of earthquakes above a minimum magnitude (known as a-values) and the slope of the magnitude-frequency distribution (known as b-values), is used to model the frequency of earthquakes occurring within the distributed seismicity zones. To capture spatial variations of a- and b-values within source zones, the CEUS SSC project used a smoothing technique known as the penalized-likelihood approach. In applying this technique, the background sources are subdivided in cells along parallels and meridians of either ¼° x ¼° spacing or ½° x ½° spacing for larger zones. Epistemic uncertainty in a- and b-values is modeled by three alternative sets of weighted magnitude intervals, called cases A, B, and E, and eight alternative sets of parameters for each source zone.

Mmax, i.e., the upper truncation of the earthquake recurrence relationship, and its uncertainty were assessed using a combination of two statistical techniques: a Bayesian methodology that employs prior distributions obtained from a database of earthquake magnitudes in stable continental regions; and a mathematical procedure, known as the Kijko method, that uses observed seismicity data and is best applied with large datasets. The application of these methodologies resulted in broad distributions, ultimately represented by five-point discrete approximations for use in hazard calculations.

Following the discovery of an error in the published Mmax distributions for a number of CEUS SSC seismotectonic zones (Paleozoic Extended Zone-Narrow [PEZ-N], Paleozoic Extended-Wide [PEZ-W], St. Lawrence Rift [SLR], Midcontinent-Craton [MidC] A through D, and Illinois Basin Extended Basement [IBEB]), EPRI (Reference 2.5-155) published corrected Mmax distributions for these zones and concluded that the error had a negligible effect on the recurrence parameters, calculated seismic hazard, and ground motion response spectra results.

Aleatory distributions, such as style of faulting, orientation (fault strike) and dip for each style of faulting, and epistemic alternatives (e.g., thickness of the seismogenic crust) are used in the CEUS SSC model to express the characteristics of future earthquake ruptures occurring within distributed seismicity sources. Reference 2.5-60 also provides an empirical equation to compute rupture area as a function of magnitude, and a model for aspect ratio. These equations are used to calculate the dimensions of future earthquake ruptures. Reference 2.5-60 did not develop focal depth distribution or hypocentral depth ratio models because, at the time, these models were not needed for the application of GMMs for central and eastern North America. These distributions are used in the NGA-East Ground Motion Characterization model (Reference 2.5-135) to compute the depth to top of rupture parameter.

Two types of data are used to derive earthquake recurrence for RLME sources: (1) estimated ages of paleoearthquakes, which can be used to calculate the times between consecutive events; or (2) estimates of the number of earthquakes that have occurred post the age of a particular stratigraphic horizon. For most RLME sources, the occurrence of earthquakes in time is modeled to follow a Poisson process, in which the occurrence of an earthquake is independent from the time of the previous event. For two RLMEs, there is sufficient paleoseismological data to indicate that earthquakes may occur in a more periodic fashion than is modeled by a Poisson process. For these RLME sources, a renewal model that considers the time elapsed since the most recent RLME occurrence, was also used to assess the rate of earthquake occurrences. Uncertainties in characterizing the occurrence rates for RLME sources derive from uncertainties in the paleoseismological data (e.g., uncertainties in the number of earthquakes, ages of stratigraphic horizons, and specific ages of earthquakes). Aleatory

variability in the magnitude of individual RLME occurrences is modeled by a uniform distribution over a range of ±0.25 magnitude units centered on the characteristic RLME magnitude. The characteristic RLME magnitude is assessed using various sources of data for each RLME source and the epistemic uncertainty associated with this assessment is expressed by a probability distribution in the logic tree for the source.

2.5.2.2.1.1 Maximum Magnitude Zones

The logic tree for the Mmax zone approach branch captured in Figure 2.5-35 is consistent with the application of the alternative prior distributions for assessing Mmax. Three prior distributions for the calculation of Mmax were developed in Reference 2.5-60: the first distribution is applicable to Mesozoic and younger extended crust (MESE), the second is applicable to non-extended crust, or to crust where the most recent extension occurred before the Mesozoic (called “NMESE”), and the third is a composite distribution for all stable continental regions regardless of presence or absence of Mesozoic extension.

The need to separate crust that underwent Mesozoic extension from older or not extended crust is addressed in the first node of the logic tree, which leads to a branch that models the entire CEUS (the study region [STUDY-R]) as a single zone, and an alternative branch where MESE and NMESE are separated. The approach that uses the separation is preferred (weight of 0.6) over the approach that does not recognize a separation (weight of 0.4) because there is marginal statistical significance for the separation (Chapter 6 of Reference 2.5-60).

The second node of the logic tree in Figure 2.5-35 addresses the uncertainty in the location of the boundary between MESE and NMESE and consists of two interpretations. The narrow interpretation is delineated using only MESE extensional features that are unquestionable, leading to the zones MESE-N and NMESE-N captured in Figure 2.5-36. The wide interpretation includes weaker evidence of extensional features and leads to zones MESE-W and NMESE-W captured in Figure 2.5-37. Discussion in Chapter 6 of Reference 2.5-60 attributes the preference of the narrow interpretation (weight of 0.8) over the wide interpretation (weight 0.2) to the stronger evidence for the boundary location. Figures 2.5-36 and 2.5-37 show that both interpretations of the boundary are within 200 mi. (320 km) of the site. Further discussion of this boundary is given in Section 2.5.2.2.2.3.

The following descriptions of the Mmax zones are summarized from Reference 2.5-60. Full descriptions are provided in that report.

EPRI, DOE, and NRC (Reference 2.5-60) define the western boundary of the interpreted extent of Mesozoic age and younger extensional features using a variety of geologic, geophysical, and seismologic data such as:

- The presence of grabens and basins of Mesozoic age
- The presence of plutonic masses of Mesozoic age and younger
- The presence of faults and dikes of Mesozoic age and younger
- Evidence for MESE uplift and normal faulting

These features are used to define the boundaries of zone MESE-Narrow (MESE-N), which includes the Extended Continental Crust-Atlantic Margin (ECC-AM), Extended Continental Crust-Gulf Coast (ECC-GC), Atlantic Highly Extended Crust (AHEX), Gulf Coast Highly

Extended (GHEX), Reelfoot Rift (RR), SLR, Northern Appalachian (NAP), Great Meteor Hotspot (GMH), and PEZ-N seismotectonic zones. The MESE-Wide (MESE-W) zone adopts the wide alternative geometries for the PEZ-W, RR with Rough Creek Graben (RR-RCG), and IBEB zones.

The largest historical non-RMLE earthquake in the MESE was the E[**M**] 6.25 on September 16, 1732, in the St. Lawrence region of Canada.

The NMESE eastern boundary corresponds to the western boundary of MESE described above. There are two alternative geometries: narrow (NMESE-N) and wide (NMESE-W). The largest historical non-RMLE earthquake in the NMESE-N zone was the E[**M**] 5.91 on May 31, 1897, in Giles County, Virginia; the largest historical non-RLME earthquake in the NMESE-W zone was the E[**M**] 5.72 on May 16, 1909, near the border of North Dakota, Montana, and Canada.

The Study Region (STUDY-R Mmax) zone includes the entire region assessed by the CEUS SSC study. The largest historical non-RLME earthquake in the STUDY-R was the E[**M**] 6.25 on September 16, 1732, in the St. Lawrence region of Canada.

2.5.2.2.1.2 Seismotectonic Zones

Figure 2.5-38 shows the logic tree for seismotectonic zones. The first assessment (first node) pertains to the location of the western boundary of PEZ and matches the uncertainty in the location of the boundary between MESE and NMESE (Figure 2.5-37). The second node explores if the RCG should be included with the RR or with the MidC zone. Four possible interpretations of zone boundaries stem from the combination of the first two nodes, as captured in Figure 2.5-39 to Figure 2.5-42. Three seismotectonic zones are located within 200 mi. (320 km) of the site: PEZ-N, PEZ-W, and ECC-AM (with the site located within the ECC-AM zone).

The potential for hazard contributions from distant earthquakes is considered in the PSHA by incorporating zones located outside the 200 mi. (320 km) radius from the Project site: AHEX, ECC-GC, IBEB, MidC (A through D), NAP, RR, RR-RCG, and SLR.

The seismotectonic zones are presented in alphabetical order below. For each zone, a brief description, summarized from Reference 2.5-60, is provided; full descriptions of the sources are provided in that document.

The AHEX zone marks the transition between the extended, thick continental crust of the ECC-AM to the thin, mafic-oceanic crust of the Atlantic Ocean. In addition to differences in composition of the crust, other characteristics such as the thinner seismogenic crust and sparse seismicity, are used in Reference 2.5-60 to justify separating the AHEX from the ECC-AM. The zone is entirely offshore, and its geometry follows the continental shelf edge from Nova Scotia, Canada, to Georgia.

The ECC-AM is the host zone of the Project site. The zone extends from Nova Scotia, Canada, to Georgia and includes onshore portions of the Piedmont and Coastal Plain provinces and most of the offshore continental shelf region.

The east-dipping Paleozoic basal detachment surface is mapped by seismic reflection profiles at depths of about 3.7 mi. (6 km) at the western flank of the mountains, deepening to about 6.2 mi. (10 km) in the Piedmont, and then steepening to about 21.7 mi. (35 km) in the east. Paleozoic thrust sheets above the detachment are predominantly “thin-skinned” in the west and

"thick-skinned" in the east. The gravity anomaly gradient and other geophysical data show the thinning of the continental crust toward the inferred Late Precambrian-Early Paleozoic continental margin, which lies underneath the Piedmont. The gravity anomaly gradient is taken to define the structural western boundary of the thinned, extension-dominated crust. A major geophysical feature is the East Coast Magnetic Anomaly that runs parallel to the Atlantic margin and is correlated with igneous rocks, marking the transition from continental-rifted crust to mafic-oceanic crust.

The ECC-AM includes multiple shear zones and faults, mostly related to Paleozoic accretion of terrains during the Appalachian orogenies. Normal faults bound Mesozoic rift basins and have been interpreted to be reactivated Paleozoic structures. Cretaceous and younger faults are predominately north – south or northeast – southwest oriented, reverse faults. Some of these faults have experienced Cenozoic activity; however, poor exposure, lack of suitable stratigraphy, small displacement, and low slip rates make the identification of Cenozoic movement difficult. Future earthquakes are modeled to prefer north and northeast orientations, although some weight is assigned to east – west-oriented ruptures.

Seismicity is variable within the ECC-AM, with concentrations of activity in the CVSZ, the greater New York City – Philadelphia area, the Charleston, South Carolina, area, the Piedmont region of South Carolina and Georgia, and in New England. The largest earthquake observed in the ECC-AM was the 1886 Charleston, South Carolina, event, which is associated with the Charleston RLME source. Aside from this earthquake, the largest historical event located in the ECC-AM was the 1755, M 6.1 Cape Ann earthquake. The earthquake was located near the boundary with the NAP zone, and because of the uncertainty in location, two alternative models are used in the calculation of Mmax. In the first model (weight of 0.6), the Cape Ann earthquake is the largest observed earthquake in the ECC-AM. In the second model (weight of 0.4), the Cape Ann earthquake is in zone NAP, and the largest observed earthquake prior to 2011 in the ECC-AM occurred on June 11, 1638 (E[**M**] 5.32).

The Mineral, Virginia, earthquake of August 23, 2011, E[**M**] 5.73, occurred in the ECC-AM and is described in Section 2.5.2.1.3.

The ECC-GC seismotectonic zone delineates areas of thick transitional crust that mark one of the three large crustal domains that formed in the Gulf of America region during the break-up of Pangea. The lack of preferential orientation of structures is used to separate ECC-GC from ECC-AM; differences in seismogenic thickness are used to separate ECC-GC from GHEX (ECC-GC has a thicker crust).

The largest earthquakes in the ECC-GC historical catalog were the October 22, 1882, E[**M**] 5.58 and October 24, 1997, E[**M**] 4.88 earthquakes. Paleoseismic data collected in southeastern Arkansas, northeastern Louisiana, and western Mississippi suggest earthquakes from magnitude 5, potentially up to magnitude 6.5, may occur in the seismotectonic zone, possibly related to the Saline River fault in southern Arkansas. In the CEUS SSC model, the magnitude distribution of paleoearthquakes is used as one of the options to formulate the Mmax posterior distribution for the ECC-GC zone.

The IBEB zone is defined to account for moderate-to-large magnitude earthquakes occurring on deep structures in the Precambrian basement and on Paleozoic faults that extend into the Paleozoic sedimentary rocks. The crust underlying the southern Illinois basin appears to be

different from that of adjacent zones, such that future earthquake characteristics will also be different.

The geometry of the zone is defined to roughly encompass the basement rift sediments and the areas where paleoearthquakes have been identified. Evidence of RLMEs is used to characterize the Wabash RLME source (see Section 2.5.2.2.1.3); however, other paleoseismological evidence exists outside the Wabash Valley, including four paleoearthquakes with approximate **M** 6.2-6.3, as inferred from widely distributed liquefaction features.

The largest historical earthquakes recorded within the IBEB were the September 27, 1891, E[**M**] 5.52; August 15, 1891, E[**M**] 4.97; and April 18, 2008, E[**M**] 5.30 earthquakes. Additionally, four prehistoric earthquakes inferred from the paleoliquefaction studies have estimated magnitudes that are larger than the historical earthquakes. These are the ~**M** 6.3 Vallonia, ~**M** 6.2 Shoal Creek, ~**M** 6.2 Springfield, and **M** 6.2 Waverly earthquakes (Chapter 7, Reference 2.5-60).

The MidC seismotectonic zone is composed of continental crust that has not been involved in orogenic episodes during the Phanerozoic, including the Canadian Shield and the platform. As captured in Figures 2.5-39 to 2.5-42, there are four possible geometries for the MidC zone (A – D) that stem from alternative configurations of the PEZ, RR, and RR-RCG seismotectonic zones.

According to the description in Chapter 7 of Reference 2.5-60, Precambrian basement structures in the MidC zone include northeast-striking shear zones and northwest-trending strike-slip faults interpreted to form fault and fold zones that could be reactivated in the current stress regime. The distribution of seismicity within the MidC zone varies spatially, with concentrations in the Anna Seismic Zone in western Ohio, the Northeastern Ohio Seismic Zone, and the Nemaha Ridge-Humboldt Fault Seismic Zone in Kansas. Paleoseismic investigations in these zones do not identify **M** > 7 earthquakes in the past few thousand years but cannot preclude moderate-sized (**M** 6 to **M** < 7) earthquakes; the data, however, are insufficient to define RLME sources in these areas.

The largest historical earthquakes recorded within the MidC zone were May 16, 1909, E[**M**] 5.72 (although it is noted that the location of the event may be poorly constrained) and the November 15, 1877, E[**M**] 5.50 earthquake (Chapter 7, Reference 2.5-60).

The NAP zone is considered MESE and is separated from the ECC-AM because it does not contain fault-bounded rift basins. Moderate-magnitude, shallow seismicity (depth less than 6.2 mi. [10 km]) occurs above the continental margin within the crust of amalgamated-composite Appalachian terranes. These terranes were formed outboard of the Laurentian margin and post-date Iapetan rifting. For this reason, the NAP zone is separated from the PEZ and SLR zones.

The largest historical earthquakes reported within the NAP have moderate magnitudes: these include the March 21, 1904, E[**M**] 5.73 earthquake, the June 11, 1638, E[**M**] 5.32 earthquake, and the December 24, 1940, E[**M**] 5.6 earthquake. There is some possibility that the 1755 Cape Ann earthquake (E[**M**] 6.1) might be located in the NAP zone rather than in the ECC-AM.

The PEZ zone delineates a region of continental crust of the Iapetan-rifted margin showing some evidence of reactivation during Mesozoic extension, in contrast to the crust of adjacent zones (ECC-AM, ECC-GC, NAP, and SLR) that have strong evidence of Mesozoic reactivation. The two geometries of PEZ (narrow and wide, i.e., PEZ-N and PEZ-W, respectively) are defined on the basis of the evidence for Iapetan rift faults and sediments.

Zones of elevated seismicity within the PEZ include Giles County, Virginia; the ETSZ; and the Clarendon-Linden Fault System. According to EPRI, DOE, and NRC (Reference 2.5-60), paleoseismic investigations in these areas do not provide sufficient data to characterize RLME sources. The largest historical earthquake in the PEZ was the 1897 Giles County earthquake (E[**M**] 5.91) (Chapter 7, Reference 2.5-60).

The August 9, 2020, E[**M**] 5.15 Sparta earthquake occurred in the PEZ and is described in Section 2.5.2.1.3.

The RR seismotectonic zone includes an area of localized tectonic strain interpreted to be a Cambrian aulacogen reactivated during Mesozoic rifting. The rate of earthquakes in this zone is higher than in adjacent zones, and multiple Quaternary active faults have been identified in the zone. The New Madrid Fault System (NMFS), Eastern Rift Margin (ERM), Marianna, and Commerce Geophysical Lineament RLME sources are located inside the RR.

The seismogenic thickness is less in the RR than in the adjacent IBEB zone, as evidenced by focal depths of well-located earthquakes. The RR is differentiated from MidC and ECC-GC based on the orientation of structures (Chapter 7, Reference 2.5-60).

The RCG extends east from the RR and includes faults that formed during the initial phases of rifting and reactivation during the Appalachian-Ouachita orogeny. Figure 2.5-39 through Figure 2.5-42 represent alternative configurations that stem from the uncertainty about the inclusion of the RCG in the RR source zone. The inclusion (zone RR-RCG) receives a lower weight (0.333) compared to the alternative (RCG inside IBEB, weight 0.667) because there is some evidence that Mesozoic reactivation was limited in the RCG (Chapter 7, Reference 2.5-60).

The two largest historical earthquakes reported in the zone that are not associated with RLME sources were the January 5, 1843, and October 31, 1895, **M** 6 (E[**M**] 6.00) earthquakes (Chapter 7, Reference 2.5-60).

The SLR seismotectonic zone is an area of elevated seismicity representing crust that was rifted during the late Proterozoic-early Paleozoic opening of the Iapetus Ocean. Faults were subsequently reactivated during the Paleozoic and Mesozoic. The Charlevoix RLME source area is located within the SLR seismotectonic zone.

The largest historical earthquakes reported in the zone that are not associated with the Charlevoix RLME source include the 1732, E[**M**] 6.25 Montreal earthquake; 1925, E[**M**] 6.18 St. Lawrence earthquake; 1935, E[**M**] 6.08 Timiskaming earthquake; 1944, E[**M**] 5.71 Cornwall-Massena earthquake; 1988, E[**M**] 5.84 Saguenay earthquake.

2.5.2.2.1.3 Repeated Large-Magnitude Earthquake Sources

RLME (**M** ≥ 6.5) sources are included as sources on both the Mmax and the seismotectonic source branches of the master logic tree because they model the occurrence of RLMEs on a specific fault or within a localized area. RLMEs are defined by the historical record, the paleoearthquake record, or a combination of the two. EPRI, DOE, and NRC (Reference 2.5-60) characterize 10 RLME sources, captured in Figure 2.5-43.

The TI Team evaluated the results of the seismic hazard analysis presented in Appendix I of Goulet et al. (Reference 2.5-135) for seven demonstration sites to determine which RLME source may contribute to the seismic hazard at the Project site. The TI Team selected the

Chattanooga demonstration site as a proxy for the Project site because of its relative proximity and similar tectonic environment. The TI Team also evaluated the Savannah demonstration site but concluded that its proximity to the Charleston RLME source obscures the effect of other RLME sources.

The RLME sources that contribute the most to the hazard at Chattanooga are New Madrid and Charleston. Lower contributions are given by the Eastern Rift Margin-South (ERM-S), Wabash Valley and Marianna, Eastern Rift Margin-North (ERM-N), and Commerce RLME sources.

These RLME sources are used in the seismic hazard analysis for the Project site, and their descriptions are taken from the SSHAC Level 2 report. Full descriptions of the RLME sources are provided in Chapter 6 of Reference 2.5-60.

The Charleston RLME source in South Carolina is centered on the coastal city of Charleston (Figure 2.5-44) where in 1886, an E[**M**] 6.9 earthquake was located (see Section 2.5.2.1.3). The earthquake produced high-intensity macroseismic effects (MMI X) in the epicentral area. Paleoseismic evidence, such as sand-blow craters and other paleoliquefaction features along the coast of South Carolina, evaluated by EPRI, DOE, and NRC (Reference 2.5-60) is indicative of RLMEs in this area. Additionally, available geologic and geomorphic evidence suggests that the rate of mid-Holocene to modern seismicity in the Charleston Seismic Zone is transient, alternating periods of activity with periods of quiescence. The Charleston RLME source was modeled as a fault zone within which the earthquake is randomly located because it is not possible to localize the earthquake onto a specific fault. As captured in Figure 2.5-44, the source zone geometry has three configurations: local, narrow, and regional.

- The local geometry is based on the extent of the largest macroseismic intensities, liquefaction features, recorded seismicity, and postulated faults.

- The narrow geometry is designed to encompass a number of postulated faults.

- The regional geometry covers a large area of coastal South Carolina, including the majority of liquefaction features and postulated faults, and extends offshore to include the Helena Banks fault zone.

The Charleston RLME magnitude distribution of future large earthquakes in the CEUS SSC model is based on the range of interpreted magnitudes of the 1886 earthquake and prehistoric earthquakes and assumes that future earthquakes will have similar magnitudes.

The Commerce fault zone RLME source encompasses Late Pleistocene and possible Holocene active faults identified from geophysical, geomorphologic, and geologic data. The Commerce geophysical lineament is defined by gravity and magnetic anomalies and coincides with these tectonic features and with paleoliquefaction features in southeastern Missouri. The data are insufficient to determine whether RLMEs exhibit temporal clustering.

Future earthquake ruptures in the Commerce fault zone RLME source are modeled as vertical, with strike-slip motion and orientation subparallel to the main faults within the zone (Commerce and Penitentiary faults). The northeast and southwest boundaries of the fault zone allow ruptures to extend beyond the zone boundary, while the opposite boundaries (northwest and southeast) do not permit ruptures to extend outside the zone.

The ERM is modeled as a fault zone in which recurrent earthquakes occurred in the Quaternary, with the most recent event in the Holocene. Two independent RLMEs, the ERM-N and the ERM-S are defined on the basis of different timing and the recency of surface deformation. The available data are insufficient to determine whether the RLMEs occur in clusters.

Due to the uncertainty in the dimension of paleoruptures, the two RLME sources have a wide distribution of expected future earthquake magnitudes. The maximum value for the ERM-N is slightly smaller than for ERM-S because of the shorter length of the fault.

The Marianna RLME source is in the southeastern part of the RR seismotectonic zone, outside the NMFS. The source is defined by the presence of earthquake-induced liquefaction features, e.g., large sand blows that predate paleoearthquakes associated with the NMFS. The geometry of the RLME source encompasses the paleoliquefaction sites and structures that have been considered possible causative faults of the paleoearthquakes.

The occurrence of RLMEs is modeled as either “in cluster” or “out of cluster,” with the two models receiving equal weight because there is a possibility that some paleoliquefaction features in the Marianna region might have been caused by earthquakes originating in the ERM RLME sources.

The three largest historical earthquakes in the CEUS occurred in the New Madrid region between December 1811 and February 1812. Three main trends of seismicity are observed in the New Madrid region: two northeast-trending alignments, interpreted to be the location of right-lateral strike-slip faults, and one northwest-trending pattern interpreted as a compressional left-stepover zone.

The December 16, 1811, E[**M**] 7.17 earthquake is believed to have occurred on the southern arm of seismicity (New Madrid South), associated with the Blytheville Arch fault. There are two alternative interpretations for the events of January 23, 1812, E[**M**] 7.50, and February 7, 1812, E[**M**] 7.80. One interpretation is that the January 23, 1812, earthquake occurred on the northern seismicity arm (New Madrid North), and the February 7, 1812, earthquake occurred on the Reelfoot fault. The alternative scenario is that the January 23, 1812, earthquake occurred on the Reelfoot fault, and that the February 7, 1812, earthquake ruptured both the New Madrid North and Reelfoot faults.

The maximum magnitudes of the three earthquakes in the 1811 – 1812 sequence are inferred from macroseismic intensity data and, to a lesser extent, the analysis of paleoliquefaction features. The recurrence of RLMEs in the New Madrid region was obtained from paleoliquefaction studies and analyses of fault-related deformation on the Reelfoot fault. Geodetic, seismological, and geomorphic observations suggest that earthquakes in the NMFS may be temporally clustered, with periods of quiescence separating clusters of activity, and that seismicity migrates within the RR. Based on this, there are three alternative models: (1) future earthquakes on the three faults in the NMFS will occur at the rate inferred from paleoliquefaction studies (weight 0.9); (2) the NMFS is no longer capable of large-magnitude earthquakes and the hazard is modeled by the background seismicity (weight 0.05); and (3) only the Reelfoot thrust is active and is producing RLMEs at a lower rate (weight 0.05).

Uncertainty in the location and extent of the causative faults that ruptured during the 1811 – 1812 earthquake sequence is modeled by the alternative geometries of the three faults that make up the NMFS.

Paleoseismic evidence indicates that at least eight moderate-to-large earthquakes have occurred since the latest Pleistocene time in the Wabash Valley region of southern Illinois and southern Indiana. The two largest paleoearthquakes (**M** ~ 6.7 – 7.8) inferred from the paleoliquefaction data are known as the Vincennes and Skelton earthquakes: their proximity, suggests the existence of an RLME source in the Wabash Valley. There is no clear association of paleoearthquakes with specific tectonic features; therefore, the Wabash Valley RLME source is modeled as a zone where earthquakes are randomly located. The paleoseismic record is insufficient to recognize temporal clustering periods.

2.5.2.2.2 New Information Affecting the Characterization of Seismic Sources

The TI Team's approach to evaluating the need to update the CEUS SSC model is introduced at the beginning of Section 2.5.2. This section summarizes the TI Team's evaluation of new data, models, and methods developed after the completion of the CEUS SSC project (documented in Chapter 6 of the SSHAC Level 2 report). The key issues evaluated by the TI Team and summarized below are:

- Evaluation of the need to update earthquake recurrence rates for distributed seismicity sources (Section 2.5.2.2.2.1)
- Evaluation of the need to update Mmax distributions for seismic source zones (Section 2.5.2.2.2.2)
- Evaluation of the need to update the geometry of the MESE boundary (Section 2.5.2.2.2.3)
- Evaluation of the need to update CEUS SSC RLME sources and to add postulated new faults (Section 2.5.2.2.2.4)

2.5.2.2.2.1 Evaluation of the Need to Update Earthquake Recurrence Rates for Distributed Seismicity Sources

The earthquake catalog described in Section 2.5.2.1 collected an additional 15.3 years of data, including two moderate-sized earthquakes. The TI Team evaluated whether the updated earthquake catalog should be used to update earthquake occurrence rates. The TI Team employed a statistical test that compares the number of earthquakes predicted by the CEUS SSC recurrence rates in 15.3 years with the observed counts of earthquakes observed during the same time interval.

The CEUS SSC model (Reference 2.5-60) uses the Poisson recurrence model to represent the frequency of earthquakes occurring in the distributed seismicity sources. Given the frequency of earthquakes (λ) and the time interval of observation (t), the probability of observing exactly n earthquakes ($P[N=n]$) is given by Equation 2.5.2-5:

$$P[N = n] = \frac{(\lambda t)^n e^{-\lambda t}}{n!} \qquad \text{(Equation 2.5.2-5)}$$

The distributions computed from the CEUS SSC model parameters for distributed seismicity sources can be used to represent uncertainty distributions for the true rate of earthquakes in the region around the Project site. Using a one-sided Poisson test, the TI Team evaluated if the observed number of earthquakes within the portion of CEUS covered by the catalog update (January 1, 2009, to April 30, 2024) is consistent with a tectonic process modeled by the CEUS SSC long-term Poisson rates for the same region. The null hypothesis is that the observed number of earthquakes in 15.3 years (e.g., the duration of the catalog update from January 1, 2009, to April 30, 2024) is consistent with a Poisson process with a "true" rate parameter equal to the recurrence rate in the distribution calculated from the CEUS SSC model.

The one-sided Poisson test is conducted first for the seismicity within 200 mi. (320 km) of the Project site. The probability of observing the actual count of E[**M**] ≥ 2.9, E[**M**] ≥ 3.6, etc., or greater counts, given the true rate λ_i (where λ_i is the mean of the uncertainty distribution for λ calculated from the CEUS SSC model parameters) is computed with Equation 2.5.2-6.

$$P\left[N \geq n_{obs} \middle| \lambda_i\right] = 1 - \sum_{n=0}^{n=n_{obs}-1} P\left[N = n \middle| \lambda_i\right] \qquad \text{(Equation 2.5.2-6)}$$

The test is repeated selecting the region within 400 mi. (640 km) of the Project site. Results are captured in the last two columns of Table 2.5-6 for the region within 200 mi. (320 km) of the Project site, and in in the last two columns of Table 2.5-7 for the region within 400 mi. (640 km) of the Project site. Both tests were conducted with and without human-induced earthquakes as part of the observed counts. Typical statistical test confidence intervals of 5 percent or less are used to indicate significant departures from the null hypothesis. The probability values in Table 2.5-6 and Table 2.5-7 are generally 5 percent or larger, indicating that the observed earthquake counts could be generated by a Poisson process with rate λ equal to the long-term rate predicted by the CEUS SSC model. The TI Team concluded that the observed seismicity does not warrant an update of the earthquake recurrence rates in the region within 400 mi. (640 km) of the Project site because it does not modify the CBR of the TDI.

The TI Team also evaluated the effect of modifications to the earthquake catalog for the southeastern United States introduced by EPRI (Reference 2.5-156), namely the removal of reservoir-induced earthquakes in South Carolina and aftershocks of the Charleston earthquake. The TI Team found that using the revised catalog to compute recurrence rates produces a small percentage decrease in the mean AFE for all magnitudes and concluded that the modification does not affect the CBR of the TDI.

2.5.2.2.2.2 Evaluation of the Need to Update Mmax Distributions for Seismic Source Zones

Section 2.5.2.2.1 introduces the two statistical methods adopted by EPRI, DOE, and NRC (Reference 2.5-60) to compute Mmax distributions for source zones. The TI Team repeated the analysis performed by EPRI, DOE, and NRC (Reference 2.5-60), extending the earthquake dataset with all **M** ≥ 4.3 located within the CEUS SSC source zones that occurred from January 1, 2009, to April 30, 2024. The magnitude threshold of 4.3 was selected to be consistent with the EPRI, DOE, and NRC (Reference 2.5-60) study.

The analysis follows three main steps: (1) application of the Bayesian approach with a set of prior distributions obtained from updated groupings or “superdomains” of stable continental regions with similar crust (age, type of crust, stress state, tectonic history); (2) application of the Kijko statistical approach; and (3) assessment of the relative weights to assign to each method.

2.5.2.2.2.2.1 Bayesian Approach

In the Bayesian approach described in Chapter 5 of Reference 2.5-60, a normal prior distribution is computed from observed data and convolved with a likelihood function to arrive at a posterior distribution of Mmax. The likelihood function is obtained with source-specific information about the number and sizes of observed earthquakes. The likelihood function is zero for all values below the maximum observed magnitude, has a peak near the maximum observed, and then becomes essentially constant at larger magnitudes. The sharpness of the peak and the relative amplitude of the peak compared to the plateau are controlled by the sample size *N*, which is the number of observed earthquakes greater than a threshold magnitude. As *N* increases, the sharpness of the peak increases, and the amplitude of the plateau becomes much less than that of the peak. The last step of the analysis involves representing the continuous posterior distribution by a discrete distribution for use in hazard analysis. In the CEUS SSC model, the chosen representation was a five-point discrete approximation to an arbitrary continuous distribution developed by Miller and Rice (Reference 2.4-157).

Table 2.5-8 lists the number of earthquakes with E[**M**] ≥ 4.3 from earliest available to December 31, 2008, obtained from the CEUS SSC catalog, and the number of earthquakes with **M** ≥ 4.3 from January 1, 2009, to April 30, 2024, inclusive of human-induced earthquakes and aftershocks, obtained by the TI Team from the Global Centroid Moment Tensor Solution catalog and from Saint Louis University. The counts show a notable increase in the number of earthquakes from 2009 onward, particularly in the NMESE and in the MidC zones. These numbers are likely associated with human-induced seismicity in areas of Oklahoma, Texas, and Arkansas. The increased number of earthquakes causes the likelihood function for these source zones to be much more peaked compared to the likelihood function in the CEUS SSC model. For example, Figure 2.5-45 compares the Mmax distribution calculated for zone NMESE-W in the EPRI, DOE, and NRC (Reference 2.5-60) study (part a of the figure) with the recalculated distributions using the extended catalog (part b of the figure). The Bayesian distribution is illustrated by the black histogram for the NMESE prior and is much more peaked and skewed toward lower magnitude values in part b of the figure compared to part a.

2.5.2.2.2.2.2 Kijko Approach

The Kijko approach uses only the observed distribution of earthquakes in a region to determine the Mmax distribution. The method assumes that the earthquake catalog is complete and that the maximum observed magnitude is a true representative of the largest earthquake anticipated to occur within a source zone.

2.5.2.2.2.2.3 Assessment of Relative Weights of Bayesian and Kijko Approaches

EPRI, DOE, and NRC (Reference 2.5-60) show that for sample size *N* less than approximately 100, the cumulative probability function of the Kijko approach reaches a limiting value that is less than unity as the upper-bound magnitude approaches infinity. The limiting value was taken

as an indicator of the probability that the methodology provides meaningful results and was used to assess the relative weight of the Kijko and Bayesian approaches with Equation 2.5.2-7:

$$W_{Kijko} = \begin{cases} 0.5 - P\left(m^u > 8\frac{1}{4} | m^u \geq 5\frac{1}{2}\right) & \text{for} \quad P\left(m^u > 8\frac{1}{4} | m^u \geq 5\frac{1}{2}\right) \leq 0.5 \\ \vdots & \vdots \quad \vdots \\ 0 & \text{for} \quad P\left(m^u > 8\frac{1}{4} | m^u \geq 5\frac{1}{2}\right) > 0.5 \end{cases} \qquad \text{(Equation 2.5.2-7)}$$

Where m^u is the upper-bound magnitude.

From the equation it can be inferred that the Kijko approach works best when the truncated probability mass ($P\left(m^u > 8\frac{1}{4} | m^u \geq 5\frac{1}{2}\right)$) is small, which is the case when the number of observed earthquakes is large. However, when the truncated probability mass is 0.5, the Kijko approach has reached its limit of applicability.

Table 2.5-9 compares the weights of the Kijko approach obtained from Table 5.2.1-5 of Reference 2.5-60 with the weights obtained by the TI Team using the data in Table 2.5-8. Results can be summarized as follows:

- For zones MESE-N, PEZ-N, PEZ-W, the weight assigned to the Kijko approach increases slightly.
- For zones ECC-AM, RR-RCG, and SLR, the weight assigned to the Kijko approach decreases slightly.
- For zones NMESE-W and MidC (all geometries), the weight assigned to the Kijko approach increases substantially due to the large number of earthquakes added to the catalog.
- For all other zones, there are no changes.

The combined effect of larger sample sizes on the resulting composite distribution is to skew the distribution toward lower magnitudes as captured in part b of Figure 2.5-45, where the Kijko distribution is illustrated by the purple histograms, and the resulting composite distribution is illustrated in red.

Using a Miller and Rice (Reference 2.5-157) five-point approximation, the TI Team obtained the Mmax distribution captured in Table 2.5-10, which is compared to the distributions in the CEUS SSC model (as corrected by EPRI [Reference 2.5-155] where necessary). There are small changes for many of the zones that generally tend to lower the average Mmax. To assess the potential hazard significance of this change, the TI Team calculated the annual frequency of earthquakes with E[**M**] ≥ 2.9 for the region encompassing 400 mi. (640 km) of Project site. The TI Team results show that the updated Mmax distributions generate a small decrease in AFE for E[**M**] ≥ 6 (5 to 13 percent). The TI Team does not consider this change to be significant to hazard at the Project site and did not consider the use of updated Mmax.

2.5.2.2.2.3 Evaluation of the Need to Update the Geometry of the MESE Boundary

The Project site is located approximately 3.7 mi. (6 km) west of the “Narrow” interpretation of the western boundary of Mesozoic extension, within crust that did not experience extension during the Mesozoic. Given the proximity of the site to the boundary, the TI Team re-visited the justification for the location of the boundary to determine whether a site-specific refinement is appropriate.

The western boundary of the crust that experienced extension during the Mesozoic is based on the location of a gravity gradient that generally follows the western edge of the Triassic-Jurassic onshore basins or the boundaries of the structural blocks in which they occur. The TI Team used high-resolution datasets mapping Mesozoic basins and concluded that while at a regional scale the western extent of the Mesozoic basins generally coincides with the regional gravity gradient, at a local scale there are two exceptions: the Newark-Gettysburg basin in New Jersey, and the Dan River basin in NC. The Dan River basin is the closest Mesozoic basin to the Project site, and this finding suggests that in the Project site vicinity Mesozoic extension occurred farther west than currently represented in the CEUS SSC model.

Section 2.5.2.2.1 explains that in the CEUS SSC model, MESE crust is separated from NMESE crust because different Mmax prior distributions apply. Given the importance of this boundary and the geologic observations described above, the TI Team postulated an alternative boundary that extends the MESE crust to the western edge of the Dan River basin, as captured in Figure 2.5-46. In this figure, source zone ECC-AM is superimposed on the gravity anomaly gradient map. The geophysical boundary is the western edge of the zone (in blue), and the alternative geologic boundary postulated by the TI Team is illustrated in orange.

The TI Team considers the geophysical (gravity gradient) data and the geologic (basin mapping) data as two possible alternatives to identify the edge of the Mesozoic extensional margin. As captured in Figure 2.5-46, the Project site is in NMESE crust when the geophysical boundary is used but is in MESE crust when the geologic boundary is applied. Hazard sensitivity analyses conducted by the TI Team resulted in 30 to 35 percent differences in AFE for ground motions at the 1E-4 to 1E-6 level, confirming that this site-specific refinement of the CEUS SSC model is warranted.

Given the uncertainty in the datasets and the structural complexity of the fault geometries in the subsurface of which little is known, the TI Team decided to treat the geophysical and geological boundaries as equally weighted epistemic uncertainties. The modification of the boundary affects the geometry of five source zones: ECC-AM, PEZ-N, PEZ-W in the seismotectonic branch, and MESE-N, NMESE-N in the Mmax branch of the CEUS SSC model (see Section 2.5.2.4.1).

2.5.2.2.2.4 Evaluation of the Need to Update CEUS SSC RLME Sources and Add Postulated New Faults

This section summarizes the TI Team’s evaluation of potential changes to the characterization of RLME sources that are included in the CEUS SSC model, and the need to include local sources proposed in recent literature.

The evaluations are described first for RLME sources, followed by postulated new fault sources. The TI Team focused on the two RLME sources with the largest contribution to the hazard at

the Project site, i.e., Charleston, South Carolina, and the RLME sources in the New Madrid region.

Charleston RLME Source. The TI Team reviewed recent studies and found that there is still no consensus on the location of the 1886 Charleston earthquake fault or if that fault is the only Quaternary active fault in the area. Recent studies, however, seem to indicate that the event was within the smaller, “Local” or “Narrow” geometries of the Charleston RLME source. The TI Team evaluated the effect of increasing the weight on the “Narrow” geometry, and results indicate a negligible effect (a few percent increase) on the hazard (see Figure 2.5-47) that does not change the CBR of the TDI. None of the studies reviewed by the TI Team suggest that the magnitude distribution for this source should be updated.

RLME Sources in the New Madrid Region. The TI Team evaluated studies published since the completion of the CEUS SSC model that use paleoseismological and geological investigations to extend the paleoearthquake record and use new LiDAR data to better constrain the length of known faults or identify new ones. The TI Team evaluated the hazard significance of the following modifications:

- Changes in the geometry of the New Madrid South segments (Bootheel and Axial fault sections) and the Reelfoot fault

- Changes in the geometry of the ERM-N and ERM-S RLME sources

- Changes in the geometry of the Commerce RLME source and associated changes in the RLME magnitude distribution

As captured in Figure 2.5-47, these changes produce a small increase (few percents) in hazard, and the TI Team concluded that their inclusion in the seismic hazard model for the Project site is not warranted.

Central Virginia Seismic Zone. The CVSZ is modeled to account for a region of higher seismicity that includes the 2011 E[**M**] 5.72 Mineral, Virginia, earthquake, 1758 E[**M**] 4.95, the 1774 E[**M**] 4.38, and the 1875 E[**M**] 4.77 events. The TI Team reviewed the recent literature and concluded that there is not sufficient paleoseismic evidence for repeated **M** 6.5+ earthquakes in the CVSZ; therefore, based on current knowledge, the TI Team did not consider CVSZ as an RLME source. The TI Team, however, evaluated if the CVSZ should be included in the seismic hazard model as a local source. The TI Team adopted the source characterization published in Thompson-Jobe et al. (Reference 2.5-59), with a modification of the Mmax distribution (**M** 6.5 and **M** 6.75, equally weighted) based on the work of Tuttle et al. (Reference 2.5-72; Reference 2.5-73).

East Tennessee Seismic Zone. The ETSZ is a region of elevated seismicity in the Valley and Ridge province of Tennessee. There are various possible explanations for the higher rates of earthquakes in the region, including being an aftershock sequence from a prehistoric event; a phase of strain release, but the location of strain release (earthquakes) can change; a zone of weakness that experiences higher strain rates and/or earthquakes; local and regional stresses resulting in a higher deviatoric stress tensor.

The TI Team reviewed the recent literature suggesting the presence of Quaternary faulting along a 50-mi. (80-km)-long, northeast-trending corridor, termed the Dandridge-Vonore fault corridor. According to some authors, there is evidence for earthquakes of magnitude greater

than 6.5 in the last 40 kyr, while for others the evidence could be related to fluvial mechanisms. The TI Team concluded that evidence for repeated **M** 6.5+ earthquakes in the ETSZ is insufficient and did not test the hazard significance of such events in the ETSZ for the Project site. The elevated levels of seismicity in ETSZ, compared to the surrounding crust, are captured by the spatially varying seismicity parameters of the CEUS SSC model.

Giles County Seismic Zone. The Giles County Seismic Zone is a region of elevated seismicity in southwestern Virginia. The largest historical earthquake in the region was the E[**M**] 5.91 Giles County earthquake, which occurred on May 31, 1897, with a maximum intensity of VIII. The TI Team did not find published evidence for repeated, **M** 6.5+ earthquakes in the Giles County Seismic Zone. As a result, the Giles County Seismic Zone was not included in the seismic hazard model for the Project site as a distinct seismic source with seismicity rates above those derived from the recorded historical seismicity.

Little River fault. The Little River fault is associated with the surface rupture from the 2020 E[**M**] 5.15 Sparta earthquake. The TI Team evaluated the need to include this fault in the seismic hazard model due to its proximity (approximately 57 mi. [92 km] west-northwest of the Project site). The interpreted fault length based on surface information appears to be insufficient to generate earthquakes of **M** 6.5+, and the TI Team did not find evidence for earthquakes to be repeated. The earthquake rate distribution captured in Table 2.5-11 was obtained by the TI Team using data provided by resource expert Dr. Figueiredo. The TI Team applied the likelihood method adopted in Reference 2.5-60 to develop a five-point distribution of the annual frequency of earthquakes and associated weights.

Saline River. The Saline River fault zone trends northwest-southeast across southeastern Arkansas in the Mississippi Embayment and is interpreted to be a left-lateral strike-slip fault. The TI Team reviewed recent papers describing paleoliquefaction features and trenching studies in the region. While there is no evidence of repeated **M** 6.5+ earthquakes, the TI Team concluded that the contribution of this fault to the total hazard for the Project site should be evaluated. The TI Team adopted the source characterization in Thompson-Jobe et al.(Reference 2.5-59) for the hazard sensitivity analysis.

Figure 2.5-48 shows that the contribution of the new postulated fault sources described above (faults in the New Madrid region, CVSZ, and Saline River) to the total mean seismic hazard at the Project site is not significant (1 percent or less); therefore, the TI Team concluded that its inclusion in the hazard model is not warranted.

2.5.2.3 Correlation of Seismicity with Seismic Sources

Section 2.5.2.1 describes the updated earthquake catalog obtained as part of the SSHAC Level 2 study. Figure 2.5-30 shows that only a few small earthquakes are reported to have occurred within 50 mi. (80 km) of the Project site. The 2020 Sparta, NC, earthquake (E[**M**] 5.15) is associated with the Little River fault, which is located approximately 57 mi. (92 km) west-northwest of the Project site (see Section 2.5.2.2.2.4). The earthquake ruptured on a northwest-southeast–trending fault, perpendicular to the regional structural orientation of the Appalachian Mountains, with an oblique-strike-slip motion. LiDAR data and field mapping indicate a total length of the surface rupture associated with this earthquake of approximately 2.5 mi. (4 km).

Figure 2.5-29 shows that the seismicity appears distributed in specific zones corresponding to the CVSZ (described in Section 2.5.2.2.2.4) to the northeast of the site, scattered along the coast of NC, in South Carolina, and along the Appalachian Mountains.

Earthquakes in South Carolina tend to occur in a cluster around Charleston (see Sections 2.5.2.1.3 and 2.5.2.2.1.3), and around the town of Bowman. Scattered small earthquakes are also reported in the Piedmont region. In the 1970s and 1980s, this physiographic province experienced reservoir-induced earthquakes associated with the impoundments in the basins. Sixteen of these earthquakes were identified during the compilation of the CEUS SSC earthquake catalog and removed. Figure 2.5-29 does not show these earthquakes. After the publication of the CEUS SSC model, EPRI conducted additional reviews of published literature and identified 30 more reservoir-induced earthquakes and 17 aftershocks of the Charleston earthquakes that should have been removed from the catalog (Reference 2.5-156).

In the Southern Appalachian orogen, earthquakes are associated with prevailing northeast-trending structures, particularly in the Valley and Ridge province, which includes the Giles County Seismic Zone in Virginia (north of the site), where the 1897, E[**M**] 5.91 earthquake occurred (see Sections 2.5.2.1.3 and 2.5.2.2.2.4), and the ETSZ (see Section 2.5.2.2.2.4).

2.5.2.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

This section describes the PSHA conducted for the Project site. Section 2.5.2.2 describes the CEUS SSC model, and the evaluations conducted as part of the SSHAC Level 2 study to determine the need to refine the model for site-specific applications. The resulting SSC logic tree is presented in Section 2.5.2.4.1.

Section 2.5.2.4.2 describes the ground motion characterization model by providing a summary of the NGA-East GMM; Section 2.5.2.4.3 summarizes the TI Team's evaluation of the model using new data, models, and methods, and the resulting ground motion characterization logic tree.

Seismic hazard results for reference rock conditions (mean hazard and deaggregation) are presented in Section 2.5.2.4.4 and include sensitivity analyses to illustrate the effect of modeling choices.

2.5.2.4.1 Seismic Source Characterization Model

The SSC model adopted for the SSHAC Level 2 PSHA is presented in Figure 2.5-49. The TI Team evaluation of new data, models, and method concluded that the CEUS SSC model should be refined to include the possibility for an alternative MESE boundary. This is addressed by the first node of the logic tree in Figure 2.5-49, which considers the use of alternative datasets to determine the local geometry of the boundary between MESE and NMESE. As discussed in Section 2.5.2.2.2.3, the TI Team assigned equal weight to the two alternatives because there is no clear choice for a favored interpretation.

The next two nodes of the logic tree in Figure 2.5-49 match the CEUS SSC master logic tree captured in Figure 4.2.1-1 of Reference 2.5-60 and address the basic conceptual models used to characterize the spatial and temporal distribution of future seismicity. These nodes are followed by branches representing uncertainties in the implementation of these models (see Figures 4.2.3-1, 4.2.4-1a and 4.2.4-1b of Reference 2.5-60). The SSHAC Level 2 SSC model

includes Mmax zones and seismotectonic zones that are partly or entirely within a distance of 621 mi. (1000 km) of the Project site: AHEX, ECC-AM, ECC-GC, IBEB, MidC (A through D), NAP, PEZ-N, PEZ-W, RR, RR-RCG, and SLR. As discussed in Section 2.5.2.2.1.3, the RLME sources included in the SSHAC Level 2 SSC model are: Charleston, Commerce, ERM-N, ERM-S, Marianna, New Madrid, and Wabash Valley.

The node addressing the location of the boundary of the Mesozoic extension precedes the CEUS SSC master logic tree because this choice is correlated between Mmax zones and seismotectonic zones. This means that when the geophysical boundary is selected, the original geometry of the MESE-N and NMESE-N zones (from CEUS SSC) is used in the Mmax branch, and the original geometry of zones ECC-AM, PEZ-N, and PEZ-W is used in the seismotectonic branch. Alternatively, if the geological boundary is selected for MESE-N and NMESE-N, the geological boundary is also selected for ECC-AM, PEZ-N, and PEZ-W.

The TI Team obtained a set of earthquake recurrence parameters for the zones affected by the alternative (geologic) MESE boundary (zones ECC-AM, PEZ-N, PEZ-W, MESE-N, and NMESE-N). To ensure consistency between the recurrence parameters associated with the published CEUS SSC model and the recurrence parameters computed for the alternative zone geometry, the TI Team used the computer software ABSMOOTH v. 14, developed by G. Toro of Lettis Consultants International for the EPRI, DOE, and NRC (Reference 2.5-60) study, and used the CEUS SSC earthquake catalog without RLMEs with its published completeness intervals.

2.5.2.4.2 Ground Motion Characterization Model

The NGA-East model (Reference 2.5-135) was adopted as the starting point for the characterization of ground motions for the SSHAC Level 2 study as indicated at the beginning of Section 2.5.2.

The NGA-East project was a multidisciplinary research effort led by the Pacific Earthquake Engineering Center at the University of California, and co-sponsored by the NRC, DOE, EPRI, and USGS. The project, which was conducted over a 10-year period, had two main phases of work: the first phase consisted of a series of scientific research tasks, and the second phase was a SSHAC Level 3 model-building effort.

The ground motion characterization (GMC) model components are summarized in the following sections from the SSHAC Level 2 report.

2.5.2.4.2.1 Median Models

The NGA-East median GMMs are constructed using an innovative approach in which individual GMMs can be thought of as samples from a continuous ground motion space.

A suite of 19 ground motion predictive equations (GMPEs) were developed by a number of different researchers that represented a range of approaches (e.g., stochastic point-source and finite-fault simulations, broadband deterministic simulations, hybrid-empirical approaches, modeling of Fourier spectra of recorded motions). These were used by the NGA-East TI Team to obtain candidate ground motion prediction tables for 374 scenarios resulting from the combination of 11 moment magnitudes (ranging from 4.0 to 8.2) and 34 values of rupture distance (ranging between 0 and 932 mi. [1500 km]). From these predictions, a set of joint continuous distributions of ground motions was developed and constraints were imposed to

guarantee smoothness and physicality of the predictions, as well as the level of uncertainty with magnitude, distance, and frequency.

A model space of 10,000 samples was drawn from these continuous distributions and visualized using the Sammon's map approach that allows representing differences in model prediction using a two-dimensional image. The space was subdivided into an optimal number of cells, determined to be 17, to represent the range of ground motion values. From these 17 cells, Goulet et al. (Reference 2.5-135) obtained 17 median GMMs, weighted based on comparison to empirical CENA ground motion data and density of individual GMPE samples within each cell, with preference (weight 0.8) to density of samples within each cell. The preference for sample density was based on the limited bandwidth of the usable recordings, the magnitude-distance distribution for the CEUS recordings favored relatively low magnitudes at large distances, and large uncertainty in adjusting the recorded motions to the target reference site conditions.

The specified reference site conditions for the NGA-East GMM is a nominal shear wave velocity (V_S) of 9842 feet per second (ft/s) (3000 meters per second [m/s]) and nominal kappa (high frequency seismic waves attenuation parameter) of 0.006 sec. As described in Section 14 of the NGA-East report (Reference 2.5-135), the candidate models used as seed models for NGA-East GMMs were developed for a range of hard rock site conditions, thus incorporating a degree of epistemic uncertainty in the reference rock conditions into the overall epistemic uncertainty in the reference rock median ground motions.

2.5.2.4.2.2 Aleatory Variability Models

The NGA-East TI Team relied on statistical analyses of aleatory variability in motions recorded in CENA and in datasets from active tectonic regions to develop uncertainty distributions for the event-to-event variability (denoted by the symbol τ) and for the single-station within-event variability (denoted by the symbol φ_{SS}). Combining τ and φ_{SS} produces the single-station sigma σ_{SS}. The aleatory variability models were developed independently from the median GMMs.

The form of the aleatory distribution of ground motions was modeled using a lognormal distribution (traditional approach, weighted 0.2) and a mixture of two lognormal distributions (mixture approach, weighted 0.8). For each branch, there are three alternative values for σ_{SS}.

For seismic hazard applications where an ergodic aleatory variability model may be needed, the NGA-East project developed a model for site-to-site variability (φ_{S2S}) based on CENA data with adjustments for the effect of small-magnitude bias and application to hard rock conditions. Epistemic uncertainty in φ_{S2S} was quantified by a three-point discrete distribution like the characterization of uncertainty described above for single-station sigma.

2.5.2.4.2.3 Adjustments

The NGA-East GMM includes three adjustments to the models for median ground motion: (1) attenuation in the Gulf Coast Region (GCR); (2) the effect of source depth; and (3) hanging-wall effect.

The crustal structure and anelastic attenuation in the GCR are different from the Midcontinent Region data on which the NGA-East GMMs are based. NGA-East developed two models to adjust the NGA-East GMMs for GCR attenuation to use in cases where most of the travel path occurs within the GCR.

Goulet et al. (Reference 2.5-135) developed a model for source depth effect because the stress parameter is shown to have a strong dependance on depth for depths shallower than 6.2 mi. (10 km). The source depth effect is parameterized by ΔZ_{TOR} (i.e., the difference between the depth to top of rupture for an individual earthquake rupture [Z_{TOR}], and the magnitude-dependent expected value, $E[\Delta Z_{TOR}]$) and can produce positive or negative adjustments depending on magnitude, frequency, and Z_{TOR}. The adjustment is given by Equation 2.5.2-8:

$$f_{Z_{TOR}} = f_{Z_{TOR,M}} \times \Delta Z_{TOR} \qquad \text{(Equation 2.5.2-8)}$$

Where:

- $f_{Z_{TOR,M}}$ is the magnitude-dependent source depth scaling factor
- ΔZ_{TOR} is the depth deviation from the magnitude-dependent centered Z_{TOR} value.

Equation 2.5.2-9 is used to compute $f_{Z_{TOR,M}}$.

$$f_{Z_{TOR,M}} = \begin{cases} b_1 \ \ for\ \boldsymbol{M} \leq 5.0 \\ b_1 + b_2 \dfrac{\boldsymbol{M} - 5}{1.5} \ \ for\ 5.0 < \boldsymbol{M} \leq 6.5 \\ b_1 + b_2 \ \ for\ \boldsymbol{M} > 6.5 \end{cases} \qquad \text{(Equation 2.5.2-9)}$$

Where:

- b_1 and b_2 are frequency-dependent coefficients given in Table 13-3 of Goulet et al. (Reference 2.5-135)
- **M** is the earthquake moment magnitude

The parameter ΔZ_{TOR} is given in Equation 2.5.2-10:

$$\Delta Z_{TOR} = \begin{cases} Z_{TOR} - E[Z_{TOR}] + 2 \ for\ Z_{TOR} < E[Z_{TOR}] - 2 \\ 0 \ for\ E[Z_{TOR}] - 2 \leq Z_{TOR} \leq for\ E[Z_{TOR}] + 2 \\ \min(10, Z_{TOR}) - E[Z_{TOR}] - 2 \ for\ Z_{TOR} > E[Z_{TOR}] + 2 \end{cases} \qquad \text{(Equation 2.5.2-10)}$$

The NGA-East model documented in Reference 2.5-135 includes focal depth distributions, hypocentral depth ratios (relative depth location of hypocenter within the rupture), and a model for rupture aspect ratio that is conditional on the style of faulting that can be used in estimating Z_{TOR}.

Hanging-wall (HW) effect models are additive terms that adjust ground motions at sites located above dipping rupture planes. These sites are expected to have higher ground motions compared to sites located on the footwall side of earthquake ruptures. These models are generally applicable when the site is in proximity to a known fault. Goulet et al. (Reference 2.5-135) present results of application of HW effects to the hazard from distributed seismicity

sources that show approximately a 2 to 5 percent increase in AFE at the 1E-5 level from application of HW effects to hazard from distributed seismicity sources.

2.5.2.4.3 Evaluation of the Need to Update the NGA-East Model

The process followed by the TI Team to evaluate and determine the need to update elements of the NGA-East model is described at the beginning of Section 2.5.2. The TI Team focused the evaluation of NGA-East in light of new data, models, and methods on the following aspects:

1) The use of an extended set of GMM seeds.

2) Evaluation of NGA-East against an extended database of recordings.

3) Evaluation of aleatory variability model.

4) Evaluation of seismic source parameters for the calculation of Z_{TOR}.

2.5.2.4.3.1 Evaluation of Extended Seed Models

The TI Team evaluated the expanded seed approach adopted for the 2023 update of the National Seismic Hazard Map (NSHM) (Reference 2.5-158). In the NSHM, USGS used the NGA-East models with a weight of 0.667 to represent the ground motion in CEUS and assigned the remaining weight to a subset of the extended NGA-East seed models that included 14 GMMs. The 14 seed GMMs were grouped by their physical characteristics, such as geometric spreading and model type (point source, empirical, hybrid empirical, stochastic), and were weighted based on these groupings. In contrast, the approach used by the NGA-East authors was to develop individual continuous distributions of ground motion in magnitude-distance-frequency space from their seed GMMs, then expand and smooth the resulting distribution beyond what is modeled by the seed GMMs.

To determine whether the use of expanded seeds modifies the CBR of the TDI, the TI Team examined Figure 2.5-50 (Reference 2.5-159). The figure is a representation of the epistemic uncertainty of NGA-East GMMs (red) and updated seed GMMs (green) represented by the range and distribution of median ground motions for a magnitude 7 earthquake. In the top part of the figure, the distance is fixed at 31 mi. (50 km), and the three plots show different spectral periods. At the bottom of the figure, the spectral period is fixed, and the two plots show different distances. The TI Team observation is that:

1. In all cases, the range of epistemic uncertainty in the NGA-East model is much larger than in the 14 seed GMMs.

2. The weighting of the NGA-East models is more similar to a continuous normal probability distribution, whereas the weights assigned to the 14 seed GMMs are random and asymmetric.

Figure 2.5-51(a) (Reference 2.5-160) compares the median ground motion obtained from the NGA-East model (dashed black lines) for a magnitude 5 and a magnitude 7.5 earthquake at a 6.2 mi. (10 km) distance, the extended seed approach (dashed blue lines), and the combination of the two for the 2018 NSHM (red curve). Figure 2.5-51(b) (Reference 2.5-160) compares the median ground motions for a spectral period of 1 sec. as a function of distance for the same two

earthquake magnitudes. The TI Team observation is that the weighted combination of NGA-East and the expanded seed model, illustrated by the red curve, is not significantly different from the prediction obtained using the NGA-East model alone, except for very large magnitude at relatively short distances where the NGA-East prediction is higher than the weighted combination of NGA-East and expanded seed approach.

Based on these evaluations and considering that the NGA-East project examined each sample model drawn from the continuous distributions for physicality and checked that the response spectra resulting from the model are smooth and consistent with physical models of ground motions, the TI Team concluded that the expanded seed model does not improve the representation of the CBR of the TDI.

2.5.2.4.3.2 Comparison of NGA-East with Expanded Database of Recordings

Ramos-Sepúlveda et al. (Reference 2.5-161) studied the compatibility between the NGA-East GMMs and the CENA site amplification model of Stewart et al. (Reference 2.5-162) using an expanded database of observed ground motions that incorporates earthquakes recorded in the CENA region between November 2011 and April 2022. The data were assigned to three regions: (1) Texas-Oklahoma-Arkansas (TOK) with potentially distinct ground motion scaling; (2) Coastal Plain with distinct path effects and relatively deep sediments; and (3) the rest of CENA, which contains the Project site. The updated ground motion database increased the number of recordings at short distances, mostly in the TOK region, but did not extend the magnitude coverage beyond that of the NGA-East database.

The study found a consistent overprediction of ground motions at short periods (0.01 – 0.6 sec.) and underprediction at long periods, with regional variations in the misfit with the TOK region exhibiting larger absolute misfits compared to other areas within the CENA. The authors attribute these discrepancies to two main factors: (1) differences between the site amplification model used during the development of the NGA-East GMMs and the CENA site amplification model by Stewart et al. (Reference 2.5-162); and (2) potential biases in the simulation-based model to adjust hard rock ground motion conditions (V_S approximately 9842 ft/s [3000 m/s]) to site conditions of V_{S30} 2493 ft/s (760 m/s). To address this misfit, the authors propose adjustment factors derived from the expanded CENA database that are added to the natural-log mean ground motions calculated using the NGA-East GMMs.

The TI Team evaluated the work of Ramos-Sepúlveda et al. (Reference 2.5-161) and concluded that the potential bias in the NGA-East GMMs should be addressed in the hazard assessment for the Project. The TI Team decided to conduct further analyses of the residuals between the NGA-East GMMs and CENA-recorded ground motions for conditions specific to the Project site. The site is in the non-TOK, non-Coastal Plain region of the CENA, and is classified as stiff, i.e., $V_{S30} \geq 4921$ ft/s (1500 m/s).

The TI Team extracted peak amplitudes for ground motions from the database compiled by Ramos-Sepúlveda et al. (Reference 2.5-161) recorded from earthquakes with **M** ≥ 4 and distances up to 373 mi. (600 km) in the non-TOK, non-Coastal Plain region. Events classified as potentially induced were not included in the analysis. This selection resulted in a dataset of 23 events (captured in Figure 2.5-52 and Table 2.5-12) and 251 recordings. In Figure 2.5-52, the symbol size is proportional to the earthquake magnitude, the color is based on the number of stiff site recordings available: red for more than 15, white for fewer than 15 recordings. Recorded ground motions were adjusted to hard rock conditions (V_S of 9842 ft/s [3000 m/s])

using the CENA amplification model by Stewart et al. (Reference 2.5-162), and the misfit was calculated as described in Ramos-Sepúlveda et al. (Reference 2.5-161), taking care to adjust the NGA-East GMMs for source depth effects using the values of Z_{TOR} captured in Table 2.5-12 for each earthquake. Figure 2.5-53 illustrates the comparison obtained for the Sparta, NC, earthquake for peak ground acceleration and the spectral acceleration for seven spectral periods ranging from 0.05 to 5 sec. The TI Team obtained similar comparisons for the remaining 22 earthquakes and concluded that the observed ground motions are generally within the range of uncertainty of the NGA-East GMMs.

The TI Team performed a cross-classified mixed-effect analysis to decompose the total residual into mean total residual, event-specific, site-specific, within-event, and within-site components. The analysis was conducted for two ranges of distance to rupture (Rrup): Rrup ≤ 373 mi. (600 km) and Rrup ≤ 249 mi. (400 km). The influence of distance range is not considered significant for spectral periods shorter than 3 s. For longer periods, the TI Team observed greater absolute bias, suggesting the influence of sampling bias. Based on this observation, the TI Team decided to use the misfit calculated for Rrup ≤ 249 mi. (400 km), which is consistent with the distance range used by Ramos-Sepúlveda et al. (Reference 2.5-161) in their evaluations. It is noted that the NGA-East TI Team also limited the distance range of data used for assessing model weights to ≤ 249 mi. (400 km) for the same reason. The mean total residual and the corresponding standard error are captured in Figure 2.5-54 by the blue dots and error bars. In the development of the NGA-East GMMs, the NGA-East authors imposed strong smoothing to ensure that the reference rock response spectra would conform to the expected spectral shapes. To maintain this behavior, the TI Team imposed a strong smoothing on the mean total residual by computing an average constant value for the period range of 0.005 sec. (peak ground acceleration) to 0.2 sec., and a broad triangular smoothing window encompassing 19 adjacent periods for periods longer than 0.2 sec. The corresponding 5th and 95th percentiles were similarly smoothed. The smoothed values are captured in Figure 2.5-54 by the thick black lines. Table 2.5-13 captures the values of mean error and corresponding standard deviation.

2.5.2.4.3.3 Evaluation of Aleatory Variability Models

The TI Team reviewed recently published literature and found no new significant work on aleatory variability beyond that represented in the NGA-East GMM. Consequently, the TI Team adopted the NGA-East partially non-ergodic model for use in the seismic hazard calculations for the Project site. The partially nonergodic model is selected because epistemic uncertainty in site amplification is explicitly incorporated into the analysis in developing site-specific ground motions.

The TI Team also conducted a seismic hazard sensitivity analysis to evaluate the effects of using the weighted combination of lognormal and mixture models to represent the form of the aleatory variability distribution versus using the models individually. The results of the test indicate that using a lognormal or mixture model produces a small difference in hazard at the AFEs of interest (1E-4 to 1E-6): the mixture model produces results that are 0.5 percent to 1.6 percent higher than the total mean hazard obtained as a weighted combination of lognormal and mixture models. Therefore, the TI Team decided to simplify the implementation of the NGA-East model by using only the mixture model.

2.5.2.4.3.4 Evaluation of Seismic Source Parameters for the Calculation of Z_{TOR}

As discussed in Section 2.5.2.4.2.3, the NGA-East GMMs include an adjustment for depth effect that is quantified by the parameter Z_{TOR}. The NGA-East authors developed a relationship to obtain the rupture area as a function of magnitude, focal depth distributions, aspect ratio models, and hypocentral depth ratio distributions for use in calculating Z_{TOR} in the PSHA. The TI Team compared the relationship between rupture area and magnitude with recently published relationships and with observations from the Ramos-Sepúlveda et al. (Reference 2.5-161) extended dataset of recordings and concluded that the relationship between rupture area and magnitude published with the NGA-East model remains valid.

Similarly, the TI Team compared the focal depth distribution obtained by the NGA-East TI Team with updated distributions obtained from the catalog update described in Section 2.5.2.1 and found that, in general, the distribution of depths is consistent between the data prior to 2009 (from the CEUS SSC model) and the data after 2009 (from the updated catalog in Section 2.5.2.1), except for a large number of very shallow earthquakes (depths less than 1.2 mi. [2 km]) in the post-2009 data. These differences are indicative of a potential residual contamination of induced earthquakes in the catalog update. Based on this observation, the TI Team concludes that the focal depth distribution in the NGA-East model is applicable to the seismic hazard for the Project site for the purpose of calculating Z_{TOR}.

2.5.2.4.3.5 Application to the Project Site

Figure 2.5-55 shows the ground motion characterization logic tree adopted for the reference rock hazard calculations. The first node of the logic tree addresses the need to adjust the NGA-East model for bias (see Section 2.5.2.4.3.2): one branch does not include the bias adjustment, i.e., the NGA-East model is used as published; the alternative branch includes the bias adjustment. The TI Team applied equal weighting (maximum uncertainty) to the two branches because there is no clear basis, at this point in time, to determine how much of the bias stems from the NGA-East GMMs and how much from the site amplification model.

The second node of the logic tree applies only if the bias adjustment is selected. The node represents epistemic uncertainty in the amount of adjustment, which is represented by using the median plus or minus the epistemic uncertainty (smoothed 5th and 95th percentiles captured in Figure 2.5-54).

As discussed in Section 2.5.2.4.3.3, the partially non-ergodic aleatory variability model is appropriate for use in the PSHA for the Project site, but only the mixture model is used. This is captured in the last two levels of the logic tree.

Following the discussion in Section 2.5.2.4.2.3, adjustments for GCR are not applicable because there are no travel paths through the GCR from seismic sources of significance to the site hazard. Adjustments for HW effects are assessed to be essentially zero at an AFE of 1E-4 and at most 2 to 5 percent increases in ground motions at an AFE of 1E-5. Including the HW effects from distributed seismicity sources is shown to produce only a small percentage increase (2 to 5 percent) in the range of AFEs of interest. Finally, as discussed in Section 2.5.2.4.3.4, the TI Team found that the parameters required for the calculation of Z_{TOR} provided with the NGA-East model can be used in estimating seismic hazard at the Project site.

2.5.2.4.4 Seismic Hazard Results for Reference Rock

This section describes the PSHA results for reference rock hazard (V_S 3000 m/s, approximately 9842 ft/s) obtained using the SSC model captured in Figure 2.5-49 and the ground motion characterization model captured in Figure 2.5-55.

The minimum magnitude for hazard calculations is 5.0, and the cumulative absolute velocity filter is not applied. Reference rock hazard calculations were conducted for a single location in the center of the Project site. The coordinates of this center point are latitude 36.27295°N, longitude -80.0558°E. The analyses were conducted for peak ground acceleration (PGA) and spectral acceleration response spectral ordinates at frequencies of 100, 50, 40, 33.33, 25, 20, 13.33, 10, 6.67, 5, 4, 3.33, 2.5, 2, 1.33, 1, 0.67, 0.5, 0.33, 0.25, 0.2, 0.13, and 0.1 Hz (periods of 0.01, 0.02, 0.025, 0.03, 0.04, 0.05, 0.075, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5, 0.75, 1, 1.5, 2, 3, 4, 5, 7.5, and 10 sec.). The results extend to cover, as a minimum, to AFE 1E-8.

Figures presented in this section illustrate the effect of elements of the SSC and GMC model for four spectral frequencies (PGA and 10 Hz, 1 Hz, and 0.1 Hz, or spectral periods of 0.1, 1, and 10 sec.) representative of high, medium, and low frequency ranges. Figure 2.5-56 shows the relative contribution to the total mean hazard (black) from distributed seismicity sources (blue) and RLME sources (red). At the annual frequencies of interest (1E-4 to 1E-5), the hazard is controlled by the distributed seismicity sources for high frequency motions (PGA to 10 Hz), while the RLMEs become the dominant contributors to the hazard for low frequency motions.

The total mean reference rock hazard is deaggregated to show the distributions of magnitude-distance-epsilon (number of standard deviations in the ground motion) combination that contributes to hazard. Deaggregation histograms are captured in Figure 2.5-57 to Figure 2.5-60 for AFEs of 1E-4, 1E-5, 1E-6 (return periods of 10,000, 100,000, and 1 million years, respectively). As discussed above, the hazard for high frequency motions (PGA and 10 Hz [0.1 sec.] spectral acceleration) at AFE 1E-4 is contributed primarily by distributed seismicity sources, which cover a broad range of magnitude and distances within 62 mi. (100 km) of the site, with smaller contributions by RLME sources, which are large-magnitude earthquakes at distances of 186 mi. (300 km) or more from the site. For annual frequencies of exceedance smaller than 1E-4, the RLME contribution decreases. This is evident in Figure 2.5-57 and Figure 2.5-58 for return periods of 100,000 and 1 million years (parts [b] and [c] of each figure), where the hazard is dominated by distributed seismicity sources.

For 1 Hz (1 sec. period) spectral acceleration (Figure 2.5-59), the largest contributions to the total mean hazard at AFE 1E-4 to 1E-6 are associated with the Charleston RLME source, as illustrated by a peak contribution centered around magnitude 7.5 at distance of about 186 mi. (300 km). For 0.1 Hz (10 sec.) spectral acceleration (Figure 2.5-60), the hazard is dominated by the New Madrid RLME source, as shown by the peak centered around magnitude 7.8 at a distance of more than 311 mi. (500 km).

Sensitivity analyses explore the effect of specific modeling alternatives on the total hazard. In these analyses, the total mean hazard is obtained by systematically assigning a weight of 1.0 to one branch of the logic tree and zero to the other alternatives at a specific node, while keeping the rest of the logic tree unaltered. The elements of the logic tree that have been tested for sensitivity include the alternative geometry of the MESE boundary and the choice of including the bias adjustment and its epistemic uncertainty. These nodes represent the refinements to the

published CEUS SSC (Reference 2.5-60) and NGA-East (Reference 2.5-135) models introduced by the SSHAC Level 2 TI Team.

Figure 2.5-61 shows the effect of using alternative boundaries for MESE: the site hazard computed using the geologic boundary is represented by the red curve, while the hazard computed using the geophysical boundary is represented by the green curve. The geophysical boundary corresponds to the published CEUS SSC model and places the Project site in the PEZ seismotectonic zone, and the geologic boundary places the Project site in the ECC-AM seismotectonic zone. As Figure 2.5-61 shows, the effect of introducing an alternative boundary is to reduce the hazard for high frequency motions, compared to using the CEUS SSC model as published. Low frequency motions are not affected by the alternative MESE boundary because the hazard is dominated by RLME sources.

Figure 2.5-62 shows the effect of introducing bias adjustments to compensate for the potential misfit between NGA-East predictions and recorded ground motions. The mean hazard curve obtained without applying the bias correction is illustrated in green: this corresponds to a direct implementation of the published NGA-East model. The solid blue curve represents the hazard obtained when the bias adjustment is applied, and the dashed curves represent the epistemic uncertainty on how large the adjustment for bias should be. As Figure 2.5-54 shows, the level of bias adjustment is frequency-dependent, meaning that for high frequencies (between PGA and 5 Hz [0.2 sec.]) the adjustment is constant, with median and 5th percentile (in lognormal scale) being less than zero and the 95th percentile being greater than zero. As frequency decreases (between 5 Hz [0.2 sec.] and 0.33 Hz [3 sec.]), the bias adjustment progressively increases, although the median and 5th percentile remain less than zero and the 95th percentile remains greater than zero. Only for very low frequency (0.2 Hz [5 sec.] to 0.1 Hz [10 sec.]) the mean and 95th percentiles are both greater than zero, while the 5th percentile remains less than zero. This behavior is reflected in the curves on Figure 2.5-62, where PGA and 10 Hz (0.1 sec.) are similar (parts (a) and (b) of the figure), 1 Hz (1 sec.) shows a larger difference between the “no bias” and the upper branch of the bias adjustment (part (c) of the figure), and for 0.1 Hz (10 sec.), the bias adjustment is higher than the “no bias” results because both median (labeled “Bias Central” in the legend) and 95th percentile (labeled “Bias Upper” in the figure) are greater than zero.

Variance histograms show the combined effect of the range in hazard and the weights assigned to the various branches in the logic tree. The fractional contributions of the variance from each level of the logic trees in Figure 2.5-49 and Figure 2.5-55 to the total variance are captured in Figure 2.5-63 for PGA and 10 Hz (0.1 sec.) spectral acceleration and in Figure 2.5-64 for 1 Hz (1 sec.) and 0.1 Hz (10 sec.) spectral acceleration. Histograms are obtained for AFEs of 1E-4 (blue), and for AFE 1E-5 (red). Histograms for the two AFEs are similar: the single largest variance is always associated with the uncertainty in the median NGA-East model. For high frequency motions (Figure 2.5-63), the nodes of the logic tree associated with uncertainty in the earthquake recurrence and Mmax on the distributed seismicity zones have contributions between 5 and 20 percent, larger contributions for AFE 1E-5. For low frequency motions (captured on Figure 2.5-64), the nodes associated with magnitude and frequency of RLMEs contribute about half or more of the total variance. The bias adjustment and the alternative basis for the MESE boundary do not have significant variance contributions, just a small percentage at high frequency motions.

2.5.2.5 Seismic Wave Transmission Characteristics of the Site

This section describes the data available to characterize the propagation of seismic waves from the reference rock condition of the NGA-East ground motion models to the control point depths of the technologies being considered for each Plant Complex. These data are used to develop the site response model and site amplification functions that compute performance-based response spectra (see Section 2.5.2.6).

Section 2.5.2.5.1 contains a description of the location and the configuration of the Plant Complexes, including a description of the topography and planned site grading. A summary of the parameters used in SRA, such as velocity profiles, modulus reduction and damping curves, properties of the fill materials, unit weights, and site attenuation parameter kappa, is also presented in Section 2.5.2.5.1.

A description of the approach and logic tree for SRA analyses opens Section 2.5.2.5.2, which continues with discussions of the profile randomization, calculation of conditional mean spectra (CMS), and derivation of site amplification functions (SAFs).

The final part of this section discusses topographic effects and summarizes the design recommendations.

2.5.2.5.1 Site Conditions

The site geology is described in detail in Section 2.5.1 and can be summarized as consisting of the inner Piedmont Cambrian Gneiss and Schist and residual soils (sand, silt, and some clay) of the Cecil-Appling-Pacolet soil series. The TI Team developed cross sections of the Project site, generally following the axis of the peninsula and extending into Belews Lake. The cross section in Figure 2.5-65 shows the main rock and soil units present at the Project site. As captured in the figure, the topography is moderately steep, with ridge slopes at angles of 11 degrees to 18 degrees. The depth to top of bedrock and thickness of overburden and partially weathered rock vary across the site. Across the site, i.e., at the center of the ridge and along the slopes, the average depth to bedrock and variability of that depth to bedrock are similar, as illustrated on Figure 2.5-66.

Ground surface elevations range from 760 ft. (232 m) to 850 ft. (259 m) in the three complex areas, with the toe of the ridge slope at an elevation of about 720 feet. Figure 2.5-67 part (b) shows the elevation of the planned finished grade (yellow) and the estimated bedrock surfaces based on the median depths to rock from boring data (solid blue curve), and one standard deviation (dash-dotted curves), for the North Plant Complex. The location of the cross section is shown in Figure 2.5-67 part (a). Similar plots are captured in Figure 2.5-68 for the Middle Plant Complex, and in Figure 2.5-69 for the South Plant Complex. As the figures show, varying amounts of cut and fill are needed to grade each Plant Complex to reach the planned pad elevation of 810 ft. (247 m).

Figure 2.5-70 shows in more detail the topography of the North Plant Complex in the area where future safety-related structures may be located. The safety-related area (black polygon) is approximately 800 ft. x 1800 ft. (244 m x 549 m), and the planned pad elevation is 810 ft. (247 m). To capture the variability in ground surface, soil/fill thickness, and corresponding depth to bedrock, the TI Team determined that site response analyses should be performed for three 300 ft. x 300 ft. (91 m x 91 m) areas (red squares in the figure) representing the approximate

spatial dimension of nuclear facilities (Reference 2.5-163): one located in a central ridge location, one located in the upper slopes, and one located farther down the slope at the corner of the area. These locations give rise to two possible scenarios: one in which the materials above the target pad elevation of 810 ft. (247 m) are removed (labeled "cut,") the other in which fill material must be added to reach the target pad elevation (called "fill"). Depending on the ground surface elevation, the amount of material that must be cut varies, as Table 2.5-14 shows. The table summarizes the different site conditions for the three locations selected for SRA in the North Plant Complex. The TI Team conducted a sensitivity analysis to determine whether the two site grading cases (cut and fill) were sufficient to capture variability in site amplification across the site, or if additional cases should be added to capture intermediate conditions. Figure 2.5-71 shows an example of this analysis for the North Plant Complex for a scenario magnitude of 7 along with two alternative velocity profiles (see Section 2.5.2.5.2). On each plot, the purple and red curves correspond to the cut and fill cases, while the blue curve is obtained using velocity profiles for the site that do not include any amount of cut or fill. The TI Team concluded that the site grading cases tested for the North Plant Complex result in very similar amplifications at the top of partially weathered rock (PWR). For the control point at the surface, the results generally capture the range of possible site amplifications. The TI Team included a case with 10 ft. (3 m) of cut to obtain a smoother transition between the amplification peaks produced by various cases.

The TI Team used similar considerations to determine the site grading cases to use in SRA for the Middle and South Plant Complexes. Figure 2.5-72 and Figure 2.5-73 show the safety-related areas (black polygons) and site areas for SRA (red boxes) in the Middle and South Plant Complexes, respectively. The size of the red boxes is the same in the Middle and South Plant Complexes as in the North Plant Complex; the size of the safety-related area (black polygon) in the South Plant Complex is approximately 1500 ft. x 1800 ft. (457 m x 549 m). As described for the North Plant Complex, there are two possible site grading scenarios (cut or fill), and different amounts of material (removed or added), as Table 2.5-15 shows for the Middle Plant Complex and Table 2.5-16 shows for the South Plant Complex.

The TI Team noted that the depth to bedrock is generally shallower for the Middle Plant Complex (40 ft. [12 m]) compared to the average depth to bedrock for the North and South Plant Complexes (50 ft. [15 m]). The site grading scenarios applicable to the Middle Plant Complex are very similar to those obtained from North Plant Complex.

As Table 2.5-16 shows, the amount of cut and fill necessary to reach the planned pad elevation is greater in the South Plant Complex compared to the North and Middle Complexes. For this reason, TI Team used five scenarios to capture the variability in the topography for the South Plant Complex: three scenarios correspond to the three scenarios for the North and Middle Plant Complexes and two scenarios capture the larger amounts of cut (38 ft. [11.5 m]) and fill (40 ft. [12 m]) present in the South Plant Complex.

2.5.2.5.2 Velocity Profiles

This section describes the development of V_S profiles representative of the North, Middle, and South Plant Complex areas using the velocity data collected at the site, as well as suspension logging, downhole measurements, and Spectral Analysis of Surface Waves (SASW) testing. Section 2.5.4 discusses the velocity data in more detail.

Figure 2.5-74 compares V_S profiles obtained with different datasets: solid curves represent profiles obtained from suspension logs, and dashed curves are the profiles obtained from SASW measurements. The black dash-dotted curve on each plot is the velocity profile from downhole measurements at the deep borehole in each Plant Complex. As shown, the downhole and suspension log data have large gradients in the velocity around a depth of 50 ft. (15.2 m) at the soil-to-bedrock transition zone and higher velocities in the rock of around 8000 to 10,000 ft/s (2438 to 3048 m/s). The TI Team compared the depth to rock for each boring with geophysics to the depth of the large gradient in the suspension log data for each boring and found the depths to be similar. The SASW data differ in that they show a thicker lower velocity PWR layer with V_S around 2000 to 2500 ft/s (610 to 762 m/s), and lower velocities (about 6000 to 8000 ft/s [1829 to 2438 m/s]) for the rock.

The red square symbols are laboratory unconfined free-free (Fr-Fr) measurements from samples collected at each complex area. The majority of Fr-Fr testing results have velocities similar to the suspension log and downhole datasets, although three samples have lower velocities, around 2000 to 2500 ft/s (610 to 762 m/s), with one of those samples located in the upper portion of the bedrock and the other sampled from about 160 ft. (48.8 m) in depth. One of the three samples is located in the PWR and shows similar velocities to those obtained from suspension logs in the PWR.

Figure 2.5-75 compares the V_S profiles along the 12 SASW arrays and includes an average SASW profile (solid black curve). The figure shows that velocities are generally similar in the three complexes.

The TI Team evaluation of suspension log data is illustrated in Figure 2.5-76. Part (a) of the figure shows the data collected at each Plant Complex, color-coded to identify the location of the boreholes: blue dots are individual measurements from boreholes located in the North Plant Complex, orange dots are from the Middle Plant Complex, and green dots are from the South Plant Complex. The red line represents the average shear wave velocity profile obtained combining measurements from the three Plant Complexes. The deepest log (at B-8 in the Middle Plant Complex) measured a consistent V_S of more than 10,000 ft/s (3000 m/s) below a depth of about 275 ft. (84 m). The TI Team used this observation to place the reference rock halfspace at that depth for the three Plant Complexes. Part (b) of Figure 2.5-76 shows the average V_S profiles evaluated for each Plant Complex using three suspension logs for each profile and the average V_S profile obtained using all the data.

The TI Team made two observations from Figure 2.5-76. The first is that the transition to higher velocities occurs at a shallower depth in the Middle Plant Complex compared to the other two Plant Complexes. Given that the site grading scenarios are the same for the North and Middle Plant Complex, the TI Team conducted a sensitivity analysis to determine whether the difference in velocity profiles yields significantly different SAFs between the North/South and Middle Plant Complexes. An example of the sensitivity analysis is captured in Figure 2.5-77 for a magnitude 7 scenario, for control points at the surface and at the top of the PWR: the red curves are SAFs obtained using velocity profiles derived for the North Plant Complex and the blue curves are SAFs obtained using velocity profiles derived for the Middle Plant Complex. The TI Team concluded that the variability in results between the North and Middle Plant Complex is smaller than the larger variability resulting from epistemic uncertainty in input model parameters. Consequently, the TI Team calculated one set of SAFs applicable to North and Middle Plant Complexes. The second observation made by the TI team on Figure 2.5-76, is that the variations between the average V_S profiles obtained within each Plant Complex were within the

range of variations observed across the entire Project site. The TI Team concluded that the overall average V_S profile obtained by combining all the suspension logs is appropriate for use in SRA. The suspension logging V_S profile is listed in Table 2.5-17.

The TI Team compared downhole V_S measurements to the suspension log data for the same borehole and found that the velocities were similar; therefore, the TI Team did not develop an average velocity profile for the downhole data.

SASW measurements conducted at the Project site included four arrays in each Plant Complex. The V_S profiles for the 12 arrays vary from the V_S measurements from suspension log and downhole data as captured in Figure 2.5-74, with generally lower velocities, particularly for the PWR and upper rock portions of the profiles. The TI Team noted that these differences are present even for those arrays that are located adjacent to boreholes with suspension logging testing. The TI Team evaluated whether the ground surface elevations and direction of source input for the SASW arrays could be correlated to changes in the V_S profiles, but no correlations were found. The SASW V_S profile is captured in Table 2.5-18. The TI Team placed the halfspace reference rock elevation at the average bottom depth of the SASW-derived profiles (540 ft. [164.6 m]) to capture the uncertainty in the depth of the reference rock horizon. The velocity of the halfspace was assumed to be the same as for the suspension log profile because the SASW data did not reach layers with velocities above 9000 ft/s (2743 m/s).

The TI Team compared the dispersion curves computed for the mean profile derived from suspension log data and those calculated for the mean profile derived from SASW with the experimental dispersion data. This comparison is captured in Figure 2.5-78: data points represent experimental dispersion data, while the solid red and green curves are the dispersion curves from suspension logging and SASW velocity profiles, respectively. The mean and three standard deviation bounds of the compacted dispersion curves from SASW are also illustrated on the figure. The comparison shows relative agreement between the mean and standard deviation of the dispersion curves from the velocity profiles and the experimental data. TI Team used this comparison to conclude that the suspension log profile appears to be consistent with the upper part of the dispersion curve dataset for the site and that both the suspension log and SASW profiles are reasonable interpretations of the subsurface conditions at the Project site.

To account for a reduction or increase in isotropic confining pressure (σ_0) based on either a cut or fill scenario, the TI Team adjusted the V_S in the soil using data from resonant column torsional shear (RCTS) testing of eight intact soil specimens. Figure 2.5-79 shows the variation in the small-strain V_S with increasing (normally consolidated range) or decreasing (overconsolidated range) confining pressure. The adjustments range from reductions of about 50 to 250 ft/s (15 to 76 m/s) for cut scenarios that use the overconsolidated range and increases of about 100 to 450 ft/s (30 to 137 m/s) for the fill scenarios that use the normally consolidated range.

2.5.2.5.3 Evaluation of Site Kappa

The TI Team computed the site attenuation parameter kappa (κ_0) in two ways: (1) using the Anderson and Hough (Reference 2.5-164) waveform-based estimation; and (2) using empirical relationships.

For the first approach, the TI Team obtained recordings of recent earthquakes from stations with geologic conditions similar to the Project site. Table 2.5-19 shows the list of stations in NC and

Virginia from the N4 (Central and Eastern U.S. Network) and Transportable Array networks that the TI Team evaluated. Of the stations with similar geology to the Project site, only two, N4.T57A and N4.U56A, had ground motion records with high signal-to-noise ratio. The stations are located within approximately 62 mi. (100 km) of the Project site. Each station recorded 12 earthquakes, and the TI Team used these records to compute kappa.

The TI Team downloaded the horizontal components of these recordings from the data center of the Incorporated Research Institutions for Seismology and processed the recordings by correcting for instrument response and then by removing the mean. The value of kappa was computed from the smoothed and unsmoothed Fourier amplitude spectra (FAS) of each horizontal component using the Anderson and Hough (Reference 2.5-164) acceleration slope methodology, in which a line is fitted to the natural logarithm of FAS as a function of frequency. Kappa is obtained from the slope of the fitted line. Three frequency ranges were used to derive kappa: 15 – 35 Hz; 20 – 35 Hz; and 15 – 30 Hz. These ranges are similar to those used in Reference 2.5-136 to estimate kappa from recordings.

Figure 2.5-80 shows the average of kappa from two horizontal components calculated using the widest reliable frequency range, plotted as a function of distance. The TI Team excluded records with a difference of more than 20 percent between the kappa values computed from the two horizontal components and records with distances greater than 373 mi. (600 km). Following Anderson and Hough (Reference 2.5-164), a linear trend was fitted to the data and used to remove the distance dependence for kappa. The resulting kappa ranges between 0.03 and 0.04 sec., and the TI Team concluded that a value of 0.033 sec. was appropriate to represent the range.

For the second approach, the TI Team considered the empirical relations of Campbell (Reference 2.5-165), Van Houtte et al. (Reference 2.5-166), and Xu et al. (Reference 2.5-167), which are applicable to stable continental regions according to Rodriguez-Marek et al. (Reference 2.5-136). Campbell (Reference 2.5-165) developed an equation to estimate kappa by modifying the general model for kappa in Hough and Anderson (Reference 2.5-168) and propose four models to capture the variability of the effective quality factor at depth. The TI Team obtained a kappa value for each of the four models and computed the geometric mean of kappa, which is 0.010 s. The empirical equation from Van Houtte et al. (Reference 2.5-166) was developed using data from the NGA database, the Kiban Kyoshin Network (KiK-net), and previous literature. Using this method, the TI Team obtained a site kappa of 0.040 s. Xu et al. (Reference 2.5-167) derived their model for kappa using data from 51 sites from the KiK-net. The resulting site kappa calculated by the TI Team is 0.020 s.

Table 2.5-20 summarizes the values of kappa calculated by the TI Team and the assigned relative weights. The highest weight (0.5) is assigned to the kappa value obtained with the Campbell (Reference 2.5-165) empirical relationship because the model is derived for CENA and is based on a more robust dataset than the waveform analysis conducted by the TI Team. The kappa from waveform analysis is given weight of 0.3 because the values are evaluated from site-specific data at recording stations located on similar geologic units as the Project site. Kappa values based on Xu et al. (Reference 2.5-167) and Van Houtte et al. (Reference 2.5-166) receive weights of 0.16 and 0.04, respectively, because these empirical equations are derived from data from the Japanese KiK-net database, which is not directly applicable at the Project site. The higher weight assigned to Xu et al. (Reference 2.5-167) compared to Van Houtte et al. (Reference 2.5-166) is because the Xu et al. model (Reference 2.5-167) incorporates the depth to the 2.5 km/s (3281 ft/s) V_S horizon. The weighted average site kappa for the Project site is

0.02 s, which is consistent with kappa estimates (0.018 s) in the Piedmont region of South Carolina near Lake Monticello obtained by Chapman et al. (2003)(Reference 2.5-169).

EPRI (Reference 2.5-163) recommends an epistemic uncertainty in site kappa of $\sigma\left(ln(\kappa_0)\right) = 0.4$; Xu et al. (Reference 2.5-167) reports instead an uncertainty of $\sigma\left(ln(\kappa_0)\right) = 0.22$. The TI Team applied the $\sigma\left(ln(\kappa_0)\right) = 0.22$ value to each value of kappa from Table 2.5-20 and derived the cumulative density function (CDF) for kappa, from which they extracted the 10th, 50th, and 90th percentiles. Following recommendations in EPRI (2013) (Reference 2.5-163), the TI Team assigned weights of 0.3, 0.4, 0.3 to the three percentiles. A sensitivity analysis showed that sampling five branches from the CDF instead of three does not provide a better representation of the uncertainty in site kappa. The site kappa model for use in SRA is given in Table 2.5-21.

2.5.2.5.4 Shear Modulus Reduction and Damping

The TI Team derived two sets of shear modulus reduction and damping curves (material curves) to capture the uncertainty in the residual soils. Note that the upper soils, which are likely to be removed during grading operations, were not included in the analyses.

The first set of material curves for residual soils was derived using the RCTS results, which were fit with a power function similar to Darendeli (2001) (Reference 2.5-170). The fitted curve was then used to derive modulus reduction curves for five different confining stresses that represented the range of possible depths for the residual soils. Even though the RCTS testing was performed on samples in the upper 24 feet of the residual soils, the derived material curves are applicable to all depth ranges because the residual soils had consistent soil types across all depths, and the material curves are extrapolated to higher confining stresses to be appropriate for the deeper residual soils. The five different confining stresses represented approximately 15-foot-thick layers going from an average depth of 7.5 ft. (2.3 m) to about 67.5 ft. (20.6 m). These modulus reduction curves are captured in the top part of Figure 2.5-81. To confirm that the higher strain portion of the curves is representative of the shear strength of the residual soils based on lab strength testing, the TI Team plotted the shear strain versus shear stress curves for the lab-derived modulus reduction curves, evaluated using the approximate V_S values for the residual soils. The shear strength data showed no trend with depth of the sample tested; therefore, the data were compared to material curves for various depth ranges. Also captured on Figure 2.5-81 are the undrained shear strength results for residual soils from the unconfined compressive strength and unconsolidated-undrained triaxial compression tests for the Project site. These test results are plotted at an arbitrary 2 percent shear strain for comparison to the curves. The TI Team concluded that the lab strength data generally match the range of shear strengths interpreted from the modulus reduction curves, especially considering that the lab data are obtained from samples at shallower depths than about 20 ft. (6 m). Consequently, the TI Team did not adjust the modulus reduction curves at high strains.

A similar process was used to derive the damping curves from the RCTS lab testing for the residual soils. The TI Team fitted the minimum damping (Dmin) versus the confining stresses values from laboratory testing with a power function, which results in an average Dmin of about 1.8 percent for the residual soils. The TI Team found that the RCTS results for damping were adequately matched using the standard coefficients from Darendeli (Reference 2.5-170). Figure 2.5-82 shows the lab-derived damping curves for the residual soils.

The second set of material curves for residual soils is directly based on the Darendeli (Reference 2.5-170) equations for modulus reduction and damping using a plasticity index of 0,

consistent with the results of laboratory testing and other standard parameters. The modulus reduction and damping curves for the residual soils are captured in Figure 2.5-83(a). The TI Team did not adjust the high strain portions of the Darendeli (Reference 2.5-170) curves because the interpreted shear stress versus shear strain curves are similar to those captured in Figure 2.5-83(b) at strains above about 1 percent.

The TI Team used two sets of curves to capture uncertainty in the material curves for the rock layer (i.e., PWR and rock). The curves were evaluated for lower reference strain and higher reference strain sets. For PWR, the TI Team adopted the curves for unweathered shale from Stokoe et al. (2003) (Reference 2.5-171) and EPRI (2013) (Reference 2.5-163) rock for a depth of 2000 to 5000 ft. (610 to 1524 m). These curves are captured in Figure 2.5-84. For rock layers with V_S less than 8000 ft/s (2438 m/s) the TI Team assumed the rock to be linear for the more linear set of curves and used the unweathered shale Stokoe et al. (Reference 2.5-171) curves for the less linear set. The TI Team assumed rock layers with V_S above 8000 ft/s (2438 m/s) to be linear for both sets of reference strains.

Rodriguez-Marek et al. (Reference 2.5-136) indicate that the cumulative impact of small-strain damping (Dmin) must be compatible with the assigned values of kappa for the site. The TI Team adjusted the small-strain portion of the damping curves to match the kappa values in Table 2.5-21 using the approach presented in Xu et al. (Reference 2.5-167). First, the TI Team used the models from Campbell (Reference 2.5-165) to obtain Dmin values in the rock layers, based on the V_S profile from suspension logging (see Table 2.5-17). The resulting Dmin values ranged from 0.7 percent to 0.9 percent. The TI Team then conducted linear site response analysis using the calculated Dmin values in the rock, the lab-derived material curves for the residual soils (Dmin of 1.8 percent), and the Stokoe et al. (Reference 2.5-171) unweathered shale curve for the PWR (Dmin of 1.0 percent). This calculation produced a kappa value of 0.012 sec. for the surface output FAS. The TI Team found that the halfspace and intrinsic profile kappa was equal to 0.007 s, and that the remaining 0.005 sec. were the contribution of the profile damping. The TI Team considers the calculated scale factors to be in the range of scale factors reported in Xu et al. (Reference 2.5-167). For the 10th percentile kappa value of 0.007 s, the profile should have insignificant damping; therefore, the TI Team imposed a Dmin of 0.1 percent in all layers to limit the damping to a small value. The resulting scaled Dmin values for various soil and rock units for the range of kappa values are captured in Table 2.5-22. The small-strain damping values for the highest kappa value of 0.035 sec. are very high compared to the original damping values and the damping values for a kappa value of 0.014 sec. The TI Team noted that these values represent the upper 90th percentile Dmin values and thus represent the upper range of enhanced wave scattering effects on the damping. Given the relatively thin soil profile for the Project site, these high Dmin values are necessary to achieve kappa values that correspond to those obtained from inversion of earthquake recordings for similar geologic conditions. Figure 2.5-85 shows two examples of the adjustments to the small-strain damping to match the site kappa. The top part of the figure shows the adjustments to the lab-derived damping curves for residual soils (0 to 15 ft. [0 to 4.6 m] in depth) and the bottom part shows the adjustments applied to the Stokoe et al. (Reference 2.5-171) unweathered shale curve for PWR. For site kappa of 0.007 sec. (orange curves in Figure 2.5-85), the TI Team used the small-strain damping values for shear strains of 0.0005 percent to 0.001 percent, beyond this level the curve is smoothly transitioned to the original (unadjusted) curve (dashed curves in Figure 2.5-85). For the other kappa values, the damping is constant in the low shear strain portion until the original curve is reached.

2.5.2.5.5 Dynamic Properties for Fill Materials

The dynamic properties of fill materials are described in Section 2.5.4. Table 2.5-23 contains the V_S profiled developed by the TI Team, which includes a top layer with V_s of 1000 ft/s (305 m/s). To define how the velocity in the fill would increase with depth, the TI Team relied on equations from Seed et al. (1984) (Reference 2.5-172) and prior experience with granular fill. Material curves for the fill are based on the range of curves from Seed and Idriss (1970) (Reference 2.5-173), Rollins et al. (1998) (Reference 2.5-174), and on experience with granular fill with gravel.

2.5.2.5.6 Layer Unit Weights

The TI Team developed unit weight for the upper residual soils and the rock units using data from lab testing. An average value of 100 pounds per cubic foot (pcf) (1602 kilograms per cubic meter [kg/m^3]) was evaluated for the upper residual soils and an average value of 170 pcf (2723 kg/m^3) was evaluated for the rock layers. The TI Team reviewed boring logs that indicated that residual soils below about 20 to 30 ft. (6 to 9 m) in depth had higher blow counts than soils above that depth. Consequently, the TI Team assigned a unit weight of 115 pcf (1842 kg/m^3) to the residual soils below depths of about 20 to 30 ft. The TI Team relied on prior experience to assess a unit weight of 135 pcf (2162 kg/m^3) to the PWR. Fill materials are assigned a unit weight of 120 pcf (1922 kg/m^3).

2.5.2.5.7 Site Response Analysis

The TI Team conducted site response analyses to develop amplification functions that capture the uncertainty in the location of future reactors and control point depths. The TI Team conducted a series of sensitivity analyses to evaluate the base depth and base elevations of the technologies considered for deployment at each Plant Complex (summarized in Table 2.5-24 and captured in Figure 2.5-65 by the dashed red lines). The parameters in Table 2.5-24 were provided to the TI Team in the Hazard Products Document and included only five technologies. The TI Team did not evaluate the sixth technology (TerraPower); however, it has a similar base elevation to Technology 4 in Table 2.5-24, such that design response spectra (DRS) applicable to Technology 4 can also be considered valid for TerraPower. Examples of these analyses results are captured in Figure 2.5-86 for alternative velocity profiles, alternative site grading cases, AFEs, and earthquake magnitudes. The TI Team concluded that the control points for technologies 2 and 3 in Table 2.5-24 could be represented by a single depth of 85 ft. (26 m) for the purpose of conducting site response analyses, except for the South Plant Complex, where the control point at depth of 115 ft. (35 m) was also analyzed separately. The combination of control points and alternative site grading conditions (see Table 2.5-14 to Table 2.5-16) gives rise to 21 site response analysis cases, which are summarized in Table 2.5-25.

The TI Team developed a logic tree for conducting site response analysis, which is captured in Figure 2.5-87. The first node addresses the methodology used to conduct SRA. The TI Team chose the equivalent linear (EQL) Random Vibration Theory (RVT) approach to site response analyses, which was originally implemented in the code Strata (Reference 2.5-175). The version of the code used by the TI Team implements RVT site response analysis with Vanmarcke's (Reference 2.5-176) peak factor formulation and Boore and Thompson (Reference 2.5-177) oscillator duration adjustment for CENA. In each SRA, the input motion is applied at the base of the profile as an outcropping motion. For each epistemic alternative case, the TI Team used 60 randomized profiles and sets of properties. The input FAS are obtained by calculating broadened CMS (Reference 2.5-178) and then inverting the response spectra to Fourier

amplitude using Inverse Random Vibration. Outputs of the SRA are response spectra at the control point elevations and peak shear strains and strain compatible properties in each layer. To address the underprediction of the high-frequency components of motion at large strains, Xu and Rathje (Reference 2.5-179) proposed a kappa correction to the FAS computed from EQL site response analysis. The National Center for Research on Earthquake Engineering (Reference 2.5-180) modified this kappa correction method so that the EQL FAS remains unmodified below a specified transition frequency. This kappa correction approach is designated the kappa2 approach. The transition frequency is based on the frequency at which the EQL FAS decreases below some fraction of its peak. The TI Team used the values recommended in Rodriguez-Marek et al. (Reference 2.5-136), i.e., 0.05, 0.11, and 0.17 with weights of 0.2, 0.6, and 0.2. This is captured in the second node of the logic tree in Figure 2.5-87. The kappa2 approach (kappa-corrected EQL) receives a weight of 0.7 compared to the unadjusted EQL (weight 0.3). TI Team assigned a weight of 0.3 to the unadjusted results following indications in Rodriguez-Marek et al. (Reference 2.5-136) that the unadjusted amplification (without using the kappa2 approach) could still be valid.

Xu and Rathje (Reference 2.5-179) observed that kappa does not vary systematically with the induced shear strain but remains at its small-strain value. Their study also demonstrates motions computed using the small-strain kappa as κ_{target} in a kappa-corrected EQL analysis are more consistent with recorded motions. Following Rodriguez-Marek et al. (Reference 2.5-136) and Xu and Rathje (Reference 2.5-179), the small-strain kappa values evaluated from linear site response runs for each analysis (randomized profile and input motion combination) were used as the target kappa for each analysis. The TI Team applied the kappa2 approach after the calculation of iterated equivalent linear site response, with the modifications only applied to the output FAS. Subsequently, the modified site response FAS at the target horizons are converted back to response spectral values for use in computing site amplification factors. The kappa2 approach is only applied to the output when the peak shear strain in the profile is above 0.1 percent (i.e., the minimal level at which, according to Zalachoris and Rathje (Reference 2.5-181), the equivalent linear analysis may not be reliable). The kappa2 approach adjustments are not applied to periods above 1 sec. because EQL analyses are reliable at higher periods. Preliminary site response analyses show that the effect of the kappa2 approach is generally small (negligible at frequencies below about 2 Hz and at lower ground motion levels) and that the correction is needed when the maximum shear strains in the rock is above 0.1 percent. The kappa2 approach was not implemented for control point elevations in the rock, i.e., top of PWR; reactor base depths of 44 ft. (13 m) and below for the cut locations (number 1, 2, and 4 from Table 2.5-24); reactor base depth of 85 ft. (25.9 m) and below for the thinner fill location (number 3 in Table 2.5-24); reactor base depth of 115 ft. (35 m) and below for the thicker fill location (number 5 in Table 2.5-24).

The third node of the logic tree addresses the uncertainty in the velocity profile (see discussion in Section 2.5.2.5.2). The TI Team conducted a sensitivity analysis to evaluate whether the results obtained with the two velocity profiles captured a range of amplification and to determine the variability of the results. Figure 2.5-88 shows examples of the SRA sensitivity analyses that the TI Team conducted. The plots compare a site amplification function calculated with the velocity profile obtained using suspension log data (in purple) and one calculated with the velocity profile obtained with SASW data (in green). Plots are presented for cut and fill scenarios and for control points at the surface and at the top of the PWR (interface). The TI Team determined that the results capture a range of amplifications and that large differences between the results occur, in particular for the control point at top of PWR. The V_S profile from suspension logging receives a higher weight compared to the SASW profile because the

velocities from suspension log data, downhole data, and URC Fr-Fr testing are consistent. Additionally, the boring logs also indicate higher velocity at shallow depths, consistent with the P-S profile.

The fourth level of the logic tree addresses the uncertainty in alternative material curves. As discussed in Section 2.5.2.5.3, the TI Team developed two sets of curves: one based on laboratory testing results on samples collected at the site (called “site-specific set” in Figure 2.5-87), the other based on the Darendeli (Reference 2.5-170) curves. The TI Team preference for the site-specific set is motivated by the fact that the curves are derived using site-specific RCTS data and should, therefore, represent the nonlinear behavior of site soils better than the Darendeli (Reference 2.5-170) curves.

The fifth and final level of the logic tree in Figure 2.5-87 addresses the uncertainty in site kappa, which is described in Section 2.5.2.5.3.

2.5.2.5.7.1 Randomization of Velocity Profiles and Material Curves

The V_S profiles and material curves described in Sections 2.5.2.5.2 and 2.5.2.5.4 were randomized to represent spatial variability in the wave paths and material properties and to smooth out sharp resonance peaks produced by deterministic profiles. For each logic tree branch, the TI Team obtained 60 randomized profiles using the layer velocity correlation model developed by Toro (Reference 2.5-182) with parameters for firm sediments (USGS Site Class C). Site Class C was chosen because the site is essentially a sequence of flat-lying sediments, though most have become rock. Layer thicknesses were randomized based on the variation of thickness of each layer from the site investigation geophysical data. The velocities between the fill (when present) and the underlying rock were not correlated. Similarly, the velocities between soil and PWR were not correlated. For the cut cases, the profile was first randomized, then adjusted to remove the materials above the pad elevations, such that the variation of the existing ground surface in each area is modeled. For fill cases, the fill layer thicknesses are varied to capture the total variation of the fill thickness for each area.

Following the randomization of the V_s profiles, dispersion curves of the 60 randomized profiles were compared to the SASW dispersion curves to confirm all randomizations are realistic. Figure 2.5-89 shows an example of the 60 randomized velocity profiles (gray) and their median (blue) compared to the target velocity profile (red), on the left-hand side of each figure. On the right-hand side, the standard deviation of the log of the velocity from the simulations (blue) is compared to the target (red). The randomization was rerun until the p-values between the target median V_S profile and the median of the 60 randomized profiles reached a minimum value of 0.1 and an average above 0.5.

For each logic tree branch, 60 randomized sets of material properties were also obtained. Randomization of the modulus reduction (G/Gmax) curves was performed assuming a Beta distribution, which is limited to the range of 0 to 1. The parameters of the Beta distribution are adjusted to produce the target sigma of ln(G/Gmax) of 0.15 in the vicinity of shear strain $3x10^{-2}$ percent. Randomization of damping curves was performed assuming a target sigma of 0.3. Randomized damping values were limited to a maximum of 15 percent in the vicinity of shear strain $3x10^{-2}$ percent following guidance given in Appendix E of RG 1.208 and guidance for development of dynamic properties for soil structure interaction analyses given in Section 3.7.2 of NUREG-0800 and Section C5.2 of the American Society of Civil Engineers, Structural Engineering Institute (ASCE/SEI) 4-16 (Reference 2.5-183). A correlation coefficient of -0.7

between modulus reduction and damping curves was used in the randomization process. Figure 2.5-90 shows an example of the randomized material curves.

2.5.2.5.7.2 Broadened Conditional Mean Spectra

The use of broadened CMS extends the concept of low frequency and high frequency "controlling earthquakes" discussed in RG 1.208 and reduces the tendency to overdrive the site profile by using broad-banded input motions scaled to high levels. To calculate the broadened CMS, first the reference rock hazard was deaggregated for 14 levels of motion equally spaced in log space between AFE 1E-2 and 3E-9. Input rock motion scenarios for **M** 5, 6, 7, and 8 earthquakes and mean distance of contributing events for each AFE were generated using the ground motion characterization model used in the reference rock hazard calculations. This ensured consistency between the CMS and the reference rock hazard results.

The CMS was calculated for five period ranges (0.005 to 0.1; 0.03 to 0.3; 0.15 to 1; 0.4 to 3; and 1.5 to 10) using the correlation model by Baker and Bradley (2017) (Reference 2.5-184) adjusted for CENA high-frequency rich motions. The CMS are converted to FAS using inverse RVT and the significant duration (i.e., the duration between the 5th and 95th percent of the Arias intensity) obtained with the empirical model by Reference 2.5-185. Figure 2.5-91 shows the resulting CMS on separate plots for **M** 5, 6, 7, and 8 earthquake scenarios. On each plot, AFEs ranging from 1E-3 (return period 1000 years) to 1E-7 (return period of 10 million years) are represented by curves of different colors. Different line types are used to represent the uniform hazard response spectrum (UHRS) that the CMS is equal to for various ranges of conditioning frequencies. The CMS are shown with slightly darker colors compared to curves of the same AFEs.

2.5.2.5.7.3 Amplification Fitting

The amplification functions were obtained by dividing the output response spectra by the input response spectra for each randomized profile, each CMS input motion, and site response case from Table 2.5-25. These data points were then fit by a piecewise-linear function to define the median magnitude-dependent probabilistic SAF and the corresponding standard deviation in amplification. Figure 2.5-92 shows an example of fit to the site amplification data for PGA at the ground surface, obtained using the suspension log velocity profile for 24 ft. (7.3 m) of cut, the site-specific set of G/Gmax and damping curves, a site kappa of 0.014, and using a kappa2 correction factor (i.e., fraction of the FAS peak) of 0.11. The four plots correspond to CMS magnitudes 5, 6, 7, and 8. On each plot, the gray circles are amplification values for individual randomized profiles and material properties, while the red curves show the fitted median (solid), 5th and 95th (dashed) percentile SAFs.

The TI Team applied two adjustments to the SAFs. The first adjustment focuses on the standard deviation in ln(SAF). As noted by Rodriguez-Marek et al. (Reference 2.5-136), at low ground motion levels, the variability in ground motions caused by site properties is already accounted for in the evaluation of single-station sigma because recorded motions are generally at low ground motion levels. The standard deviation increases at higher ground motion levels because of variability in nonlinear response, which is not well represented in the empirical data used to develop single-station sigma values. Therefore, following Reference 2.5-136, the standard deviation obtained in the piecewise-linear fit was replaced by Equation 2.5.2-11:

$$\sigma_{non-linear} = \sqrt{\sigma_{fit}^2 - \sigma_{linear}^2} \quad \text{(Equation 2.5.2-11)}$$

Where $\sigma^2{}_{linear}$ is the variance computed at low levels of input motion where minimal levels of nonlinear behavior are manifested in the site amplification analyses. The level of motion is taken to be at the point where there is minimal variability in the SAFs. The minimum value of $\sigma_{non\text{-}linear}$ is set to 0.001.

The second adjustment focuses on the epistemic uncertainty in the SAFs. The aleatory variability model from the NGA-East project is a partially non-ergodic or single-station sigma model. Incorporating this model into PSHA necessitates including epistemic uncertainty in the site amplification analysis. Rodriguez-Marek et al. (Reference 2.5-186; Reference 2.5-136) suggested that a minimum level of epistemic uncertainty should be applied to account for unmodeled uncertainties in developing SAFs using 1-D site response analysis. Rodriguez-Marek et al. (Reference 2.5-136) recommend a value of $\sigma_{\ln\,(SAF_epistemic)}$ = 0.15 for the minimum epistemic uncertainty. Bahrampouri and Rodriguez-Marek (2023) (Reference 2.5-187) quantified modeling error in 1-D site response for a large set of KiK-net stations in Japan. The modeling error was assessed as a function of the assumed uncertainty in site properties, with modeling error decreasing with increasing assumed uncertainty in site properties. Their results suggest a minimum epistemic uncertainty of 0.2. The TI Team adopted the minimum of 0.2 suggested by their analysis, which was incorporated by expanding the epistemic distribution of SAFs resulting from the branches of the SRA logic tree in Figure 2.5-87. The expansion was achieved by scaling each amplification function resulting from the SRA analysis by $\exp(\pm 1.645\sigma_{additionl\ epistemic})$ with $\sigma_{additional\ epistemic}$, as captured in Equation 2.5.2-12:

$$\sigma_{additional\ epistemic} = \sqrt{\max\,(0, 0.20^2 - \sigma_{\ln SAF_epistemic}^2} \quad \text{(Equation 2.5.2-12)}$$

The weights assigned to the additional amplification curves are based on the Keefer and Bodily (1983) (Reference 2.5-188) discrete approximation to a normal distribution and are 0.185, 0.63, and 0.185 for the 5th, 50th, and 95th percentile values, respectively.

2.5.2.5.8 Topographic Effects

Topographic effects refer to the phenomenon where seismic waves interact with the shape of the ground surface, particularly when the shape deviates significantly from being flat. The effects can result from various mechanisms, including wave interference caused by reflections off convex or concave surfaces, sensitivity to the angle of wave incidence, and scattering or reflection from sharp topographic features. In some cases, resonance may also occur, depending on the shape and size of the terrain. Topographic effects are highly frequency-dependent, with the most significant amplification occurring when the seismic wavelengths are similar in scale to the topographic features. This amplification tends to diminish at longer periods, as long-period waves are generally unaffected by smaller-scale surface features.

As described previously, the three Plant Complexes are situated on a ridge sloping toward Belews Lake with slope angles of approximately 15 degrees. From Figure 2.5-67, the TI Team estimated that in the North Plant Complex, the main ridge slopes range from 5:1 to 4:1

(horizontal to vertical ratio) or 11 degrees to 14 degrees with a height of about 90 ft. (27 m) to the planned pad elevation. In the Middle Plant Complex (Figure 2.5-68), the main ridge slopes range from 4:1 to 3:1 (horizontal to vertical ratio) or 14 degrees to 18 degrees with a height of about 90 ft. (27 m) to the planned pad elevation. In the South Plant Complex (Figure 2.5-69), the main ridge slopes range from 4:1 to 3:1 (horizontal to vertical ratio) or 14 degrees to 18 degrees with a height of about 90 ft. (27 m) to finished grade elevation on the lake slope, but only about 50 ft. (15 m) on the west side.

The TI Team reviewed several models to estimate potential topographic amplification effects at the site. The European Seismic Code Eurocode 8 Part 5 (Reference 2.5-189) introduces frequency-independent amplification factors up to 40 percent based on simplified two-dimensional geometries. Cauzzi et al. (2010, 2012) (References 2.5-190 and 2.5-191) use three-dimensional numerical modeling to provide amplification factors for the 5 percent-damped elastic displacement response spectrum. Their model is designed to capture three-dimensional topographic effects associated with reliefs having relatively small width-to-length aspect ratios. Rai et al. (Reference 2.5-192) analyze intra-event residuals from the Chiou and Youngs (Reference 2.5-193) ground motion model using the NGA-West2 database. Rai et al. (Reference 2.5-192) focus on the correlation between residuals and geomorphologic parameters like relative elevation, slope, and curvature. The Ashford and Sitar (Reference 2.5-194) and Ashford et al. (Reference 2.5-195) model is based on two-dimensional simulations using the generalized consistent transmitting boundary method. The model computes topographic amplification factors at multiple receiver locations along a slope.

Of the models evaluated, the TI Team considered the Cauzzi et al. (2010, 2012) (References 2.5-190 and 2.5-191) models not to be applicable at the Project site for three main reasons: (1) the vertical relief at the Project site is much less than the modeled relief; (2) the frequency range is limited to 2 Hz, which does not capture the decrease in amplification expected at higher frequencies; and (3) the model was limited to a single ground motion scenario. The remaining three models were used to derive topographic amplification factors at each Plant Complex and are captured in Figure 2.5-93. Note that the Rai et al. (2017) (Reference 2.5-192) produces no topographic amplification at the South Plant Complex; therefore, it is not shown in the figure. The final topographic amplification factors for each complex were determined by combining the results from these different models, with equal weight assigned to each model. The amplification factors are listed in Table 2.5-26 and are captured in Figure 2.5-94. These factors should be multiplied by the applicable DRS (see Section 2.5.2.6) if a facility is constructed near the edge of the graded site pad.

2.5.2.6 Ground Motion Response Spectra

This section describes the development of the horizontal and vertical site-specific ground motion response spectra (GMRS). The section is organized to first describe the approach adopted to compute mean and fractile site-specific hazard (Section 2.5.2.6.1); magnitude and distance deaggregation of the site-specific hazard and calculation of controlling earthquakes (Section 2.5.2.6.2); performance-based horizontal DRS (Section 2.5.2.6.3); and vertical-to-horizontal (V/H) spectral ratios (Section 2.5.2.6.4). The site-specific seismic hazard results for the North and Middle Plant Complexes are presented next (Section 2.5.2.6.5), followed by the results for the South Plant Complex (Section 2.5.2.6.6). Sensitivity analyses showing the effect of elements of the SRA are presented in Section 2.5.2.6.7 and the section is concluded with a brief summary guidance for future use of the site-specific hazard results (Section 2.5.2.6.8).

2.5.2.6.1 Mean and Fractile Site-Specific Hazard Curves

The approach used to compute site-specific hazard results requires convolving the reference rock horizontal hazard described in Section 2.5.2.4.4, with the SAFs described in Section 2.5.2.5.7. This approach is identified as "Approach 3" in NUREG/CR-6728 (Reference 2.5-196) and its mathematical formulation is presented in Equation 2.5.2-13.

$$G_{Z,S}(z_k; m_i) = \sum_j P\left(SAF_S \geq \frac{z_k}{x_j} | x_j, m_i\right) \cdot p(x_j; m_i) \qquad \text{(Equation 2.5.2-13)}$$

Where:

- $G_Z(z_k;m_i)$ is the annual frequency of exceeding ground motion level z_k for magnitude m_i and SAF_S.
- SAF_S is the s-th branch of the logic tree in Figure 2.5-87, combined with the additional epistemic uncertainty described in Section 2.5.2.5.7.3.
- $p_X(x_j; m_i)$ is the discretized rock hazard curve giving the annual frequency of ground motions on rock of x_j (values near x_j).
- $P\left(SAF_S \geq \frac{z_k}{x_j} | x_j, m_i\right)$ is the probability that site amplification SAF_S for magnitude m_i at reference rock ground motion level x_j is greater than or equal to $\frac{z_k}{x_y}$.

Following McGuire et al. (2001) (Reference 2.5-196) and Bazzurro and Cornell (2004) (Reference 2.5-197), the site amplification SAF_S is assumed to be lognormally distributed, such that Equation 2.5.2-14 defines the probability term inside Equation 2.5.2-13:

$$P\left[SAF_S \geq \frac{z_k}{x_j} | x_j, m_i\right] = 1 - \Phi\left\{\frac{ln\left(\frac{z_k}{x_j}\right) - \overline{ln[SAF_s(x_j, m_i)]}}{\sigma_{lnSAF_s(x_j,m_i)}}\right\} \qquad \text{(Equation 2.5.2-14)}$$

Where:

- $\overline{ln[SAF_s(x_j, m_i)]}$ is the median (mean log) amplification of SAF_s for magnitude m_i at reference rock ground motion level x_j
- $\sigma_{lnSAF_s(x_j,m_i)}$ is the value of standard deviation for SAF_S or magnitude m_i at reference rock ground motion level x_j removing the linear component assumed to be contained within the single station aleatory variability.
- $\Phi[\ ]$ is the cumulative normal distribution function.

The approach to compute fractiles of the site-specific seismic hazard using Approach 3 follows the methodology presented in INL (Reference 2.5-198) and Rodriguez-Marek et al. (Reference 2.5-136). The reference rock hazard results in Section 2.5.2.4.4 consist of AFEs calculated for a discrete set of 20 ground motion values resulting from all possible paths along the SSC and

GMC logic trees. The epistemic uncertainty in the rate of exceeding each ground motion level is represented by the distribution of AFEs resulting from each logic tree path. A set of 100 hazard curves are obtained from this distribution of reference rock hazard. SAFs developed for the Project site are magnitude-dependent, introducing a level of complexity into the analysis. The INL (Reference 2.5-198) solution is to interpolate the magnitude-dependent SAFs defined for **M** 5, 6, 7, and 8 over the entire magnitude range covered by the hazard calculation (from **M** 5.0 to 8.2, using a 0.1-magnitude unit interval). This step results in 33 magnitude-dependent SAFs. Each SAF is then scaled by its relative contribution to the total mean site-specific hazard at a given ground motion level to obtain a mean magnitude-independent SAF and its uncertainty. Approach 3 can then be applied to obtain a set of site-specific fractile hazard curves from the reference rock fractiles and the mean hazard-weighted SAF.

2.5.2.6.2 Magnitude-Distance Deaggregation and Controlling Earthquakes

NUREG-0800 specifies that applications for new reactors meet the requirements of 10 CFR 100.23 when the PSHA includes a discussion of the high- and low-frequency controlling earthquakes at the site, as defined in RG 1.208. Appendix D of RG 1.208 contains a methodology to obtain magnitude-distance deaggregation tables and the magnitude and distance of the controlling earthquake from the deaggregation of the seismic hazard. INL (Reference 2.5-198) describes how to deaggregate site-specific hazard when Approach 3 is used and SAFs are magnitude-dependent. The INL (Reference 2.5-198) methodology involves five steps:

1. Obtain a set of mean magnitude-dependent amplification functions (one for each spectral frequency), interpolated to add 100 points between each consecutive ground motion level. Using the naming convention introduced in INL (Reference 2.5-198), this vector of reference rock ground motion values is called *rsa*. The magnitude-dependent amplification functions interpolated to *rsa* are then further interpolated to magnitudes between **M** 5.0 and **M** 8.2, with a step of 0.1 moment magnitude units, consistent with the magnitude range used in the PSHA. Using the INL (Reference 2.5-198) naming convention, the resulting mean magnitude-dependent amplification functions are called $mSAF_{Mi}$.
2. Obtain magnitude-dependent equivalent reference rock ground motions. This step involves finding, for each magnitude between **M** 5.0 and **M** 8.2 and each target AFE, the values of reference rock motions (called $rsa_{Mi,\ AFE}$) that, when multiplied by $mSAF_{Mi}$, produce the magnitude-dependent site-specific ground motion at the specified AFE (called $ssa_{Mi,\ AFE}$). Following RG 1.208, the target AFEs are 1E-4, 1E-5, and 1E-6, corresponding to return periods of 10 thousand years, 100 thousand years, and 1 million years. To compute rsa_{Mi}, the interpolated reference rock motions (*rsa*) are multiplied for each $mSAF_{Mi}$ to obtain ssa_{Mi}. Then, using the UHRS at the target AFE, ssa_{Mi} are interpolated to find $rsa_{Mi,\ AFE}$.
3. Obtain the distance contribution by deaggregation of the reference rock hazard for each magnitude-dependent equivalent reference rock ground motion. This produces 33 (one for each magnitude between **M** 5.0 and **M** 8.2) magnitude-distance deaggregation tables for each AFE.

4. Obtain magnitude contributions to total site-specific hazard. Site-specific hazard curves for each magnitude between **M** 5.0 and **M** 8.2 can be interpolated to obtain the AFE corresponding to the site-specific UHRS values for each spectral period and used to calculate the relative contribution of each magnitude to the total site-specific hazard.
5. Combine the distance deaggregation from step 3 with the magnitude deaggregation from step 4. For each spectral period of interest (per RG 1.208 these are: 0.1 sec., 0.2 sec., 0.4 sec., 1 sec., frequencies of 10 Hz, 5 Hz, 2.5 Hz and 1 Hz), the distance deaggregation obtained for each magnitude and AFE (step 3) is scaled first by rsa_{M_i}, AFE, then by the hazard contribution computed for magnitude $\mathbf{M}_i$ (step 4). This produces tables of magnitude and distance deaggreagation for each spectral period and AFE of interest.

INL (Reference 2.5-198) cautions that the approach is valid under the assumption that the distance is not affected by the convolution of the reference rock hazard with the magnitude-dependent SAFs. This assumption is supported by NUREG/CR-6728 (Reference 2.5-196), which recognizes that the level of reference rock motion and magnitude govern the site-specific hazard, while distance does not have a significant effect. Consequently, calculating the distance deaggregation from the reference rock hazard is possible.

Once the magnitude-distance deaggregation tables are calculated, Appendix D of RG 1.208 can be used to obtain the required tables of magnitude and distance deaggregation and controlling earthquakes. Deaggregation step 2 in RG 1.208 requires a deaggregation of the PSHA for each of the spectral accelerations (frequencies of 10 Hz, 5 Hz, 2.5 Hz, and 1 Hz, or periods of 0.1 sec., 0.2 sec., 0.4 sec., 1 sec.) and annual probability levels (AFEs of 1E-4, 1E-5, and 1E-6) and provide a table such Table D.1 for each of the 12 cases.

Appendix D of RG 1.208 also contains the procedure for calculating controlling earthquakes. The first step consists of a review of the magnitude-distance distribution for the average of 1 and 2.5 Hz to determine whether the contribution to the hazard for distances of 100 km (63 mi.) or greater is substantial, i.e., on the order of 5 percent or greater (RG 1.208, Section D.4, Step 1). The next step to determine controlling earthquakes is to calculate the mean magnitude and distance of the controlling earthquake associated with the ground motions determined in the first step of the deaggregation (above) for the average of 5 and 10 Hz. The mean magnitude of the controlling earthquake is computed using results of the entire magnitude-distance bins matrix using Equation 4 of RG 1.208, which is reproduced below as Equation 2.5.2-15.

$$M_c(5-10\ Hz) = \sum_m m \sum_d P(m,d)_2 \qquad \text{(Equation 2.5.2-15)}$$

Where:

- M_c(5-10 Hz) is the mean magnitude of the controlling earthquake for the high-frequency range.
- m is the central magnitude value of each magnitude bin.
- d is the centroid distance value for each distance bin.

The mean distance of the controlling earthquake is determined using results of the entire magnitude-distance bins matrix using Equation 5 of RG 1.208, reproduced below as Equation 2.5.2-16.

$$Ln\{D_c(5-10\ Hz)\} = \sum_d Ln(d) \sum_m P(m,d)_2 \qquad \text{(Equation 2.5.2-16)}$$

Where:

- D_c(5-10 Hz) is the mean distance of the controlling earthquake for the high-frequency range.
- m is the central magnitude value of each magnitude bin.
- d is the centroid distance value for each distance bin.

Similar calculations are repeated to obtain the controlling magnitude in the low-frequency range (M_c(1-2.5 Hz)) and the controlling distance (D_c(1-2.5 Hz)) for distances less or equal to 100 km (62 mi.) and for distances greater than 100 km (62 mi.).

2.5.2.6.3 Methodology to Obtain Performance-Based Response Spectra

RG 1.208 provides instructions to calculate performance-based GMRS using the 1E-4 and 1E-5 UHRS. The methodology is based on ASCE/SEI Standard 43-05 (Reference 2.5-199) approach for defining a risk-consistent DRS. ASCE/SEI 43-19 (Reference 2.5-200) updated the process to obtain DRS; however, for Seismic Design Category 5 structures, such as nuclear reactors, the two approaches are equivalent, as discussed in Section C2.2 of ASCE/SEI 43-19 (Reference 2.5-200) and NRC (2022) (Reference 2.5-201). This means that the DRS presented in Sections 2.5.2.6.5 and 2.5.2.6.6, which are calculated using RG 1.208, are identical to those that would be obtained using ASCE/SEI 43-19 (Reference 2.5-200).

The DRS is obtained from the site-specific UHRS using the expression provided in Equation 2.5.2-17.

$$DRS(f) = DF(f) \times UHRS(f) \qquad \text{(Equation 2.5.2-17)}$$

Where:

- $DF(f)$ is the Design Factor.
- $UHRS(f)$ is ground motion value with a mean AFE of 1E-4.

The Design Factor is defined based on the ratio of the ground motion amplitudes for mean AFEs of 1E-4 and 1E-5, and it ensures that the site-specific response spectrum is equal to or greater than the mean AFE 1E-4 UHRS. The hazard curve slope factor (AR) is determined from Equation 2.5.2-18.

$$AR = \frac{SA(0.1 \cdot H_D)}{SA(H_D)}$$ (Equation 2.5.2-18)

Where:

- *SA(H_D)* is the spectral acceleration at the target UHRS mean exceedance frequency H_D of 1E-4.
- *SA(0.1 H_D)* is the spectral acceleration at 0.1 H_D, which is equivalent to mean AFE of 1E-5.

The *DF(f)* for each spectral frequency is the maximum of two parameters: DF_1, which has a value of 1.0, and DF_2, which is calculated using Equation 2.5.2-19.

$$DF_2 = 0.6 \cdot AR^{0.8}$$ (Equation 2.5.2-19)

RG 1.208 imposes a minimum value of the DRS equal to 45 percent of the mean 1E-5 UHRS, when AR exceeds 4.2.

Table 2.5-24 shows the base depths of the control points. Section 2.5.2.5.7 discusses the TI Team evaluation that some of these control points can be grouped for the purpose of SRA. A different number of DRS are generated for each Plant Complex. Section 2.5.2.6.8 provides guidance on how to apply the DRS to various technologies. The DRS are:

- GMRS for ground surface (elevation 810 ft. [247 m]), equivalent to Performance-Based Surface Response Spectrum for the North, Middle, and South Plant Complexes.
- Foundation Input Response Spectrum (FIRS) for depth of 44 ft. (13 m) (elevation 766 ft. [234 m]) for the North, Middle, and South Plant Complexes.
- FIRS for a depth of 85 ft. (26 m) (elevation 725 ft. [221 m]) for the North, Middle, and South Plant Complexes.
- FIRS for a depth of 115 ft. (35 m) (elevation 695 ft. [211.8 m]) for the South Plant Complex only.
- Performance-Based Interface Response Spectrum (PBIRS) for the top of PWR for the North, Middle, and South Plant Complexes.

DRS are obtained by first enveloping the UHRS for each applicable site grading and average cut/fill thickness. This step is completed for both the 1E-4 UHRS and the 1E-5 UHRS, which are then used to calculate the DRS using the procedure in RG 1.208 as discussed above. In this fashion, the resulting performance-based response spectra represent a PPE.

A similar process is applied to obtain the vertical performance-based DRS: first, the horizontal 1E-4 and 1E-5 UHRS are multiplied by V/H (described in Section 2.5.2.6.4), then, the vertical 1E-4 UHRS and vertical 1E-5 UHRS are each enveloped and the DRS are calculated applying the procedure in RG 1.208.

2.5.2.6.4 Approach to Calculate Vertical-to-Horizontal Spectral Ratios

The TI Team adopted two empirical V/H models to derive the mean V/H ratios: Pezeshk et al. (Reference 2.5-202) and EPRI (Reference 2.5-203).

Pezeshk et al. (Reference 2.5-202) developed a V/H model using the NGA-East database of CENA recordings with magnitude **M** ≥ 3.4 and rupture distance (R_{rup}) < 1000 km (621 mi.), excluding those that occurred in the Gulf Coast region. The parametric model is applicable for a spectral period range from PGA to 10 sec. and provides values of V/H as a function of magnitude, source-to-site distance, and V_{S30}. Implementation of the Pezeshk et al. (Reference 2.5-202) model requires calculating V_{S30} for each control point depth, site-grading case (i.e., various amounts of cut or fill), and velocity profile. The average V_{S30} was calculated as the total thickness (98 ft. [30 m]) divided by the ratio of the total layer thickness and total shear wave travel time through that layer. The resulting V_{S30} values for the alternative profiles and control point elevations are listed in Table 2.5-27.

The functional form of the Pezeshk et al. (Reference 2.5-202) V/H model is captured in Equation 2.5.2-20:

$$ln\left(\frac{V}{H}\right) = a_1 + a_2\boldsymbol{M} + a_3\boldsymbol{M}ln\left(\sqrt{R_{rup}^2 + h^2}\right) + a_4 ln(V_{S30}) + a_5 + \Delta_{es} \quad \text{(Equation 2.5.2-20)}$$

Where:

- Coefficients a_1 to a_5 were obtained by the TI Team from Dr. Pezeshk, who indicated that the published coefficients do not reflect the final model. The TI Team interpolated the coefficients in log-linear space to produce coefficients for four periods: 0.025 sec. (40 Hz), 0.75 sec. (1.33 Hz), 4 sec. (0.25 Hz), and 7.5 sec. (0.13 Hz) to match the 24 spectral periods at which the reference rock hazard is calculated.
- **M** is the mean magnitude obtained by the TI Team from the site-specific hazard at AFE of 1E-4 and 1E-5 for each case.
- R_{rup} is the mean rupture distance obtained by the TI Team from the site-specific hazard at AFE of 1E-4 and 1E-5 for each case.
- h is depth.
- V_{S30} is the time-averaged V_S in the upper 30 m (98 ft.). In the application of Equation 2.5.2-20, the TI Team limited the V_{S30} values from Table 2.5-27 to 2000 m/s, which is the upper limit of the data used to develop the Pezeshk et al. (Reference 2.5-202) model.
- Δ_{es} represents the variations around the median prediction of V/H ratios.

The TI Team converted the median values of V/H to mean V/H for application to the DRS using Equation 2.5.2-21 (Reference 2.5-203).

$$mean\ /H\ =\ median\ V/H\ \times\ \exp\left(\sigma_{lnV/H}^2/2\right) \quad \text{(Equation 2.5.2-21)}$$

Where:

- $\sigma_{lnV/H}$ is the standard deviation calculated using the model in Pezeshk et al. (Reference 2.5-202) given in Equation 2.5.2-22.

$$\sigma = \sqrt{\tau^2 + \varphi_{S2S}^2 + \varphi_{SS}^2} \quad \text{(Equation 2.5.2-22)}$$

In Equation 2.5.2-22:

- τ is the standard deviation of between-event residuals.
- φ_{S2S} is the standard deviation of the site-to-site within-event residuals.
- φ_{SS} is the standard deviation of the single-station within-event residuals.

The V/H ratios obtained with this model show a sharp decrease at low frequencies, which the TI Team interpreted as being caused by the limited data available to develop the model in this frequency range. The TI Team observed that other V/H models developed with datasets that include larger magnitude earthquakes do not show this effect and opted to set the coefficients for frequencies < 0.33 Hz (periods > 3 sec.) equal to the coefficients for 0.33 Hz (period of 3 sec.).

The second model used by the TI Team to develop V/H is that published by EPRI (Reference 2.5-203), which updates the V/H model for hard rock in NUREG/CR-6728 (Reference 2.5-196). EPRI (Reference 2.5-203) developed V/H ratios for active tectonic regions from the horizontal and vertical GMPEs of Campbell and Bozorgnia (2003) (Reference 2.5-204) and the Gülerce and Abrahamson (2011) (Reference 2.5-205) V/H model. To account for the difference in frequency content between CEUS motions and those in active tectonic regions, the V/H ratios for active regions were shifted upward in frequency by a factor of 3.33. The frequency-shifted Campbell and Bozorgnia (Reference 2.5-204) and Gülerce and Abrahamson (Reference 2.5-205) V/H ratios were then combined with those of McGuire et al. (Reference 2.5-196) to produce V/H ratios for a range of site conditions.

EPRI (Reference 2.5-203) also describes a process to extend the V/H for soil conditions. The approach uses the V_{S30} (calculated from the velocity profile used to obtain the site DRS) together with the PGA to determine the site class from a table of values. Mean V/H ratios for different frequencies are provided in tabular form for different site classes. As explained in EPRI (Reference 2.5-203), the mean V/H ratios are generic because they do not consider plant-specific site conditions and are appropriate for general investigations or screening purposes.

The TI Team decided to develop scaling factors to adjust the EPRI (Reference 2.5-203) models for rock conditions (i.e., models A-Hard to D-Hard) to the Project site conditions. Scale factors were developed for each possible V_{S30} (Table 2.5-27), and PGA (values for AFE of 1E-4 and 1E-5). Figure 2.5-95 compares the weighted average V_{S30} from Table 2.5-27 and the corresponding horizontal DRS PGA at AFE 1E-4 (blue dots) and at AFE 1E-5 (orange dots). Also shown for comparison are the V_{S30} values obtained from the P-S profile (open triangle and open circle). After inspecting the figure, the TI Team determined that PGA values of 0.3 g and 0.85 g are representative of the site-specific hazard at AFE 1E-4 and AFE 1E-5 for a V_{S30} equal

to 1100 m/s (3609 ft/s). The TI Team assumed that for the AFE 1E-4 level, the C-Hard (PGA about 0.3 g) is appropriate for scaling, and for the AFE 1E-5 level, the appropriate EPRI (Reference 2.5-203) V/H model to scale is D-Hard (PGA about 0.45 g).

The V/H model by Gülerce and Abrahamson (2011) (Reference 2.5-205) was then used twice: first, to obtain V/H ratios for a rock condition (i.e., V_{S30} of 1000 m/s [3280 ft/s]) and for the PGA of 0.3 g or 0.45 g; second, to obtain V/H for each site-specific V_{S30} value and PGA values of 0.3 g and 0.85 g for AFEs of 1E-4 and 1E-5, respectively.

The ratio between the Gülerce and Abrahamson (2011) (Reference 2.5-205) V/H for Project-specific site conditions and the Gülerce and Abrahamson (Reference 2.5-205) V/H for rock conditions is the scale factor used in adjusting EPRI (Reference 2.5-203). Note that the ratio between the Gülerce and Abrahamson (Reference 2.5-205) V/H values at 100 Hz and PGA was applied to the 100 Hz EPRI (Reference 2.5-203) values to derive the V/H value at 200 Hz (0.005 sec.).

In addition to V_{S30}, **M**, rupture distance, and PGA, Gülerce and Abrahamson (Reference 2.5-205) uses the dominant style-of-faulting (which is strike-slip for the Project site), and the depth to top of rupture (Z_{TOR}), which is calculated using Equation 5 of Chiou and Youngs (2014) (Reference 2.5-193) for strike-slip and normal faulting. As previously described for the Pezeshk et al. (Reference 2.5-202) model, the TI Team interpolated the coefficients of the Gülerce and Abrahamson (Reference 2.5-205) model to match the 24 (CEUS) spectral frequencies used in the site-specific hazard analysis and considered EPRI (Reference 2.5-203) correction of the frequency when applying models derived for the western U.S. to CEUS.

Additionally, the TI Team noted that the constant portion of the EPRI (Reference 2.5-203) V/H models is equal to the Gülerce and Abrahamson (2011)(Reference 2.5-205) value at some frequency greater than 20 Hz for the “Hard” (V_{S30}=1000 m/s) site. Similarly, for the “Intermediate” site (V_{S30}=400 m/s), the constant part of the EPRI (Reference 2.5-203) V/H equals the Gülerce and Abrahamson (Reference 2.5-205) value at about 17 Hz. Using this observation, the TI Team decided that for frequencies of 20 Hz and below the appropriate Gülerce and Abrahamson (Reference 2.5-205) coefficients to use are:

1) Those for period of 0.15 sec. (equivalent to 22.2 Hz for CEUS sites) for $V_{S30} \geq 1000$ m/s.
2) Those for period of 0.2 sec. (equivalent to 16.7 Hz for CEUS sites) for V_{S30} of 400 m/s.
3) Log-linear interpolated coefficients for intermediate values of V_{S30}.

The final V/H ratios are calculated for each control point, site grading, and AFE using the logic tree in Figure 2.5-96. The Pezeshk et al. (Reference 2.5-202) model is given a lower weight because the database consists primarily of recordings from **M** < 5 earthquakes, while the primary interest in the hazard calculations is for **M** ≥ 5 events. The weights assigned to the velocity profiles are discussed in Section 2.5.2.5 and match the logic tree in Figure 2.5-87.

Figure 2.5-97 shows examples of V/H ratios obtained for the 10 ft. (3 m) of cut case and AFE of 1E-4 at two control points: ground surface (top) and top of PWR (bottom). On each plot, the long-dash curves show the mean V/H ratios for suspension log (P-S) and SASW profiles obtained with the EPRI (Reference 2.5-203) model; the short-dash curves (also for P-S and SASW profiles) are the V/H obtained with Pezeshk et al. (Reference 2.5-202). The solid gray line and the solid green line correspond to the weighted V/H ratios for P-S and SASW profiles,

resulting from the weighted combination of the results from the EPRI (Reference 2.5-203) and Pezeshk et al. (Reference 2.5-202) model, i.e., combining the branches on the first node of the logic tree in Figure 2.5-96. The solid red curve is the final V/H model for this case, which is obtained by combining the second node of the logic tree. The V/H values are presented in Table 2.5-28 through Table 2.5-37. Each table represents a control point depth and AFE and contains the V/H obtained for various site grading conditions using the suspension log (P-S) and SASW profiles and their weighted average.

Based on their review of a study exploring V/H ratios at depth versus at the surface, the TI Team concluded that the V/H ratios developed using the methods described above are applicable to the target depths.

2.5.2.6.5 Seismic Hazard Results for the North and Middle Plant Complexes

Seismic hazard results for the North and Middle Plant Complexes are identical. Results are obtained for three site grading cases (two cut cases and one fill case) and four control point elevations as Table 2.5-25 shows. Examples of mean and fractile hazard curves are captured in Figure 2.5-98 for PGA, 10 Hz and 1 Hz spectral acceleration. The curves represent the same site grading case (24 ft. [7 m] of cut) but different control point depths: surface grade (top row); depth of 44 ft. (13 m) (second row); depth of 85 ft. (26 m) (third row); and top of PWR (bottom row). On each plot, the mean site-specific hazard is illustrated by the solid black curve, and the 5th, 16th, 50th, 84th, and 95th site-specific hazard fractiles are shown in different colors. The figures also include, for comparison, the mean reference rock hazard, represented by the dashed black line. The site-specific hazard is generally higher than the corresponding reference rock hazard, with larger differences for high-frequency motions (PGA and 10 Hz spectral acceleration), particularly at ground surface. Note that these figures are also applicable to the South Plant Complex as shown in Table 2.5-25.

The horizontal 1E-4 site-specific UHRS and the 1E-5 site-specific UHRS obtained for the North and Middle Plant Complexes for each control point and site grading case are captured in Figure 2.5-99. Subplots in the figure contain the UHRS for control points at the surface (Figure 2.5-99a); depth of 44 ft. (13 m) (Figure 2.5-99b); depth of 85 ft. (26 m) (Figure 2.5-99c); and top of PWR (Figure 2.5-99d). Solid lines are used for the 1E-4 UHRS, and solid lines with dots are used for the 1E-5 UHRS. To calculate performance-based response spectra representative of PPE, the UHRS obtained for different site grading conditions are enveloped. The thicker, dashed blue and green spectra in Figure 2.5-99 are the enveloped 1E-4 and 1E-5 UHRS, respectively. The horizontal DRS is calculated from the enveloped UHRS using Equations 2.5-17 to 2.5-19 and is illustrated by the solid black line. The vertical UHRS for AFE 1E-4 and 1E-5 and for different site grading conditions and control point depths are obtained multiplying the envelope horizontal UHRS captured in Figure 2.5-99 by the corresponding weighted average V/H ratios (from Table 2.5-28 to Table 2.5-37). The enveloped 1E-4 and 1E-5 vertical UHRS are then used to compute the vertical DRS as described in Section 2.5.2.6.3. Figure 2.5-100 compares the horizontal and vertical DRS for control points at the surface (Figure 2.5-100a); depth of 44 ft. (13 m) (Figure 2.5-100b); depth of 85 ft. (26 m) (Figure 2.5-100c); and top of PWR (Figure 2.5-100d).

Tabulated values of the enveloped horizontal and vertical 1E-4 UHRS and 1E-5 UHRS, and corresponding horizontal and vertical DRS are provided in Table 2.5-38 for the control point at the surface (GMRS); in Table 2.5-39 for the control point at 44 ft. (13 m) depth (FIRS); in Table 2.5-40 for the control point at 85 ft. (26 m) depth (FIRS); and in Table 2.5-41 for the control point

at the top of PWR) (PBIRS). These response spectra are calculated for the set of 24 spectral ordinates at which the NGA-East GMMs are defined; however, RG 1.208 requires the performance-based response spectra be defined for a minimum of 30 spectral frequencies to ensure a smooth spectrum. To meet this requirement, horizontal and vertical GMRS, FIRS, and PBIRS are interpolated to add six more spectral frequencies. The interpolated horizontal and vertical DRS for the North and Middle Plant Complexes are listed in Table 2.5-42.

The process described in Section 2.5.2.6.2 was used to obtain magnitude-distance deaggregation tables and the high-and low-frequency controlling earthquakes for each control point and site grading. Figure 2.5-101 shows an example of magnitude-distance deaggregation for high- and low-frequency motions at AFEs of 1E-4, 1E-5, and 1E-6 for the 24 ft. (7 m) cut case and a control point at ground surface.

Table 2.5-43 summarizes magnitude and distance of the controlling earthquakes for AFE 1E-4 and 1E-5. The contribution of earthquakes located at distances greater than 100 km (62 mi.) is always greater than 5 percent for low-frequency motions at these AFEs, therefore, two sets of values are provided: one obtained for earthquakes located at distances smaller than 100 km (62 mi.), and the other for earthquakes located at greater distances. As captured in the table, there are minor variations in the magnitude and distance of controlling earthquakes for each control point and possible site grading such that controlling earthquakes for the North and Middle Plant Complexes can be summarized as follows:

- High frequency (mean of 5 and 10 Hz): **M** 6.4, R_{rup} 71 km (44 mi.) for AFE 1E-4; **M** 6.3 R_{rup} 23 km (14 mi.) for AFE 1E-5. These earthquakes are consistent with the magnitude and distance range of background seismicity in the host zone.
- Low frequency (mean of 1 and 2.5 Hz) for distance less than 100 km (62 mi.): **M** 6.3, R_{rup} 25 km (16 mi.) for AFE 1E-4; **M** 6.5 R_{rup} 17 km (11 mi.) for AFE 1E-5. These earthquakes are consistent with background seismicity in the host zone.
- Low frequency (mean of 1 and 2.5 Hz) for distance greater than 100 km (62 mi.): **M** 7.3, R_{rup} 323 km (201 mi.) for AFE 1E-4; **M** 7.4 R_{rup} 300 km (186 mi.) for AFE 1E-5. These values are consistent with the Charleston RLME source.

2.5.2.6.6 Seismic Hazard Results for South Plant Complex

Seismic hazard results for the South Plant Complex are obtained for five site grading cases (three cut cases and two fill cases) and five control point elevations as captured in Table 2.5-25. The seismic hazard curves in Figure 2.5-98 are applicable to the South Plant Complex as discussed previously. Figure 2.5-102 compares PGA, 10 Hz, and 1 Hz spectral acceleration seismic hazard curves for a site grading case (40 ft. [12 m] of fill) that is unique to the South Plant Complex and for different control points: surface grade (top row); depth of 44 ft. (13 m) (second row); depth of 85 ft. (26 m) (third row); depth of 115 ft. (35 m) (fourth row); and top of PWR (bottom row). On each plot, the mean site-specific hazard is shown by the solid black curve, and the 5th, 16th, 50th, 84th, and 95th site-specific hazard fractiles are shown in different colors. The figures also include, for comparison, the mean reference rock hazard, represented by the dashed, black line. As observed for the North and Middle Plant Complexes, the site-specific hazard is generally higher than the corresponding reference rock hazard, with larger differences for high-frequency motions (PGA and 10 Hz spectral acceleration), particularly at ground surface.

The horizontal 1E-4 site-specific UHRS and the 1E-5 site-specific UHRS obtained for the South Plant Complex control point and site grading case are captured in Figure 2.5-103. Subplots in the figure contain the UHRS for control points at the surface (Figure 2.5-103a); at a depth of 44 ft. (13 m) (Figure 2.5-103b); a depth of 85 ft. (26 m) (Figure 2.5-103c); the top of PWR (Figure 2.5-103d); and a depth of 115 ft. (35 m) (Figure 2.5-103e). Solid lines are used for the 1E-4 UHRS, and solid lines with dots are used for the 1E-5 UHRS. The approach to calculating performance-based response spectra that are representative of the PPE is described in Section 2.5.2.6.3. The thicker, dashed blue and green spectra in Figure 2.5-103 are the enveloped 1E-4 and 1E-5 UHRS, respectively. The horizontal DRS is calculated from the enveloped UHRS and is shown by the solid black line. The envelope horizontal UHRS are multiplied by the respective V/H ratios to obtain vertical UHRS for different site grading cases. The enveloped vertical UHRS are then used to compute the DRS as previously described. Figure 2.5-104 summarizes the results for the South Plant Complex by showing only the horizontal and vertical DRS.

Tabulated values of the enveloped horizontal and vertical 1E-4 UHRS and 1E-5 UHRS, and corresponding horizontal and vertical DRS are provided in Table 2.5-44 for the control point at the surface (GMRS); in Table 2.5-45 for the control point at 44 ft. (13 m) depth (FIRS); in Table 2.5-46 for the control point at 85 ft. (26 m) depth (FIRS); in Table 2.5-47 for the control point at the top of PWR (PBIRS); and in Table 2.5-48 for the control point at 115 ft. (35 m). To meet the requirements of RG 1.208, the horizontal and vertical GMRS, FIRS, and PBIRS are interpolated for six additional spectral frequencies. The interpolated spectra are captured in Table 2.5-49.

Magnitude-distance deaggregation tables and tables of high-and low-frequency controlling earthquakes for each control point and site grading were obtained following the procedure described in Section 2.5.2.6.2. Table 2.5-50 summarizes magnitude and distance of the controlling earthquakes for AFE 1E-4 and 1E-5. The contribution of earthquakes located at distances greater than 100 km (62 mi.) is always greater than 5 percent for low-frequency motions; therefore, two sets of values are provided: one obtained for earthquakes located at distances less than 100 km (62 mi.) and the other for earthquakes located at greater distances. The table shows minor variations in the magnitude and distance of controlling earthquakes for each control point and possible site grading such that controlling earthquakes for the South Plant Complex can be summarized as follows:

- High frequency (mean of 5 and 10 Hz): **M** 6.4, R_{rup} 70 km (43 mi.) for AFE 1E-4; **M** 6.3 R_{rup} 23 km (14 mi.) for AFE 1E-5. These earthquakes are consistent with the magnitude and distance range of earthquakes in the host zone.
- Low frequency (mean of 1 and 2.5 Hz) for distance less than 100 km (62 mi.): **M** 6.3, R_{rup} 25 km (16 mi.) for AFE 1E-4; **M** 6.5 R_{rup} 17 km (11 mi.) for AFE 1E-5. These earthquakes are consistent with background seismicity in the host zone.
- Low frequency (mean of 1 and 2.5 Hz) for distance greater than 100 km (62 mi.): **M** 7.3, R_{rup} 323 km (201 mi.) for AFE 1E-4; **M** 7.4 R_{rup} 300 km (186 mi.) for AFE 1E-5. These values are consistent with the Charleston RLME source.

2.5.2.6.7 Sensitivity Analysis

The TI Team generated tornado plots to illustrate how individual branches and nodes of the site characterization logic tree in Figure 2.5-87 influence the site-specific hazard. In a tornado plot, the ground motion corresponding to the hazard at a specified AFE is represented by a vertical

line. The vertical axis lists the logic tree levels, ranked from top to bottom in order of decreasing effect on the ground motion value. In this manner, the model components that produce the largest variability in ground motion at a given AFE are at the top, and those that produce the smallest variability are plotted at the bottom.

Figures were generated for the South Plant Complex at the surface target elevation, for PGA, and spectral acceleration at 10 Hz and 1 Hz, and for AFE of 1E-4 and 1E-5. The TI Team found that the three levels of the logic tree that influence the hazard the most are the V_S profile, site kappa, and additional epistemic uncertainty. Site kappa produces the largest variability in ground motion for PGA because it influences the damping in the sediments above bedrock. For shorter spectral frequencies, the stiffness of the site determines less variability in amplification from the velocity profile, such that the additional epistemic uncertainty is shown to produce the largest variability in ground motion at 1 Hz. This is captured in Figure 2.5-105, showing tornado plots for PGA at AFE 1E-4, and in Figure 2.5-106, which shows tornado plots for 1 Hz spectral acceleration at AFE 1E-5. Each figure presents five subplots arranged in two rows: the top row (three subplots) shows results for the three cut cases applicable to the South Plant Complex, while the bottom row (two subplots) shows the results for the two fill cases applicable to the South Plant Complex. The tornado plots also show that results are generally consistent for different control point depths.

2.5.2.6.8 Implementation Instructions

As described in previous sections site-specific seismic hazard curves were obtained for each possible combination of site grading and control point depth. The hazard curves were then interpolated to obtain UHRS, which were enveloped to represent the PPE site conditions. Horizontal and vertical GMRS, FIRS, and PBIRS were developed from the enveloped UHRS and captured possible variations in seismic wave transmission characteristics across the site.

In summary, the DRS obtained in this section are as follows:

- Horizontal and vertical GMRS in Table 2.5-42: applicable to all technologies in the North and Middle Plant Complexes.
- Horizontal and vertical PBIRS in Table 2.5-42: applicable to all technologies in the North and Middle Plant Complexes.
- Horizontal and vertical FIRS for depth 44 ft. (13 m) in Table 2.5-42: applicable to Westinghouse AP300 in the North and Middle Plant Complexes.
- Horizontal and vertical FIRS for depth 85 ft. (26 m) in Table 2.5-42: applicable to Holtec SMR-300, X-energy Xe-100, TerraPower Natrium, and GVH BWRX-300 in the North and Middle Plant Complexes.
- Horizontal and vertical GMRS in Table 2.5-49: applicable to all technologies in the South Plant Complex.
- Horizontal and vertical PBIRS in Table 2.5-49: applicable to all technologies in the South Plant Complex.
- Horizontal and vertical FIRS for depth 44 ft. (13 m) in Table 2.5-49: applicable to Westinghouse AP300 in the South Plant Complex.

- Horizontal and vertical FIRS for depth 85 ft. (26 m) in Table 2.5-49: applicable to Holtec SMR-300 and NuScale VOYGR in the South Plant Complex.
- Horizontal and vertical FIRS for depth 115 ft. (35 m) in Table 2.5-49: applicable to X-energy Xe-100, TerraPower Natrium, and GVH BWRX-300 in the South Plant Complex.

The DRS should be adjusted to account for topographic amplification if the technologies are to be located near the edge of the graded site pad. Table 2.5-26 contains the multiplicative factors to apply to the DRS.

In all cases, the magnitude and distance of controlling earthquakes is as follows:

- High frequency (mean of 5 and 10 Hz): **M** 6.4, R_{rup} 70 km (44 mi.) for AFE 1E-4; **M** 6.3 R_{rup} 23 km (14 mi.) for AFE 1E-5.
- Low frequency (mean of 1 and 2.5 Hz) for distance less than 100 km (62 mi.): **M** 6.3, R_{rup} 25 km (16 mi.) for AFE 1E-4 and **M** 6.5 R_{rup} 17 km (11 mi.) for AFE 1E-5.
- Low frequency (mean of 1 and 2.5 Hz) for distance greater than 100 km (62 mi.): **M** 7.3, R_{rup} 323 km (201 mi) for AFE 1E-4 and **M** 7.4 R_{rup} 300 km (186 mi.) for AFE 1E-5.

2.5.3 SURFACE DEFORMATION

This section evaluates the potential for tectonic and non-tectonic deformation at or near the ground surface for the Belews Creek, North Carolina (NC) site (Project site). This section has been developed in accordance with RG 1.208 and NUREG-0800. The tectonic and nontectonic deformation evaluated in this section includes the following:

- Potential surface deformation associated with bedrock faults.
- Other potential geologic sources of surface deformation, including karst collapse, salt tectonics, and volcanism.
- Human-induced causes of surface deformation, including the potential for mine collapse.

Consistent with these requirements, the investigations assess whether any geologic structures within the Site Area (5 mi. [8 km] radius), Site Vicinity (25 mi. [40 km] radius), or Site Region (200 mi. [320 km] radius) can be classified as capable tectonic sources that may produce surface deformation. The assessment draws on the geologic, seismologic, and tectonic framework presented in Section 2.5.1, which describes the stratigraphy, tectonic structures, and regional geologic hazards of the Piedmont and adjacent provinces. Particular emphasis is placed in this section on evaluating known structures in proximity to the Project site, including the Chatham fault zone, Stony Ridge fault, Little River fault, the Central Piedmont suture, and the Dan River – Danville basin. In addition, other mapped regional features, such as the Brevard fault zone and the ETSZ, are also evaluated.

Published geologic maps from the USGS and NC Geological Survey (NCGS), regional seismicity catalogs including the CEUS SSC project, remote-sensing datasets like high-resolution LiDAR, and paleoseismological studies were reviewed. Also evaluated were nontectonic features that may cause surface deformation, such as karst and legacy mining.

Methods and conclusions presented herein are integrated with the vibratory ground motion characterization in Section 2.5.2 and the regional tectonic framework in Section 2.5.1; this integration provides traceable consistency across data sources and regulatory guidance (RG 1.208; NUREG-0800).

2.5.3.1 Geological, Seismic and Geophysical Investigations

This section summarizes published investigations and datasets used to evaluate the potential for tectonic and nontectonic surface deformation in the Site Vicinity and provides broader tectonic context from the Site Region. The reviewed information includes (1) regional and local geologic mapping; (2) remote-sensing and geomorphic datasets; (3) seismicity and paleoseismic studies; and (4) datasets for nontectonic deformation such as karst and mining.

Where applicable, site-specific reconnaissance (e.g., aerial imagery review, LiDAR-based hillshade, and slope products) has been cross-checked against published maps to verify feature locations and assess whether any unmapped Quaternary scarps or collapse features may be present within the Site Vicinity.

2.5.3.1.1 Geologic Mapping

Geological mapping in the area surrounding the Project site documents the presence of Piedmont metamorphic units and the adjacent Mesozoic Dan River – Danville rift basin. USGS and NCGS maps show the Site Area underlain by gneissic and schistose rocks of the Milton and Charlotte terranes, while the Dan River basin to the north and northeast is expressed as a half-graben bounded on the northwest by the Chatham fault system. Numerous Triassic – Jurassic diabase dikes transect both basin and basement rocks (Reference 2.5-51; Reference 2.5-133; Reference 2.5-114; Reference 2.5-17). The Piedmont Region is located east of the Blue Ridge Mountains and is characterized by rolling relief (Reference 2.5-206). Geologic units in the Piedmont Region are mainly metamorphic rocks that are intruded by igneous rocks and, in some locations, faulted and filled with Triassic-age sediments (Reference 2.5-207). Metamorphic rocks are interpreted to have accreted onto Laurentia in the Early to Middle Ordovician (Reference 2.5-43). Collectively, these mapping datasets provide the basis for evaluating bedrock structures and tectonic setting in the Site Vicinity. Sections 2.5.1.1.4 and 2.5.1.2.3 to 2.5.1.2.4 provide a detailed narrative of terrane architecture, the Dan River – Danville basin geometry, and mapped fault systems used here as the structural context for surface-deformation screening.

Geophysical surveys summarized in Section 2.5.1 complement geologic mapping. Regional aeromagnetic data delineate major terrane boundaries and diabase dike swarms, which appear as linear magnetic highs trending northeast-southwest across the Site Region. Gravity datasets similarly highlight the Dan River – Danville basin as a negative anomaly relative to surrounding metamorphic basement, corroborating its geometry as a half-graben. Seismic reflection profiles across portions of the basin (Reference 2.5-123) constrain the thickness of Triassic – Jurassic sediments and confirm fault-bounded margins along the Chatham fault zone. However, no focused geophysical campaigns (e.g., local reflection surveys or seismic arrays) have identified Quaternary-capable structures in the Site Vicinity.

High-resolution LiDAR data acquired statewide from 2015 to 2016 (0.5 to 1 meter [m] (1.6 to 3.3 ft.) DEMs) (Reference 2.5-208) enable reconnaissance for potential Quaternary tectonic landforms. Hillshade and relative-relief analyses reveal no sharp, laterally continuous scarps of

probable Quaternary tectonic origin within the Site Area. Observed lineaments are consistent with mapped bedrock foliation, lithologic contacts, and diabase dike trends (discussed further in Section 2.5.3.5).

2.5.3.1.2 Earthquake Catalogs and Regional Seismicity

Regional seismicity was reviewed using the project earthquake catalog and the CEUS SSC project report as the standard regional source model for nuclear facility hazard studies (Reference 2.5-60). These resources provide historical and instrumental seismicity in the Site Region and the basis for characterizing background sources and recurrence in the CEUS as discussed in Section 2.5.2.

An important modern reference event is the August 9, 2020, earthquake (E[**M**]5.1), approximately 60 mi. (95 km) northwest of the Project site in Sparta, NC. Detailed field and LiDAR studies document a short reverse-sense surface rupture along the Little River fault with up to approximately 9.8 inches (in.) (25 centimeters [cm]) of vertical offset, the first well-documented historical surface rupture in the eastern United States outside the New Madrid seismic zone, underscoring that moderate intraplate events can produce localized surface deformation (Reference 2.5-83). The Sparta earthquake was not felt at the BCSS but was recorded in the turbine generator vibration monitoring system.

In addition to earthquake catalogs and as discussed in Section 2.5.2, seismic monitoring in the southeastern United States has been enhanced by broadband and short-period seismometer networks operated by the USGS and regional universities (Reference 2.5-209).

The Site Region catalog review also considers historical events in the CVSZ, ETSZ, and Giles County zone to evaluate whether any sequences or mapped trends project toward the Site Vicinity (see Section 2.5.3.2).

2.5.3.2 Geologic Evidence for Surface Deformation

There are several zones of Quaternary seismicity in the Site Region based on paleoseismology and historical seismicity (Reference 2.5-59; Figure 2.5-107); however, in many of these zones, the link between seismicity and any surface deformation is less defined (Reference 2.5-210; Reference 2.5-82; Reference 2.5-65). A summary of these zones is provided below, and Section 2.5.1 describes them in more detail.

2.5.3.2.1 Charleston

On August 31, 1886, an E[**M**] 6.9 earthquake occurred in the region near Charleston, South Carolina. It is the largest known historical earthquake in the eastern United States. Paleoliquefaction evidence indicates pre-1886 earthquakes have occurred in the same region in the last 5500 years (Reference 2.5-60). The Charleston source area remains the most robust CEUS example of repeated strong earthquakes in the late Holocene based on extensive paleoliquefaction databases (Reference 2.5-60). Multiple near-surface faults have been identified in the region; however, there is no scientific consensus on the location of the 1886 rupture(s) (Reference 2.5-61). Recent studies continue to debate the location of coseismic deformation from the 1886 event (Reference 2.5-68; Reference 2.5-211), while other studies have mapped potentially seismogenic faults in the zone that did not rupture in 1886 (Reference 2.5-61; Reference 2.5-212). These mapped structures do not project toward the Site Vicinity.

2.5.3.2.2 Central Virginia

The CVSZ has elevated rates of seismicity relative to the surrounding region in Virginia. Measured seismicity in the zone includes the 2011 E[**M**] 5.72 Mineral, Virginia, earthquake. Other large historical events in this zone include the 1758 E[**M**] 4.95, the 1774 E[**M**] 4.38, and the 1875 E[**M**] 4.77 events. No historical events in the zone are interpreted to exceed E[**M**] 6 (Reference 2.5-71). Pazzaglia et al. (Reference 2.5-213) interpreted differential uplift along river terraces in the region near the Mineral, Virginia, earthquake. They concluded that the area has undergone 30 to 94 meters per million years of tectonically driven river incision consistent with low intraplate strain rates. In the CVSZ, river-terrace geomorphology and geochronology indicate long-term differential uplift but do not document through-going Quaternary surface rupture. Paleoliquefaction features attributed to late Holocene earthquakes are recognized regionally, yet available trenching and geomorphic work in the CVSZ has not identified a specific Quaternary-rupturing fault trace (Reference 2.5-71).

2.5.3.2.3 Eastern Tennessee

The ETSZ is a region with an elevated historical seismicity rate in Tennessee (Reference 2.5-74).. The region exhibits one of the higher instrumental seismicity rates in the CEUS, and recent field studies have evaluated potential Quaternary deformation. Cox et al. (Reference 2.5-76) reported outcrops and deposits interpreted as coseismic deformation in Holocene alluvium; however, subsequent reexamination by Thompson Jobe et al. (Reference 2.5-210) reinterpreted several key exposures as fluvial features. Thompson Jobe et al. (Reference 2.5-210) did, however, interpret east-west trending lineaments from LiDAR DEMs, but conclude that these lineaments lack corroborating evidence for Quaternary surface rupture. Together, these results support the characterization of the ETSZ as an intraplate region with distributed microseismicity but without demonstrated, mappable Quaternary fault scarps.

2.5.3.2.4 Giles County

The Giles County seismic zone has an elevated historical seismicity rate in southwestern Virginia. The largest historical earthquake in the region was the E[**M**] 5.91 Giles County earthquake, which occurred on May 31, 1897. The earthquake has an estimated maximum MMI of VIII. (Reference 2.5-78).

The Pembroke faults are mapped within the Giles County seismic zone. These faults are associated with extensional cracks in fluvial terrace deposits. They are classified as having evidence of Quaternary deformation, but it is not conclusive if the deformation is related to tectonic faulting or dissolution of underlying carbonate layers (Reference 2.5-82; Reference 2.5-81).

2.5.3.2.5 Little River Fault

Within NC, the August 9, 2020, Sparta earthquake (E[**M**] 5.1) produced a short, reverse-sense surface rupture on the Little River fault, the first well-documented historical surface rupture in the eastern United States outside the New Madrid region (Reference 2.5-83). Maximum observed offset height of approximately 9.8 in. (25 cm) was documented by field mapping and LiDAR differencing. The rupture length (~2 km [1.2 mi.] at the surface) was shorter than the subsurface rupture length from focal depth data (approximately 4.35 mi. [7 km]), illustrating that moderate intraplate events can generate localized surface breaks (Reference 2.5-83). No

Sparta earthquake-related structures project toward the Project site area (see Section 2.5.1.1.4).

2.5.3.3 Timing of Deformation

The most recent regional and intense deformation in the Site Vicinity was Permian to Early Jurassic rifting associated with the breakup of Pangea in the Dan River basin (Reference 2.5-123). Dikes associated with the Central Atlantic magmatic province (CAMP) volcanics (approximately 201 million years [Ma]) that cross the rift are not displaced by the basin-bounding Chatham fault. This geological relationship indicates that movement on the fault occurred before dike emplacement (Reference 2.5-123; Reference 2.5-50).

Other mapped faults, such as the Brevard fault, are older than the Dan River basin. The Chatham fault that bounds the Dan River basin is mapped as Devonian to Mississippian in age (Reference 2.5-214). No published evidence indicates post-Miocene reactivation of mapped Site Vicinity structures; thus, by RG 1.208 criteria, these features do not meet the definition of capable tectonic sources.

2.5.3.4 Correlation of Earthquakes with Tectonic Features

There are no earthquake events above expected moment magnitude (E[**M**]) 2.9 in the Project Earthquake Catalog within the Site Vicinity 25 mi. (40 km) radius (Figure 2.5-107). E[**M**] 2.9 is the lowest value used by the CEUS SSC model for recurrence (Reference 2.5-60). This project uses the CEUS SSC project catalog updated through the end of April 2024 applying the same methodology used for the CEUS SSC (Section 2.5.2).

The closest project catalog earthquake greater than E[**M**] 5 to the Project site was the 2020 E[**M**] 5.1 Sparta earthquake with an epicenter 59 mi. (95 km) to the northwest (Figures 2.5-107; 2.5-108). The earthquake generated an average coseismic topographic step of 3.1 to 3.9 in. (8 to 10 cm) (maximum approximately 9.8 in. [25 cm]) associated with a reverse-fault scarp on the Little River fault. The scarp was mapped to be approximately 2 km [1.2 mi.] long (Reference 2.5-83). The Sparta event is the first well-documented surface rupture in the eastern United States outside the New Madrid region, and it demonstrates that moderate intraplate earthquakes can result in localized deformation. However, the Little River fault is outside the Site Vicinity, and no mapped Quaternary structures project toward the Project site (see Section 2.5.1.1.4).

Two earthquakes with epicenters located more than 77 mi. (125 km) from the Project site are associated with the Giles County seismic zone (Figure 2.5-108). The April 29, 1852, E[**M**] 5.21 and the May 31, 1897, E**[M**] 5.91 earthquakes caused damage to local structures and were felt in the greater Virginia region (Reference 2.5-139). Because both earthquakes were pre-instrumental and there is no conclusive evidence of surface deformation in their source area (Reference 2.5-82), they are not associated with a specific known-geological structure. Smaller, instrumentally recorded earthquakes in the area are interpreted to occur on reactivated Precambrian or Cambrian Iapetan normal-slip faults. These faults are below the Appalachian thrust complex (Reference 2.5-82).

The project earthquake catalog separates natural seismicity from human-induced events such as those associated with hydrocarbon extraction and waste injection. There are no induced events within the Site Vicinity. The closest rocks with hydrocarbon potential are the sedimentary

rocks in the Dan River basin. As of 2023, NC did not produce any natural gas or oil (Reference 2.5-215).

The evaluation of the correlation to earthquakes with capable tectonic sources shows:

1. No earthquakes ≥ E[**M**] 2.9 are recorded within the Site Vicinity.

2. The nearest surface-rupturing earthquake, the 2020 Sparta event, occurred approximately 59 mi. (95 km) away and has no known structural connection to the Project site.

3. Regional earthquake epicenters (Giles County, CVSZ, ETSZ, and Charleston) are located more than 25 mi. (40 km) away and lack demonstrable Quaternary surface ruptures in their source areas.

4. Induced seismicity is absent in the Site Vicinity because of the lack of hydrocarbon production or wastewater injection.

Accordingly, there is no evidence to correlate earthquakes with capable tectonic sources at or near the Project site. Regional seismicity contributes to background hazard but does not indicate the presence of capable Quaternary faults in the Site Vicinity.

2.5.3.5 Relationship of Geologic Features in the Site Vicinity (25 Mi. [40 Km]) to Regional Geologic Features

The most prominent feature in the Site Vicinity is the Mesozoic Dan River basin (Figures 2.5-109, 2.5-110; 2.5-111). The basin is a half-graben, bounded to the northwest by the Chatham fault or Dan River fault zone and to the southeast by a nonconformity (Reference 2.5-123; Reference 2.5-50). The fault is 35 mi. (56 km) long. It was originally named the Chatham fault in Virginia and the Dan River fault zone in NC (Reference 2.5-50). The Dan River basin is one of a series of continental rift basins that formed during the breakup of Pangea from the Permian to the Early Jurassic (Reference 2.5-123; Reference 2.5-50). The southeastern boundary of the Dan River basin is bound by sedimentary onlap via a nonconformity, although some short length (up to 3 mi. [4.8 km]) faults are mapped along this boundary (Reference 2.5-123; Reference 2.5-50; Figure 2.5-109). Since deposition, the sedimentary units of the Dan River basin have been tilted to the northwest and gently folded (Reference 2.5-50). Approximately north-south trending Triassic and Jurassic age diabase dikes transect both basin margins (Reference 2.5-123; Reference 2.5-133). Some of the dikes that cross the border fault do not appear offset (Reference 2.5-123), which indicates that the dikes were likely emplaced after movement ceased on the fault and the fault has not been reactivated since the Mesozoic. There is no association between the Dan River basin and the seismicity pattern from the project earthquake catalog (Section 2.5.2; Figure 2.5-107).

The Project site is within the Charlotte terrane, one of a series of northeast-southwest trending metamorphic geologic units (Reference 2.5-51; Reference 2.5-17; Figure 2.5-111). In the Site Area, the geology can be separated into the Milton terrane and Charlotte belt with the Project site sitting on the Milton terrane. This is based on interpreted differences in lithology that were not originally mapped (Reference 2.5-114; Figure 2.5-110). To the south of the Project site and within the Site Vicinity is the Carolina Slate Belt. The Sauratown Mountain anticlinorium, the Brevard fault zone, the Smith River allochthon, and the Blue Ridge Belt are mapped north of the

Project site (Reference 2.5-51; Reference 2.5-133). The Brevard fault is the closest of these features to the Project site at more than 45 mi. (75 km) away. The Brevard fault zone is mapped as Devonian to Mississippian in age (Reference 2.5-214).

The Stony Ridge fault is located approximately 12.5 mi. (20 km) northwest of the Project site (Reference 2.5-51). The Stony Ridge fault was mapped as forming during the Mesozoic reactivation of the Brevard fault (Reference 2.5-49; Reference 2.5-50); however, subsequent mapping was unable to demonstrate appreciable displacement on the fault, and the cataclasite associated with the fault may have formed from local hydrothermal alteration (Reference 2.5-49). The Stony Ridge fault can be seen as a positive feature in the LiDAR data (Figure 2.5-112) and is mapped in the geologic map (Figure 2.5-111; Reference 2.5-51). It is not a topographic step that could indicate recent offset along the fault, but the observed geomorphology is likely due to differential erosion of the more resistant cataclasite.

Prominent topographic features in the Site Vicinity are interpreted to be related to changes in underlying lithology. Approximately 9.3 mi. (15 km) northeast of the Project site, two hogback ridges in the Dan River basin between Madison and Stonewall consist of interbedded, well-indurated siltstone and sandstone (Reference 2.5-50). East of the site, a linear feature trending northeast-southwest from Belews Lake toward Gold Hill coincides with the boundary between Precambrian to Paleozoic muscovite and biotite schists and mica and gneiss schist (Reference 2.5-133; Figure 2.5-111; Figure 2.5-112, labeled as “lithologic boundary”). The contact as mapped is irregular and is not interpreted as a fault contact (Reference 2.5-133).

2.5.3.6 Potential for Surface Deformation at the Site

The Site Area lies within the Piedmont Province with rocks recording multiple Paleozoic orogenic events and Mesozoic continental rifting (Reference 2.5-17; Reference 2.5-10). As described in Section 2.5.1, the Piedmont is bounded to the northwest by the Blue Ridge Province and to the southeast by the Coastal Plain, and it contains sutures such as the Central Piedmont shear zone and Brevard fault zone. These regional features are located more than 45 mi. (75 km) from the Project site.

The tectonic structures mapped within the Site Area consist primarily of lithologic contacts, foliation-parallel fabrics, and intrusive diabase dikes within the Milton terrane (Reference 2.5-51; Reference 2.5-133; Reference 2.5-114). No Quaternary-capable faults are mapped in the Site Area (Reference 2.5-82; Reference 2.5-59). The nearest mapped fault is the Chatham fault zone, which bounds the Dan River – Danville basin approximately 2 mi. (3.2 km) northwest of the Project site (Reference 2.5-50; Reference 2.5-123). This fault was active during times of Late Paleozoic to Early Mesozoic rifting, but cross-cutting relationships with CAMP dikes indicate that slip ceased prior to approximately 201 Ma (Reference 2.5-123). Thus, tectonic structures within the Site Area are older features that do not exhibit evidence of Quaternary reactivation. Therefore, the local geologic structures in the Site Area do not show evidence of being linked to any regional Quaternary-capable earthquake sources. The mapped metamorphic foliation, intrusive dikes, and rift-basin faults are consistent with regional tectonic trends (northeast-southwest orientation) but display no geomorphic or geologic evidence of recent activity.

Aerial photographs of the Site Area were reviewed; however, the tree canopy prevented meaningful geological assessments for parts of the area (Reference 2.5-216; Figure 2.5-113). LiDAR data with a spatial resolution of 3 ft. (1 m) collected in 2015 and 2016 (Reference 2.5-

208; Figure 2.5-112) was developed into a DEM for the project (Reference 2.5-208). The aerial photographs and LiDAR DEM were compared with geologic maps of the area (Reference 2.5-133; Reference 2.5-51). Of the two maps (Reference 2.5-133 and Reference 2.5-51), Carpenter (Reference 2.5-133) mapped more subunits and lithologic changes.

Three prominent northeast-southwest trending features are identified on the DEM. Two features in the Dan River basin align with the general location of hogbacks ridges mapped by Thayer (Reference 2.5-50). The third feature trends northeast-southwest and crosses into the Site Area, aligning with the boundary between Precambrian to Paleozoic muscovite and biotite schists and mica and gneiss schist (Reference 2.5-133; Figures 2.5-111 and 2.5-112). The location of mapped faults from the geologic maps was reviewed in both the aerial and LiDAR data. Within the Site Area (5 mi. [8 km]), the only mapped fault is the Chatham fault, which does not have a strong geomorphic signature in the LiDAR DEM. No sharp linear features were identified in the LiDAR or aerial photographs that could indicate recent faulting in the Site Area.

A lineament map covering the Site Area was developed as part of the ground water analysis for the Project site (Section 2.4.12; Figure 2.5-114). A total of 1408 lineaments were identified with prominent lineament orientations centered on N30-40°W, N20-30°E, and N60-70°E. Lineament orientations are generally parallel or perpendicular to regional geologic trends. Variations are likely caused by changes in local geological unit's strike and the formation of conjugate fractures at small angles to the principal direction of stress. Most interpreted lineaments are shorter than 2 mi. (3.2 km). The longest lineament follows the Dan River valley to the northwest of the Project site. This portion of the Dan River generally follows the contact between the Mesozoic Dan River basin and the older metamorphic units. No lineaments longer than 2 mi. (3.2 km) are mapped in the Project site, including when lineaments are projected across the lake to the other shore to connect features disrupted by the datasets used for the lineament analysis that do not image the lake floor. Geologic mapping performed from 1966 to 1971 (Reference 2.5-51) maps rock surface beneath the lake location and do not show any faults or lineaments crossing the Project site.

Karegar et al. (Reference 2.5-217) conducted a regional study using Global Positioning System (GPS) data with average record lengths of 8.5 years per station from the U.S. Atlantic Coast region (Figure 2.5-115). Data from the study show the Piedmont region is generally subsiding at a rate of 0.06 to 0.02 inches per year (1.5 to 0.5 mm/yr). Three GPS stations in the Site Vicinity (25 mi. [40 km]) are subsiding within the range of the general rates for the Piedmont region. There are no indications from the regional dataset that the Site Vicinity is behaving differently from the rest of the Piedmont in NC and southern Virginia.

Within the Site Location (1 mi. [1.6 km]), the subsurface exploration study confirms that the Project site is entirely underlain by the CZbg unit, a Cambrian-age biotite gneiss and schist, which is metamorphosed to amphibolite facies and intruded locally by pegmatitic dikes. Lithologies and structures observed in boreholes are consistent with previously published regional geologic mapping (Reference 2.5-114; Reference 2.5-115). The borehole data document metamorphic fabrics, folding, and intrusive relationships characteristic of Paleozoic to Precambrian tectonism. No evidence of Quaternary or other recent deformation was observed in the core descriptions, geophysical logs, or stratigraphic profiles developed as part of this investigation.

Fracture and foliation orientations documented from borehole logging (boreholes 1, 3, 5, 6, 8, 10, 11, 13, and 15, as expressed in rose diagrams in Figure 2.5-116) exhibited generally

consistent structural patterns across the Site Area. Field data did not differentiate between joints and fractures and therefore, the more general term of “fractures” is used in this section. Most of boreholes showed a dominant northeast-southwest (N30–50°E) azimuth orientation with a secondary northwest-southeast (N20–40°W) azimuth orientation broadly consistent with conjugate fracture sets observed in Piedmont metamorphic rocks.

Several boreholes (B5, 10, 11, 13) displayed both open and filled fractures clustering tightly within these modes, whereas others (B3 and 3A, 6, 15A and B) recorded more dispersed populations that retain a preferred northeast-southwest trend.

Cross-hole comparisons show that nearly all boreholes express one or both of the principal fracture orientations, indicating that Site Area-scale fracture geometry can likely be attributed to the regional Site Vicinity and Site Region-scale structural grain of the Milton terrane and Charlotte belt. These borehole-scale results correspond directly to the lineament analysis presented in Section 2.5.3.5 (Figure 2.5-114), which identifies prominent lineament orientations centered at N30–40°E, N20–30°W, and N60–70°E. The agreement between borehole fracture orientations and regional lineament trends supports the interpretation that deformation at the Project site reflects inherited Paleozoic – Mesozoic tectonic fabrics, with no evidence of anomalous Quaternary structural trends or through-going fault zones at the Site Location.

In summary, while the Site Area is located within a tectonically complex Piedmont terrane that records multiple Paleozoic and Mesozoic deformation events, none of the mapped structures in the Site Area show evidence of Quaternary reactivation. These structures are not interpreted to be genetically related to the active tectonic sources that define historical and instrumental seismicity in the broader CEUS. Subsurface investigations confirm that the Project site is underlain entirely by Cambrian biotite gneiss and schist, with borehole logs documenting fracture and foliation orientations that are consistent across multiple boreholes. The dominant northeast-southwest and secondary northwest-southeast fracture sets are broadly consistent with Piedmont fabrics and the regional structural grain, indicating that observed fracture geometry reflects inherited tectonic fabrics. The prevalence of mineral-filled fractures further supports the interpretation that these features are ancient and not the result of recent tectonic activity. As discussed in Section 2.4.12, more than 97 percent of fractures were calculated to be filled or closed based on ATV log data. No evidence of Quaternary-capable faults, anomalous structural orientations, or recent deformation features were identified in borehole core, geophysical logs, or geomorphic datasets. This conclusion aligns with the summary of regional structure ages discussed in Section 2.5.1.

2.5.3.7 Non-Tectonic Hazard Screening (Mining, Volcanism, Karst, and Evaporites)

2.5.3.7.1 Mining

The location of mines and mine-like features that could collapse or result in surface deformation at the Project site was performed using data from the USGS Prospect- and Mine-Related Features from USGS 7.5- and 15-Minute Topographic Quadrangle Maps of the United States dataset (Reference 2.5-218, version 10 [May 2023]). This database includes prospect pits, mines, adits, dumps, and tailings, compiled from USGS topographic maps.

Forty-four mapped features within the Site Vicinity (25 mi. [40 km]) appear in the database (Figure 2.5-117). All but one are pits and quarries. The single adit, identified as “Tory’s Den” is mapped as a cave in Hanging Rock State Park (Reference 2.5-219). Mine and cave entrances

can share a symbol on topographic maps (Reference 2.5-220) and the classified adit is at the location of the cave. Based on the data contained in Horton and San Juan (Reference 2.5-218) and the interpretation of the adit as a cave entrance, the Site Vicinity contains no mapped underground mine features.

Eight mapped features are within the Site Area. Six are classified as clay pits and two are classified as quarries. No underground mining features are mapped in the Site Area. The closest feature is a quarry that is 2.8 mi. (4.5 km) to the northwest of the Project site across the Dan River. It is visible in the LiDAR DEM (Figure 2.5-112).

Aerial photographs in the Site Area were reviewed for evidence of underground mines such as tailings piles (Figure 2.5-113). Quarry features and the coal ash basin from the Belews Creek Steam Station are visible on the aerial photographs, indicating other tailing features could be mapped, although tree cover and the age of the features may make them less recognizable on aerial photographs. Topographic maps and LiDAR data were also reviewed for symbols associated with mining or topographic features.

Data compiled by Horton and San Juan (Reference 2.5-218) and analysis of aerial photographs do not indicate subterranean mining in the Site Vicinity that could lead to tunnel collapses and surface deformation at the Project site.

2.5.3.7.2 Volcanism

Prior to the breakup of Pangea, the CAMP, a large igneous province had formed (Reference 2.5-106). In the Site Vicinity, the CAMP is represented by a series of dikes that trend approximately north-south. Peak activity for the CAMP has been dated to the Triassic – Jurassic boundary, approximately 200 Ma (Reference 2.5-106). The youngest igneous features within the Site Region are Eocene volcanic dikes, sills, plugs, and diatremes near the West Virginia – Virginia border (Reference 2.5-105), more than 125 mi. (200 km) from the Project site.

Recent volcanism is typically associated with plate boundaries and mantle hotspots. Neither setting is present in the Site Region, and there are no mapped Quaternary active volcanoes (Reference 2.5-107; Reference 2.5-108; Reference 2.5-109). There are no Quaternary volcanoes in the Site Region (200 mi. [320 km]) or mapped Quaternary volcanic deposits within Site Vicinity (25 mi. [40 km]) [Reference 2.5-109]). Therefore, based on RG 4.26, which specifies if no Quaternary active volcanoes are identified in the Site Region (200 mi [320 km]), or Quaternary pyroclastic deposits within the Site Vicinity (25 mi. [40 km]), the volcanic hazard can be screened out of further analysis.

2.5.3.7.3 Karst and Evaporites

Tobin and Weary (Reference 2.5-221) compiled data for the USGS of locations in the United States of potential karst and karst analogous features. In NC, most karst-susceptible units are carbonate rocks in the Coastal Plain region. The Project site is not within a region identified to have fissures, tubes, caves, or units such as basalts that can contain tubes and tunnels and behave like karst.

Espenshade et al. (Reference 2.5-51) mapped the Project site geology as gneiss and schist of the Charlotte belt. Profile B-B' maps the unconformity at the southeast margin of the Triassic basin dipping away from the Project site (Figure 2.5-111). In Figure 2.5-111, the Project site is

projected onto the cross section that trends northwest-southeast, which, at its closest, is approximately 4.5 mi. (7.2 km) south of the Project site. The Project site projects into the unit Pzc - granitic rock; however, the Project site sits on the mapped bc unit - gneiss and schist. No evaporites or carbonate units are mapped in the Site Area (5 mi. [8 km]) (Reference 2.5-51; Reference 2.5-133). Rock units in the Triassic Dan River basin are mapped as clastic sedimentary rocks of nonmarine origin (Reference 2.5-51).

Borings and data collected at the Project site did not identify carbonate or evaporite units, or voids. LiDAR DEM data in the Site Area were reviewed for geomorphic features associated with karst and salt dissolution such as enclosed depressions, sinking streams, and other indications of karst (Reference 2.5-222; Figure 2.5-112; Reference 2.5-223). Sinkholes are the most common hazard in karst areas (Reference 2.5-224). No closed depressions or other karst features are identified in the Site Area.

2.5.4 STABILITY OF SUBSURFACE MATERIALS AND FOUNDATIONS

This section provides the details of the subsurface materials and foundation conditions for the Project site. It was prepared based on guidance presented in the relevant sections of NUREG-0800.

The Project site consists of three Plant Complexes – the North, Middle, and South Plant Complexes. At each complex, six different reactor technologies are under consideration as part of the ESPA. Table 2.5-51 provides a summary of the technologies and their anticipated bearing depth and base elevations. Additional site-specific studies will be performed during the construction permit or license application phase once a final selection on reactor technology is made.

The information presented in this section is based on results of the site-specific subsurface investigation program implemented at the Project site as part of the ESPA, and evaluation of the collected data, unless stated otherwise. NC State Plane Coordinate System (North Zone), North American Datum of 1983 (NAD 1983) is used to establish horizontal datum. North American Vertical Datum of 1988 (NAVD 88) is used to establish vertical datum, unless stated otherwise.

This section presents the required information in the following sequence:

- Section 2.5.4.1 - Geologic Features
- Section 2.5.4.2 - Properties of Subsurface Materials
- Section 2.5.4.3 - Foundation Interfaces
- Section 2.5.4.4 - Geophysical Surveys
- Section 2.5.4.5 - Excavation and Backfill
- Section 2.5.4.6 - Groundwater Conditions
- Section 2.5.4.7 - Response of Soil and Rock to Dynamic Loading
- Section 2.5.4.8 - Liquefaction Potential
- Section 2.5.4.9 - Earthquake Design Basis
- Section 2.5.4.10 - Static and Dynamic Stability

- Section 2.5.4.11 - Design Criteria
- Section 2.5.4.12 - Techniques to Improve Subsurface Conditions

2.5.4.1 Geologic Features

Section 2.5.1.1 addresses the regional physiography, geologic history, stratigraphy, structures, and tectonic setting and provides related maps, cross sections, and references.

Section 2.5.1.2 describes the physiographic, geologic, and tectonic characteristics of the Project site vicinity and Project site area using related maps, figures, and references.

The three locations explored as part of the Belews Creek, NC site ESPA investigation are referred to as the North Plant Complex, Middle Plant Complex, and South Plant Complex. Together, these are referred to as the Project site and are located in southeast Stokes County, near the intersection of four counties: Rockingham County to the east, Guilford County to the southeast, and Forsyth County to the south. The Project site is located within the Piedmont physiographic province, a distinct physiographic province that extends from New Jersey to Alabama (approximately 1000 mi. or 1600 km) (Reference 2.5-4).

Geologically, the Piedmont physiographic province is characterized by distinct tectonostratigraphic terranes. Tectonostratigraphic terranes are defined as fault-bounded geologic areas of regional extent, characterized by an internally homogeneous stratigraphy and geologic history that is different from that of adjacent terranes (Reference 2.5-15). These distinct terranes have been accreted to the ancient continent of North America (Laurentia) at different times by the convergence of tectonic plates. The terranes typically preserve an imprint of past geologic events that involved compressional, extensional, and translational tectonic activity (Reference 2.5-15). The Project site is entirely located within the Milton terrane, which is composed of Late Precambrian massive to strongly foliated biotite gneiss and schist, amphibolite, felsic gneiss, and Late Paleozoic diabase and granite intrusions. Milton terrane rocks are metamorphosed to amphibolite facies and folded into shallow, plunging, recumbent folds (Reference 2.5-115; Reference 2.5-15).

The site is underlain entirely by the CZbg unit, a Cambrian biotite gneiss and schist that ranges from approximately 520 to 650 million years old (Reference 2.5-117; Reference 2.5-116; Reference 2.5-227). The CZbg unit is a highly metamorphosed and foliated biotite gneiss and schist, described as dark colored, medium- to coarse-grained to porphyroblastic, locally contains hornblende, and is chiefly composed of biotite, quartz, potassium feldspar, muscovite, and hornblende. The CZbg formation is interlayered with mica schist and amphibolite and is locally intruded by pegmatite dikes.

Lithologies encountered during drilling operations are consistent with the published maps and reports as described above.

2.5.4.2 Properties of Subsurface Materials

The engineering stratigraphy at the Project site generally consists of overburden residual soils weathered in place from the parent rock, underlain by PWR and crystalline rock (fractured and sound rock). The degree of weathering in the residual soils and PWR is highly variable. The

upper portion of the rock is fractured to varying degrees and underlain by sound rock. The properties of subsurface materials are discussed in the following sections:

- Section 2.5.4.2.1 summarizes the Project site subsurface investigation. Section 2.5.4.2.2 describes the various strata encountered during the subsurface investigations.

- Sections 2.5.4.2.2, 2.5.4.2.3, and 2.5.4.2.4 describe the subsurface conditions and the derived geotechnical engineering properties (both static and dynamic) of the strata encountered with depth. Tables and figures referenced in these sections present the derived geotechnical engineering properties for these strata.

2.5.4.2.1 Subsurface Investigation

The subsurface investigation for the Project site was performed in accordance with the guidance outlined in RG.132 “Geologic and Geotechnical Site Characterization Investigations for Nuclear Power Plants”. This guidance was used in preparing a work plan, which formed the basis for the subsurface investigation. Deviations are identified at point of use, and alternatives and/or bases for deviations are provided. The subsurface investigation was conducted from April 2024 through March 2025. Figure 2.5-118 shows the locations of the geotechnical investigation field tests for the North, Middle, and South Plant Complexes. Figures 2.5-119 through 2.5-121 show the geotechnical investigation field tests relative to the surface and borehole geophysical explorations performed at the North, Middle, and South Plant Complexes, respectively. A summary of the geotechnical field tests is provided in Table 2.5-52. Because a specific reactor technology has not yet been selected, the locations of the boreholes were selected to be as representative of the overall site conditions as possible as part of the ESPA while considering the three potential complexes and six different technologies/layouts.

Before initiating drilling activities, the public utility service (NC 811) located and marked the underground utilities. A private utility locating subcontractor was also engaged to locate and mark underground utilities. Appropriate methods, such as ground penetrating radar, were employed to locate subsurface utilities within a 20-ft. (6.1 m) radius of each staked boring location. Soft dig excavations in the form of hand auger borings were conducted at boring and well locations to verify the absence of subsurface utilities to a depth of 5 ft. (1.5 m) or until encountering refusal on rock. No overhead utilities were found to conflict with the proposed boring locations.

Upon completion of field tests, surveying was conducted to establish the horizontal and vertical locations of investigation and testing points. The as-built survey was completed using a combination of survey-grade GPS methods and traditional differential leveling. Survey-grade GPS used for horizontal coordinates and elevations had an accuracy of 0.1 ft. (0.03 m), and differential leveling used for elevations had an accuracy of 0.02 ft. (0.006 m). The coordinates and elevations of the geotechnical field tests are captured in Table 2.5-52.

In total, 84 boreholes were completed – 26 of these boreholes were in the North Plant Complex, 28 were in the Middle Plant Complex, and 30 were in the South Plant Complex. The subsurface investigation is categorized into four series based on the primary function and is summarized below:

- "B" series borings were the primary geotechnical and geophysical borings. Forty-seven B-series borings were performed, including the offset borings that were drilled a short distance away (typically less than 10 ft. [3.0 m]) from the parent boring for rock coring or obtaining samples for laboratory testing (designated as A, B, C, or D, depending on the number of offset borings performed). Borings B-1, B-1A, B-1B, B-1C, B-2, B-2A, B-3, B-3A, B-3B, B-4, B-5, and B-5A were at the North Plant Complex; B-6, B-6A, B-6B, B-6C, B-7, B-7A, B-7B, B-8, B-8A, B-8B, B-8C, B-9, B-9A, B-9B, B-10, and B-10A were at the Middle Plant Complex; and B-11, B-11A, B-11B, B-11C, B-11D, B-12, B-13, B-13A, B-13B, B-13C, B-14, B-14A, B-14B, B-14C, B-15, B-15A, B-15B, B-15C, and B-15D were at the South Plant Complex.

- "W" series borings were performed for the shallow groundwater monitoring wells. Nineteen W-series borings were performed – W-1A, W-1B, W-2A, W-2B, W-3A, W-4A, W-5A, and W-5B were at the North Plant Complex; W-6A, W-7A, W-8A, W-9A, W-9B, and W-10A were at the Middle Plant Complex; and W-11A, W-12A, W-13A, W-14A, and W-15A were at the South Plant Complex.

- "DW" series borings were performed for the deep groundwater monitoring wells. Twelve DW-series borings were performed – DW-1A through DW-4A were at the North Plant Complex; DW-5A through DW-8A were at the Middle Plant Complex; and DW-9A through DW-12A were at the South Plant Complex.

- "S" series borings were performed for the sentinel wells (which served as water level monitoring wells during aquifer pumping tests). Six S-series borings were performed – S-1A and S-5A were at the North Plant Complex; S-7A and S-10A were at the Middle Plant Complex; and S-11A and S-15A were at the South Plant Complex.

A rig geologist (a geologist or an engineer) was assigned to each drill rig. The rig geologist was responsible for supervising/observing the drilling activities performed by their assigned crew, performing daily site equipment checks, preparing boring logs, documenting work activities, and implementing applicable sections of the work plan. The rig geologist also supervised subcontractor operations, such as borehole geophysical testing, for conformance to specified procedures and instructions.

The primary method of advancement through overburden soils was mud rotary drilling as described by ASTM D5783-18 (Reference 2.5-228) with SPT sampling. However, other methods of drilling were also employed, including rotosonic drilling (Reference 2.5-229) for some well lithology borings, and hollow-stem augers (Reference 2.5-230) for bulk soil sample collection. Upon encountering refusal on rock, borings were advanced using coring techniques.

All boreholes except for DW-11A and borings W-3A through W-15A, which were advanced using a sonic bit, had SPT split-spoon sampling. Disturbed soil samples were obtained using 1.5-in. (3.8-cm) inside diameter split-spoon samplers in conjunction with the SPT, as described by ASTM D1586 (Reference 2.5-231). The split spoon sampler was driven a minimum of 18 in (46 cm) or to refusal. The sampling interval was 2.5 ft. (0.76 m) to 5 ft. (1.5 m). The recovered soil samples were visually described and classified by the rig geologist in accordance with ASTM D2488-17e1 (Reference 2.5-232).

In addition, 24 undisturbed samples (using Shelby push tubes) were collected from the overburden soils. Undisturbed samples were obtained in accordance with ASTM D1587 (Reference 2.5-233) using nominal 3-in. (7.6-cm) outside diameter, 30-in. (76-cm)-long Shelby tubes. The samples were preserved and prepared for transport to the laboratory for subsequent testing in accordance with ASTM D4220/D4220M-14 (Reference 2.5-234).

Hollow-stem auger borings (Reference 2.5-230) collected bulk soil samples for laboratory testing. Bulk samples were taken from auger cuttings brought to the surface (approximately 100 pounds) from specified sampling intervals and stored in multiple, clean, 5-gallon buckets with lids along with separate jar samples to preserve the moisture of the material.

All geotechnical borings performed during the field investigation program penetrated into the rock layer. Rock coring was initiated once the rig geologist confirmed the presence of rock. Rock coring used the diamond core drilling method in accordance with ASTM D2113-14 (Reference 2.5-235) and water or a low-solids, high-polymer drilling mud and a wireline triple-tube, ball-bearing, swivel-type, HQ core barrel with a split inner barrel and hydraulic extrusion fittings. Core runs were generally 5 ft. (1.5 m) in length. The recovered rock samples were visually described and classified by the rig geologist in accordance with ASTM D5434-12 (Reference 2.5-236). Routine-care rock samples were wrapped following ASTM D5079-08 (Reference 2.5-237). Any special-care rock core samples as defined by ASTM D5079-08 were identified by the rig geologist or lead geologist and preserved as soon as practical after coring to preserve their in situ characteristics.

Photographs were taken of split-spoon and rock core samples. Undisturbed samples were sealed in steel tubes and therefore could not be photographed. An on-site, secure, temperature-controlled sample storage facility for soil and rock samples was established prior to initiating the field exploration program. Field samples were delivered to the sample storage facility daily. Split-spoon samples were placed into glass jars with moisture sealing screw-type lids and were transported in compartmentalized cardboard boxes. Bulk soil samples were placed in plastic buckets secured with snap-on lids. Undisturbed (intact) Shelby tube samples were temporarily capped in the field near the test location, transported in a vertical orientation to the on-site sample storage where they were cleaned and sealed, and then secured in a vertical position in custom wood racks. All samples were labeled on the containers to identify the samples and logged into the sample storage facility using a sample inventory log. Material storage and handling were in accordance with ASTM D4220/D4220M-14 (Reference 2.5-234) and ASTM D5079-08 (Reference 2.5-237) for soil and rock samples, respectively.

2.5.4.2.1.1 Standard Penetration Test Measurements and Hammer Energy Calibration

Soil samples were collected from the borings by means of SPT split-spoon and Shelby tube samples. SPT resistance (N) values were measured during the sampling and recorded on the boring logs.

Energy measurements were made on the auto-hammer-rod system on each of the drill rigs used during the field investigation in accordance with ASTM D4633 (Reference 2.5-238). A Pile Driving Analyzer was used to acquire and process hammer energy data. Table 2.5-53 summarizes the measured energies. The average energy transfer ratio measurements, defined as the ratio of the maximum recorded energy transfer to the theoretical hammer energy, ranged from 88 to 89 percent.

The SPT N-value used in correlations with engineering properties is typically the value corresponding to 60 percent hammer efficiency. The measured field SPT N-values were adjusted based on the energy measurements by applying the obtained energy transfer ratio from hammer energy measurements for each drilling rig to the measured SPT N-values. The measured SPT N-values from each boring were adjusted using the energy transfer ratio value captured in Table 2.5-53 depending on the drill rig used for a particular borehole.

Energy-corrected SPT N-values (N_{60}) ranged from 1.5 blows/ft (bpf) to 138 bpf (1.5 blows/0.3 m to 138 blows/0.3 m), with an average measured N_{60} value of approximately 31 bpf (31 blows/0.3 m) in the overburden soils, indicating typically medium dense consistency. The N_{60} value in the PWR layer was more than 100 bpf. The variability of N_{60} values across the entire site is presented in Figure 2.5-122. The figure indicates a generally increasing N_{60} value with depth; however, the variability is significant as is common in Piedmont residual soils.

2.5.4.2.1.2 Rock Core Data

The rig geologist visually described the rock core including lithology and discontinuities and distinguished mechanical breaks from natural breaks where possible. The rig geologist also calculated core recovery (CR) and RQD prior to moving the core from the drill site. RQD was measured and recorded for each core run in compliance with ASTM D6032/D6032M-17 (Reference 2.5-239).

The CR and RQD values at the site ranged between 0 percent and 100 percent. The data indicate that the upper portion of the crystalline rock layer is fractured to varying degrees. For engineering stratigraphy purposes, fractured rock for this project has been defined as cored rock with RQD values less than 50 percent. At the North Plant Complex, the mean thickness of the stratum identified as fractured rock (see Section 2.5.4.2.2.3) was 14 ft. (4.3 m) (with a standard deviation of 15 ft. [4.6 m]). At the Middle Plant Complex, the mean thickness of the fractured rock stratum was 5.2 ft. (1.6 m) (with a standard deviation of 8.4 ft. [2.6 m]). At the South Plant Complex, the mean thickness of the fractured rock stratum was 6.2 ft. (1.9 m) (with a standard deviation of 7.4 ft. [2.3 m]).

2.5.4.2.1.3 Laboratory Tests

The laboratory investigation of soils and rocks was performed in accordance with the guidance outlined in RG 1.138, *Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants*. Laboratory testing included the following:

Soil Tests:

- Classification of Soils for Engineering Purposes – ASTM D2487-17e1 (Reference 2.5-240)
- Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass – ASTM D2216-19 (Reference 2.5-241)
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils – ASTM D4318-17e1 (Reference 2.5-242)

- Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing – ASTM D1140 17 (Reference 2.5-243)
- Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis – ASTM D6913/D6913M 17 (Reference 2.5-244)
- Particle-Size Distribution (Gradation) of Soils Using Hydrometer Analysis – ASTM D7928 21e1 (Reference 2.5-245)
- Specific Gravity of Soil Solids by Water Pycnometer – ASTM D854-23 (Reference 2.5-246)
- One-Dimensional Swell or Collapse of Soil – ASTM D4546-21 (Reference 2.5-247)
- One-Dimensional Consolidation Properties of Soils Using Incremental Loading – ASTM D2435/D2435M-11 (Reference 2.5-248)
- Unconfined Compressive Strength of Cohesive Soil – ASTM D2166/D2166M-16 (Reference 2.5-249)
- Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils – ASTM D2850-23 (Reference 2.5-250)
- Consolidated-Undrained Triaxial Compression Test for Cohesive Soils – ASTM D4767-11 (2020) (Reference 2.5-251)
- Laboratory Determination of Density and Unit Weight of Soil Specimens – ASTM D7263-21 (Reference 2.5-252)
- Laboratory Compaction Characteristics of Soil Using Modified Effort – ASTM D1557-12 (2021) (Reference 2.5-253)
- X-Ray Radiography of Soil Samples – ASTM D4452/D4452M-22 (Reference 2.5-254)
- Resonant Column Torsional Shear (RCTS) - University of Texas Procedure
- Determination of Thermal Conductivity of Soil and Rock by Thermal Needle-Probe Procedure – ASTM D5334-22ae1 (Reference 2.5-255)
- Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils – ASTM D2974-20e1 (Reference 2.5-256)
- Chemical analyses:
  - pH of Soil Used in Corrosion Testing – ASTM G51-18 (Reference 2.5-257)
  - Water-Soluble Sulfate Ion Content of Soil – ASTM C1580-20 (Reference 2.5-258)
  - Water-Soluble Chloride Ion Content of Soil – AASHTO T291-22 (2022) (Reference 2.5-259)

Rock Tests:

- Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force – ASTM D5607-16 (Reference 2.5-260)
- Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures – ASTM D7012-23 method B (Reference 2.5-261)
- Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures – ASTM D7012-23 method C (Reference 2.5-261)
- Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures – ASTM D7012-23 method D (Reference 2.5-261)
- Unconfined Free-Free Resonant Column (URC) - University of Texas Procedure
- Resonant Column Torsional Shear (RCTS) - University of Texas Procedure

For all strength tests performed on rock core, specimens were prepared in accordance with ASTM D4543-19 (Reference 2.5-262). The number and types of tests were selected to be representative of the conditions encountered at the site and to allow for adequate characterization of the pertinent soil and rock properties.

- Table 2.5-54 provides a summary of the laboratory tests and specifications used for the laboratory testing program.
- Table 2.5-55 provides a summary of the index test results.
- Table 2.5-56 provides a summary of the soil consolidation and swell/collapse test results.
- Table 2.5-57 provides a summary of the soil strength test results.
- Table 2.5-58 provides a summary of the unit weight determinations on undisturbed soil samples.
- Table 2.5-59 provides a summary of the Modified Proctor test results.

In addition to the routine tests commonly performed in typical soil and rock testing laboratories, specialty tests not covered in regulatory guides were also performed for the Belews Creek site exploration. These included RCTS and unconfined Free-Free (Fr-Fr) unconfined resonant column URC tests, which were performed at the University of Texas. These tests also included constant strain rate triaxial compression of rock samples, constant strain rate uniaxial compression of rock samples, and direct shear testing of rock that were performed by RESPEC, a specialty geotechnical consultant.

The following sections provide a summary of each test, describing the most important and relevant results.

2.5.4.2.1.3.1 Soil and Rock Classification

Soil samples were classified in the laboratory using the Unified Soil Classification System (USCS) in accordance with ASTM D2487-17 (Reference 2.5-240).

2.5.4.2.1.3.2 Grain Size Distribution, Moisture Content, and Atterberg Limits

Grain size distribution tests and moisture content tests were performed as part of index tests on select samples of overburden soils in accordance with ASTM D422-63 (Reference 2.5-322) and ASTM D2216-19 (Reference 2.5-241), respectively. Select soil samples were also tested to evaluate their plasticity characteristics in accordance with ASTM D4318-17e1 (Reference 2.5-242). The results of these tests were used for classification and correlation purposes. The results of these tests were used for classification and correlation purposes. The overburden soils were generally classified as silty sands (SM) and non-plastic silts (ML), except for some near-surface fill soils (typically in the upper 10 ft. [3 m]) that were noted to be plastic (MH, CL, or CH). The Plasticity Index (PI) of the plastic samples from index tests ranged from 10 percent to 59 percent, with a mean of 24 percent. The natural moisture content of the samples from index tests ranged from 5.4 percent to 52.8 percent, with a mean of 23.3 percent. The fines content of the samples from index tests ranged from 18.4 percent to 95 percent, with a mean of 50.1 percent.

2.5.4.2.1.3.3 Specific Gravity

Specific gravity tests were performed on select overburden soil samples in accordance with ASTM D854-23 (Reference 2.5-246). The specific gravity of the soil samples ranged from 2.61 to 2.87, which is consistent with typical values of specific gravity of soils that tend to lie in a relatively narrow range of 2.7 ± 0.2.

2.5.4.2.1.3.4 Unit Weight Determination

Unit weight determinations were made on undisturbed samples of soil in accordance with ASTM D7263-21 (Reference 2.5-252) using the direct measurement method. Unit weight measurements were also made on the RCTS soil samples using calibrated calipers and scales, as well as on rock samples during Fr-Fr and RCTS tests and during unconfined compressive strength tests.

The dry unit weight of the undisturbed residual soil samples ranged from 66.8 to 90.5 pcf, with a mean of 78.6 pcf. The moisture content associated with the unit weight determinations ranged from 19.0 to 42.4 percent, with a mean of 30.3 percent. The corresponding total unit weight was between 82.2 and 117.0 pcf, with a mean of 102.3 pcf. The undisturbed samples were typically obtained from relatively looser/softer zones of overburden soils (all but one were from Stratum I as described in Section 2.5.4.2.2.1); as such, the relatively low unit weights indicated by the unit weight determinations most likely underestimate the unit weights of the deeper, more competent overburden residual soils.

The Fr-Fr and RCTS tests on rock samples indicated total rock unit weights ranging from 153.8 to 181.8 pcf, with a mean of 169.8 pcf. Rock specimens that were tested under unconfined (uniaxial) and confined (triaxial) conditions ranged from 161.9 to 195.3 pcf with a mean of 169.6 pcf.

2.5.4.2.1.3.5 Thermal/Chemical Tests

Chemical testing was performed on select samples and included pH (Reference 2.5-257), chloride ion content (Reference 2.5-259), and sulphate content (Reference 2.5-258). These tests provide information related to the potential for chemically induced corrosion of foundation materials, such as concrete and reinforcing steel.

Measurements of pH on 14 samples indicated average pH values (taken as the average of three readings) ranging from 5.0 to 6.9. Chloride ion content measurements made on 14 samples indicated water soluble chlorides ranging from 5 to 19 milligrams per kilogram (mg/kg). Sulfate content measurements made on 14 samples indicated water soluble sulfates ranging from <10 to 60 mg/kg.

2.5.4.2.1.3.6 Unconfined Compressive Strength and Unconsolidated-Undrained Triaxial Compression Test

Unconfined Compressive Strength (UCS) tests were performed on two undisturbed soil samples (Reference 2.5-249). The tests indicated undrained shear strengths of 2.6 pounds per square inch (psi) and 8.3 psi.

Unconsolidated-undrained (UU) triaxial compression tests with pore water pressure measurements were performed on eleven undisturbed overburden samples in accordance with ASTM D2850-23 (Reference 2.5-250). The tests indicated undrained shear strengths ranging from 7.6 psi to 21.0 psi.

2.5.4.2.1.3.7 Consolidated-Undrained Triaxial Compression Test with Pore Pressure Measurements

Consolidated-undrained (CU) triaxial compression tests with pore water pressure measurements were performed on select undisturbed overburden samples in accordance with ASTM D4767-11 (Reference 2.5-251). Eight tests were performed on undisturbed residual soil samples to determine their strength parameters. In addition, three tests were performed on remolded samples compacted to 95 percent of their Modified Proctor maximum dry density to provide the strength parameters for as-compacted on-site residual soils.

For the undisturbed samples tested, the laboratory data indicate total stress parameters of undrained cohesion (c) ranging from 3.3 psi to 6.6 psi and undrained friction angle (ϕ) ranging from 1.9 degrees to 35.3 degrees. The effective stress parameters of effective cohesion (c') and effective stress friction angle (ϕ') were found to range from 0 psi to 1.4 psi and from 27.5 degrees to 36.4 degrees, respectively. These results exclude the result of the sample from Boring B-11D, which was deemed unreliable for use in the analyses (possibly due to a high level of sample disturbance) and was therefore omitted.

For the remolded on-site residual soil samples tested, the laboratory data indicate total stress parameters between 6.0 psi and 9.4 psi for c and 24.9 degrees and 34.5 degrees for ϕ, and effective stress parameters between 1.76 psi and 3.41 psi for c' and 26.1 and 30.2 degrees for ϕ'.

Section 2.5.4.2.3 provides additional details on the use of the laboratory test data in developing static soil engineering properties for the project. Section 2.5.4.10.3 provides additional details on the strength characteristics of remolded on-site residual soils.

2.5.4.2.1.3.8 One-Dimensional Consolidation Test

One-dimensional consolidation tests were performed on 11 undisturbed overburden samples in accordance with ASTM D2435-11 (Reference 2.5-248) to determine stress history and compressibility parameters of residual soils. The residual soil samples tested for their consolidation characteristics included silty sands (SM), elastic silts (ML), and high plasticity silts (MH). The interpretation of the consolidation test results requires consideration of the unique process for the formation of residual soils.

The initial void ratio (e_0) of the samples tested ranged from 0.814 to 1.466. The average coefficient of consolidation (C_v) was approximately 1.1 square feet per day. The test results indicate apparent pre-consolidation pressures ranging from 3.4 tons per square foot (tsf) to 8.3 tsf for the residual soils as indicated by the Casagrande graphical construction method for evaluating pre-consolidation pressures. The recompression indices (C_r) ranged from 0.03 to 0.09, and the compression indices (C_c) ranged from 0.31 to 0.78. Using an alternate interpretation based on the simplified graphical construction method, the test results indicate apparent pre-consolidation pressures ranging from 0.9 to 2.6 tsf. The recompression indices ranged from 0.05 to 0.13, and the compression indices ranged from 0.31 to 0.77.

It is not uncommon for different graphical interpretation methods to produce different results when evaluating consolidation test data. Further, interpretation of consolidation results in Piedmont residual soils is particularly challenging due to the mode of formation, soil fabric effects, and the sand-like nature of the silty sands and non-plastic silts. Section 2.5.4.10.3 provides additional details on the consolidation characteristics of the on-site residual soils.

2.5.4.2.1.3.9 One-Dimensional Swell/Collapse Test

One-dimensional swell/collapse tests were performed on three undisturbed overburden samples in accordance with ASTM D4546-21 (Reference 2.5-247) to determine swell or collapse potential of residual soils after wetting. Using an overburden pressure of 0.25 tsf, one sample experienced a heave of -1.0 percent (negative value indicating downward compression) after adding water, while the other two samples experienced heave between +0.6 and +0.7 percent (positive value indicating upward swell). The measured swell pressures for the two samples that experienced positive heave ranged from 0.3 to 1.4 tsf. The test results indicate low swell or collapse potential of the soils.

2.5.4.2.1.3.10 Compaction Testing

Select bulk samples of overburden residual soils were tested in accordance with ASTM D1557-12 (Reference 2.5-253) to determine the maximum dry density and optimum moisture content using the Modified Proctor procedure. The results are used in assessing the compaction characteristics of soils to evaluate their suitability as backfill.

The maximum dry density of the samples tested ranged from 101.8 to 125.9 pcf, with optimum moisture contents between 9.3 percent and 23.4 percent. In general, the high-plasticity silt (MH) samples exhibited lower maximum dry density and higher optimum moisture content. The

results also show that the natural moisture content of the samples is, at times, much greater than the optimum moisture contents, indicating that significant moisture conditioning may be required prior to the use of on-site residual soils as backfill. Section 2.5.4.5.2.1 provides additional details on the compaction characteristics of the on-site residual soils.

2.5.4.2.1.3.11 Unconfined and Confined Compressive Strength of Rock

Unconfined (uniaxial) compressive strength (UCS) and confined (triaxial) compressive strength (TCS) tests were performed on representative rock core specimens to determine their compressive strength in accordance with ASTM D7012-23. The UCS tests were performed at a constant rate of strain and zero confinement pressure on specimens that were approximately 2.4 inches (61.0 mm) in diameter with length-to-diameter ratio equal to approximately 2.0. The TCS tests were performed under constant strain rate conditions and various confining pressures ranging between 75 psi and 750 psi on specimens that were approximately 2.0 in. (50.8 mm) in diameter with length-to-diameter ratio equal to approximately 2.0.

Forty-two samples (6 schist and 36 gneiss) were tested for UCS, and 68 samples (4 schist and 64 gneiss) were tested for TCS. Elastic modulus and Poisson's ratio measurements were also made in all 68 TCS samples and 25 of the 42 UCS samples.

The UCS of all the samples tested ranged between 1580 and 28,440 psi, with a mean of 14,324 psi and a standard deviation of 6170 psi. For the schist samples, the mean UCS was 7890 psi with a standard deviation of 4307 psi. For the gneiss samples, the mean UCS was 15,396 psi with a standard deviation of 5803 psi. The TCS of all the samples tested, as indicated by the peak deviatoric stress observed during testing, ranged between 6170 and 41,490 psi, with a mean of 20,347 psi and a standard deviation of 6772 psi. For the schist samples only, the mean TCS was 14,020 psi with a standard deviation of 819 psi. For the gneiss samples only, the mean UCS was 20,743 psi with a standard deviation of 6785 psi.

The elastic modulus of all the samples tested ranged between 4.09E+05 psi and 1.02E+07 psi, with a mean of 5.15E+06 psi and a standard deviation of 1.83E+06 psi. The Poisson's ratio of all the samples tested ranged between 0.01 and 0.19, with a mean of 0.08 and a standard deviation of 0.04. For the schist samples, the mean elastic modulus was 3.48E+06 psi with a standard deviation of 1.74E+06 psi, and the mean Poisson's ratio was 0.06 with a standard deviation of 0.01. For the gneiss samples, the mean elastic modulus was 5.25E+06 psi with a standard deviation of 1.80E+06 psi and the mean Poisson's ratio was 0.08 with a standard deviation of 0.04.

Section 2.5.4.2.3 provides additional details on the use of the laboratory test data in developing static rock engineering properties for the project.

2.5.4.2.1.3.12 Direct Shear Testing of Rock

Direct shear tests were performed on 26 representative rock core samples to determine their strength under constant normal force conditions in accordance with ASTM D5607-16 (Reference 2.5-263). The direct shear tests were performed on natural, open joints and intact rocks using the multi-stage method, with the sample initially sheared at a normal stress representative of the in-situ stress conditions to evaluate peak and residual shear strengths,

followed by shearing the same rock specimen under increasing normal stresses. After the initial shearing stage, the joint surfaces were brushed clean, and the test specimen was reset to its original position. The normal stresses during tests were between 51 psi and 564 psi.

The test results indicate peak friction angles (with cohesion taken as zero) between 33.3 degrees and 79.3 degrees with a mean of 55.0 degrees and a standard deviation of 12.8 degrees, and residual friction angles (with cohesion taken as zero) ranging between 24.7 and 49.0 degrees with a mean of 35.8 degrees and a standard deviation of 5.4 degrees.

Section 2.5.4.2.3 provides additional details on the use of the laboratory test data in developing static rock engineering properties for the project.

2.5.4.2.1.3.13 Resonant Column Torsional Shear Test

RCTS tests were conducted according to the procedure developed by the University of Texas at Austin. Eight tests were performed on undisturbed residual soil specimens, and three tests were performed on select rock samples. The focus of the RCTS testing program was to evaluate the dynamic properties (mainly, stress and strain-dependent shear modulus and damping) of the overburden soils and rock for use in site response and other relevant dynamic analyses. Sections 2.5.4.2.4 and 2.5.4.7 discuss how the RCTS test results are used for the dynamic analyses.

2.5.4.2.1.3.14 Free-Free Unconfined Resonant Column Test

Fr-Fr URC tests were conducted according to the procedure developed by the University of Texas at Austin. Sixteen Fr-Fr tests were performed on special care rock samples retrieved from various boring locations. The term "Free-Free" is used to differentiate from the "Fixed-Free" condition of the typical resonant column test, meaning that one end of the sample is fixed, while the other is free to rotate or displace. No confining pressure is used in this test. Fr-Fr testing in torsional and longitudinal motion is used to measure shear wave and compression wave velocities, V_S and V_P, respectively, and damping at small strains, from which initial (maximum) shear modulus (G_{max}), Young's modulus of elasticity (E_{max}), and the minimum damping ratio (D_{min}) can be determined. The Poisson's ratio (ν) of the specimen can also be calculated using the relationship between V_S and V_P. A discussion of how the Fr-Fr testing results are used for the dynamic analyses is presented in Sections 2.5.4.2.4 and 2.5.4.7.

2.5.4.2.1.4 Geophysical Tests

Geophysical data collected at the site included suspension P-S velocity logging, downhole wave velocity profiling, SASW surveys, and electrical resistivity (ER) surveys. Figure 2.5-119 through Figure 2.5-121 capture the locations of each test for the North, Middle, and South Plant Complexes, respectively. Table 2.5-60 summarizes the surface geophysics (SASW and ER) locations. In addition, induction/natural gamma, three-arm caliper/natural gamma, electric log/natural gamma, and acoustic televiewer/borehole deviation data were collected in the P-S suspension velocity logging boreholes. The tests are described in detail in Section 2.5.4.4.

2.5.4.2.2 Description of Subsurface Materials

As discussed in Section 2.5.1.2, the Project site is located in the Piedmont physiographic province. The overburden soil at the site is composed of residual soils that formed in-place from weathering of the parent bedrock. Some fill soils were also encountered in the upper 10 ft. (3 m) of a few of the borings; however, soils identified as fill will be removed as part of the plant construction, and their properties were not considered. Below the residual soils is typically a zone of PWR, which is underlain by crystalline metamorphic rocks. The upper portion of the rock is fractured to varying degrees and becomes more sound with depth.

Figure 2.5-118 depicts the location of the geotechnical investigation borings at the North, Middle, and South Plant Complexes. Each boring log was inspected with a primary emphasis on soil types and field SPTN-values for the overburden soils, and CR and RQD for the rock layers. Based on evaluation of the characteristics and consistencies of the soil and rock encountered in the borings, the subsurface conditions at the site are defined by the following five strata:

- Stratum I (Residuum 1) – Residual soil with field SPT N-values of 15 bpf or less
- Stratum II (Residuum 2) – Residual soil with field SPT N-values greater than 15 bpf and less than 50 blows for 0.5 ft. (6 in.) of penetration (100 bpf)
- Stratum III (Partially Weathered Rock) – (PWR) – Residual material with field SPT N-values of 100 bpf or greater; for lithologic borings drilled using sonic rigs, this stratum was identified based on field descriptions of the material and drilling difficulty
- Stratum IV (Fractured Rock) – Cored rocks with RQD less than 50 percent
- Stratum V (Sound Rock) – Cored rocks with RQD equal to or greater than 50 percent

Tables 2.5-61 through 2.5-63 provide a summary of thicknesses and elevations for each strata, including minimum, maximum, and average values based on the subsurface investigation findings for the North, Middle, and South Plant Complexes, respectively. While the strata are delineated to represent in situ conditions, differential weathering, common in the Piedmont physiographic province, typically results in variations of the materials and properties within each stratum. This variation is depicted on the equally spaced fence diagrams captured in Figure 2.5-123 and 2.5-124 for the North Plant Complex, Figure 2.5-125 and 2.5-126 for the Middle Plant Complex, and Figure 2.5-127 and 2.5-128 for the South Plant Complex. These figures show the average stratum elevation overlaid on the individual fence diagrams for each boring to help visualize the variability between the average stratum elevations and the different stratum elevations at the individual boring locations.

2.5.4.2.2.1 Stratum I and II (Residuum)

Stratum I consists primarily of residual soils with lower relative densities compared to Stratum II and field SPT N-values of 15 bpf or less. The mean N_{60}-value was 13.6 bpf with a standard deviation of 0.5.3 bpf, 14.0 bpf with a standard deviation of 3.9 bpf, and 13.7 bpf with a standard deviation of 4.3 bpf in the North, Middle, and South Plant Complexes, respectively. In the North Plant Complex, Stratum I materials exhibit a mean thickness of 7.0 ft. (2.1 m) and

extend to an average base elevation of 809.0 ft. (246.6 m) NAVD 88. In the Middle Plant Complex, Stratum I materials exhibit a mean thickness of 18.9 ft. (5.8 m) and extend to an average base elevation of 789.5 ft. (240.6 m) NAVD 88. In the South Plant Complex, Stratum I materials exhibit a mean thickness of 21.0 ft. (6.4 m) and extend to an average base elevation of 799.5 ft. (243.7 m) NAVD 88. The thickness of Stratum I varies significantly between borings, with a minimum thickness of 0 ft. and a maximum thickness of 32.5 ft. (9.9 m).

Stratum II consists primarily of residual soils with higher densities compared to Stratum I, with field SPT N-values greater than 15 bpf but less than 100 bpf. The mean N_{60}-value was 57.2 bpf with a standard deviation of 27.4 bpf, 39.0 bpf with a standard deviation of 18.0 bpf, and 45.7 bpf with a standard deviation of 21.7 bpf in the North, Middle, and South Plant Complexes, respectively. In the North Plant Complex, Stratum II materials exhibit a mean thickness of 27.1 ft. (8.3 m) and extend to an average base elevation of 784.0 ft. (239.0 m) NAVD 88. In the Middle Plant Complex, Stratum II materials exhibit a mean thickness of 20.2 ft. (6.2 m) and extend to an average base elevation of 772.0 ft. (235.3 m) NAVD 88. In the South Plant Complex, Stratum II materials exhibit a mean thickness of 18.4 ft. (5.6 m) and extend to an average base elevation of 780.5 ft. (237.9 m) NAVD 88. The thickness of Stratum II also varies between borings, with a minimum thickness of 0 ft. and a maximum thickness of 72.7 ft. (22.2 m). This degree of differential weathering is not uncommon in the Piedmont physiographic province. The engineering challenges associated with this differential weathering profile are addressed in the subsequent report sections.

The residual soils of Strata I and II were generally classified as silty sands (SM) and non-plastic silts (ML), except for some near-surface fill soils, typically in the upper 10 ft. (3 m), that were noted to be plastic (high plasticity silts [MH], low plasticity clays [CL] or high plasticity clays [CH]). Of the 141 samples tested for their plasticity characteristics, only 23 were noted to be plastic and of those, only three samples below 10 ft. (3 m) were plastic. The plasticity index of the plastic soils in index tests ranged between 10 percent and 59 percent, with a mean of 24 percent. The natural moisture content in index test samples was between 5.4 percent and 52.8 percent, with a mean of 23.3 percent. The fines content of the index test samples tested was between 18.4 percent and 95 percent, with a mean of 50.1 percent.

Due to difficulties with Shelby tube sampling in the denser residual soils, most of the undisturbed samples were obtained from Stratum I. The dry unit weight of the undisturbed residual samples tested from Stratum I ranged from 66.8 to 90.5 pcf, with a mean of 78.1 pcf. The corresponding total unit weight was between 82.2 and 117.0 pcf, with a mean of 101.7 pcf. The only undisturbed sample from Stratum II (B-6B, UD-2) indicated a dry unit weight of 87.4 pcf and a corresponding total unit weight of 113.4 pcf.

UU triaxial compression tests and UCS tests indicate undrained shear strengths between 2.6 and 21.0 psi. Non-plastic residual soils, such as those typically encountered at the Project site, are normally analyzed as drained (using effective stress strength parameters); therefore, the undrained shear strengths should be used with caution.

CU triaxial compression tests with pore water pressure measurements were performed on eight undisturbed residual soil samples and three remolded residual soil samples compacted to 95 percent of their Modified Proctor maximum dry density. For the undisturbed samples tested, the laboratory data indicate total stress strength parameters, cohesion (c) and total stress friction angle (ϕ), between 3.3 psi and 6.6 psi for c and between 1.9 and 35.3 degrees

for ϕ and effective stress parameters, effective cohesion (c') and effective stress friction angle (ϕ'), between 0 and 1.4 psi for c' and 27.5 and 36.4 degrees for ϕ'. These results exclude the results of the sample from Boring B-11D, which showed results deemed unreliable for use in the analyses (possibly due to a high level of sample disturbance) and therefore were omitted. Using an alternate Mohr-Coulomb interpretation with c' equal to 0 would yield slightly higher values of ϕ'. The strength parameters are generally consistent with published values for Piedmont residual soils (Reference 2.5-264; Reference 2.5-265; Reference 2.5-266).

For the remolded samples tested that were compacted to 95 percent of their Modified Proctor maximum dry density then tested under saturated conditions, the laboratory data using a Mohr-Coulomb interpretation indicate effective stress parameters between 1.76 and 3.41 psi for c' and 26.1 and 30.2 degrees for ϕ'.

Consolidation testing performed on undisturbed samples of residual soils indicate an initial void ratio between 0.814 and 1.466. The average coefficient of consolidation was approximately 1.1 square feet per day. The test results indicate pre-consolidation pressures between 3.4 tsf and 8.3 tsf for the residual soils as indicated by the Casagrande graphical construction method for evaluating pre-consolidation pressures. The recompression indices ranged from 0.03 to 0.09, and the compression indices ranged from 0.31 to 0.78. Using an alternate interpretation based on the simplified graphical construction method, the test results indicate pre-consolidation pressures between 0.9 tsf and 2.6 tsf. The recompression indices ranged from 0.05 to 0.13, and the compression indices ranged from 0.31 and 0.77. It is not uncommon for different graphical interpretation methods to produce different results when evaluating consolidation test data. Further, interpretation of consolidation results in Piedmont residual soils is particularly challenging due to mode of formation, soil fabric effects and the more sand-like nature of the silty sands and non-plastic silts.

One-dimensional swell/collapse tests were performed on three undisturbed overburden samples in accordance with ASTM D4546-21 (Reference 2.5-247) to determine swell or collapse potential of residual soils after wetting. Using an overburden pressure of 0.25 tsf, one sample experienced a heave of -1.0 percent (negative value indicating downward compression) after adding water, while the other two samples experienced heave between 0.6 and 0.7 percent (positive value indicating upward swell). The measured swell pressures for the two samples that experienced positive heave ranged from 0.3 to 1.4 tsf. The test results indicate low swell or collapse potential of the samples.

The compaction characteristics of the in situ residual soils are discussed in Section 2.5.4.5.2.1. The consolidation and swell/collapse characteristics of the in situ residual soils are discussed in Section 2.5.4.10.3.

2.5.4.2.2.2 Stratum III (Partially Weathered Rock)

This stratum consists of residual materials with field SPT N-values of 100 bpf or greater. For lithologic borings drilled using sonic rigs, this stratum was identified based on field descriptions of the material and drilling difficulty. In the North Plant Complex, Stratum III materials exhibit a mean thickness of 19.2 ft. (5.9 m) and extend to an average base elevation of 764.5 ft. (233.0 m) NAVD 88. In the Middle Plant Complex, Stratum III materials exhibit a mean thickness of 9.6 ft. (2.9 m) and extend to an average base elevation of 762.5 ft. (232.4 m) NAVD 88. In the South Plant Complex, Stratum III materials exhibit a mean thickness of 6.3 ft. (1.9 m) and extend to an average base elevation of 774.0 ft. (235.9 m)

NAVD 88. The thickness of Stratum III varies between borings, with a minimum thickness of 0 ft. and a maximum thickness of 78.4 ft. (23.9 m). This degree of differential weathering is not uncommon in the Piedmont physiographic province. The engineering challenges associated with this differential weathering profile are addressed in the subsequent report sections.

No undisturbed samples were obtained from Stratum III due to their high relative density; therefore, relevant engineering properties were estimated based on empirical correlations and engineering judgment.

2.5.4.2.2.3 Stratum IV (Fractured Rock) and Stratum V (Sound Rock)

Stratum IV consists of cored rocks with RQD less than 50 percent. In the North Plant Complex, Stratum IV materials exhibit a mean thickness of 14.0 ft. (4.3 m) and extend to an average base elevation of 750.5 ft. (228.8 m) NAVD 88. In the Middle Plant Complex, Stratum IV materials exhibit a mean thickness of 5.2 ft. (1.6 m) and extend to an average base elevation of 757.5 ft. (230.9 m) NAVD 88. In the South Plant Complex, Stratum IV materials exhibit a mean thickness of 6.2 ft. (1.9 m) and extend to an average base elevation of 768.0 ft. (234.1 m) NAVD 88. The thickness of Stratum IV varies between borings, with a minimum thickness of 0 ft. and a maximum thickness of 51.3 ft. (15.6 m).

Stratum V consists of mostly intact gneiss and schist rocks with RQD values equal to or greater than 50 percent. The thickness of this stratum was not determined because the borings were terminated at varying depths within this stratum. Typically, the CR and RQD values were 100 percent, indicating a high quality and largely intact rock mass with soundness increasing with increasing depth.

As discussed in Section 2.5.4.2.1.3.11, the UCS of all the rock samples tested ranged between 1580 and 28,440 psi, with a mean of 14,324 psi and a standard deviation of 6170 psi. For the schist samples, the mean UCS was 7890 psi with a standard deviation of 4307 psi. For the gneiss samples, the mean UCS was 15,396 psi with a standard deviation of 5803 psi. The TCS of all the samples tested, as indicated by the peak deviatoric stress observed during testing, ranged between 6170 and 41,490 psi, with a mean of 20,347 psi and a standard deviation of 6772 psi. For the schist samples , the mean TCS was 14,020 psi with a standard deviation of 819 psi. For the gneiss samples, the mean UCS was 20,743 psi with a standard deviation of 6785 psi.

The elastic modulus of all the samples tested ranged between 4.09E+05 psi and 1.02E+07 psi, with a mean of 5.15E+06 psi and a standard deviation of 1.83E+06 psi. The Poisson's ratio of all the samples tested ranged between 0.01 and 0.19, with a mean of 0.08 and a standard deviation of 0.04. For the schist samples, the mean elastic modulus was 3.48E+06 psi with a standard deviation of 1.74E+06 psi, and the mean Poisson's ratio was 0.06 with a standard deviation of 0.01. For the gneiss samples, the mean elastic modulus was 5.25E+06 psi with a standard deviation of 1.80E+06 psi, and the mean Poisson's ratio was 0.08 with a standard deviation of 0.04.

As discussed in Section 2.5.4.2.1.3.12, the direct shear tests performed on natural, open joints and intact rocks using the multi-stage method indicate peak friction angles (with cohesion taken as zero) between 33.3 degrees and 79.3 degrees with a mean of 55.0 degrees and a standard deviation of 12.8 degrees, and residual friction angles (with cohesion

taken as zero) between 24.7 and 49.0 degrees with a mean of 35.8 degrees and a standard deviation of 5.4 degrees.

The measured UCS, elastic moduli and Poisson's ratio are generally within the typical range of reported values for gneiss and schist (Reference 2.5-268; Reference 2.5-321). Section 2.5.4.2.3 provides additional details on the use of the laboratory test data in developing static engineering properties of rock for the project.

2.5.4.2.3 Static Soil and Rock Engineering Properties

The static engineering properties of the five engineering strata identified were determined by laboratory testing and empirical correlations based on in situ test results, as well as comparison to values in published literature and engineering judgment. Because of the similarities in subsurface conditions for the identified strata, the provided parameters represent the corresponding strata at all three Plant Complexes.

For Stratum I and II (residual soils), the field SPT N-values were corrected for hammer energy, borehole diameter, rod length, sampling method, and overburden pressure effects to establish hammer energy corrected N_{60}-values and fully corrected $(N1)_{60}$-values (Reference 2.5-267). For empirical estimates of engineering properties in these strata, a lognormal distribution was used for the SPT N-values, with the lower bound, best estimate, and upper bound values taken as 5th percentile, 50th percentile, and 95th percentile, respectively. These N-values were then used in empirical correlations (Reference 2.5-268; Reference 2.5-269; Reference 2.5-270; Reference 2.5-271; Reference 2.5-272; Reference 2.5-273) for estimation of the relevant static soil properties, and the results were compared against the published literature and laboratory test results where applicable (Reference 2.5-274; Reference 2.5-275; Reference 2.5-276; Reference 2.5-277; Reference 2.5-264; Reference 2.5-265; Reference 2.5-266; Reference 2.5-278; Reference 2.5-279; Reference 2.5-280) to establish the final lower bound, best estimate, and upper bound values.

For Stratum III, the engineering properties were based on empirical correlations (Reference 2.5-268; Reference 2.5-269; Reference 2.5-270; Reference 2.5-271; Reference 2.5-273) and published literature (Reference 2.5-274; Reference 2.5-266; Reference 2.5-278) due to lack of laboratory tests in this stratum (which was too dense to sample but too weak to core).

For Stratum IV and Stratum V, the engineering properties were based on laboratory test results, empirical correlations and published literature. For Stratum IV, based on review of the conditions indicated on the boring logs and using the Geologic Strength Index (GSI) criteria as outlined in Hoek (Reference 2.5-321), the rock surface conditions were judged to range from "Poor" to "Fair," and the rock structure was judged to range from "Disintegrated" to "Blocky/Disturbed/Seamy.". This resulted in a GSI range of 14 to 45. For Stratum V, the rock surface conditions were judged to range from "Fair" to "Very Good," and the rock structure was judged to range from "Blocky" to "Intact/Massive." This resulted in a GSI range of 44 to 95. The static engineering properties were then determined using the intact rock properties (as measured from the laboratory tests) to calculate equivalent Mohr-Coulomb rock mass parameters for strength and rock mass deformation moduli as discussed in Hoek (Reference 2.5-321). Lower bound, best estimate, and upper bound values were established based on the weaker schist and the range of GSI values, as well as consideration for the variability in the strength and deformation properties of the rock samples.

Table 2.5-64 summarizes the static properties for Stratum I, II and III (residual soils and PWR); Table 2.5-65 summarizes the static properties for Stratum IV and V (fractured and sound rock). The static properties for structural backfill are discussed in Section 2.5.4.5.2.2. The best estimate engineering properties (strength and deformation) of the rock mass at the Project site, conservatively based on the weaker schist, indicate that the rock mass is stronger and less compressible than the structural backfill. Structural backfill is used as the bounding scenario for the static stability analyses described in Section 2.5.4.10.1 and 2.5.4.10.2; therefore, the Project site is expected to meet the static stability requirements (bearing capacity and settlement) with the proposed reactors supported on either structural backfill or bedrock. Ground improvement techniques for the various proposed reactor technologies are described in Section 2.5.4.12.

2.5.4.2.4 Dynamic Soil and Rock Engineering Properties

As part of the dynamic analyses discussed in Section 2.5.4.7, representative shear wave velocity (V_S) and compression wave velocity (V_P) profiles were determined, incorporating the results from downhole, P-S suspension logging, and SASW surveys as well as laboratory testing. The best-estimate wave velocity profiles from the SASW surveys and P-S suspension logging were used to establish the range of low-strain dynamic elastic property recommendations for use in more routine engineering calculations. The best-estimate V_S and V_P profiles used in determining the low-strain dynamic elastic properties are captured in Figure 2.5-129 and Figure 2.5-130, respectively. The SASW surveys generally indicate a slower wave velocity profile compared to the P-S suspension logging results; therefore, the dynamic properties associated with the SASW survey results are more conservative. The calculated low-strain dynamic elastic properties using the P-S logging and SASW velocities are summarized in Table 2.5-66 and 2.5-67, respectively.

While the values presented in Tables 2.5-66 and 2.5-67 are based on the best-estimate wave velocity profiles, the dynamic analyses described in Section 2.5.4.7 consider the variability of these parameters through randomization of the layer thicknesses, as well as shear modulus and damping curves as a function of shear strain.

2.5.4.3 Foundation Interfaces

The planned finish plant grade is at an elevation (EL.) of approximately 810 ft. (247 m). The reactor base elevations for the six different technologies under consideration are summarized below:

- EL. = 766 ft. (233.5 m) for Westinghouse (embedment depth = 44 ft. [13.4 m])
- EL. = 727 ft. (221.6 m) for NuScale (embedment depth = 83 ft. [25.3 m])
- EL. = 724 ft. (220.7 m) for Holtec (embedment depth = 86 ft. [26.2 m])
- EL. = 696.8 ft. (212.4 m) for TerraPower (embedment depth = 113.2 ft. [34.5 m])
- EL. = 695 ft. (211.8 m) for X-energy (embedment depth = 115 ft. [35.1 m])
- EL. = 685 ft. (208.8 m) for GVH (embedment depth = 125 ft. [38.1 m])

Based on the above-mentioned base elevations and the conditions encountered at those elevations, all reactor technologies except Westinghouse are anticipated to bear on competent rock. The subsurface investigation indicates the potential for the presence of residual soils, PWR, and/or fractured rock at or below the Westinghouse reactor-bearing elevation. For the Westinghouse technology, any pockets of weaker residual soils or PWR encountered at the bottom of the base mat excavation would be over-excavated and replaced with structural backfill or lean concrete. Static and dynamic stability of the reactor base mats is discussed in Section 2.5.4.10, while techniques to improve the ground below the reactor base mats are described in Section 2.5.4.12.

2.5.4.3.1 Subsurface Uniformity

Soil-structure interaction and foundation design are a function of the uniformity of the soil and rock below the structures. As discussed in Section 2.5.4.2.2, differential weathering has resulted in variable subsurface conditions in the overburden residual soils and PWR. As discussed in Section 2.5.4.3, all reactor technologies except Westinghouse are anticipated to be founded on competent rock due to their embedment depths. All residual soils and non-uniform PWR will be excavated and removed from below the reactor base mats and replaced with structural backfill or lean concrete as discussed in Section 2.5.4.12. The best estimate V_S profiles as discussed in Section 2.5.4.2.4 indicate V_S greater than 2000 feet per second (ft/s) (610 meters per second [mps]) below the highest proposed reactor base-mat elevation of 766 ft. (233.5 m) for the Westinghouse reactor. The minimum V_S for structural backfill if required below the reactor base mat is 1000 ft/s (305 mps) per Section 2.5.4.5.2.2.

As an additional check, the layer dips between borings were evaluated at the site. For subsurface layers that dip less than 20 degrees from horizontal, a generic analysis using horizontal layers is applicable as described in NUREG/CR-0693. The analysis indicates dip angles of less than 20 degrees from horizontal in the fractured rock and sound rock layers in all cases except two instances (out of the 1080 boring pairs considered for all three Plant Complexes, based on 16 borings in each Plant Complex area resulting in 360 unique combinations per complex). These dip angles exceeding 20 degrees were encountered between adjacent borings located near each other. At these close spacings, relatively small differences in the subsurface conditions due to differential weathering exaggerate the calculated dip values and thus can be disregarded relative to the assessment of site uniformity because the values are not considered representative of the subsurface conditions across the site.

Once the final reactor technology and site are selected, additional closely spaced borings and geophysical explorations will be performed in the safety-related structure footprints to further evaluate subsurface uniformity.

2.5.4.3.2 Coefficient of Interface Sliding Friction

Unified Facilities Criteria (UFC) (Reference 2.5-280) provides recommendations for ultimate coefficient of interface static sliding friction between dissimilar materials. For mass concrete on sound rock, the friction factor is given as 0.7. For mass concrete on clean gravel, gravel-sand mixtures, or coarse sand, the ultimate coefficient of interface static sliding friction is between 0.55 and 0.60.

Duncan and Mokwa (Reference 2.5-270) recommend 0.76 x ϕ (soil friction angle) for a conservative estimate of the ultimate concrete-sand interface friction angle. For PWR with a

best-estimate friction angle of 43 degrees per Section 2.5.4.2.3, this results in a coefficient of 0.64. For structural backfill with a minimum friction angle of 40 degrees per Section 2.5.4.5.2.2, this results in an ultimate coefficient of interface static sliding friction of 0.59.

Base mats of the safety-related structures will not be founded on the in situ residual soils (i.e., Stratum I or Stratum II); therefore, no ultimate coefficient of interface static sliding friction values are provided for those strata.

2.5.4.4 Geophysical Surveys

Geophysical data collected at the site included borehole geophysical surveys (Reference 2.5-281) using suspension P-S velocity logging and downhole wave velocity profiling, as well as surface geophysics using SASW surveys and ER surveys. Additional data were also collected in the P-S suspension velocity logging boreholes, including natural gamma, dual induction (conductivity), long- and short-normal resistivity, three-arm caliper, acoustic televiewer, and borehole deviation.

The location of each test is captured in Figure 2.5-119 through Figure 2.5-121 for the North, Middle, and South Plant Complexes, respectively. Figure 2.5-131 presents the V_S obtained from the different methods (including laboratory measurements for comparison) for all the complexes, with the range of the proposed reactor base mat elevations shown for reference. The V_S are also captured separately in Figures 2.5-132 through 2.5-134 for the North, Middle, and South Plant Complexes, respectively.

The details of suspension P-S velocity logging, downhole V_S profiling, SASW surveys, and ER surveys are provided below.

2.5.4.4.1 Suspension P-S Velocity Logging

Suspension P-S velocity logging was performed in accordance with GEOVision procedure for OYO P-S Suspension Seismic Velocity Logging, Rev. 1.5 (Reference 2.5-282). P-S logging measures S-waves and P-waves generated by a source on the P-S logging probe within the borehole to determine wave travel times upward past multiple receivers on the probe and subsequently S- and P-wave velocities of the subsurface materials. The receivers that detect the waves and the source that generates the waves are moved as a unit in each boring, which produces a relatively constant amplitude signal at all depths. The testing is performed in a fluid-filled borehole, with both V_S and V_P measurements taken at 1.64-ft. (0.5-m) intervals.

P-S suspension logging velocity data were collected in boreholes B-1A, B-3/B-3A, B-5, B-6, B-8/B-8A, B-10/B-10A, B-11A/B-11B, B-13/B-13A, and B-15A/B-15B. Boreholes B-1, B-3/B-3A, and B-5 are in the North Plant Complex. B-6, B-8/B-8A, and B-10/B-10A are in the Middle Plant Complex, and B-11A/B-11B, B-13/B-13A, and B-15A/B-15B are in the South Plant Complex. The survey in Borehole B-8/B-8A was extended to a depth of 588.9 ft. (179.5 m) below the existing ground surface to allow for deep shear and compression wave profiling in at least one of the boreholes.

As part of the P-S data collection, additional data were also collected in the boreholes, including natural gamma, dual induction (conductivity), long- and short-normal resistivity, single-point resistance, three-arm caliper, spontaneous potential, ATV, and borehole deviation. Natural gamma (Reference 2.5-283) records the amount of natural gamma

radiation emitted by the materials surrounding the borehole. Natural gamma sensors were onboard the dual induction, three-arm caliper, and E-log probes. Dual induction (conductivity) (Reference 2.5-284) uses an electromagnetic induction probe consisting of transmitter and receiver coils to create eddy currents in the subsurface materials that give rise to a secondary electromagnetic field. The secondary electromagnetic field generates an alternating electrical current that is measured by the receiver coils and is proportional to the conductivity of the formation. Formation conductivity is the reciprocal of formation resistivity. Long- and short-normal resistivity measurements are made via a low-frequency, bi-directional electric current from a source electrode on the probe and returns through the formation to the probe. Potentials from this current flow are measured on various electrodes on the probe with respect to a voltage reference located at the surface. These measurements are converted to apparent formation resistivities within the probe and transmitted to the surface. Three-arm caliper (Reference 2.5-285) measurements use caliper logs to record borehole diameter at different depths. Changes in borehole diameter are related to boring construction, such as casing or drilling bit size, and to fracturing, caving, or breakouts along the borehole wall. The caliper tool consists of three arms that are spring-loaded to contact the borehole sides. The movement of the arms is converted into a voltage recorded by the probe. ATV (Reference 2.5-286) provides a continuous and oriented 360-degree view of the borehole wall from which the character, relation, and orientation of lithologic and structural planar features, such as discontinuity orientations; dip directions, and aperture widths; and fracture frequency, can be defined. The televiewer also measures borehole inclination and deviation from vertical using an accelerometer in the probe.

2.5.4.4.2 Downhole Velocity Tests

Downhole seismic testing was performed in boreholes B-3/B-3A (North Plant Complex), B-8/B-8A (Middle Plant Complex), and B-13/B-13A (South Plant Complex) in accordance with ASTM D7400/D7400M-19 (Reference 2.5-287). Downhole logging obtains direct measurements of S- and P-waves generated from an elastic-accelerated, high-energy impulsive surface source. These measurements are used to determine wave travel times to a downhole receiver and subsequently S- and P-wave velocities of the subsurface materials. The logging system orients the downhole receiver parallel to the axis of excitation at the surface to ensure that signals received at the downhole geophones are of maximum amplitude and are not subject to errors in travel time caused by incorrect phase of first arrival picks.

The boreholes were cased and pumped dry prior to testing, with both V_S and V_P measurements taken at 3.28 ft. (1.0 m) intervals. The downhole velocity test data were interpreted using a layered approach for comparison to the P-S suspension logging results in the same boreholes.

2.5.4.4.3 Spectral Analysis of Surface Waves Arrays

Twelve SASW arrays were performed across the Project site, with four arrays at each Plant Complex (North, Middle, and South). SASW is a nondestructive and nonintrusive seismic method that uses the dispersive nature of Rayleigh-type surface waves propagating through layered materials to determine the S-wave velocity profile. Dispersion of the surface waves occurs because of changes in stiffness of the soil or rock layers with depth. A high-frequency surface wave that propagates with a short wavelength stresses material only near the exposed surface and thus only samples the properties of the shallow, near-surface material.

A low-frequency surface wave with a long wavelength stresses material to a greater depth and thus samples the properties of both shallow and deeper materials. Spectral analysis is used to separate the waves by frequency and wavelength to determine the composite experimental (field) dispersion curve. An analytical, forward-modeling procedure is then used to theoretically match the field dispersion curve with a one-dimensional layered system of varying layer stiffnesses and thicknesses. The profile that generates a theoretical dispersion curve that most closely matches the field dispersion curve is presented as the S-wave velocity profile.

SASW testing in the field involved generating surface waves at one point on the surface and measuring the motions perpendicular to the surface created by the passage of the waves past multiple receivers (geophones). The receivers were arranged on the surface along a single radial path from the source. Successively longer spacings between the source and receivers were used to measure progressively longer wavelengths. The number and progression of the receiver spacings was selected to measure progressively longer wavelengths and to produce significant overlap of the individual dispersion curves to enhance test reliability. Hammers or metal plates were generally used to generate surface waves for shorter receiver spacings, and a large mobile vibrator was used for larger receiver spacings.

SASW differs from P-S logging and downhole velocity testing in that it is a surface-wave based method that provides a non-destructive, area-based assessment. P-S logging and downhole velocity testing provide depth-specific, interval-based measurements. As such, it is not considered atypical for the different methods to produce varying subsurface profiles.

2.5.4.4.4 Electrical Resistivity Arrays (Not Safety-Related)

Field ER testing was performed using four-pin Wenner resistivity arrays to determine the in-place ER of the subsurface materials at the site. Testing followed ASTM G57-20 (Reference 2.5-288) and was completed along two traverses at each complex. For each traverse, resistance and apparent resistivity measurements were recorded at electrode spacings (A-spacings) of 1, 1.5, 2, 3, 4.5, 7, 10, 15, 20, 30, 50, 70, 100, 150, 200 ft. (0.3, 0.5, 0.6, 0.9, 1.4, 2.1, 3.0, 4.6, 6.1, 9.1, 15.2, 21.3, 30.4, 45.7, and 61.0 m).

2.5.4.4.5 Geophysical Characteristics

Figure 2.5-131 presents the shear wave velocities obtained from the different methods (including laboratory measurements for comparison) for the three complexes, with the proposed reactor base mat elevations shown for reference. The shear wave velocities are also captured separately in Figures 2.5-132 through 2.5-134 for the North, Middle, and South Plant Complexes, respectively.

In general, V_S and V_P determined from the suspension P-S logging tests in geophysical boreholes near the SASW arrays were found to be higher than V_S and V_P determined from the SASW arrays. This can be attributed to the SASW involving a larger rock mass volume than the localized downhole tests. Based on the proposed reactor base mat elevations, all technologies except (Westinghouse at EL. 766 ft [233.5 m]) are underlain by geomaterials with V_S greater than 1000 ft/s (305 m/s). Section 2.5.4.12 discusses techniques for ground improvement.

Section 2.5.4.7 provides more specific discussions on the use of the geophysical measurements for response of soil and rock to dynamic loading.

2.5.4.5 Excavation and Backfill

A combination of temporary excavation (cut slopes), fill slopes, and retaining structures will be used to facilitate construction of below-grade portions of the plant. The materials anticipated to be excavated are overburden residual soils, PWR, fractured rock, and sound rock.

Based on the existing site elevations, significant cuts and fills are anticipated to achieve the proposed finished plant grade. The planned final plant grade is at an elevation of approximately 810 ft. (247 m). The reactor base elevations for the six different technologies under consideration are 766 ft. (233.5 m) for Westinghouse, 727 ft. (221.6 m) for NuScale, 724 ft. (220.7 m) for Holtec, 697 ft. (212.4 m) for TerraPower, 695 ft. (211.8 m) for X-energy, and 685 ft. (208.8 m) for GVH. Depending on the technology selected, the reactor building excavation varies between approximately 44 ft. (13.4 m) and 125 ft. (38.1 m) in depth from finished grade elevation.

Because a reactor technology has not yet been selected and final site grading plans have not been developed, this section provides a general discussion on the anticipated extent of excavations and methods, backfill sources and quality control, and compaction characteristics of backfill.

Stability of permanent excavations, fill slopes and retaining structures are addressed in Section 2.5.5.

2.5.4.5.1 Excavation Extents and Methods

2.5.4.5.1.1 Excavations in Soil and Partially Weathered Rock

Temporary excavations up to 20 ft. (6 m) in depth can typically be graded by open cut in accordance with Occupational Health and Safety Administration (OSHA) 1926, Subpart P – Excavations guidelines (Reference 2.5-319). Limitations of the shallow, open cut slopes are as follows:

- For unsaturated residual soils, typically classified as Type C soil, the cut slopes are no steeper than 1.5 horizontal (H):1.0 vertical (V).
- For unstable rock, such as PWR and fractured rock in dry conditions, typically classified as Type B, the slopes are no steeper than 1.0H:1.0V.
- For unstable rock, such as PWR and fractured rock in saturated or submerged conditions, typically classified as Type C, the slopes are no steeper than 1.5H:1.0V.

Alternatively, the infinite slope theory can be used to approximate the maximum slopes for temporary excavations in residual soils and PWR. For partially saturated soils (i.e., no porewater pressure), and conservatively assuming apparent cohesion of zero (this is conservative because partially saturated residual soils tend to exhibit matric suction that increases their shear strength), the factor of safety (FS) for the slope, according to the U.S. Army Corps of Engineers (Reference 2.5-320) can be calculated as shown in Equation 42.5.4-1:

$$\mathrm{FS} = \frac{\tan(\phi')}{\tan(\beta)} \qquad \text{(Equation 2.5.4-1)}$$

Where:

1) ϕ' is the Effective stress friction angle (deg)
2) β is the slope angle (deg) = $\text{atan}\left(\frac{V}{H}\right)$, with V = vertical rise and H = horizontal run

Based on Section 2.5.4.2.3, the best-estimate of effective stress friction angle is 31 degrees for the upper residual soils (Stratum I), 36 degrees for the lower residual soils (Stratum II), and 43 degrees for the PWR (Stratum III). In the infinite slope theory formulation, FS = 1.0 (unity) implies a stable slope; however, to account for variations in soil properties, FS = 1.1 is targeted for temporary excavations herein, resulting in a maximum slope of 1.8H:1.0V for Stratum I, 1.5H:1.0V for Stratum II, and 1.2H:1.0V for Stratum III. These slopes are generally flatter than indicated by OSHA guidelines; however, as previously noted, partially saturated residual soils often exhibit apparent cohesion (Reference 2.5-266; Reference 2.5-289), which if accounted for would slightly lower the FS determined using the infinite slope method. Final temporary excavation slope dimensions will be determined once a reactor technology is selected and final grading plans are developed at the construction permit or license application phase. Regular inspections of temporary excavations and the adjacent areas will be performed to identify potentially hazardous conditions.

Deeper excavations will likely require earth-retaining system(s). Alternatively, earth-retaining system(s) can be used to reduce the lateral extent of excavations. Commonly used methods in the Piedmont physiographic province include soil nail walls, soldier piles and timber lagging, and secant or tangent walls. If needed, earth-retaining systems will be designed once a reactor technology is selected and final grading plans are developed at the construction permit or license application phase.

2.5.4.5.1.2 Excavations in Rock

Stable sound rock is typically graded using a maximum slope at or near vertical. A typical P-wave velocity of 3500 ft/s is the boundary between conventional means and ripping, and 6000 ft/s is the boundary between ripping and blasting (Reference 2.5-273). Figures 2.5-135 through 2.5-137 capture the measured compression wave velocities from suspension P-S logging and SASW surveys at the North, Middle, and South Plant Complexes, respectively.

The compression wave velocities from suspension P-S logging for the North and Middle Plant Complexes indicate that the rock excavation for the Westinghouse reactor (base elevation of 766 ft. [233.5 m]) can generally be achieved using conventional means or ripping, whereas the other five reactor technologies (base elevations ranging from 727 ft. [221.6 m] to 685 ft. [208.8 m]) likely require blasting. The compression wave velocities from suspension P-S logging for the South Plant Complex indicate rock blasting is likely for all six technologies. On the other hand, SASW results indicate that the rock excavation for all six proposed technologies can be achieved using conventional means or ripping. This difference is attributed to the global versus local nature of SASW testing compared to suspension P-S logging, and differential weathering resulting in variable subsurface conditions even within short horizontal distance, which is common in the Piedmont physiographic province. Variability in excavation difficulty is anticipated during construction.

If required, typical blasting methods include presplit and production blasting. Production blasting uses large explosive, widely spaced charges that are designed to fragment a large amount rock between the existing slope face and the blasthole. This method is the most efficient way to

remove large rock burdens but typically creates radial fractures that reduce the strength of the remaining rock mass and increase susceptibility to slope raveling and rockfall. Controlled blasting is generally used for removing material along the final slope face, or in some cases, to create an artificial fracture along the final cut slope to prevent radial fractures caused by production blasting (Reference 2.5-290). The use of rock bolts or retaining structures (such as secant walls) may be required to stabilize the near-vertical rock slope faces or to facilitate reactor construction.

Geologic mapping will be needed as the excavation proceeds. In addition, the rock excavations will require monitoring for movement during and after the excavation.

2.5.4.5.2 Backfill Sources

2.5.4.5.2.1 On-Site Residual Soils

Residual soils will be excavated as part of site grading and/or power block construction. The compaction and strength characteristics of residual soils were evaluated via a series of Modified Proctor and triaxial tests. Eleven samples were tested to evaluate their compaction characteristics using the Modified Proctor method, and three samples were tested using the CU triaxial method to evaluate their strength characteristics at the as-compacted densities.

The maximum dry density of the samples tested ranged from 101.8 to 125.9 pcf, with optimum moisture contents between 9.3 and 23.4 percent. In general, the high-plasticity silt (MH) samples exhibited lower maximum dry density and higher optimum moisture content. The results also show that the natural moisture content of the samples is at times much greater than the optimum moisture content, indicating that significant moisture conditioning may be required prior to the use of residual soils as non-safety-related backfill.

CU triaxial tests were performed on three bulk samples remolded to 95 percent of the Modified Proctor maximum dry density. Because the maximum shear stress was not clearly defined (i.e., the samples did not show a clear peak even at ultimate strain), alternate interpretations of the Mohr-Coulomb parameters c' (effective stress cohesion) and ϕ' (effective stress friction angle) were performed at reference strain levels of 5 and 10 percent. A Mohr-Coulomb envelope with c' = 200 pounds per square foot (psf) and ϕ' = 30 degrees was selected as the best estimate for all interpretations at various strain levels. This estimate can be used for stability analyses of earth structures (such as new fill slopes) constructed using the excavated residual soils compacted to 95 percent of their Modified Proctor maximum dry density, with a best estimate total unit weight of 130 pcf.

The parameters described above are generally consistent with the typical values of c' and ϕ' for compacted soils from the literature. The Federal Highway Administration (2017) (Reference 2.5-291) indicates that for SM, ML, and CL soils, the best-estimate of c' under saturated conditions is 400 psf, 200 psf, and 300 psf, respectively, with best estimate ϕ' of 34 degrees, 32 degrees, and 28 degrees, respectively.

Compacted residual soils are commonly used as construction materials; however, Blight and Simmons (2012) (Reference 2.5-292) indicate there are various challenges associated with compaction of residual soils, including:

- Relatively high in situ moisture contents

- Soil structures that are lightly cemented
- Weathered particles that break down under compaction effort
- Minerals that are affected by wetting and drying

Because the parent rock is usually variable in composition, the degree of weathering is also variable, which can create challenges with selection of representative samples for testing and quality control during placement and compaction. Additionally, drying of the soil from the in situ moisture content can change both its index and physical properties, including compaction properties. Further, moisture control during compaction has important implications on the compacted soil behavior. Compacted soils in a partially saturated condition, compacted well dry of the optimum moisture content, have a potential to collapse when wetted (Reference 2.5-292). Alternatively, as the water content of compacted residual soils reaches an equilibrium with the surrounding environment (which often means an increase in water content after placement), a reduction in strength and volume change can occur due to loss of suction/surface tension between particles with increasing water content.

More specifically for Piedmont residual soils, the mica content has an effect on shear strength and compressibility characteristics of compacted fills. Studies have shown that the presence of mica can alter the soil packing to increase compressibility and reduce compacted densities and strength (Reference 2.5-293; Reference 2.5-294; Reference 2.5-266; Reference 2.5-295; Reference 2.5-296). In some cases, ultimate compression (settlement) has also been shown to increase with the degree of saturation (Reference 2.5-293).

The inherent variability of Piedmont residual soils and their sensitivity to moisture and mica content create challenges with the selection of representative samples for testing and quality control during placement and compaction and their use as structural backfill where strength and compressibility are of primary concern. This is also evident from the relatively low strength parameters indicated by the previously described triaxial tests performed on residual soil samples compacted to 95 percent of the Modified Proctor maximum dry density. As such, the use of residual soils as backfill will be limited to non-safety-related areas of the Plant Complex, provided screening and compaction control techniques are implemented.

2.5.4.5.2.2 Structural Backfill

Some of the reactor technologies may be founded on structural backfill in cases where unsuitable materials are encountered below the base mat that require excavation and replacement with compacted structural backfill. A structural backfill source had not yet been identified at the time of the ESPA investigation. Granular structural backfill is expected to consist of Unified Soil Classification System soil type GW (well-graded clean gravels, gravel-sand mixtures) to provide high-strength, low-deformation characteristics and compactability. Lean concrete is also suitable for use as structural backfill.

Based on published literature (Reference 2.5-297), past experience with structural backfill materials, and the project requirements, the following static properties are assumed for granular structural backfill. These properties will be reevaluated and verified during the final design phase once the reactor technology is selected and a backfill source identified. Other materials may also be suitable for use as structural backfill based on additional testing and final technology selection / design requirements.

- A minimum dry unit weight of 125 pcf

- A minimum total unit weight of 135 pcf
- A minimum effective stress friction angle of 40 degrees
- A minimum elastic modulus of 2000 kips per square foot (ksf)
- A minimum shear wave velocity of 1000 ft/s

2.5.4.5.3 Compaction Specifications, Monitoring, and Quality Control

Fill placement and compaction control procedures are addressed in a technical specification prepared during the detailed design stage of the project, which includes requirements for suitable fill, testing to address potential material variations, and in-place density and moisture content testing frequency. The technical specification also includes requirements for an on-site testing laboratory for quality control, especially material gradation and plasticity characteristics, the achievement of specified moisture-density criteria, fill placement/compaction, and other requirements to ensure that the fill operations conform to the earthwork specifications for the project. The soil testing company is required to be independent of the earthwork contractor and to have an approved quality program. A sufficient number of laboratory tests are required to ensure that variations in the fill material are accounted for. A trial fill program is normally conducted to determine an optimum number of compactor passes, the maximum loose lift thickness, and other relevant data to achieve the specified moisture-density criteria.

Piedmont residual soils commonly have less than 5 percent organic content by weight, a maximum particle size of 3 in. (76 mm) and consist of materials classified as either SC, SM, SP, SW, GC, GM, GP, or GW per ASTM D2487. Based on past experience with similar soils and laboratory test results from the ESP investigation, the excavated residual soils used as non-structural backfill in non-safety-related areas of the plant are expected to be classified as SM, ML, or CL, with a plasticity index no greater than 15. Soils classified as plastic silts (MH), high-plasticity clays (CH), organic silts (OL), organic clays (OH), or highly organic clays/peat (PT) are not suitable for use as backfill.

Fill is typically placed in maximum 8-in. (203-mm)-thick horizontal, loose lifts, and compacted to at least 95 percent of maximum dry density per ASTM D1557 (Reference 2.5-253), the Modified Proctor test procedure, at moisture contents within 2 percent of its optimum moisture. The degree of compaction is typically increased to a minimum of 98 percent of the Modified Proctor maximum dry density for the upper 1 ft. (0.3 m). Fill placed in landscape, non-structure support, and non-pavement areas is typically compacted to at least 90 percent of the Modified Proctor maximum dry density.

Excavated SM, ML, or CL soils can be difficult to compact if too wet or too dry. As a result, the ability to use such soils depends on their moisture contents. Soils that are too wet to properly compact can be dried by aeration or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction.

2.5.4.6 Groundwater Conditions

2.5.4.6.1 Groundwater Measurements and Elevations

Section 2.4.1.2 provides detailed descriptions of the hydrogeologic and groundwater conditions.

Per Section 2.4.1.2, the water table interface at the Project site generally occurs within the overburden/PWR and upper 10 to 20 ft. (3.0 to 6.1 m) of the bedrock. For foundation stability analyses, the groundwater levels (GWT) were further evaluated by reviewing measurements from the monitoring wells across the site, as well as considering the Probable Maximum Flood (PMF) elevation provided in Section 2.4.3.5, given as elevation 747.9 ft. (227.9 m).

The saturation state of the residual soils was assessed by comparing GWT (taken as the highest reading from each well) and PMF elevation with the elevation of the top of PWR as described in Section 2.5.4.2.2. The GWT is below the top of PWR in all wells, indicating that the residual soil is unsaturated, except for wells W-7, W-11, W-12, W-14, and W-15 (and for W-12 and W-14, the GWT is near the residual soil – PWR interface). Similarly, the PMF elevation is below PWR in all wells except W-15. No SPT data were available for Wells W-7, W-11, W-12, W-14, and W-15; therefore, the elevation of the top of PWR at these locations is uncertain. As such, the residual soils at the Project site are judged to be in a predominantly partially saturated state.

Pavement and structures following construction will likely reduce groundwater recharge, potentially affecting groundwater baseflow discharge into nearby perennial creeks and Belews Lake. Unpaved areas covered by permeable gravel or fill may receive increased recharge, countering effects of increased impermeable surfaces. As a whole, the on-site residual soils are expected to remain partially saturated as long as adequate drainage measures are provided during and after construction of the reactors to prevent net positive water infiltration into the soils in the power block. Localized areas of saturated residual soils may occur near the residual soil – PWR interface, but they are not anticipated to affect overall site/foundation stability. The groundwater level for stability considerations was taken as at the interface of residual soils and PWR.

Additional groundwater measurements from the existing monitoring wells, as well as data from additional wells that may be installed as part of the final site investigation after a reactor technology is selected, will be used for assessment of groundwater conditions during the final design phase.

2.5.4.6.2 Construction Dewatering

Even though the water table is typically at or below the interface of residual soils and PWR and the subsurface materials are relatively low in permeability, temporary dewatering is expected during excavation and construction of the power block and potentially other building foundations. The amount of dewatering required to support the construction of the new advanced reactor plant is unknown because the reactor technology has not been selected.

The dewatering system will likely consist of either deep bedrock wells or sump pumping from a system of shallow excavations to collect groundwater and rainwater, which is then pumped to a discharge point away from the excavation. A series of groundwater monitoring wells are typically used to monitor the effectiveness of the dewatering system in reducing the groundwater level. Some of the existing monitoring wells may be used to monitor the effectiveness of dewatering. Additional monitoring wells will likely be installed to provide adequate monitoring on all four sides of the excavations.

The general sequence of excavation and dewatering for the reactor is expected as follows. First, the overburden soils are removed, then the excavation proceeds down through PWR, fractured rock, and/or sound rock until the planned reactor base elevation is reached. A gravity-based

system such as sumps and sump pumps in the bottom of the excavation can be used to keep the groundwater elevation below the floor of the excavation. Alternatively, dewatering wells can be installed around and within the excavation area. If dewatering wells are used, effluent from the dewatering systems will most likely need to be routed through a temporary storage pond or holding tanks. The required pumping rate will partially depend on when the dewatering system is implemented and how fast the excavation proceeds downward. Section 2.4.12 estimates a dewatering system designed for the deepest foundation excavations will likely require temporary pumping between 57 and 370 gallons per minute. Stormwater runoff into the excavations will also need to be considered for final dewatering design to prevent intense rain events from creating ponding in the excavations.

Following decommissioning of the dewatering system, the groundwater will attempt to return to a natural condition. Pavement and structures will likely reduce groundwater recharge, potentially affecting groundwater baseflow discharge into nearby perennial creeks and Belews Lake. Unpaved areas covered by permeable gravel or fill may receive increased recharge, countering effects of increased impermeable surfaces.

For reactor technologies sited below the groundwater table, permanent dewatering using wells may be required if the reactor structure is unable to resist hydrostatic uplift pressures. As an example, the GVH reactor technology has a foundation depth of 125 ft. (38.1 m), corresponding to a base mat bottom elevation of 685 ft. (208.8 m), relative to the proposed finished plant grade elevation of 810 ft. (247 m). For the North Plant Complex, the groundwater level from the monitoring wells was observed between approximate elevation 725 ft. (221 m) and 780 ft. (237.7 m), which would result in a hydrostatic pressure of (780 –685 ft.) x 62.4 pcf (unit weight of water) = 5928 psf for the upper-bound scenario and (725 – 685 ft.) x 62.4 pcf = 2496 psf for the lower-bound scenario.

2.5.4.7 Response of Soil and Rock to Dynamic Loading

The seismic history of the area and the Project site, including any prior history of seismicity, is addressed in Sections 2.5.2.1 and 2.5.3.3. Liquefaction is addressed in Section 2.5.4.8. Detailed descriptions of the development of the GMRS and the associated PSHA are included in Section 2.5.2. Additional descriptions on site-specific geophysical methods and results are discussed in Section 2.5.4.4.

2.5.4.7.1 Wave Velocity Profiles

The Project site is divided into three main areas: the North, Middle, and South Plant Complexes. As part of the geotechnical site investigation, boreholes were drilled to depths of up to 300 ft. (91 m) in the North and South Plant Complexes, and up to 600 ft. (183 m) in the Middle Plant Complex.

To characterize dynamic soil properties, a combination of geophysical methods was employed:

- Suspension P-S logging was conducted in 15 boreholes, resulting in 9 velocity profiles (three per Plant Complex).
- Downhole velocity measurements were performed in 6 boreholes, consolidated into 3 profiles (one per Plant Complex).
- SASW testing was carried out using 12 arrays (four per Plant Complex).

Sections 2.5.4.2.1.4 and 2.5.4.4 provide additional details on geophysical methods and data interpretation.

Figure 2.5-138 compares V_S profiles (by depth) derived from various data sources, including P-S suspension logging profiles (solid lines), SASW profiles (dashed lines), downhole velocity profiles (black dash-dotted lines), and laboratory Fr-Fr resonant column measurements (red square symbols). As shown, the suspension logging and downhole data exhibit consistent large velocity gradients near the soil-rock transition zone at approximately 50 ft. (15.2 m) depth, with rock V_S ranging from 8000 to 10,000 ft/s (2438 to 3048 m/s). The depth of the velocity gradient observed in the suspension log data corresponds closely with the depth to the top of rock identified in the boring logs, indicating agreement between geophysical and geologic interpretations. In contrast, SASW data indicate a thicker layer of PWR with lower V_S of 2000 to 2500 ft/s (610 to 762 m/s), and underlying rock V_S of 6000 to 8000 ft/s (1829 to 2438 m/s). The suspension P-S logging results also generally indicate higher V_S compared to the SASW results. This difference is attributed in part to the global versus local nature of SASW testing compared to suspension logging.

Most Fr-Fr laboratory results are consistent with suspension and downhole data, though three samples (from borings W-1, B-6, and DW-11) show lower velocities between 1200 and 2500 ft/s (366 to 762 m/s), attributed to their location in upper, more fractured rock layers.

2.5.4.7.1.1 Suspension P-S Logging Profiles

Suspension P-S logging data from boreholes across the three Plant Complexes are color-coded in Figure 2.5-139a: blue for the North Plant Complex, orange for the Middle Plant Complex, and green for the South Plant Complex. The solid red line represents the V_S profile compiled from all measurements. Each Plant Complex includes two boreholes to approximately 280 ft. (85 m), while the Middle Plant Complex includes a deeper approximately 590-ft. (180-m) borehole. This deeper suspension log recorded consistent V_S values exceeding 10,000 ft/s (3048 m/s) below 275 ft. (84 m), supporting the selection of this depth as the reference rock half-space for the site.

Following excavation to the planned final plant grade of 810 ft. (247 m), the remaining soil profile exhibits a V_S of approximately 1000 ft/s (305 m/s). The deepest soil layer is about 5 ft. (1.5 m) in thickness with V_S around 1500 ft/s (457 m/s), underlain by a 4-ft. (1.2-m)-thick PWR layer with velocities ranging from 2400 to 3400 ft/s (732 to 1036 m/s).

Figure 2.5-139(b) presents average V_S profiles for each Plant Complex, based on three suspension logs per complex, along with an overall average profile derived from all nine logs. The Middle Plant Complex shows a transition to higher velocities at shallower depths, consistent with boring log data. Variations between the average V_S profiles for each complex were found to be within the range of variability observed within each complex. Therefore, the overall average V_S profile was selected.

Table 2.5-68 summarizes this average suspension V_S and V_P profiles, which have a weighted average V_S to 30 m ($V_{S\text{-}30}$) of 1807 ft/s (551 m/s). Downhole V_S measurements closely match the suspension log data for corresponding boreholes. As a result, a separate average profile for the downhole data was not developed.

2.5.4.7.1.2 Spectral Analysis of Surface Waves Profiles

Figure 2.5-140 compares V_S profiles from 12 SASW arrays and an average SASW profile captured as a solid black curve. In general, V_S values from SASW testing are lower than those from suspension logs, particularly within the PWR and upper rock layers. The SASW data indicate a thicker low-velocity PWR layer, approximately 100 ft. (30.4 m) thick with V_S between 2000 and 2500 ft/s (610 to 762 m/s), compared to the much thinner PWR layer (approximately 4 ft. [1.2 m]) identified in suspension logs. Additionally, the lower rock V_S from SASW ranges from 6000 to 8000 ft/s (1829 to 2438 m/s), whereas suspension logs show higher velocities of 8000 to 10,000 ft/s (2438 to 3048 m/s).

Table 2.5-69 summarizes the average SASW V_S and V_P profiles. To account for uncertainty in the depth to reference rock, the SASW-derived half-space was placed at an average depth of 540 ft. (164.6 m), which is significantly deeper than the depth indicated by suspension logs. Because the SASW data do not reach layers with velocities exceeding 9000 ft/s (2743 m/s), the velocity of the half-space was assumed to match that of the suspension log-based profile.

Layer thicknesses were converted to elevations by averaging the borehole elevations where suspension logging was performed for the suspension logging-based analysis, and by averaging the elevations of the array center and endpoints for the SASW-based analysis.

The best-estimate V_S and V_P profiles derived from suspension log and SASW data are presented in Figure 2.5-129 and Figure 2.5-130, respectively.

2.5.4.7.1.3 Dispersion Curves

Figure 2.5-141 compares dispersion curves derived from the mean V_S profiles obtained through suspension P-S logging and SASW data with experimental dispersion measurements. The figure also includes compacted dispersion curves (i.e., the averaged evaluated dispersion curves for each array), and their mean and ±3 standard deviation bounds. The mean and standard deviation bounds for the compacted curves are similar to the mean and bounds for the dispersion curve data points.

The comparison indicates that the suspension logging-derived profile aligns well with the upper portion of the observed dispersion data. Overall, both the suspension log and SASW profiles are considered reasonable representations of subsurface conditions because their modeled dispersion curves fall within the bounds defined by the dispersion curve data for the SASW profiles at the site.

2.5.4.7.1.4 Adjustment of Analysis Velocity Profiles for Cut/Fill

V_S in soils were adjusted to account for changes in isotropic confining pressure (σ_0) due to cut or fill conditions. These adjustments were based on RCTS testing of eight intact soil specimens at the Project site that evaluate V_S variation under increasing (normally consolidated, NC) and decreasing (over-consolidated, OC) confining pressures. The relationship between V_S and σ_0 was modeled using Equation 2.5.4-2:

$$V_s = A_s \times (\sigma_0 / P_a)^{n_s} \qquad \text{(Equation 2.5.4-2)}$$

Where:

3) A_S is shear wave velocity at σ_0 equal to one atmosphere
4) σ_0 is total isotropic confining pressure
5) P_a is atmospheric pressure (one atmosphere)
6) n_S is dimensionless exponent

Average values of n_S were 0.11 for over-consolidated conditions and 0.23 for normally consolidated conditions. These values were applied to adjust V_S for cut (over-consolidated) and fill (normally consolidated) scenarios, respectively. Resulting adjustments ranged from reductions of 50 to 250 ft/s (15 to 76 m/s) for cut scenarios and increases of 100 to 450 ft/s (30 to 137 m/s) for fill scenarios.

2.5.4.7.2 Shear Modulus Reduction and Damping Material Curves

Atterberg limit testing indicates that the residual soils at the Project site are generally non-plastic, with only a few samples from the upper few feet showing plasticity index values greater than zero. These upper soils are expected to be removed during grading and are therefore excluded from further analysis.

Despite the non-plastic results from Atterberg testing (except for one sample), the RCTS test results (Figures 2.5-142 and 2.5-143) resemble modulus reduction and damping curves typically associated with higher plasticity soils. To account for uncertainty in soil behavior, two sets of modulus reduction and damping curves were developed for the site: site-specific curves and original Darendeli curves.

Site-specific modulus reduction curves were developed using lab-derived data. For each test, the fitted reference strain was plotted against the corresponding confining stress. The data were fitted using a power function consistent with Darendeli (Reference 2.5-170), and new site-specific coefficients for Darendeli's modulus reduction equations were derived based on this relationship. Using these validated coefficients and an average 'a' value of 1.013, site-specific modulus reduction curves were generated for five confining stress levels representing the range of possible depths for the residual soils (i.e., approximately 15-ft. [4.6 m]-thick layers, from depths of 7.5 to 67.5 ft. [2.2 to 20.6 m]). The site-specific modulus reduction curves are presented in Figure 2.5-144 with the RCTS test results.

In addition, evaluation of shear strength from the modulus reduction curves indicates that the high-strain portion of the site-specific modulus reduction curves reasonably represents the shear strength of the residual soils based on lab strength data, and no adjustments to the curves are needed.

A similar process was used to derive the site-specific damping curves from the RCTS lab testing for the residual soils. For each test, the D_{min} was plotted against the corresponding confining stress. The data were fitted using a power function consistent with Darendeli (Reference 2.5-170), and new site-specific coefficients for Darendeli's damping curves were derived based on this relationship. Using these validated coefficients, the site-specific damping curves were generated for the same five confining stress levels and are presented in Figure 2.5-145. The fitted power function results in an average D_{min} of about 1.8 percent for the residual soils. Table 2.5-70 presents the site-specific modulus reduction and damping curves for the residual soils.

2.5.4.7.2.1 Darendeli Material Curves for Residual Soils

The second set of modulus reduction and damping curves for the residual soils was developed directly using Darendeli's equations (Reference 2.5-170), incorporating a plasticity index of 0 based on laboratory test results and other standard input parameters. Figures 2.5-146 and 2.5-147 present these curves. Table 2.5-71 presents the Darendeli modulus reduction and damping curves for the residual soils.

2.5.4.7.2.2 Material Curves for Partially Weathered Rock and Rock

To account for uncertainty in the material properties of the crystalline rock (fractured rock and sound rock) layer, two sets of curves were evaluated for both PWR and rock. For PWR, there are no available published curves for this type of material so the selected curves include unweathered shale (Reference 2.5-298) and EPRI rock (Reference 2.5-299) at depths of 2000 to 5000 ft. (609.6 to 1524 m). For rock layers with shear wave velocities less than 8000 ft/s (2438 m/s), two sets of curves were used: linear curves and unweathered shale curves from Stokoe et al. (Reference 2.5-298). For rock layers with velocities greater than 8000 ft/s (2438 m/s), linear behavior was assumed for both sets. The curves are captured on Figures 2.5-148 and Figures 2.5-149. Tables 2.5-72 and 2.5-73 present the two sets of modulus reduction and damping curves for the PWR and rock.

2.5.4.7.3 Low-Strain Dynamic Properties for Residual Soils, Partially Weathered Rock, and Rock

See Section 2.5.4.2.4.

2.5.4.7.4 Dynamic Properties for Fill

To raise portions of the site to the required final plant grade of 810 ft. (247 m), up to 50 ft. (15.2 m) of granular fill will be placed and compacted to 95 percent Modified Proctor, with a minimum shear wave velocity of 1000 ft/s (305 m/s) per Section 2.5.4.5.2.2. The shear wave velocity profile for the fill was developed using prior experience and Reference 2.5-172 equations, assuming a surface V_S of 1000 ft/s (305 m/s) and increasing with depth. Table 2.5-74 presents the derived V_S profile.

Material curves for the proposed granular fill were assumed based on published curves from Seed and Idriss (Reference 2.5-173), Rollins et al. (Reference 2.5-300), and prior experience with gravelly soils. Figures 2.5-150 and 2.5-151 show the assumed modulus reduction and damping curves, which are more nonlinear than the EPRI (Reference 2.5-163) shallow soil curves due to the expected higher gravel content in the fill.

2.5.4.7.5 Randomization of Material Properties

To capture spatial variability and reduce resonance effects, velocity profiles and material curves were randomized using Toro's (Reference 2.5-182) correlation model for firm sediments (USGS Site Class C), appropriate for the site's flat-lying sedimentary structure. For each logic tree branch, 60 randomized profiles were generated.

Layer thicknesses were randomized based on the variation of thickness of each layer from the site investigation geophysical data. Velocity correlations were not applied between fill and underlying rock, or between soil and PWR materials. For cut scenarios, profiles were trimmed to

pad elevations after randomization to model the variation in existing ground surface across different areas. For fill scenarios, fill thicknesses were varied to reflect observed site conditions.

Figure 2.5-152 shows an example of the 60 randomized velocity profiles (gray) generated for each logic tree branch, along with their median (blue) compared to the target velocity profile (red) on the left side. The right side displays the standard deviation of the logarithm of the velocities from the simulations (blue) versus the target (red). The randomization process was iterated until statistical criteria were met: a minimum p-value of 0.1 and an average p-value above 0.5 between the target median V_S profile and the median of the 60 randomized profiles.

2.5.4.7.6 Site Response Spectra

Site-specific DRS were developed for the North, Middle, and South Plant Complexes in accordance with RG 1.208 and ASCE/SEI 43-05. These include:

- GMRS at the surface (elevation 810 ft. [247 m]), which are equivalent to performance-based surface response spectra for the North, Middle, and South Plant Complexes.

- Foundation input response spectra (FIRS) at depths of 44 ft. [13.4 m] (elevation 766 ft. [233.5 m]) and 85 ft. [25.9 m] (elevation 725 ft. [221 m]) for all complexes, and at 115 ft. [35.1 m] (elevation 695 ft. [211.8 m]) for the South Plant Complex Only.

- Performance-based interface response spectra (PBIRS) at the top of the PWR for each complex.

The GMRS, FIRS, and PBIRS were derived from site-specific uniform hazard response spectra (UHRS) for annual frequencies of exceedance (AFE) of 1E-4 and 1E-5. Horizontal UHRS were enveloped across site grading cases and scaled using design factors to produce the DRS. Vertical response spectra were calculated by applying weighted vertical-to-horizontal (V/H) spectral ratios to the horizontal UHRS.

See Sections 2.5.2.6.1 through 2.5.2.6.4 for details on mean and fractile site-specific hazard curves, V/H spectral ratios, magnitude-distance deaggregation, and controlling earthquakes.

2.5.4.7.6.1 Seismic Hazard Results for Plant Complexes

Seismic hazard results for the North and Middle Plant Complexes are identical. Results were obtained for three site grading cases, including two cut cases (10 ft. [3 m] and 24 ft, [7.3 m]) and one fill case (15 ft. [4.6 m]), and for four control point elevations: surface, 44 ft. [13.4 m], 85 ft. [25.9 m], and the top of the PWR. For the South Plant Complex, seismic hazard results were developed for five site grading cases, three cut cases (10 ft. [3 m], 24 ft. [7.3 m], and 38 ft. [11.6 m]) and two fill cases (15 ft. [4.6 m] and 40 ft. [12.2 m]), and five control point elevations: surface, 44 ft. [13.4 m], 85 ft. [25.9 m], 115 ft. [35.1 m], and the top of the PWR.

The horizontal 1E-4 and 1E-5 site-specific UHRS for the North and Middle Plant Complexes and South Plant Complex were developed for each control point and site grading case and are presented in Figures 2.5-153 and 2.5-154, respectively. Subplots include control points at the surface (a) at depths of 44 ft. [13.4 m]; (b) 85 ft. [25.9 m]; and (c) 115 ft. [35.1 m]

(Figures 2.5-154e), and at the top of the PWR (Figure 2.5-153d and Figure 2.5-154d). Solid lines represent the 1E-4 UHRS, while solid lines with dots represent the 1E-5 UHRS.

To develop performance-based response spectra representative of the PPE, the UHRS for different site grading conditions were enveloped for each Plant Complex. For the North/Middle and South Plant Complexes, the enveloped 1E-4 and 1E-5 horizontal UHRS are shown as the thicker dashed blue and green curves in Figures 2.5-153 and 2.5-154, respectively. DRS were calculated from the enveloped UHRS and are shown by the solid black lines in the figures.

Vertical UHRS were obtained by multiplying the enveloped horizontal UHRS by the corresponding weighted average V/H spectral ratios, as provided in Section 2.5.2.6.4. These vertical UHRS were then used to compute the vertical DRS. Figures 2.5-155 and 2.5-156 present the results by comparing horizontal and vertical DRS across all control points for the North/Middle and South Plant Complexes, respectively.

Tabulated values of the enveloped horizontal and vertical 1E-4 and 1E-5 site-specific UHRS, along with the corresponding horizontal and vertical DRS, are provided for the North and Middle Plant Complexes in Table 2.5-75 (surface – GMRS), Table 2.5-76 (44 ft. [13.4 m] depth – FIRS), Table 2.5-77 (85 ft. [25.9 m] depth – FIRS), and Table 2.5-78 (top of PWR – PBIRS). These spectra were initially calculated for 24 spectral ordinates defined by the Next Generation Attenuation-East ground motion models. However, to meet the RG 1.208 requirement for a minimum of 30 spectral frequencies to ensure a smooth spectrum, horizontal and vertical GMRS, FIRS, and PBIRS were interpolated to include six additional frequencies. The interpolated spectra are presented in Table 2.5-79.

For the South Plant Complex, tabulated values of the enveloped horizontal and vertical 1E-4 and 1E-5 UHRS, and the corresponding horizontal and vertical DRS, are provided in Table 2.5-80 (surface – GMRS), Table 2.5-81 (44 ft. [13.4 m] depth – FIRS), Table 2.5-82 (85 ft. [25.9 m] depth – FIRS), Table 2.5-83 (top of PWR – PBIRS), and Table 2.5-84 (115 ft. [35.1 m] depth – FIRS). To satisfy the RG 1.208 requirement for 30 spectral frequencies, the horizontal and vertical GMRS, FIRS, and PBIRS were interpolated similarly, with results captured in Table 2.5-85.

2.5.4.8 Liquefaction Potential

Soil liquefaction is a process by which loose, saturated, primarily granular deposits lose a significant portion of their shear strength due to pore pressure buildup resulting from cyclic loading, such as that caused by an earthquake. During liquefaction, pore water pressure increases and soil particles lose contact, causing the soil to behave more like a liquid than a solid. Soil liquefaction occurrence (or lack thereof) depends on geologic age, state of soil saturation, density, gradation, plasticity, and earthquake intensity and duration. In addition to loss of strength, liquefaction can cause settlement of the overlying layers as the liquefying layer densifies following earthquake shaking.

The reactor base mats will be founded either on structural backfill, lean concrete, or competent rock. Structural backfill or lean concrete are not susceptible to liquefaction. Nevertheless, RG 1.198, *Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites*, was used as a guide for assessing liquefaction potential of the on-site residual soils at the Project site for conservatism.

RG 1.198 states that earthquake-induced liquefaction is most commonly observed in (but not restricted to) fluvial-alluvial deposits, eolian sands and silts, beach sands, reclaimed land, and uncompacted hydraulic fills. Also, per RG 1.198, most liquefaction risk is associated with recent Holocene deposits and uncompacted fills, and soils with dual Unified Soil Classification system designations including SM-SC or GM-GC are potentially liquefiable. Additionally, RG 1.198 states that "if it can be demonstrated that any potentially liquefiable soil types present at a site (1) are currently unsaturated (e.g., are above the water table), (2) have not been saturated previously (e.g., are above the historic high water table), and (3) cannot reasonably be expected to become saturated, such soils can be considered to pose no potential liquefaction hazard." For water levels to be considered in assessing liquefaction, RG 1.198 states that groundwater tables or pool elevations should be assumed to lie at the maximum or the minimum of the range that can be expected at the site of the facility, in the direction that is most critical to the analysis, including consideration of the water levels governed by flood conditions.

The presence of sandy soil layers (typically classified as SM/SC) at the Project site indicates a potential for liquefaction under seismic loading based on soil type. As discussed in Section 2.5.4.6, the water table at the Project site is predominantly located at or below the soil-rock interface, and residual soils are expected to remain partially saturated as long as adequate drainage measures are provided during and after construction of the reactors to prevent net positive water infiltration into the soils in the power block. Accordingly, these soils are considered to pose no potential liquefaction hazard based on RG 1.198.

An analysis based on V_S was performed that considers the groundwater table to be at the plant final grade elevation of 810 ft. [247 m] (critical case) using the V_S based methodology outlined in Reference 2.5-267. Unlike SPT measurements that can fail to adequately capture soil fabric/microstructure-related phenomena contributing to strength and stiffness (manifested as cyclic resistance), V_S measurements can more accurately represent the in situ state of soils including aging effects (Reference 2.5-301; Reference 2.5-302). The best-estimate V_S profiles as described in Section 2.5.4.2.4 were used in this assessment. The V_S values were corrected for overburden pressure (V_{S1}) and indicate a minimum of 827 ft/s (252 m/s) below elevation 810 ft. [247 m]. Based on Reference 2.5-267, V_{S1} greater than 200 m/s (656.1 ft/s) for soils with fines content greater than 35 percent (as is typical for the Project site) for a moment magnitude of 7.5 indicate no potential for liquefaction. The mean magnitudes for the surface site-specific hazard range from 5.9 to 7.3 for AFEs of 1E-4 and 1E-5 for frequencies of peak ground acceleration to 1 Hz, thus the mean magnitudes are less than 7.5 for the critical AFEs and frequencies for liquefaction hazard for the site, and the 200 m/s value is a conservative liquefaction susceptibility limit for the site. As the minimum V_{S1} value for the residual soils is greater than 200 m/s, the residual soils pose no potential liquefaction hazard based on RG 1.198 if even saturated.

2.5.4.9 Earthquake Design Basis

The site GMRS is derived and discussed in detail in Section 2.5.2.6.

2.5.4.10 Static and Dynamic Stability

The following sections discuss general static aspects of stability. Dynamic aspects of the foundation interface will be discussed in Sections 3.7 and 3.8, once a reactor technology is selected and a more site- and technology-specific study is conducted at the construction permit or license application phase.

Once the excavation to reach the base of safety-related structures is completed, the base of the excavation will be evaluated for any areas of residual soils or weak rock that may need further excavation and replacement with structural backfill or lean concrete. As such, all safety-related structures will be founded on either structural backfill, lean concrete, or competent rock.

2.5.4.10.1 Bearing Capacity

The bounding scenario for bearing capacity is reactor base mats founded on structural backfill. Based on the anticipated base mat elevations, the Westinghouse reactor technology has the highest proposed base mat elevation of 766 ft. (233.4 m) and will likely be founded on structural backfill or lean concrete. Per Section 2.5.4.5.2.2, the minimum effective friction angle for structural backfill is 40 degrees. All other reactor technologies have a deeper base mat embedment and will be underlain by more competent materials (typically sound rock).

The ultimate bearing capacity (q_{ult}) for a strip footing (with a length-to-width ratio greater than 10) can be evaluated, in terms of effective stress or drained analysis, using Terzaghi's general shear bearing capacity expression included below as Equation 2.5.4-3:

$$q_{ult} = c\,N_c + q\,N_q + 0.5\,\gamma\,B\,N_\gamma \qquad \text{(Equation 2.5.4-3)}$$

Where:

- c is effective stress cohesion
- q is effective vertical stress at the bearing elevation
- B is footing width
- L is footing length
- γ is effective unit weight of soil
- N_c, N_γ, and N_q are bearing capacity factors that depend on the friction angle

For a reactor base mat bearing on structural backfill with zero cohesion, and conservatively ignoring the foundation embedment effects, the equation above simplifies to Equation 2.5.4-4:

$$q_{ult} = 0.5\,\gamma\,B\,N_\gamma \qquad \text{(Equation 2.5.4-4)}$$

The above-calculated q_{ult} values further need to be adjusted for L/B ratios less than 10 by applying a shape correction factor (s_γ). The final equation (Equation 2.5.4-5) used to calculate ultimate bearing capacity is thus:

$$q_{ult} = 0.5\,\gamma\,B\,N_\gamma s_\gamma \qquad \text{(Equation 2.5.4-5)}$$

As indicated by this equation, the ultimate bearing capacity increases with increasing width for foundations bearing on granular materials (such as structural backfill). A reactor base mat width and length of 100 ft. (30.4 m) were used for bearing capacity calculations, which is conservative because the length and width of the base mats associated with the six proposed reactor technologies are all wider than 100 ft. (30.5 m). Per Section 2.5.4.5.2.2, the total unit weight of

structural backfill is 135 pcf. Assuming groundwater to be at the reactor base mat (most conservative assumption), the effective unit weight is:

$$\gamma = 135 \text{ pcf} - 62.4 \text{ pcf} = 72.6 \text{ pcf}$$

Different bearing capacity and shape correction factors have been established by various researchers (e.g., Terzaghi, Meyerhoff, Hansen). The more conservative bearing capacity and shape correction factors proposed by Hansen, as given in Reference 2.5-280, were used for the calculations, resulting in N_γ = 80 and s_γ = 0.6. The ultimate bearing capacity is then calculated as:

$$q_{ult} = 0.5\ (72.6 \text{ pcf})\ (100 \text{ ft})\ (80)\ (0.6) = 174{,}240 \text{ psf} = 174.2 \text{ ksf}\ (8.3 \text{ MPa})$$

As a comparison, this is much greater than the required minimum ultimate bearing capacity of 75 ksf (3.6 megapascals [MPa]) for NuScale as indicated in Section 2.5.4 of the NuScale Final Safety Analysis Report (Reference 2.5-303). The ultimate bearing capacity associated with the NuScale technology is considered bounding for the other technologies for the purposes of the ESPA. The ultimate bearing capacity of the final reactor technology will be calculated once a selection is made at the construction permit or license application phase; however, ultimate bearing capacity is not anticipated to be the controlling factor for the reactor base mats.

2.5.4.10.2 Elastic Settlement

The bounding scenario for elastic settlement is base mats underlain by the thickest compressible materials. Residual soils below the reactor base mats will be excavated; therefore, the compressible materials are structural backfill and PWR. The compressibility of the fractured and sound rock is considered negligible. This assumption is justified because the best-estimate elastic moduli of fractured rock and sound rock layers are approximately 10 to 100 times that of the structural backfill/PWR, respectively.

The subsurface profile used for elastic settlement estimation purposes is based on the conditions indicated by boring B-4 in the north complex. Based on a mat bearing elevation of 766 ft. (233.5 m) corresponding to the reactor technology with the highest reactor base mat elevation and the bottom of Stratum III (PWR) at elevation 712.8 ft. (217.3 m), there is 53.2 ft. (16.2 m) of structural backfill and/or PWR below the base mat at this location which represents the thickest combination of compressible materials (structural backfill and/or PWR) below the base mat bottom.

Settlement analyses typically assume the following form as shown in Equation 2.5.4-6 (Reference 2.5-274):

$$\Delta H = \varepsilon\, H = \sum_{H_i}^{H_{i+1}} \frac{\Delta q_i}{E_{si}} \quad (i = 1 \text{ to } n) \qquad \text{(Equation 2.5.4-6)}$$

Where:

- ΔH is settlement
- ε is axial strain
- H = thickness of compressible layer
- Δq = stress increase at the mid-point of each layer due to net load imposed by the base mat
- E_s= elastic modulus

In other words, the total settlement is the sum of the strain in each layer multiplied by the layer thickness. Per Section 2.5.4.5.2.2 and Section 2.5.4.5.2.2, the minimum and best estimate elastic modulus for the PWR and structural backfill are both 2000 ksf (95.8 MPa). This means that elastic settlement estimates will be identical even if all the PWR is excavated and replaced with structural backfill or if some PWR remains in-place.

A flexible foundation was assumed such that the applied loads can be represented as a uniform soil bearing pressure at the base of the mat. Reactor-specific design pressures were not provided at the ESP phase. A net mat pressure of 6 ksf (0.29 MPa) was assumed. The net pressure considers the effects of the overburden stress removed due to excavation of the materials above the base mat; for example, a mat with a gross bearing pressure of 10 ksf (0.48 MPa) bearing at a depth of 44 ft. (13.4 m) below final grade (such as the Westinghouse reactor) would impart a net pressure of 5.6 ksf (0.27 MPa) on the excavation bottom assuming a unit weight of 100 pcf for the excavated overburden soils. Reactor base mats that are embedded deeper may experience no net bearing pressure increase or associated settlement if the overburden stress removed due to excavation is the same or greater than the gross mat bearing pressure, creating a “compensated” condition. Because the in situ residual soils below the reactor base mat will be over-excavated and replaced with compacted structural backfill, there was no need to evaluate potential time-dependent consolidation settlements.

Stress increase in layers below the loaded foundation is typically modeled using various stress distribution methods (e.g., Boussinesq, Westergaard, 2:1 assumption, Schmertmann). Because stresses will be distributed over a wider footprint than that of the base mat as depths increase, the stress increase in subsequent layers decreases as depth increases. It is conservatively assumed that the underlying layers will be subject to stress increase the same as the net base mat pressure (i.e., no load distribution). The difference in surcharge due to replacing the excavated in situ residual soils with compacted structural backfill (i.e., due to difference of total unit weights) is considered negligible.

Accordingly, the uniform elastic settlement of the base mat can be calculated as:

$$\Delta H = \left(\frac{\Delta q}{E_s}\right) \text{ x } H = \left(\frac{6 \text{ ksf}}{2000 \text{ ksf}}\right) \text{ x } 53.2 \text{ ft} = 0.16 \text{ ft} = 1.9 \text{ in } (4.8 \text{ cm})$$

A time influence factor was used for added conservatism to consider the time rate of development of settlement in coarse-grained layers, which may occur in the structural backfill and PWR layers. The work by Liu et al., contained in Reference 2.5-304, builds on previous work done by several other researchers (e.g., Reference 2.5-305; Reference 2.5-306), suggests the following relationship (Equation 2.5.4-7) for computing a time influence correction factor (f_t):

$$f_t = 1 + R_{ref} + R \text{ x } \log\left(\frac{t}{0.1 \text{ x } T_0}\right) \quad \text{(Equation 2.5.4-7)}$$

Where:

7) $R_{ref} = 0.1 - 0.015 \text{ x } \log(F)$ (F is the factor of safety)
8) $R = 0.182 - 0.043 \text{ x } \log(F)$
9) t is time in years
10) T_0 is duration of load application

Conservatively assuming F = 3 (actual factor of safety is likely much higher) and using T_0 = 1 year, this relationship gives a time influence correction factor of approximately 1.25 after t = 1 year and 1.58 after t = 100 years. There is no guidance on what value of t to use in the calculations; using t = 100 years is likely overly conservative whereas using t = 1 years is likely insufficient. An f_t value of 1.5 was used in this calculation.

The total elastic settlement including time effects is then calculated as:

$$\Delta H_t = f_t \text{ x } \Delta H = (1.5) \text{ x } (1.9 \text{ in}) = 2.9 \text{ in } (7.4 \text{ cm})$$

The settlement requirements for the NuScale technology, as indicated in Section 2.5.4 of the NuScale Final Safety Analysis Report, are a maximum allowable total settlement of 4 in. (101.6 mm) along the base mat, and a settlement tilt limit of 1 in. (25.4 mm) total in any direction or half an inch per 50 ft. of building length (Reference 2.5-303). Assuming similar total settlement criterion for the other reactor technologies, the estimated upper-bound total settlement of 2.9 in. (73.7 mm) is satisfactory. The settlement tilt was not evaluated because it is a function of mat rigidity and final site/technology selection. Because the reactor base mats of all other technologies are located deeper and/or underlain by more competent materials, the total settlement for the other technologies is expected to be smaller. Using the above approach, a sensitivity analysis was also performed to estimate total elastic settlement (in inches) for various net mat pressures between 2 and 10 ksf and compressible layer thicknesses between 10 and 100 ft. The results are summarized in Figure 2.5-157. From this figure, as one example for a potential reactor base mat bearing at elevation 800 ft. (243.8 m) with a net mat pressure of 5 ksf (0.24 MPa), and considering the conditions in boring B-4 with the bottom of the compressible materials at elevation 712.8 ft. (217.3 m) resulting in a total compressible material thickness of 87.2 ft. (26.6 m), the total elastic settlement is approximately 4 in. (101.6 mm).

2.5.4.10.3 Consolidation and Swell/Collapse Potential

None of the base mats for the six different reactor technologies under consideration will be underlain by in situ residual soils that are subject to potential time-dependent consolidation, collapse, or swell. There may be other shallow structures associated with the nuclear plant supported on residual soils; however, because a specific reactor technology has not been selected at this time and the locations of various structures associated with a specific plant configuration are not known, the test results are interpreted to provide a preliminary evaluation and demonstration of the general consolidation and collapse/swell characteristics of the in situ residual soils at the subject site. Once a reactor technology is selected and structure locations are identified at the construction permit or license application phase, there will be additional structure-specific subsurface investigations and laboratory testing performed.

Piedmont residual soils are formed in-place from weathering of the parent rock and are not subject to some of the typical mechanisms that result in over-consolidation of natural deposits, with the exception of water level changes and subsequent desiccation. The term “apparent OCR” is commonly used to refer to the apparent pre-consolidation pressure inferred from consolidation test results from Piedmont residual soils (Reference 2.5-264; Reference 2.5-307; Reference 2.5-266). In addition, Piedmont residual soils are prone to sample disturbance and stress release upon extrusion from sampling tubes in the laboratory because of the high fine sand fraction and/or presence of mica minerals (Reference 2.5-264). As such, it is challenging to interpret the characteristic of compressibility of the Piedmont residual soils based on results of the consolidation tests because, for example, there may not be a well-defined yield point on the typical e-log p plots used to present consolidation data (Reference 2.5-308), and the estimation of pre-consolidation stress in Piedmont residual soils requires considerable engineering judgment (Reference 2.5-307).

The residual soil samples tested for their consolidation characteristics included silty sands (SM), elastic silts (ML), and high plasticity silts (MH). The liquid limit of the plastic samples tested ranged between 57 and 69, and plasticity index ranged between 13 and 24. The initial void ratio ranged between 0.814 and 1.466 with a mean of 1.133. The average coefficient of consolidation was approximately 1.1 square feet per day.

Using the Casagrande method, the recompression index ranged from 0.03 to 0.09, and the compression index ranged from 0.31 to 0.78. The estimated pre-consolidation pressures ranged from 6.8 ksf to 16.6 ksf. The calculated apparent OCR based on the estimated pre-consolidation pressures ranged from 5.2 to 98.6. When excluding the shallow samples (in the upper approximate 8 ft. [2.4 m]) that are subject to frequent moisture content fluctuations/desiccation, the pre-consolidation pressures ranged from 6.8 ksf to 16.6 ksf, and the calculated OCR values ranged from 5.2 to 14.6. These pressures are significantly greater than the typical pre-consolidation pressures of 1 to 5 ksf and apparent OCR values of 1 to 4 reported in literature for Piedmont residual soils (Reference 2.5-264; Reference 2.5-266; Reference 2.5-308).

Using the Simplified Method (Reference 2.5-309) (where the straight portion of the initial recompression curve is projected forward and the straight portion of primary consolidation curve is projected backward, with the intersection point representing the pre-consolidation pressure and the slope of the projected lines representing the recompression and compression indices), the recompression index ranged from 0.05 to 0.13, and the compression index ranged from 0.31 to 0.77. The estimated pre-consolidation pressures ranged from 1.8 ksf to 5.2 ksf. The calculated over-consolidation ratio based on the estimated pre-consolidation pressures ranged from 1.8 to 26.6. The pre-consolidation pressures estimated using the Simplified Method are in good agreement with the typical pre-consolidation pressures of 1 to 5 ksf. The calculated apparent OCR values are generally higher than the typical values; however, when excluding the shallow samples (in the upper approximate 8 ft. [2.4 m]) that are subject to frequent moisture content fluctuations/desiccation, the calculated apparent OCR values of 1.8 to 3.5 are in better agreement with the typical values for Piedmont residual soils.

Alternative interpretation methods for one-dimensional consolidation tests can yield different results with respect to the pre-consolidation pressure/OCR as well as recompression and compression indices (Reference 2.5-310; Reference 2.5-311; Reference 2.5-312). This is particularly the case in Piedmont residual soils as previously discussed. Therefore, the interpretation and use of consolidation parameters from laboratory oedometer tests on Piedmont residual soils require significant care, and in most cases, the use of sound

engineering judgment. In addition, conventional consolidation tests have been shown to overpredict settlements in Piedmont residual soils, and SPT-based and elastic modulus-based methods are frequently used instead for predicting settlement (Reference 2.5-273).

2.5.4.10.4 Displacement Monitoring

For structures founded on structural backfill, competent PWR, or crystalline rock, elastic displacement is expected during load additions for construction. A displacement (settlement) monitoring plan will be developed to monitor rebound/heave in the subsurface soil and rock due to excavation, changes in pore pressures due to excavation and dewatering, and settlement due to construction of the structures. The displacement monuments will be monitored on a regular basis and will include conventional survey, electronic instrumentation, and possibly remote telemetry. The tilt and differential movement of the structures will be a monitoring priority.

2.5.4.10.5 Lateral Earth Pressures

2.5.4.10.5.1 Residual Soils and Backfill

Below grade walls are subject to lateral earth pressures based on the state of stress of the soil behind the wall and the movement experienced by the wall. For rigid walls that experience little to no movement (typical for buried safety-related structures), the “At-Rest” earth pressure is typically used. Conservatively assuming no friction between the wall and the backfill, Rankine’s method (Equation 2.5.4-8) can be used to estimate the lateral at-rest earth pressures for a vertical wall as follows (Reference 2.5-313):

$$\sigma'_h = \gamma' \cdot h \cdot K_0 \qquad \text{(Equation 2.5.4-8)}$$

Where:

11) σ'_h is Static horizontal effective stress
12) γ' is Effective unit weight (buoyant unit weight below the water table, and total unit weight above)
13) h is Depth below the top of wall
14) K_0 is Coefficient of at-rest earth pressure where ϕ' is the effective stress friction angle of the backfill

$$K_0 = (1 - \sin(\phi'))(1 - \sin(\beta)) \text{ for normally consolidated soils}$$

$$K_0 = (1 - \sin(\phi')) \times OCR^{\sin(\phi')} \text{ for overconsolidated soils}$$

Where β is the slope angle of backfill surface behind retaining wall. For unrestrained retaining walls where wall movement away from the backfill can occur, the coefficient of at-rest earth pressure in Equation 2.5.4-8 can be replaced with the coefficient of “Active” earth pressure (K_A) in Equation 2.5.4-9 for estimating active earth pressures (for $\beta \leq \phi'$):

$$K_A = \cos(\beta)\frac{\cos(\beta) - \sqrt{\cos^2(\beta) - \cos^2(\phi')}}{\cos(\beta) + \sqrt{\cos^2(\beta) - \cos^2(\phi')}} \qquad \text{(Equation 2.5.4-9)}$$

For a non-sloping backfill, the expression above can be simplified to Equation 2.5.4-10:

$$K_A = \frac{1 - \sin(\phi')}{1 + \sin(\phi')} \quad \text{(Equation 2.4.5-10)}$$

Lastly, for walls where movement occurs into the backfill (e.g., in front of the wall footing), the coefficient of "Passive" earth pressure (Equation 2.5.4-11) can be used (for $\beta \leq \phi'$):

$$K_P = \cos(\beta)\frac{\cos(\beta) + \sqrt{\cos^2(\beta) - \cos^2(\phi')}}{\cos(\beta) - \sqrt{\cos^2(\beta) - \cos^2(\phi')}} \quad \text{(Equation 2.5.4-11)}$$

For a non-sloping backfill, the expression above can be simplified to Equation 2.5.4-12:

$$K_P = \frac{1 + \sin(\phi')}{1 - \sin(\phi')} \quad \text{(Equation 2.5.4-12)}$$

For cases where interface friction between the wall and the backfill is considered, Coulomb's method is sometimes used to estimate the active and passive lateral earth pressure coefficients as follows in Equation 2.5.4-13 and 2.5.4-14:

$$K_{A(C)} = \frac{\cos^2(\phi' - \omega)}{\cos^2(\omega)\cos(\delta + \omega)\left[1 + \sqrt{\left(\frac{\sin(\delta + \phi')\sin(\phi' - \beta)}{\cos(\delta + \omega)\cos(\omega - \beta)}\right)}\right]^2} \quad \text{(Equation 2.5.4-13)}$$

$$K_{P(C)} = \frac{\cos^2(\phi' + \omega)}{\cos^2(\omega)\cos(\delta - \omega)\left[1 - \sqrt{\left(\frac{\sin(\delta + \phi')\sin(\phi' + \beta)}{\cos(\delta - \omega)\cos(\beta - \omega)}\right)}\right]^2} \quad \text{(Equation 2.5.4-14)}$$

Where:

15) the subscript "(C)" denotes Coulomb

16) ω is the wall face inclination from vertical

17) δ is the interface friction angle between the wall and the backfill

18) β is the backfill slope angle as previously defined

However, subsequent studies have shown that using the Columb method for estimating K_P can produce unconservative values, and that the log-spiral method is more suitable for calculating passive pressures (Reference 2.5-280). For a vertical wall with non-sloping backfill, the coefficient of passive pressure using the log-spiral method ($K_{P(LS)}$) can be estimated by Equation 2.5.4-15:

$$\ln\left(K_{P(LS)}\right) = \ln\left(\frac{1+\sin(\phi')}{1-\sin(\phi')}\right)\left[1.443\left(\frac{\delta}{\phi'}\right)\sin(\phi')+1\right] \quad \text{(Equation 2.5.4-15)}$$

For cases involving non-vertical walls and/or inclined backfill, design charts can be used to determine the $K_{P(LS)}$ values (Reference 2.5-280).

The selection of the effective stress friction angle used in lateral earth pressure calculations also needs to consider the potential for interaction with the in situ soils where the annular (filled) space between the wall and the backfill is small, where the lesser of effective stress friction angles between the backfill material and in situ materials would control.

Additional lateral forces to be considered for buried walls include:

- Hydrostatic pressure (below the water table)
- Lateral pressures induced by other structures or equipment
- Seismically induced pressure

Once a reactor technology is selected, additional assessment of the lateral earth pressures will be performed at the construction permit or license application phase, including dynamic soil-structure interaction analyses considering the site-specific foundation input response spectra.

2.5.4.10.5.2 Rock

The annular space between the excavation in fractured and sound rock and the reactor structure wall is typically backfilled with lean concrete. For unjointed massive hard rock, only water pressure typically needs to be accommodated once post-excavation elastic strain has developed. For fractured or bedded rock masses, the lateral earth pressures depend on the nature of and movement along the discontinuities (Reference 2.5-314).

For fractured rock, the lateral earth pressures can be conservatively estimated as described in Section 2.5.4.10.5.1, assuming a friction angle of 43 degrees (consistent with the best estimate for the PWR as described in Section 2.5.4.2.3). For sound rock, the lateral earth pressures can be considered negligible (but with consideration for the hydrostatic pressure below the water table and lateral pressures induced by other structures or equipment).

Additional assessment of the stresses in rock will be performed following additional data collection once a reactor technology is selected at the construction permit or license application phase.

2.5.4.11 Design Criteria

Foundation design criteria were available for only one of the six potential reactor technologies (Reference 2.5-303). Once a final reactor technology is selected at the construction permit or license application phase, the applicable design criteria will be used to further assess foundation stability.

2.5.4.12 Techniques to Improve Subsurface Conditions

The Westinghouse reactor has a proposed embedment depth of 44 ft. (13.4 m) where variable subsurface conditions were encountered. The remaining five reactor technologies (NuScale, Holtec, TerraPower, X-energy, and GVH) are anticipated to be supported on competent rock due to their relatively deep embedment depths and the subsurface conditions encountered at the proposed base mat elevations.

For the Westinghouse technology, variable subsurface conditions including residuum, PWR, fractured rock, and sound rock were encountered at the proposed base mat bottom elevation. Once the excavation reaches the proposed base mat elevation, the conditions need to be evaluated to identify areas of unsuitable materials (such as residuum) below the base mat. Excavation and replacement with structural backfill, “dental concrete” treatment where lean concrete is used to backfill excavated areas of unsuitable materials, or high-mobility (cement slurry) rock grouting are potential ground improvement alternatives to achieve a relatively uniform-bearing surface to promote even stress distribution. However, there is a risk with this approach that this remedial work may not be able to identify and address deeper layers of weaker residual soils that may be interbedded within the PWR due to differential weathering common in the Piedmont physiographic province. Such conditions were identified in several of the borings (in particular, at the North Plant Complex).

As an alternative, the excavation can be extended to a predetermined depth and backfilled with structural fill. The exact depth of this potential over-excavation is not known at this time. Per Section 2.5.4.2.2, the average bottom elevation of the PWR layer was identified as elevation 764.5 ft. (233 m), 762.5 ft. (232.4 m),and 774 ft. (235.9 m) for the North, Middle, and South Plant Complexes, respectively; however, the standard deviations for these elevations are on the order of 21 to 27 ft. (6.4 to 8.2 m). Additional subsurface investigation to be performed during the final design phase can be used to determine the final excavation depth once a reactor technology is selected at the construction permit or license application phase.

Another alternative to achieve a uniform bearing surface is through the use of a load transfer platform (LTP) below the mat. Also referred to as a “bridging layer,” a LTP often consists of a select well-graded granular backfill to provide adequate strength and promote arching (Reference 2.5-315). The thickness of the LTP is typically on the order of 2 to 4 ft. (0.6 to 1.2 m). Geosynthetic reinforcement is also sometimes used within the LTP to increase resistance to lateral spreading and/or to increase global stability. Lastly, the use of piles to create a pile-supported mat can also be considered. Drilled piers will most likely be used for this purpose because of the challenges associated with driving piles in highly variable subsurface conditions.

For the NuScale, Holtec, TerraPower, X-energy, and GVH technologies, ground improvement will likely consist of dental concrete to address areas of fractured or weak rock that may be identified once the excavation bottom is reached.

Detailed ground improvement plans, including the installation of piles if needed, will be addressed once a final reactor technology is selected and plans, including ancillary structure locations, are available.

2.5.5 STABILITY OF SLOPES

This section discusses the site characteristics and parameters concerning the stability of earth and rock slopes, both natural and manmade, whose failure could adversely affect the safety of the Site.

Specifically, this section evaluates the dynamic and static stability of the planned slopes and embankments at the Project site, addressing the following elements:

- Slope Characteristics (Section 2.5.5.1)
- Design Criteria and Design Analyses (Section 2.5.5.2)
- Site Investigations Boring Logs (Section 2.5.5.3)
- Properties of Borrow Material (Section 2.5.5.4)

Final grading plan will depend on advanced reactor technology selected in the construction permit or license application phase. Therefore, specific locations of safety-related slopes are not known at the ESPA phase. The site grading plan and the stability of any safety-related slopes will be evaluated in the construction permit or license application phase.

2.5.5.1 Slope Characteristics

The Project site consists of three separate areas located on a peninsula that trends southeast - northeast and extends into the southwestern portion of Belews Lake. The three Plant Complexes within the Project site are shown in Figure 2.5-158.

Based on the existing site elevations, significant cuts and fills are anticipated to achieve the proposed finished plant grade, which is planned at an approximate elevation of 810 ft. (247 m). As a result, the perimeter of each power block will primarily consist of compacted fill slopes downward and away from the critical structures. This grading will not result in significant upward slopes that could impact the facilities.

The final location of safety-related structures and their proximity to these fill slopes will be established in the final design. At this time, the safety-related structures are a minimum of 100 ft. (30.5 m) from the crest of the nearest slope.

Figures 2.5-159 through 2.5-161 present a preliminary grading plan for each of the three Plant Complexes. Also indicated are the critical slope sections that have been evaluated. Figures 2.5-162 through 2.5-171 present the cross-section of each slope considered.

The excavations to achieve the proposed plant grade will generally encounter existing overburden residual soils, partially weathered rock, fractured bedrock, and sound bedrock. These materials are discussed in Section 2.5.5.3.

The constructed slopes are designed with nominal slopes of 3 horizontal to 1 vertical (3H:1V). They will be constructed with the material excavated to establish the site grade. This construction will include:

- Removal of organic and otherwise unsuitable soils.
- Establishing a firm and unyielding subgrade prior to fill placement.
- Grading the exposed subgrade to provide terraces to key the new fill into the natural soils.
- Placement of moisture conditioned fill in nominal-maximum 8-in. (203-mm)-thick horizontal, loose lifts.
- Compaction of each lift to a minimum 95 percent of maximum dry density per ASTM D1557 (Modified Proctor test), with moisture contents within 2 percent of its optimum moisture as determined by ASTM D1557.
- Testing of compaction and moisture content to validate construction procedures.
- Establishing vegetation or aggregate surfacing to control soil erosion from the fill slopes.

Based on the explored condition, compacted fill consisting of the residual soils (generally consisting of silty sand (SM), sandy silt (ML) and lean clay (CL)), is considered to result in less desirable engineering properties than fill consisting of compacted partially weathered rock, fractured bedrock or sound bedrock (following crushing and processing). Thus, the use of residual soil is appropriately conservative for this evaluation.

Laboratory testing of residual soils obtained from the Site are discussed in Section 2.5.4.2.1. Based on this testing, a Mohr-Coulomb envelope with c' = 200 pounds per square foot (psf) and ϕ' = 30 degrees was selected as the best estimate for all interpretations at various strain levels. These values are used for stability analyses of slopes constructed with the excavated residual soils when compacted to 95 percent of their Modified Proctor maximum dry density.

Section 2.4.12 provides detailed descriptions of the hydrogeologic and groundwater conditions, while Section 2.5.4.6.1 concludes that the residual soils at the Project site are judged to be in a predominantly partially saturated state.

The engineering stratigraphy and properties of the natural materials below the future fill are discussed in Sections 2.5.4.2.2 and 2.5.4.2.3, as well as Table 2.5-64.

In general, groundwater levels are higher in the wells located farther from the natural slope crests and decrease as they approach the crests. In this evaluation, groundwater levels are considered to remain constant from the natural slope crests to the fill slope crests, then decrease along the slope faces to the water level of Belews Lake. These constant groundwater levels are used as average groundwater elevations for each site area and are depicted on each cross section (Figures 2.5-162 through 2.5-171). Using average groundwater levels across the slope crests is considered conservative, since well monitoring data indicate that most groundwater elevations near slope crests were lower than these average values.

The horizontal PGA are 0.432g (gravitational acceleration) for three Plant Complexes; the vertical PGAs are 0.317g for North and Middle Plant Complexes and 0.326g for the South Plant Complex, as provided with Section 2.5.2.6.8.

Peak ground motions occurring in both horizontal and vertical directions are considered in the slope stability analyses. However, it is unlikely that the PGAs in all directions occur simultaneously. Based on NUREG/CR-0098 (Reference 2.5-323), pages 29 to 30, it is conservative to take the combined effects as 100 percent of the effect due to motion in one direction and 40 percent of the effects corresponding to the two directions of motion at right angles to the principal motion considered. In the slope stability analyses, one horizontal motion is considered 100 percent with the remaining two motions considered 40 percent. The resultant horizontal PGA is 0.465 g (for three Plant Complexes). The corresponding 40 percent vertical PGAs are 0.127 g (North and Middle Plant Complexes) and 0.130 g (South Plant Complex). The vertical PGA of 0.130 g is used in all three Plant Complexes as a conservative value representative of the Project Site.

In a pseudo-static slope stability analysis, the ground shaking is performed by applying seismic coefficients in SLOPE/W software. The Federal Highway Administration suggests that a seismic coefficient equal to 50 percent of the design PGA be used (Reference 2.5-324). Thus, the horizontal, vertical seismic accelerations used are:

- Horizontal Direction: 0.233
- Vertical Direction: -0.065 (upward)

2.5.5.2 Design Criteria and Analyses

The slope stability analysis methodology used in the evaluations is based on limit equilibrium analysis. This involves calculating a factor of safety (FS) by comparing the resisting (stabilizing) forces within the mass of the structure to driving (destabilizing) forces. The main destabilizing factor is the self-weight of the slope mass. The FS is the ratio of the resisting forces to driving forces.

A number of limit equilibrium methods have been developed to analyze slope stability. Depending on the complexity of the assumptions made in deriving the FS equations, different methods provide varying levels of accuracy. The Spencer method, considered one of the more robust analytical tools, was used to perform the slope stability analysis.

The slope stability was analyzed using SLOPE/W Version 8.0 for Windows. The computer software is developed by GeoStudio, and the program has been appropriately verified and validated.

Two critical load cases are analyzed for slope stability as follows:

- Steady-state Condition: This analysis considers that the proposed slopes will exist a sufficient length of time after construction to develop hydrostatic conditions. In this analysis, the normal operating pool elevation of El. 725.0 ft. (221.0 m) is used. The phreatic lines through the embankment slope are conservatively considered. A surcharge load of 250 psf is considered under the steady-state loading condition to represent non-heavy-construction traffic loading. This surcharge is applied to the slope crest with a 5-ft distance from the edge.

- Pseudo-static Condition: This analysis considers the stability of the slopes under the ground shaking of a seismic event. This analysis is applicable for locations that do not

include soils that will liquefy or cyclically soften under the design seismic event. For this analysis, the ground shaking is performed by applying a seismic coefficient into SLOPE/W software.

The normal operating pond elevation is at El. 725.0 ft. (221.0 m) and the probable maximum flood (PMF) flooding elevation is at 747.86 ft. (227.95 m). As shown in Figures 2.5-156 through 2.5-165 (cross-section of each slope considered), the naturally formed partially weathered rock extends above the normal operating as well as the PMF elevations. As there is such a negligible effect on the fill slope and given the engineering properties of the partially weathered rock, it is appropriate to forgo evaluations for flood surcharge and rapid drawdown loading conditions.

Because the slopes are located more than 100 ft. (30.5 m) from safety-related structures and non-safety-related with special treatment (NSRST) structures, the acceptance criteria for this structural assessment of slope stability are in general accordance with the required safety factors on the United States Society on Dams (Reference 2.5-325) as follows:

- The calculated static FS under the long-term, drained condition must equal or exceed 1.5.
- The calculated seismic FS using pseudo-static analysis approach must equal or exceed 1.1

Considering the slope and geotechnical characteristics described herein, the minimum FS against failure for fill slopes has been determined by engineering calculations outlined in Table 2.5-86.

2.5.5.3 Boring Logs

Section 2.5.4.5 of this SSAR presents the requirements of the fill material to be used to raise the site.

2.5.5.4 Compacted Fill

Section 2.5.4.5 of this SSAR presents the requirements of the fill material to be used to raise the site.

2.5.5.5 Human Induced Surface Deformation

Human-induced causes of surface deformation, such as dewatering of the natural groundwater levels or anticipated construction activities, are not considered to have a significant impact on the safety of the slopes that are located well away from the safety-related structures.

Table 2.5-1
Scale Area and Range of Distances for Characterization

Scale Area	Required Minimum Radius (km)	Required Minimum Radius (mile)
Site Region	320	200
Site Vicinity	40	25
Site Area	8	5
Site Location	1	0.6

Table 2.5-2
Aggregate Modified Mercalli Intensity (MMI) from the 2011 Mineral, Virginia, and 2020 Sparta, NC, Earthquakes from the U.S. Geological Survey Did You Feel It (DYFI) Database

Event	Location	Zip Code	MMI	Responses
Mineral, Virginia (2011)	Belews Creek, NC	27009	V	9
	Walnut Cove	27052	IV	17
	Stokesdale	27357	IV	11
Sparta, NC (2020)	Belews Creek, NC	27009	III	14
	Walnut Cove	27052	IV	53
	Stokesdale	27357	III	50

Table 2.5-3
Summary of Magnitude Conversions

Magnitude Type	No. Records	No. Magnitudes	Magnitude Range	Notes	Equation (from NUREG-2115, Table 3.3-1)
m_b, m_{bLg}, m_{Lg}, M_N	264	298	2 to 5.9	205 records in the northeast region; 124 magnitudes from GSC	$E[\mathbf{M}] = m_b - 0.316 - 0.118Z_{NE} - 0.192Z_{1997GSC} + 0.280Z_{1982NE}$ $\sigma_{E[\mathbf{M}\|X]}=0.24$
M_L	1,214	1,762	0.8 to 4.2	1,650 records in the northeast region; no magnitudes from GSC	For records in northeastern U.S. (other than GSC) $E[\mathbf{M}] = 0.633 + 0.806(M_C, M_D, \text{or } M_L)$ $\sigma_{E[\mathbf{M}\|X]}=0.27$
M_C	43	43	2.2 to 3.7	43 records in the northeast region	For records in midcontinent U.S. east of longitude 100°W
M_D	1,111	1,112	2 to 3.4	17 records in the northeast region	$E[\mathbf{M}] = 0.869 + 0.762(M_C, M_D, \text{or } M_L)$ $\sigma_{E[\mathbf{M}\|X]}=0.25$
M_S	3	3	4.8 to 5.8		$E[\mathbf{M}] = 2.654 + 0.334M_S + 0.040M_S^2$ $\sigma_{E[\mathbf{M}\|X]}=0.20$

Key: m_b = body-wave magnitude; m_{bLg}, m_{Lg}, and M_N = Lg-wave magnitude; M_L = local magnitude; M_C = coda magnitude; M_D = duration magnitude; M_S = surface-wave magnitude; $\sigma_{E[\mathbf{M}|X]}$ = standard deviation of the magnitude conversion relationship; Z_{NE} = 1 for earthquakes located in the northeast, 0 otherwise; $Z_{1997GSC}$ = 1 for earthquakes recorded by GSC after 1997, 0 otherwise; Z_{1982NE} = 1 for earthquakes in the northeast prior to 1982, 0 otherwise.

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 1 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP00243	1758	3	23	2	58	0.00	37.910	-77.400	0.0	50.0	4.95	1.390	0.371	185	298
TMP00245	1758	4	25	2	30	0.00	38.900	-76.500	0.0	40.0	3.31	1.872	0.512	266	428
TMP00254	1763	10	13	13	0	0.00	40.000	-75.200	0.0	45.0	3.98	1.877	0.513	369	593
TMP00268	1772	4	25	13	0	0.00	39.800	-75.500	0.0	45.0	3.00	1.385	0.369	348	559
TMP00270	1774	2	21	19	0	0.00	37.200	-77.400	0.0	45.0	4.38	1.057	0.152	160	258
TMP00277	1776	1	1	14	0	0.00	39.900	-82.000	0.0	40.0	3.98	1.877	0.513	272	438
TMP00287	1779	2	13	0	0	0.00	40.200	-81.900	0.0	45.0	3.98	1.877	0.513	289	465
TMP00306	1791	1	13	9	0	0.00	37.730	-77.680	0.0	40.0	3.77	1.390	0.371	165	266
TMP00327	1795	2	12	1	0	0.00	37.410	-77.630	0.0	50.0	3.38	1.390	0.371	155	250
TMP00331	1799	4	11	8	20	0.00	33.950	-80.180	0.0	40.0	4.68	1.390	0.371	161	259
TMP00335	1800	11	20	9	45	0.00	40.280	-76.550	0.0	34.0	4.11	1.390	0.371	336	540
TMP00336	1800	11	20	10	5	0.00	40.276	-76.885	0.0	38.0	2.98	1.877	0.513	326	524
TMP00346	1802	8	23	10	0	0.00	37.400	-79.100	0.0	30.0	3.31	1.872	0.512	94	151
TMP00367	1807	5	1	9	0	0.00	37.400	-79.100	0.0	30.0	3.31	1.872	0.512	94	151
TMP00447	1812	2	2	9	30	0.00	37.600	-77.400	0.0	30.0	3.27	1.371	0.363	173	278
TMP00672	1817	12	11	0	0	0.00	35.730	-83.090	0.0	30.0	4.53	1.390	0.371	174	280
TMP00678	1818	8	14	14	36	0.00	36.091	-84.131	0.0	38.0	3.31	1.872	0.512	228	366
TMP00689	1820	8	21	14	35	0.00	40.042	-76.301	0.0	38.0	3.27	1.371	0.363	331	532
TMP00698	1821	5	11	4	0	0.00	39.301	-76.611	0.0	34.0	3.98	1.877	0.513	281	453
TMP00699	1822	5	4	20	30	0.00	40.042	-76.301	0.0	38.0	3.44	1.371	0.363	331	532
TMP00702	1822	11	9	15	30	0.00	39.952	-82.012	0.0	34.0	3.98	1.877	0.513	276	443
TMP00713	1824	7	15	16	20	0.00	39.700	-80.500	0.0	30.0	4.20	1.107	0.206	238	383
TMP00723	1827	5	11	0	0	0.00	36.100	-81.200	0.0	30.0	3.11	1.123	0.220	65	104
TMP00726	1827	8	7	7	0	0.00	38.300	-85.800	0.0	30.0	3.98	1.877	0.513	345	556
TMP00731	1828	3	9	0	0	0.00	37.000	-80.000	0.0	30.0	4.86	1.058	0.153	50	81

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 2 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP00732	1828	3	10	3	0	0.00	38.300	-78.470	0.0	34.0	5.08	1.175	0.260	165	265
TMP00745	1830	3	29	7	0	0.00	39.650	-77.720	0.0	30.0	3.42	1.108	0.207	266	428
TMP00761	1833	8	27	11	0	0.00	37.700	-78.000	0.0	38.0	4.37	1.052	0.146	150	242
TMP00762	1834	2	5	22	30	0.00	39.850	-76.140	0.0	30.0	3.70	1.107	0.206	326	525
TMP00767	1834	11	20	19	40	0.00	38.650	-83.800	0.0	38.0	3.47	1.093	0.193	263	423
TMP00796	1840	4	8	0	0	0.00	41.120	-83.180	0.0	38.0	2.98	1.877	0.513	375	603
TMP00822	1843	6	19	23	0	0.00	40.100	-83.800	0.0	38.0	3.02	1.129	0.225	333	537
TMP00824	1843	8	9	0	0	0.00	35.600	-87.100	0.0	30.0	3.58	1.091	0.191	397	638
TMP00828	1843	10	30	3	0	0.00	38.630	-83.780	0.0	38.0	2.98	1.877	0.513	261	420
TMP00836	1844	11	28	8	0	0.00	35.950	-83.820	0.0	30.0	4.41	1.390	0.371	211	340
TMP00884	1848	4	6	11	0	0.00	39.500	-82.400	0.0	38.0	3.76	1.090	0.190	257	414
TMP00935	1852	2	16	6	0	0.00	39.330	-76.300	0.0	30.0	3.49	1.107	0.206	294	474
TMP00936	1852	4	29	18	0	0.00	37.360	-80.680	0.0	34.0	5.21	1.175	0.260	83	133
TMP00947	1852	8	25	2	40	0.00	33.480	-82.000	0.0	30.0	3.25	1.120	0.218	222	358
TMP00948	1852	9	15	0	0	0.00	41.630	-80.170	0.0	30.0	3.98	1.877	0.513	370	596
TMP00951	1852	10	10	1	0	0.00	33.000	-83.000	0.0	38.0	2.98	1.877	0.513	281	453
TMP00952	1852	11	2	23	35	0.00	37.600	-78.600	0.0	34.0	4.18	1.056	0.151	122	196
TMP00959	1853	5	2	14	20	0.00	38.470	-80.560	0.0	34.0	5.16	1.175	0.260	154	248
TMP00960	1853	5	20	5	10	0.00	32.550	-81.770	0.0	30.0	4.54	1.390	0.371	275	443
TMP00979	1854	1	11	2	0	0.00	39.400	-83.700	0.0	34.0	3.60	1.093	0.193	294	472
TMP00988	1854	2	28	0	0	0.00	37.600	-84.000	0.0	30.0	3.61	1.091	0.191	236	380
TMP00990	1854	3	20	6	15	0.00	32.820	-83.620	0.0	30.0	3.21	1.123	0.220	313	504
TMP00992	1854	7	1	0	0	0.00	39.100	-84.500	0.0	38.0	2.98	1.877	0.513	312	502
TMP01007	1855	2	2	8	0	0.00	37.000	-78.600	0.0	30.0	3.78	1.056	0.151	95	153
TMP01025	1855	6	28	0	18	0.00	39.070	-76.580	0.0	30.0	3.75	1.106	0.205	271	436
TMP01043	1857	1	1	0	0	0.00	38.642	-79.539	0.0	38.0	3.31	1.872	0.512	166	267

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 3 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP01045	1857	2	10	23	30	0.00	40.080	-74.750	0.0	38.0	3.13	1.122	0.219	390	628
TMP01049	1857	3	1	1	40	0.00	41.800	-80.600	0.0	30.0	3.11	1.373	0.364	383	616
TMP01050	1857	3	1	22	45	0.00	33.000	-83.180	0.0	30.0	3.36	1.115	0.213	288	463
TMP01058	1857	12	19	13	50	0.00	32.780	-80.730	0.0	30.0	3.85	1.080	0.179	244	393
TMP01089	1860	1	19	23	0	0.00	33.680	-80.570	0.0	30.0	4.21	1.092	0.192	182	292
TMP01100	1860	10	22	5	0	0.00	34.130	-82.640	0.0	30.0	2.99	1.123	0.220	208	334
TMP01105	1861	1	3	16	30	0.00	35.090	-83.360	0.0	30.0	4.23	1.107	0.206	203	326
TMP01107	1861	1	20	0	0	0.00	40.042	-76.301	0.0	38.0	3.31	1.872	0.512	331	532
TMP01114	1861	8	31	5	0	0.00	35.910	-82.820	0.0	30.0	5.63	1.175	0.260	156	252
TMP01144	1864	12	24	7	0	0.00	35.120	-77.079	0.0	38.0	2.98	1.877	0.513	185	298
TMP01146	1865	1	25	0	0	0.00	40.763	-82.527	0.0	34.0	3.98	1.877	0.513	338	544
TMP01156	1866	9	3	5	0	0.00	39.000	-76.890	0.0	30.0	3.09	1.124	0.221	256	412
TMP01174	1868	2	22	11	0	0.00	36.780	-81.750	0.0	30.0	3.05	1.126	0.223	100	162
TMP01181	1868	10	11	0	0	0.00	36.910	-80.320	0.0	38.0	3.31	1.872	0.512	46	75
TMP01190	1869	2	20	0	0	0.00	38.100	-84.500	0.0	30.0	3.27	1.371	0.363	275	443
TMP01191	1869	3	30	6	45	0.00	38.140	-78.190	0.0	38.0	3.31	1.872	0.512	165	265
TMP01199	1869	6	1	0	0	0.00	39.634	-84.927	0.0	38.0	3.31	1.872	0.512	353	567
TMP01222	1870	11	1	21	55	0.00	42.000	-80.000	0.0	38.0	3.31	1.872	0.512	396	637
TMP01250	1871	10	9	14	40	0.00	39.700	-75.500	0.0	30.0	3.42	1.126	0.223	343	552
TMP01266	1872	6	5	3	0	0.00	37.700	-78.000	0.0	30.0	3.66	1.106	0.205	150	242
TMP01267	1872	6	17	14	30	0.00	33.060	-83.220	0.0	30.0	3.13	1.109	0.208	286	460
TMP01301	1873	10	3	12	45	0.00	37.200	-78.200	0.0	30.0	3.56	1.107	0.206	121	195
TMP01302	1873	10	4	0	0	0.00	33.000	-83.900	0.0	30.0	3.19	1.118	0.216	314	506
TMP01322	1874	3	1	0	0	0.00	35.929	-86.842	0.0	34.0	4.30	1.886	0.515	380	611
TMP01329	1874	5	14	20	30	0.00	37.200	-77.350	0.0	38.0	3.31	1.872	0.512	163	262
TMP01340	1875	4	10	0	0	0.00	35.290	-82.510	0.0	30.0	3.35	1.111	0.210	153	247

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 4 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP01344	1875	6	18	13	43	0.00	40.200	-84.000	0.0	30.0	4.60	1.270	0.316	346	556
TMP01354	1875	11	1	22	30	0.00	33.490	-82.900	0.0	30.0	4.30	1.052	0.145	251	404
TMP01362	1875	12	23	4	45	0.00	37.600	-78.500	0.0	34.0	4.77	1.270	0.316	126	202
TMP01377	1876	6	1	0	0	0.00	40.400	-84.200	0.0	30.0	3.27	1.371	0.363	363	584
TMP01379	1876	8	24	23	0	0.00	32.837	-83.657	0.0	38.0	2.98	1.877	0.513	314	505
TMP01392	1877	1	23	21	0	0.00	38.800	-83.500	0.0	30.0	3.05	1.119	0.217	257	414
TMP01413	1877	9	10	14	59	0.00	40.300	-74.900	0.0	38.0	3.16	1.062	0.158	394	635
TMP01414	1877	10	9	1	0	0.00	35.300	-82.500	13.0	38.0	3.03	1.128	0.224	153	246
TMP01420	1877	11	16	7	38	0.00	35.500	-84.000	0.0	30.0	3.48	1.055	0.149	227	366
TMP01431	1878	5	18	0	0	0.00	35.500	-82.200	0.0	34.0	4.63	1.896	0.517	131	211
TMP01441	1879	3	26	0	30	0.00	39.200	-75.500	0.0	30.0	3.20	1.124	0.221	321	516
TMP01452	1879	10	26	20	0	0.00	34.370	-81.080	0.0	30.0	2.94	1.104	0.203	144	231
TMP01463	1880	3	19	0	0	0.00	39.850	-77.750	0.0	38.0	3.31	1.872	0.512	277	446
TMP01516	1881	9	18	4	0	0.00	33.379	-84.788	0.0	34.0	3.98	1.877	0.513	335	539
TMP01525	1882	2	9	20	0	0.00	40.400	-84.200	0.0	30.0	2.92	1.154	0.245	363	584
TMP01561	1883	1	6	7	30	0.00	41.350	-82.100	0.0	34.0	4.63	1.896	0.517	368	592
TMP01573	1883	3	11	23	57	0.00	39.500	-76.400	0.0	30.0	3.07	1.125	0.222	299	481
TMP01583	1883	7	16	17	30	0.00	35.580	-80.810	0.0	38.0	2.98	1.877	0.513	64	103
TMP01597	1884	1	18	8	0	0.00	34.590	-77.590	0.0	30.0	3.72	1.091	0.191	181	291
TMP01604	1884	3	21	4	30	0.00	32.800	-83.050	0.0	30.0	3.54	1.109	0.208	294	474
TMP01622	1884	8	24	19	45	0.00	36.070	-83.830	0.0	30.0	3.29	1.114	0.212	211	339
TMP01625	1884	9	19	20	14	0.00	40.700	-84.100	0.0	30.0	4.69	1.049	0.141	376	605
TMP01641	1885	1	3	2	12	0.00	39.200	-77.500	0.0	30.0	3.69	1.057	0.152	246	395
TMP01645	1885	1	18	10	30	0.00	41.160	-81.600	0.0	30.0	3.36	1.093	0.193	348	560
TMP01663	1885	8	6	9	0	0.00	36.120	-81.830	0.0	30.0	3.15	1.069	0.167	99	160
TMP01668	1885	10	10	4	35	0.00	37.700	-78.800	0.0	30.0	4.11	1.056	0.151	121	194

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 5 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP01669	1885	10	17	18	20	0.00	33.170	-82.710	0.0	30.0	3.55	1.107	0.206	262	422
TMP01682	1886	2	5	2	0	0.00	35.930	-81.520	0.0	30.0	3.41	1.059	0.155	85	137
TMP01691	1886	5	3	3	0	0.00	39.360	-82.240	0.0	30.0	3.45	1.057	0.152	244	393
TMP01721	1886	8	29	0	0	0.00	38.900	-86.400	0.0	34.0	4.30	1.886	0.515	392	631
TMP01725	1886	9	1	2	51	0.00	33.000	-80.200	0.0	41.0	6.90	1.074	0.173	226	364
TMP01731	1886	9	1	6	0	0.00	33.910	-82.020	0.0	38.0	4.54	1.108	0.207	197	318
TMP01739	1886	9	1	9	45	0.00	34.300	-82.860	0.0	30.0	4.17	1.107	0.206	209	336
TMP01880	1886	9	15	4	0	0.00	32.070	-81.120	0.0	30.0	3.54	1.107	0.206	297	477
TMP01886	1886	9	19	5	0	0.00	32.230	-80.960	0.0	30.0	3.36	1.109	0.208	284	457
TMP01924	1886	9	25	2	0	0.00	36.700	-80.050	0.0	30.0	2.98	1.124	0.221	30	47
TMP01939	1886	9	28	0	21	0.00	40.000	-76.400	0.0	38.0	3.27	1.371	0.363	325	523
TMP01949	1886	9	29	4	0	0.00	40.154	-76.599	0.0	38.0	2.98	1.877	0.513	327	527
TMP02019	1886	10	22	5	0	0.00	34.710	-81.660	0.0	30.0	4.13	1.107	0.206	141	226
TMP02025	1886	10	22	14	45	0.00	33.870	-81.010	0.0	30.0	4.50	1.036	0.122	175	281
TMP02104	1886	11	17	0	0	0.00	34.212	-77.911	0.0	34.0	3.98	1.877	0.513	187	301
TMP02151	1887	1	2	22	30	0.00	39.570	-77.000	0.0	30.0	3.14	1.108	0.207	282	454
TMP02159	1887	1	4	6	0	0.00	33.810	-78.610	0.0	41.0	3.43	1.108	0.207	189	304
TMP02315	1887	8	2	1	0	0.00	34.410	-78.830	0.0	30.0	3.44	1.108	0.207	146	235
TMP02360	1888	1	12	9	55	0.00	34.180	-80.170	0.0	30.0	4.33	1.107	0.206	145	233
TMP02379	1888	2	11	2	0	0.00	41.000	-81.500	0.0	38.0	3.31	1.872	0.512	336	540
TMP02425	1888	9	17	21	30	0.00	33.420	-83.350	0.0	30.0	3.43	1.112	0.211	272	437
TMP02458	1889	3	8	23	40	0.00	40.000	-76.000	0.0	34.0	3.82	1.048	0.140	339	545
TMP02462	1889	3	30	21	30	0.00	38.562	-76.078	0.0	38.0	3.31	1.872	0.512	270	434
TMP02472	1889	7	11	21	47	0.00	32.400	-80.330	0.0	30.0	3.77	1.091	0.191	268	431
TMP02482	1889	8	26	0	0	0.00	35.532	-77.031	0.0	38.0	2.98	1.877	0.513	177	285
TMP02486	1889	9	29	5	0	0.00	35.030	-84.870	0.0	30.0	3.46	1.111	0.210	284	456

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 6 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP02488	1889	10	16	3	0	0.00	35.260	-82.460	0.0	34.0	3.98	1.877	0.513	152	244
TMP02489	1889	10	24	10	0	0.00	34.720	-82.600	0.0	30.0	3.11	1.123	0.220	179	288
TMP02504	1890	9	23	8	20	0.00	34.039	-80.886	0.0	38.0	3.31	1.872	0.512	161	260
TMP02511	1890	12	23	11	0	0.00	35.800	-84.000	0.0	38.0	3.27	1.371	0.363	223	358
TMP02532	1891	8	15	0	0	0.00	39.211	-85.913	0.0	34.0	4.97	1.914	0.521	379	610
TMP02540	1891	10	26	17	55	0.00	33.004	-80.179	0.0	38.0	3.31	1.872	0.512	226	364
TMP02541	1891	11	17	0	0	0.00	36.728	-86.574	0.0	38.0	2.98	1.877	0.513	363	585
TMP02543	1891	12	5	0	0	0.00	39.140	-84.506	0.0	34.0	3.98	1.877	0.513	314	505
TMP02582	1892	12	12	8	4	0.00	35.350	-85.550	0.0	38.0	3.96	1.106	0.205	314	506
TMP02591	1893	1	11	20	0	0.00	38.300	-85.700	0.0	38.0	3.27	1.371	0.363	340	548
TMP02592	1893	1	11	22	15	0.00	39.428	-77.417	0.0	34.0	3.98	1.877	0.513	261	420
TMP02604	1893	4	7	11	0	0.00	33.789	-81.930	0.0	38.0	3.31	1.872	0.512	202	325
TMP02611	1893	6	21	4	5	0.00	32.900	-80.000	0.0	38.0	3.31	1.872	0.512	233	375
TMP02784	1895	8	19	15	0	0.00	38.500	-83.700	0.0	38.0	3.40	1.093	0.193	252	406
TMP02794	1895	10	7	4	30	0.00	35.900	-77.500	0.0	30.0	3.31	1.872	0.512	145	233
TMP39333	1895	11	20	3	0	0.00	39.980	-75.750	0.0	30.0	3.00	1.130	0.226	347	558
TMP02873	1896	11	20	15	0	0.00	39.730	-75.390	0.0	30.0	3.00	1.130	0.226	349	561
TMP02877	1896	12	8	16	55	0.00	39.980	-79.614	0.0	38.0	3.65	1.872	0.512	257	414
TMP02887	1897	2	7	4	30	0.00	39.301	-76.611	0.0	38.0	3.31	1.872	0.512	281	453
TMP02912	1897	5	6	20	45	0.00	33.480	-81.310	0.0	30.0	3.12	1.117	0.215	206	331
TMP02921	1897	5	31	18	58	0.00	37.300	-80.700	0.0	30.0	5.91	1.270	0.316	79	128
TMP02937	1897	9	29	0	0	0.00	34.941	-82.411	0.0	34.0	3.98	1.877	0.513	161	259
TMP02953	1897	12	18	23	45	0.00	37.700	-77.500	0.0	30.0	3.81	1.038	0.125	172	277
TMP02973	1898	6	6	8	0	0.00	38.250	-84.050	0.0	34.0	3.75	1.091	0.191	259	416
TMP02979	1898	6	19	15	0	0.00	36.070	-83.670	0.0	30.0	3.69	1.107	0.206	202	325
TMP02981	1898	7	23	21	30	0.00	36.750	-82.830	0.0	30.0	3.54	1.107	0.206	158	254

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 7 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP03017	1899	10	5	10	15	0.00	35.556	-83.999	0.0	34.0	4.63	1.896	0.517	226	364
TMP03034	1900	4	28	19	7	0.00	39.840	-75.150	0.0	20.0	3.07	1.125	0.222	363	584
TMP03054	1901	5	17	7	0	0.00	38.950	-82.660	0.0	20.0	3.96	1.028	0.107	233	376
TMP03084	1902	5	18	4	0	0.00	37.300	-80.600	0.0	20.0	3.31	1.872	0.512	77	124
TMP03088	1902	5	29	7	30	0.00	35.100	-85.300	0.0	20.0	3.27	1.371	0.363	305	491
TMP03091	1902	6	14	7	0	0.00	40.300	-81.400	0.0	20.0	2.98	1.877	0.513	288	463
TMP03101	1902	10	18	22	0	0.00	35.000	-85.300	0.0	20.0	3.15	1.115	0.213	307	495
TMP03110	1903	1	24	1	0	0.00	32.900	-80.000	0.0	20.0	4.01	1.052	0.145	233	375
TMP03116	1903	3	15	9	0	0.00	34.650	-84.800	0.0	25.0	3.44	1.371	0.363	290	466
TMP03150	1904	3	5	0	30	0.00	35.700	-83.500	0.0	20.0	3.46	1.055	0.149	197	316
TMP03227	1906	4	23	7	12	0.00	40.700	-83.600	0.0	20.0	3.31	1.872	0.512	361	581
TMP03229	1906	5	8	6	58	0.00	39.500	-85.800	0.0	20.0	3.29	1.095	0.195	384	619
TMP03231	1906	5	8	17	41	0.00	38.700	-75.700	0.0	20.0	3.15	1.108	0.207	292	470
TMP03294	1906	12	5	6	0	0.00	38.670	-76.080	0.0	20.0	2.98	1.131	0.227	274	441
TMP39338	1907	1	26	6	0	0.00	37.270	-81.223	0.0	25.0	2.98	1.877	0.513	94	152
TMP03309	1907	2	11	13	22	0.00	37.700	-78.300	0.0	22.0	3.76	1.107	0.206	138	222
TMP03314	1907	4	19	8	30	0.00	32.900	-80.000	0.0	20.0	3.71	1.057	0.152	233	375
TMP03349	1908	8	23	9	30	0.00	37.500	-77.900	0.0	20.0	3.37	1.115	0.213	146	235
TMP03367	1909	1	21	0	0	0.00	39.140	-84.506	0.0	25.0	2.98	1.877	0.513	314	505
TMP03376	1909	4	2	7	25	0.00	39.400	-78.000	0.0	20.0	3.47	1.059	0.155	243	392
TMP03387	1909	9	22	0	0	0.00	38.700	-86.500	0.0	20.0	3.57	1.108	0.207	391	629
TMP03390	1909	10	8	10	0	0.00	34.900	-85.000	0.0	20.0	3.13	1.056	0.151	294	472
TMP03401	1909	12	23	0	0	0.00	38.555	-75.573	0.0	22.0	3.98	1.877	0.513	292	470
TMP03406	1910	2	8	14	0	0.00	38.800	-78.700	0.0	20.0	3.20	1.117	0.215	190	305
TMP03417	1910	5	8	21	10	0.00	37.700	-78.400	0.0	20.0	3.47	1.108	0.207	134	216
TMP03419	1910	6	8	23	0	0.00	34.769	-84.976	0.0	25.0	3.31	1.872	0.512	296	476

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 8 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP03440	1911	4	20	22	0	0.00	35.100	-82.700	0.0	25.0	3.21	1.046	0.137	169	272
TMP03448	1912	1	31	22	5	0.00	31.944	-81.109	0.0	25.0	3.31	1.872	0.512	305	491
TMP03452	1912	6	12	10	30	0.00	32.900	-80.000	0.0	22.0	4.50	1.723	0.477	233	375
TMP03453	1912	6	20	0	0	0.00	32.000	-81.000	0.0	20.0	3.31	1.872	0.512	300	483
TMP03455	1912	8	7	20	0	0.00	37.700	-78.400	0.0	20.0	3.00	1.130	0.226	134	216
TMP03462	1912	10	23	1	15	0.00	32.700	-83.500	0.0	20.0	3.26	1.115	0.213	315	507
TMP03469	1913	1	1	18	28	0.00	34.700	-81.700	0.0	22.0	4.54	1.270	0.316	143	230
TMP03474	1913	3	28	21	50	0.00	36.200	-83.700	0.0	22.0	3.65	1.055	0.149	203	327
TMP03476	1913	4	17	16	30	0.00	35.300	-84.200	0.0	20.0	3.59	1.053	0.147	242	389
TMP03487	1913	11	11	14	0	0.00	38.200	-85.800	0.0	22.0	3.61	1.373	0.364	343	552
TMP03495	1914	1	24	3	24	0.00	35.600	-84.500	0.0	20.0	3.43	1.094	0.194	253	407
TMP03504	1914	3	5	20	5	0.00	33.500	-83.500	0.0	25.0	4.43	1.052	0.146	273	440
TMP03515	1914	9	22	7	4	0.00	32.900	-80.000	0.0	20.0	4.09	1.038	0.125	233	375
TMP03543	1915	10	29	5	23	0.00	35.800	-82.700	0.0	20.0	2.94	1.135	0.230	151	243
TMP03555	1916	2	21	22	39	0.00	35.500	-82.500	0.0	20.0	5.13	1.270	0.316	147	236
TMP03574	1916	8	26	19	36	0.00	36.000	-81.000	0.0	20.0	3.55	1.058	0.154	56	90
TMP03577	1916	10	18	22	3	40.00	33.500	-86.200	0.0	22.0	4.98	1.270	0.316	397	639
TMP39345	1917	3	27	20	0	0.00	36.100	-83.500	0.0	20.0	3.33	1.083	0.183	192	310
TMP03631	1918	1	16	15	45	0.00	35.900	-83.900	0.0	20.0	3.27	1.100	0.200	216	348
TMP03635	1918	4	10	2	9	0.00	38.700	-78.400	0.0	20.0	4.41	1.107	0.206	191	307
TMP03639	1918	4	19	16	55	0.00	36.800	-76.300	0.0	28.0	3.14	1.116	0.214	212	341
TMP03641	1918	6	22	1	0	0.00	36.100	-84.100	0.0	20.0	3.48	1.054	0.148	226	363
TMP03675	1919	9	6	2	46	0.00	38.800	-78.200	0.0	20.0	3.98	1.877	0.513	202	325
TMP03697	1920	12	24	7	30	0.00	36.000	-85.000	0.0	20.0	3.30	1.118	0.216	276	445
TMP03703	1921	1	26	23	40	0.00	40.010	-74.910	0.0	25.0	3.03	1.074	0.173	380	612
TMP03723	1921	7	15	0	0	0.00	36.600	-82.300	0.0	20.0	3.93	1.371	0.363	127	204

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 9 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP03440	1911	4	20	22	0	0.00	35.100	-82.700	0.0	25.0	3.21	1.046	0.137	169	272
TMP03448	1912	1	31	22	5	0.00	31.944	-81.109	0.0	25.0	3.31	1.872	0.512	305	491
TMP03452	1912	6	12	10	30	0.00	32.900	-80.000	0.0	22.0	4.50	1.723	0.477	233	375
TMP03453	1912	6	20	0	0	0.00	32.000	-81.000	0.0	20.0	3.31	1.872	0.512	300	483
TMP03455	1912	8	7	20	0	0.00	37.700	-78.400	0.0	20.0	3.00	1.130	0.226	134	216
TMP03462	1912	10	23	1	15	0.00	32.700	-83.500	0.0	20.0	3.26	1.115	0.213	315	507
TMP03469	1913	1	1	18	28	0.00	34.700	-81.700	0.0	22.0	4.54	1.270	0.316	143	230
TMP03474	1913	3	28	21	50	0.00	36.200	-83.700	0.0	22.0	3.65	1.055	0.149	203	327
TMP03476	1913	4	17	16	30	0.00	35.300	-84.200	0.0	20.0	3.59	1.053	0.147	242	389
TMP03487	1913	11	11	14	0	0.00	38.200	-85.800	0.0	22.0	3.61	1.373	0.364	343	552
TMP03495	1914	1	24	3	24	0.00	35.600	-84.500	0.0	20.0	3.43	1.094	0.194	253	407
TMP03504	1914	3	5	20	5	0.00	33.500	-83.500	0.0	25.0	4.43	1.052	0.146	273	440
TMP03515	1914	9	22	7	4	0.00	32.900	-80.000	0.0	20.0	4.09	1.038	0.125	233	375
TMP03543	1915	10	29	5	23	0.00	35.800	-82.700	0.0	20.0	2.94	1.135	0.230	151	243
TMP03555	1916	2	21	22	39	0.00	35.500	-82.500	0.0	20.0	5.13	1.270	0.316	147	236
TMP03574	1916	8	26	19	36	0.00	36.000	-81.000	0.0	20.0	3.55	1.058	0.154	56	90
TMP03577	1916	10	18	22	3	40.00	33.500	-86.200	0.0	22.0	4.98	1.270	0.316	397	639
TMP39345	1917	3	27	20	0	0.00	36.100	-83.500	0.0	20.0	3.33	1.083	0.183	192	310
TMP03631	1918	1	16	15	45	0.00	35.900	-83.900	0.0	20.0	3.27	1.100	0.200	216	348
TMP03635	1918	4	10	2	9	0.00	38.700	-78.400	0.0	20.0	4.41	1.107	0.206	191	307
TMP03639	1918	4	19	16	55	0.00	36.800	-76.300	0.0	28.0	3.14	1.116	0.214	212	341
TMP03641	1918	6	22	1	0	0.00	36.100	-84.100	0.0	20.0	3.48	1.054	0.148	226	363
TMP03675	1919	9	6	2	46	0.00	38.800	-78.200	0.0	20.0	3.98	1.877	0.513	202	325
TMP03697	1920	12	24	7	30	0.00	36.000	-85.000	0.0	20.0	3.30	1.118	0.216	276	445
TMP03703	1921	1	26	23	40	0.00	40.010	-74.910	0.0	25.0	3.03	1.074	0.173	380	612
TMP03723	1921	7	15	0	0	0.00	36.600	-82.300	0.0	20.0	3.93	1.371	0.363	127	204

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 10 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP39347	1921	8	7	6	30	0.00	37.800	-78.400	0.0	20.0	3.61	1.110	0.209	140	225
TMP03740	1921	12	15	13	20	0.00	35.800	-84.600	0.0	20.0	3.30	1.118	0.216	256	412
TMP03808	1924	10	20	8	30	0.00	35.000	-82.600	0.0	20.0	4.21	1.039	0.126	168	270
TMP03810	1924	11	13	10	30	0.00	36.600	-82.200	0.0	20.0	2.98	1.877	0.513	121	195
TMP03813	1924	12	26	4	30	0.00	37.300	-79.900	0.0	20.0	3.31	1.872	0.512	71	115
TMP03872	1925	3	27	4	6	0.00	39.500	-83.900	0.0	20.0	3.31	1.872	0.512	306	492
TMP03890	1925	5	16	1	30	0.00	37.300	-77.500	0.0	20.0	3.31	1.872	0.512	158	255
TMP03952	1926	7	8	9	50	0.00	35.900	-82.100	0.0	22.0	3.23	1.152	0.243	117	188
TMP03966	1926	11	5	14	53	0.00	39.100	-82.100	0.0	20.0	4.76	1.375	0.365	225	362
TMP04012	1927	6	10	7	16	0.00	38.000	-79.000	0.0	20.0	3.49	1.110	0.209	133	214
TMP04013	1927	6	16	12	0	0.00	34.700	-86.000	0.0	20.0	3.41	1.061	0.157	352	566
TMP04019	1927	10	8	4	30	0.00	35.100	-85.300	0.0	20.0	3.01	1.122	0.219	305	491
TMP04026	1927	10	29	0	0	0.00	40.900	-81.200	0.0	20.0	3.31	1.872	0.512	326	524
TMP04044	1928	3	7	2	45	0.00	35.600	-87.000	0.0	20.0	2.99	1.097	0.197	391	629
TMP04089	1928	10	30	11	45	0.00	37.500	-77.500	0.0	20.0	3.41	1.109	0.208	165	265
TMP04091	1928	11	3	4	2	49.80	36.110	-82.830	0.0	39.0	4.43	1.029	0.109	155	250
TMP04099	1928	11	20	3	45	0.00	35.800	-82.300	0.0	28.0	3.57	1.058	0.154	130	209
TMP04117	1929	3	8	9	6	0.00	40.400	-84.200	0.0	39.0	3.62	1.107	0.206	363	584
TMP04159	1929	12	26	2	56	0.00	38.100	-78.500	0.0	22.0	3.37	1.062	0.159	153	245
TMP04184	1930	6	26	21	45	0.00	40.500	-84.000	0.0	20.0	3.13	1.122	0.219	362	582
TMP04195	1930	8	30	9	28	0.00	35.900	-84.400	0.0	20.0	3.18	1.097	0.197	244	393
TMP04204	1930	9	30	20	40	0.00	40.300	-84.300	0.0	39.0	3.13	1.176	0.260	361	581
TMP04212	1930	10	16	21	50	0.00	36.000	-83.900	0.0	20.0	3.11	1.373	0.364	215	347
TMP04231	1930	12	26	3	0	0.00	34.500	-80.300	0.0	20.0	3.11	1.123	0.220	123	198
TMP04277	1931	9	20	23	4	54.00	40.430	-84.270	5.0	22.0	4.58	1.723	0.477	367	590
TMP04293	1932	1	5	4	5	0.00	37.600	-78.400	0.0	20.0	3.17	1.065	0.162	129	208

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 11 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP04326	1933	1	25	2	0	0.00	40.200	-74.700	0.0	25.0	3.20	1.124	0.221	397	640
TMP04331	1933	2	23	3	20	0.00	40.300	-84.200	0.0	20.0	3.31	1.112	0.211	358	575
TMP04338	1933	5	28	15	10	0.00	38.600	-83.700	0.0	20.0	3.22	1.103	0.202	257	413
TMP04359	1933	12	23	9	40	0.00	32.900	-80.000	0.0	20.0	3.31	1.872	0.512	233	375
TMP04396	1934	10	29	20	7	0.00	42.000	-80.200	0.0	20.0	3.07	1.135	0.230	396	637
TMP04404	1935	1	1	8	15	0.00	35.100	-83.600	0.0	39.0	3.59	1.040	0.128	215	346
TMP04495	1936	1	1	8	0	0.00	35.100	-84.000	0.0	25.0	3.20	1.114	0.212	236	379
TMP04537	1936	10	8	16	30	0.00	39.300	-84.400	0.0	20.0	2.99	1.123	0.220	316	509
TMP04555	1937	2	3	1	26	0.00	37.700	-78.700	0.0	20.0	3.55	1.107	0.206	124	199
TMP04560	1937	3	9	5	44	35.50	40.400	-84.200	3.0	17.0	5.11	1.270	0.316	363	584
TMP04569	1937	4	23	17	15	0.00	40.700	-84.000	0.0	20.0	2.91	1.073	0.172	373	600
TMP04603	1937	12	3	12	15	0.00	38.700	-75.500	0.0	20.0	2.98	1.877	0.513	301	484
TMP04616	1938	3	31	10	10	0.00	35.600	-83.500	0.0	20.0	3.59	1.091	0.191	198	319
TMP04635	1938	7	15	22	46	12.00	40.680	-78.430	1.0	20.0	3.09	1.045	0.135	317	510
TMP04753	1939	3	18	13	3	0.00	40.400	-84.100	0.0	25.0	2.93	1.128	0.224	360	579
TMP04764	1939	5	5	2	45	0.00	33.700	-85.800	0.0	20.0	3.25	1.120	0.218	370	596
TMP04785	1939	6	24	10	27	0.00	34.700	-86.600	0.0	20.0	3.27	1.063	0.160	384	618
TMP04814	1939	11	15	2	53	48.70	39.580	-75.050	3.0	39.0	3.50	1.040	0.128	356	573
TMP04815	1939	11	18	2	33	0.00	39.500	-76.600	0.0	20.0	3.11	1.123	0.220	292	470
TMP04835	1940	3	25	21	0	0.00	38.800	-78.500	0.0	20.0	2.94	1.164	0.252	194	313
TMP04876	1940	10	19	5	54	0.00	34.700	-85.100	0.0	20.0	3.27	1.054	0.148	304	489
TMP04889	1940	12	25	6	50	0.00	35.900	-82.900	0.0	20.0	3.45	1.060	0.156	161	259
TMP04930	1941	9	8	9	45	0.00	35.000	-85.300	0.0	20.0	3.03	1.068	0.166	307	495
TMP04980	1942	10	7	2	15	0.00	37.600	-78.400	0.0	20.0	3.26	1.115	0.213	129	208
TMP04999	1943	3	9	3	25	24.90	41.630	-81.310	7.0	17.0	4.31	1.019	0.089	376	605
TMP05028	1944	1	8	0	0	0.00	39.800	-75.500	0.0	20.0	3.31	1.872	0.512	348	559

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 12 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP05033	1944	2	5	16	22	0.00	40.800	-76.200	0.0	39.0	3.61	1.198	0.275	376	605
TMP05105	1944	11	13	11	52	0.00	40.400	-84.400	0.0	20.0	3.71	1.107	0.206	370	595
TMP05142	1945	6	14	3	25	0.00	35.000	-84.500	0.0	20.0	3.57	1.058	0.153	265	426
TMP05148	1945	7	26	10	32	16.40	33.750	-81.380	5.0	39.0	4.52	1.033	0.117	190	305
TMP05238	1947	12	27	19	0	0.00	35.000	-85.300	0.0	20.0	3.21	1.117	0.215	307	495
TMP05243	1948	1	4	23	0	0.00	37.600	-78.600	0.0	20.0	3.29	1.114	0.212	122	196
TMP05256	1948	2	10	0	4	0.00	36.400	-84.100	0.0	20.0	3.53	1.088	0.188	225	362
TMP05297	1949	5	8	11	1	0.00	37.600	-77.600	0.0	20.0	3.49	1.110	0.209	164	263
TMP05310	1949	9	17	9	30	0.00	36.700	-83.000	0.0	20.0	3.10	1.123	0.220	166	267
TMP05331	1950	6	19	4	19	0.00	35.800	-84.000	0.0	20.0	3.62	1.052	0.146	223	358
TMP05341	1950	11	26	7	45	0.00	37.700	-78.300	0.0	20.0	3.28	1.119	0.217	138	222
TMP05346	1951	3	9	7	0	0.00	37.600	-77.600	0.0	20.0	3.31	1.872	0.512	164	263
TMP05414	1952	6	11	20	20	0.00	36.300	-82.300	0.0	20.0	3.27	1.371	0.363	125	201
TMP05416	1952	6	20	9	38	8.60	39.640	-82.020	9.0	17.0	3.76	1.057	0.152	256	412
TMP05429	1952	9	11	3	15	0.00	38.100	-78.500	0.0	25.0	3.01	1.130	0.226	153	245
TMP05444	1952	11	19	0	0	0.00	32.900	-80.000	0.0	20.0	3.05	1.137	0.232	233	375
TMP05457	1953	2	7	7	5	0.00	37.700	-78.100	0.0	20.0	3.29	1.114	0.212	146	235
TMP05488	1953	11	10	15	45	0.00	36.000	-83.900	0.0	20.0	2.94	1.136	0.231	215	347
TMP05495	1954	1	2	3	25	0.00	36.600	-83.700	0.0	28.0	4.12	1.038	0.125	204	328
TMP05496	1954	1	7	7	25	0.00	40.300	-76.000	0.0	20.0	3.45	1.055	0.149	355	571
TMP05523	1954	1	23	1	0	0.00	35.300	-84.400	0.0	20.0	3.05	1.116	0.214	253	406
TMP05571	1955	1	6	20	30	0.00	36.600	-82.200	0.0	20.0	3.30	1.114	0.212	121	195
TMP05575	1955	1	17	12	37	0.00	37.300	-78.400	0.0	20.0	3.34	1.111	0.210	116	187
TMP05582	1955	1	25	19	34	0.00	36.000	-83.900	0.0	20.0	3.23	1.103	0.202	215	347
TMP05604	1955	5	26	18	9	0.00	41.300	-81.400	0.0	20.0	3.14	1.063	0.160	355	571
TMP05618	1955	9	28	7	1	41.50	36.600	-81.300	0.0	28.0	3.48	1.055	0.150	73	117

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 13 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP05640	1956	1	27	11	3	27.00	40.500	-84.000	0.0	20.0	3.52	1.092	0.192	362	582
TMP05669	1956	9	7	13	35	50.80	36.440	-83.790	5.0	39.0	3.88	1.056	0.151	208	335
TMP05670	1956	9	7	13	49	29.00	35.500	-84.000	0.0	17.0	3.88	1.052	0.145	227	366
TMP05710	1957	5	13	14	24	51.10	35.800	-82.140	5.0	39.0	3.79	1.057	0.152	121	195
TMP05712	1957	6	23	6	34	16.00	35.950	-84.100	5.0	39.0	3.20	1.124	0.221	227	365
TMP05714	1957	7	2	9	33	1.00	35.600	-82.700	0.0	22.0	3.63	1.040	0.128	155	250
TMP05731	1957	11	24	20	6	17.00	35.000	-83.500	0.0	39.0	3.63	1.052	0.146	212	342
TMP05747	1958	3	5	11	53	43.00	34.200	-77.800	0.0	20.0	3.28	1.118	0.216	192	308
TMP05782	1958	10	20	6	16	0.00	34.500	-82.700	0.0	20.0	3.31	1.872	0.512	193	310
TMP05804	1959	4	23	20	58	39.50	37.390	-80.680	1.0	17.0	3.51	1.041	0.129	85	136
TMP05813	1959	7	7	23	17	0.00	37.300	-80.700	0.0	28.0	3.05	1.126	0.223	79	128
TMP05816	1959	8	3	6	8	36.80	33.050	-80.130	1.0	39.0	4.13	1.039	0.126	223	358
TMP05817	1959	8	12	18	6	1.40	34.790	-86.560	5.0	39.0	3.61	1.058	0.154	380	611
TMP05829	1959	10	27	2	7	28.00	34.500	-80.200	0.0	22.0	3.60	1.058	0.154	123	198
TMP05833	1960	1	3	7	30	0.00	35.900	-82.100	0.0	25.0	3.07	1.125	0.222	117	188
TMP05839	1960	2	9	14	0	6.00	35.300	-82.500	0.0	20.0	2.92	1.153	0.244	153	246
TMP05840	1960	3	12	12	47	44.00	33.070	-80.120	9.0	39.0	3.71	1.040	0.128	221	356
TMP05844	1960	4	15	10	10	10.00	35.800	-84.000	0.0	28.0	3.37	1.062	0.158	223	358
TMP05867	1961	2	22	9	45	3.00	41.200	-83.300	0.0	20.0	3.62	1.107	0.206	383	616
TMP05988	1963	1	17	11	40	26.80	37.300	-80.100	0.0	20.0	3.36	1.040	0.128	71	114
TMP06026	1963	5	4	21	1	50.30	32.970	-80.190	5.0	39.0	3.03	1.124	0.221	228	367
TMP06065	1963	10	10	14	59	52.30	39.655	-78.197	0.0	17.0	3.33	1.083	0.183	255	410
TMP06076	1963	10	28	22	38	0.30	36.700	-81.000	0.0	20.0	3.48	1.041	0.129	60	97
TMP06093	1964	1	20	13	37	52.00	35.900	-82.300	0.0	20.0	2.91	1.139	0.233	128	206
TMP06102	1964	2	18	9	31	10.40	34.670	-85.390	15.0	6.0	3.72	1.045	0.135	320	515
TMP06105	1964	3	7	18	2	58.60	33.720	-82.390	5.0	39.0	2.98	1.153	0.244	220	355

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 14 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP06106	1964	3	13	1	20	17.50	33.190	-83.310	1.0	39.0	3.66	1.046	0.137	282	454
TMP06126	1964	4	20	19	4	44.10	33.840	-81.100	3.0	39.0	3.49	1.062	0.158	178	287
TMP06154	1964	5	12	6	45	10.70	40.300	-76.410	1.0	6.0	3.84	1.066	0.164	341	549
TMP06271	1965	4	26	15	26	19.70	37.320	-81.600	5.0	6.0	3.18	1.153	0.244	112	180
TMP06328	1965	9	9	14	42	20.00	34.700	-81.200	0.0	20.0	3.40	1.073	0.172	126	203
TMP06354	1965	10	8	2	17	27.00	40.080	-79.750	0.0	39.0	3.21	1.152	0.243	264	424
TMP06370	1965	11	8	12	58	1.00	33.200	-83.200	0.0	39.0	2.90	1.074	0.173	277	446
TMP06511	1966	5	31	6	18	59.50	37.660	-78.130	2.0	17.0	3.82	1.032	0.114	143	230
TMP06598	1966	8	24	6	0	0.00	35.800	-84.000	0.0	28.0	2.96	1.134	0.229	223	358
TMP06684	1967	4	8	5	40	30.50	39.650	-82.530	1.0	6.0	3.47	1.062	0.158	269	434
TMP06789	1967	10	23	9	4	2.50	32.800	-80.220	19.0	17.0	3.40	1.066	0.164	240	386
TMP06816	1967	12	16	12	23	33.40	37.360	-81.600	2.0	17.0	3.18	1.153	0.244	114	183
TMP06830	1968	3	8	5	38	15.70	37.280	-80.770	8.0	6.0	3.66	1.030	0.112	80	129
TMP06868	1968	9	22	21	41	18.20	34.110	-81.480	1.0	39.0	3.18	1.029	0.110	170	273
TMP06904	1968	12	10	9	12	0.00	39.700	-74.600	0.0	20.0	2.96	1.046	0.137	380	611
TMP06906	1968	12	11	16	0	0.00	38.300	-85.800	0.0	28.0	3.31	1.872	0.512	345	556
TMP06934	1969	5	9	0	0	0.00	33.950	-82.580	0.0	17.0	2.95	1.074	0.173	215	346
TMP06953	1969	7	13	21	51	9.80	36.120	-83.690	1.0	6.0	3.90	1.030	0.111	203	327
TMP07006	1969	11	20	1	0	9.30	37.450	-80.930	5.0	6.0	4.50	1.048	0.140	95	152
TMP07011	1969	12	11	23	44	37.40	37.840	-77.670	1.0	39.0	3.48	1.032	0.114	170	274
TMP07012	1969	12	13	10	19	29.70	35.040	-82.850	6.0	17.0	3.46	1.025	0.101	178	287
TMP07051	1970	7	30	8	48	53.00	36.999	-82.163	7.0	20.0	2.98	1.153	0.244	127	205
TMP07053	1970	7	31	0	31	0.00	37.700	-83.400	0.0	20.0	3.18	1.153	0.244	209	337
TMP07056	1970	8	11	6	14	25.50	38.230	-82.050	10.0	17.0	3.20	1.064	0.161	174	280
TMP07060	1970	9	10	1	41	5.20	36.020	-81.420	1.0	17.0	3.37	1.025	0.102	78	126
TMP07130	1971	5	19	12	54	3.60	33.360	-80.660	1.0	39.0	3.51	1.021	0.094	204	329

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 15 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP07153	1971	7	13	2	3	0.00	36.000	-84.000	0.0	20.0	3.18	1.044	0.134	221	355
TMP07154	1971	7	13	3	3	0.00	36.000	-84.300	0.0	20.0	3.34	1.111	0.210	238	382
TMP07159	1971	7	13	11	42	26.00	34.800	-83.000	0.0	17.0	3.63	1.018	0.087	194	313
TMP07165	1971	7	31	20	16	55.00	33.340	-80.630	4.0	39.0	3.63	1.034	0.118	205	330
TMP07179	1971	9	12	0	6	27.60	38.150	-77.590	5.0	39.0	3.38	1.033	0.116	188	302
TMP07200	1971	10	22	21	55	0.00	36.000	-83.000	0.0	20.0	2.98	1.153	0.244	165	266
TMP07229	1972	1	9	23	24	29.00	37.400	-81.600	0.0	20.0	3.10	1.074	0.173	116	186
TMP07236	1972	2	3	23	11	9.70	33.310	-80.580	2.0	17.0	4.31	1.055	0.150	207	333
TMP07243	1972	2	11	0	16	0.30	39.700	-75.600	0.0	20.0	3.21	1.123	0.220	339	545
TMP07259	1972	5	20	19	39	6.00	37.000	-82.200	0.0	20.0	3.30	1.079	0.178	129	208
TMP07283	1972	8	14	15	5	19.00	33.200	-81.400	0.0	28.0	3.28	1.046	0.137	226	363
TMP07289	1972	9	5	16	0	0.00	37.600	-77.700	0.0	6.0	3.30	1.043	0.133	159	256
TMP07316	1972	12	8	3	0	33.30	40.140	-76.240	2.0	6.0	3.33	1.034	0.118	338	544
TMP07350	1973	2	28	8	21	33.20	39.690	-75.430	12.0	17.0	3.77	1.020	0.092	345	555
TMP07369	1973	4	9	23	11	0.00	37.300	-77.700	0.0	20.0	3.38	1.110	0.209	148	239
TMP07436	1973	11	30	7	48	40.50	35.890	-83.990	12.0	6.0	4.01	1.090	0.190	221	356
TMP07500	1974	4	28	14	19	0.00	39.800	-75.600	0.0	8.0	3.28	1.152	0.243	344	553
TMP07510	1974	5	30	21	28	35.30	37.460	-80.540	5.0	6.0	3.55	1.032	0.115	86	139
TMP07514	1974	6	5	0	16	40.20	38.480	-84.750	10.0	17.0	3.29	1.066	0.164	299	482
TMP07565	1974	8	2	8	52	11.10	33.910	-82.530	4.0	6.0	3.91	1.055	0.150	215	346
TMP07647	1974	10	20	15	13	55.60	39.060	-81.610	4.0	17.0	3.43	1.043	0.132	210	339
TMP07652	1974	10	28	11	33	0.00	33.790	-81.920	0.0	28.0	3.00	1.073	0.172	201	324
TMP07658	1974	11	5	3	0	0.00	33.730	-82.220	0.0	28.0	3.35	1.064	0.161	214	345
TMP07679	1974	11	22	5	25	56.70	32.920	-80.160	6.0	6.0	3.91	1.055	0.150	232	373
TMP07767	1975	2	3	10	31	0.00	41.300	-83.200	0.0	28.0	3.21	1.117	0.215	386	622
TMP07779	1975	2	16	23	21	34.40	38.880	-82.350	4.0	6.0	3.42	1.027	0.106	220	353

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 16 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP07827	1975	4	1	21	9	0.00	33.200	-83.200	0.0	8.0	3.89	1.047	0.139	277	446
TMP07840	1975	4	28	5	46	52.60	33.000	-80.220	10.0	6.0	3.12	1.052	0.145	226	364
TMP08058	1975	11	11	8	10	37.60	37.220	-80.890	1.0	17.0	3.20	1.041	0.129	80	129
TMP08078	1975	11	25	15	17	34.80	34.930	-82.900	10.0	6.0	3.21	1.062	0.159	185	297
TMP08160	1976	1	19	6	20	39.60	36.870	-83.860	1.0	6.0	4.00	1.025	0.102	215	346
TMP08183	1976	2	4	19	53	53.00	34.970	-84.700	14.0	6.0	3.37	1.032	0.115	276	444
TMP08330	1976	6	19	5	54	13.40	37.340	-81.600	1.0	17.0	3.29	1.029	0.110	113	182
TMP08400	1976	9	13	18	54	38.00	36.620	-80.770	9.0	17.0	3.74	1.030	0.112	46	75
TMP08527	1976	12	27	6	57	15.20	32.060	-82.500	14.0	17.0	3.48	1.124	0.221	323	520
TMP39451	1977	1	18	18	29	13.68	33.051	-80.212	2.2	15.0	2.99	1.100	0.200	223	359
TMP08673	1977	6	5	0	42	29.70	33.050	-81.410	4.0	6.0	3.03	1.066	0.163	236	379
TMP08697	1977	6	17	15	39	46.90	40.710	-84.710	1.0	39.0	3.07	1.037	0.123	397	638
TMP08741	1977	7	27	22	3	20.80	35.420	-84.410	5.0	2.0	3.38	1.072	0.171	251	404
TMP08774	1977	8	25	4	20	7.00	33.390	-80.690	0.0	4.0	3.11	1.049	0.141	202	326
TMP08897	1977	12	15	7	15	55.00	33.000	-80.290	9.0	15.0	3.11	1.063	0.160	227	365
TMP09000	1978	2	11	5	19	0.20	34.346	-81.349	1.0	8.0	2.93	1.208	0.281	152	244
TMP09059	1978	3	17	18	26	34.80	36.780	-80.740	16.0	4.0	3.00	1.045	0.136	52	83
TMP09145	1978	5	2	1	46	11.80	34.187	-82.738	10.0	6.0	3.13	1.096	0.196	209	336
TMP09261	1978	7	9	7	3	35.60	35.505	-82.798	10.0	17.0	3.00	1.203	0.278	162	261
TMP09269	1978	7	16	6	39	29.70	39.900	-76.220	0.0	8.0	3.30	1.027	0.105	326	525
TMP09354	1978	8	27	10	23	8.00	34.313	-81.337	2.0	8.0	2.93	1.208	0.281	153	247
TMP09434	1978	10	6	19	25	47.40	40.080	-76.150	0.0	17.0	3.34	1.054	0.148	338	544
TMP09614	1979	1	27	23	55	14.95	33.047	-80.173	9.3	15.0	3.08	1.097	0.197	223	359
TMP09822	1979	5	4	12	13	8.90	34.330	-81.950	1.0	8.0	2.93	1.208	0.281	172	276
TMP09965	1979	7	19	10	27	3.90	35.229	-84.825	10.0	4.0	3.08	1.200	0.276	277	446
TMP10004	1979	8	13	5	18	56.80	35.210	-84.360	10.0	1.0	3.63	1.071	0.169	252	406

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 17 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP39373	1979	8	13	5	19	25.20	33.900	-82.540	23.0	6.0	3.99	1.174	0.259	216	347
TMP10034	1979	8	26	1	31	45.00	34.916	-82.956	1.0	22.0	3.64	1.056	0.151	188	303
TMP10050	1979	9	6	20	38	16.30	35.300	-83.240	10.0	8.0	3.31	1.189	0.269	191	307
TMP10054	1979	9	12	6	24	4.00	35.580	-83.910	12.0	2.0	3.20	1.072	0.171	221	355
TMP10103	1979	10	8	8	53	52.80	36.440	-82.080	5.0	17.0	3.61	1.180	0.263	113	182
TMP10104	1979	10	8	23	20	11.00	34.306	-81.344	1.0	8.0	3.16	1.095	0.195	154	248
TMP10151	1979	11	9	21	29	59.80	38.490	-82.810	1.0	6.0	3.49	1.062	0.158	215	346
TMP10183	1979	12	7	5	43	34.90	33.010	-80.160	5.0	1.0	3.12	1.045	0.135	226	363
TMP10303	1980	3	5	17	6	56.50	40.170	-75.070	8.0	17.0	3.16	1.034	0.118	382	614
TMP10337	1980	3	23	21	38	16.20	37.600	-86.760	9.0	17.0	3.17	1.072	0.171	381	614
TMP10453	1980	6	25	18	2	1.60	35.730	-84.030	1.0	2.0	3.03	1.124	0.221	225	363
TMP10504	1980	7	27	18	52	21.40	38.190	-83.890	16.0	6.0	5.01	1.038	0.125	249	401
TMP10506	1980	7	29	1	10	22.70	34.351	-81.364	1.0	8.0	3.31	1.189	0.269	152	244
TMP10566	1980	9	1	5	44	42.20	32.980	-80.190	7.0	1.0	3.18	1.058	0.153	228	366
TMP10851	1981	2	3	14	26	50.00	35.312	-84.539	4.0	1.0	3.00	1.203	0.278	260	418
TMP10865	1981	2	11	13	44	16.40	37.720	-78.440	6.0	1.0	3.35	1.044	0.134	134	216
TMP10940	1981	4	2	6	32	39.10	35.319	-84.524	5.0	1.0	3.00	1.203	0.278	259	417
TMP10960	1981	4	9	7	10	31.20	35.510	-82.050	0.0	1.0	3.28	1.046	0.137	123	199
TMP11061	1981	6	3	20	54	22.40	36.180	-81.670	1.0	8.0	2.91	1.124	0.221	90	145
TMP11310	1981	9	4	17	21	44.50	34.630	-85.170	3.0	15.0	3.16	1.195	0.273	309	498
TMP11484	1982	1	2	2	0	26.20	35.180	-86.430	13.0	1.0	3.07	1.065	0.162	365	588
TMP11596	1982	1	28	4	52	51.90	32.980	-81.390	7.0	3.0	2.97	1.061	0.157	240	386
TMP11606	1982	1	30	12	39	12.90	35.800	-83.960	20.0	15.0	3.00	1.203	0.278	221	355
TMP11676	1982	3	1	3	33	13.60	32.940	-80.140	7.0	3.0	3.04	1.041	0.130	230	371
TMP11787	1982	4	13	13	4	13.30	36.510	-82.040	3.0	15.0	3.16	1.195	0.273	112	180
TMP11825	1982	5	5	11	11	2.60	32.710	-83.470	0.0	17.0	2.93	1.208	0.281	314	505

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 18 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP12002	1982	7	16	14	16	2.90	34.320	-81.550	2.0	17.0	3.09	1.149	0.241	159	256
TMP12114	1982	9	2	21	52	45.50	34.960	-82.900	3.0	8.0	3.16	1.195	0.273	184	296
TMP12122	1982	9	5	10	11	9.40	35.190	-84.510	13.0	25.0	2.96	1.072	0.171	261	420
TMP12170	1982	9	24	21	57	42.50	35.680	-84.240	13.0	25.0	3.28	1.031	0.113	237	382
TMP39919	1982	9	24	22	19	21.50	35.860	-84.460	10.0	15.0	2.93	1.208	0.281	248	398
TMP12279	1982	10	31	3	7	36.70	32.670	-84.870	0.0	2.0	3.02	1.073	0.172	370	596
TMP12312	1982	11	14	10	31	59.10	36.210	-82.880	10.0	15.0	2.93	1.208	0.281	157	253
TMP12357	1982	12	5	11	11	2.60	32.710	-83.470	0.0	8.0	2.93	1.208	0.281	314	505
TMP12510	1983	1	31	23	41	1.40	34.302	-82.394	8.0	2.0	3.08	1.097	0.197	190	305
TMP12633	1983	3	25	2	47	11.10	35.330	-82.460	12.0	25.0	3.21	1.048	0.140	150	241
TMP12796	1983	7	8	19	29	5.90	35.550	-84.150	10.0	25.0	3.14	1.048	0.140	234	377
TMP12879	1983	8	17	14	3	15.00	38.470	-82.770	10.0	2.0	3.49	1.039	0.126	213	342
TMP12900	1983	8	28	22	45	7.40	36.680	-83.820	18.0	1.0	3.00	1.066	0.163	211	340
TMP13026	1983	11	6	9	2	19.80	32.940	-80.160	10.0	1.0	3.50	1.078	0.177	230	371
TMP13080	1983	11	29	19	30	28.10	36.027	-82.653	7.0	15.0	2.93	1.208	0.281	146	235
TMP13291	1984	2	14	20	54	30.90	36.130	-83.740	10.0	1.0	3.57	1.029	0.109	206	331
TMP13442	1984	3	17	23	26	11.40	35.830	-84.050	7.0	1.0	3.24	1.082	0.181	225	362
TMP13487	1984	4	23	1	36	0.00	39.950	-76.370	4.0	2.0	4.05	1.018	0.086	324	521
TMP13680	1984	8	9	2	42	35.80	34.620	-86.300	8.0	1.0	3.29	1.061	0.157	369	595
TMP13693	1984	8	17	18	5	46.90	37.868	-78.324	8.0	1.0	3.88	1.047	0.138	146	235
TMP13717	1984	8	30	16	26	28.40	35.570	-84.340	13.0	15.0	3.26	1.043	0.132	245	394
TMP13790	1984	10	9	11	54	26.90	34.750	-85.200	12.0	1.0	4.20	1.038	0.125	308	495
TMP13826	1984	10	22	18	58	41.70	36.360	-81.680	11.0	1.0	3.18	1.072	0.171	91	146
TMP13872	1984	11	18	20	23	58.10	34.744	-86.600	1.3	31.0	2.93	1.208	0.281	383	616
TMP13931	1984	12	17	18	48	28.20	35.415	-84.309	14.0	15.0	3.00	1.203	0.278	245	395
TMP14236	1985	6	10	12	22	38.30	37.248	-80.485	11.0	1.0	3.03	1.074	0.173	71	115

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 19 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP14282	1985	7	12	18	20	28.40	35.198	-85.156	3.0	1.0	3.16	1.195	0.273	295	476
TMP14583	1985	12	22	0	56	5.00	35.701	-83.720	13.0	5.0	3.38	1.186	0.267	209	336
TMP14623	1986	1	7	1	26	43.30	35.609	-84.762	22.0	5.0	3.35	1.091	0.191	267	430
TMP14699	1986	1	27	6	44	26.80	35.926	-83.636	20.0	5.0	2.93	1.208	0.281	201	324
TMP14710	1986	1	31	16	46	42.30	41.650	-81.162	2.0	2.0	4.65	1.103	0.202	376	605
TMP14740	1986	2	13	11	35	45.30	34.793	-82.907	5.0	2.0	3.32	1.073	0.172	190	306
TMP14815	1986	3	26	16	36	23.90	37.245	-80.494	12.0	1.0	3.11	1.152	0.243	71	115
TMP14850	1986	4	19	7	40	53.00	35.187	-85.510	27.0	5.0	3.16	1.195	0.273	315	507
TMP14908	1986	5	19	23	46	47.00	35.516	-84.529	11.0	5.0	3.00	1.203	0.278	256	412
TMP14989	1986	6	24	19	22	42.00	35.990	-83.931	24.0	5.0	3.08	1.200	0.276	217	349
TMP15024	1986	7	11	14	26	14.80	34.937	-84.987	13.0	22.0	3.65	1.028	0.108	292	470
TMP15027	1986	7	12	8	19	37.90	40.537	-84.371	10.0	2.0	4.37	1.035	0.120	376	605
TMP15079	1986	8	7	12	36	46.00	35.506	-84.561	20.0	5.0	2.94	1.101	0.201	258	415
TMP15118	1986	8	19	20	51	26.00	36.291	-85.020	30.0	5.0	3.08	1.200	0.276	276	445
TMP15186	1986	9	17	9	33	49.40	32.928	-80.152	8.0	2.0	3.03	1.060	0.156	231	372
TMP15251	1986	10	18	8	31	38.80	34.946	-81.172	23.0	5.0	3.09	1.097	0.197	111	179
TMP15373	1986	12	11	14	7	11.50	34.898	-82.880	9.0	2.0	3.16	1.195	0.273	185	298
TMP15524	1987	2	22	10	35	26.50	36.340	-84.186	19.0	5.0	3.00	1.203	0.278	230	370
TMP15581	1987	3	16	13	9	26.80	34.560	-80.948	3.0	5.0	3.23	1.192	0.271	129	207
TMP15601	1987	3	27	7	29	30.40	35.567	-84.229	19.0	22.0	4.03	1.034	0.118	239	384
TMP15813	1987	6	19	1	5	14.10	36.431	-82.619	12.1	1.0	2.93	1.208	0.281	143	230
TMP15870	1987	7	11	0	4	29.40	36.103	-83.817	25.0	25.0	3.53	1.029	0.110	210	338
TMP15878	1987	7	13	5	49	17.43	41.900	-80.770	5.0	25.0	3.61	1.013	0.073	391	629
TMP16034	1987	9	22	17	23	50.10	35.623	-84.311	19.0	25.0	3.24	1.065	0.162	242	390
TMP16085	1987	10	20	22	49	55.90	35.841	-84.444	12.8	25.0	2.93	1.168	0.255	247	397
TMP16104	1987	11	4	20	30	45.80	34.699	-85.265	12.0	5.0	2.93	1.208	0.281	313	503

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 20 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP16141	1987	11	27	18	58	20.80	36.850	-83.092	13.3	1.0	2.98	1.100	0.200	173	279
TMP16201	1987	12	18	23	20	17.40	35.104	-82.970	9.1	1.0	2.93	1.208	0.281	182	294
TMP16239	1988	1	9	0	16	55.40	35.274	-84.188	9.0	5.0	3.08	1.200	0.276	242	389
TMP16272	1988	1	23	1	57	16.30	32.935	-80.157	7.0	1.0	3.34	1.051	0.144	231	371
TMP16314	1988	2	16	15	26	54.50	36.561	-82.304	5.0	1.0	3.32	1.051	0.144	127	204
TMP16691	1988	9	7	2	28	8.60	38.142	-83.834	10.0	1.0	4.14	1.035	0.120	245	394
TMP16778	1988	11	1	16	34	16.30	36.266	-83.714	20.3	5.0	2.93	1.208	0.281	204	328
TMP16937	1989	1	2	16	35	16.20	32.936	-80.158	4.0	1.0	2.93	1.087	0.187	231	371
TMP16943	1989	1	4	9	39	4.00	32.210	-80.740	6.0	4.0	2.91	1.156	0.246	283	456
TMP17295	1989	7	15	0	8	2.60	38.607	-83.569	10.0	2.0	3.21	1.072	0.170	251	404
TMP17406	1989	9	7	5	18	6.20	35.493	-84.436	14.1	5.0	3.08	1.200	0.276	251	404
TMP17629	1990	1	19	17	36	52.70	34.956	-84.907	10.8	5.0	3.00	1.203	0.278	287	462
TMP17636	1990	1	24	18	20	24.40	38.133	-86.434	5.0	1.0	3.92	1.049	0.141	374	601
TMP17705	1990	2	17	16	30	32.00	35.716	-84.230	1.0	5.0	2.93	1.208	0.281	236	381
TMP17777	1990	3	21	9	11	39.40	38.142	-85.650	4.2	1.0	2.93	1.208	0.281	334	537
TMP17935	1990	6	18	10	3	33.40	32.951	-80.158	4.9	1.0	2.94	1.086	0.186	230	370
TMP17970	1990	7	11	18	41	10.70	35.799	-83.991	17.0	5.0	3.08	1.200	0.276	222	358
TMP18002	1990	7	28	11	9	39.00	34.919	-85.008	13.9	5.0	3.08	1.200	0.276	293	472
TMP18041	1990	8	17	21	1	17.90	36.794	-83.340	10.0	1.0	3.54	1.036	0.121	186	299
TMP18086	1990	9	8	0	3	57.40	38.061	-83.731	5.0	2.0	3.34	1.072	0.170	237	381
TMP18110	1990	9	19	21	56	45.00	34.539	-85.491	6.0	5.0	3.08	1.200	0.276	329	529
TMP18191	1990	10	23	1	34	48.20	39.512	-75.506	10.0	2.0	2.99	1.027	0.106	334	538
TMP18376	1991	1	26	3	21	22.60	41.536	-81.453	5.0	2.0	3.35	1.049	0.141	371	598
TMP18409	1991	2	17	17	35	13.90	33.140	-85.772	0.5	6.0	3.08	1.200	0.276	390	628
TMP18460	1991	3	15	6	54	8.20	37.746	-77.916	17.0	1.0	3.55	1.072	0.170	156	251
TMP18517	1991	4	22	1	1	20.20	37.941	-80.207	14.0	2.0	3.40	1.071	0.169	116	186

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 21 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP18590	1991	5	29	2	47	18.90	35.415	-84.292	21.6	5.0	3.08	1.200	0.276	245	394
TMP18720	1991	8	17	17	59	9.20	34.914	-85.483	21.4	5.0	2.93	1.208	0.281	319	513
TMP18723	1991	8	18	22	46	43.87	32.944	-80.140	5.9	5.0	3.06	1.202	0.277	230	370
TMP18769	1991	9	24	7	21	6.40	35.711	-84.095	5.0	25.0	3.09	1.072	0.170	229	369
TMP18824	1991	10	30	14	54	12.60	34.904	-84.713	8.1	5.0	3.23	1.192	0.271	278	448
TMP18951	1992	1	3	4	21	22.20	33.946	-82.465	5.0	25.0	3.48	1.070	0.168	211	339
TMP18959	1992	1	7	11	48	40.10	33.835	-81.945	3.0	2.0	2.93	1.208	0.281	199	321
TMP19066	1992	3	15	6	13	55.20	41.911	-81.245	5.0	2.0	3.19	1.045	0.136	395	635
TMP19290	1992	8	21	16	31	55.10	33.050	-80.116	10.0	22.0	4.06	1.034	0.119	223	358
TMP19475	1993	1	1	5	8	5.30	35.877	-82.090	3.0	1.0	3.16	1.195	0.273	117	188
TMP19499	1993	1	15	2	2	51.80	35.075	-84.974	1.0	25.0	3.23	1.051	0.144	288	464
TMP19660	1993	4	23	17	36	53.90	33.376	-82.853	0.0	4.0	2.93	1.208	0.281	255	411
TMP19852	1993	8	8	9	24	31.10	33.633	-81.595	5.0	1.0	3.14	1.073	0.172	202	325
TMP19945	1993	10	16	6	30	5.30	41.796	-81.280	5.7	2.0	3.31	1.029	0.109	387	623
TMP20103	1994	1	17	4	42	25.60	40.329	-76.023	0.0	2.0	2.93	1.094	0.194	355	572
TMP20209	1994	4	5	22	21	59.00	34.961	-85.493	5.0	25.0	3.29	1.072	0.170	319	513
TMP20313	1994	5	26	4	6	4.50	35.176	-84.500	13.1	1.0	2.93	1.208	0.281	261	419
TMP20393	1994	8	6	19	54	9.90	35.067	-76.751	5.0	10.0	3.61	1.047	0.139	203	327
TMP20636	1995	1	12	21	25	51.00	40.800	-82.680	0.0	2.0	2.98	1.153	0.244	343	553
TMP20648	1995	1	22	8	24	48.70	37.050	-80.789	9.0	2.0	2.92	1.036	0.122	67	108
TMP20712	1995	2	19	12	57	6.00	39.120	-83.470	10.0	2.0	3.55	1.071	0.169	271	436
TMP20756	1995	3	11	21	10	16.00	40.100	-76.400	5.0	2.0	2.94	1.082	0.182	331	532
TMP20769	1995	3	18	22	6	21.00	35.425	-84.922	17.0	1.0	3.35	1.144	0.237	279	449
TMP20844	1995	4	17	13	45	57.80	32.947	-80.068	10.0	22.0	3.64	1.050	0.143	230	370
TMP20952	1995	6	26	0	36	17.00	36.747	-81.452	5.0	4.0	3.29	1.045	0.135	84	135
TMP20969	1995	7	5	14	16	44.40	35.366	-84.212	10.0	3.0	3.54	1.104	0.203	241	388

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 22 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP20974	1995	7	7	21	1	2.80	36.515	-81.873	11.0	2.0	3.03	1.036	0.121	102	165
TMP21206	1995	11	29	18	24	46.00	37.970	-81.350	19.0	2.0	3.16	1.195	0.273	137	221
TMP22251	1997	5	19	19	45	33.60	34.782	-85.444	5.0	25.0	2.98	1.072	0.171	320	515
TMP22378	1997	7	19	17	6	34.30	35.056	-84.808	10.0	25.0	3.46	1.071	0.169	280	450
TMP22404	1997	7	30	12	29	23.30	36.436	-83.509	5.0	25.0	3.70	1.036	0.122	192	310
TMP22595	1997	10	19	18	39	55.10	35.286	-84.753	15.1	22.0	3.15	1.165	0.253	272	438
TMP22991	1998	4	13	9	56	11.30	34.610	-80.466	5.0	2.0	3.78	1.049	0.142	117	189
TMP23098	1998	6	5	2	31	1.90	35.479	-80.821	5.0	1.0	3.29	1.072	0.170	70	112
TMP23124	1998	6	17	8	0	23.40	35.926	-84.405	10.0	25.0	3.38	1.048	0.140	244	393
TMP23127	1998	6	18	5	9	59.50	34.714	-85.194	3.2	5.0	2.93	1.208	0.281	308	496
TMP23201	1998	7	23	23	11	41.90	34.857	-84.947	7.0	5.0	2.93	1.208	0.281	292	470
TMP23346	1998	9	25	19	52	53.20	41.478	-80.411	5.0	2.0	4.55	1.072	0.171	360	580
TMP23395	1998	10	21	5	56	47.20	37.381	-78.367	13.0	1.0	3.47	1.050	0.143	121	194
TMP23570	1999	1	17	18	38	4.70	36.854	-83.691	5.0	1.0	2.96	1.072	0.171	206	331
TMP23742	1999	3	17	3	13	0.40	38.761	-83.832	0.0	12.0	3.00	1.203	0.278	269	433
TMP23787	1999	3	29	14	49	37.80	33.064	-80.140	10.7	1.0	2.99	1.052	0.146	222	357
TMP24585	2000	1	18	22	19	31.90	32.993	-83.214	5.0	25.0	3.38	1.072	0.171	289	465
TMP24812	2000	3	20	10	0	50.20	34.685	-85.362	3.9	5.0	3.00	1.203	0.278	318	512
TMP25320	2000	7	11	14	59	47.50	35.880	-83.810	5.0	25.0	3.12	1.082	0.182	211	340
TMP25626	2000	9	14	16	5	22.00	34.675	-85.296	0.0	5.0	2.93	1.208	0.281	315	507
TMP26201	2001	1	26	3	3	22.20	41.906	-80.788	7.0	2.0	3.86	1.024	0.100	391	630
TMP26409	2001	3	7	17	12	25.00	35.510	-84.810	6.0	25.0	3.09	1.072	0.171	271	437
TMP26482	2001	3	21	23	35	35.00	34.857	-85.439	3.0	25.0	3.16	1.146	0.239	318	512
TMP26588	2001	4	13	16	36	20.70	36.530	-83.340	0.0	1.0	3.16	1.195	0.273	183	295
TMP26813	2001	5	17	6	43	48.50	36.045	-83.838	0.3	5.0	2.93	1.208	0.281	212	340
TMP27286	2001	7	26	5	26	44.70	35.932	-83.575	5.0	1.0	3.12	1.072	0.170	198	318

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 23 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP28136	2001	12	8	1	8	21.50	34.735	-86.245	5.0	2.0	3.68	1.063	0.160	364	586
TMP28213	2001	12	23	5	57	41.72	32.934	-80.149	6.3	5.0	3.05	1.098	0.198	231	371
TMP29201	2002	5	6	22	26	51.50	38.948	-81.889	5.0	4.0	3.00	1.203	0.278	210	338
TMP30287	2002	11	11	23	39	29.72	32.404	-79.936	2.4	2.0	3.98	1.024	0.100	267	430
TMP30430	2002	12	16	5	32	30.80	33.049	-80.184	8.5	5.0	3.13	1.064	0.161	223	359
TMP39403	2003	3	18	6	4	24.20	33.689	-82.888	5.0	2.0	3.19	1.124	0.221	240	386
TMP31104	2003	4	29	8	59	39.00	34.494	-85.629	19.0	22.0	4.57	1.024	0.100	337	542
TMP31138	2003	5	5	16	32	32.70	37.755	-78.072	5.0	12.0	3.53	1.024	0.100	150	241
TMP31284	2003	6	30	19	21	17.20	41.800	-81.200	4.0	2.0	3.22	1.036	0.121	387	622
TMP31316	2003	7	13	20	15	16.90	32.335	-82.144	5.0	2.0	3.16	1.124	0.221	297	478
TMP31599	2003	10	14	10	45	38.60	32.946	-80.177	7.2	5.0	2.94	1.101	0.201	230	370
TMP31784	2003	12	9	20	59	14.10	37.587	-77.903	5.0	2.0	4.33	1.070	0.168	150	241
TMP32103	2004	3	13	17	7	58.00	36.480	-84.030	8.9	3.0	2.93	1.208	0.281	222	356
TMP32131	2004	3	21	18	11	34.20	35.502	-82.053	9.2	5.0	2.93	1.208	0.281	124	199
TMP32994	2004	9	12	13	5	19.10	39.594	-85.796	6.0	2.0	3.81	1.024	0.100	388	624
TMP33025	2004	9	17	15	21	43.60	36.933	-84.004	1.3	2.0	3.60	1.047	0.139	224	360
TMP39406	2004	11	30	23	59	34.20	36.936	-83.893	10.0	2.0	3.16	1.195	0.273	218	350
TMP33590	2004	12	23	6	54	21.00	35.430	-84.200	7.0	2.0	3.04	1.150	0.242	239	385
TMP33796	2005	2	8	11	42	53.00	37.220	-81.930	9.4	2.0	2.93	1.208	0.281	123	197
TMP33857	2005	2	18	14	21	55.90	34.118	-81.112	0.0	2.0	3.13	1.058	0.153	160	258
TMP33974	2005	3	18	1	2	16.00	35.720	-84.160	9.0	2.0	2.91	1.072	0.171	233	374
TMP34061	2005	4	5	20	37	42.60	36.147	-83.693	10.0	3.0	3.08	1.200	0.276	203	327
TMP34101	2005	4	14	15	38	16.00	35.470	-84.090	15.0	1.0	3.00	1.203	0.278	233	374
TMP34631	2005	8	25	3	9	42.00	35.880	-82.800	8.0	1.0	3.63	1.024	0.100	156	250
TMP34800	2005	10	12	6	27	30.00	35.510	-84.540	8.0	1.0	3.54	1.036	0.122	256	413
TMP34865	2005	10	28	21	5	40.30	33.003	-83.094	14.4	1.0	2.93	1.208	0.281	284	458

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 24 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
TMP35348	2006	3	6	10	28	2.00	35.895	-82.359	0.0	4.0	3.20	1.154	0.245	131	211
TMP35592	2006	5	10	12	17	29.00	35.530	-84.400	24.0	25.0	3.16	1.146	0.239	248	400
TMP35729	2006	6	16	0	57	27.70	35.515	-83.229	4.0	1.0	3.17	1.072	0.170	185	298
TMP35756	2006	6	20	20	11	18.50	41.840	-81.230	5.0	2.0	3.53	1.024	0.100	390	627
TMP35930	2006	8	7	8	44	28.00	34.940	-85.460	12.0	1.0	3.08	1.200	0.276	317	510
TMP36157	2006	9	22	11	22	0.20	34.551	-79.583	5.0	12.0	3.35	1.071	0.169	122	196
TMP36410	2006	11	2	17	53	2.11	37.200	-81.920	1.0	2.0	3.98	1.153	0.244	121	195
TMP36586	2006	12	18	8	34	27.00	35.360	-84.350	17.0	25.0	3.35	1.144	0.237	249	400
TMP36651	2007	1	3	23	5	45.00	35.920	-83.950	15.3	2.0	2.98	1.100	0.200	219	352
TMP36949	2007	3	12	23	18	16.41	41.280	-81.380	5.0	25.0	3.20	1.049	0.141	353	568
TMP37341	2007	6	19	18	16	27.00	35.790	-85.360	1.2	2.0	3.50	1.077	0.176	298	480
TMP37480	2007	8	4	10	4	46.00	35.490	-82.090	9.3	2.0	3.00	1.073	0.172	126	203
TMP37784	2007	10	17	20	4	9.74	41.750	-81.420	5.0	25.0	2.94	1.049	0.141	385	620
TMP37804	2007	10	23	5	16	12.00	35.590	-84.100	21.3	2.0	3.00	1.203	0.278	231	372
TMP38741	2008	6	23	23	30	20.00	34.920	-84.840	8.8	2.0	3.12	1.082	0.182	285	458
TMP38997	2008	9	30	1	6	38.55	40.410	-84.310	5.0	2.0	3.05	1.062	0.159	367	591
TMP39088	2008	10	31	16	37	34.00	35.770	-84.000	7.0	25.0	2.97	1.153	0.244	223	359
TMP39202	2008	12	16	12	42	17.47	33.072	-80.187	15.8	2.0	3.16	1.124	0.221	221	356
TMP39207	2008	12	27	5	4	34.60	40.110	-76.400	4.0	25.0	3.34	1.152	0.243	331	533
M9_00003	2009	1	27	11	20	12.69	36.773	-84.131	26.1	0.9	3.31	1.161	0.250	229	368
M9_00019	2009	4	4	20	45	33.67	33.215	-83.202	0.0	2.7	3.23	1.161	0.250	277	445
M9_00026	2009	4	24	13	42	48.16	38.900	-82.299	8.4	1.8	3.49	1.078	0.177	219	353
M9_00033	2009	5	23	1	3	31.27	35.592	-84.156	7.8	0.3	2.93	1.161	0.250	234	377
M9_00035	2009	7	1	13	44	43.38	39.644	-75.483	5.0	1.1	2.96	1.091	0.191	341	549
M9_00052	2009	8	31	14	7	10.23	35.778	-84.124	14.3	0.3	3.38	1.161	0.250	230	370
M9_00080	2010	4	4	9	19	14.01	38.599	-80.916	0.0	1.6	3.08	1.148	0.240	167	270

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 25 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
M9_00082	2010	4	20	9	28	20.04	35.725	-84.001	2.2	0.4	2.98	1.148	0.240	224	360
M9_00100	2010	6	3	12	25	2.93	40.086	-76.974	1.5	0.7	2.97	1.055	0.149	312	502
M9_00103	2010	7	16	9	4	47.80	39.261	-77.410	7.0	1.0	3.42	1.024	0.100	252	406
M9_00112	2010	8	30	16	31	3.25	36.489	-81.725	10.6	1.1	2.93	1.161	0.250	94	151
M9_00144	2011	3	21	22	2	2.28	34.827	-79.830	8.3	3.9	3.08	1.161	0.250	101	162
M9_00177	2011	8	23	17	51	4.25	37.910	-77.936	6.0	1.9	5.72	1.024	0.100	163	262
M9_00184	2011	8	25	5	59	13.76	37.916	-80.215	12.9	2.0	2.93	1.161	0.250	114	183
M9_00241	2011	11	9	16	44	34.39	34.773	-84.982	5.2	0.8	2.93	1.161	0.250	296	476
M9_00343	2012	11	10	17	8	14.28	37.139	-83.054	17.0	0.4	4.19	1.024	0.100	177	284
M9_00378	2013	2	19	19	13	49.75	39.113	-80.382	37.4	2.4	2.92	1.078	0.177	197	317
M9_00433	2013	3	31	14	1	24.03	38.645	-80.833	8.0	1.3	3.43	1.024	0.100	169	273
M9_00556	2013	5	21	19	42	6.44	40.312	-81.243	12.6	0.7	2.93	1.091	0.191	286	461
M9_00689	2013	7	30	6	9	4.85	38.839	-80.909	12.7	1.1	3.00	1.161	0.250	183	295
M9_00739	2013	8	25	19	50	40.32	36.165	-81.664	9.4	0.4	3.08	1.161	0.250	90	145
M9_00879	2013	11	20	17	59	39.82	39.445	-82.205	8.0		3.42	1.074	0.173	249	400
M9_01007	2014	2	15	3	23	38.15	33.817	-82.092	5.2	0.6	4.14	1.024	0.100	205	330
M9_01100	2014	4	13	2	34	0.65	35.449	-84.467	13.9	0.4	3.00	1.161	0.250	253	408
M9_01110	2014	4	21	5	5	7.04	35.555	-84.158	11.7	0.4	3.00	1.161	0.250	235	378
M9_01139	2014	5	22	1	47	15.96	37.530	-78.070	9.9	0.9	3.15	1.024	0.100	140	225
M9_01153	2014	6	8	12	12	4.93	35.530	-85.090	13.8	0.4	3.00	1.161	0.250	286	461
M9_01373	2014	12	15	6	44	16.56	36.059	-81.520	13.2	0.7	3.15	1.161	0.250	83	134
M9_01437	2015	3	8	17	35	1.08	36.670	-84.118	9.1	0.6	2.98	1.161	0.250	227	366
M9_01449	2015	3	14	4	51	28.73	35.453	-83.283	0.1	0.4	2.90	1.161	0.250	189	305
M9_01527	2015	7	1	9	6	46.55	35.102	-85.492	20.2	0.3	2.90	1.161	0.250	316	508
M9_01530	2015	7	21	3	10	45.34	36.459	-83.747	10.5	0.3	2.90	1.161	0.250	206	331
M9_01536	2015	8	20	2	45	41.38	37.998	-84.839	33.6	0.5	3.02	1.161	0.250	289	465

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 26 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
M9_01541	2015	9	10	20	23	53.00	40.027	-81.155	18.0	--	2.96	1.074	0.173	266	428
M9_01545	2015	10	6	2	52	13.10	38.290	-85.257	4.6	0.4	2.99	1.161	0.250	318	512
M9_01553	2015	11	4	11	0	52.07	37.563	-78.431	7.5	0.3	2.90	1.161	0.250	126	204
M9_01568	2015	12	13	10	38	26.09	36.688	-83.731	9.0	0.3	2.91	1.161	0.250	206	332
M9_01585	2016	1	17	19	12	49.05	39.319	-77.828	4.7	0.4	3.08	1.191	0.270	243	391
M9_01707	2016	10	25	2	42	50.48	35.816	-84.094	3.3	0.4	2.93	1.161	0.250	228	367
M9_01733	2016	11	30	11	44	53.38	35.814	-84.080	14.6	--	2.90	1.161	0.250	227	365
M9_01786	2017	4	6	1	49	12.64	33.261	-83.040	11.2	0.4	2.94	1.161	0.250	268	432
M9_01801	2017	5	12	4	31	10.02	37.277	-80.841	4.1	0.3	2.96	1.161	0.250	82	132
M9_01808	2017	5	24	16	24	5.21	39.230	-82.476	10.0	4.6	3.48	1.074	0.173	243	392
M9_01827	2017	6	21	8	1	32.72	38.200	-81.399	16.6	0.6	2.93	1.161	0.250	152	245
M9_01838	2017	7	17	12	44	57.20	36.126	-83.703	9.9	0.3	2.99	1.161	0.250	204	328
M9_01842	2017	7	23	13	22	58.71	35.725	-84.165	22.6	0.3	2.95	1.161	0.250	233	375
M9_01845	2017	8	4	0	40	14.83	35.945	-83.561	10.3	0.2	2.93	1.161	0.250	197	317
M9_01856	2017	8	25	20	16	26.62	35.934	-84.030	10.7	0.2	2.90	1.161	0.250	223	359
M9_01860	2017	9	13	17	33	10.93	37.473	-80.703	17.8	0.3	3.31	1.161	0.250	90	145
M9_01874	2017	10	20	15	38	10.61	34.748	-85.916	5.0	0.4	2.94	1.161	0.250	346	557
M9_01877	2017	10	22	10	48	16.24	35.785	-84.645	24.0	0.3	2.96	1.161	0.250	259	416
M9_01879	2017	10	30	5	39	37.36	36.858	-83.843	3.3	0.6	2.96	1.161	0.250	214	344
M9_01895	2017	11	30	6	16	32.66	36.319	-83.709	18.6	0.4	2.91	1.161	0.250	203	327
M9_01899	2017	11	30	21	47	31.25	39.198	-75.433	9.9	2.5	4.21	1.024	0.100	323	521
M9_01905	2017	12	17	5	8	35.96	38.679	-83.896	13.6	0.4	2.99	1.161	0.250	268	432
M9_01908	2017	12	20	23	55	3.54	34.657	-86.114	8.5	0.3	2.92	1.161	0.250	359	577
M9_01910	2017	12	26	17	15	52.48	35.340	-83.867	9.4	0.2	2.96	1.161	0.250	223	359
M9_01915	2018	1	7	9	53	19.63	34.955	-85.192	10.9	0.1	2.92	1.161	0.250	302	487
M9_01923	2018	1	22	12	7	43.89	36.895	-83.647	25.9	0.6	2.94	1.161	0.250	204	328

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 27 of 28)

ID[a]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
M9_01957	2018	4	25	7	56	16.53	36.026	-83.789	8.2	0.3	2.96	1.161	0.250	209	336
M9_01961	2018	4	29	22	32	8.32	36.297	-83.390	21.2	0.2	3.23	1.161	0.250	186	299
M9_01969	2018	5	24	20	8	50.83	35.863	-84.295	16.0	0.2	2.95	1.161	0.250	238	384
M9_01976	2018	6	10	23	56	36.75	36.267	-81.101	2.1	0.4	2.91	1.161	0.250	58	94
M9_02004	2018	8	29	2	45	6.02	35.397	-84.424	18.5	0.3	2.90	1.161	0.250	252	406
M9_02042	2018	11	23	14	59	55.02	34.436	-85.036	9.5	0.4	2.94	1.161	0.250	308	496
M9_02051	2018	12	12	9	14	43.61	35.612	-84.732	7.9	0.2	4.38	1.024	0.100	265	427
M9_02062	2018	12	16	4	12	2.03	36.038	-83.696	19.7	0.3	3.16	1.161	0.250	204	328
M9_02086	2019	1	15	23	30	48.66	37.232	-73.010	10.0	6.8	4.63	1.024	0.100	396	637
M9_02087	2019	1	16	2	37	55.75	35.486	-86.309	6.5	0.5	2.98	1.161	0.250	354	570
M9_02109	2019	3	5	20	56	2.39	36.296	-83.736	17.1	0.3	3.44	1.161	0.250	205	330
M9_02185	2019	6	10	14	50	45.30	41.680	-81.456	2.0	4.4	3.74	1.024	0.100	381	613
M9_02196	2019	6	13	0	30	57.95	40.422	-77.506	26.7	0.4	3.38	1.024	0.100	318	512
M9_02206	2019	7	17	15	23	28.23	36.391	-83.647	13.1	0.3	3.12	1.161	0.250	200	322
M9_02244	2019	9	15	1	11	8.00	39.918	-76.930	5.0	0.9	2.96	1.024	0.100	304	489
M9_02264	2019	10	12	17	39	52.64	37.139	-84.373	6.2	0.4	2.90	1.161	0.250	246	397
M9_02315	2020	1	20	19	12	11.26	36.431	-84.027	34.8	0.3	3.79	1.024	0.100	221	356
M9_02324	2020	2	3	10	4	11.36	37.929	-78.016	7.9	0.7	2.90	1.161	0.250	160	258
M9_02353	2020	4	25	10	33	49.05	38.708	-82.934	26.9	0.4	3.10	1.161	0.250	231	371
M9_02366	2020	5	10	8	33	14.74	35.141	-85.892	8.4	0.3	3.25	1.161	0.250	337	542
M9_02386	2020	6	27	22	13	28.30	34.859	-85.357	12.0	0.3	2.90	1.161	0.250	313	505
M9_02411	2020	8	9	12	7	37.65	36.474	-81.087	4.1	0.4	5.15	1.024	0.100	59	95
M9_02481	2021	2	12	8	27	31.09	36.065	-82.482	2.9	0.4	3.00	1.161	0.250	136	219
M9_02505	2021	5	26	20	29	38.99	36.472	-84.110	11.8	0.3	3.02	1.161	0.250	226	364
M9_02517	2021	7	2	22	38	15.74	36.592	-84.154	26.3	0.6	2.93	1.084	0.183	229	368
M9_02521	2021	7	15	0	55	47.41	37.240	-80.824	20.4	0.4	2.97	1.161	0.250	79	127

Table 2.5-4
Catalog of Earthquakes with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site
(Sheet 28 of 28)

ID[(a)]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
M9_02537	2021	8	30	13	13	26.55	35.385	-84.430	18.4	0.3	2.99	1.161	0.250	253	406
M9_02545	2021	9	27	16	49	14.62	33.044	-80.162	5.8	0.4	3.02	1.161	0.250	223	359
M9_02556	2021	10	24	17	55	10.73	35.518	-83.962	7.6	0.3	2.94	1.161	0.250	225	362
M9_02583	2021	12	12	17	52	56.07	38.691	-83.582	14.5	0.4	3.19	1.161	0.250	255	411
M9_02587	2021	12	27	19	18	54.19	34.182	-80.720	3.1	0.6	3.16	1.024	0.100	149	240
M9_02600	2022	1	21	4	47	27.77	34.968	-84.713	14.8	0.3	3.11	1.161	0.250	277	445
M9_02643	2022	6	18	8	5	23.72	32.453	-82.141	0.8	0.5	3.91	1.024	0.100	289	466
M9_02673	2022	8	13	10	16	53.26	34.980	-86.619	13.1	0.5	2.90	1.161	0.250	379	610
M9_02713	2022	12	8	3	23	21.42	35.306	-82.493	1.5	0.4	2.92	1.161	0.250	152	245
M9_02726	2023	2	17	21	54	5.80	38.939	-82.062	10.8	1.8	3.00	1.161	0.250	214	345
M9_02744	2023	5	20	21	55	32.23	36.383	-83.747	17.3	0.3	3.02	1.161	0.250	206	331
M9_02745	2023	5	23	23	28	54.08	35.576	-82.862	1.3	0.4	2.97	1.161	0.250	164	264
M9_02760	2023	6	24	14	26	54.94	36.124	-83.701	15.4	0.3	2.94	1.161	0.250	203	327
M9_02763	2023	7	6	9	50	51.97	36.716	-80.725	0.1	0.5	2.93	1.161	0.250	48	77
M9_02785	2023	8	28	2	43	26.22	41.731	-80.972	5.0	4.5	3.68	1.024	0.100	380	612
M9_02831	2023	12	9	5	27	26.52	40.432	-84.108	6.8	1.3	2.91	1.024	0.100	362	582
M9_02866	2024	3	30	8	42	40.01	40.897	-81.050	5.9	1.2	2.92	1.080	0.179	324	521

Note:

(a) Record identifier. Records from CEUS SSC catalog (Reference 2.5-60) begin with “TMP,” records updated as part of the SSHAC Level 2 catalog update begin with “M9_”.

Key: “--” = no data; E[**M**] = expected moment magnitude; km = kilometer; mi. = mile

Table 2.5-5
Human-Induced Events with E[M] 2.9 and Larger Located Within 400 Mi. (640 Km) of the Project Site

ID[(a)]	Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	ERH (km)	E[M]	N*	σE[M]	Distance (mi.)	Distance (km)
M9_00199	2011	8	31	9	35	12.41	39.400	-81.270	5.0	-	3.15	1.161	0.250	226	364
M9_00262	2011	12	31	20	5	1.06	41.122	-80.684	5.0	0.5	3.78	1.024	0.100	337	542
M9_01783	2017	4	2	11	58	12.39	39.664	-81.243	3.9	1.1	2.98	1.074	0.173	243	391
M9_02313	2020	1	19	10	19	24.07	36.431	-84.028	33.9	0.4	2.96	1.161	0.250	221	356

Note:

(a) Record identifier. Records from CEUS SSC catalog (Reference 2.5-60) begin with “TMP”, records updated as part of the SSHAC Level 2 catalog update begin with “M9_”.

Key: E[**M**] = expected moment magnitude; km = kilometer; mi. = mile

Table 2.5-6
One-Sided Poisson Test Results Within 200 Mi. (320 Km) of the Project Site

E[M]	Annual Rate		Predicted No. Earthquakes in 15.4 Years	Observed No. Earthquakes		p-value	
				With Human Induced	Without Human Induced	With Human Induced	Without Human Induced
≥2.9	5th%	1.514	23	28	28	18%	18%
	Mean	2.322	36			92%	92%
	95th%	3.388	52			100%	100%
≥3.6	5th%	0.309	5	3	3	85%	85%
	Mean	0.456	7			97%	97%
	95th%	0.676	10			100%	100%
≥4.3	5th%	0.062	1	2	2	24%	24%
	Mean	0.090	1			40%	40%
	95th%	0.132	2			60%	60%
≥5.0	5th%	0.015	0	2	2	2%	2%
	Mean	0.022	0			5%	5%
	95th%	0.033	1			9%	9%
≥5.7	5th%	0.002	0	1	1	3%	3%
	Mean	0.003	0			5%	5%
	95th%	0.005	0			7%	7%

Key: E[**M**] = expected moment magnitude; km = kilometer; mi = mile

Table 2.5-7
One-Sided Poisson Test Results Within 400 Mi. (640 Km) of the Project Site

E[M]	Annual Rate		Predicted No. Earthquakes in 15.4 Years	Observed No. Earthquakes		p-value	
				With Human Induced	Without Human Induced	With Human Induced	Without Human Induced
≥2.9	5th%	3.981	61	102	105	0%	0%
	Mean	6.492	99			41%	30%
	95th%	8.913	136			100%	100%
≥3.6	5th%	0.776	12	11	12	64%	52%
	Mean	1.275	20			99%	97%
	95th%	1.660	25			100%	100%
≥4.3	5th%	0.155	2	4	4	22%	22%
	Mean	0.250	4			53%	53%
	95th%	0.324	5			73%	73%
≥5.0	5th%	0.038	1	2	2	12%	12%
	Mean	0.061	1			24%	24%
	95th%	0.078	1			33%	33%
≥5.7	5th%	0.005	0	1	1	7%	7%
	Mean	0.009	0			13%	13%
	95th%	0.012	0			16%	16%

Key: E[**M**] = expected moment magnitude; km = kilometer; mi = mile

Table 2.5-8
Number of Earthquakes with E[M] ≥ 4.3

Source Zone	E[M] ≥ 4.3 from Earliest Available to 12/31/2008 (CEUS SSC)	M ≥ 4.3 from 1/1/2009 to 4/30/2024 (GCMT, SLU)
Atlantic Highly Extended Crust (AHEX)	3	0
Extended Continental Crust-Atlantic Margin (ECC-AM)	25	1
Extended Continental Crust-Gulf Coast (ECC-GC)	4	4
Gulf Coast Highly Extended (GHEX)	2	0
Great Meteor Hotspot (GMH)	2	1
Illinois Basin Extended Basement (IBEB)	24	0
Mesozoic and Younger Extended Crust-Narrow (MESE-N)	112	7
Mesozoic and Younger Extended Crust-Wide (MESE-W)	156	10
Midcontinent-Craton-A (MIDC-A)	45	46
Midcontinent-Craton-B (MIDC-B)	45	46
Midcontinent-Craton-C (MIDC-C)	43	46
Midcontinent-Craton-D (MIDC-D)	43	46
Northern Appalachian (NAP)	10	0
Non-Extended Crust or Crust Where the Most Recent Extension Occurred Before the Mesozoic-Narrow (NMESE-N)	88	49
Non-Extended Crust or Crust Where the Most Recent Extension Occurred Before the Mesozoic-Wide (NMESE-W)	44	46
Oklahoma Aulacogen (OKA)	1	0
Paleozoic Extended Zone-Narrow (PEZ-N)	18	3
Paleozoic Extended Zone-Wide (PEZ-W)	20	3
Reelfoot Rift (RR)	31	0
Reelfoot Rift with Rough Creek Graben (RR-RCG)	31	0
St. Lawrence Rift (SLR)	37	1
Study Region (STUDY-R)	200	56

Key: CEUS SSC = Central and Eastern United States Seismic Source Characterization; E[**M**] = expected moment magnitude; GCMT= Global Centroid Moment Tensor solution catalog; **M** = observed moment magnitude; SLU= Saint Louis University catalog of moment tensors for parts of North America;

Table 2.5-9
Comparison of the Weights Assigned to Kijko Approach in EPRI, DOE, and NRC (Reference 2.5-60) and Corresponding Weight Obtained with Updated Earthquake Numbers
(Sheet 1 of 2)

Source	EPRI, DOE, and NRC (Reference 2.5-60)		Belews Creek SSHAC Level 2	
	$P\left(m^u > 8\frac{1}{4}\right)$	Weight Assigned to Kijko Approach	$P\left(m^u > 8\frac{1}{4}\right)$	Weight Assigned to Kijko Approach
Study Region (Study-R) (paleo eq)	0.84	0	0.84	0
Mesozoic and Younger Extended Crust-Narrow (MESE-N)	0.44	0.06	0.42	0.08
Mesozoic and Younger Extended Crust-Wide (MESE-W) (paleo eq)	0.83	0	0.83	0
Non-Extended Crust or Crust Where the Most Recent Extension Occurred Before the Mesozoic-Narrow (NMESE-N) (paleo eq)	0.87	0	0.87	0
Non-Extended Crust or Crust Where the Most Recent Extension Occurred Before the Mesozoic-Wide (NMESE-W)	0.27	0.23	0.09	0.41
Atlantic Highly Extended Crust (AHEX)	1.00	0	1.00	0
Extended Continental Crust-Atlantic Margin (ECC-AM)	0.45	0.05	0.85	0
Extended Continental Crust-Gulf Coast (ECC-GC)	0.78	0	0.60	0
Gulf Coast Highly Extended (GHEX)	0.80	0	0.71	0

Table 2.5-9
Comparison of the Weights Assigned to Kijko Approach in EPRI, DOE, and NRC (Reference 2.5-60) and Corresponding Weight Obtained with Updated Earthquake Numbers
(Sheet 2 of 2)

Source	EPRI, DOE, and NRC (Reference 2.5-60)		Belews Creek SSHAC Level 2	
	$P\left(m^u > 8\frac{1}{4}\right)$	Weight Assigned to Kijko Approach	$P\left(m^u > 8\frac{1}{4}\right)$	Weight Assigned to Kijko Approach
Great Meteor Hotspot (GMH)	0.81	0	0.51	0
Illinois Basin Extended Basement (IBEB) (paleo eq)	0.72	0	0.72	0
Midcontinent-Craton-A (MidC-A)	0.26	0.24	0.10	0.4
Midcontinent-Craton-B (MidC-B)	0.26	0.24	0.10	0.4
Midcontinent-Craton-C (MidC-C)	0.26	0.24	0.10	0.4
Midcontinent-Craton-D (MidC-D)	0.26	0.24	0.10	0.4
Northern Appalachian (NAP)	0.58	0	0.58	0
Oklahoma Aulacogen (OKA)	0.69	0	0.69	0
Paleozoic Extended Zone-Narrow (PEZ-N)	0.65	0	0.48	0.02
Paleozoic Extended Zone-Wide (PEZ-W)	0.49	0.01	0.45	0.05
Reelfoot Rift (RR)	0.67	0	0.67	0
Reelfoot Rift with Rough Creek Graben (RR-RCG)	0.43	0.07	0.67	0
St. Lawrence Rift (SLR)	0.48	0.02	0.53	0

Key: DOE = Department of Energy; EPRI = Electric Power Research Institute; NRC = U.S. Nuclear Regulatory Commission; SSHAC = Senior Seismic Hazard Analysis Committee

Table 2.5-10
Comparison of Five-Point Mmax Distributions for Seismic Source Zones
(Sheet 1 of 2)

Weight	Study Region		MESE-N		MESE-W		NMESE-N		NMESE-W	
	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update
0.101	6.5	6.5	6.4	6.4	6.5	6.5	6.4	6.4	5.7	5.7
0.244	6.9	6.8	6.8	6.7	6.9	6.9	6.8	6.7	6.1	5.9
0.31	7.2	7.2	7.2	7.2	7.3	7.3	7.1	7	6.6	6.2
0.244	7.7	7.6	7.7	7.6	7.7	7.7	7.5	7.5	7.2	6.8
0.101	8.1	8.1	8.1	8.1	8.1	8.1	8	8	7.9	7.7
weighted average	7.3	7.2	7.2	7.2	7.3	7.3	7.1	7.1	6.7	6.4
Weight	**AHEX**		**ECC-AM**		**ECC-GC**		**GHEX**		**GMH**	
	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update
0.101	6	6	6	6.2	6	6	6	6	6	5.9
0.244	6.7	6.6	6.7	6.8	6.7	6.6	6.7	6.6	6.7	6.6
0.31	7.2	7.2	7.2	7.2	7.2	7.1	7.2	7.2	7.2	7.1
0.244	7.7	7.6	7.7	7.7	7.7	7.6	7.7	7.6	7.7	7.6
0.101	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
weighted average	7.2	7.1	7.2	7.2	7.2	7.1	7.2	7.1	7.2	7.1
Weight	**IBEB**		**MidC-All**		**NAP**		**OKA**		**PEZ-N**	
	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update
0.101	6.4	6.4	5.6	5.7	6.1	6.1	5.8	5.8	6	5.9
0.244	6.7	6.7	6.1	5.9	6.7	6.6	6.4	6.3	6.5	6.4
0.31	7.1	7.1	6.6	6.2	7.2	7.2	6.9	6.8	6.9	6.9
0.244	7.5	7.5	7.2	6.9	7.7	7.6	7.4	7.3	7.4	7.4
0.101	8	8	7.9	7.7	8.1	8.1	8	7.9	8	8
weighted average	7.1	7.1	6.7	6.4	7.2	7.1	6.9	6.8	6.9	6.9

Table 2.5-10
Comparison of Five-Point Mmax Distributions for Seismic Source Zones
(Sheet 2 of 2)

Weight	PEZ-W		RR		RR-RCG		SLR	
	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update	CEUS SSC	Update
0.101	6	5.9	6.2	6.2	6.1	6.2	6.4	6.4
0.244	6.4	6.4	6.7	6.7	6.6	6.7	6.8	6.8
0.31	6.9	6.9	7.2	7.2	7.1	7.2	7.3	7.2
0.244	7.4	7.4	7.7	7.6	7.6	7.6	7.7	7.7
0.101	8	8	8.1	8.1	8.1	8.1	8.1	8.1
weighted average	6.9	6.9	7.2	7.2	7.1	7.2	7.3	7.2

Key: AHEX = Atlantic Highly Extended Crust; CEUS SSC = Central and Eastern United States Seismic Source Characterization; ECC-AM = Extended Continental Crust-Atlantic Margin; ECC-GC = Extended Continental Crust-Gulf Coast; GHEX = Gulf Coast Highly Extended; GMH = Great Meteor Hotspot; IBEB = Illinois Basin Extended Basement; MESE-N = Mesozoic and younger extended crust-narrow; MESE-W = Mesozoic and younger extended crust-wide; MIDC = Midcontinent-Craton; NAP = Northern Appalachian; NMESE-N= Non-extended crust or crust where the most recent extension occurred before the Mesozoic-Narrow; NMESE-W = Non-extended crust or crust where the most recent extension occurred before the Mesozoic-Wide; OKA = Oklahoma Aulacogen; PEZ-N = Paleozoic Extended Zone-Narrow; PEZ-W = Paleozoic Extended Zone-Wide; RR = Reelfoot Rift; RR-RCG = Reelfoot Rift with Rough Creek Graben; SLR = St. Lawrence Rift

Table 2.5-11
Little River Fault Characterization for Hazard Sensitivity Analysis

Style-of-Faulting	Dip	Magnitude	Annual Frequency
Strike slip	90°	5.7	2.51E-04 (0.101)
			1.55E-04 (0.244)
			1.02E-04 (0.310)
			6.45E-05 (0.244)
			3.24E-05 (0.101)

Table 2.5-12
Data Set of CENA Events with M ≥ 4 Recorded on Stiff Sites at Distance Less than 621 Mi. (1000 Km)
(Sheet 1 of 2)

Event ID[(a)]	Event Name*	Date (Year-Month-Day)	Latitude	Longitude	Mw	Z_{TOR}	Z_{TOR}_source	Number of Recordings on Stiff Sites
2119	Saguenay_1988-11-25	11/25/1988	48.117	-71.184	5.85	21.47	Rea2023	8
2121	LaMalbaie_1997-10-28	10/28/1997	47.672	-69.905	4.29	5	NGA-East simulation	10
2122	CapRouge_1997-11-06	11/6/1997	46.801	-71.424	4.45	20.9	NGA-East simulation	11
2123	CoteNord_1999-03-16	3/16/1999	49.615	-66.344	4.43	16.5	NGA-East simulation	11
2124	Kipawa_2000-01-01	1/1/2000	46.84	-78.925	4.62	12.4	NGA-East simulation	7
2130	AuSableForks_2002-04-20	4/20/2002	44.513	-73.699	4.99	9.1	NGA-East simulation	16
2133	Boyd_2002-11-03	11/3/2002	42.768	-98.896	4.18	7.6	NGA-East simulation	2
2140	Jefferson_2003-12-09	12/9/2003	37.774	-78.1	4.25	9.6	NGA-East simulation	11
2143	PrairieCntr_2004-06-28	6/28/2004	41.435	-88.937	4.18	7.4	NGA-East simulation	10
2146	RiviereDuLoup_2005-03-06	3/6/2005	47.7528	-69.7321	4.65	12.3	Rea2023	41
2174	ValDesBois_2010-06-23	6/23/2010	45.904	-75.497	5.10	17.3	NGA-East simulation	36
2177	MontLaurier_1990-10-19	10/19/1990	46.474	-75.591	4.47	10.8	NGA-East simulation	5

Table 2.5-12
Data Set of CENA Events with M ≥ 4 Recorded on Stiff Sites at Distance Less than 621 Mi. (1000 Km)
(Sheet 2 of 2)

Event ID[(a)]	Event Name*	Date (Year-Month-Day)	Latitude	Longitude	Mw	Z_{TOR}	Z_{TOR}_source	Number of Recordings on Stiff Sites
2184	Nahanni_1985-12-23	12/23/1985	62.187	-124.243	6.76	2	Rea2023	3
2185	Nahanni_1985-12-23a	12/23/1985	62.14	-124.377	5.1	5.3	NGA-East simulation	1
2186	Nahanni_1985-12-25	12/25/1985	62.018	-124.183	5.15	5.3	NGA-East simulation	1
2202	Mineral_2011-08-23	8/23/2011	37.905	-77.975	5.74	5.84	Rea2023	7
2209	Saguenay_1988-11-23	11/23/1988	48.13	-71.2	4.19	27.6	NGA-East simulation	6
2253	20 km NNE of Shawville, Canada	5/17/2013	45.75683	-76.3533	4.7	13.55	Rea2023	30
2286	5 km S of Galesburg, Michigan	5/2/2015	42.2357	-85.4285	4.2	5.03	Rea2023	7
2347	207 km S of Shelburne, Canada	4/12/2012	41.927	-65.762	4.19	18.29	Rea2023	6
2258	4 km SE of Sparta, North Carolina	8/9/2020	36.47433	-81.0865	5.1	4.85	Rea2023	1
2317	53 km SSE of Maliotenam, Canada	9/21/2013	49.7668	-65.9147	4.2	18.59	Rea2023	14
3580	2024 Tewksbury, New Jersey Earthquake	4/5/2024	40.696	-74.76	4.74	1.92	Rea2023	7

Note: (a) as it appears in the database by Reference 2.5-161.

Key: CENA = Central Eastern North America; km = kilometer; mi. = mile; Mw = moment magnitude; NGA = Next Generation Attenuation; Rea= Ramos-Sepúlveda et al., 2024 (Reference 2.5-161); Z_{TOR} = depth to top of rupture

Table 2.5-13
Mixed-Effect Analysis Results of Total Residual Between Observed and Predicted Ground Motions

Period (sec.)	meanR	Smoothed meanR	sigR	dof	t_value	p-value
0	-0.04578	-0.18688	0.145713	27.06826	-0.31419	0.755788
0.01	-0.23642	-0.18688	0.130497	22.45345	-1.81168	0.083433
0.02	-0.28983	-0.18688	0.145704	21.07433	-1.98919	0.059817
0.025	-0.27713	-0.18688	0.153529	22.90211	-1.80505	0.084233
0.03	-0.28449	-0.18688	0.140612	23.40446	-2.02325	0.054613
0.04	-0.1143	-0.18688	0.155487	25.26812	-0.7351	0.469048
0.05	-0.13864	-0.18688	0.147839	29.89792	-0.9378	0.35586
0.075	-0.08024	-0.18688	0.137259	28.09391	-0.58461	0.563478
0.1	-0.14158	-0.18688	0.142867	27.46293	-0.99102	0.330328
0.15	-0.15275	-0.18688	0.156361	31.61444	-0.97689	0.336041
0.2	-0.18567	-0.18688	0.159094	30.43311	-1.16703	0.25226
0.25	-0.19855	-0.17495	0.15958	29.38875	-1.24419	0.223263
0.3	-0.2236	-0.17151	0.168366	28.15567	-1.32805	0.194828
0.4	-0.23315	-0.16273	0.168815	29.26064	-1.3811	0.177707
0.5	-0.25601	-0.15320	0.162603	29.58069	-1.57442	0.126026
0.75	-0.1928	-0.13267	0.143191	29.82567	-1.34645	0.188302
1	-0.12697	-0.11192	0.157273	35.72302	-0.80734	0.424814
1.5	-0.04661	-0.08683	0.131035	25.26368	-0.35573	0.724994
2	-0.11657	-0.06159	0.111606	19.96847	-1.04447	0.308747
3	0.046339	-0.03305	0.132345	16.17743	0.350134	0.730755
4	-0.05606	-0.01244	0.14426	11.93566	-0.38858	0.70443
5	0.037647	0.00569	0.158791	14.22456	0.237083	0.815973
7.5	0.204435	0.03199	0.124827	11.01612	1.637749	0.129694
10	0.165668	0.04683	0.124261	11.10423	1.333225	0.209164

Key: dof = degree of freedom; meanR = mean total residual; p_value = probability of observing the data; sec. = second; sigR = standard error of total residual;; t_value = test statistic measuring the difference between sample and population mean;

Table 2.5-14
Variability in Site Conditions at the North Plant Complex

Location	Average Ground Surface Elevation		Average Rock Elevation		Average Change in Ground Surface Elevation for Cut/Fill		Average Soil Thickness		Ground Surface Elevation Range	
	ft.	m	ft.	m	ft.	m	ft.	m	ft.	m
High GS/Cut	834	254.2	784	238.9	-24	-7.3	26	7.9	828-840	252.3-256.0
Medium GS/Cut	820	249.9	770	234.7	-10	-3.0	40	12.2	810-830	246.9-253.0
Low GS/Fill	795	242.3	745	227.1	+15	+4.6	65	19.8	780-810	237.7-246.9

Key: ft. = foot; m = meter; GS = ground surface

Table 2.5-15
Variability in Site Conditions at the Middle Plant Complex

Location	Average Ground Surface Elevation		Average Rock Elevation		Average Change in Ground Surface Elevation for Cut/Fill		Soil Thickness		Ground Surface Elevation Range	
	ft.	m	ft.	m	ft.	m	ft.	m	ft.	m
High GS/Cut	824	251.2	784	239.0	14	4.3	26	7.9	820-828	249.9-252.4
Medium GS/Cut	819	249.6	779	237.4	9	2.7	31	9.4	810-828	246.9-252.4
Low GS/Fill	794	242.0	754	229.8	16	4.9	56	17.1	779-809	237.4-246.6

Key: ft. = foot; m = meter; GS = ground surface

Table 2.5-16
Variability in Site Conditions at the South Plant Complex

Location	Average Ground Surface Elevation		Average Rock Elevation		Average Change in Ground Surface Elevation for Cut/Fill		Soil Thickness		Ground Surface Elevation Range	
	ft.	m	ft.	m	ft.	m	ft.	m	ft.	m
High GS/Cut	824	251.2	784	239.0	-14	-4.3	26	7.9	820-828	249.9-252.4
Medium GS/Cut	819	249.6	779	237.4	-9	-2.7	31	9.4	810-828	246.9-252.4
Low GS/Fill	794	242.0	754	229.8	+16	+4.9	56	17.1	779-809	237.4-246.6
High GS/Cut	848	258.5	798	243.2	-38	-11.6	12	3.7	844-852	257.3-259.7
Low GS/Fill	770	234.7	720	219.5	+40	-12.2	90	27.4	760-780	231.6-237.7

Key: ft. = foot; m = meter; GS = ground surface

Table 2.5-17
Shear Wave Velocity Profile From Suspension Logging

Layer	Material Type	Top Depth		Thickness		Average V_S	
		ft.	m	ft.	m	ft/s	m/s
1	Residual Soil	0.0	0.0	8.9	2.7	722	220
2	Residual Soil	8.9	2.7	10.2	3.1	945	288
3	Residual Soil	19.1	5.8	9.8	3.0	982	299
4	Residual Soil	28.9	8.8	10.7	3.3	1035	315
5	Residual Soil	39.6	12.1	4.8	1.5	1419	433
6	PWR	44.4	13.5	4.2	1.3	2869	874
7	Rock, Transition	48.6	14.8	5.0	1.5	5096	1553
8	Rock, Transition	53.5	16.3	6.1	1.8	6795	2071
9	Rock	59.6	18.2	8.5	2.6	8794	2680
10	Rock	68.1	20.7	28.4	8.6	9019	2749
11	Rock	96.4	29.4	41.2	12.6	8815	2687
12	Rock	137.6	41.9	48.3	14.7	9171	2795
13	Rock	185.9	56.7	48.7	14.8	9087	2770
14	Rock	234.6	71.5	40.6	12.4	9137	2785
15	Halfspace	275.1	83.9	315.0	96.0	10494	3199

Key: ft. = foot; ft/s = foot per second; m = meter; m/s = meter per second; PWR = partially weathered rock; V_S = shear wave velocity

Table 2.5-18
Shear Wave Velocity Profile From Spectral Analysis of Surface Waves

Layer	Material Type	Top Depth		Thickness		Average V_S	
		ft.	m	ft.	m	ft/s	m/s
1	Residual Soil	0.0	0	6.0	1.8	584	178
2	Residual Soil	6.0	1.8	7.0	2.1	584	178
3	Residual Soil	13.0	3.9	9.0	2.7	893	272
4	Residual Soil	22.0	6.6	10.0	3.0	893	272
5	Residual Soil	32.0	9.6	25.0	7.6	939	286
6	PWR	57.0	17.2	5.0	1.5	2272	693
7	PWR	62.0	18.7	6.0	1.8	2272	693
8	PWR	68.0	20.5	6.0	1.8	2272	693
9	PWR	74.0	22.3	18.0	5.5	2272	693
10	PWR	92.0	27.8	37.0	11.3	2272	693
11	PWR	129.0	39.1	48.0	14.6	2272	693
12	Rock	177.0	53.7	53.0	16.2	7128	2173
13	Rock	230.0	69.9	55.0	16.8	7128	2173
14	Rock	285.0	86.7	55.0	16.8	7128	2173
15	Rock	340.0	103.5	200.0	61.0	7128	2173
16	Halfspace	540.0	164.5	-	-	10494	3199

Key: ft. = foot; ft/s = foot per second; m = meter; m/s = meter per second; PWR = partially weathered rock; V_S = shear wave velocity

Table 2.5-19
List of Recording Stations in North Carolina and Virginia

Network	Station	Locality	Latitude	Longitude	Start Date	End Date
N4	U56A	King, NC	36.347	-80.383	4/24/2013	currently operating
TA	U56A	King, NC	36.347	-80.383	4/24/2013	4/13/2015
TA	U55A	Sparta, NC	36.5023	-81.047	2/21/2013	12/13/2014
TA	U57A	Blanch, NC	36.4319	-79.336	4/21/2013	3/31/2015
N4	V55A	Taylorsville, NC	35.8518	-81.2149	2/17/2013	currently operating
TA	V55A	Taylorsville, NC	35.8518	-81.2149	2/17/2013	12/19/2014
TA	V56A	Mocksville, NC	35.8097	-80.4963	3/24/2013	4/3/2015
TA	V57A	Coltrane Farms, NC	35.8875	-79.7758	3/13/2013	4/3/2015
TA	56A	Rocky Mt., VA	37.0288	-80.0311	3/18/2013	4/12/2015
N4	T57A	Hurt, VA	36.9983	-79.2538	1/13/2013	currently operating
TA	T57A	Hurt, VA	36.9983	-79.2538	1/13/2013	3/18/2015
TA	T58A	Green View Acres, VA	36.9454	-78.5338	3/18/2013	4/13/2015
TA	S58A	Powhatan, VA	37.612	-78.051	4/4/2013	4/24/2015
N4	R58B	Mineral, VA	37.9636	-77.8787	8/2/2012	currently operating
TA	R58B	Mineral, VA	37.9636	-77.8787	8/2/2012	4/28/2015
TA	R58A	Rapidan, VA	38.2989	-78.0034	4/17/2013	4/15/2015

Key: N4 = Central and Eastern U.S. Network; NC = North Carolina; TA = Transportable Array; VA = Virginia

Table 2.5-20
Computed Site Kappa Values

Model	κ_0	Weight
Waveform analysis	0.033	0.3
Campbell (2009) (Reference 2.5-165)	0.010	0.5
Van Houtte et al. (2011) (Reference 2.5-166)	0.040	0.04
Xu et al. (2020) (Reference 2.5-167)	0.020	0.16

Key: κ_0 = site attenuation parameter (kappa)

Table 2.5-21
Site Kappa Values For Use In Site Response Analysis

Logic Tree Branch	κ_0	Weight
10th percentile	0.007	0.3
50th percentile	0.014	0.4
90th percentile	0.035	0.3

Key: κ_0 = site attenuation parameter (kappa)

Table 2.5-22
Site Kappa Values and Corresponding Profile Small-Strain Damping Values

Material Curve/Layer Type	κ_0		
	0.007	**0.014**	**0.035**
	Small-Strain Damping (%)		
Residual Soil	0.1	2.5	10.0
PWR	0.1	1.4	5.6
Rock, V_S<8000 ft/s	0.1	1.3	5.0
Rock, V_S>8000 ft/s	0.1	1.0	3.9

Key: κ_0 = site attenuation parameter (kappa); *D*min = small-strain damping; ft/s = foot per second; PWR = partially weathered rock; V_S = shear wave velocity

Table 2.5-23
Shear Wave Velocity Profile for Fill Materials

Layer	Thickness (ft.)	Shear Wave Velocity (ft/s)	Shear Wave Velocity (m/s)
1	3	1000	305
2	3	1090	332
3	3	1149	350
4	3	1205	367
5	3	1220	372
6	3	1243	379
7	6	1271	387
8	6	1301	397
9	10	1331	406

Key: ft. = foot; ft/s = foot per second; m/s = meter per second

Table 2.5-24
Base Depths And Base Elevations of Proposed Technologies

Technology	Base Depth (ft.)	Base Depth (m)	Base Elevation (ft.)	Base Elevation (m)
1	44	13.4	766	233.5
2	83	25.3	727	221.6
3	86	26.2	724	220.7
4	115	35.1	695	211.8
5	125	38.1	685	208.8

Note: Base depth and base elevations are determined with respect to the final plant grade elevation of 810 ft. (247 m).

Key: ft. = foot; m = meter

Table 2.5-25
Site Response Analysis Cases

Plant Complex	Grading	Control Point Depth
North, Middle, South	Cut – 24 ft.	Surface
North, Middle, South	Cut – 24 ft.	44 ft.
North, Middle, South	Cut – 24 ft.	85 ft.
North, Middle, South	Cut – 24 ft.	Top of PWR
North, Middle, South	Cut – 10 ft.	Surface
North, Middle, South	Cut – 10 ft.	44 ft.
North, Middle, South	Cut – 10 ft.	85 ft.
North, Middle, South	Cut – 10 ft.	Top of PWR
North, Middle, South	Fill – 15 ft.	Surface
North, Middle, South	Fill – 15 ft.	44 ft.
North, Middle, South	Fill – 15 ft.	85 ft.
North, Middle, South	Fill – 15 ft.	Top of PWR
South	Cut – 38 ft.	Surface
South	Cut – 38 ft.	44 ft.
South	Cut – 38 ft.	85 ft.
South	Cut – 38 ft.	Top of PWR
South	Fill – 40 ft.	Surface
South	Fill – 40 ft.	44 ft.
South	Fill – 40 ft.	85 ft.
South	Fill – 40 ft.	115 ft.
South	Fill – 40 ft.	Top of PWR

Key: ft. = foot; PWR = partially weathered rock

Table 2.5-26
Topographic Amplification Scale Factors

Frequency (Hz)	North Plant Complex	Middle Plant Complex	South Plant Complex
0.1	1.000	1.000	1.000
0.133	1.000	1.000	1.000
0.2	1.000	1.000	1.000
0.25	1.000	1.000	1.000
0.333	1.000	1.000	1.000
0.4	1.000	1.000	1.000
0.5	1.001	1.001	1.002
0.667	1.006	1.009	1.005
1	1.014	1.021	1.011
1.333	1.022	1.032	1.017
2	1.030	1.046	1.020
2.5	1.028	1.040	1.021
3.333	1.027	1.034	1.024
4	1.029	1.031	1.027
5	1.028	1.028	1.029
6.667	1.031	1.031	1.032
10	1.034	1.034	1.034
13.333	1.034	1.034	1.034
20	1.034	1.034	1.034
25	1.034	1.034	1.034
33.333	1.034	1.034	1.034
50	1.034	1.034	1.034
100	1.034	1.034	1.034

Key: Hz = hertz

Table 2.5-27
V_{S30} Values For Alternative Velocity Profiles, Site Grading, and Control Points
(Sheet 1 of 2)

Profile	Cut/Fill	Control Point	V_{S30} (m/s)	V_{S30} (ft/s)
PS Profile	Cut 24 ft. (7 m)	Surface	900	2952
PS Profile	Cut 24 ft. (7 m)	44 ft. (13 m)	2736	8975
PS Profile	Cut 24 ft. (7 m)	85 ft. (26 m)	2757	9046
PS Profile	Cut 24 ft. (7 m)	Top of PWR	2366	7762
PS Profile	Cut 10 ft. (3 m)	Surface	672	2203
PS Profile	Cut 10 ft. (3 m)	44 ft. (13 m)	2673	8770
PS Profile	Cut 10 ft. (3 m)	85 ft. (26 m)	2747	9011
PS Profile	Cut 10 ft. (3 m)	Top of PWR	2366	7762
PS Profile	Cut 38 ft. (11.5 m)	Surface	1620	5315
PS Profile	Cut 38 ft. (11.5 m)	44 ft. (13 m)	2742	8996
PS Profile	Cut 38 ft. (11.5 m)	85 ft. (26 m)	2769	9086
PS Profile	Cut 38 ft. (11.5 m)	Top of PWR	2366	7762
PS Profile	Fill 15 ft. (4.5 m)	Surface	516	1694
PS Profile	Fill 15 ft. (4.5 m)	44 ft. (13 m)	1282	4207
PS Profile	Fill 15 ft. (4.5 m)	85 ft. (26 m)	2737	8978
PS Profile	Fill 15 ft. (4.5 m)	Top of PWR	2366	7762
PS Profile	Fill 40 ft. (12 m)	Surface	432	1416
PS Profile	Fill 40 ft. (12 m)	44 ft. (13 m)	774	2539
PS Profile	Fill 40 ft. (12 m)	85 ft. (26 m)	2393	7851
PS Profile	Fill 40 ft. (12 m)	Top of PWR	2366	7762
PS Profile	Fill 40 ft. (12 m)	115 ft. (35 m)	2739	8986
SASW Profile	Cut 24 ft. (7 m)	Surface	436	1431
SASW Profile	Cut 24 ft. (7 m)	44 ft. (13 m)	693	2272
SASW Profile	Cut 24 ft. (7 m)	85 ft. (26 m)	877	2878
SASW Profile	Cut 24 ft. (7 m)	Top of PWR	693	2272
SASW Profile	Cut 10 ft. (3 m)	Surface	378	1240
SASW Profile	Cut 10 ft. (3 m)	44 ft. (13 m)	663	2174

Table 2.5-27
V_{S30} Values For Alternative Velocity Profiles, Site Grading, and Control Points
(Sheet 2 of 2)

Profile	Cut/Fill	Control Point	V_{S30} (m/s)	V_{S30} (ft/s)
SASW Profile	Cut 10 ft. (3 m)	85 ft. (26 m)	781	2563
SASW Profile	Cut 10 ft. (3 m)	Top of PWR	693	2272
SASW Profile	Cut 38 ft. (11.5 m)	Surface	508	1666
SASW Profile	Cut 38 ft. (11.5 m)	44 ft. (13 m)	709	2327
SASW Profile	Cut 38 ft. (11.5 m)	85 ft. (26 m)	1000	3280
SASW Profile	Cut 38 ft. (11.5 m)	Top of PWR	693	2272
SASW Profile	Fill 15 ft. (4.5 m)	Surface	354	1161
SASW Profile	Fill 15 ft. (4.5 m)	44 ft. (13 m)	509	1669
SASW Profile	Fill 15 ft. (4.5 m)	85 ft. (26 m)	693	2272
SASW Profile	Fill 15 ft. (4.5 m)	Top of PWR	693	2272
SASW Profile	Fill 40 ft. (12 m)	Surface	352	1154
SASW Profile	Fill 40 ft. (12 m)	44 ft. (13 m)	441	1446
SASW Profile	Fill 40 ft. (12 m)	85 ft. (26 m)	613	2011
SASW Profile	Fill 40 ft. (12 m)	Top of PWR	693	2272
SASW Profile	Fill 40 ft. (12 m)	115 ft. (35 m)	693	2272

Key: ft = foot; ft/s = foot per second; m = meter; m/s = meter per second; PWR = partially weathered rock; SASW = spectral analysis of surface waves; V_{S30} = time-averaged shear wave velocity to a depth of 30 meters

Table 2.5-28
Vertical-to-Horizontal (V/H) Spectral Ratios for AFE 1E-4, and Control Point at Ground Surface

Ground Surface, AFE 1E-4		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
V_{S30} (m/s)		1620	900	672	432	516	508	436	378	352	354	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.810	0.730	0.700	0.700	0.700	0.700	0.700	0.700	0.710	0.710	0.777	0.721	0.700	0.703	0.703
0.01	100.00	0.830	0.790	0.800	0.850	0.830	0.830	0.850	0.880	0.900	0.890	0.830	0.808	0.824	0.865	0.848
0.02	50.00	0.880	0.880	0.930	1.050	0.990	1.000	1.050	1.110	1.150	1.140	0.916	0.931	0.984	1.080	1.035
0.025	40.00	0.850	0.850	0.900	1.020	0.960	0.960	1.010	1.070	1.110	1.110	0.883	0.898	0.951	1.047	1.005
0.03	33.33	0.820	0.810	0.840	0.950	0.900	0.900	0.940	1.000	1.030	1.030	0.844	0.849	0.888	0.974	0.939
0.04	25.00	0.780	0.730	0.750	0.830	0.790	0.790	0.830	0.870	0.890	0.890	0.783	0.760	0.786	0.848	0.820
0.05	20.00	0.760	0.710	0.710	0.740	0.720	0.720	0.740	0.760	0.770	0.770	0.748	0.719	0.725	0.749	0.735
0.075	13.33	0.740	0.690	0.690	0.730	0.710	0.710	0.730	0.750	0.760	0.760	0.731	0.702	0.708	0.739	0.725
0.1	10.00	0.730	0.680	0.680	0.720	0.700	0.700	0.710	0.730	0.750	0.750	0.721	0.689	0.695	0.729	0.715
0.15	6.67	0.730	0.680	0.680	0.710	0.690	0.690	0.710	0.730	0.740	0.740	0.718	0.689	0.695	0.719	0.705
0.2	5.00	0.740	0.680	0.680	0.710	0.700	0.700	0.710	0.730	0.740	0.740	0.728	0.689	0.695	0.719	0.712
0.25	4.00	0.760	0.700	0.690	0.720	0.710	0.710	0.720	0.740	0.750	0.750	0.745	0.706	0.705	0.729	0.722
0.3	3.33	0.770	0.710	0.700	0.730	0.710	0.710	0.730	0.740	0.750	0.750	0.752	0.716	0.712	0.736	0.722
0.4	2.50	0.780	0.710	0.710	0.730	0.720	0.720	0.730	0.750	0.760	0.760	0.762	0.716	0.722	0.739	0.732
0.5	2.00	0.790	0.720	0.710	0.740	0.720	0.720	0.740	0.750	0.760	0.760	0.769	0.726	0.722	0.746	0.732
0.75	1.33	0.790	0.730	0.720	0.740	0.730	0.730	0.740	0.760	0.770	0.770	0.772	0.733	0.732	0.749	0.742
1	1.00	0.800	0.730	0.730	0.750	0.730	0.740	0.750	0.760	0.780	0.770	0.782	0.736	0.739	0.759	0.742
1.5	0.67	0.790	0.730	0.720	0.750	0.730	0.730	0.750	0.760	0.780	0.770	0.772	0.736	0.732	0.759	0.742
2	0.50	0.760	0.700	0.690	0.720	0.710	0.710	0.720	0.740	0.750	0.750	0.745	0.706	0.705	0.729	0.722
3	0.33	0.740	0.680	0.680	0.710	0.690	0.690	0.710	0.720	0.730	0.730	0.725	0.689	0.692	0.716	0.702
4	0.25	0.740	0.680	0.680	0.710	0.690	0.690	0.700	0.720	0.730	0.730	0.725	0.686	0.692	0.716	0.702
5	0.20	0.740	0.680	0.680	0.710	0.690	0.690	0.700	0.720	0.730	0.730	0.725	0.686	0.692	0.716	0.702
7.5	0.13	0.740	0.680	0.670	0.700	0.690	0.690	0.700	0.720	0.730	0.730	0.725	0.686	0.685	0.709	0.702
10	0.10	0.740	0.680	0.670	0.700	0.690	0.690	0.700	0.720	0.730	0.730	0.725	0.686	0.685	0.709	0.702

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m = meter; m/s = meter per second; P-S = suspension log; sec. = second; SASW = spectral analysis of surface waves; V_{S30} = time-averaged shear wave velocity to a depth of 30 meters

Table 2.5-29
Vertical-to-Horizontal (V/H) Spectral Ratios for AFE 1E-5, and Control Point at Ground Surface

Ground Surface, AFE 1E-5		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
V_{S30} (m/s)		1620	900	672	432	516	508	436	378	352	354	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.810	0.720	0.720	0.780	0.750	0.760	0.780	0.810	0.830	0.820	0.795	0.738	0.747	0.795	0.771
0.01	100.00	0.870	0.830	0.900	1.080	0.990	1.000	1.070	1.160	1.210	1.210	0.909	0.902	0.978	1.119	1.056
0.02	50.00	0.930	0.970	1.110	1.460	1.290	1.300	1.450	1.620	1.730	1.720	1.041	1.114	1.263	1.541	1.419
0.025	40.00	0.900	0.930	1.060	1.420	1.250	1.260	1.410	1.580	1.690	1.680	1.008	1.074	1.216	1.501	1.379
0.03	33.33	0.870	0.880	1.000	1.320	1.160	1.180	1.310	1.480	1.570	1.560	0.963	1.009	1.144	1.395	1.280
0.04	25.00	0.810	0.770	0.860	1.130	1.000	1.010	1.120	1.250	1.330	1.330	0.870	0.875	0.977	1.190	1.099
0.05	20.00	0.800	0.740	0.790	0.960	0.880	0.880	0.960	1.050	1.100	1.090	0.824	0.806	0.868	1.002	0.943
0.075	13.33	0.770	0.720	0.760	0.940	0.850	0.860	0.930	1.020	1.080	1.070	0.797	0.783	0.838	0.982	0.916
0.1	10.00	0.750	0.690	0.740	0.920	0.830	0.840	0.910	1.000	1.060	1.050	0.777	0.756	0.818	0.962	0.896
0.15	6.67	0.740	0.690	0.740	0.910	0.820	0.830	0.910	0.990	1.050	1.040	0.767	0.756	0.815	0.952	0.886
0.2	5.00	0.760	0.700	0.740	0.910	0.830	0.840	0.910	1.000	1.050	1.040	0.784	0.763	0.818	0.952	0.893
0.25	4.00	0.780	0.720	0.760	0.930	0.840	0.850	0.920	1.010	1.060	1.060	0.801	0.780	0.835	0.969	0.906
0.3	3.33	0.800	0.730	0.770	0.940	0.850	0.860	0.930	1.020	1.070	1.070	0.818	0.790	0.845	0.979	0.916
0.4	2.50	0.810	0.740	0.780	0.950	0.860	0.870	0.940	1.030	1.080	1.080	0.828	0.800	0.855	0.989	0.926
0.5	2.00	0.820	0.750	0.790	0.950	0.870	0.880	0.950	1.030	1.080	1.080	0.838	0.810	0.862	0.989	0.933
0.75	1.33	0.830	0.750	0.790	0.960	0.880	0.880	0.950	1.040	1.090	1.090	0.845	0.810	0.865	0.999	0.943
1	1.00	0.830	0.760	0.800	0.960	0.880	0.890	0.960	1.040	1.090	1.090	0.848	0.820	0.872	0.999	0.943
1.5	0.67	0.820	0.750	0.800	0.960	0.880	0.890	0.960	1.040	1.100	1.090	0.841	0.813	0.872	1.002	0.943
2	0.50	0.790	0.720	0.770	0.940	0.850	0.860	0.930	1.020	1.070	1.070	0.811	0.783	0.845	0.979	0.916
3	0.33	0.770	0.710	0.750	0.920	0.830	0.840	0.910	1.000	1.050	1.050	0.791	0.770	0.825	0.959	0.896
4	0.25	0.770	0.710	0.750	0.920	0.830	0.840	0.910	1.000	1.050	1.050	0.791	0.770	0.825	0.959	0.896
5	0.20	0.770	0.700	0.750	0.920	0.830	0.840	0.910	1.000	1.050	1.050	0.791	0.763	0.825	0.959	0.896
7.5	0.13	0.760	0.700	0.750	0.920	0.830	0.840	0.910	1.000	1.050	1.050	0.784	0.763	0.825	0.959	0.896
10	0.10	0.760	0.700	0.740	0.910	0.830	0.840	0.910	1.000	1.050	1.040	0.784	0.763	0.818	0.952	0.893

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m/s = meter per second; P-S = suspension log; sec. = second; SASW = spectral analysis of surface waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-30
Vertical-to-Horizontal (V/H) Spectral Ratios for AFE 1E-4, and Control Point at Depth 44 Ft. (13 M)

Depth 44 ft., AFE 1E-4		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
V_{S30} (m/s)		2742	2736	2673	774	1282	709	693	663	441	509	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.820	0.820	0.820	0.720	0.790	0.710	0.710	0.710	0.700	0.700	0.787	0.787	0.787	0.714	0.763
0.01	100.00	0.840	0.840	0.840	0.790	0.810	0.800	0.800	0.800	0.850	0.830	0.828	0.828	0.828	0.808	0.816
0.02	50.00	0.890	0.890	0.890	0.900	0.870	0.920	0.920	0.930	1.050	1.000	0.899	0.899	0.902	0.945	0.909
0.025	40.00	0.860	0.860	0.860	0.870	0.840	0.880	0.890	0.900	1.010	0.960	0.866	0.869	0.872	0.912	0.876
0.03	33.33	0.830	0.830	0.830	0.820	0.810	0.830	0.840	0.840	0.940	0.900	0.830	0.833	0.833	0.856	0.837
0.04	25.00	0.780	0.780	0.780	0.740	0.760	0.750	0.750	0.750	0.820	0.790	0.771	0.771	0.771	0.764	0.769
0.05	20.00	0.770	0.770	0.760	0.700	0.740	0.710	0.710	0.710	0.740	0.720	0.752	0.752	0.745	0.712	0.734
0.075	13.33	0.740	0.740	0.740	0.690	0.720	0.690	0.690	0.690	0.730	0.710	0.725	0.725	0.725	0.702	0.717
0.1	10.00	0.730	0.730	0.730	0.670	0.710	0.680	0.680	0.680	0.710	0.700	0.715	0.715	0.715	0.682	0.707
0.15	6.67	0.740	0.730	0.730	0.670	0.710	0.680	0.680	0.680	0.710	0.690	0.722	0.715	0.715	0.682	0.704
0.2	5.00	0.750	0.750	0.750	0.680	0.720	0.680	0.680	0.680	0.710	0.700	0.729	0.729	0.729	0.689	0.714
0.25	4.00	0.770	0.770	0.770	0.690	0.740	0.690	0.690	0.690	0.720	0.710	0.746	0.746	0.746	0.699	0.731
0.3	3.33	0.780	0.780	0.780	0.700	0.750	0.700	0.700	0.700	0.720	0.710	0.756	0.756	0.756	0.706	0.738
0.4	2.50	0.790	0.790	0.790	0.710	0.760	0.710	0.710	0.710	0.730	0.720	0.766	0.766	0.766	0.716	0.748
0.5	2.00	0.800	0.800	0.800	0.710	0.760	0.710	0.710	0.710	0.730	0.720	0.773	0.773	0.773	0.716	0.748
0.75	1.33	0.810	0.810	0.810	0.720	0.770	0.720	0.720	0.720	0.740	0.730	0.783	0.783	0.783	0.726	0.758
1	1.00	0.810	0.810	0.810	0.720	0.780	0.720	0.720	0.730	0.750	0.740	0.783	0.783	0.786	0.729	0.768
1.5	0.67	0.800	0.800	0.800	0.720	0.770	0.720	0.720	0.720	0.750	0.730	0.776	0.776	0.776	0.729	0.758
2	0.50	0.760	0.760	0.760	0.690	0.740	0.690	0.690	0.690	0.720	0.710	0.739	0.739	0.739	0.699	0.731
3	0.33	0.750	0.750	0.750	0.680	0.720	0.680	0.680	0.680	0.710	0.690	0.729	0.729	0.729	0.689	0.711
4	0.25	0.750	0.750	0.750	0.670	0.720	0.670	0.680	0.680	0.700	0.690	0.726	0.729	0.729	0.679	0.711
5	0.20	0.750	0.750	0.750	0.670	0.720	0.670	0.680	0.680	0.700	0.690	0.726	0.729	0.729	0.679	0.711
7.5	0.13	0.740	0.740	0.740	0.670	0.720	0.670	0.670	0.670	0.700	0.690	0.719	0.719	0.719	0.679	0.711
10	0.10	0.740	0.740	0.740	0.670	0.710	0.670	0.670	0.670	0.700	0.690	0.719	0.719	0.719	0.679	0.704

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m = meter; m/s = meter per second; P-S = suspension log; sec. = second; SASW = spectral analysis of surface waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-31
Vertical-to-Horizontal (V/H) Spectral Ratios for AFE 1E-5, and Control Point at Depth 44 Ft. (13 M)

Depth 44 ft., AFE 1E-5		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
V_{S30} (m/s)		2742	2736	2673	774	1282	709	693	663	441	509	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.820	0.820	0.820	0.710	0.790	0.720	0.720	0.730	0.780	0.760	0.790	0.790	0.793	0.731	0.781
0.01	100.00	0.870	0.870	0.870	0.860	0.850	0.880	0.890	0.900	1.070	1.000	0.873	0.876	0.879	0.923	0.895
0.02	50.00	0.940	0.940	0.940	1.030	0.920	1.070	1.090	1.110	1.440	1.300	0.979	0.985	0.991	1.153	1.034
0.025	40.00	0.900	0.900	0.900	0.990	0.890	1.030	1.050	1.070	1.400	1.260	0.939	0.945	0.951	1.113	1.001
0.03	33.33	0.870	0.870	0.870	0.930	0.850	0.970	0.980	1.000	1.300	1.170	0.900	0.903	0.909	1.041	0.946
0.04	25.00	0.820	0.820	0.820	0.810	0.790	0.840	0.850	0.870	1.110	1.000	0.826	0.829	0.835	0.900	0.853
0.05	20.00	0.800	0.800	0.800	0.760	0.780	0.780	0.780	0.790	0.950	0.880	0.794	0.794	0.797	0.817	0.810
0.075	13.33	0.770	0.770	0.770	0.730	0.750	0.750	0.760	0.770	0.930	0.860	0.764	0.767	0.770	0.790	0.783
0.1	10.00	0.750	0.750	0.750	0.710	0.730	0.730	0.730	0.750	0.910	0.840	0.744	0.744	0.750	0.770	0.763
0.15	6.67	0.750	0.750	0.750	0.700	0.730	0.720	0.730	0.740	0.900	0.830	0.741	0.744	0.747	0.760	0.760
0.2	5.00	0.770	0.770	0.770	0.710	0.740	0.730	0.740	0.750	0.900	0.840	0.758	0.761	0.764	0.767	0.770
0.25	4.00	0.790	0.790	0.790	0.730	0.760	0.750	0.750	0.760	0.920	0.850	0.778	0.778	0.781	0.787	0.787
0.3	3.33	0.810	0.810	0.810	0.740	0.770	0.760	0.760	0.770	0.930	0.860	0.795	0.795	0.798	0.797	0.797
0.4	2.50	0.820	0.820	0.820	0.750	0.790	0.770	0.780	0.790	0.940	0.870	0.805	0.808	0.811	0.807	0.814
0.5	2.00	0.830	0.830	0.830	0.760	0.800	0.770	0.780	0.790	0.940	0.880	0.812	0.815	0.818	0.814	0.824
0.75	1.33	0.840	0.840	0.840	0.760	0.800	0.780	0.790	0.800	0.950	0.880	0.822	0.825	0.828	0.817	0.824
1	1.00	0.840	0.840	0.840	0.770	0.810	0.790	0.790	0.800	0.950	0.890	0.825	0.825	0.828	0.824	0.834
1.5	0.67	0.830	0.830	0.830	0.760	0.800	0.780	0.790	0.800	0.950	0.890	0.815	0.818	0.821	0.817	0.827
2	0.50	0.800	0.800	0.800	0.740	0.770	0.750	0.760	0.770	0.920	0.860	0.785	0.788	0.791	0.794	0.797
3	0.33	0.780	0.780	0.780	0.720	0.750	0.740	0.740	0.750	0.910	0.840	0.768	0.768	0.771	0.777	0.777
4	0.25	0.780	0.780	0.780	0.720	0.750	0.740	0.740	0.750	0.910	0.840	0.768	0.768	0.771	0.777	0.777
5	0.20	0.770	0.770	0.770	0.710	0.740	0.730	0.740	0.750	0.910	0.840	0.758	0.761	0.764	0.770	0.770
7.5	0.13	0.770	0.770	0.770	0.710	0.740	0.730	0.740	0.750	0.900	0.840	0.758	0.761	0.764	0.767	0.770
10	0.10	0.770	0.770	0.770	0.710	0.740	0.730	0.740	0.750	0.900	0.840	0.758	0.761	0.764	0.767	0.770

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m = meter; m/s = meter per second; P-S = suspension log; sec. = second; SASW = spectral analysis of surface waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-32
Vertical-to-Horizontal (V/H) Spectral Ratios AFE 1E-4, and Control Point at Depth 85 Ft. (26 M)

Depth 85 ft., AFE 1E-4		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
V_{S30} (m/s)		2769	2757	2747	2393	2737	1000	877	781	613	693	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.820	0.820	0.820	0.820	0.820	0.750	0.720	0.710	0.710	0.710	0.799	0.790	0.787	0.787	0.787
0.01	100.00	0.840	0.840	0.840	0.840	0.840	0.790	0.790	0.790	0.810	0.800	0.825	0.825	0.825	0.831	0.828
0.02	50.00	0.890	0.890	0.890	0.890	0.890	0.870	0.890	0.900	0.950	0.920	0.884	0.890	0.893	0.908	0.899
0.025	40.00	0.860	0.860	0.860	0.860	0.860	0.840	0.850	0.870	0.910	0.890	0.854	0.857	0.863	0.875	0.869
0.03	33.33	0.830	0.830	0.830	0.830	0.830	0.800	0.810	0.820	0.860	0.840	0.821	0.824	0.827	0.839	0.833
0.04	25.00	0.780	0.780	0.780	0.780	0.780	0.730	0.730	0.740	0.760	0.750	0.765	0.765	0.768	0.774	0.771
0.05	20.00	0.770	0.770	0.770	0.760	0.770	0.720	0.700	0.700	0.710	0.710	0.755	0.749	0.749	0.745	0.752
0.075	13.33	0.740	0.740	0.740	0.740	0.740	0.700	0.690	0.690	0.700	0.690	0.728	0.725	0.725	0.728	0.725
0.1	10.00	0.730	0.730	0.730	0.730	0.730	0.690	0.670	0.670	0.680	0.680	0.718	0.712	0.712	0.715	0.715
0.15	6.67	0.740	0.740	0.730	0.730	0.730	0.690	0.670	0.670	0.680	0.680	0.725	0.719	0.712	0.715	0.715
0.2	5.00	0.750	0.750	0.750	0.750	0.750	0.700	0.680	0.680	0.690	0.680	0.735	0.729	0.729	0.732	0.729
0.25	4.00	0.770	0.770	0.770	0.770	0.770	0.710	0.700	0.690	0.700	0.690	0.752	0.749	0.746	0.749	0.746
0.3	3.33	0.780	0.780	0.780	0.780	0.780	0.720	0.700	0.700	0.700	0.700	0.762	0.756	0.756	0.756	0.756
0.4	2.50	0.790	0.790	0.790	0.790	0.790	0.730	0.710	0.710	0.710	0.710	0.772	0.766	0.766	0.766	0.766
0.5	2.00	0.800	0.800	0.800	0.800	0.800	0.730	0.720	0.710	0.720	0.710	0.779	0.776	0.773	0.776	0.773
0.75	1.33	0.810	0.810	0.810	0.810	0.810	0.740	0.720	0.720	0.720	0.720	0.789	0.783	0.783	0.783	0.783
1	1.00	0.810	0.810	0.810	0.810	0.810	0.740	0.730	0.720	0.730	0.720	0.789	0.786	0.783	0.786	0.783
1.5	0.67	0.800	0.800	0.800	0.800	0.800	0.740	0.720	0.720	0.720	0.720	0.782	0.776	0.776	0.776	0.776
2	0.50	0.760	0.760	0.760	0.760	0.760	0.710	0.690	0.690	0.700	0.690	0.745	0.739	0.739	0.742	0.739
3	0.33	0.750	0.750	0.750	0.750	0.750	0.690	0.680	0.670	0.680	0.680	0.732	0.729	0.726	0.729	0.729
4	0.25	0.750	0.750	0.750	0.750	0.750	0.690	0.680	0.670	0.680	0.680	0.732	0.729	0.726	0.729	0.729
5	0.20	0.750	0.750	0.750	0.750	0.750	0.690	0.680	0.670	0.680	0.680	0.732	0.729	0.726	0.729	0.729
7.5	0.13	0.740	0.740	0.740	0.740	0.740	0.690	0.670	0.670	0.680	0.670	0.725	0.719	0.719	0.722	0.719
10	0.10	0.740	0.740	0.740	0.740	0.740	0.690	0.670	0.670	0.680	0.670	0.725	0.719	0.719	0.722	0.719

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m = meter; m/s = meter per second; sec. = second; SASW = Spectral Analysis of Surface Waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-33
Vertical-to-Horizontal (V/H) Spectral Ratios AFE 1E-5, and Control Point at Depth 85 Ft. (26 M)

Depth 85 ft., AFE 1E-5		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
V_{S30} (m/s)		2769	2757	2747	2393	2737	1000	877	781	613	693	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.820	0.820	0.820	0.820	0.820	0.750	0.720	0.720	0.740	0.720	0.799	0.790	0.790	0.796	0.790
0.01	100.00	0.870	0.870	0.870	0.870	0.870	0.830	0.830	0.860	0.920	0.890	0.858	0.858	0.867	0.885	0.876
0.02	50.00	0.940	0.940	0.940	0.940	0.940	0.930	0.980	1.030	1.160	1.090	0.937	0.952	0.967	1.006	0.985
0.025	40.00	0.910	0.910	0.910	0.910	0.900	0.900	0.940	0.990	1.120	1.050	0.907	0.919	0.934	0.973	0.945
0.03	33.33	0.880	0.880	0.880	0.870	0.880	0.850	0.890	0.930	1.050	0.980	0.871	0.883	0.895	0.924	0.910
0.04	25.00	0.820	0.820	0.820	0.820	0.820	0.770	0.780	0.810	0.900	0.850	0.805	0.808	0.817	0.844	0.829
0.05	20.00	0.800	0.800	0.800	0.800	0.800	0.750	0.740	0.750	0.810	0.780	0.785	0.782	0.785	0.803	0.794
0.075	13.33	0.770	0.770	0.770	0.770	0.770	0.730	0.720	0.730	0.790	0.760	0.758	0.755	0.758	0.776	0.767
0.1	10.00	0.750	0.750	0.750	0.750	0.750	0.710	0.690	0.710	0.770	0.730	0.738	0.732	0.738	0.756	0.744
0.15	6.67	0.750	0.750	0.750	0.750	0.750	0.700	0.690	0.700	0.760	0.730	0.735	0.732	0.735	0.753	0.744
0.2	5.00	0.770	0.770	0.770	0.770	0.770	0.710	0.700	0.710	0.770	0.740	0.752	0.749	0.752	0.770	0.761
0.25	4.00	0.790	0.790	0.790	0.790	0.790	0.730	0.720	0.730	0.790	0.750	0.772	0.769	0.772	0.790	0.778
0.3	3.33	0.810	0.810	0.810	0.810	0.810	0.740	0.730	0.740	0.800	0.760	0.789	0.786	0.789	0.807	0.795
0.4	2.50	0.820	0.820	0.820	0.820	0.820	0.760	0.740	0.750	0.810	0.770	0.802	0.796	0.799	0.817	0.805
0.5	2.00	0.830	0.830	0.830	0.830	0.830	0.760	0.750	0.760	0.810	0.780	0.809	0.806	0.809	0.824	0.815
0.75	1.33	0.840	0.840	0.840	0.840	0.840	0.770	0.750	0.760	0.820	0.790	0.819	0.813	0.816	0.834	0.825
1	1.00	0.840	0.840	0.840	0.840	0.840	0.770	0.760	0.770	0.820	0.790	0.819	0.816	0.819	0.834	0.825
1.5	0.67	0.830	0.830	0.830	0.830	0.830	0.770	0.750	0.760	0.820	0.790	0.812	0.806	0.809	0.827	0.818
2	0.50	0.800	0.800	0.800	0.800	0.800	0.740	0.720	0.730	0.790	0.760	0.782	0.776	0.779	0.797	0.788
3	0.33	0.780	0.780	0.780	0.780	0.780	0.720	0.700	0.720	0.780	0.740	0.762	0.756	0.762	0.780	0.768
4	0.25	0.780	0.780	0.780	0.780	0.780	0.720	0.700	0.720	0.770	0.740	0.762	0.756	0.762	0.777	0.768
5	0.20	0.770	0.770	0.770	0.770	0.770	0.720	0.700	0.710	0.770	0.740	0.755	0.749	0.752	0.770	0.761
7.5	0.13	0.770	0.770	0.770	0.770	0.770	0.720	0.700	0.710	0.770	0.740	0.755	0.749	0.752	0.770	0.761
10	0.10	0.770	0.770	0.770	0.770	0.770	0.710	0.700	0.710	0.770	0.740	0.752	0.749	0.752	0.770	0.761

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m = meter; m/s = meter per second; sec. = second; SASW = Spectral Analysis of Surface Waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-34
Vertical-to-Horizontal (V/H) Spectral Ratios AFE 1E-4, and Control Point at the Top of Partially Weathered Rock (PWR)

Top of PWR, AFE 1E-4		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
V_{S30} (m/s)		2366	2366	2366	2366	2366	693	693	693	693	693	-	-	-	-	-
Period (sec.)	**Freq (Hz)**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**	**V/H**
0.005	200.00	0.820	0.820	0.820	0.820	0.820	0.710	0.710	0.710	0.710	0.710	0.787	0.787	0.787	0.787	0.787
0.01	100.00	0.840	0.840	0.840	0.840	0.840	0.800	0.800	0.800	0.800	0.800	0.828	0.828	0.828	0.828	0.828
0.02	50.00	0.890	0.890	0.890	0.890	0.890	0.920	0.920	0.920	0.920	0.920	0.899	0.899	0.899	0.899	0.899
0.025	40.00	0.860	0.860	0.860	0.860	0.860	0.890	0.890	0.890	0.890	0.890	0.869	0.869	0.869	0.869	0.869
0.03	33.33	0.830	0.830	0.830	0.830	0.830	0.840	0.840	0.840	0.840	0.840	0.833	0.833	0.833	0.833	0.833
0.04	25.00	0.780	0.780	0.780	0.780	0.780	0.750	0.750	0.750	0.750	0.750	0.771	0.771	0.771	0.771	0.771
0.05	20.00	0.770	0.770	0.760	0.760	0.760	0.710	0.710	0.710	0.710	0.710	0.752	0.752	0.745	0.745	0.745
0.075	13.33	0.740	0.740	0.740	0.740	0.740	0.690	0.690	0.690	0.690	0.690	0.725	0.725	0.725	0.725	0.725
0.1	10.00	0.730	0.730	0.730	0.730	0.730	0.680	0.680	0.680	0.680	0.680	0.715	0.715	0.715	0.715	0.715
0.15	6.67	0.740	0.740	0.740	0.740	0.740	0.680	0.680	0.680	0.680	0.680	0.722	0.722	0.722	0.722	0.722
0.2	5.00	0.750	0.750	0.750	0.750	0.750	0.680	0.680	0.680	0.680	0.680	0.729	0.729	0.729	0.729	0.729
0.25	4.00	0.770	0.770	0.770	0.770	0.770	0.690	0.690	0.690	0.690	0.690	0.746	0.746	0.746	0.746	0.746
0.3	3.33	0.780	0.780	0.780	0.780	0.780	0.700	0.700	0.700	0.700	0.700	0.756	0.756	0.756	0.756	0.756
0.4	2.50	0.790	0.790	0.790	0.790	0.790	0.710	0.710	0.710	0.710	0.710	0.766	0.766	0.766	0.766	0.766
0.5	2.00	0.800	0.800	0.800	0.800	0.800	0.710	0.710	0.710	0.710	0.710	0.773	0.773	0.773	0.773	0.773
0.75	1.33	0.810	0.810	0.810	0.810	0.810	0.720	0.720	0.720	0.720	0.720	0.783	0.783	0.783	0.783	0.783
1	1.00	0.810	0.810	0.810	0.810	0.810	0.720	0.720	0.720	0.720	0.720	0.783	0.783	0.783	0.783	0.783
1.5	0.67	0.800	0.800	0.800	0.800	0.800	0.720	0.720	0.720	0.720	0.720	0.776	0.776	0.776	0.776	0.776
2	0.50	0.760	0.760	0.760	0.760	0.760	0.690	0.690	0.690	0.690	0.690	0.739	0.739	0.739	0.739	0.739
3	0.33	0.750	0.750	0.750	0.750	0.750	0.680	0.680	0.680	0.680	0.680	0.729	0.729	0.729	0.729	0.729
4	0.25	0.750	0.750	0.750	0.750	0.750	0.680	0.680	0.680	0.680	0.680	0.729	0.729	0.729	0.729	0.729
5	0.20	0.750	0.750	0.750	0.750	0.750	0.680	0.680	0.680	0.680	0.680	0.729	0.729	0.729	0.729	0.729
7.5	0.13	0.740	0.740	0.740	0.740	0.740	0.670	0.670	0.670	0.670	0.670	0.719	0.719	0.719	0.719	0.719
10	0.10	0.740	0.740	0.740	0.740	0.740	0.670	0.670	0.670	0.670	0.670	0.719	0.719	0.719	0.719	0.719

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m/s = meter per second; sec. = second; SASW = Spectral Analysis of Surface Waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-35
Vertical-to-Horizontal (V/H) Spectral Ratios AFE 1E-5, and Control Point at the Top of Partially Weathered Rock (PWR)

Top of PWR, AFE 1E-5		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
	V_{S30} (m/s)	2366	2366	2366	2366	2366	693	693	693	693	693	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.820	0.820	0.820	0.820	0.820	0.720	0.720	0.720	0.720	0.720	0.790	0.790	0.790	0.790	0.790
0.01	100.00	0.870	0.870	0.870	0.870	0.870	0.890	0.890	0.890	0.890	0.890	0.876	0.876	0.876	0.876	0.876
0.02	50.00	0.940	0.940	0.940	0.940	0.940	1.090	1.090	1.090	1.090	1.090	0.985	0.985	0.985	0.985	0.985
0.025	40.00	0.900	0.900	0.900	0.900	0.900	1.050	1.050	1.050	1.050	1.050	0.945	0.945	0.945	0.945	0.945
0.03	33.33	0.880	0.870	0.870	0.870	0.870	0.980	0.980	0.980	0.980	0.980	0.910	0.903	0.903	0.903	0.903
0.04	25.00	0.820	0.820	0.820	0.820	0.820	0.850	0.850	0.850	0.850	0.850	0.829	0.829	0.829	0.829	0.829
0.05	20.00	0.800	0.800	0.800	0.800	0.800	0.780	0.780	0.780	0.780	0.780	0.794	0.794	0.794	0.794	0.794
0.075	13.33	0.770	0.770	0.770	0.770	0.770	0.760	0.760	0.760	0.760	0.760	0.767	0.767	0.767	0.767	0.767
0.1	10.00	0.750	0.750	0.750	0.750	0.750	0.730	0.730	0.730	0.730	0.730	0.744	0.744	0.744	0.744	0.744
0.15	6.67	0.750	0.750	0.750	0.750	0.750	0.730	0.730	0.730	0.730	0.730	0.744	0.744	0.744	0.744	0.744
0.2	5.00	0.770	0.770	0.770	0.770	0.770	0.740	0.740	0.740	0.740	0.740	0.761	0.761	0.761	0.761	0.761
0.25	4.00	0.790	0.790	0.790	0.790	0.790	0.750	0.750	0.750	0.750	0.750	0.778	0.778	0.778	0.778	0.778
0.3	3.33	0.810	0.810	0.810	0.810	0.810	0.760	0.760	0.760	0.760	0.760	0.795	0.795	0.795	0.795	0.795
0.4	2.50	0.820	0.820	0.820	0.820	0.820	0.770	0.770	0.770	0.770	0.770	0.805	0.805	0.805	0.805	0.805
0.5	2.00	0.830	0.830	0.830	0.830	0.830	0.780	0.780	0.780	0.780	0.780	0.815	0.815	0.815	0.815	0.815
0.75	1.33	0.840	0.840	0.840	0.840	0.840	0.790	0.790	0.790	0.790	0.790	0.825	0.825	0.825	0.825	0.825
1	1.00	0.840	0.840	0.840	0.840	0.840	0.790	0.790	0.790	0.790	0.790	0.825	0.825	0.825	0.825	0.825
1.5	0.67	0.830	0.830	0.830	0.830	0.830	0.790	0.790	0.790	0.790	0.790	0.818	0.818	0.818	0.818	0.818
2	0.50	0.800	0.800	0.800	0.800	0.800	0.760	0.760	0.760	0.760	0.760	0.788	0.788	0.788	0.788	0.788
3	0.33	0.780	0.780	0.780	0.780	0.780	0.740	0.740	0.740	0.740	0.740	0.768	0.768	0.768	0.768	0.768
4	0.25	0.780	0.780	0.780	0.780	0.780	0.740	0.740	0.740	0.740	0.740	0.768	0.768	0.768	0.768	0.768
5	0.20	0.770	0.770	0.770	0.770	0.770	0.740	0.740	0.740	0.740	0.740	0.761	0.761	0.761	0.761	0.761
7.5	0.13	0.770	0.770	0.770	0.770	0.770	0.740	0.740	0.740	0.740	0.740	0.761	0.761	0.761	0.761	0.761
10	0.10	0.770	0.770	0.770	0.770	0.770	0.740	0.740	0.740	0.740	0.740	0.761	0.761	0.761	0.761	0.761

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m/s = meter per second; sec. = second; SASW = Spectral Analysis of Surface Waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-36
Vertical-to-Horizontal (V/H) Spectral Ratios for the South Plant Complex, AFE 1E-4, and Control Point at Depth 115 Ft. (35 M)

Depth 115 Ft. (35 M), AFE 1E-4 (Only South Plant Complex)		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
	V_{S30} (m/s)	2769	2757	2747	2739	2737	1000	877	781	693	693	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.820	0.820	0.820	0.820	0.820	0.750	0.720	0.710	0.710	0.710	0.799	0.790	0.787	0.787	0.787
0.01	100.00	0.840	0.840	0.840	0.840	0.840	0.790	0.790	0.790	0.800	0.800	0.825	0.825	0.825	0.828	0.828
0.02	50.00	0.890	0.890	0.890	0.890	0.890	0.870	0.890	0.900	0.920	0.920	0.884	0.890	0.893	0.899	0.899
0.025	40.00	0.860	0.860	0.860	0.860	0.860	0.840	0.850	0.870	0.890	0.890	0.854	0.857	0.863	0.869	0.869
0.03	33.33	0.830	0.830	0.830	0.830	0.830	0.800	0.810	0.820	0.840	0.840	0.821	0.824	0.827	0.833	0.833
0.04	25.00	0.780	0.780	0.780	0.780	0.780	0.730	0.730	0.740	0.750	0.750	0.765	0.765	0.768	0.771	0.771
0.05	20.00	0.770	0.770	0.770	0.770	0.770	0.720	0.700	0.700	0.710	0.710	0.755	0.749	0.749	0.752	0.752
0.075	13.33	0.740	0.740	0.740	0.740	0.740	0.700	0.690	0.690	0.690	0.690	0.728	0.725	0.725	0.725	0.725
0.1	10.00	0.730	0.730	0.730	0.730	0.730	0.690	0.670	0.670	0.680	0.680	0.718	0.712	0.712	0.715	0.715
0.15	6.67	0.740	0.740	0.730	0.740	0.730	0.690	0.670	0.670	0.680	0.680	0.725	0.719	0.712	0.722	0.715
0.2	5.00	0.750	0.750	0.750	0.750	0.750	0.700	0.680	0.680	0.680	0.680	0.735	0.729	0.729	0.729	0.729
0.25	4.00	0.770	0.770	0.770	0.770	0.770	0.710	0.700	0.690	0.690	0.690	0.752	0.749	0.746	0.746	0.746
0.3	3.33	0.780	0.780	0.780	0.780	0.780	0.720	0.700	0.700	0.700	0.700	0.762	0.756	0.756	0.756	0.756
0.4	2.50	0.790	0.790	0.790	0.790	0.790	0.730	0.710	0.710	0.710	0.710	0.772	0.766	0.766	0.766	0.766
0.5	2.00	0.800	0.800	0.800	0.800	0.800	0.730	0.720	0.710	0.710	0.710	0.779	0.776	0.773	0.773	0.773
0.75	1.33	0.810	0.810	0.810	0.810	0.810	0.740	0.720	0.720	0.720	0.720	0.789	0.783	0.783	0.783	0.783
1	1.00	0.810	0.810	0.810	0.810	0.810	0.740	0.730	0.720	0.720	0.720	0.789	0.786	0.783	0.783	0.783
1.5	0.67	0.800	0.800	0.800	0.800	0.800	0.740	0.720	0.720	0.720	0.720	0.782	0.776	0.776	0.776	0.776
2	0.50	0.760	0.760	0.760	0.760	0.760	0.710	0.690	0.690	0.690	0.690	0.745	0.739	0.739	0.739	0.739
3	0.33	0.750	0.750	0.750	0.750	0.750	0.690	0.680	0.670	0.680	0.680	0.732	0.729	0.726	0.729	0.729
4	0.25	0.750	0.750	0.750	0.750	0.750	0.690	0.680	0.670	0.680	0.680	0.732	0.729	0.726	0.729	0.729
5	0.20	0.750	0.750	0.750	0.750	0.750	0.690	0.680	0.670	0.680	0.680	0.732	0.729	0.726	0.729	0.729
7.5	0.13	0.740	0.740	0.740	0.740	0.740	0.690	0.670	0.670	0.670	0.670	0.725	0.719	0.719	0.719	0.719
10	0.10	0.740	0.740	0.740	0.740	0.740	0.690	0.670	0.670	0.670	0.670	0.725	0.719	0.719	0.719	0.719

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m = meter; m/s = meter per second; sec. = second; SASW = Spectral Analysis of Surface Waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-37
Vertical-to-Horizontal (V/H) Spectral Ratios for the South Plant Complex, AFE 1E-5, and Control Point at Depth 115 Ft. (35 M)

Depth 115 Ft. (35 M), AFE 1E-5 (Only South Plant Complex)		P-S Profile					SASW Profile					Weighted Average				
		Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.	Cut 38 ft.	Cut 24 ft.	Cut 10 ft.	Fill 40 ft.	Fill 15 ft.
	V_{S30} (m/s)	2769	2757	2747	2739	2737	1000	877	781	693	693	-	-	-	-	-
Period (sec.)	Freq (Hz)	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
0.005	200.00	0.820	0.820	0.820	0.820	0.820	0.750	0.720	0.720	0.720	0.720	0.799	0.790	0.790	0.790	0.790
0.01	100.00	0.870	0.870	0.870	0.870	0.870	0.830	0.830	0.860	0.890	0.890	0.858	0.858	0.867	0.876	0.876
0.02	50.00	0.940	0.940	0.940	0.940	0.940	0.930	0.980	1.030	1.090	1.090	0.937	0.952	0.967	0.985	0.985
0.025	40.00	0.910	0.910	0.910	0.900	0.900	0.900	0.940	0.990	1.050	1.050	0.907	0.919	0.934	0.945	0.945
0.03	33.33	0.880	0.880	0.880	0.870	0.880	0.850	0.890	0.930	0.980	0.980	0.871	0.883	0.895	0.903	0.910
0.04	25.00	0.820	0.820	0.820	0.820	0.820	0.770	0.780	0.810	0.850	0.850	0.805	0.808	0.817	0.829	0.829
0.05	20.00	0.800	0.800	0.800	0.800	0.800	0.750	0.740	0.750	0.780	0.780	0.785	0.782	0.785	0.794	0.794
0.075	13.33	0.770	0.770	0.770	0.770	0.770	0.730	0.720	0.730	0.760	0.760	0.758	0.755	0.758	0.767	0.767
0.1	10.00	0.750	0.750	0.750	0.750	0.750	0.710	0.690	0.710	0.730	0.730	0.738	0.732	0.738	0.744	0.744
0.15	6.67	0.750	0.750	0.750	0.750	0.750	0.700	0.690	0.700	0.730	0.730	0.735	0.732	0.735	0.744	0.744
0.2	5.00	0.770	0.770	0.770	0.770	0.770	0.710	0.700	0.710	0.740	0.740	0.752	0.749	0.752	0.761	0.761
0.25	4.00	0.790	0.790	0.790	0.790	0.790	0.730	0.720	0.730	0.750	0.750	0.772	0.769	0.772	0.778	0.778
0.3	3.33	0.810	0.810	0.810	0.810	0.810	0.740	0.730	0.740	0.760	0.760	0.789	0.786	0.789	0.795	0.795
0.4	2.50	0.820	0.820	0.820	0.820	0.820	0.760	0.740	0.750	0.770	0.770	0.802	0.796	0.799	0.805	0.805
0.5	2.00	0.830	0.830	0.830	0.830	0.830	0.760	0.750	0.760	0.780	0.780	0.809	0.806	0.809	0.815	0.815
0.75	1.33	0.840	0.840	0.840	0.840	0.840	0.770	0.750	0.760	0.790	0.790	0.819	0.813	0.816	0.825	0.825
1	1.00	0.840	0.840	0.840	0.840	0.840	0.770	0.760	0.770	0.790	0.790	0.819	0.816	0.819	0.825	0.825
1.5	0.67	0.830	0.830	0.830	0.830	0.830	0.770	0.750	0.760	0.790	0.790	0.812	0.806	0.809	0.818	0.818
2	0.50	0.800	0.800	0.800	0.800	0.800	0.740	0.720	0.730	0.760	0.760	0.782	0.776	0.779	0.788	0.788
3	0.33	0.780	0.780	0.780	0.780	0.780	0.720	0.700	0.720	0.740	0.740	0.762	0.756	0.762	0.768	0.768
4	0.25	0.780	0.780	0.780	0.780	0.780	0.720	0.700	0.720	0.740	0.740	0.762	0.756	0.762	0.768	0.768
5	0.20	0.770	0.770	0.770	0.770	0.770	0.720	0.700	0.710	0.740	0.740	0.755	0.749	0.752	0.761	0.761
7.5	0.13	0.770	0.770	0.770	0.770	0.770	0.720	0.700	0.710	0.740	0.740	0.755	0.749	0.752	0.761	0.761
10	0.10	0.770	0.770	0.770	0.770	0.770	0.710	0.700	0.710	0.740	0.740	0.752	0.749	0.752	0.761	0.761

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; m = meter; m/s = meter per second; sec. = second; SASW = Spectral Analysis of Surface Waves; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

Table 2.5-38
Horizontal And Vertical Uniform Hazard Response Spectra (UHRS) and Ground Motion Response Spectra (GMRS) for the North and Middle Plant Complexes

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal GMRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical GMRS
0.005	200.00	0.3209	0.8806	0.4318	0.2314	0.6499	0.3172
0.01	100.00	0.3539	0.9965	0.4861	0.2860	0.8988	0.4289
0.02	50.00	0.4768	1.3345	0.6517	0.4439	1.4866	0.7004
0.025	40.00	0.5255	1.5050	0.7316	0.4719	1.6164	0.7582
0.03	33.33	0.5720	1.6163	0.7878	0.4856	1.6308	0.7680
0.04	25.00	0.6312	1.7969	0.8746	0.4797	1.5723	0.7440
0.05	20.00	0.6594	1.8296	0.8951	0.4741	1.4747	0.7051
0.075	13.33	0.7120	1.9227	0.9458	0.4998	1.5055	0.7245
0.1	10.00	0.6976	1.8075	0.8965	0.4806	1.3665	0.6653
0.15	6.67	0.6967	1.6068	0.8157	0.4842	1.3095	0.6439
0.2	5.00	0.6055	1.4565	0.7332	0.4208	1.1914	0.5805
0.25	4.00	0.5691	1.2918	0.6579	0.4109	1.1680	0.5687
0.3	3.33	0.5381	1.2435	0.6310	0.3885	1.0754	0.5263
0.4	2.50	0.4413	1.0227	0.5187	0.3230	0.9470	0.4582
0.5	2.00	0.3553	0.8561	0.4308	0.2601	0.7987	0.3829
0.75	1.33	0.1731	0.4842	0.2365	0.1285	0.4566	0.2126
1	1.00	0.1209	0.3239	0.1596	0.0897	0.3054	0.1434
1.5	0.67	0.0787	0.1910	0.0960	0.0584	0.1801	0.0863
2	0.50	0.0616	0.1430	0.0725	0.0445	0.1310	0.0633
3	0.33	0.0373	0.0840	0.0428	0.0262	0.0752	0.0365
4	0.25	0.0273	0.0601	0.0308	0.0192	0.0538	0.0263
5	0.20	0.0215	0.0476	0.0244	0.0151	0.0427	0.0208
7.5	0.13	0.0137	0.0315	0.0160	0.0096	0.0283	0.0137
10	0.10	0.0100	0.0227	0.0115	0.0070	0.0202	0.0098

Key: Hz = hertz; sec. = second

Table 2.5-39
Horizontal And Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 44 ft. [13 m]) for the North and Middle Plant Complexes

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 44 ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 44 ft.)
0.005	200.00	0.2722	0.7819	0.3799	0.2077	0.6106	0.2953
0.01	100.00	0.3011	0.9023	0.4347	0.2457	0.8075	0.3819
0.02	50.00	0.3991	1.2435	0.5944	0.3628	1.2858	0.5990
0.025	40.00	0.4404	1.3938	0.6642	0.3858	1.3952	0.6473
0.03	33.33	0.4778	1.5213	0.7240	0.3999	1.4391	0.6684
0.04	25.00	0.5524	1.7001	0.8147	0.4248	1.4502	0.6807
0.05	20.00	0.5708	1.7388	0.8349	0.4190	1.4084	0.6631
0.075	13.33	0.6115	1.7546	0.8527	0.4385	1.3739	0.6560
0.1	10.00	0.5138	1.4957	0.7247	0.3632	1.1412	0.5446
0.15	6.67	0.5281	1.3668	0.6780	0.3718	1.0388	0.5075
0.2	5.00	0.6045	1.4291	0.7219	0.4316	1.1004	0.5475
0.25	4.00	0.6217	1.4316	0.7270	0.4545	1.1267	0.5638
0.3	3.33	0.5662	1.3123	0.6655	0.4179	1.0459	0.5223
0.4	2.50	0.4402	1.0433	0.5267	0.3292	0.8492	0.4216
0.5	2.00	0.3558	0.8473	0.4274	0.2661	0.6982	0.3454
0.75	1.33	0.1752	0.4986	0.2427	0.1328	0.4108	0.1967
1	1.00	0.1211	0.3292	0.1617	0.0930	0.2746	0.1327
1.5	0.67	0.0789	0.1975	0.0986	0.0598	0.1633	0.0802
2	0.50	0.0619	0.1455	0.0736	0.0452	0.1160	0.0576
3	0.33	0.0374	0.0843	0.0430	0.0268	0.0655	0.0329
4	0.25	0.0274	0.0603	0.0309	0.0197	0.0469	0.0236
5	0.20	0.0216	0.0478	0.0245	0.0154	0.0368	0.0186
7.5	0.13	0.0137	0.0316	0.0161	0.0098	0.0244	0.0122
10	0.10	0.0100	0.0227	0.0116	0.0071	0.0175	0.0088

Key: ft. = foot; Hz = hertz; m = meter; sec. = second

Table 2.5-40
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 85 Ft. [26 M]) for the North and Middle Plant Complexes

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 85 ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 85 ft.)
0.005	200.00	0.1570	0.4973	0.2369	0.1240	0.3929	0.1872
0.01	100.00	0.1717	0.5584	0.2646	0.1417	0.4795	0.2254
0.02	50.00	0.2298	0.7845	0.3682	0.2045	0.7543	0.3486
0.025	40.00	0.2586	0.8976	0.4199	0.2216	0.8291	0.3821
0.03	33.33	0.2843	0.9929	0.4639	0.2343	0.8767	0.4040
0.04	25.00	0.3252	1.1128	0.5221	0.2488	0.9020	0.4183
0.05	20.00	0.3255	1.0985	0.5168	0.2442	0.8674	0.4039
0.075	13.33	0.3475	1.1305	0.5357	0.2519	0.8649	0.4055
0.1	10.00	0.2968	0.9082	0.4357	0.2113	0.6721	0.3199
0.15	6.67	0.3082	0.8744	0.4259	0.2203	0.6506	0.3143
0.2	5.00	0.3046	0.8307	0.4078	0.2221	0.6322	0.3077
0.25	4.00	0.2960	0.7853	0.3876	0.2217	0.6039	0.2965
0.3	3.33	0.2925	0.7552	0.3748	0.2211	0.5936	0.2923
0.4	2.50	0.2431	0.5907	0.2967	0.1862	0.4742	0.2360
0.5	2.00	0.2101	0.5026	0.2533	0.1624	0.4096	0.2042
0.75	1.33	0.1320	0.3240	0.1625	0.1034	0.2673	0.1326
1	1.00	0.1022	0.2425	0.1224	0.0800	0.2001	0.0999
1.5	0.67	0.0717	0.1657	0.0841	0.0556	0.1356	0.0681
2	0.50	0.0576	0.1293	0.0660	0.0426	0.1019	0.0513
3	0.33	0.0365	0.0817	0.0417	0.0266	0.0628	0.0317
4	0.25	0.0269	0.0589	0.0302	0.0196	0.0452	0.0230
5	0.20	0.0211	0.0466	0.0238	0.0154	0.0354	0.0180
7.5	0.13	0.0135	0.0310	0.0158	0.0097	0.0236	0.0119
10	0.10	0.0098	0.0223	0.0114	0.0070	0.0170	0.0085

Key: ft. = foot; Hz = hertz; m = meter; sec. = second

Table 2.5-41
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Performance Based Interface Response Spectra (PBIRS) for the North and Middle Plant Complexes

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal PBIRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical PBIRS
0.005	200.00	0.1852	0.5915	0.2813	0.1458	0.4673	0.2221
0.01	100.00	0.2080	0.6919	0.3264	0.1723	0.6061	0.2828
0.02	50.00	0.2802	0.9610	0.4506	0.2519	0.9465	0.4358
0.025	40.00	0.3100	1.0704	0.5013	0.2694	1.0115	0.4658
0.03	33.33	0.3311	1.1459	0.5364	0.2758	1.0347	0.4766
0.04	25.00	0.3744	1.2614	0.5936	0.2887	1.0457	0.4850
0.05	20.00	0.3815	1.2655	0.5974	0.2845	1.0048	0.4684
0.075	13.33	0.3969	1.2692	0.6035	0.2877	0.9735	0.4577
0.1	10.00	0.3493	1.0457	0.5039	0.2498	0.7780	0.3719
0.15	6.67	0.3603	0.9985	0.4886	0.2602	0.7429	0.3614
0.2	5.00	0.3499	0.8959	0.4454	0.2551	0.6818	0.3361
0.25	4.00	0.3186	0.8211	0.4077	0.2377	0.6388	0.3145
0.3	3.33	0.2914	0.7521	0.3733	0.2203	0.5980	0.2938
0.4	2.50	0.2480	0.6231	0.3109	0.1899	0.5016	0.2478
0.5	2.00	0.2017	0.4802	0.2422	0.1559	0.3914	0.1953
0.75	1.33	0.1307	0.3102	0.1566	0.1023	0.2559	0.1278
1	1.00	0.1028	0.2385	0.1209	0.0805	0.1967	0.0987
1.5	0.67	0.0724	0.1647	0.0838	0.0562	0.1347	0.0679
2	0.50	0.0582	0.1308	0.0667	0.0430	0.1030	0.0519
3	0.33	0.0368	0.0822	0.0420	0.0268	0.0632	0.0319
4	0.25	0.0270	0.0591	0.0303	0.0197	0.0454	0.0231
5	0.20	0.0212	0.0467	0.0239	0.0154	0.0355	0.0180
7.5	0.13	0.0135	0.0311	0.0158	0.0097	0.0237	0.0119
10	0.10	0.0098	0.0224	0.0114	0.0071	0.0170	0.0086

Key: Hz = hertz; sec. = second

Table 2.5-42
Interpolated Horizontal and Vertical Ground Motion Response Spectra (GMRS), Foundation Input Response Spectra (FIRS), and Performance-Based Interface Response Spectra (PBIRS) for the North and Middle Plant Complexes

Period	Frequency	GMRS		FIRS (Depth 44 ft.)		FIRS (Depth 85 ft.)		PBIRS	
(sec.)	(Hz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
0.005	200.00	0.4318	0.3172	0.3799	0.2953	0.2369	0.1872	0.2813	0.2221
0.0067	150.00	0.4589	0.3730	0.4073	0.3386	0.2508	0.2063	0.3039	0.2524
0.01	100.00	0.4861	0.4289	0.4347	0.3819	0.2646	0.2254	0.3264	0.2828
0.013	75.00	0.5689	0.5647	0.5145	0.4904	0.3164	0.2870	0.3885	0.3593
0.015	66.67	0.5965	0.6099	0.5411	0.5266	0.3337	0.3075	0.4092	0.3848
0.02	50.00	0.6517	0.7004	0.5944	0.5990	0.3682	0.3486	0.4506	0.4358
0.025	40.00	0.7316	0.7582	0.6642	0.6473	0.4199	0.3821	0.5013	0.4658
0.03	33.33	0.7878	0.7680	0.7240	0.6684	0.4639	0.4040	0.5364	0.4766
0.04	25.00	0.8746	0.7440	0.8147	0.6807	0.5221	0.4183	0.5936	0.4850
0.05	20.00	0.8951	0.7051	0.8349	0.6631	0.5168	0.4039	0.5974	0.4684
0.075	13.33	0.9458	0.7245	0.8527	0.6560	0.5357	0.4055	0.6035	0.4577
0.1	10.00	0.8965	0.6653	0.7247	0.5446	0.4357	0.3199	0.5039	0.3719
0.13	7.50	0.8359	0.6493	0.6897	0.5168	0.4283	0.3157	0.4924	0.3640
0.15	6.67	0.8157	0.6439	0.6780	0.5075	0.4259	0.3143	0.4886	0.3614
0.2	5.00	0.7332	0.5805	0.7219	0.5475	0.4078	0.3077	0.4454	0.3361
0.25	4.00	0.6579	0.5687	0.7270	0.5638	0.3876	0.2965	0.4077	0.3145
0.3	3.33	0.6310	0.5263	0.6655	0.5223	0.3748	0.2923	0.3733	0.2938
0.4	2.50	0.5187	0.4582	0.5267	0.4216	0.2967	0.2360	0.3109	0.2478
0.5	2.00	0.4308	0.3829	0.4274	0.3454	0.2533	0.2042	0.2422	0.1953
0.75	1.33	0.2365	0.2126	0.2427	0.1967	0.1625	0.1326	0.1566	0.1278
1	1.00	0.1596	0.1434	0.1617	0.1327	0.1224	0.0999	0.1209	0.0987
1.3	0.75	0.1119	0.1006	0.1144	0.0933	0.0937	0.0760	0.0931	0.0756
1.5	0.67	0.0960	0.0863	0.0986	0.0802	0.0841	0.0681	0.0838	0.0679
2	0.50	0.0725	0.0633	0.0736	0.0576	0.0660	0.0513	0.0667	0.0519
2.5	0.40	0.0547	0.0473	0.0552	0.0428	0.0514	0.0396	0.0519	0.0399
3	0.33	0.0428	0.0365	0.0430	0.0329	0.0417	0.0317	0.0420	0.0319
4	0.25	0.0308	0.0263	0.0309	0.0236	0.0302	0.0230	0.0303	0.0231
5	0.20	0.0244	0.0208	0.0245	0.0186	0.0238	0.0180	0.0239	0.0180
7.5	0.13	0.0160	0.0137	0.0161	0.0122	0.0158	0.0119	0.0158	0.0119
10	0.10	0.0115	0.0098	0.0116	0.0088	0.0114	0.0085	0.0114	0.0086

Key: ft. = foot; Hz = hertz; sec. = second

Table 2.5-43
Magnitude and Distance of the Controlling Earthquakes for the North and Middle Plant Complexes

North and Middle Plant Complex	AFE 1E-4						AFE 1E-5					
	High Frequency		Low Frequency R < 100 km (62 mi.)		Low Frequency R > 100 km (62 mi.)		High Frequency		Low Frequency R < 100 km (62 mi.)		Low Frequency R > 100 km (62 mi.)	
Surface	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 24 ft.	6.4	67	6.3	25	7.3	322	6.3	22	6.5	17	7.4	300
Cut 10 ft.	6.4	68	6.3	25	7.3	322	6.3	22	6.6	17	7.4	300
Fill 15 ft.	6.4	69	6.3	25	7.3	322	6.3	19	6.6	17	7.4	300
Depth 44 ft.	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 24 ft.	6.4	71	6.3	25	7.3	323	6.3	23	6.5	17	7.4	300
Cut 10 ft.	6.4	69	6.3	25	7.3	322	6.3	23	6.6	17	7.4	301
Fill 15 ft.	6.4	70	6.3	25	7.3	322	6.3	23	6.5	17	7.4	300
Depth 85 ft.	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 24 ft.	6.4	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Cut 10 ft.	6.5	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Fill 15 ft.	6.5	72	6.3	25	7.3	322	6.3	24	6.5	17	7.4	300
Top of PWR	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 24 ft.	6.4	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Cut 10 ft.	6.5	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Fill 15 ft.	6.4	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300

Key: AFE = annual frequency of exceedance; ft. = foot; Hz = hertz; km = kilometer; M = magnitude; mi. = mile; PWR = partially weathered rock; R = distance; Rrup = distance to earthquake rupture

Table 2.5-44
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Ground Motion Response Spectra (GMRS) for the South Plant Complex

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal GMRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical GMRS
0.005	200.00	0.3209	0.8806	0.4318	0.2314	0.6736	0.3264
0.01	100.00	0.3539	1.0037	0.4889	0.2860	0.9124	0.4341
0.02	50.00	0.4768	1.4198	0.6848	0.4439	1.4866	0.7004
0.025	40.00	0.5255	1.5891	0.7642	0.4719	1.6164	0.7582
0.03	33.33	0.5720	1.7219	0.8288	0.4856	1.6582	0.7782
0.04	25.00	0.6312	1.8313	0.8880	0.4797	1.5932	0.7519
0.05	20.00	0.6594	1.8466	0.9017	0.4741	1.5216	0.7230
0.075	13.33	0.7120	1.9227	0.9458	0.4998	1.5055	0.7245
0.1	10.00	0.6976	1.8075	0.8965	0.4806	1.3665	0.6653
0.15	6.67	0.6967	1.6068	0.8157	0.4842	1.3095	0.6439
0.2	5.00	0.6055	1.4565	0.7332	0.4208	1.1914	0.5805
0.25	4.00	0.5691	1.2918	0.6579	0.4109	1.1680	0.5687
0.3	3.33	0.5381	1.2435	0.6310	0.3911	1.1809	0.5680
0.4	2.50	0.4467	1.0227	0.5199	0.3301	0.9765	0.4716
0.5	2.00	0.3947	0.9235	0.4675	0.2945	0.9133	0.4370
0.75	1.33	0.2054	0.5602	0.2750	0.1538	0.5596	0.2593
1	1.00	0.1327	0.3598	0.1768	0.1007	0.3594	0.1672
1.5	0.67	0.0822	0.2006	0.1007	0.0624	0.2010	0.0954
2	0.50	0.0634	0.1475	0.0748	0.0462	0.1444	0.0690
3	0.33	0.0378	0.0854	0.0436	0.0271	0.0819	0.0394
4	0.25	0.0277	0.0609	0.0312	0.0198	0.0584	0.0282
5	0.20	0.0218	0.0482	0.0247	0.0156	0.0462	0.0223
7.5	0.13	0.0138	0.0318	0.0162	0.0098	0.0305	0.0146
10	0.10	0.0100	0.0228	0.0116	0.0071	0.0217	0.0104

Key: Hz = hertz; sec. = second

Table 2.5-45
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 44 Ft. [13 M]) for the South Plant Complex

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 44 ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 44 ft.)
0.005	200.00	0.2722	0.7819	0.3799	0.2077	0.6106	0.2953
0.01	100.00	0.3011	0.9023	0.4347	0.2457	0.8075	0.3819
0.02	50.00	0.3991	1.2435	0.5944	0.3628	1.2858	0.5990
0.025	40.00	0.4404	1.3938	0.6642	0.3858	1.3952	0.6473
0.03	33.33	0.4778	1.5213	0.7240	0.3999	1.4391	0.6684
0.04	25.00	0.5524	1.7001	0.8147	0.4248	1.4502	0.6807
0.05	20.00	0.5708	1.7388	0.8349	0.4190	1.4084	0.6631
0.075	13.33	0.6115	1.7546	0.8527	0.4385	1.3739	0.6560
0.1	10.00	0.5521	1.5012	0.7374	0.3765	1.1559	0.5542
0.15	6.67	0.5281	1.3668	0.6780	0.3718	1.0388	0.5075
0.2	5.00	0.6045	1.4291	0.7219	0.4316	1.1004	0.5475
0.25	4.00	0.6217	1.4316	0.7270	0.4545	1.1267	0.5638
0.3	3.33	0.6094	1.4034	0.7126	0.4302	1.1185	0.5544
0.4	2.50	0.5114	1.1842	0.6007	0.3662	0.9556	0.4733
0.5	2.00	0.4585	1.1079	0.5572	0.3283	0.9018	0.4421
0.75	1.33	0.2306	0.7099	0.3401	0.1674	0.5800	0.2714
1	1.00	0.1422	0.4354	0.2089	0.1037	0.3587	0.1679
1.5	0.67	0.0854	0.2287	0.1127	0.0622	0.1868	0.0900
2	0.50	0.0654	0.1595	0.0801	0.0457	0.1266	0.0620
3	0.33	0.0383	0.0873	0.0444	0.0268	0.0678	0.0338
4	0.25	0.0280	0.0619	0.0317	0.0197	0.0481	0.0241
5	0.20	0.0221	0.0491	0.0251	0.0154	0.0378	0.0190
7.5	0.13	0.0140	0.0323	0.0164	0.0098	0.0248	0.0123
10	0.10	0.0101	0.0231	0.0118	0.0071	0.0177	0.0089

Key: Hz = hertz; m = meter; sec. = second

Table 2.5-46
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 85 Ft. [26 M]) for the South Plant Complex

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 85 ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 85 ft.)
0.005	200.00	0.2408	0.6875	0.3344	0.1895	0.5473	0.2656
0.01	100.00	0.2601	0.7726	0.3729	0.2161	0.6838	0.3259
0.02	50.00	0.3400	1.0516	0.5034	0.3087	1.0579	0.4962
0.025	40.00	0.3790	1.1822	0.5650	0.3316	1.1503	0.5382
0.03	33.33	0.4145	1.3000	0.6206	0.3477	1.2012	0.5625
0.04	25.00	0.4758	1.4744	0.7055	0.3683	1.2444	0.5853
0.05	20.00	0.5051	1.5248	0.7335	0.3763	1.2244	0.5802
0.075	13.33	0.5323	1.5334	0.7446	0.3875	1.1899	0.5705
0.1	10.00	0.5038	1.3949	0.6827	0.3602	1.0545	0.5104
0.15	6.67	0.4443	1.2611	0.6142	0.3177	0.9496	0.4577
0.2	5.00	0.4732	1.1654	0.5839	0.3464	0.8974	0.4451
0.25	4.00	0.5307	1.1961	0.6100	0.3975	0.9449	0.4768
0.3	3.33	0.5224	1.2088	0.6133	0.3949	0.9755	0.4885
0.4	2.50	0.4412	1.0041	0.5111	0.3379	0.8203	0.4122
0.5	2.00	0.4068	0.9459	0.4794	0.3157	0.7794	0.3903
0.75	1.33	0.2106	0.6108	0.2962	0.1649	0.5094	0.2439
1	1.00	0.1305	0.3829	0.1852	0.1025	0.3194	0.1527
1.5	0.67	0.0821	0.2152	0.1065	0.0637	0.1780	0.0870
2	0.50	0.0635	0.1529	0.0770	0.0471	0.1219	0.0605
3	0.33	0.0379	0.0861	0.0438	0.0276	0.0672	0.0337
4	0.25	0.0277	0.0612	0.0314	0.0202	0.0476	0.0241
5	0.20	0.0219	0.0485	0.0248	0.0159	0.0374	0.0189
7.5	0.13	0.0139	0.0320	0.0162	0.0100	0.0246	0.0124
10	0.10	0.0101	0.0230	0.0117	0.0073	0.0177	0.0089

Key: Hz = hertz; m = meter; sec. = second

Table 2.5-47
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Performance-Based Interface Response Spectrum (PBIRS) for the South Plant Complex

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal PBIRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical PBIRS
0.005	200.00	0.1852	0.5915	0.2813	0.1458	0.4673	0.2221
0.01	100.00	0.2080	0.6919	0.3264	0.1723	0.6061	0.2828
0.02	50.00	0.2802	0.9622	0.4511	0.2519	0.9477	0.4363
0.025	40.00	0.3100	1.0705	0.5013	0.2694	1.0116	0.4658
0.03	33.33	0.3311	1.1515	0.5385	0.2758	1.0398	0.4784
0.04	25.00	0.3744	1.2660	0.5953	0.2887	1.0495	0.4864
0.05	20.00	0.3836	1.2711	0.6002	0.2858	1.0093	0.4705
0.075	13.33	0.3969	1.2692	0.6035	0.2877	0.9735	0.4577
0.1	10.00	0.3493	1.0520	0.5063	0.2498	0.7827	0.3737
0.15	6.67	0.3603	0.9985	0.4886	0.2602	0.7429	0.3614
0.2	5.00	0.3499	0.8959	0.4454	0.2551	0.6818	0.3361
0.25	4.00	0.3310	0.8406	0.4186	0.2469	0.6540	0.3230
0.3	3.33	0.3117	0.7820	0.3904	0.2356	0.6217	0.3072
0.4	2.50	0.2480	0.6231	0.3109	0.1899	0.5016	0.2478
0.5	2.00	0.2162	0.5131	0.2590	0.1671	0.4182	0.2089
0.75	1.33	0.1455	0.3471	0.1750	0.1139	0.2863	0.1429
1	1.00	0.1082	0.2533	0.1282	0.0847	0.2090	0.1047
1.5	0.67	0.0739	0.1681	0.0856	0.0573	0.1375	0.0693
2	0.50	0.0590	0.1322	0.0675	0.0436	0.1042	0.0525
3	0.33	0.0370	0.0827	0.0422	0.0269	0.0635	0.0321
4	0.25	0.0271	0.0594	0.0305	0.0198	0.0456	0.0232
5	0.20	0.0212	0.0469	0.0240	0.0155	0.0357	0.0181
7.5	0.13	0.0136	0.0312	0.0158	0.0097	0.0237	0.0119
10	0.10	0.0099	0.0224	0.0114	0.0071	0.0171	0.0086

Key: Hz = hertz; sec. = second

Table 2.5-48
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 115 Ft. [35 M]) for the South Plant Complex

Period (sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal PBIRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (depth 115 ft.)
0.005	200.00	0.1590	0.5071	0.2412	0.1270	0.4051	0.1928
0.01	100.00	0.1741	0.5700	0.2698	0.1436	0.4891	0.2297
0.02	50.00	0.2337	0.8018	0.3759	0.2066	0.7543	0.3493
0.025	40.00	0.2628	0.9163	0.4283	0.2245	0.8310	0.3838
0.03	33.33	0.2874	1.0070	0.4702	0.2359	0.8771	0.4047
0.04	25.00	0.3281	1.1292	0.5292	0.2510	0.9090	0.4216
0.05	20.00	0.3292	1.1114	0.5228	0.2485	0.8724	0.4072
0.075	13.33	0.3509	1.1478	0.5434	0.2555	0.8700	0.4086
0.1	10.00	0.2968	0.9104	0.4366	0.2113	0.6721	0.3199
0.15	6.67	0.3082	0.8744	0.4259	0.2203	0.6506	0.3143
0.2	5.00	0.3102	0.8528	0.4180	0.2280	0.6413	0.3129
0.25	4.00	0.3171	0.8471	0.4176	0.2384	0.6540	0.3207
0.3	3.33	0.2960	0.7734	0.3830	0.2255	0.6102	0.3001
0.4	2.50	0.2431	0.5907	0.2967	0.1862	0.4742	0.2360
0.5	2.00	0.2101	0.5026	0.2533	0.1624	0.4096	0.2042
0.75	1.33	0.1418	0.3406	0.1715	0.1110	0.2810	0.1400
1	1.00	0.1048	0.2493	0.1258	0.0820	0.2057	0.1027
1.5	0.67	0.0720	0.1659	0.0842	0.0559	0.1357	0.0682
2	0.50	0.0577	0.1293	0.0660	0.0426	0.1019	0.0514
3	0.33	0.0366	0.0819	0.0418	0.0267	0.0629	0.0318
4	0.25	0.0269	0.0590	0.0303	0.0196	0.0453	0.0230
5	0.20	0.0211	0.0466	0.0239	0.0154	0.0355	0.0180
7.5	0.13	0.0135	0.0311	0.0158	0.0098	0.0236	0.0119
10	0.10	0.0098	0.0223	0.0114	0.0071	0.0170	0.0086

Key: ft. = foot; Hz = hertz; m = meter; sec. = second

Table 2.5-49
Interpolated Horizontal and Vertical Ground Motion Response Spectra (GMRS), Foundation Input Response Spectra (FIRS), and Performance-Based Interface Response Spectrum (PBIRS) for the South Plant Complex

Period	Frequency	GMRS		FIRS (Depth 44 ft.)		FIRS (Depth 85 ft.)		FIRS (Depth 115 ft.)		PBIRS	
(sec.)	(Hz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
0.005	200.00	0.4318	0.3264	0.3799	0.2953	0.3344	0.2656	0.2412	0.1928	0.2813	0.2221
0.0067	150.00	0.4603	0.3802	0.4073	0.3386	0.3537	0.2957	0.2555	0.2112	0.3039	0.2524
0.01	100.00	0.4889	0.4341	0.4347	0.3819	0.3729	0.3259	0.2698	0.2297	0.3264	0.2828
0.013	75.00	0.5869	0.5672	0.5145	0.4904	0.4381	0.4110	0.3229	0.2895	0.3888	0.3595
0.015	66.67	0.6195	0.6116	0.5411	0.5266	0.4599	0.4394	0.3405	0.3094	0.4095	0.3851
0.02	50.00	0.6848	0.7004	0.5944	0.5990	0.5034	0.4962	0.3759	0.3493	0.4511	0.4363
0.025	40.00	0.7642	0.7582	0.6642	0.6473	0.5650	0.5382	0.4283	0.3838	0.5013	0.4658
0.03	33.33	0.8288	0.7782	0.7240	0.6684	0.6206	0.5625	0.4702	0.4047	0.5385	0.4784
0.04	25.00	0.8880	0.7519	0.8147	0.6807	0.7055	0.5853	0.5292	0.4216	0.5953	0.4864
0.05	20.00	0.9017	0.7230	0.8349	0.6631	0.7335	0.5802	0.5228	0.4072	0.6002	0.4705
0.075	13.33	0.9458	0.7245	0.8527	0.6560	0.7446	0.5705	0.5434	0.4086	0.6035	0.4577
0.1	10.00	0.8965	0.6653	0.7374	0.5542	0.6827	0.5104	0.4366	0.3199	0.5063	0.3737
0.13	7.50	0.8359	0.6493	0.6929	0.5192	0.6313	0.4709	0.4285	0.3157	0.4931	0.3645
0.15	6.67	0.8157	0.6439	0.6780	0.5075	0.6142	0.4577	0.4259	0.3143	0.4886	0.3614
0.2	5.00	0.7332	0.5805	0.7219	0.5475	0.5839	0.4451	0.4180	0.3129	0.4454	0.3361
0.25	4.00	0.6579	0.5687	0.7270	0.5638	0.6100	0.4768	0.4176	0.3207	0.4186	0.3230
0.3	3.33	0.6310	0.5680	0.7126	0.5544	0.6133	0.4885	0.3830	0.3001	0.3904	0.3072
0.4	2.50	0.5199	0.4716	0.6007	0.4733	0.5111	0.4122	0.2967	0.2360	0.3109	0.2478
0.5	2.00	0.4675	0.4370	0.5572	0.4421	0.4794	0.3903	0.2533	0.2042	0.2590	0.2089
0.75	1.33	0.2750	0.2593	0.3401	0.2714	0.2962	0.2439	0.1715	0.1400	0.1750	0.1429
1	1.00	0.1768	0.1672	0.2089	0.1679	0.1852	0.1527	0.1258	0.1027	0.1282	0.1047
1.3	0.75	0.1197	0.1134	0.1367	0.1095	0.1262	0.1034	0.0946	0.0768	0.0962	0.0781
1.5	0.67	0.1007	0.0954	0.1127	0.0900	0.1065	0.0870	0.0842	0.0682	0.0856	0.0693
2	0.50	0.0748	0.0690	0.0801	0.0620	0.0770	0.0605	0.0660	0.0514	0.0675	0.0525
2.5	0.40	0.0560	0.0512	0.0587	0.0451	0.0571	0.0444	0.0515	0.0396	0.0524	0.0403
3	0.33	0.0436	0.0394	0.0444	0.0338	0.0438	0.0337	0.0418	0.0318	0.0422	0.0321
4	0.25	0.0312	0.0282	0.0317	0.0241	0.0314	0.0241	0.0303	0.0230	0.0305	0.0232
5	0.20	0.0247	0.0223	0.0251	0.0190	0.0248	0.0189	0.0239	0.0180	0.0240	0.0181
7.5	0.13	0.0162	0.0146	0.0164	0.0123	0.0162	0.0124	0.0158	0.0119	0.0158	0.0119
10	0.10	0.0116	0.0104	0.0118	0.0089	0.0117	0.0089	0.0114	0.0086	0.0114	0.0086

Key: ft. = foot; Hz = hertz; sec. = second

Table 2.5-50
Magnitude and Distance of the Controlling Earthquakes for the South Plant Complex

	AFE 1E-4						AFE 1E-5					
South Plant Complex	**High Frequency**		**Low Frequency R < 100 km (62 mi.)**		**Low Frequency R > 100 km (62 mi.)**		**High Frequency**		**Low Frequency R < 100 km (62 mi.)**		**Low Frequency R > 100 km (62 mi.)**	
Surface	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 38 ft.	6.4	67	6.3	25	7.3	323	6.3	22	6.5	17	7.4	300
Cut 24 ft.	6.4	67	6.3	25	7.3	322	6.3	22	6.5	17	7.4	300
Cut 10 ft.	6.4	68	6.3	25	7.3	322	6.3	22	6.6	17	7.4	300
Fill 40 ft.	6.4	68	6.3	26	7.3	323	6.2	21	6.5	18	7.4	300
Fill 15 ft.	6.4	69	6.3	25	7.3	322	6.3	19	6.6	17	7.4	300
Depth 44 ft.	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 38 ft.	6.4	71	6.3	26	7.3	323	6.3	23	6.5	18	7.4	300
Cut 24 ft.	6.4	71	6.3	25	7.3	323	6.3	23	6.5	17	7.4	300
Cut 10 ft.	6.4	69	6.3	25	7.3	322	6.3	23	6.6	17	7.4	301
Fill 40 ft.	6.4	69	6.3	26	7.3	323	6.3	22	6.5	18	7.4	299
Fill 15 ft.	6.4	70	6.3	25	7.3	322	6.3	23	6.5	17	7.4	300
Depth 85 ft.	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 38 ft.	6.4	71	6.3	26	7.3	323	6.3	24	6.5	18	7.4	300
Cut 24 ft.	6.4	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Cut 10 ft.	6.5	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Fill 40 ft.	6.4	65	6.3	25	7.3	322	6.3	22	6.6	17	7.4	299
Fill 15 ft.	6.5	72	6.3	25	7.3	322	6.3	24	6.5	17	7.4	300
Depth 115 ft.	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 38 ft.	6.4	71	6.3	26	7.3	323	6.3	24	6.5	18	7.4	300
Cut 24 ft.	6.4	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Cut 10 ft.	6.5	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Fill 40 ft.	6.5	71	6.3	25	7.3	323	6.3	23	6.5	18	7.4	300
Fill 15 ft.	6.5	72	6.3	25	7.3	322	6.3	24	6.5	17	7.4	300
Top of PWR	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup	**M**	Rrup
Cut 38 ft.	6.4	71	6.3	26	7.3	323	6.3	23	6.5	18	7.4	300
Cut 24 ft.	6.4	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Cut 10 ft.	6.5	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300
Fill 40 ft.	6.4	72	6.3	26	7.3	323	6.3	23	6.5	18	7.4	300
Fill 15 ft.	6.4	72	6.3	25	7.3	323	6.3	24	6.5	17	7.4	300

Key: AFE = annual frequency of exceedance; ft. = foot; km = kilometer; **M** = moment magnitude; mi. = mile; PWR = partially weathered rock; Rrup = rupture distance

Table 2.5-51
Summary of Reactor Base Mat Embedment Depths and Elevations

Technology	Base Depth (ft.)	Base EL.[(a)] (ft.)
Westinghouse	44	766
NuScale	83	727
Holtec	86	724
TerraPower	113.2	696.8
X-energy	115	695
GVH	125	685

Note: EL = elevation; ft: = feet

(a) Based on a final plant grade of Elevation 810 feet.

Table 2.5-52
Testing Summary – Borings
(Sheet 1 of 7)

	Equipment		As-Drilled Coordinates/Elevations			Drilling/Sampling					Downhole Testing							
Boring Number	Drill Rig	Termination Depth (ft.)	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	SPT[a]	Rock Coring	Bulk	Grab	UD[b]	Packer Testing	Dual Induction	Natural Gamma	E-Log[c]	Three-Arm Caliper	Acoustic Televiewer/ Borehole Deviation	Downhole Seismic	P-S Suspension Logging
B-1	CME750X	120.1	923,605.1	1,691,516.0	815.7	x	x											
B-1A	CME750X	201.3	923,613.9	1,691,519.8	815.1	x	x					x	x	x	x	x		x
B-1B	Diedrich D-70	24.0	923,610.3	1,691,520.0	815.0			x										
B-1C	Diedrich D-70	5.75	923,616.0	1,691,523.4	815.3					x								
B-2	Diedrich D-70	150.7	922,851.7	1,690,036.5	821.6	x	x											
B-2A	CME750X	31.0	922,850.0	1,690,040.2	822.1			x										
B-3	Diedrich D-70	301.0	922,973.9	1,691,010.2	842.9	x	x				x	x	x	x	x	x	x	x
B-3A	Diedrich D-70	132.0	922,971.0	1,691,003.8	842.6							x	x	x	x	x	x	x
B-3B	Diedrich D-70	56.0	922,971.5	1,691,012.3	842.4			x										
B-4	Diedrich D-70	150.5	922,951.7	1,692,113.9	799.1	x	x											
B-5	CME550X	201.0	922,549.7	1,690,869.0	818.1	x	x					x	x	x	x	x		x
B-5A	CME750X	43.0	922,552.1	1,690,865.9	818.5			x										
B-6	CME750X	201.0	919,711.9	1,688,755.3	815.1	x	x					x	x	x	x	x		x
B-6A	Diedrich D-70	33.0	919,709.9	1,688,750.6	815.3			x										

Table 2.5-52
Testing Summary – Borings
(Sheet 2 of 7)

	Equipment		As-Drilled Coordinates/Elevations			Drilling/Sampling					Downhole Testing							
Boring Number	Drill Rig	Termination Depth (ft.)	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	SPT[a]	Rock Coring	Bulk	Grab	UD[b]	Packer Testing	Dual Induction	Natural Gamma	E-Log[c]	Three-Arm Caliper	Acoustic Televiewer/ Borehole Deviation	Downhole Seismic	P-S Suspension Logging
B-6B	Diedrich D-70	19.8	919,713.6	1,688,753.0	815.2					x								
B-6C	Diedrich D-70	2.8	919,713.6	1,688,755.4	815.2					x								
B-7	Diedrich D-70	151.2	918,589.0	1,687,365.9	808.2	x	x											
B-7A	CME550X	20.0	918,589.7	1,687,362.0	808.2			x										
B-7B	CME550X	10.3	918,591.8	1,687,362.8	808.1					x								
B-8	CME750X	601.2	918,731.3	1,688,259.9	827.7	x	x				x	x	x	x	x	x	x	x
B-8A	CME750X	110.0	918,729.2	1,688,263.9	827.4							x	x	x	x	x	x	x
B-8B	Diedrich D-70	23.8	918,729.9	1,688,256.8	827.6					x								
B-8C	Diedrich D-70	13.8	918,732.1	1,688,256.7	827.6					x								
B-9	CME750X	151.0	918,553.2	1,689,394.7	825.5	x	x											
B-9A	CME550X	45.7	918,560.0	1,689,393.8	826.0			x	x									
B-9B	CME550X	45.8	918,563.2	1,689,393.6	825.7			x										
B-10	CME750X	55.1	918,052.5	1,688,611.7	788.6	x	x					x	x		x	x		x
B-10A	CME750X	201.1	918,048.3	1,688,605.0	788.3	x	x		x			x	x	x	x	x		x
B-11	CME550X	3.9	917,307.2	1,687,321.6	839.1	x												

Table 2.5-52
Testing Summary – Borings
(Sheet 3 of 7)

Boring Number	Equipment		As-Drilled Coordinates/Elevations			Drilling/Sampling					Downhole Testing							
	Drill Rig	Termination Depth (ft.)	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	SPT[a]	Rock Coring	Bulk	Grab	UD[b]	Packer Testing	Dual Induction	Natural Gamma	E-Log[c]	Three-Arm Caliper	Acoustic Televiewer/ Borehole Deviation	Downhole Seismic	P-S Suspension Logging
B-11A	CME550X	50.2	917,300.2	1,687,319.0	839.3	x						x	x		x	x		x
B-11B	CME550X	200.6	917,305.9	1,687,315.3	839.4		x					x	x	x	x	x		x
B-11C	Diedrich D-70	34.0	917,303.6	1,687,324.1	839.3			x										
B-11D	Diedrich D-70	17.8	917,306.0	1,687,320.5	839.4					x								
B-12	Diedrich D-70	151.5	917,011.7	1,686,026.8	838.0	x	x											
B-13	CME550X	300.6	916,893.0	1,686,509.0	836.3	x	x				x	x	x	x	x	x	x	x
B-13A	CME550X	39.4	916,889.7	1,686,511.9	836.4							x	x	x	x	x		x
B-13B	Diedrich D-70	40.0	916,896.1	1,686,511.3	836.4			x										
B-13C	Diedrich D-70	6.8	916,892.4	1,686,512.2	836.2					x								
B-14	CME550X	150.8	916,592.8	1,687,097.7	811.6	x	x											
B-14A	Diedrich D-70	51.0	916,595.4	1,687,099.7	811.6			x										
B-14B	Diedrich D-70	41.4	916,595.1	1,687,095.3	811.3	x				x								
B-14C	Diedrich D-70	2.8	916,590.8	1,687,097.8	811.2					x								
B-15	CME550X	81.7	916,088.3	1,686,030.2	848.9	x	x											
B-15A	CME550X	200.6	916,084.0	1,686,027.0	848.9		x		x			x	x	x	x	x		x

Table 2.5-52
Testing Summary – Borings
(Sheet 4 of 7)

Boring Number	Equipment	Termination Depth (ft.)	As-Drilled Coordinates/Elevations			Drilling/Sampling					Downhole Testing							
	Drill Rig		Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	SPT[a]	Rock Coring	Bulk	Grab	UD[b]	Packer Testing	Dual Induction	Natural Gamma	E-Log[c]	Three-Arm Caliper	Acoustic Televiewer/ Borehole Deviation	Downhole Seismic	P-S Suspension Logging
B-15B	CME550X	59.0	916,078.3	1,686,031.9	849.0							x	x	x	x	x		x
B-15C	Diedrich D-70	31.0	916,080.8	1,686,029.4	848.8			x										
B-15D	Diedrich D-70	21.8	916,079.4	1,686,026.6	848.9					x								
W-1A	CME550X	64.3	923,692.5	1,690,328.1	802.7	x	x											
W-1B	Diedrich D-70	84.5	923,697.4	1,690,326.4	802.5	x	x											
W-2A	CME750X	56.5	923,208.2	1,690,471.0	829.5	x	x											
W-2B	Diedrich D-70	101.1	923,202.5	1,690,464.5	829.4		x											
W-3A	Geoprobe 8140LS, CME750X	75.5	923,209.1	1,691,829.6	820.6		x		x									
W-4A	Geoprobe 8140LS, CME550X	66.9	922,871.2	1,691,393.8	826.1		x		x									
W-5A	Geoprobe 8140LS, CME550X	66.7	922,695.1	1,690,496.6	835.7		x		x									
W-5B	Diedrich D-70	91.1	922,697.7	1,690,490.6	835.8		x											
W-6A	Geoprobe 8140LS, CME550X	89.2	919,036.6	1,687,926.7	798.9		x		x									
W-7A	Geoprobe 8140LS, CME750X	90.5	919,063.4	1,688,462.0	815.4		x		x									
W-8A	Geoprobe 8140LS, CME550X	57.2	918,588.8	1,688,775.6	812.0		x		x									
W-9A	Geoprobe 8140LS, CME750X	77.0	918,532.4	1,687,704.7	823.2		x		x									

Table 2.5-52
Testing Summary – Borings
(Sheet 5 of 7)

	Equipment		As-Drilled Coordinates/Elevations			Drilling/Sampling					Downhole Testing							
Boring Number	Drill Rig	Termination Depth (ft.)	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	SPT[a]	Rock Coring	Bulk	Grab	UD[b]	Packer Testing	Dual Induction	Natural Gamma	E-Log[c]	Three-Arm Caliper	Acoustic Televiewer/ Borehole Deviation	Downhole Seismic	P-S Suspension Logging
W-9B	Diedrich D-70	101.0	918,524.3	1,687,700.3	823.4		x											
W-10A	Geoprobe 8140LS, CME750X	70.9	918,332.1	1,688,251.4	810.6		x		x									
W-11A	Geoprobe 8140LS, CME550X	100.5	917,695.8	1,687,051.8	817.4		x		x									
W-12A	Geoprobe 8140LS, CME550X	70.7	917,655.7	1,686,362.2	798.7		x		x									
W-13A	Geoprobe 8140LS, CME550X	79.3	917,098.7	1,686,918.8	842.6		x		x									
W-14A	Geoprobe 8140LS, CME550X	74.0	916,540.0	1,686,202.3	849.8		x		x									
W-15A	Geoprobe 8140LS, CME550X	78.7	916,304.0	1,686,744.7	774.5		x		x									
DW-1A	Diedrich D-70	200.3	923,473.2	1,691,105.7	836.8	x	x											
DW-2A	CME750X	200.3	923,266.4	1,692,366.4	801.2	x	x											
DW-3A	Diedrich D-70	200.8	922,848.6	1,689,838.5	811.3	x	x											
DW-4A	CME550X	200.9	922,668.8	1,690,993.2	830.6	x	x											
DW-5A	Diedrich D-70	200.8	919,683.7	1,688,445.9	813.0	x	x											
DW-6A	CME750X	200.6	919,102.9	1,689,201.0	819.4	x	x											
DW-7A	CME750X	200.1	918,848.9	1,687,673.7	803.9	x	x											
DW-8A	Diedrich D-70	200.8	918,184.1	1,687,757.8	803.1	x	x											

Table 2.5-52
Testing Summary – Borings
(Sheet 6 of 7)

	Equipment		As-Drilled Coordinates/Elevations			Drilling/Sampling					Downhole Testing							
Boring Number	Drill Rig	Termination Depth (ft.)	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	SPT[a]	Rock Coring	Bulk	Grab	UD[b]	Packer Testing	Dual Induction	Natural Gamma	E-Log[c]	Three-Arm Caliper	Acoustic Televiewer/ Borehole Deviation	Downhole Seismic	P-S Suspension Logging
DW-9A	CME550X	200.8	917,980.7	1,686,788.3	799.8	x	x											
DW-10A	CME550X	201.0	916,880.5	1,687,618.6	814.6	x	x											
DW-11A	CME750X	201.0	916,014.2	1,685,548.6	852.4		x		x									
DW-12A	CME550X	200.9	915,587.5	1,686,791.8	825.8	x	x											
S-1A	Diedrich D-70	116.5	923,757.8	1,690,265.5	798.1	x	x											
S-5A	Diedrich D-70	109.7	923,664.4	1,690,299.8	804.5	x	x											
S-7A	Diedrich D-70	79.5	919,065.7	1,687,896.6	794.6	x	x											
S-10A	Diedrich D-70	85.2	919,095.8	1,687,949.8	795.8	x	x											
S-11A	Diedrich D-70	169.2	918,036.9	1,686,710.9	794.0	x	x											
S-15A	Diedrich D-70	164.7	917,951.1	1,686,757.8	798.5	x	x											

Table 2.5-52
Testing Summary – Borings
(Sheet 7 of 7)

Notes:

Coordinates are North American Datum (NAD) 83 State Plane North Carolina FIPS 3200 (US Feet); elevations are North American Vertical Datum (NAVD) 1988.

(a) SPT - Standard Penetration Test

(b) UD - Undisturbed Sample (Shelby Tube Sampler)

(c) E-log includes single-point resistance, self-potential, long-normal, and short-normal resistivity, and electrical conductivity.

Below is a list of geotechnical borings terminated prior to planned depth or portion of depth rejected due to quality or mechanical constraints:

B-1: Boring terminated at 120.1 ft. due to tooling stuck in the hole. Re-assigned in offset as B-1A using the same drill rig to complete rock coring.

B-9A: Boring terminated at 45.7 ft. due to auger refusal. Sample was discarded and resampled in B-9B.

B-9B: Boring terminated at 45.8 ft. due to auger refusal.

B-10: Boring terminated at 55.1 ft. due to casing installation complications from a possible boulder. Re-assigned in offset as B-10A using the same drill rig

B-11: Boring terminated at 3.9 ft. due to tricone refusal. Re-assigned in offset as B-11A using the same drill rig.

B-11A: Boring terminated at 50.2 ft. due to tricone refusal and potential difficulties coring through PVC casing. Re-assigned in offset as B-11B using the same drill rig.

B-15: Boring terminated at 81.7 ft. due to complications with PVC casing during coring. Re-assigned in offset as B-15A using the same drill rig.

Key: ft = foot; SPT = standard penetration test

Table 2.5-53
Drilling Equipment

Driller	Drill Rig Model	Carrier Type	Owner	Auto Hammer	Hammer Serial Number	Auto Hammer Energy Ratio (%)	Rig Use
G. Owens	Geoprobe 8140LS	Track	Geologic Exploration	NA	NA	NA	Geotechnical (Rotosonic)
C. Lackey	CME 550X	All-terrain vehicle	Premier	Yes	336353	88	Geotechnical (Mud Rotary)
C. Maddox	CME 750X	All-terrain vehicle	Premier	Yes	323438	89	Geotechnical (Mud Rotary)
J. Messick	Diedrich D-70	Track	Geologic Exploration	Yes	047	89	Geotechnical (Mud Rotary)
B. Thomas	Geoprobe 3230DT	Track	Geologic Exploration	NA	NA	NA	Well Installation (Air Hammer)

Key: NA = Not Applicable

Table 2.5-54
Summary of Geotechnical Laboratory Testing

Test Standard	Test Description
ASTM D854-23	Specific Gravity of Soil Solids by Water Pycnometer
ASTM D1140-17	Amount of Material Finer than 75-µm (No. 200) Sieve
ASTM D1557-12(2021)	Laboratory Compaction Characteristics of Soil Using Modified Effort
ASTM D2166-16	Unconfined Compressive Strength of Cohesive Soil
ASTM D2216-19	Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2435/D2435M-11(2020)	One-Dimensional Consolidation Properties of Soils Using Incremental Loading
ASTM D2487-17e1	Classification of Soils for Engineering Purposes
ASTM D2850-23	Unconsolidated-Undrained Triaxial Compression Test
ASTM D2974-20e1	Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils
ASTM D4318-17e1	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4546-21	One-Dimensional Swell or Collapse of Soil
ASTM D4767-11(2020)	Consolidated-Undrained Triaxial Compression Test for Cohesive Soils
ASTM D5334-22ae1	Determination of Thermal Conductivity of Soil and Rock by Thermal Needle-Probe Procedure
ASTM D6913/D6913M-17	Particle-Size Distribution of Soils Using Sieve Analysis
ASTM D7012-23 Method C	Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
ASTM D7263-21	Laboratory Determination of Density and Unit weight of Soil Specimens
ASTM D7928-21e1	Particle-Size Distribution (Gradation) of Soils Using Hydrometer Analysis
ASTM G51-18	pH of Soil Used in Corrosion Testing
ASTM D4452-14	X-Ray Radiography of Soil Samples
ASTM D5607-16	Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force
ASTM D7012-23 Method B	Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
ASTM D7012-23 Method C	Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
ASTM D7012-23 Method D	Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
AASHTO T291-94(2018)	Water-Soluble Chloride Ion Content of Soil
ASTM C1580-20	Water-Soluble Sulfate Ion Content of Soil
RCTS	Resonant Column Torsional Shear Testing
URC	Unconfined, Free-Free Resonant Column Testing

Table 2.5-55
Summary of Soil Index Test Results
(Sheet 1 of 7)

Boring Number	Sample Number	Depth (ft.)	Sample Type	Specific Gravity	Gravel (%)	Sand (%)	Fines[(a)] (%)	Silt[(a)] (%)	Clay[(a)] (%) (<2mm)	USCS Symbol	Natural Moisture (%)	LL (%)	PI (%)
Assignment 1													
B-8	SS-2	2.9-4.4	SS	--	3.5	52.0	44.5	--	--	SM	19.3	NP	NP
B-8	SS-5	10.3-11.8	SS	--	0.0	39.4	60.6	--	--	ML	23.6	NP	NP
B-8	SS-7	15.3-16.8	SS	--	--	--	34.3	--	--	--	22.3	NT	NT
B-8	SS-10	22.8-24.3	SS	--	0.0	35.4	64.6	--	--	ML	27.0	NP	NP
B-8	SS-12	32.8-34.3	SS	--	0.0	66.5	33.5	--	--	SM	23.4	NP	NP
DW-2A	SS-6	12.9-14.4	SS	--	0.0	59.8	40.2	--	--	--	15.1	NT	NT
DW-2A	SS-10	22.9-24.4	SS	--	0.0	40.5	59.5	57.2	2.3	ML	30.1	NP	NP
DW-2A	SS-15	42.9-44.4	SS	--	0.0	41.7	58.3	56.4	1.9	ML	17.8	NP	NP
DW-4A	SS-4	8.5-10.0	SS	--	--	--	63.0	--	--	--	12.8	NT	NT
DW-4A	SS-5	11.0-12.5	SS	--	0.0	17.8	82.2	75.3	6.9	ML	20.4	NP	NP
DW-4A	SS-12	33.5-35.0	SS	--	0.0	31.3	68.7	63.1	5.6	ML	22.4	NP	NP
W-2A	SS-5	10.0-11.5	SS	--	--	--	27.4	--	--	--	14.3	NT	NT
W-2A	SS-6	12.4-13.9	SS	--	0.0	24.8	75.2	71.2	4.0	ML	29.0	NP	NP
W-2A	SS-7	15.0-16.5	SS	--	--	--	37.1	--	--	--	12.3	NT	NT
W-9A	GB-3A	10.0-12.5	GB	--	0.0	52.8	47.2	38.8	8.4	SM	18.9	NP	NP
W-9A	GB-3B	12.5-15.5	GB	--	--	--	57.3	--	--	--	21.5	NT	NT
W-10A	GB-7A	30.5-33.5	GB	--	0.0	5.0	95.0	91.8	3.2	ML	36.2	NP	NP
W-10A	GB-7B	33.5-35.5	GB	--	38.6	31.8	29.6	--	--	--	8.0	NT	NT
W-15A	GB-2	5.1-10.0	GB	--	0.4	51.8	47.8	26.0	21.8	SC	15.2	34	15
W-15A	GB-3	10.0-15.5	GB	--	--	--	33.8	--	--	--	15.0	NT	NT

Table 2.5-55
Summary of Soil Index Test Results
(Sheet 2 of 7)

Boring Number	Sample Number	Depth (ft.)	Sample Type	Specific Gravity	Gravel (%)	Sand (%)	Fines[a] (%)	Silt[a] (%)	Clay[a] (%) (<2mm)	USCS Symbol	Natural Moisture (%)	LL (%)	PI (%)
W-15A	GB-9A	40.5-43.0	GB	--	--	--	29.1	--	--	--	12.8	NT	NT
W-15A	GB-9B	43.0-45.6	GB	--	2.5	53.3	44.2	35.6	8.6	SM	19.0	NP	NP
Assignment 2													
B-1C	UD-1	2.0-3.8	UD	2.721	0.0	25.1	74.90	49.4	25.5	ML	29.3	NP	NP
B-1C	UD-2	4.0-5.8	UD	2.743	2.3	63.7	34.0	29.5	4.5	SM	16.3	NP	NP
B-6B	UD-2	3.0-4.8	UD	2.773	0.0	15.5	84.5	51.9	32.6	MH	29.2	56	17
B-6B	UD-3	6.0-7.8	UD	2.608	0.1	24.4	75.5	65.4	10.1	ML	23.0	NP	NP
B-6B	UD-4	8.0-9.8	UD	2.646	0.4	31.9	67.7	57.4	10.3	ML	32.5	NP	NP
B-6B	UD-5	16.0-17.8	UD	2.725	0.0	23.6	76.4	73.6	2.8	ML	35.0	NP	NP
B-6B	UD-6	18.0-19.8	UD	2.868	0.0	39.6	60.4	54.8	5.6	ML	25.7	NP	NP
B-7B	UD-1	6.5-8.3	UD	2.626	0.0	21.0	79.0	--	--	ML	38.1	NP	NP
B-7B	UD-2	8.5-10.3	UD	2.686	0.0	33.6	66.4	--	--	ML	24.7	NP	NP
B-8B	UD-1	10.0-11.8	UD	--	0.3	45.0	54.7	--	--	ML	26.4	NP	NP
B-8B	UD-2	12.0-13.8	UD	--	0.0	43.4	56.6	--	--	ML	33.1	NP	NP
B-8B	UD-4	22.0-23.8	UD	2.714	0.0	45.1	54.9	--	--	ML	19.0	NP	NP
B-8C	UD-1	10.0-11.8	UD	2.731	0.0	50.9	49.1	--	--	SM	22.4	NP	NP
B-8C	UD-2	12.0-13.8	UD	2.678	0.0	58.7	41.3	--	--	SM	25.0	NP	NP
B-11D	UD-1	0.5-2.3	UD	2.690	0.0	25.5	74.5	--	--	MH	35.1	64	22
B-11D	UD-2	8.3-10.1	UD	2.757	0.0	67.5	32.5	--	--	SM	19.4	NP	NP
B-11D	UD-3	16.0-17.8	UD	2.695	0.0	60.0	40.0	--	--	SM	24.1	NP	NP
B-13C	UD-1	1.0-2.8	UD	2.721	0.0	44.5	55.5	--	--	MH	32.6	60	17
B-13C	UD-2	3.0-4.8	UD	2.640	0.0	54.7	45.3	--	--	SM	29.9	55	NP
B-13C	UD-3	5.0-6.8	UD	2.631	2.1	79.5	18.4	--	--	SM	24.1	NP	NP

Table 2.5-55
Summary of Soil Index Test Results
(Sheet 3 of 7)

Boring Number	Sample Number	Depth (ft.)	Sample Type	Specific Gravity	Gravel (%)	Sand (%)	Fines[a] (%)	Silt[a] (%)	Clay[a] (%) (<2mm)	USCS Symbol	Natural Moisture (%)	LL (%)	PI (%)
B-14B	UD-2	3.0-4.8	UD	2.685	0.0	32.6	67.4	--	--	MH	23.6	69	24
B-14C	UD-1	1.0-2.8	UD	2.721	0.5	26.8	72.7	--	--	MH	35.4	80	42
B-15D	UD-1	16.0-17.8	UD	2.770	0.0	58.6	41.4	--	--	SM	47.2	57	NP
B-15D	UD-2	18.0-19.8	UD	2.755	0.0	55.6	44.4	--	--	SM	35.1	57	13
B-15D	UD-3	20.0-21.8	UD	2.769	0.9	44.5	54.6	--	--	ML	42.4	NP	NP
Assignment 3													
B-1	SS-4	7.1-8.6	SS	--	0.0	58.1	41.9	--	--	SM	16.2	NP	NP
B-1	SS-8	17.1-18.6	SS	--	2.7	49.1	48.2	--	--	SM	20.3	NP	NP
B-1	SS-10	22.1-23.6	SS	--	0.3	47.9	51.8	--	--	ML	25.1	NP	NP
B-1	SS-15	41.0-42.5	SS	--	0.0	55.6	44.4	--	--	SM	11.3	NP	NP
B-1	SS-18	56.0-57.5	SS	--	0.0	28.6	71.4	--	--	ML	21.6	NP	NP
B-1	SS-20	66.0-67.5	SS	--	0.0	31.0	69.0	--	--	ML	29.3	NP	NP
B-2	SS-3B	6.8-7.5	SS	--	0.0	25.5	74.5	--	--	ML	24.8	NP	NP
B-2	SS-8	18.5-20.0	SS	--	12.0	29.5	58.5	--	--	ML	11.9	NP	NP
B-2	SS-11	28.5-30.0	SS	--	0.0	56.8	43.2	--	--	SM	17.2	NP	NP
B-3	SS-4	8.5-10.0	SS	--	0.0	60.1	39.9	--	--	SM	9.6	NP	NP
B-3	SS-7	15.9-17.4	SS	--	0.0	69.0	31.0	--	--	SM	8.8	NP	NP
B-3	SS-16	53.5-55.0	SS	--	0.0	59.0	41.0	--	--	SM	14.6	NP	NP
B-4	SS-2	3.0-4.5	SS	--	0.0	71.6	28.4	--	--	SM	7.6	NP	NP
B-4	SS-5	10.9-11.7	SS	--	0.0	73.1	26.9	--	--	SM	12.9	NP	NP
B-4	SS-11	28.5-29.2	SS	--	1.6	64.7	33.7	--	--	SM	14.1	NP	NP
B-4	SS-17	58.5-58.9	SS	--	0.0	70.4	29.6	--	--	SM	18.0	NP	NP
B-4	SS-21B	78.7-79.8	SS	--	0.0	29.8	70.2	--	--	ML	24.3	NP	NP

Table 2.5-55
Summary of Soil Index Test Results
(Sheet 4 of 7)

Boring Number	Sample Number	Depth (ft.)	Sample Type	Specific Gravity	Gravel (%)	Sand (%)	Fines[a] (%)	Silt[a] (%)	Clay[a] (%) (<2mm)	USCS Symbol	Natural Moisture (%)	LL (%)	PI (%)
B-5	SS-3	6.0-7.5	SS	--	0.0	53.4	46.6	--	--	SM	25.1	NP	NP
B-5	SS-11A	28.6-29.3	SS	--	0.0	61.5	38.5	--	--	SM	14.0	NP	NP
B-5	SS-11B	29.3-30.1	SS	--	--	--	47.1	--	--	--	15.3	NT	NT
B-6	SS-2	3.3-4.8	SS	--	0.0	16.1	83.9	--	--	MH	28.6	56	18
B-6	SS-6	13.3-14.8	SS	--	0.0	49.2	50.8	--	--	ML	31.2	NP	NP
B-6	SS-12	33.3-34.8	SS	--	0.0	44.1	55.9	--	--	ML	21.9	NP	NP
B-6	SS-14A	43.3-44.0	SS	--	0.0	44.2	55.8	--	--	ML	22.3	NP	NP
B-7	SS-6	13.5-15.0	SS	--	5.0	51.3	43.7	--	--	SM	25.3	NP	NP
B-7	SS-8	18.5-20.0	SS	--	0.0	47.9	52.1	--	--	ML	26.1	NP	NP
B-7	SS-13	38.5-40.0	SS	--	0.0	39.4	60.6	--	--	ML	22.4	NP	NP
B-7	SS-16	53.5-54.8	SS	--	0.4	49.0	50.6	--	--	ML	16.1	NP	NP
B-9	SS-5	10.1-11.6	SS	--	0.4	45.2	54.4	--	--	ML	21.5	NP	NP
B-9	SS-6	12.6-14.1	SS	--	0.0	58.0	42.0	--	--	SM	20.5	NP	NP
B-9	SS-14	32.6-34.1	SS	--	2.0	56.4	41.6	--	--	SM	21.8	NP	NP
B-9	SS-15	35.1-36.6	SS	--	0.0	50.4	49.6	--	--	SM	20.5	NP	NP
B-10	SS-7	24.8-26.3	SS	--	5.1	28.3	66.6	--	--	ML	34.6	NP	NP
B-11	SS-2A	3.0-3.9	SS	--	0.0	42.4	57.6	--	--	ML	24.2	39	11
B-11A	SS-4	8.5-10.0	SS	--	0.0	59.4	40.6	--	--	SM	36.4	NP	NP
B-11A	SS-8	18.5-20.0	SS	--	0.0	67.4	32.6	--	--	SM	19.0	NP	NP
B-11A	SS-13	34.2-35.7	SS	--	0.0	47.6	52.4	--	--	ML	16.2	NP	NP
B-12	SS-2	2.9-4.4	SS	--	3.8	64.4	31.8	--	--	SM	10.6	NP	NP
B-12	SS-4	8.5-9.9	SS	--	0.6	71.7	27.7	--	--	SM	9.5	NP	NP
B-13	SS-1	0.0-1.5	SS	--	--	--	--	--	--	--	26.7	54	22

Table 2.5-55
Summary of Soil Index Test Results
(Sheet 5 of 7)

Boring Number	Sample Number	Depth (ft.)	Sample Type	Specific Gravity	Gravel (%)	Sand (%)	Fines[a] (%)	Silt[a] (%)	Clay[a] (%) (<2mm)	USCS Symbol	Natural Moisture (%)	LL (%)	PI (%)
B-13	SS-4	8.5-10.0	SS	--	0.0	60.0	40.0	--	--	SM	25.2	NP	NP
B-13	SS-9	21.0-22.5	SS	--	0.0	64.8	35.2	--	--	SM	25.5	NP	NP
B-13	SS-14	33.5-35.0	SS	--	0.0	61.8	38.2	--	--	SM	13.0	NP	NP
B-14	SS-7	16.0-17.5	SS	--	0.0	54.0	46.0	--	--	SM	30.9	NP	NP
B-14	SS-10	23.5-25.0	SS	--	0.0	66.1	33.9	--	--	SM	22.5	NP	NP
B-14	SS-15	36.0-37.5	SS	--	0.0	65.1	34.9	--	--	SM	24.9	NP	NP
B-14	SS-19	54.3-55.8	SS	--	0.0	67.3	32.7	--	--	SM	17.5	NP	NP
B-14B	SS-2	27.5-29.0	SS	--	0.0	71.7	28.3	--	--	SM	15.4	NP	NP
B-14B	SS-5	35.0-36.5	SS	--	0.0	70.6	29.4	--	--	SM	20.3	NP	NP
B-15	SS-2	3.0-4.5	SS	--	0.0	31.3	68.7	--	--	MH	29.3	65	NP
B-15	SS-5	11.0-12.5	SS	--	0.2	55.7	44.1	--	--	SM	34.4	NP	NP
B-15	SS-8	18.5-20.0	SS	--	0.0	39.6	60.4	--	--	ML	44.3	NP	NP
B-15	SS-10A	23.5-24.4	SS	--	0.0	56.9	43.1	--	--	--	52.8	NT	NT
B-15	SS-10B	24.4-25.0	SS	--	--	--	45.7	--	--	--	47.5	NT	NT
B-15	SS-14	39.0-40.5	SS	--	0.0	67.1	32.9	--	--	SM	13.7	NP	NP
DW-1A	SS-1	0.0-1.5	SS	--	37.0	31.1	31.9	--	--	--	5.4	NT	NT
DW-1A	SS-4	8.8-10.3	SS	--	9.3	60.3	30.4	--	--	SM	12.7	NP	NP
DW-1A	SS-8	18.5-20.0	SS	--	28.9	45.9	25.2	--	--	SM	16.4	NP	NP
DW-1A	SS-12	31.0-32.3	SS	--	27.8	43.0	29.2	--	--	SM	17.4	NP	NP
DW-2A	SS-3	5.4-6.9	SS	--	3.1	48.2	48.7	--	--	SM	28.5	NP	NP
DW-3A	SS-9	21.0-22.5	SS	--	0.5	73.5	26.0	22.8	3.2	SM	12.2	NP	NP
DW-3A	SS-14	43.6-45.1	SS	--	0.2	39.2	60.6	58.9	1.7	ML	26.2	NP	NP
DW-4A	SS-15A	48.5-48.9	SS	--	0.0	81.4	18.6	--	--	--	11.9	NT	NT

Table 2.5-55
Summary of Soil Index Test Results
(Sheet 6 of 7)

Boring Number	Sample Number	Depth (ft.)	Sample Type	Specific Gravity	Gravel (%)	Sand (%)	Fines[a] (%)	Silt[1] (%)	Clay[a] (%) (<2mm)	USCS Symbol	Natural Moisture (%)	LL (%)	PI (%)
DW-4A	SS-17	58.5-59.8	SS	--	0.0	56.0	44.0	39.4	4.6	SM	18.0	NP	NP
DW-5A	SS-1	0.0-1.5	SS	--	0.1	20.2	79.7	37.9	41.8	MH	10.8	59	27
DW-5A	SS-4	8.6-10.1	SS	--	0.0	30.1	69.9	64.3	5.6	ML	39.9	NP	NP
DW-5A	SS-7	16.0-17.5	SS	--	0.0	55.0	45.0	41.7	3.3	SM	34.1	NP	NP
DW-5A	SS-10	23.5-25.0	SS	--	0.2	50.8	49.0	46.6	2.4	SM	18.9	NP	NP
DW-6A	SS-1	0.0-1.5	SS	--	1.1	34.8	64.1	34.8	29.3	CL	24.3	35	12
DW-6A	SS-4	7.6-9.1	SS	--	1.4	46.5	52.1	44.6	7.5	ML	37.1	NP	NP
DW-6A	SS-8	17.6-19.1	SS	--	0.0	47.5	52.5	49.3	3.2	ML	35.1	NP	NP
DW-6A	SS-13	37.6-38.9	SS	--	0.1	68.9	31.0	27.3	3.7	SM	10.5	NP	NP
DW-7A	SS-3	5.4-6.9	SS	--	0.0	24.7	75.3	--	--	MH	33.7	67	18
DW-7A	SS-6	12.9-14.4	SS	--	0.0	53.4	46.6	--	--	SM	33.2	NP	NP
DW-7A	SS-8	17.9-19.4	SS	--	12.2	39.7	48.1	44.7	3.4	SM	22.5	NP	NP
DW-7A	SS-11	27.9-29.4	SS	--	0.0	43.0	57.0	55.0	2.0	ML	29.1	NP	NP
DW-8A	SS-1	0.0-1.5	SS	--	14.4	41.3	44.3	28.1	16.2	SM	13.0	37	11
DW-8A	SS-4	8.6-10.1	SS	--	0.1	29.2	70.7	65.6	5.1	ML	37.4	NP	NP
DW-8A	SS-7	16.0-17.5	SS	--	1.0	36.3	62.7	59.9	2.8	ML	30.1	NP	NP
DW-8A	SS-11	28.5-30.0	SS	--	0.2	47.2	52.6	49.2	3.4	ML	25.5	NP	NP
DW-8A	SS-14	43.5-44.8	SS	--	3.6	53.3	43.1	40.2	2.9	SM	14.8	NP	NP
DW-10A	SS-1	0.0-1.5	SS	--	0.0	29.2	70.8	28.3	42.5	MH	30.7	72	34
DW-10A	SS-5	11.3-12.8	SS	--	0.1	42.4	57.5	54.7	2.8	ML	25.7	NP	NP
DW-10A	SS-9	21.0-22.5	SS	--	1.2	47.7	51.1	47.7	3.4	ML	32.4	NP	NP
DW-10A	SS-14	43.7-45.2	SS	--	0.0	64.8	35.2	33.4	1.8	SM	21.9	NP	NP
DW-12A	SS-1	0.0-1.5	SS	--	0.0	28.5	71.5	28.2	43.3	CH	34.1	61	30

Table 2.5-55
Summary of Soil Index Test Results
(Sheet 7 of 7)

Boring Number	Sample Number	Depth (ft.)	Sample Type	Specific Gravity	Gravel (%)	Sand (%)	Fines[(a)] (%)	Silt[(a)] (%)	Clay[(a)] (%) (<2mm)	USCS Symbol	Natural Moisture (%)	LL (%)	PI (%)
DW-12A	SS-4	8.5-10.0	SS	--	7.7	59.2	33.1	28.5	4.6	SM	18.0	NP	NP
DW-12A	SS-8	18.5-20.0	SS	--	0.2	61.5	38.3	35.9	2.4	SM	18.1	NP	NP
DW-12A	SS-12	29.0-30.5	SS	--	0.2	62.5	37.3	34.1	3.2	SM	19.8	64	31
W-1A	SS-1	0.0-1.5	SS	--	0.0	35.6	64.4	46.7	17.7	CL	22.5	33	10
W-1A	SS-4	8.5-9.7	SS	--	0.3	60.5	39.2	35.3	3.9	SM	14.9	NP	NP
W-1A	SS-10	23.5-25.0	SS	--	0.1	55.8	44.1	41.7	2.4	SM	16.7	NP	NP
W-2A	SS-1	0.7-2.2	SS	--	0.9	18.8	80.3	28.9	51.4	CH	35.5	68	38
W-2A	SS-3	5.6-7.0	SS	--	1.2	61.8	37.0	33.2	3.8	SM	10.8	NP	NP
W-7A	GB-1B	3.5-5.0	GB	--	0.0	14.2	85.8	33.4	52.4	MH	35.7	81	39
W-7A	GB-2	5.0-10.0	GB	--	0.2	43.2	56.6	43.2	13.4	ML	33.3	NP	NP
W-8A	GB-1A	0.0-3.0	GB	--	0.8	33.1	66.1	21.8	44.3	MH	29.3	67	32
W-8A	GB-3	10.0-15.5	GB	--	41.5	40.1	18.4	--	--	GM	17.2	NP	NP
W-9A	GB-1A	0.0-2.5	GB	--	0.8	14.9	84.3	13.8	70.5	MH	37.1	101	59
W-9A	GB-10	45.5-46.8	GB	--	39.4	26.8	33.8	--	--	GM	11.4	38	11
W-11A	GB-5B	22.5-25.5	GB	--	0.1	53.7	46.2	41.8	4.4	SM	16.0	NP	NP
W-12A	GB-1B	3.0-5.0	GB	--	0.0	27.9	72.1	50.3	21.8	MH	32.4	55	NP
W-12A	GB-5A	20.5-23.5	GB	--	0.2	43.9	55.9	49.5	6.4	ML	19.4	NP	NP
W-12A	GB-5B	23.5-25.5	GB	--	0.4	52.2	47.4	41.3	6.1	SM	14.2	NP	NP
W-14A	GB-3A	10.0-12.6	GB	--	--	--	--	--	--	--	18.2	NP	NP
W-14A	GB-3B	12.6-13.6	GB	--	0.8	41.9	57.3	34.8	22.5	ML	29.4	NP	NP
W-14A	GB-6A	25.6-27.5	GB	--	0.7	69.1	30.2	25.8	4.4	SM	25.8	NP	NP
W-14A	GB-6B	27.5-30.0	GB	--	21.1	39.9	39.0	32.7	6.3	SM	18.9	NP	NP

Note:

(a) Fines content is Silt and Clay added together.

Key: ft. = feet; mm = micrometer (10-6 meter); NT = Not Tested due to insufficient sample; NP = Non-Plastic sample; USCS = Unified Soil Classification System; SS = Split Spoon Sample; UD = Undisturbed Sample; GB = Grab Sample; LL = Liquid Limit; PI : Plasticity Index

Table 2.5-56
Summary of Consolidation and Swell/Collapse Test Results

Boring Number	Sample Number	Depth (ft.)	Consolidation							Swell/Collapse		
						Initial		Final				
			Recompression Index Cr	Compression Index Cc	Preconsolidation Pressure (tsf)[a]	Dry Unit Weight (pcf)[b]	Moisture Content (%)[b]	Dry Unit Weight (pcf)[b]	Moisture Content (%)[b]	Overburden Pressure (tsf)	Heave (%)[c]	Swell Pressure (tsf)
Assignment 2												
B-1C*	UD-2	4.0-5.8	0.06	0.39	8.0	85.5	23.5	99.6	25.9			
B-6B*	UD-4	8.0-9.8	0.06	0.52	6.3	74.3	30.5	95.4	28.7			
B-6B**	UD-4	8.0-9.8	0.06	0.73	5.0	71.2	29.8	116.0	15.3			
B-6C*	UD-1	1.0-2.8	0.04	0.32	6.6	83.4	36.0	92.3	32.2			
B-8C*	UD-2	12.0-13.8	0.05	0.31	6.3	92.2	18.4	110.6	19.0			
B-8C**	UD-2	12.0-13.8	0.09	0.59	3.4	81.7	24.9	112.1	21.8			
B-11D*	UD-1	0.5-2.3	0.04	0.52	7.6	81.3	35.5	97.9	31.1			
B-13C*	UD-1	1.0-2.8	0.03	0.31	6.8	86.8	31.7	98.7	27.1			
B-13C**	UD-1	1.0-2.8	0.04	0.43	5.1	85.7	30.3	110.9	21.9			
B-14B*	UD-2	3.0-4.8	0.06	0.62	6.8	75.9	38.5	88.4	36.2			
B-15D*	UD-2	18.0-19.8	0.04	0.59	8.3	69.7	45.9	84.1	39.5			
B-15D**	UD-2	18.0-19.8	0.05	0.78	7.8	72.1	44.8	92.4	37.1			
B-02A	BK-1	21.0-31.0				98.9	11.9	107.4	20.4	0.25	-1.0	N/A
B-09A	BK-1	2.0-9.0				95.1	15.5	100.8	25.3	0.25	0.7	1.4
B-13B	BK-1	33.0-40.0				104.3	11.6	111.4	18.1	0.25	0.6	0.3

Notes:

(a) Preconsolidation pressure was estimated using Casagrande Graphical Method for Estimating Preconsolidation Pressure; see Section 2.5.4.10.3 for discussion on consolidation parameters.

(b) Initial and final dry unit weight and moisture obtained as part of consolidation testing.

(c) Negative values indicate samples experienced compression (collapsed) after adding water.

Key: ft. = foot; UD = undisturbed sample; BK = bulk sample; N/A = not applicable; pcf = pounds per cubic foot; tsf = tons per square foot

Table 2.5-57
Summary of Triaxial and Unconfined Compression Test Results
(Sheet 1 of 2)

Boring Number	Sample Number	Depth (Ft.)	USCS	Consolidated Undrained (CU) Triaxial				Unconsolidated Undrained (UU) Triaxial		Unconfined Compression (UC)
				Total Stress Parameters		Effective Stress Parameters				
				Friction Angle (Degrees)	Cohesion (psi)	Friction Angle (Degrees)	Cohesion (psi)	Confining Stress (psi)	Undrained Shear Strength (psi)	Undrained Shear Strength (psi)
UNDISTURBED SAMPLES										
B-1C	UD-2	4.0-5.8	SM	35.3	3.6	36.4	0	--	--	--
B-6B	UD-2 T	3.0-4.8	MH	--	--	--	--	2.1	16.1	--
B-6B	UD-2 M	3.0-4.8	MH	--	--	--	--	4.2	18.2	--
B-6B	UD-2 B	3.0-4.8	MH	--	--	--	--	8.3	18.9	--
B-6B	UD-4	8.0-9.8	ML	--	--	--	--	--	--	2.59
B-6B	UD-5 T	16.0-17.8	ML	--	--	--	--	3.5	7.58	--
B-6B	UD-5 M	16.0-17.8	ML	--	--	--	--	6.9	10.0	--
B-6B	UD-5 B	16.0-17.8	ML	--	--	--	--	13.9	21.0	--
B-6B	UD-6	18.0-19.8	ML	4.5	6.6	33.1	0.9	--	--	--
B-6C	UD-1	1.0-2.8	CL	--	--	--	--	--	--	8.25
B-7B	UD-1	6.5-8.3	ML	18.7	3.8	27.5	1.4	--	--	--
B-8B	UD-3 T	13.8-15.6	ML	--	--	--	--	3.5	8.61	--
B-8B	UD-3 B	13.8-15.6	ML	--	--	--	--	13.9	17.5	--
B-8C	UD-1	10.0-11.8	SM	1.9	6.6	29.1	1.3	--	--	--
B-8C	UD-2	12.0-13.8	SM	12.9	3.4	34.0	0	--	--	--
B-11D	UD-1 T	0.5-2.3	MH	--	--	--	--	1.0	8.74	--
B-11D	UD-1 M	0.5-2.3	MH	--	--	--	--	2.0	10.7	--

Table 2.5-57
Summary of Triaxial and Unconfined Compression Test Results
(Sheet 2 of 2)

Boring Number	Sample Number	Depth (Ft.)	USCS	Consolidated Undrained (CU) Triaxial				Unconsolidated Undrained (UU) Triaxial		Unconfined Compression (UC)
				Total Stress Parameters		Effective Stress Parameters				
				Friction Angle (Degrees)	Cohesion (psi)	Friction Angle (Degrees)	Cohesion (psi)	Confining Stress (psi)	Undrained Shear Strength (psi)	Undrained Shear Strength (psi)
B-11D	UD-1 B	0.5-2.3	MH	--	--	--	--	2.4	8.69	--
B-11D	UD-2	8.3-10.1	SM	0	5.8	0	5.4	--	--	--
B-13C	UD-2	3.0-4.8	SM	31.7	4.4	36.0	0	--	--	--
B-15D	UD-1	16.0-17.8	SM	20.3	3.3	33.4	0.8	--	--	--
BULK SAMPLES (REMOLDED)										
B-02A	BK-1	21.0-31.0	SM	34.5	9.4	30.2	2.3	--	--	--
B-09A	BK-1	2.0-9.0	ML	28.8	7.1	26.6	3.4	--	--	--
B-13B	BK-1	33.0-40.0	CL	24.9	6	26.1	1.8	--	--	--

Key: ft. = foot; psi = pound per square inch; USCS = Unified Soil Classification System

Table 2.5-58
Summary of Soil Unit Weight Determinations
(Sheet 1 of 2)

Boring Number	Sample Number	Depth (Ft.)	Sample Type	USCS Symbol	LL (%)[a]	PI (%)[a]	Dry Unit Weight (pcf)	Moisture Content (%)
Assignment 2								
B-1C	UD-2	4.0-5.8	UD	SM	NP	NP	83.7	34.3
B-1C[b]	UD-1	2.0-3.8	UD	ML	NP	NP	90.5	29.3
B-6B	UD-2	3.0-4.8	UD	MH	56	17	87.4	29.7
B-6B	UD-5	16.0-17.8	UD	ML	NP	NP	71.2	35.3
B-6B	UD-6	18.0-19.8	UD	ML	NP	NP	68.7	34.7
B-6B[b]	UD-3	6.0-7.8	UD	ML	NP	NP	75.1	23.0
B-7B	UD-1	6.5-8.3	UD	ML	NP	NP	77.4	32.6
B-7B[b]	UD-2	8.5-10.3	UD	ML	NP	NP	81.3	24.7
B-8B[b]	UD-4	22.0-23.8	UD	ML	NP	NP	84.7	19.0
B-8C	UD-1	10.0-11.8	UD	SM	NP	NP	84.3	24.0
B-8C	UD-2	12.0-13.8	UD	SM	NP	NP	78.7	27.0
B-11D	UD-2	8.3-10.1	UD	SM	NP	NP	66.8	23.1
B-11D[b]	UD-3	16.0-17.8	UD	SM	NP	NP	77.2	24.1
B-13C	UD-1	1.0-2.8	UD	MH	60	17	85.5	32.6
B-13C	UD-2	3.0-4.8	UD	SM	55	NP	84.3	35.3
B-13C[b]	UD-3	5.0-6.8	UD	SM	NP	NP	80.5	24.1
B-14B	UD-2	3.0-4.8	UD	MH	69	24	86.2	32.8
B-14C[b]	UD-1	1.0-2.8	UD	MH	80	42	76.4	35.4
B-15D	UD-1	16.0-17.8	UD	SM	57	NP	68.0	38.3
B-15D	UD-2	18.0-19.8	UD	SM	57	13	73.7	35.1
B-15D[b]	UD-3	20.0-21.8	UD	ML	NP	NP	68.4	42.4

Table 2.5-58
Summary of Soil Unit Weight Determinations
(Sheet 2 of 2)

Notes:

(a) Reported in the Soil Index Testing Results.

(b) Dry Unit Weight and Moisture Content Results Determined as part of Resonant Column Torsional Shear (RCTS) Testing.

Key: ft. = foot; LL = Liquid Limit; pcf = pound per cubic foot; PI = Plasticity Index; UD = undisturbed sample; USCS = Unified Soil Classification System

Table 2.5-59
Summary of Modified Proctor Tests

Boring Number	Depth (Ft.)	Sample Type	Sample No.	Modified Proctor		Natural Moisture Content (%)	USCS Soil Type	Liquid Limit	Plasticity Index
				Maximum Dry Density (pcf)	Optimum Moisture (%)				
B-01B	14.0-24.0'	Bulk	BK-1	114.4	13.5	22.9	ML	NP	NP
B-02A[(a)]	21.0-31.0'	Bulk	BK-1	118.5	12.2	9.7	SM	NP	NP
B-03B	46.0-56.0'	Bulk	BK-1	121.4	12.2	8.1	ML	NP	NP
B-05A	33.0-43.0'	Bulk	BK-1	110.9	13.3	31.9	ML	NP	NP
B-06A	1.0-5.0'	Bulk	BK-1	107.3	19.8	26.0	MH	66	22
B-06A	23.0-33.0'	Bulk	BK-2	115.4	14.9	21.7	CH	52	25
B-07A	13.0-20.0'	Bulk	BK-1	116.2	13.2	21.0	ML	43	NP
B-09A	2.0-9.0'	Bulk	BK-1	108.6	14.8	23.1	ML	NP	NP
B-09B	40.0-45.8'	Bulk	BK-1	121.1	10.3	18.0	SM	NP	NP
B-11C	26.0-34.0'	Bulk	BK-1	125.1	9.7	12.0	CL	48	21
B-13B	33.0-40.0'	Bulk	BK-1	123.1	11.5	18.0	CL	39	15
B-14A	11.0-18.0'	Bulk	BK-1	109.1	14.9	26.3	MH	72	NP
B-14A	41.0-51.0'	Bulk	BK-2	125.9	9.3	20.8	ML	41	15
B-15C	23.0-31.0'	Bulk	BK-1	101.8	23.4	16.3	MH	66	24

Note:

(a) Maximum dry density and optimum moisture content shown have been corrected coarse aggregate/rock particles retained on No.4 sieve.

Key: BK = Bulk Sample; ft. = foot; pcf = pound per square foot; USCS = Unified Soil Classification System

Table 2.5-60
Testing Summary – Surface Geophysics

Point ID	Coordinates/Elevations - End Point			Coordinates/Elevations - Middle Point			Coordinates/Elevations - End Point		
	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)	Northing (ft.)	Easting (ft.)	Ground Surface Elevation (ft.)
Array-1	924422.8	1692181.8	801.5	924035.0	1691955.2	785.7	923647.7	1691728.3	795.0
Array-2	923096.0	1691575.7	831.2	922996.5	1691293.3	839.5	922897.5	1691010.3	844.1
Array-3	923464.5	1690334.8	827.3	923132.0	1690557.1	833.2	922799.9	1690778.5	832.3
Array-4	922849.3	1689885.1	814.6	922738.4	1690320.1	832.0	922620.1	1690764.2	825.9
Array-5	919893.6	1688667.4	814.8	919497.2	1688719.4	811.2	919100.4	1688769.4	818.9
Array-6	918547.1	1687694.9	823.3	918679.0	1688072.2	825.9	918812.8	1688448.4	821.9
Array-7	918921.9	1688647.9	824.0	918564.6	1688271.1	815.2	918201.1	1687899.7	801.5
Array-8	918399.0	1687210.0	797.7	918306.9	1687495.2	799.9	918208.2	1687778.4	803.8
Array-9	917819.9	1687494.0	807.1	917458.9	1687149.2	827.5	917090.7	1686811.8	842.9
Array-10	916930.5	1686527.7	836.1	917027.7	1686915.4	838.4	917118.1	1687299.2	833.9
Array-11	916993.3	1686025.8	837.8	916941.0	1686320.8	835.6	916896.9	1686606.9	836.4
Array-12	915666.1	1685882.2	853.8	916204.5	1686146.3	845.4	916738.6	1686419.2	834.2
ER-1	923093.2	1691584.3	830.7	922978.1	1691308.0	839.1	922863.9	1691031.0	842.0
ER-2	923368.6	1690399.0	824.7	923118.6	1690564.1	833.4	922868.1	1690729.5	838.3
ER-3	918528.6	1687664.0	823.8	918638.2	1687942.4	822.8	918734.1	1688226.5	829.0
ER-4	918406.6	1687215.7	798.1	918305.7	1687498.3	799.9	918201.7	1687779.5	803.7
ER-5	917598.8	1687285.1	818.7	917379.6	1687081.0	831.1	917159.6	1686878.1	844.0
ER-6	916998.8	1686025.8	838.4	916948.9	1686321.5	835.0	916900.8	1686617.2	836.3

Notes:

All coordinates and elevations taken from as-built survey.

Horizontal/Vertical Datum: North Carolina State Plane Coordinates NAD 1983/NAVD 1988 GEOID18.

Key: ft. = foot

Table 2.5-61
Stratum Thicknesses and Elevations – North Plant Complex

	Boring	State Plane Coordinates (U.S. survey feet)		Ground EL (ft)	Thickness (ft.)				Bottom Elevation (ft.)			
		Northing	Easting		Residuum 1	Residuum 2	PWR	Fractured Rock	Residuum 1	Residuum 2	PWR	Fractured Rock
North Plant Complex	B-1/B-1A[(a)]	923605.1	1691516.0	815.7	6.6	72.7	3.8	51.3	809.2	736.5	732.7	681.4
	B-2	922851.7	1690036.5	821.6	15.4	16.4	12.0	1.0	806.2	789.9	777.9	776.9
	B-3	922973.9	1691010.2	842.9	5.3	12.7	60.2	0.0	837.7	825.0	764.8	764.8
	B-4	922951.7	1692113.9	799.1	2.3	5.7	78.4	28.2	796.9	791.2	712.8	684.6
	B-5	922549.7	1690869.0	818.1	8.0	43.8	18.0	5.0	810.1	766.4	748.4	743.4
	DW-1A	923473.2	1691105.7	836.8	0.0	30.5	20.8	0.0	836.8	806.4	785.6	785.6
	DW-2A	923266.4	1692366.4	801.2	27.4	20.5	0.0	0.0	773.8	753.3	753.3	753.3
	DW-3A	922848.6	1689838.5	811.3	15.5	33.1	0.0	1.1	795.8	762.7	762.7	761.6
	DW-4A	922668.8	1690993.2	830.6	2.5	46.4	19.0	16.8	828.1	781.7	762.7	745.9
	S-1A	923757.8	1690265.5	798.1	0.0	51.8	3.8	0.0	798.1	746.4	742.6	742.6
	S-5A	923664.4	1690299.8	804.5	2.3	3.0	43.4	5.9	802.3	799.3	755.9	750.0
	W-1A/W-1B[(a)]	923692.5	1690328.1	802.7	2.3	0.0	31.6	30.5	800.5	800.5	768.9	738.4
	W-2A/W-2B[(a)]	923208.2	1690471.0	829.5	3.0	16.0	7.0	14.0	826.5	810.5	803.5	789.5
	W-3A	923209.1	1691829.6	820.6	--	--	0.0	21.3	--	776.4	776.4	755.1
	W-4A	922871.2	1691393.8	826.1	--	--	10.1	24.0	--	800.6	790.5	766.5
	W-5A	922695.1	1690496.6	835.7	--	--	0.0	24.1	--	800.2	800.2	776.1
	Average			***818.4***	***7.0***	***27.1***	***19.2***	***14.0***	***809.0***	***784.0***	***764.5***	***750.5***
	Std Dev			***14.5***	***8.0***	***21.7***	***23.3***	***15.0***	***18.4***	***25.1***	***24.3***	***30.7***
	Max			***842.9***	***27.4***	***72.7***	***78.4***	***51.3***	***837.7***	***825.0***	***803.5***	***789.5***
	Min			***798.1***	***0.0***	***0.0***	***0.0***	***0.0***	***773.8***	***736.5***	***712.8***	***681.4***

Notes:

(a) The coordinates and ground elevation for the parent boring are shown. The offset boring is within 10 ft. (distance), with less than 1-ft. **elevation difference relative to the parent boring.**

Cells with dashed lines ("--") indicate the boring did not have standard penetration test (SPT) and/or rock coring performed; thus, no contact elevation was identified.

Key: EL = elevation; ft. = foot; max = maximum; min = minimum; PWR = partially weathered rock; Std Dev = standard deviation

Table 2.5-62
Stratum Thicknesses and Elevations – Middle Plant Complex

	Boring	State Plane Coordinates (U.S. survey feet)		Ground EL (ft)	Thickness (ft.)				Bottom Elevation (ft.)			
		Northing	Easting		Residuum 1	Residuum 2	PWR	Fractured Rock	Residuum 1	Residuum 2	PWR	Fractured Rock
Middle Plant Complex	**B-6**	919711.9	1688755.3	815.1	31.6	10.0	5.5	8.0	783.6	773.6	768.1	760.1
	B-7	918589.0	1687365.9	808.2	13.0	28.8	18.9	0.0	795.3	766.5	747.6	747.6
	B-8	918731.3	1688259.9	827.7	26.1	10.0	4.4	0.0	801.7	791.7	787.3	787.3
	B-9	918553.2	1689394.7	825.5	27.6	20.0	0.3	4.7	797.9	777.9	777.6	772.9
	B-10/B-10A[(a)]	918052.5	1688611.7	788.6	2.7	2.2	24.0	0.0	785.9	783.7	759.7	759.7
	DW-5A	919683.7	1688445.9	813.0	23.0	7.3	0.0	1.5	790.0	782.7	782.7	781.2
	DW-6A	919102.9	1689201.0	819.4	25.9	10.0	3.1	21.2	793.6	783.6	780.5	759.3
	DW-7A	918848.9	1687673.7	803.9	22.5	9.3	0.0	5.6	781.4	772.1	772.1	766.5
	DW-8A	918184.1	1687757.8	803.1	18.0	24.0	6.5	0.0	785.1	761.1	754.7	754.7
	S-7A	919065.7	1687896.6	794.6	18.0	28.8	21.7	11.0	776.6	747.8	726.1	715.1
	S-10A	919095.8	1687949.8	795.8	0.0	71.8	2.5	0.0	795.8	724.1	721.6	721.6
	W-6A	919036.6	1687926.7	798.9	--	--	23.2	0.6	--	763.4	740.2	739.6
	W-7A	919063.4	1688462.0	815.4	--	--	20.0	28.0	--	774.9	754.9	726.9
	W-8A	918588.8	1688775.6	812.0	--	--	16.5	2.7	--	802.0	785.5	782.8
	W-9A	918532.4	1687704.7	823.2	--	--	0.0	0.0	--	776.4	776.4	776.4
	W-10A	918332.1	1688251.4	810.6	--	--	7.0	0.0	--	777.1	770.1	770.1
	Average			***809.7***	***18.9***	***20.2***	***9.6***	***5.2***	***789.5***	***772.0***	***762.5***	***757.5***
	Std Dev			***11.5***	***10.1***	***19.3***	***9.3***	***8.4***	***7.8***	***18.0***	***20.5***	***22.2***
	Max			***827.7***	***31.6***	***71.8***	***24.0***	***28.0***	***801.7***	***802.0***	***787.3***	***787.3***
	Min			***788.6***	***0.0***	***2.2***	***0.0***	***0.0***	***776.6***	***724.1***	***721.6***	***715.1***

Notes: Note: EL – elevation; ft. = foot; PWR = partially weathered rock

(a)* The coordinates and ground elevation for the parent boring are shown. The offset boring is within 10 ft. (distance), with less than 1-ft. elevation difference relative to the parent boring.

Cells with dashed lines ("--") indicate the boring did not have standard penetration test (SPT) and/or rock coring performed; thus, no contact elevation was identified.

Key: EL – elevation; ft. = foot; max = maximum; min = minimum; PWR = partially weathered rock; Std Dev = standard deviation

Table 2.5-63
Stratum Thicknesses and Elevations – South Plant Complex

	Boring	State Plane Coordinates (U.S. survey feet)		Ground EL (ft.)	Thickness (ft.)				Bottom Elevation (ft.)			
		Northing	Easting		Residuum 1	Residuum 2	PWR	Fractured Rock	Residuum 1	Residuum 2	PWR	Fractured Rock
South Plant Complex	**B-11A/B-11B***	917300.2	1687319.0	839.3	32.5	10.0	11.9	10.0	806.8	796.8	784.9	774.9
	B-12	917011.7	1686026.8	838.0	2.2	5.8	5.6	0.0	835.8	830.1	824.5	824.5
	B-13	916893.0	1686509.0	836.3	28.0	13.0	0.0	3.8	808.3	795.3	795.3	791.5
	B-14	916592.8	1687097.7	811.6	25.5	37.1	4.2	0.0	786.1	749.1	744.9	744.9
	B-15/B-15A[(a)]	916088.3	1686030.2	848.9	28.2	24.1	6.0	10.9	820.7	796.7	790.7	779.8
	DW-9A	917980.7	1686788.3	799.8	10.5	21.5	3.2	24.4	789.3	767.9	764.7	740.3
	DW-10A	916880.5	1687618.6	814.6	27.0	20.0	19.3	8.6	787.6	767.7	748.4	739.8
	DW-11A	916014.2	1685548.6	852.4	--	--	8.9	15.6	--	807.0	798.1	782.5
	DW-12A	915587.5	1686791.8	825.8	20.5	13.0	0.7	0.0	805.3	792.3	791.6	791.6
	S-11A	918036.9	1686710.9	794.0	15.5	28.8	0.0	0.0	778.5	749.7	749.7	749.7
	S-15A	917951.1	1686757.8	798.5	20.5	11.2	7.0	0.0	778.0	766.8	759.8	759.8
	W-11A	917695.8	1687051.8	817.4	--	--	15.2	4.1	--	767.1	751.9	747.8
	W-12A	917655.7	1686362.8	798.7	--	--	5.0	0.0	--	763.2	758.2	758.2
	W-13A	917098.7	1686918.8	842.6	--	--	8.2	15.7	--	802.1	793.9	778.2
	W-14A	916540.0	1686202.3	849.8	--	--	0.6	6.4	--	807.8	807.2	800.8
	W-15A	916304.0	1686744.7	774.5	--	--	5.5	0.0	--	731.5	726.0	726.0
	Average			***821.4***	***21.0***	***18.4***	***6.3***	***6.2***	***799.5***	***780.5***	***774.0***	***768.0***
	Std Dev			***23.7***	***9.3***	***9.7***	***5.5***	***7.4***	***19.0***	***26.6***	***27.3***	***26.6***
	Max			***852.4***	***32.5***	***37.1***	***19.3***	***24.4***	***835.8***	***830.1***	***824.5***	***824.5***
	Min			***774.5***	***2.2***	***5.8***	***0.0***	***0.0***	***778.0***	***731.5***	***726.0***	***726.0***

(a) The coordinates and ground elevation for the parent boring are shown. The offset boring is within 10 ft. (distance), with less than 1-ft. elevation difference relative to the parent boring.

Cells with dashed lines ("--") indicate the boring did not have standard penetration test (SPT) and/or rock coring performed; thus, no contact elevation was identified.

Key: EL = elevation; ft. = foot; max = maximum; min = minimum; PWR = partially weathered rock; Std Dev = standard deviation

Table 2.5-64
Summary of Static Soil Engineering Properties for Strata I, II, and III
(Sheet 1 of 2)

Parameter	Description	Stratum I – Residuum 1	Stratum II – Residuum 2	Stratum III – PWR
USCS Groups	Lab Testing	SM/SC/ML/ MH/CL/CH	SM/ML/GM	--
Field SPT-N_{Field} (bpf)[a]	Lower Bound	*5*	*13*	*>100*
	Best Estimate	***8***	***28***	***>100***
	Upper Bound	*14*	*60*	*>100*
Hammer Efficiency (ER)	All Complexes		88 – 89%	
SPT-N_{60} (bpf)[a]	Lower Bound	*7*	*20*	*>100*
	Best Estimate	***13***	***42***	***>100***
	Upper Bound	*22*	*89*	*>100*
SPT-$(N1)_{60}$ (bpf)[a]	Lower Bound	*8*	*15*	*>100*
	Best Estimate	***15***	***36***	***>100***
	Upper Bound	*25*	*84*	*>100*
Dry Unit Weight, γ_{dry} (pcf)	Lab Testing	66.8 – 90.5 (Mean 78.1)	87.4	--
Moisture Content, MC (%)[b]	Lab Testing	19 – 42.4 (Mean 30.4)	29.7	--
Total Unit Weight, γ_{total} (pcf)	Lab Testing	82.2 – 117.0 (Mean 101.7)	113.4	--
	Lower Bound	*82*	*110*	*130*
	Best Estimate	***100***	***115***	***135***
	Upper Bound	*117*	*130*	*140*
Fines Content (%)	Lab Testing	18.4 – 95.0 (Mean 50.1)		--
Plasticity Index (PI)[c]	Lab Testing	10.0 – 59.0 (Mean 24.0)		--
Effective Stress Friction Angle, ϕ' (deg)	Lower Bound	*29*	*32*	*40*
	Best Estimate	***31***	***36***	***43***
	Upper Bound	*34*	*40*	*45*

Table 2.5-64
Summary of Static Soil Engineering Properties for Strata I, II, and III
(Sheet 2 of 2)

Parameter	Description	Stratum I – Residuum 1	Stratum II – Residuum 2	Stratum III – PWR
Effective Cohesion, c' (psf)[d]	**Best Estimate**	***50***		***0***
Total Stress Strength Parameters, c and ϕ[e]	**Best Estimate**	***c = 270 psf*** ***φ = 23 deg***		--
Static Poisson's Ratio, v	Lower Bound	*0.20*	*0.20*	*0.10*
	Best Estimate	***0.30***	***0.30***	***0.25***
	Upper Bound	*0.40*	*0.40*	*0.40*
Elastic Modulus, E (tsf)	Lower Bound	*40*	*80*	*500*
	Best Estimate	***65***	***150***	***1,000***
	Upper Bound	*105*	*300*	*2,000*
Concrete-Soil Ultimate Interface Friction Factor, tan(δ)[f]	**Best Estimate**	***--***	***--***	***0.64***

Notes:

(a) Based on lognormal distribution assumption; lower bound taken as 5th percentile, best estimate as 50th percentile and upper bound as 95th percentile.

(b) As measured during unit weight determinations.

(c) Majority of samples tested were non-plastic; values shown are for the plastic samples only.

(d) For slope stability analyses only for cut slopes in Stratum I and/or Stratum II under unsaturated conditions. If there is a potential for the residual soils in the cut slope to become saturated, then effective cohesion should be zero.

(e) For undrained slope stability analyses during Rapid Drawdown conditions.

(f) No value shown for Stratum I and II because safety-related structures will not be founded on these strata. Per Section 2.5.4.3.2, structural backfill with a minimum friction angle of 40 degrees has an ultimate coefficient of interface static sliding friction of 0.59

Key: bpf = blows per foot; PWR = partially weathered rock; SPT = standard penetration test; psf = pounds per square foot; tsf = tons per square foot; USCS = Unified Soil Classification System

Table 2.5-65
Summary of Static Rock Engineering Properties for Strata IV and V
(Sheet 1 of 2)

Parameter	Description	Stratum IV – Fractured Rock	Stratum V – Sound Rock
Total Unit Weight, γ_{total} (pcf)	Lab Testing	161.9 – 195.3 (Avg. 169.6)	
	Best Estimate	*170*	
Unconfined Compressive Strength, UCS (psi)	Lab Testing	1,580 – 28,440 (Avg. 14,324)	
	Best Estimate[(a)]	*7,890*	
Elastic Modulus of Intact Rock, E_i (psi)	Lab Testing	4.09E+05 – 1.02E+07 (Avg. 5.15E+06)	
	Best Estimate[(a)]	*3.48E+06*	
Poisson's Ratio of Intact Rock, v	Lab Testing	0.01 – 0.19 (Avg. 0.08)	
	Best Estimate	*0.10*	
Rock Quality Designation, RQD (%)	Field Testing	0 - 49	50 - 100
Geologic Strength Index, GSI	Lower Bound	14	44
	Best Estimate	30	70
	Upper Bound	45	95
Equivalent Rock Mass Mohr-Coulomb Strength Parameters, c and ϕ[(a)]	Lower Bound	c = 0 psi, ϕ = 40 deg	c = 51 psi, ϕ = 47 deg
	Best Estimate	**c = 34 psi, ϕ = 41 deg**	**c = 157 psi, ϕ = 55 deg**
	Upper Bound	c = 53 psi, ϕ = 48 deg	c = 888 psi, ϕ = 55 deg

Table 2.5-65
Summary of Static Rock Engineering Properties for Strata IV and V
(Sheet 2 of 2)

Parameter	Description	Stratum IV – Fractured Rock	Stratum V – Sound Rock
Rock Mass Deformation Elastic Modulus, E_{rm} (psi) [(a)]	Lower Bound	44,800	345,250
	Best Estimate	153,155	1,522,260
	Upper Bound	368,480	2,481,610
Rock Mass Deformation Shear Modulus, G_{rm} (psi) [(a)]	Lower Bound	20,365	156,930
	Best Estimate	69,615	691,935
	Upper Bound	167,490	1,128,005
Concrete-Soil Ultimate Interface Friction Factor, tan(δ)	Best Estimate	0.70[(b)]	0.70

Note:

(a) Values shown based on the weaker schist.

(b) Following ground improvement as discussed in Section 2.5.4.12

Table 2.5-66
Dynamic Soil and Rock Properties Based on Best-Estimate Suspension Logging Velocity Profile

Layer	Top Elevation (ft.)	Bottom Elevation (ft.)	Layer Thickness (ft.)	Total Unit Weight, γ (pcf)	V_S (ft/s)	V_P (ft/s)	Poisson's Ratio, v	$G_{max} = p*Vs^2$ (ksf)	$E_{max} = 2*G_{max}*(1+v)$ (ksf)	D_{S0} (%)
FILL		VARIES		120	1,000	2,000	0.33	3,730	9,946	1.3
1	825.8	816.9	8.9	100	722	1,573	0.37	1,620	4,428	1.8
2	816.9	806.7	10.2	100	945	1,870	0.33	2,776	7,375	1.8
3	806.7	796.9	9.8	100	982	2,224	0.38	2,997	8,266	1.8
4	796.9	786.2	10.7	115	1,035	2,425	0.39	3,829	10,634	1.8
5	786.2	781.4	4.8	115	1,419	3,704	0.41	7,197	20,353	1.8
6	781.4	777.2	4.2	135	2,869	6,964	0.40	34,537	96,552	1.0
7	777.2	772.2	5.0	170	5,096	10,460	0.34	137,215	368,941	0.9
8	772.2	766.2	6.0	170	6,795	13,611	0.33	243,962	650,900	0.9
9	766.2	757.7	8.5	170	8,794	16,637	0.31	408,617	1,067,420	0.7
10	757.7	729.4	28.4	170	9,019	16,894	0.30	429,794	1,118,062	0.7
11	729.4	688.2	41.2	170	8,815	16,482	0.30	410,571	1,067,224	0.7
12	688.2	639.9	48.3	170	9,171	16,886	0.29	444,403	1,147,279	0.7
13	639.9	591.2	48.7	170	9,087	16,856	0.30	436,300	1,130,151	0.7
14	591.2	550.6	40.6	170	9,137	17,042	0.30	441,114	1,145,391	0.7
15	550.6	235.7	315.0	170	10,494	18,019	0.24	581,870	1,446,963	0.7

Key: ft. = foot; ft/s = foot per second; G_{max} = maximum shear modulus; E_{max} = maximum Young's modulus; p= mass density; pcf = ksf = kips per square foot; pounds per cubic foot; V_P = compression wave velocity; V_S = shear wave velocity

Table 2.5-67
Dynamic Soil and Rock Properties Based on Best-Estimate Spectral Analysis of Surface Waves (SASW) Velocity Profile

Layer	Top Elevation (ft.)	Bottom Elevation (ft.)	Layer Thickness (ft.)	Total Unit Weight, γ (pcf)	V_s (ft/s)	V_p (ft/s)	Poisson's Ratio, v	$G_{max} = p*Vs^2$ (ksf)	$E_{max} = 2*G_{max}*(1+v)$ (ksf)	D_{S0} (%)
FILL		VARIES		120	1,000	2,000	0.33	3,730	9,946	1.3
1	823.6	817.6	6.0	100	584	1,159	0.33	1,060	2,819	1.8
2	817.6	810.6	7.0	100	584	1,159	0.33	1,060	2,819	1.8
3	810.6	801.6	9.0	100	893	1,772	0.33	2,479	6,592	1.8
4	801.6	791.6	10.0	115	893	1,772	0.33	2,850	7,581	1.8
5	791.6	766.6	25.0	115	939	2,253	0.39	3,152	8,792	1.8
6	766.6	761.6	5.0	135	2,272	4,968	0.37	21,659	59,250	1.0
7	761.6	755.6	6.0	135	2,272	4,968	0.37	21,659	59,250	1.0
8	755.6	749.6	6.0	135	2,272	4,968	0.37	21,659	59,250	1.0
9	749.6	731.6	18.0	135	2,272	4,968	0.37	21,659	59,250	1.0
10	731.6	694.6	37.0	135	2,272	4,968	0.37	21,659	59,250	1.0
11	694.6	646.6	48.0	135	2,272	4,968	0.37	21,659	59,250	1.0
12	646.6	593.6	53.0	170	7,128	12,273	0.25	268,460	668,731	0.9
13	593.6	538.6	55.0	170	7,128	12,273	0.25	268,460	668,731	0.9
14	538.6	483.6	55.0	170	7,128	12,273	0.25	268,460	668,731	0.9
15	483.6	283.6	200.0	170	7,128	12,273	0.25	268,460	668,731	0.9

Key: ft. = foot; ft/s = foot per second; G_{max} = maximum shear modulus; E_{max} = maximum Young's modulus; p= mass density; pcf = pounds per cubic foot; ksf = kips per square foot; V_P = compression wave velocity; V_S = shear wave velocity

Table 2.5-68
Shear Wave Velocity Profile from Suspension P-S Logging for All Plant Complexes

Layer	Material Type	Top Depth		Thickness		Top Elevation	Bottom Elevation	Average V_S		Average V_P	
		ft.	m	ft.	m	ft.	ft.	ft/s	m/s	ft/s	m/s
1	Residual Soil	0.0	0.0	8.9	2.7	825.8	816.9	722	220	1573	479
2	Residual Soil	8.9	2.7	10.2	3.1	816.9	806.7	945	288	1870	570
3	Residual Soil	19.1	5.8	9.8	3.0	806.7	796.9	982	299	2224	678
4	Residual Soil	28.9	8.8	10.7	3.3	796.9	786.2	1035	315	2425	739
5	Residual Soil	39.6	12.1	4.8	1.5	786.2	781.4	1419	433	3704	1129
6	PWR	44.4	13.5	4.2	1.3	781.4	777.2	2869	874	6964	2123
7	Rock, Transition	48.6	14.8	5.0	1.5	777.2	772.2	5096	1553	10,460	3188
8	Rock, Transition	53.5	16.3	6.1	1.8	772.2	766.2	6795	2071	13,611	4149
9	Rock	59.6	18.2	8.5	2.6	766.2	757.7	8794	2680	16,637	5071
10	Rock	68.1	20.7	28.4	8.6	757.7	729.4	9019	2749	16,894	5149
11	Rock	96.4	29.4	41.2	12.6	729.4	688.2	8815	2687	16,482	5024
12	Rock	137.6	41.9	48.3	14.7	688.2	639.9	9171	2795	16,886	5147
13	Rock	185.9	56.7	48.7	14.8	639.9	591.2	9087	2770	16,856	5138
14	Rock	234.6	71.5	40.6	12.4	591.2	550.6	9137	2785	17,042	5194
15	Half-space	275.1	83.9	315.0	96.0	550.6	235.7	10,494	3199	18,019	5492

Key: ft. = foot; ft/s = foot per second; m = meter; m/s = meter per second; PWR = partially weathered rock; V_P = compression wave velocity; V_S = shear wave velocity

Table 2.5-69
Shear Wave Velocity Profile from Spectral Analysis of Surface Waves (SASW) for All Plant Complexes

Layer	Material Type	Top depth		Thickness		Top Elevation	Bottom Elevation	Average V_S		Average V_P	
		ft.	m	ft.	m	ft.	ft.	ft/s	m/s	ft/s	m/s
1	Residual Soil	0.0	0.0	6.0	1.8	823.6	817.6	584	178	1159	353
2	Residual Soil	6.0	1.8	7.0	2.1	817.6	810.6	584	178	1159	353
3	Residual Soil	13.0	3.9	9.0	2.7	810.6	801.6	893	272	1772	540
4	Residual Soil	22.0	6.6	10.0	3.0	801.6	791.6	893	272	1772	540
5	Residual Soil	32.0	9.6	25.0	7.6	791.6	766.6	939	286	2253	687
6	PWR	57.0	17.2	5.0	1.5	766.6	761.6	2272	693	4968	1514
7	PWR	62.0	18.7	6.0	1.8	761.6	755.6	2272	693	4968	1514
8	PWR	68.0	20.5	6.0	1.8	755.6	749.6	2272	693	4968	1514
9	PWR	74.0	22.3	18.0	5.5	749.6	731.6	2272	693	4968	1514
10	PWR	92.0	27.8	37.0	11.3	731.6	694.6	2272	693	4968	1514
11	PWR	129.0	39.1	48.0	14.6	694.6	646.6	2272	693	4968	1514
12	Rock	177.0	53.7	53.0	16.2	646.6	593.6	7128	2173	12,273	3741
13	Rock	230.0	69.9	55.0	16.8	593.6	538.6	7128	2173	12,273	3741
14	Rock	285.0	86.7	55.0	16.8	538.6	483.6	7128	2173	12,273	3741
15	Rock	340.0	103.5	200.0	61.0	483.6	283.6	7128	2173	12,273	3741
16	Half-space	540.0	164.5	-	-	283.6	-	10,494	3199	18,019	5492

Key: ft. = foot; ft/s = foot per second; m = meter; m/s = meter per second; PWR = partially weathered rock; V_P = compression wave velocity; V_S = shear wave velocity

Table 2.5-70
Site-Specific (Lab-Derived) Material Curves for Residual Soils

Residual Soil 0-15 ft.			Residual Soil 15-30 ft.		Residual Soil 30-45 ft.		Residual Soil 45-60 ft.		Residual Soil 60-75 ft.	
Shear Strain (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)
1.00E-04	0.997	1.770	0.998	1.791	0.999	1.802	0.999	1.810	0.999	1.816
2.00E-04	0.995	1.806	0.996	1.816	0.997	1.823	0.997	1.829	0.998	1.833
3.00E-04	0.992	1.842	0.995	1.841	0.996	1.844	0.996	1.847	0.996	1.850
5.00E-04	0.987	1.913	0.991	1.890	0.993	1.886	0.993	1.885	0.994	1.885
1.00E-03	0.974	2.089	0.982	2.013	0.985	1.99	0.987	1.978	0.988	1.970
2.00E-03	0.950	2.433	0.965	2.255	0.970	2.194	0.973	2.161	0.975	2.139
3.00E-03	0.926	2.767	0.948	2.491	0.956	2.395	0.960	2.341	0.963	2.306
5.00E-03	0.882	3.406	0.915	2.950	0.928	2.787	0.935	2.694	0.940	2.631
1.00E-02	0.787	4.854	0.843	4.019	0.864	3.709	0.877	3.529	0.886	3.406
2.00E-02	0.647	7.251	0.726	5.878	0.759	5.344	0.780	5.027	0.794	4.807
3.00E-02	0.548	9.164	0.638	7.446	0.677	6.753	0.701	6.334	0.719	6.041
5.00E-02	0.420	12.051	0.512	9.958	0.555	9.069	0.583	8.517	0.604	8.124
1.00E-01	0.264	16.398	0.342	14.105	0.382	13.047	0.409	12.364	0.430	11.862
2.00E-01	0.151	20.439	0.205	18.42	0.235	17.405	0.256	16.718	0.272	16.199
3.00E-01	0.105	22.351	0.146	20.667	0.169	19.774	0.185	19.154	0.199	18.675
5.00E-01	0.066	24.133	0.092	22.955	0.108	22.281	0.119	21.794	0.129	21.408
7.00E-01	0.048	24.918	0.068	24.077	0.079	23.562	0.088	23.178	0.095	22.868
1.00E+00	0.034	25.438	0.048	24.929	0.057	24.578	0.063	24.305	0.068	24.078
1.00E+01	0.003	23.91	0.005	24.515	0.006	24.773	0.006	24.933	0.007	25.047

Key: ft. = foot; G_{max} = maximum shear modulus

Table 2.5-71
Darendeli Material Curves for Residual Soils

Residual Soil 0-15 ft.			Residual Soil 15-30 ft.		Residual Soil 30-45 ft.		Residual Soil 45-60 ft.		Residual Soil 60-75 ft.	
Shear Strain (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)	G/G_{max}	Damping (%)
1.00E-04	0.993	1.197	0.995	0.869	0.996	0.749	0.996	0.679	0.997	0.631
2.00E-04	0.987	1.255	0.991	0.908	0.992	0.782	0.993	0.708	0.994	0.658
3.00E-04	0.982	1.312	0.987	0.948	0.989	0.815	0.99	0.737	0.991	0.685
5.00E-04	0.971	1.426	0.980	1.026	0.983	0.880	0.984	0.796	0.986	0.738
1.00E-03	0.947	1.704	0.962	1.218	0.968	1.042	0.971	0.941	0.973	0.871
2.00E-03	0.904	2.235	0.931	1.591	0.940	1.358	0.946	1.223	0.950	1.131
3.00E-03	0.867	2.734	0.902	1.949	0.916	1.662	0.924	1.496	0.929	1.383
5.00E-03	0.803	3.652	0.853	2.621	0.872	2.240	0.883	2.018	0.892	1.866
1.00E-02	0.683	5.569	0.754	4.096	0.783	3.531	0.800	3.196	0.813	2.965
2.00E-02	0.532	8.336	0.618	6.399	0.656	5.611	0.680	5.132	0.697	4.794
3.00E-02	0.439	10.263	0.527	8.130	0.568	7.226	0.594	6.665	0.613	6.264
5.00E-02	0.329	12.814	0.411	10.589	0.451	9.595	0.477	8.961	0.498	8.499
1.00E-01	0.206	16.074	0.269	14.022	0.303	13.046	0.326	12.401	0.344	11.919
2.00E-01	0.121	18.667	0.163	17.028	0.187	16.209	0.204	15.65	0.217	15.224
3.00E-01	0.086	19.778	0.118	18.428	0.137	17.737	0.150	17.258	0.160	16.889
5.00E-01	0.056	20.734	0.077	19.754	0.09	19.235	0.099	18.869	0.107	18.582
7.00E-01	0.042	21.111	0.058	20.358	0.068	19.951	0.075	19.659	0.081	19.429
1.00E+00	0.03	21.316	0.043	20.779	0.05	20.482	0.055	20.266	0.059	20.093
1.00E+01	0.004	19.644	0.005	19.819	0.006	19.915	0.007	19.981	0.008	20.03

Key: ft. = foot; G_{max} = maximum shear modulus

Table 2.5-72
First Sets of Material Curves for Partially Weathered Rock (PWR) and Rock

PWR				Rock V_S < 8,000 ft/s			Rock V_S > 8,000 ft/s		
Shear Strain (%)	G/G_{max}	Shear Strain (%)	Damping (%)	Shear Strain (%)	G/G_{max}	Damping (%)	Shear Strain (%)	G/G_{max}	Damping (%)
1.00E-05	1.00	1.00E-05	1.00	1.00E-04	1.00	0.90	1.00E-04	1.00	0.70
1.00E-04	1.00	1.00E-04	1.01	1.00E+01	1.00	0.90	1.00E+01	1.00	0.70
1.00E-03	1.00	1.00E-03	1.06						
3.00E-03	0.99	3.00E-03	1.19						
5.00E-03	0.98	5.00E-03	1.31						
1.00E-02	0.95	1.00E-02	1.61						
2.00E-02	0.91	2.00E-02	2.19						
3.00E-02	0.87	3.00E-02	2.73						
4.00E-02	0.83	4.00E-02	3.25						
5.00E-02	0.80	5.00E-02	3.74						
6.00E-02	0.77	6.00E-02	4.21						
7.00E-02	0.74	7.00E-02	4.66						
8.00E-02	0.71	8.00E-02	5.08						
1.00E-01	0.67	1.00E-01	5.88						
1.50E-01	0.57	1.50E-01	7.59						
2.00E-01	0.50	2.00E-01	9.02						
5.00E-01	0.29	3.00E-01	11.3						
1.00E+00	0.17	5.00E-01	15.0						
3.00E+00	0.06	1.00E+00	16.5						
1.00E+01	0.02	1.00E+01	20.0						

Key: ft/s = foot per second; G_{max} = maximum shear strength; V_S = shear wave velocity

Table 2.5-73
Second Sets of Material Curves for Partially Weathered Rock (PWR) and Rock
(Sheet 1 of 2)

PWR				Rock V_S < 8000 ft/s				Rock V_S > 8000 ft/s		
Shear Strain (%)	G/G_{max}	Shear Strain (%)	Damping (%)	Shear Strain (%)	G/G_{max}	Shear Strain (%)	Damping (%)	Shear Strain (%)	G/G_{max}	Damping (%)
1.00E-04	1.000	1.00E-04	3.079	1.00E-05	1.00	1.00E-05	1.00	1.00E-04	1.00	0.70
2.00E-04	1.000	2.00E-04	3.079	1.00E-04	1.00	1.00E-04	1.01	1.00E+01	1.00	0.70
3.00E-04	1.000	3.00E-04	3.079	1.00E-03	1.00	1.00E-03	1.06			
5.00E-04	1.000	5.00E-04	3.079	3.00E-03	0.99	3.00E-03	1.19			
1.00E-03	1.000	1.00E-03	3.079	5.00E-03	0.98	5.00E-03	1.31			
2.00E-03	1.000	2.00E-03	3.154	1.00E-02	0.95	1.00E-02	1.61			
3.00E-03	0.998	3.00E-03	3.260	2.00E-02	0.91	2.00E-02	2.19			
5.00E-03	0.982	5.00E-03	3.513	3.00E-02	0.87	3.00E-02	2.73			
1.00E-02	0.954	1.00E-02	4.002	4.00E-02	0.83	4.00E-02	3.25			
2.00E-02	0.874	2.00E-02	5.013	5.00E-02	0.80	5.00E-02	3.74			
3.00E-02	0.828	3.00E-02	5.779	6.00E-02	0.77	6.00E-02	4.21			
5.00E-02	0.721	5.00E-02	7.475	7.00E-02	0.74	7.00E-02	4.66			

Table 2.5-73
Second Sets of Material Curves for Partially Weathered Rock (PWR) and Rock
(Sheet 2 of 2)

PWR				Rock V_S < 8000 ft/s				Rock V_S > 8000 ft/s		
Shear Strain (%)	**G/G_{max}**	**Shear Strain (%)**	**Damping (%)**	**Shear Strain (%)**	**G/G_{max}**	**Shear Strain (%)**	**Damping (%)**	**Shear Strain (%)**	**G/G_{max}**	**Damping (%)**
1.00E-01	0.571	1.00E-01	10.013	8.00E-02	0.71	8.00E-02	5.08			
2.00E-01	0.422	2.00E-01	13.138	1.00E-01	0.67	1.00E-01	5.88			
3.00E-01	0.346	3.00E-01	15.143	1.50E-01	0.57	1.50E-01	7.59			
5.00E-01	0.258	5.00E-01	18.054	2.00E-01	0.50	2.00E-01	9.02			
7.00E-01	0.200	7.00E-01	20.024	5.00E-01	0.29	3.00E-01	11.3			
1.00E+00	0.150	1.00E+00	22.182	1.00E+00	0.17	5.00E-01	15.0			
2.00E+00	0.090	2.00E+00	25.339	3.00E+00	0.06	1.00E+00	16.5			
3.00E+00	0.060	3.00E+00	27.126	1.00E+01	0.02	1.00E+01	20.0			

Key: ft/s = foot per second; G_{max} = maximum shear modulus; V_S = shear wave velocity

Table 2.5-74
Fill Shear Wave Velocity Profile

Layer	Thickness (ft.)	Shear Wave Velocity (ft/s)	Shear Wave Velocity (m/s)	Poisson's Ratio, v
1	3	1000	305	0.33
2	3	1090	332	0.33
3	3	1149	350	0.33
4	3	1205	367	0.33
5	3	1220	372	0.33
6	3	1243	379	0.33
7	6	1271	387	0.33
8	6	1301	397	0.33
9	10	1331	406	0.33

Key: ft. = foot; ft/s = foot per second; m/s = meter per second

Table 2.5-75
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Ground Motion Response Spectra (GMRS) for the North and Middle Plant Complexes

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal GMRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical GMRS
0.005	200.00	0.3209	0.8806	0.4318	0.2314	0.6499	0.3172
0.01	100.00	0.3539	0.9965	0.4861	0.2860	0.8988	0.4289
0.02	50.00	0.4768	1.3345	0.6517	0.4439	1.4866	0.7004
0.025	40.00	0.5255	1.5050	0.7316	0.4719	1.6164	0.7582
0.03	33.33	0.5720	1.6163	0.7878	0.4856	1.6308	0.7680
0.04	25.00	0.6312	1.7969	0.8746	0.4797	1.5723	0.7440
0.05	20.00	0.6594	1.8296	0.8951	0.4741	1.4747	0.7051
0.075	13.33	0.7120	1.9227	0.9458	0.4998	1.5055	0.7245
0.1	10.00	0.6976	1.8075	0.8965	0.4806	1.3665	0.6653
0.15	6.67	0.6967	1.6068	0.8157	0.4842	1.3095	0.6439
0.2	5.00	0.6055	1.4565	0.7332	0.4208	1.1914	0.5805
0.25	4.00	0.5691	1.2918	0.6579	0.4109	1.1680	0.5687
0.3	3.33	0.5381	1.2435	0.6310	0.3885	1.0754	0.5263
0.4	2.50	0.4413	1.0227	0.5187	0.3230	0.9470	0.4582
0.5	2.00	0.3553	0.8561	0.4308	0.2601	0.7987	0.3829
0.75	1.33	0.1731	0.4842	0.2365	0.1285	0.4566	0.2126
1	1.00	0.1209	0.3239	0.1596	0.0897	0.3054	0.1434
1.5	0.67	0.0787	0.1910	0.0960	0.0584	0.1801	0.0863
2	0.50	0.0616	0.1430	0.0725	0.0445	0.1310	0.0633
3	0.33	0.0373	0.0840	0.0428	0.0262	0.0752	0.0365
4	0.25	0.0273	0.0601	0.0308	0.0192	0.0538	0.0263
5	0.20	0.0215	0.0476	0.0244	0.0151	0.0427	0.0208
7.5	0.13	0.0137	0.0315	0.0160	0.0096	0.0283	0.0137
10	0.10	0.0100	0.0227	0.0115	0.0070	0.0202	0.0098

Key: Hz = hertz; sec. = second

Table 2.5-76
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 44 Ft. [13.4 M]) for the North and Middle Plant Complexes

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal PBIRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical PBIRS
0.005	200.00	0.2722	0.7819	0.3799	0.2077	0.6106	0.2953
0.01	100.00	0.3011	0.9023	0.4347	0.2457	0.8075	0.3819
0.02	50.00	0.3991	1.2435	0.5944	0.3628	1.2858	0.5990
0.025	40.00	0.4404	1.3938	0.6642	0.3858	1.3952	0.6473
0.03	33.33	0.4778	1.5213	0.7240	0.3999	1.4391	0.6684
0.04	25.00	0.5524	1.7001	0.8147	0.4248	1.4502	0.6807
0.05	20.00	0.5708	1.7388	0.8349	0.4190	1.4084	0.6631
0.075	13.33	0.6115	1.7546	0.8527	0.4385	1.3739	0.6560
0.1	10.00	0.5138	1.4957	0.7247	0.3632	1.1412	0.5446
0.15	6.67	0.5281	1.3668	0.6780	0.3718	1.0388	0.5075
0.2	5.00	0.6045	1.4291	0.7219	0.4316	1.1004	0.5475
0.25	4.00	0.6217	1.4316	0.7270	0.4545	1.1267	0.5638
0.3	3.33	0.5662	1.3123	0.6655	0.4179	1.0459	0.5223
0.4	2.50	0.4402	1.0433	0.5267	0.3292	0.8492	0.4216
0.5	2.00	0.3558	0.8473	0.4274	0.2661	0.6982	0.3454
0.75	1.33	0.1752	0.4986	0.2427	0.1328	0.4108	0.1967
1	1.00	0.1211	0.3292	0.1617	0.0930	0.2746	0.1327
1.5	0.67	0.0789	0.1975	0.0986	0.0598	0.1633	0.0802
2	0.50	0.0619	0.1455	0.0736	0.0452	0.1160	0.0576
3	0.33	0.0374	0.0843	0.0430	0.0268	0.0655	0.0329
4	0.25	0.0274	0.0603	0.0309	0.0197	0.0469	0.0236
5	0.20	0.0216	0.0478	0.0245	0.0154	0.0368	0.0186
7.5	0.13	0.0137	0.0316	0.0161	0.0098	0.0244	0.0122
10	0.10	0.0100	0.0227	0.0116	0.0071	0.0175	0.0088

Key: Hz = hertz; PBIRS = performance-based interface response spectrum; sec. = second

Table 2.5-77
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 85 Ft. [25.9 M]) for the North and Middle Plant Complexes

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 85 Ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 85 Ft.)
0.005	200.00	0.1570	0.4973	0.2369	0.1240	0.3929	0.1872
0.01	100.00	0.1717	0.5584	0.2646	0.1417	0.4795	0.2254
0.02	50.00	0.2298	0.7845	0.3682	0.2045	0.7543	0.3486
0.025	40.00	0.2586	0.8976	0.4199	0.2216	0.8291	0.3821
0.03	33.33	0.2843	0.9929	0.4639	0.2343	0.8767	0.4040
0.04	25.00	0.3252	1.1128	0.5221	0.2488	0.9020	0.4183
0.05	20.00	0.3255	1.0985	0.5168	0.2442	0.8674	0.4039
0.075	13.33	0.3475	1.1305	0.5357	0.2519	0.8649	0.4055
0.1	10.00	0.2968	0.9082	0.4357	0.2113	0.6721	0.3199
0.15	6.67	0.3082	0.8744	0.4259	0.2203	0.6506	0.3143
0.2	5.00	0.3046	0.8307	0.4078	0.2221	0.6322	0.3077
0.25	4.00	0.2960	0.7853	0.3876	0.2217	0.6039	0.2965
0.3	3.33	0.2925	0.7552	0.3748	0.2211	0.5936	0.2923
0.4	2.50	0.2431	0.5907	0.2967	0.1862	0.4742	0.2360
0.5	2.00	0.2101	0.5026	0.2533	0.1624	0.4096	0.2042
0.75	1.33	0.1320	0.3240	0.1625	0.1034	0.2673	0.1326
1	1.00	0.1022	0.2425	0.1224	0.0800	0.2001	0.0999
1.5	0.67	0.0717	0.1657	0.0841	0.0556	0.1356	0.0681
2	0.50	0.0576	0.1293	0.0660	0.0426	0.1019	0.0513
3	0.33	0.0365	0.0817	0.0417	0.0266	0.0628	0.0317
4	0.25	0.0269	0.0589	0.0302	0.0196	0.0452	0.0230
5	0.20	0.0211	0.0466	0.0238	0.0154	0.0354	0.0180
7.5	0.13	0.0135	0.0310	0.0158	0.0097	0.0236	0.0119
10	0.10	0.0098	0.0223	0.0114	0.0070	0.0170	0.0085

Key: Hz = hertz; m = meter; sec. = second

Table 2.5-78
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Performance Based Interface Response Spectra (PBIRS) for the North and Middle Plant Complexes

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal GMRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical GMRS
0.005	200.00	0.1852	0.5915	0.2813	0.1458	0.4673	0.2221
0.01	100.00	0.2080	0.6919	0.3264	0.1723	0.6061	0.2828
0.02	50.00	0.2802	0.9610	0.4506	0.2519	0.9465	0.4358
0.025	40.00	0.3100	1.0704	0.5013	0.2694	1.0115	0.4658
0.03	33.33	0.3311	1.1459	0.5364	0.2758	1.0347	0.4766
0.04	25.00	0.3744	1.2614	0.5936	0.2887	1.0457	0.4850
0.05	20.00	0.3815	1.2655	0.5974	0.2845	1.0048	0.4684
0.075	13.33	0.3969	1.2692	0.6035	0.2877	0.9735	0.4577
0.1	10.00	0.3493	1.0457	0.5039	0.2498	0.7780	0.3719
0.15	6.67	0.3603	0.9985	0.4886	0.2602	0.7429	0.3614
0.2	5.00	0.3499	0.8959	0.4454	0.2551	0.6818	0.3361
0.25	4.00	0.3186	0.8211	0.4077	0.2377	0.6388	0.3145
0.3	3.33	0.2914	0.7521	0.3733	0.2203	0.5980	0.2938
0.4	2.50	0.2480	0.6231	0.3109	0.1899	0.5016	0.2478
0.5	2.00	0.2017	0.4802	0.2422	0.1559	0.3914	0.1953
0.75	1.33	0.1307	0.3102	0.1566	0.1023	0.2559	0.1278
1	1.00	0.1028	0.2385	0.1209	0.0805	0.1967	0.0987
1.5	0.67	0.0724	0.1647	0.0838	0.0562	0.1347	0.0679
2	0.50	0.0582	0.1308	0.0667	0.0430	0.1030	0.0519
3	0.33	0.0368	0.0822	0.0420	0.0268	0.0632	0.0319
4	0.25	0.0270	0.0591	0.0303	0.0197	0.0454	0.0231
5	0.20	0.0212	0.0467	0.0239	0.0154	0.0355	0.0180
7.5	0.13	0.0135	0.0311	0.0158	0.0097	0.0237	0.0119
10	0.10	0.0098	0.0224	0.0114	0.0071	0.0170	0.0086

Key: Hz = hertz; sec. = second

Table 2.5-79
Interpolated Horizontal and Vertical Ground Motion Response Spectra (GMRS), Foundation Input Response Spectra (FIRS), and Performance-Based Interface Response Spectra (PBIRS) for the North and Middle Plant Complexes
(Sheet 1 of 2)

Period	Frequency	GMRS		FIRS (Depth 44 Ft.)		FIRS (Depth 85 Ft.)		PBIRS	
(Sec.)	(Hz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
0.005	200.00	0.4318	0.3172	0.3799	0.2953	0.2369	0.1872	0.2813	0.2221
0.0067	150.00	0.4589	0.3730	0.4073	0.3386	0.2508	0.2063	0.3039	0.2524
0.01	100.00	0.4861	0.4289	0.4347	0.3819	0.2646	0.2254	0.3264	0.2828
0.013	75.00	0.5689	0.5647	0.5145	0.4904	0.3164	0.2870	0.3885	0.3593
0.015	66.67	0.5965	0.6099	0.5411	0.5266	0.3337	0.3075	0.4092	0.3848
0.02	50.00	0.6517	0.7004	0.5944	0.5990	0.3682	0.3486	0.4506	0.4358
0.025	40.00	0.7316	0.7582	0.6642	0.6473	0.4199	0.3821	0.5013	0.4658
0.03	33.33	0.7878	0.7680	0.7240	0.6684	0.4639	0.4040	0.5364	0.4766
0.04	25.00	0.8746	0.7440	0.8147	0.6807	0.5221	0.4183	0.5936	0.4850
0.05	20.00	0.8951	0.7051	0.8349	0.6631	0.5168	0.4039	0.5974	0.4684
0.075	13.33	0.9458	0.7245	0.8527	0.6560	0.5357	0.4055	0.6035	0.4577
0.1	10.00	0.8965	0.6653	0.7247	0.5446	0.4357	0.3199	0.5039	0.3719
0.13	7.50	0.8359	0.6493	0.6897	0.5168	0.4283	0.3157	0.4924	0.3640
0.15	6.67	0.8157	0.6439	0.6780	0.5075	0.4259	0.3143	0.4886	0.3614
0.2	5.00	0.7332	0.5805	0.7219	0.5475	0.4078	0.3077	0.4454	0.3361
0.25	4.00	0.6579	0.5687	0.7270	0.5638	0.3876	0.2965	0.4077	0.3145
0.3	3.33	0.6310	0.5263	0.6655	0.5223	0.3748	0.2923	0.3733	0.2938

Table 2.5-79
Interpolated Horizontal and Vertical Ground Motion Response Spectra (GMRS), Foundation Input Response Spectra (FIRS), and Performance-Based Interface Response Spectra (PBIRS) for the North and Middle Plant Complexes
(Sheet 2 of 2)

Period	Frequency	GMRS		FIRS (Depth 44 Ft.)		FIRS (Depth 85 Ft.)		PBIRS	
(Sec.)	(Hz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
0.4	2.50	0.5187	0.4582	0.5267	0.4216	0.2967	0.2360	0.3109	0.2478
0.5	2.00	0.4308	0.3829	0.4274	0.3454	0.2533	0.2042	0.2422	0.1953
0.75	1.33	0.2365	0.2126	0.2427	0.1967	0.1625	0.1326	0.1566	0.1278
1	1.00	0.1596	0.1434	0.1617	0.1327	0.1224	0.0999	0.1209	0.0987
1.3	0.75	0.1119	0.1006	0.1144	0.0933	0.0937	0.0760	0.0931	0.0756
1.5	0.67	0.0960	0.0863	0.0986	0.0802	0.0841	0.0681	0.0838	0.0679
2	0.50	0.0725	0.0633	0.0736	0.0576	0.0660	0.0513	0.0667	0.0519
2.5	0.40	0.0547	0.0473	0.0552	0.0428	0.0514	0.0396	0.0519	0.0399
3	0.33	0.0428	0.0365	0.0430	0.0329	0.0417	0.0317	0.0420	0.0319
4	0.25	0.0308	0.0263	0.0309	0.0236	0.0302	0.0230	0.0303	0.0231
5	0.20	0.0244	0.0208	0.0245	0.0186	0.0238	0.0180	0.0239	0.0180
7.5	0.13	0.0160	0.0137	0.0161	0.0122	0.0158	0.0119	0.0158	0.0119
10	0.10	0.0115	0.0098	0.0116	0.0088	0.0114	0.0085	0.0114	0.0086

Key: ft. = foot; Hz = hertz; sec. = second

Table 2.5-80
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Ground Motion Response Spectra (GMRS) for the South Plant Complex

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 44 Ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 44 Ft.)
0.005	200.00	0.3209	0.8806	0.4318	0.2314	0.6736	0.3264
0.01	100.00	0.3539	1.0037	0.4889	0.2860	0.9124	0.4341
0.02	50.00	0.4768	1.4198	0.6848	0.4439	1.4866	0.7004
0.025	40.00	0.5255	1.5891	0.7642	0.4719	1.6164	0.7582
0.03	33.33	0.5720	1.7219	0.8288	0.4856	1.6582	0.7782
0.04	25.00	0.6312	1.8313	0.8880	0.4797	1.5932	0.7519
0.05	20.00	0.6594	1.8466	0.9017	0.4741	1.5216	0.7230
0.075	13.33	0.7120	1.9227	0.9458	0.4998	1.5055	0.7245
0.1	10.00	0.6976	1.8075	0.8965	0.4806	1.3665	0.6653
0.15	6.67	0.6967	1.6068	0.8157	0.4842	1.3095	0.6439
0.2	5.00	0.6055	1.4565	0.7332	0.4208	1.1914	0.5805
0.25	4.00	0.5691	1.2918	0.6579	0.4109	1.1680	0.5687
0.3	3.33	0.5381	1.2435	0.6310	0.3911	1.1809	0.5680
0.4	2.50	0.4467	1.0227	0.5199	0.3301	0.9765	0.4716
0.5	2.00	0.3947	0.9235	0.4675	0.2945	0.9133	0.4370
0.75	1.33	0.2054	0.5602	0.2750	0.1538	0.5596	0.2593
1	1.00	0.1327	0.3598	0.1768	0.1007	0.3594	0.1672
1.5	0.67	0.0822	0.2006	0.1007	0.0624	0.2010	0.0954
2	0.50	0.0634	0.1475	0.0748	0.0462	0.1444	0.0690
3	0.33	0.0378	0.0854	0.0436	0.0271	0.0819	0.0394
4	0.25	0.0277	0.0609	0.0312	0.0198	0.0584	0.0282
5	0.20	0.0218	0.0482	0.0247	0.0156	0.0462	0.0223
7.5	0.13	0.0138	0.0318	0.0162	0.0098	0.0305	0.0146
10	0.10	0.0100	0.0228	0.0116	0.0071	0.0217	0.0104

Key: ft. = foot; Hz = hertz; sec. = second

Table 2.5-81
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 44 Ft. [13.4 M]) for the South Plant Complex

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 44 Ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 44 Ft.)
0.005	200.00	0.2722	0.7819	0.3799	0.2077	0.6106	0.2953
0.01	100.00	0.3011	0.9023	0.4347	0.2457	0.8075	0.3819
0.02	50.00	0.3991	1.2435	0.5944	0.3628	1.2858	0.5990
0.025	40.00	0.4404	1.3938	0.6642	0.3858	1.3952	0.6473
0.03	33.33	0.4778	1.5213	0.7240	0.3999	1.4391	0.6684
0.04	25.00	0.5524	1.7001	0.8147	0.4248	1.4502	0.6807
0.05	20.00	0.5708	1.7388	0.8349	0.4190	1.4084	0.6631
0.075	13.33	0.6115	1.7546	0.8527	0.4385	1.3739	0.6560
0.1	10.00	0.5521	1.5012	0.7374	0.3765	1.1559	0.5542
0.15	6.67	0.5281	1.3668	0.6780	0.3718	1.0388	0.5075
0.2	5.00	0.6045	1.4291	0.7219	0.4316	1.1004	0.5475
0.25	4.00	0.6217	1.4316	0.7270	0.4545	1.1267	0.5638
0.3	3.33	0.6094	1.4034	0.7126	0.4302	1.1185	0.5544
0.4	2.50	0.5114	1.1842	0.6007	0.3662	0.9556	0.4733
0.5	2.00	0.4585	1.1079	0.5572	0.3283	0.9018	0.4421
0.75	1.33	0.2306	0.7099	0.3401	0.1674	0.5800	0.2714
1	1.00	0.1422	0.4354	0.2089	0.1037	0.3587	0.1679
1.5	0.67	0.0854	0.2287	0.1127	0.0622	0.1868	0.0900
2	0.50	0.0654	0.1595	0.0801	0.0457	0.1266	0.0620
3	0.33	0.0383	0.0873	0.0444	0.0268	0.0678	0.0338
4	0.25	0.0280	0.0619	0.0317	0.0197	0.0481	0.0241
5	0.20	0.0221	0.0491	0.0251	0.0154	0.0378	0.0190
7.5	0.13	0.0140	0.0323	0.0164	0.0098	0.0248	0.0123
10	0.10	0.0101	0.0231	0.0118	0.0071	0.0177	0.0089

Key: ft. = foot Hz = hertz; sec. = second

Table 2.5-82
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 85 Ft. [25.9 M]) for the South Plant Complex

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal FIRS (Depth 85 Ft.)	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 85 Ft.)
0.005	200.00	0.2408	0.6875	0.3344	0.1895	0.5473	0.2656
0.01	100.00	0.2601	0.7726	0.3729	0.2161	0.6838	0.3259
0.02	50.00	0.3400	1.0516	0.5034	0.3087	1.0579	0.4962
0.025	40.00	0.3790	1.1822	0.5650	0.3316	1.1503	0.5382
0.03	33.33	0.4145	1.3000	0.6206	0.3477	1.2012	0.5625
0.04	25.00	0.4758	1.4744	0.7055	0.3683	1.2444	0.5853
0.05	20.00	0.5051	1.5248	0.7335	0.3763	1.2244	0.5802
0.075	13.33	0.5323	1.5334	0.7446	0.3875	1.1899	0.5705
0.1	10.00	0.5038	1.3949	0.6827	0.3602	1.0545	0.5104
0.15	6.67	0.4443	1.2611	0.6142	0.3177	0.9496	0.4577
0.2	5.00	0.4732	1.1654	0.5839	0.3464	0.8974	0.4451
0.25	4.00	0.5307	1.1961	0.6100	0.3975	0.9449	0.4768
0.3	3.33	0.5224	1.2088	0.6133	0.3949	0.9755	0.4885
0.4	2.50	0.4412	1.0041	0.5111	0.3379	0.8203	0.4122
0.5	2.00	0.4068	0.9459	0.4794	0.3157	0.7794	0.3903
0.75	1.33	0.2106	0.6108	0.2962	0.1649	0.5094	0.2439
1	1.00	0.1305	0.3829	0.1852	0.1025	0.3194	0.1527
1.5	0.67	0.0821	0.2152	0.1065	0.0637	0.1780	0.0870
2	0.50	0.0635	0.1529	0.0770	0.0471	0.1219	0.0605
3	0.33	0.0379	0.0861	0.0438	0.0276	0.0672	0.0337
4	0.25	0.0277	0.0612	0.0314	0.0202	0.0476	0.0241
5	0.20	0.0219	0.0485	0.0248	0.0159	0.0374	0.0189
7.5	0.13	0.0139	0.0320	0.0162	0.0100	0.0246	0.0124
10	0.10	0.0101	0.0230	0.0117	0.0073	0.0177	0.0089

Key: ft. = foot; Hz = hertz; sec. = second

Table 2.5-83
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Performance-Based Interface Response Spectrum (PBIRS) for the South Plant Complex

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal PBIRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical PBIRS
0.005	200.00	0.1852	0.5915	0.2813	0.1458	0.4673	0.2221
0.01	100.00	0.2080	0.6919	0.3264	0.1723	0.6061	0.2828
0.02	50.00	0.2802	0.9622	0.4511	0.2519	0.9477	0.4363
0.025	40.00	0.3100	1.0705	0.5013	0.2694	1.0116	0.4658
0.03	33.33	0.3311	1.1515	0.5385	0.2758	1.0398	0.4784
0.04	25.00	0.3744	1.2660	0.5953	0.2887	1.0495	0.4864
0.05	20.00	0.3836	1.2711	0.6002	0.2858	1.0093	0.4705
0.075	13.33	0.3969	1.2692	0.6035	0.2877	0.9735	0.4577
0.1	10.00	0.3493	1.0520	0.5063	0.2498	0.7827	0.3737
0.15	6.67	0.3603	0.9985	0.4886	0.2602	0.7429	0.3614
0.2	5.00	0.3499	0.8959	0.4454	0.2551	0.6818	0.3361
0.25	4.00	0.3310	0.8406	0.4186	0.2469	0.6540	0.3230
0.3	3.33	0.3117	0.7820	0.3904	0.2356	0.6217	0.3072
0.4	2.50	0.2480	0.6231	0.3109	0.1899	0.5016	0.2478
0.5	2.00	0.2162	0.5131	0.2590	0.1671	0.4182	0.2089
0.75	1.33	0.1455	0.3471	0.1750	0.1139	0.2863	0.1429
1	1.00	0.1082	0.2533	0.1282	0.0847	0.2090	0.1047
1.5	0.67	0.0739	0.1681	0.0856	0.0573	0.1375	0.0693
2	0.50	0.0590	0.1322	0.0675	0.0436	0.1042	0.0525
3	0.33	0.0370	0.0827	0.0422	0.0269	0.0635	0.0321
4	0.25	0.0271	0.0594	0.0305	0.0198	0.0456	0.0232
5	0.20	0.0212	0.0469	0.0240	0.0155	0.0357	0.0181
7.5	0.13	0.0136	0.0312	0.0158	0.0097	0.0237	0.0119
10	0.10	0.0099	0.0224	0.0114	0.0071	0.0171	0.0086

Key: Hz = hertz; sec. = second

Table 2.5-84
Horizontal and Vertical Uniform Hazard Response Spectra (UHRS) and Foundation Input Response Spectra (FIRS) (Depth 115 Ft. [35.1 M]) for the South Plant Complex

Period (Sec.)	Frequency (Hz)	Horizontal UHRS 1E-4 (Envelope)	Horizontal UHRS 1E-5 (Envelope)	Horizontal PBIRS	Vertical UHRS 1E-4 (Envelope)	Vertical UHRS 1E-5 (Envelope)	Vertical FIRS (Depth 115 Ft.)
0.005	200.00	0.1590	0.5071	0.2412	0.1270	0.4051	0.1928
0.01	100.00	0.1741	0.5700	0.2698	0.1436	0.4891	0.2297
0.02	50.00	0.2337	0.8018	0.3759	0.2066	0.7543	0.3493
0.025	40.00	0.2628	0.9163	0.4283	0.2245	0.8310	0.3838
0.03	33.33	0.2874	1.0070	0.4702	0.2359	0.8771	0.4047
0.04	25.00	0.3281	1.1292	0.5292	0.2510	0.9090	0.4216
0.05	20.00	0.3292	1.1114	0.5228	0.2485	0.8724	0.4072
0.075	13.33	0.3509	1.1478	0.5434	0.2555	0.8700	0.4086
0.1	10.00	0.2968	0.9104	0.4366	0.2113	0.6721	0.3199
0.15	6.67	0.3082	0.8744	0.4259	0.2203	0.6506	0.3143
0.2	5.00	0.3102	0.8528	0.4180	0.2280	0.6413	0.3129
0.25	4.00	0.3171	0.8471	0.4176	0.2384	0.6540	0.3207
0.3	3.33	0.2960	0.7734	0.3830	0.2255	0.6102	0.3001
0.4	2.50	0.2431	0.5907	0.2967	0.1862	0.4742	0.2360
0.5	2.00	0.2101	0.5026	0.2533	0.1624	0.4096	0.2042
0.75	1.33	0.1418	0.3406	0.1715	0.1110	0.2810	0.1400
1	1.00	0.1048	0.2493	0.1258	0.0820	0.2057	0.1027
1.5	0.67	0.0720	0.1659	0.0842	0.0559	0.1357	0.0682
2	0.50	0.0577	0.1293	0.0660	0.0426	0.1019	0.0514
3	0.33	0.0366	0.0819	0.0418	0.0267	0.0629	0.0318
4	0.25	0.0269	0.0590	0.0303	0.0196	0.0453	0.0230
5	0.20	0.0211	0.0466	0.0239	0.0154	0.0355	0.0180
7.5	0.13	0.0135	0.0311	0.0158	0.0098	0.0236	0.0119
10	0.10	0.0098	0.0223	0.0114	0.0071	0.0170	0.0086

Key: ft. = foot; Hz = hertz; sec. = second

Table 2.5-85
Interpolated Horizontal and Vertical Ground Motion Response Spectra (GMRS), Foundation Input Response Spectra (FIRS), and Performance-Based Interface Response Spectrum (PBIRS) for the South Plant Complex
(Sheet 1 of 2)

Period	Frequency	GMRS		FIRS (Depth 44 Ft.)		FIRS (Depth 85 Ft.)		FIRS (Depth 115 Ft.)		PBIRS	
(Sec.)	(Hz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
0.005	200.00	0.4318	0.3264	0.3799	0.2953	0.3344	0.2656	0.2412	0.1928	0.2813	0.2221
0.0067	150.00	0.4603	0.3802	0.4073	0.3386	0.3537	0.2957	0.2555	0.2112	0.3039	0.2524
0.01	100.00	0.4889	0.4341	0.4347	0.3819	0.3729	0.3259	0.2698	0.2297	0.3264	0.2828
0.013	75.00	0.5869	0.5672	0.5145	0.4904	0.4381	0.4110	0.3229	0.2895	0.3888	0.3595
0.015	66.67	0.6195	0.6116	0.5411	0.5266	0.4599	0.4394	0.3405	0.3094	0.4095	0.3851
0.02	50.00	0.6848	0.7004	0.5944	0.5990	0.5034	0.4962	0.3759	0.3493	0.4511	0.4363
0.025	40.00	0.7642	0.7582	0.6642	0.6473	0.5650	0.5382	0.4283	0.3838	0.5013	0.4658
0.03	33.33	0.8288	0.7782	0.7240	0.6684	0.6206	0.5625	0.4702	0.4047	0.5385	0.4784
0.04	25.00	0.8880	0.7519	0.8147	0.6807	0.7055	0.5853	0.5292	0.4216	0.5953	0.4864
0.05	20.00	0.9017	0.7230	0.8349	0.6631	0.7335	0.5802	0.5228	0.4072	0.6002	0.4705
0.075	13.33	0.9458	0.7245	0.8527	0.6560	0.7446	0.5705	0.5434	0.4086	0.6035	0.4577
0.1	10.00	0.8965	0.6653	0.7374	0.5542	0.6827	0.5104	0.4366	0.3199	0.5063	0.3737
0.13	7.50	0.8359	0.6493	0.6929	0.5192	0.6313	0.4709	0.4285	0.3157	0.4931	0.3645
0.15	6.67	0.8157	0.6439	0.6780	0.5075	0.6142	0.4577	0.4259	0.3143	0.4886	0.3614
0.2	5.00	0.7332	0.5805	0.7219	0.5475	0.5839	0.4451	0.4180	0.3129	0.4454	0.3361
0.25	4.00	0.6579	0.5687	0.7270	0.5638	0.6100	0.4768	0.4176	0.3207	0.4186	0.3230
0.3	3.33	0.6310	0.5680	0.7126	0.5544	0.6133	0.4885	0.3830	0.3001	0.3904	0.3072
0.4	2.50	0.5199	0.4716	0.6007	0.4733	0.5111	0.4122	0.2967	0.2360	0.3109	0.2478
0.5	2.00	0.4675	0.4370	0.5572	0.4421	0.4794	0.3903	0.2533	0.2042	0.2590	0.2089
0.75	1.33	0.2750	0.2593	0.3401	0.2714	0.2962	0.2439	0.1715	0.1400	0.1750	0.1429
1	1.00	0.1768	0.1672	0.2089	0.1679	0.1852	0.1527	0.1258	0.1027	0.1282	0.1047
1.3	0.75	0.1197	0.1134	0.1367	0.1095	0.1262	0.1034	0.0946	0.0768	0.0962	0.0781
1.5	0.67	0.1007	0.0954	0.1127	0.0900	0.1065	0.0870	0.0842	0.0682	0.0856	0.0693
2	0.50	0.0748	0.0690	0.0801	0.0620	0.0770	0.0605	0.0660	0.0514	0.0675	0.0525
2.5	0.40	0.0560	0.0512	0.0587	0.0451	0.0571	0.0444	0.0515	0.0396	0.0524	0.0403
3	0.33	0.0436	0.0394	0.0444	0.0338	0.0438	0.0337	0.0418	0.0318	0.0422	0.0321

Table 2.5-85
Interpolated Horizontal and Vertical Ground Motion Response Spectra (GMRS), Foundation Input Response Spectra (FIRS), and Performance-Based Interface Response Spectrum (PBIRS) for the South Plant Complex
(Sheet 2 of 2)

Period	Frequency	GMRS		FIRS (Depth 44 Ft.)		FIRS (Depth 85 Ft.)		FIRS (Depth 115 Ft.)		PBIRS	
(Sec.)	(Hz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
4	0.25	0.0312	0.0282	0.0317	0.0241	0.0314	0.0241	0.0303	0.0230	0.0305	0.0232
5	0.20	0.0247	0.0223	0.0251	0.0190	0.0248	0.0189	0.0239	0.0180	0.0240	0.0181
7.5	0.13	0.0162	0.0146	0.0164	0.0123	0.0162	0.0124	0.0158	0.0119	0.0158	0.0119
10	0.10	0.0116	0.0104	0.0118	0.0089	0.0117	0.0089	0.0114	0.0086	0.0114	0.0086

Key: ft. = feet; Hz = hertz; sec. = second

Table 2.5-86
Calculated Factors of Safety

Cross Sections	Analysis Case	Minimum Factor of Safety	Calculated Factor of Safety	Remarks
N1-N1 (North Complex)	Steady-state condition	1.5	2.36	Suitable
	Pseudo-static condition	1.1	1.29	Suitable
M1-M1 (Middle Complex)	Steady-state condition	1.5	2.32	Suitable
	Pseudo-static condition	1.1	1.25	Suitable
M2-M2 (Middle Complex)	Steady-state conditionstate condition	1.5	2.58	Suitable
	Pseudo-static condition	1.1	1.40	Suitable
S1-S1 (South Complex)	Steady-state condition	1.5	2.16	Suitable
	Pseudo-static condition	1.1	1.13	Suitable
S2-S2 (South Complex)	Steady-state condition	1.5	2.32	Suitable
	Pseudo-static condition	1.1	1.35	Suitable

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Figure 2.1-1
Project Site Topological Features

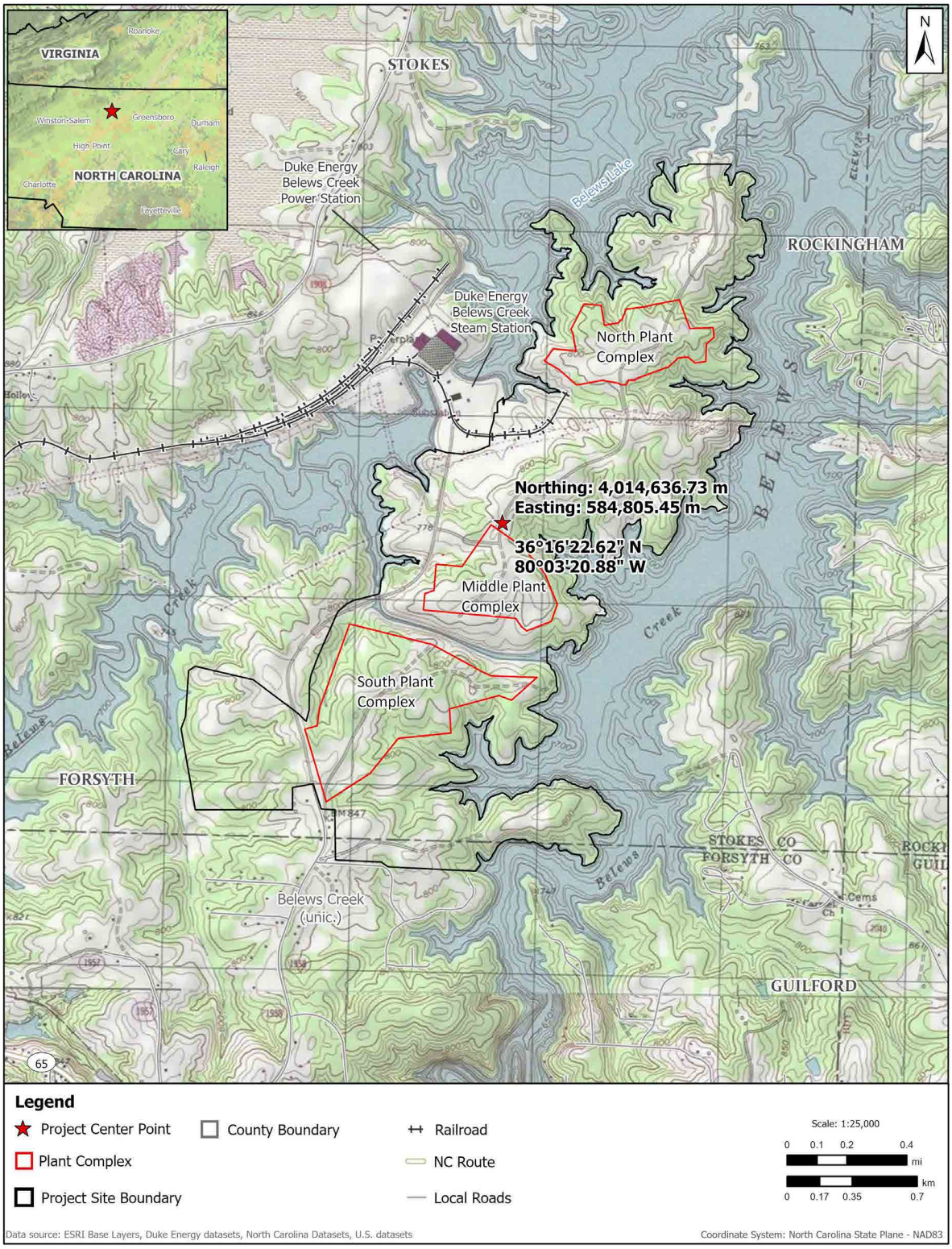


Figure 2.1-2
Project Site Location & 6-Mile Surrounding Area

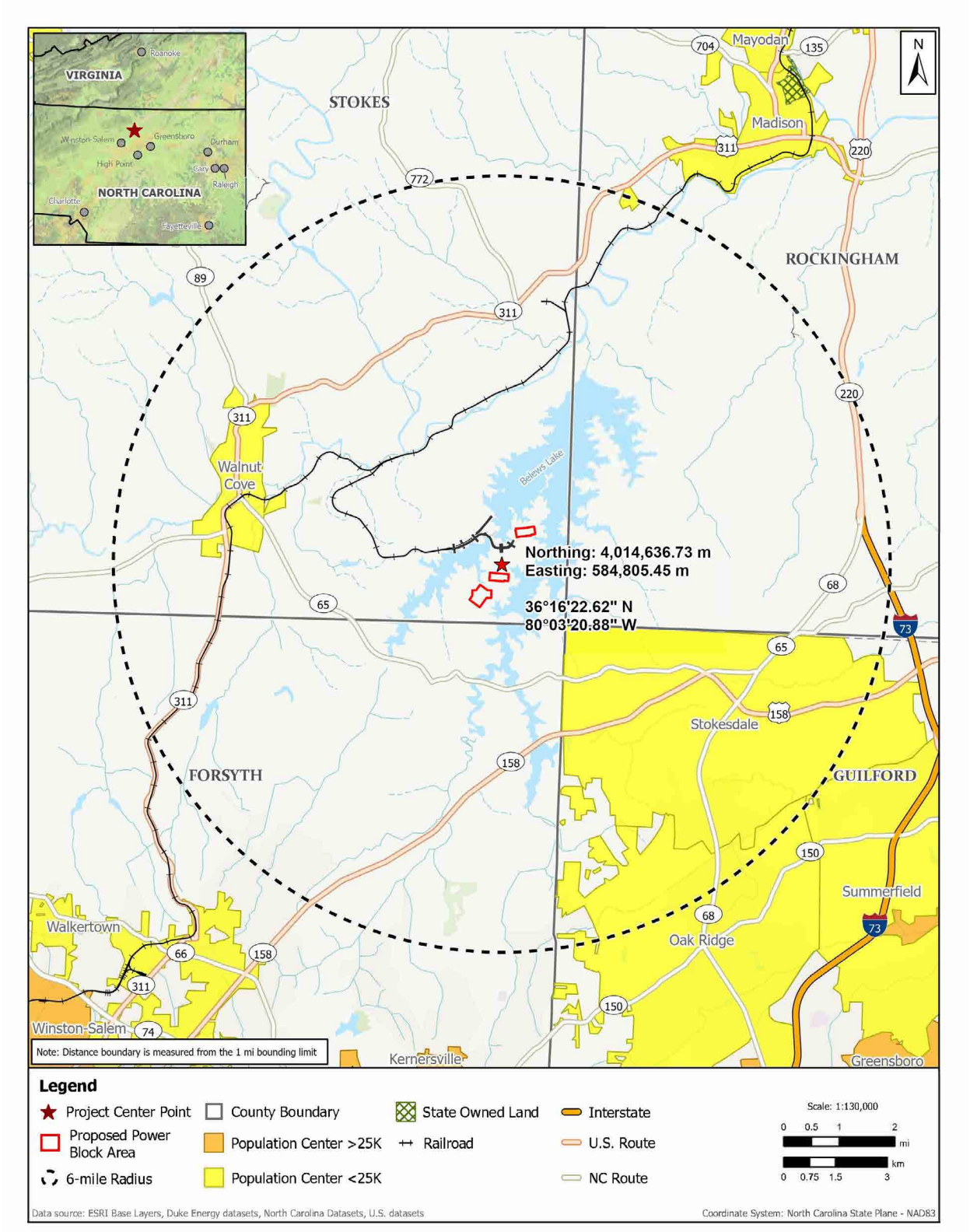


Figure 2.1-3
Project Site Location & 50-Mile Surrounding Area

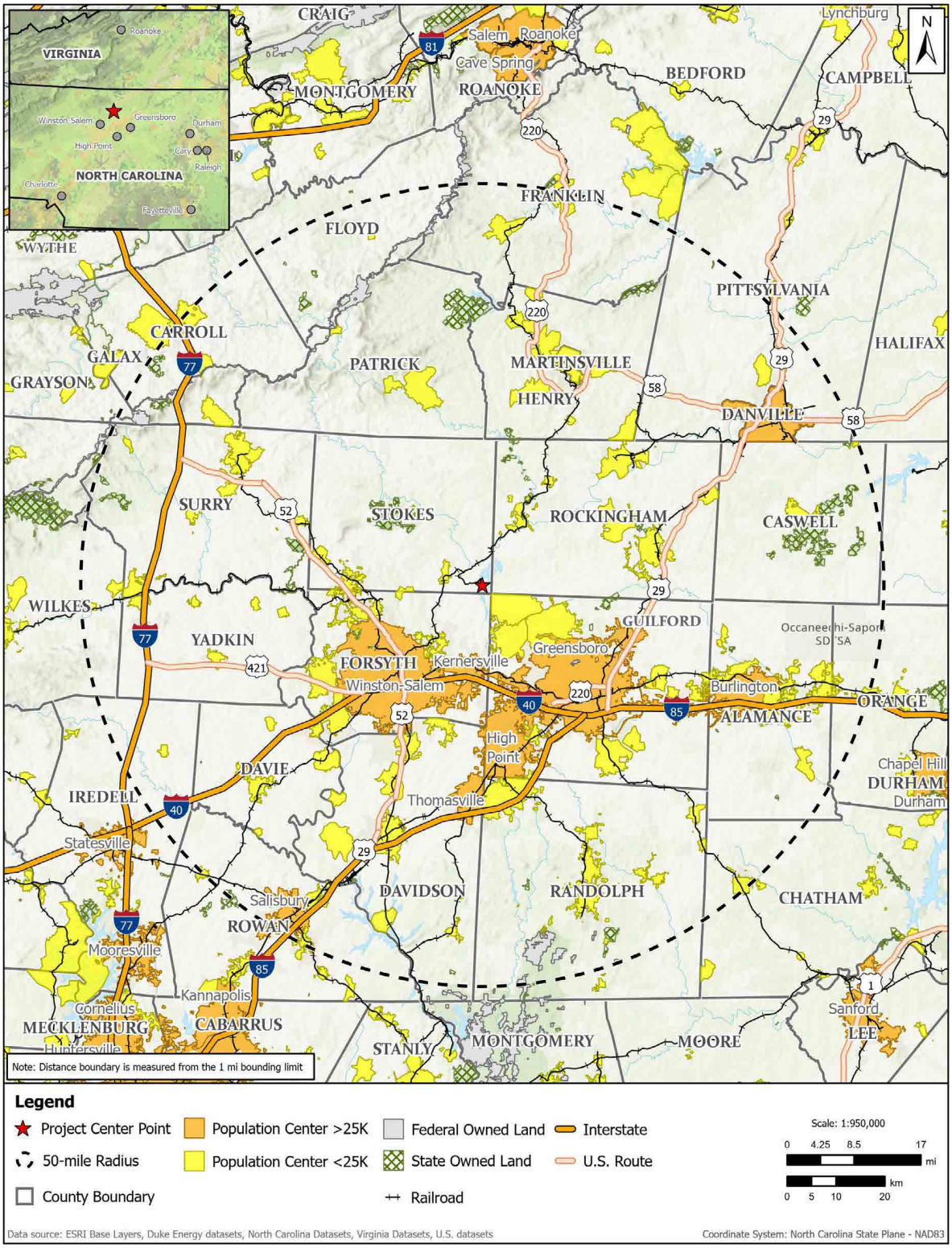


Figure 2.1-4
Project Site Vicinity Map

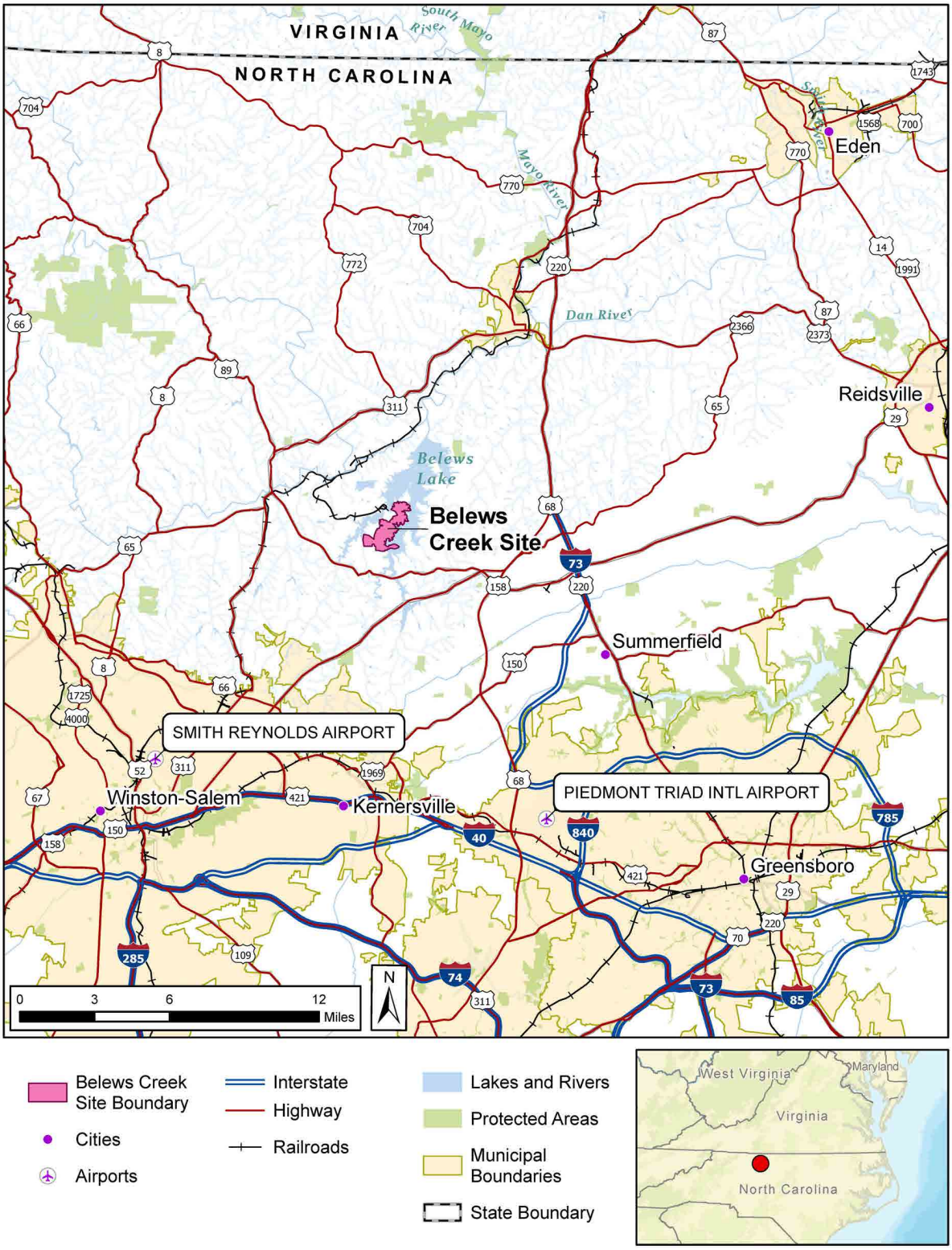


Figure 2.1-5
Belews Creek, NC Site Exclusion Area and Low Population Zone

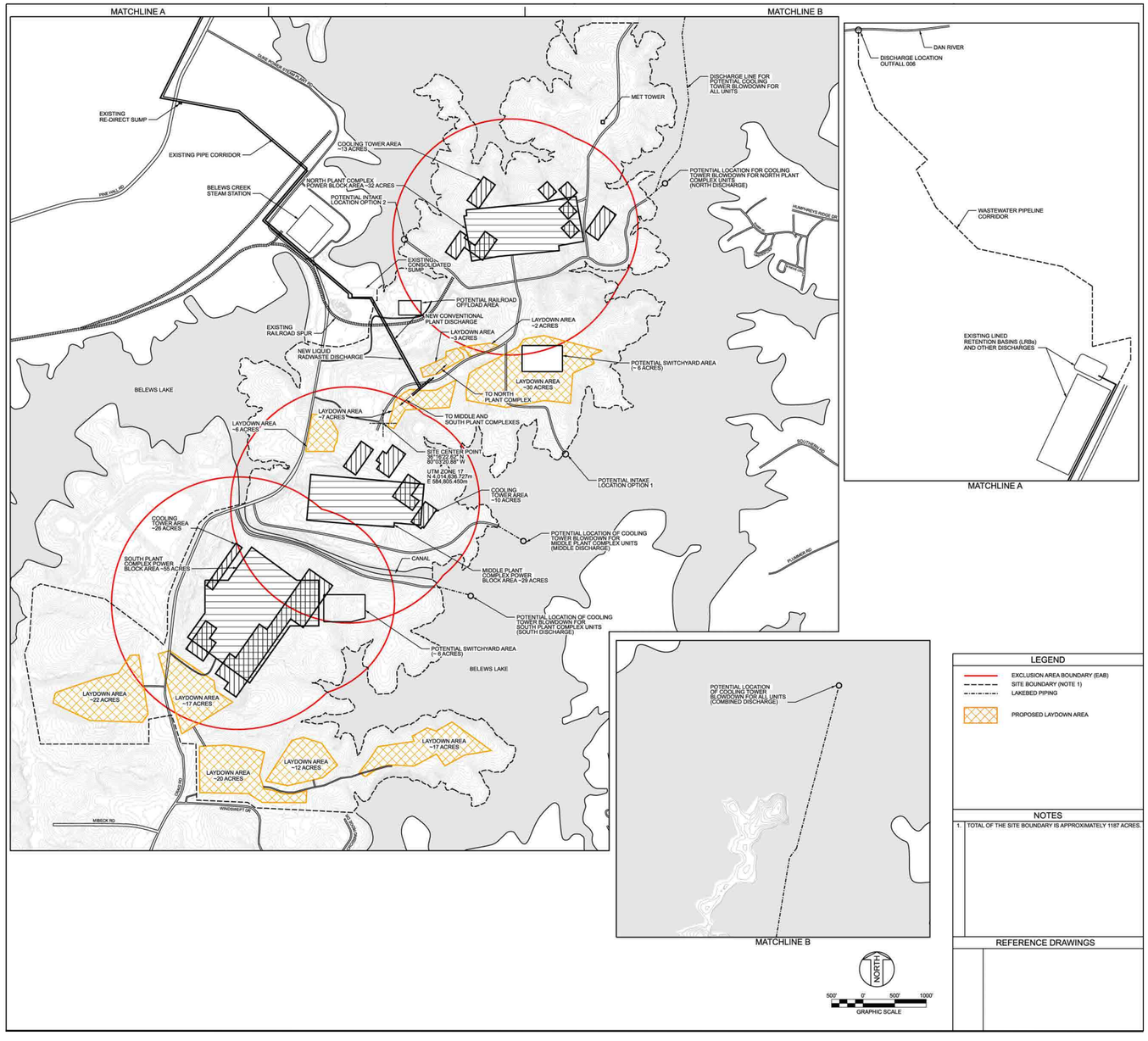


Figure 2.1-6
Project Site Boundary and Property Map

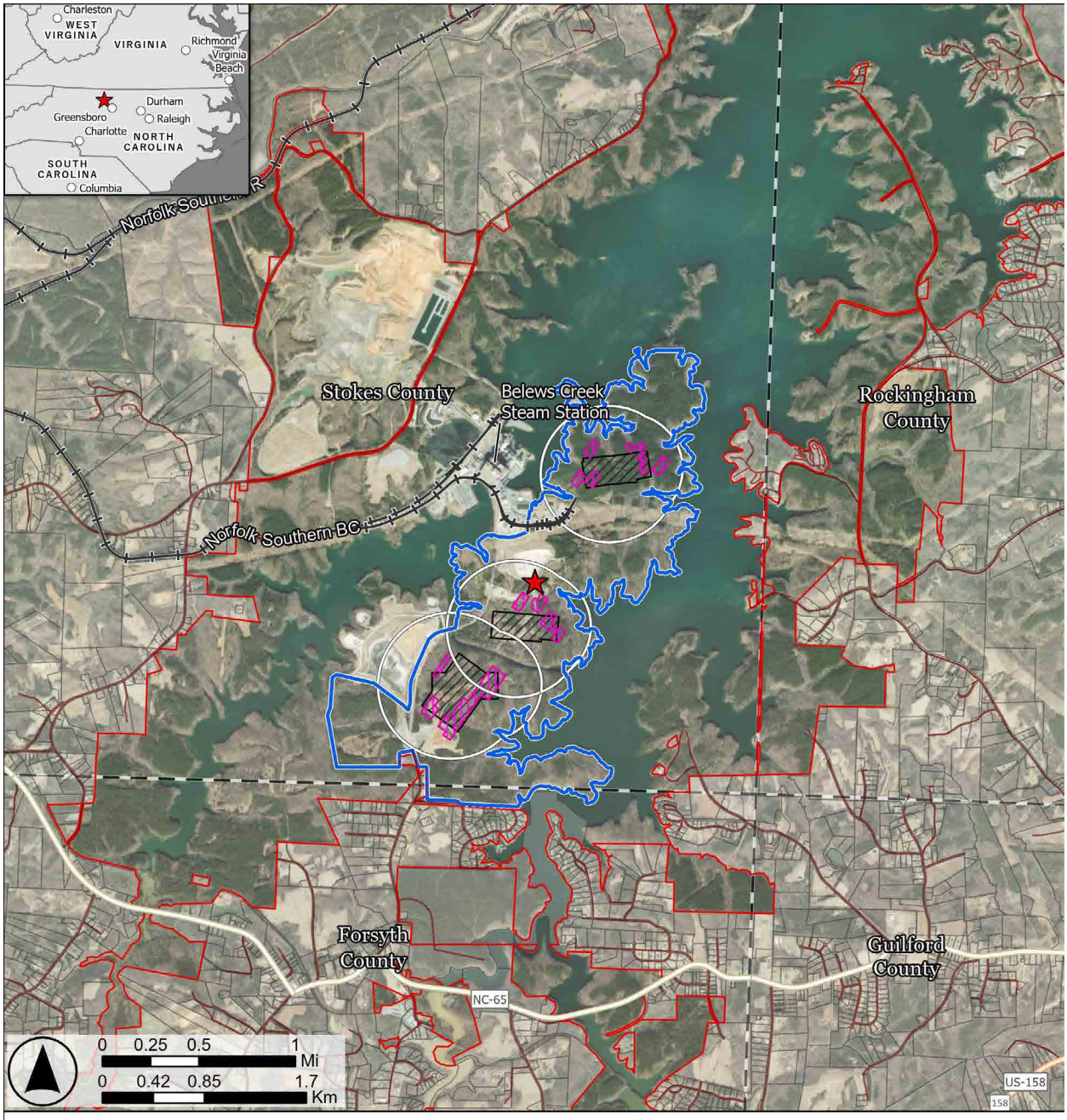


Figure 2.1-7
20-Mile Surrounding Area

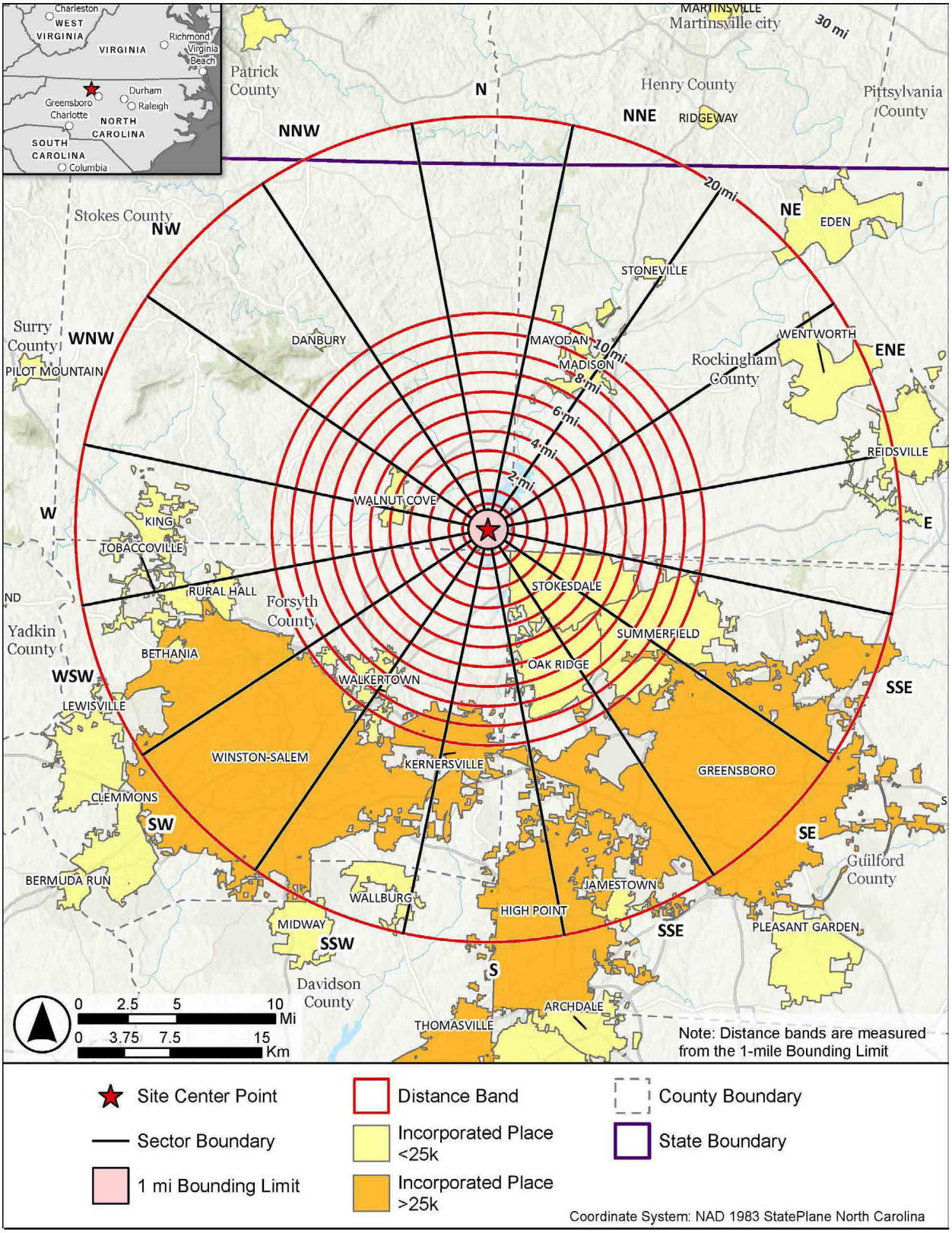


Figure 2.1-8
20-to 50-Mile Surrounding Area

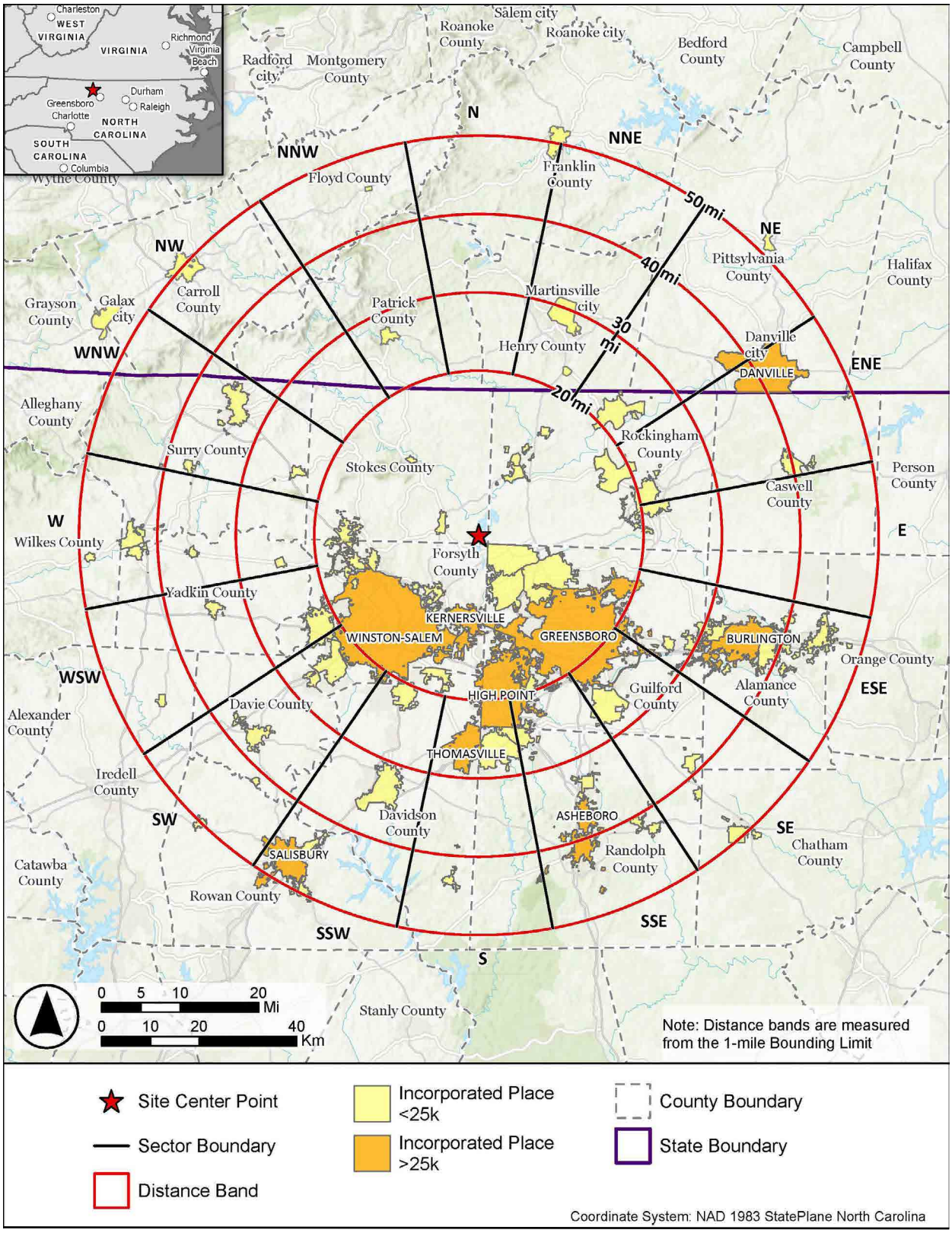


Figure 2.1-9
20-Mile Resident and Transient Population Distribution – 2020

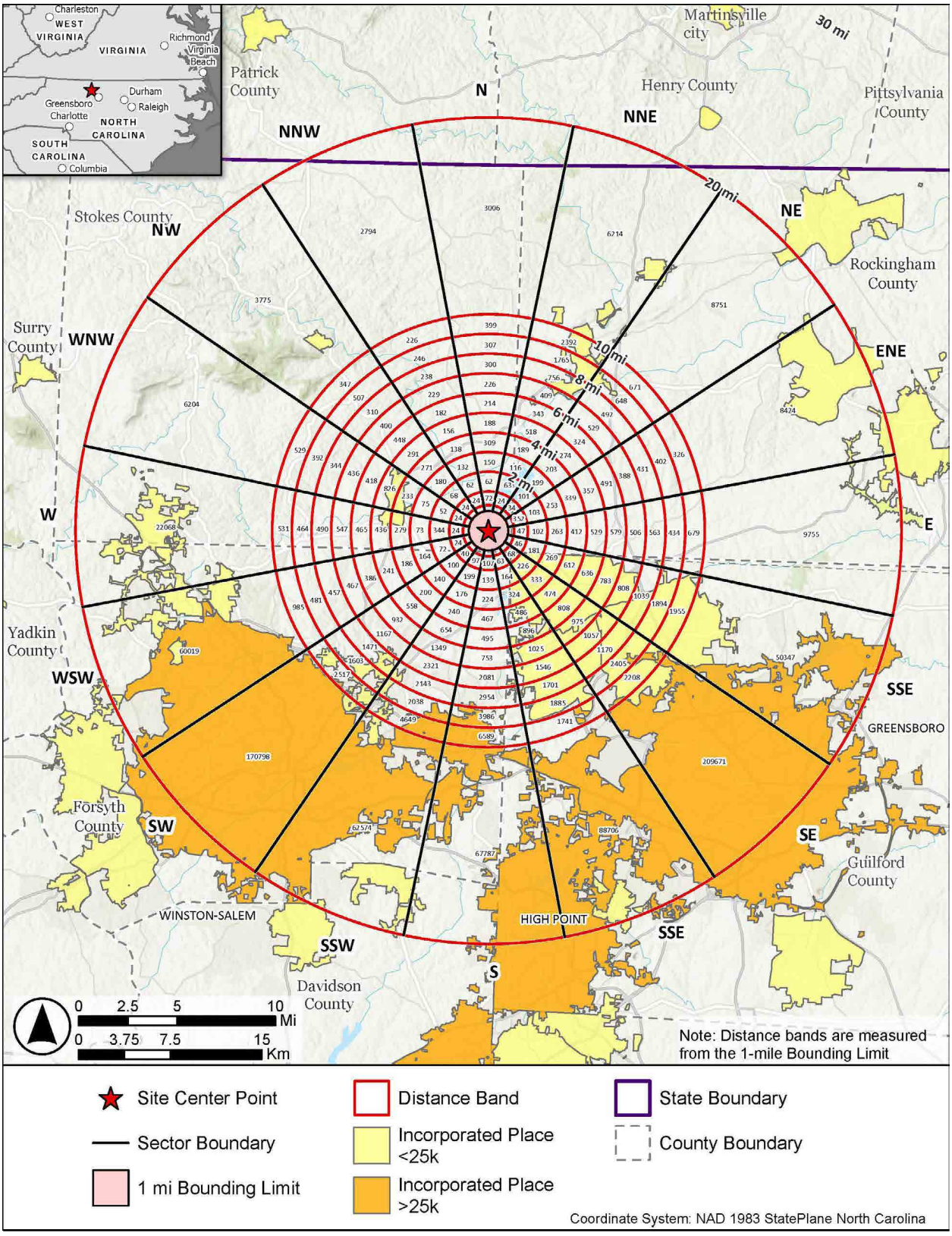


Figure 2.1-10
20-Mile Resident and Transient Population Distribution – 2024

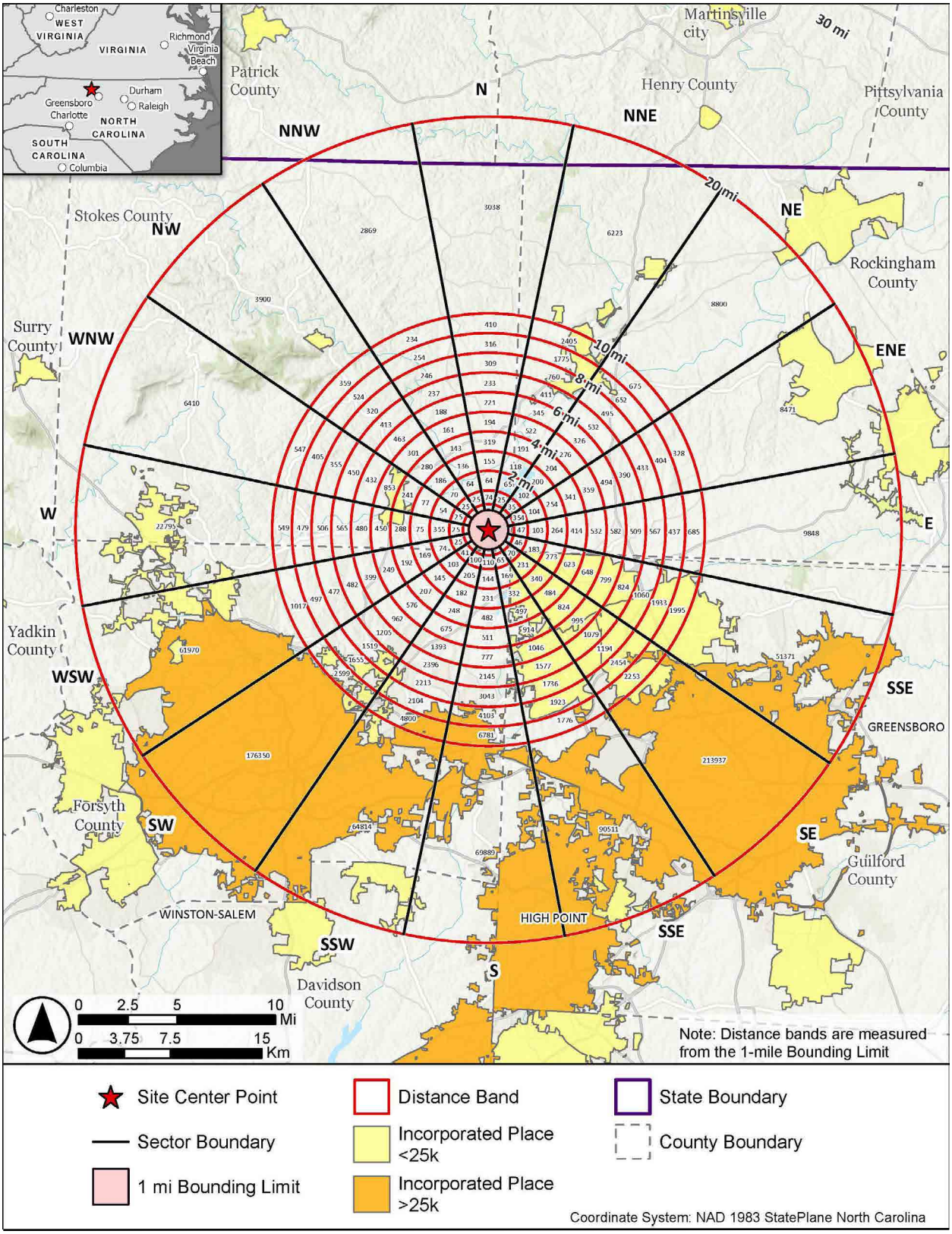


Figure 2.1-11
20-Mile Resident and Transient Population Distribution – 2030

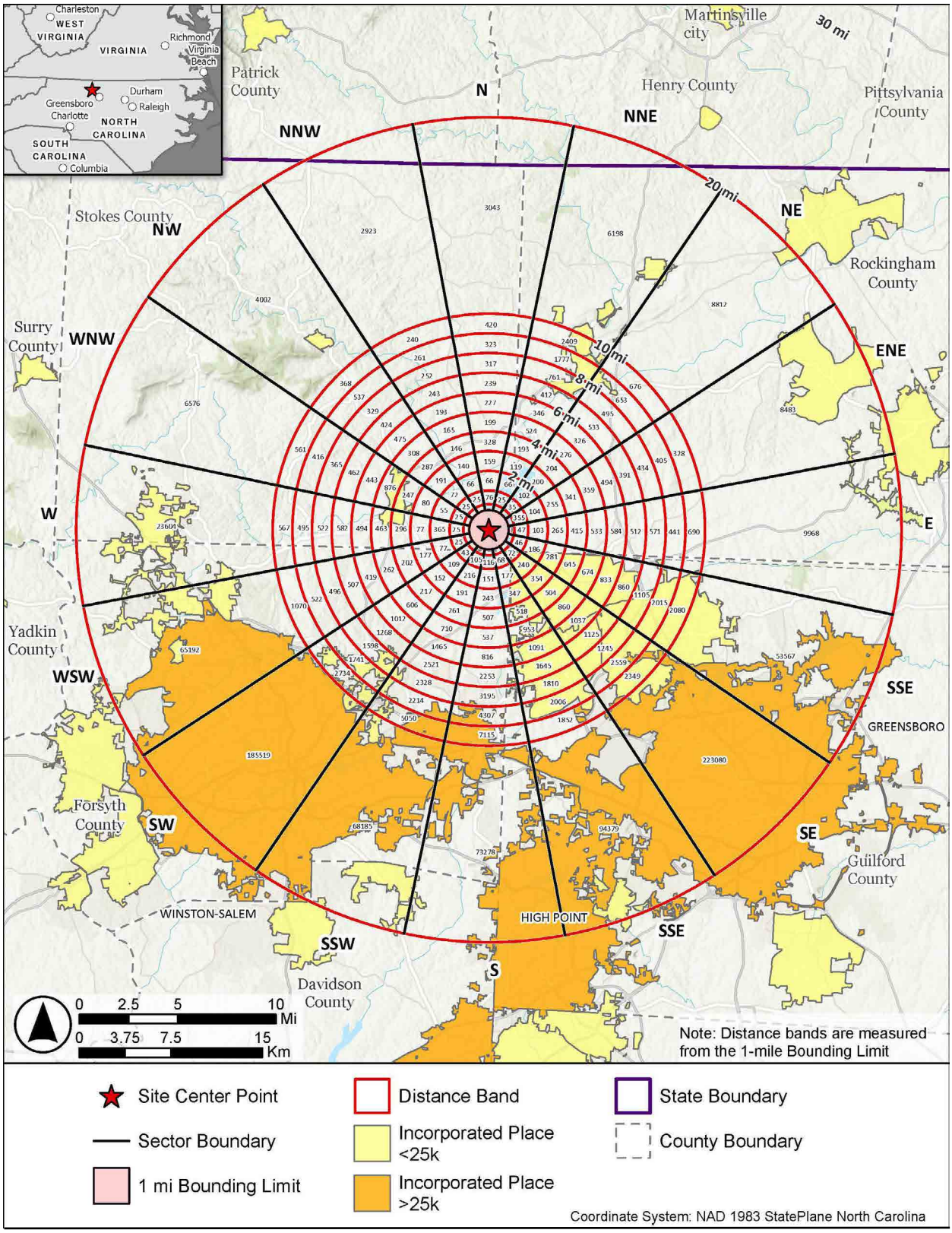


Figure 2.1-12
20-Mile Resident and Transient Population Distribution – 2034

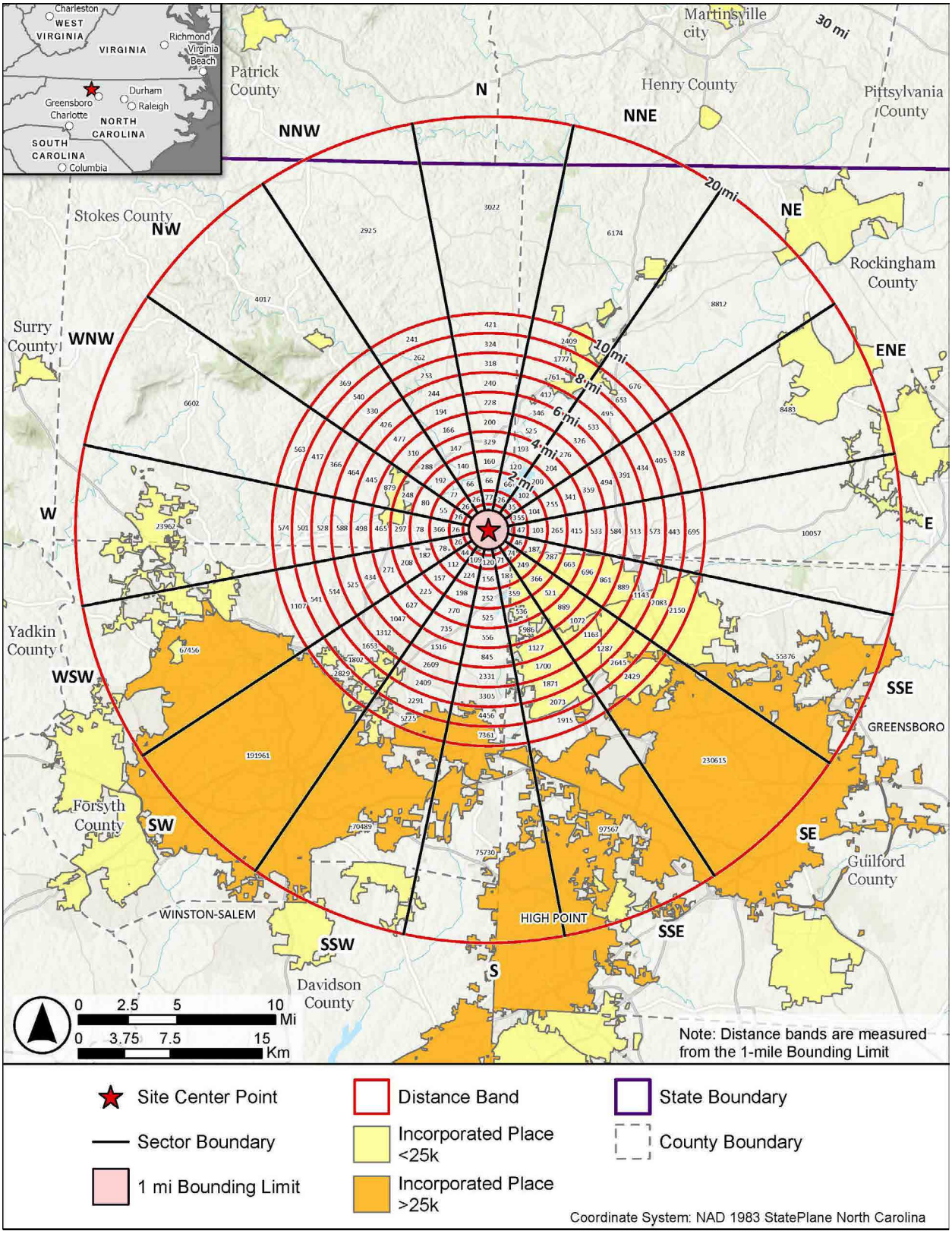


Figure 2.1-13
20-Mile Resident and Transient Population Distribution – 2039

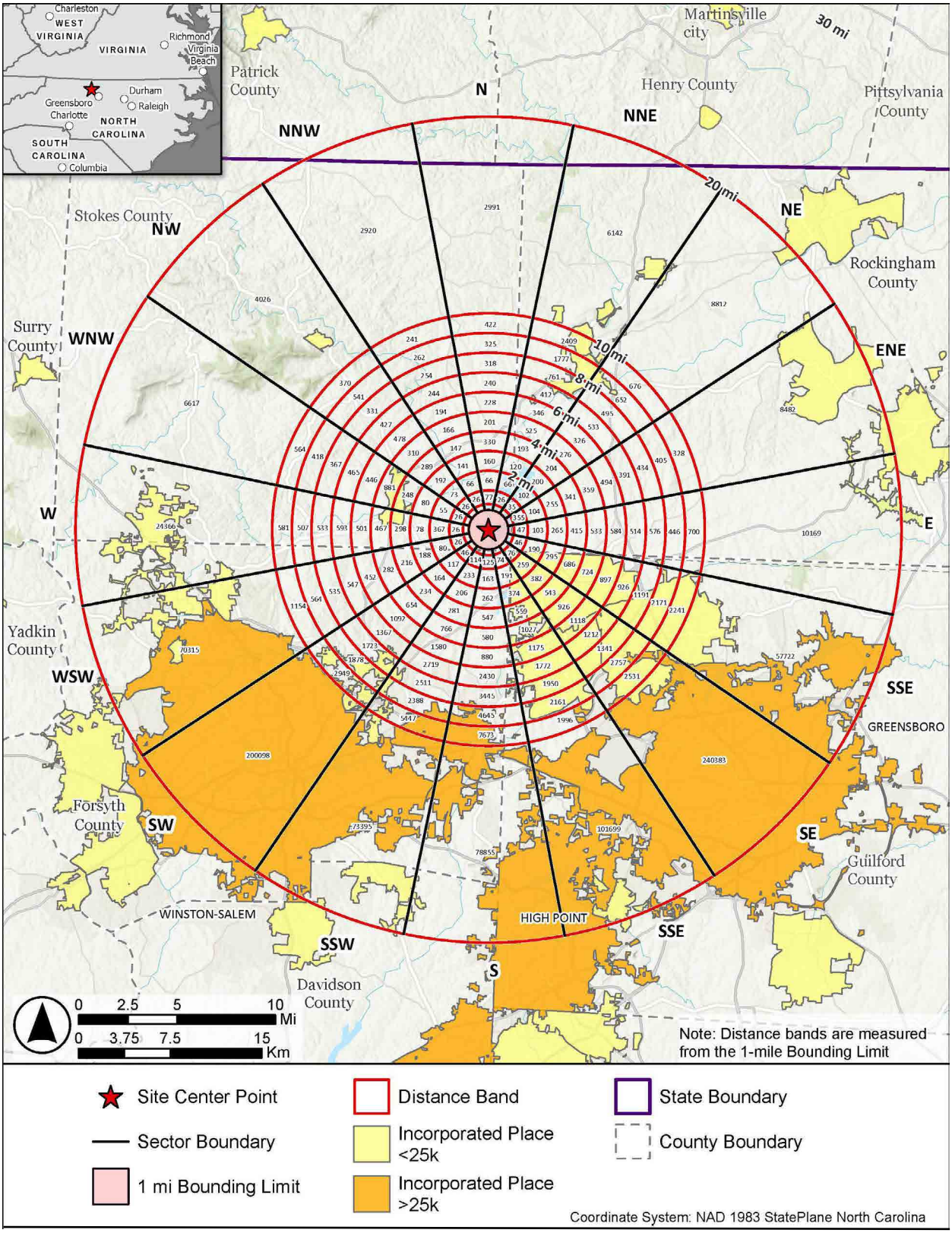


Figure 2.1-14
20-Mile Resident and Transient Population Distribution – 2079

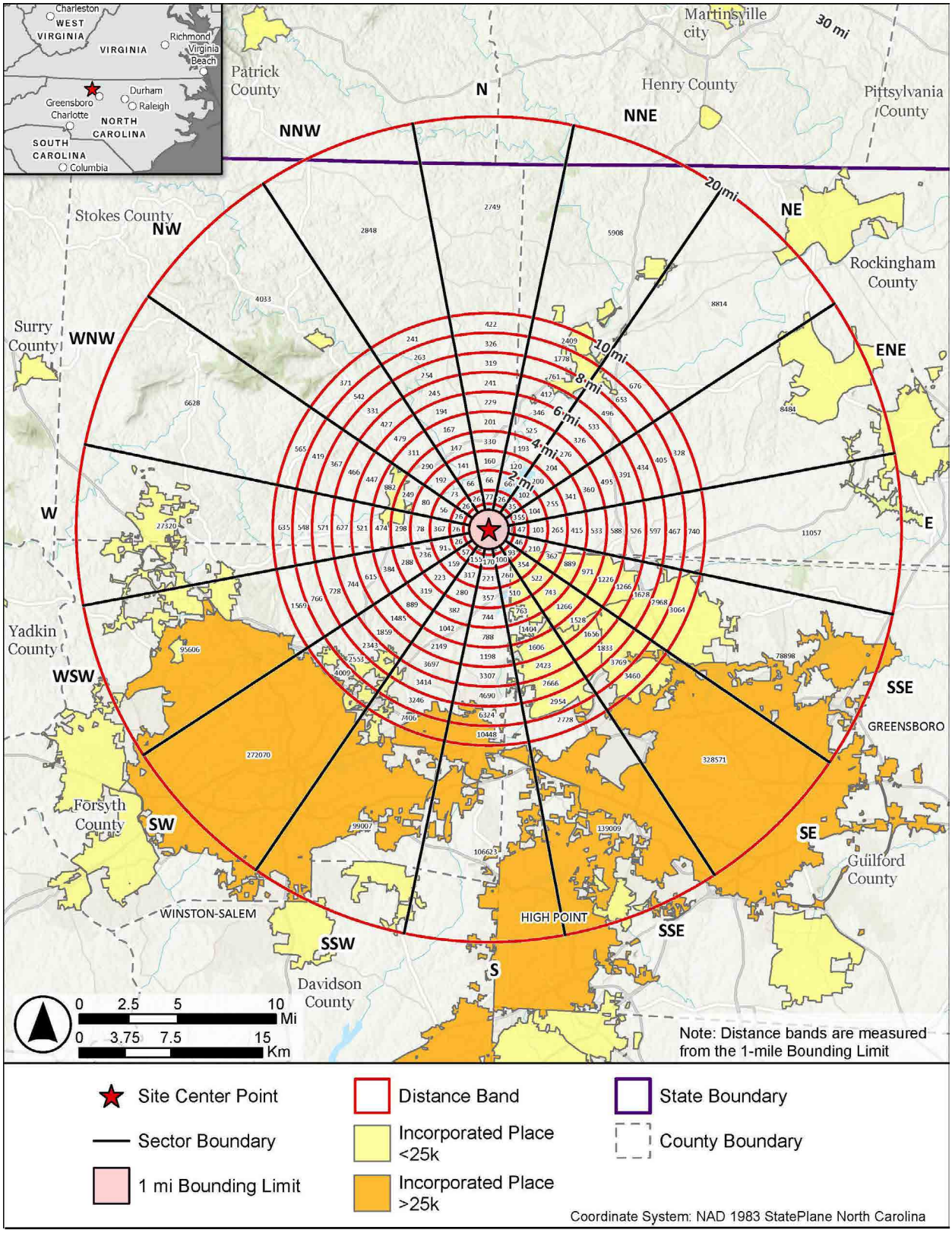


Figure 2.1-15
20-to 50-Mile Resident Population Distribution – 2020

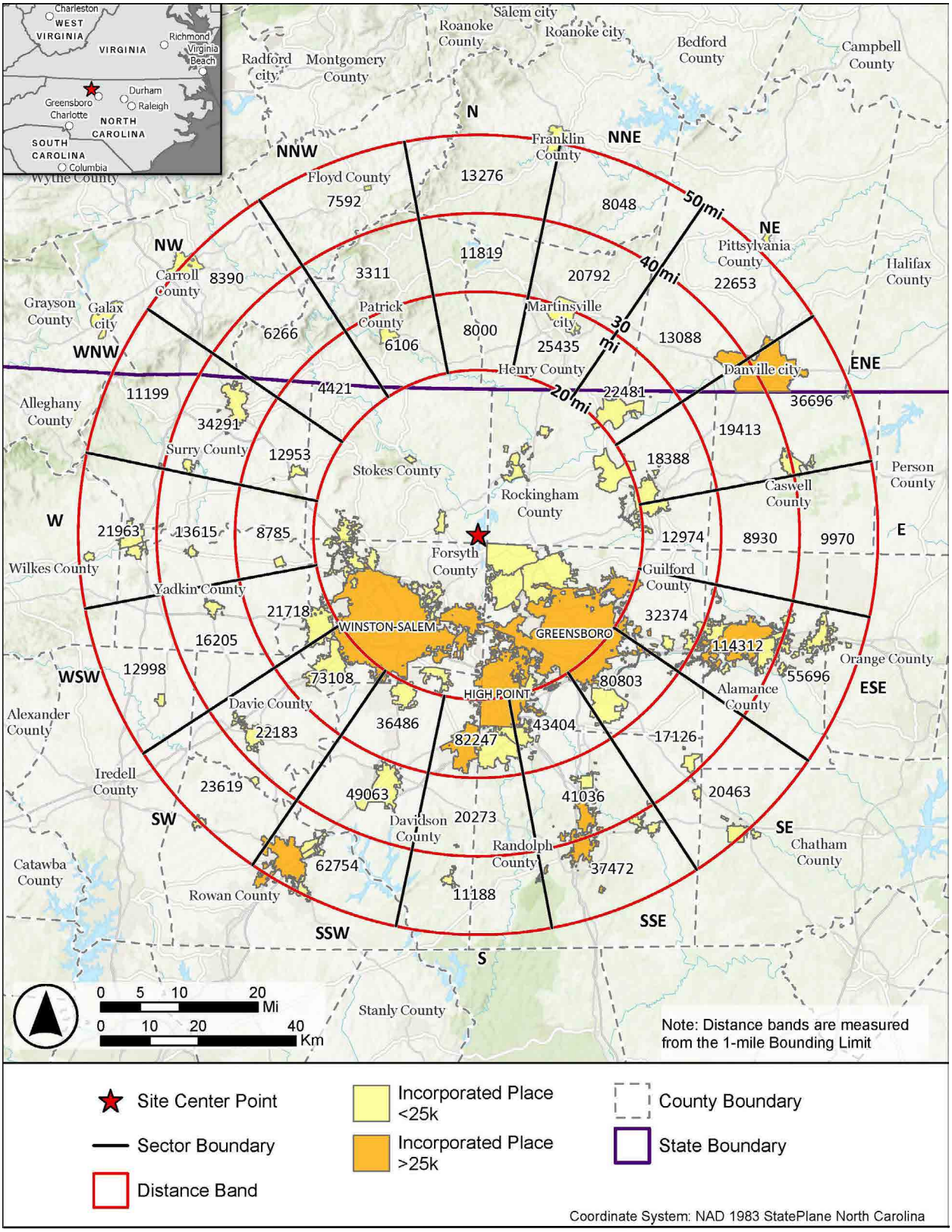


Figure 2.1-16
20-to 50-Mile Resident Population Distribution – 2024

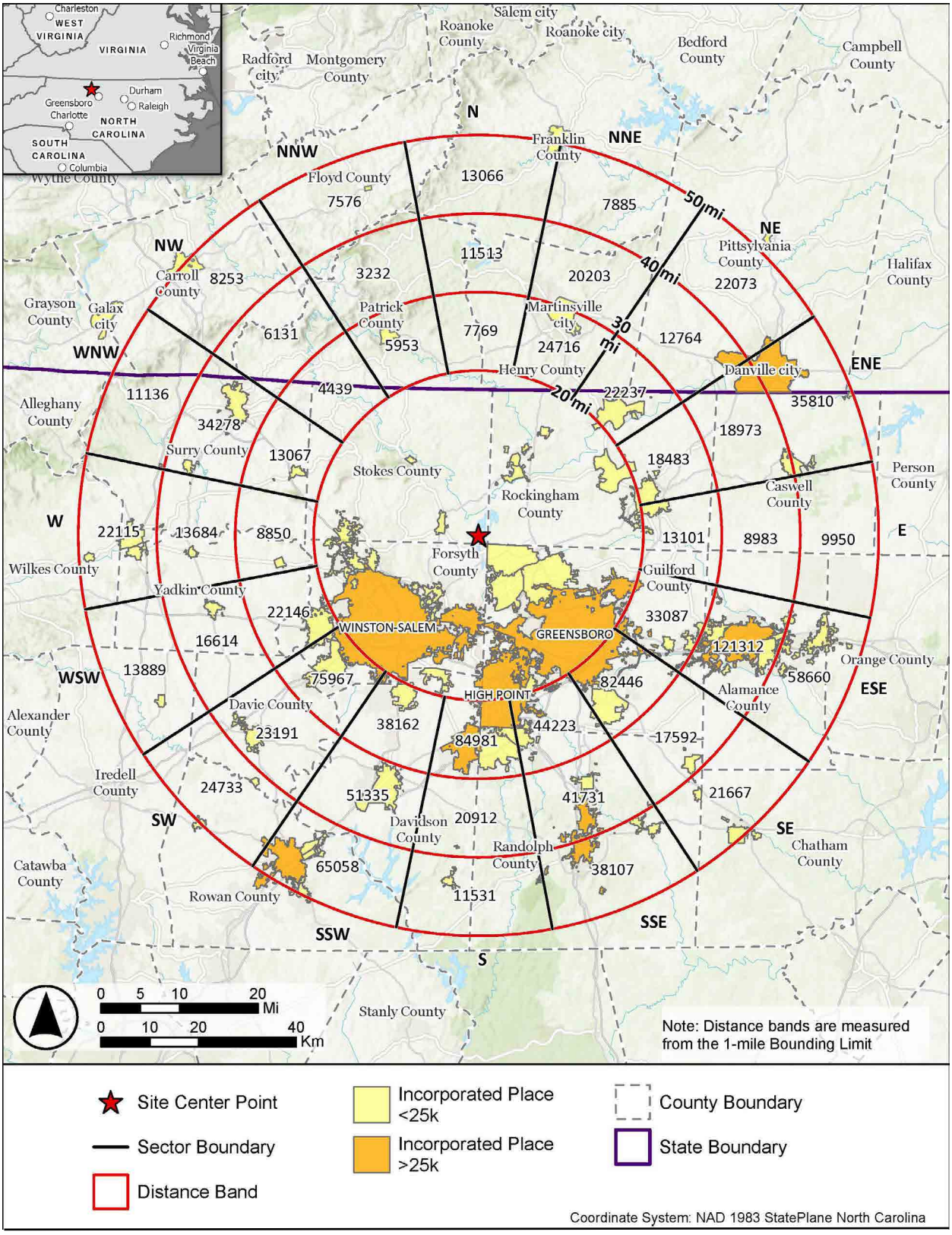


Figure 2.1-17
20-to 50-Mile Resident Population Distribution – 2030

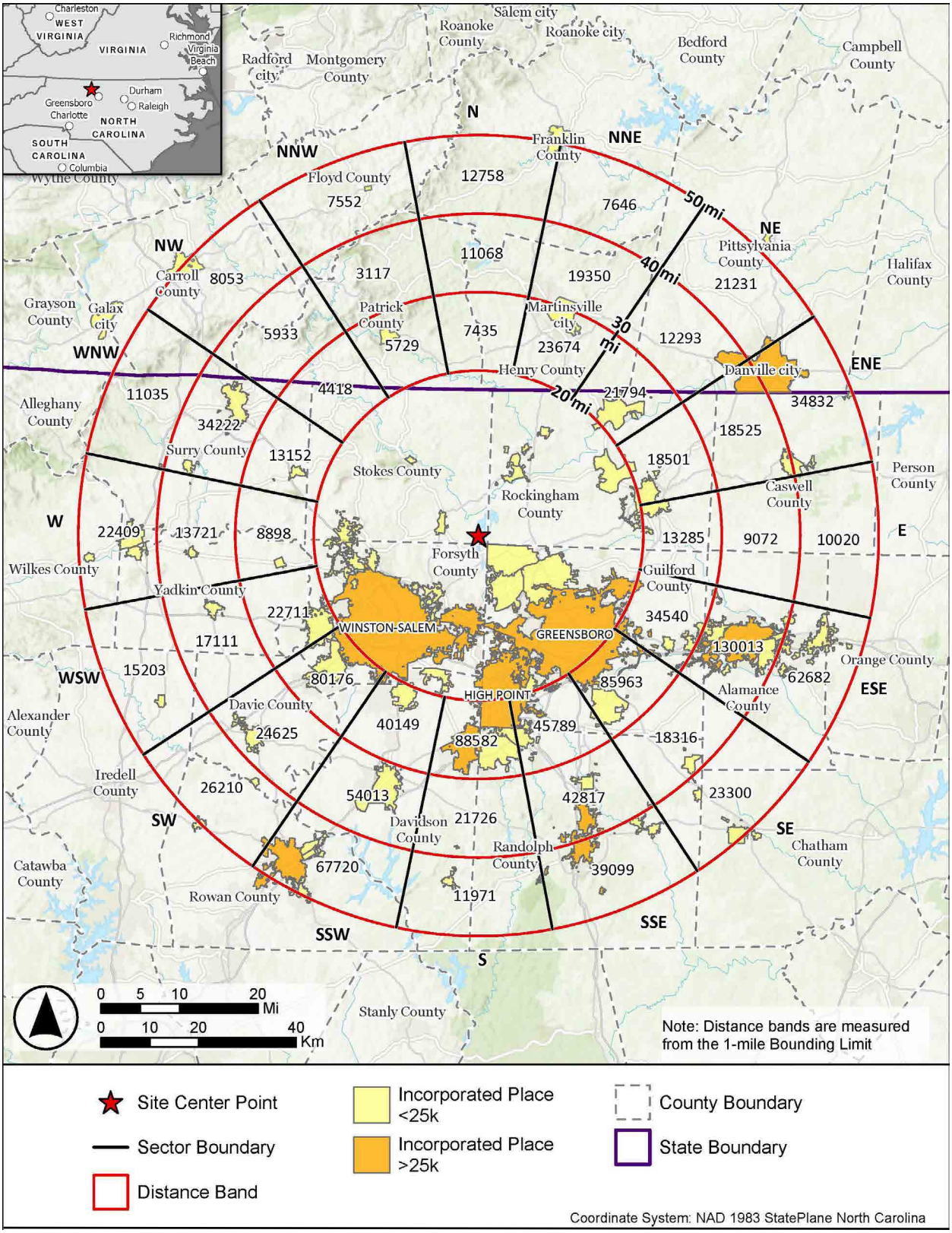


Figure 2.1-18
20-to 50-Mile Resident Population Distribution – 2034

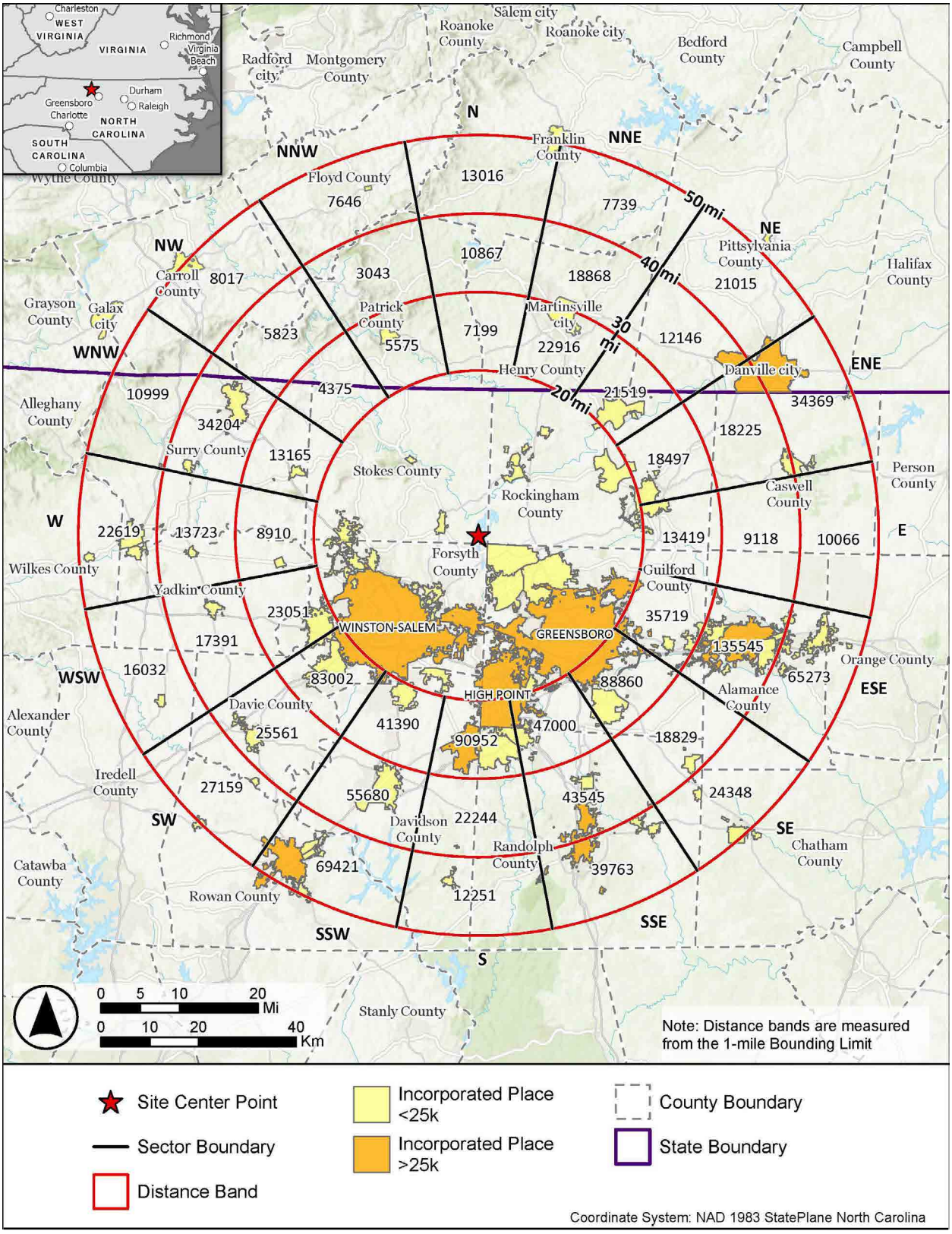


Figure 2.1-19
20-to 50-Mile Resident Population Distribution – 2039

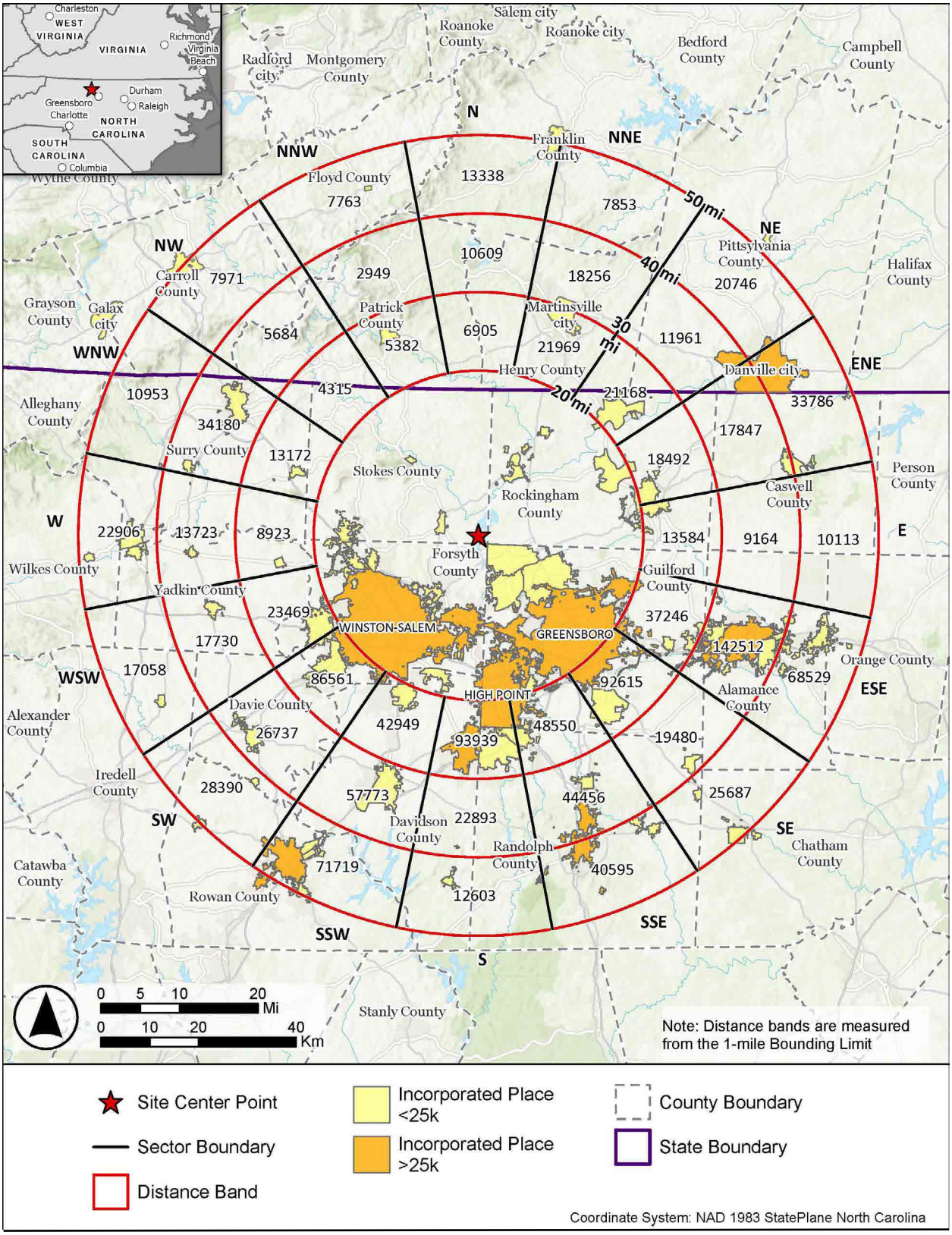


Figure 2.1-20
20- to 50-Mile Resident Population Distribution – 2079

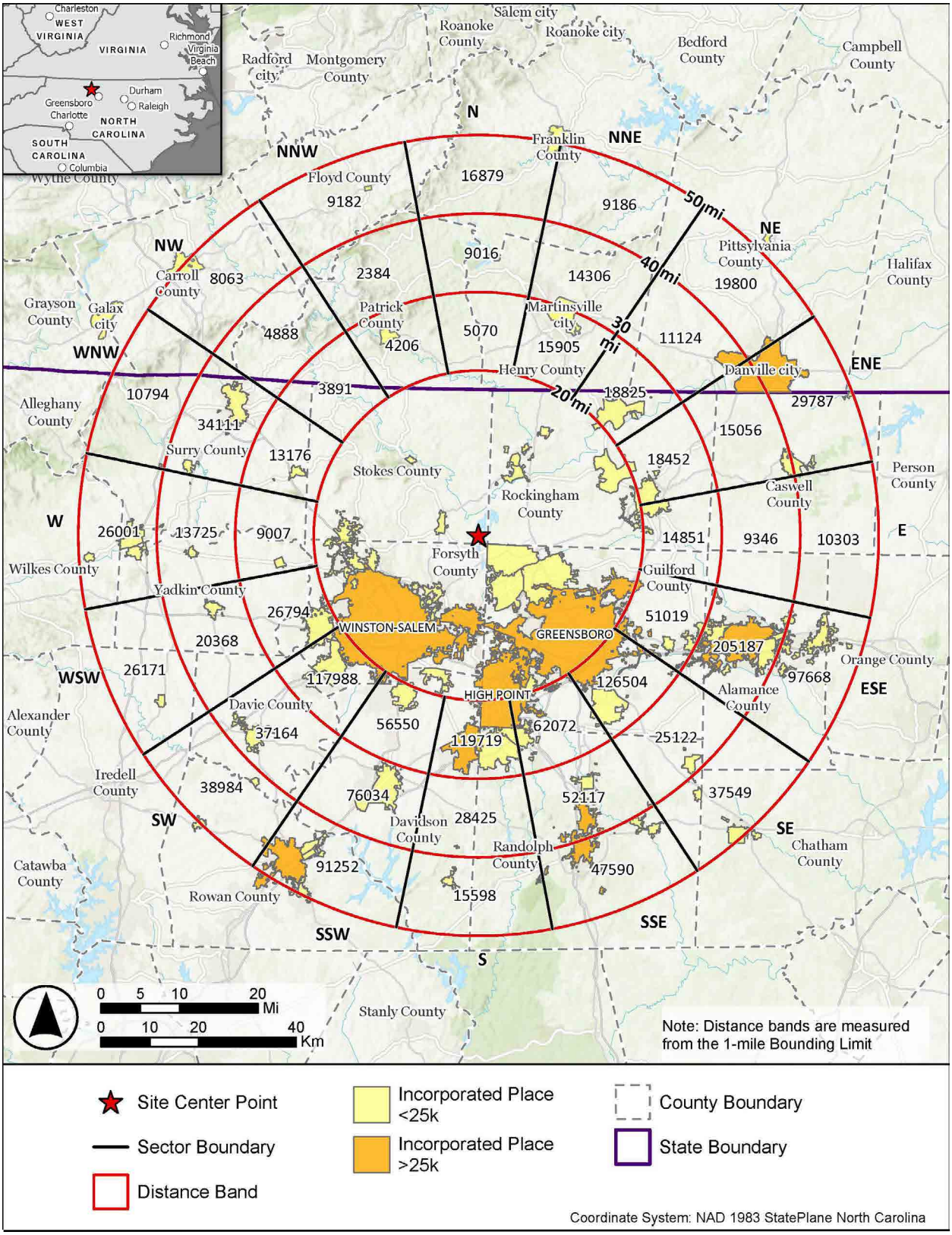
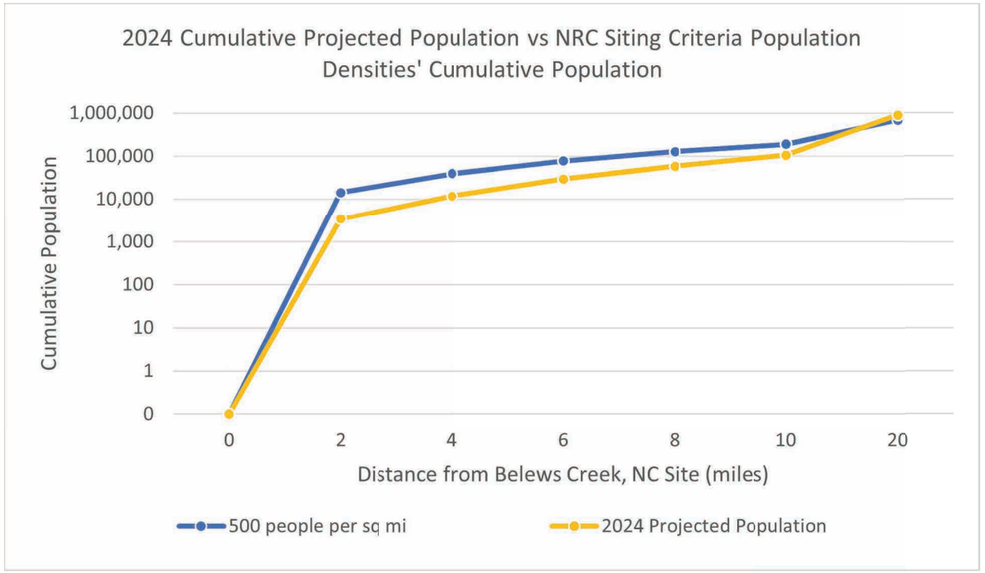
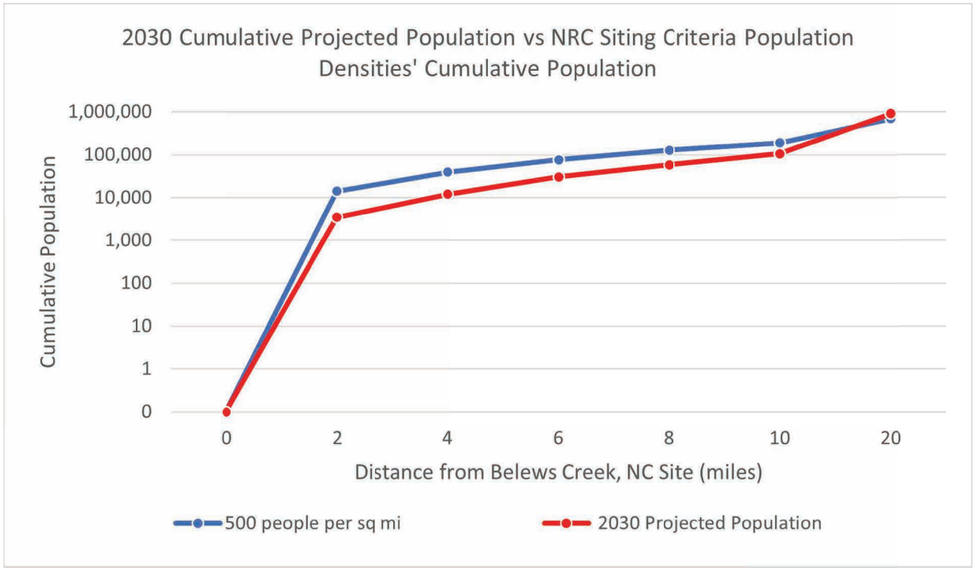


Figure 2.1-21
Project Site Cumulative Populations at Termination of Operating License,
0- to 20-Miles, Compared to NRC Siting Criteria
(Sheet 1 of 2)





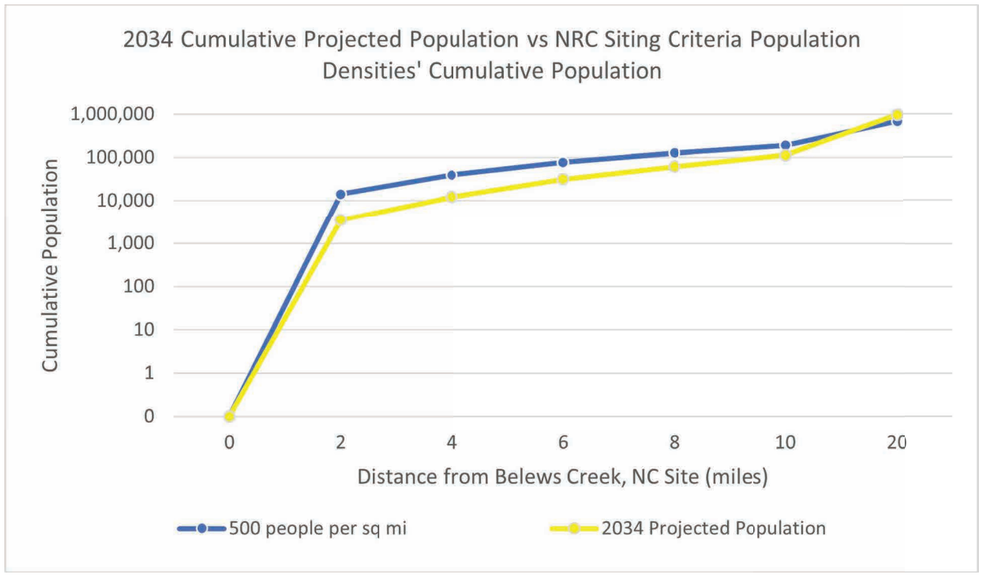
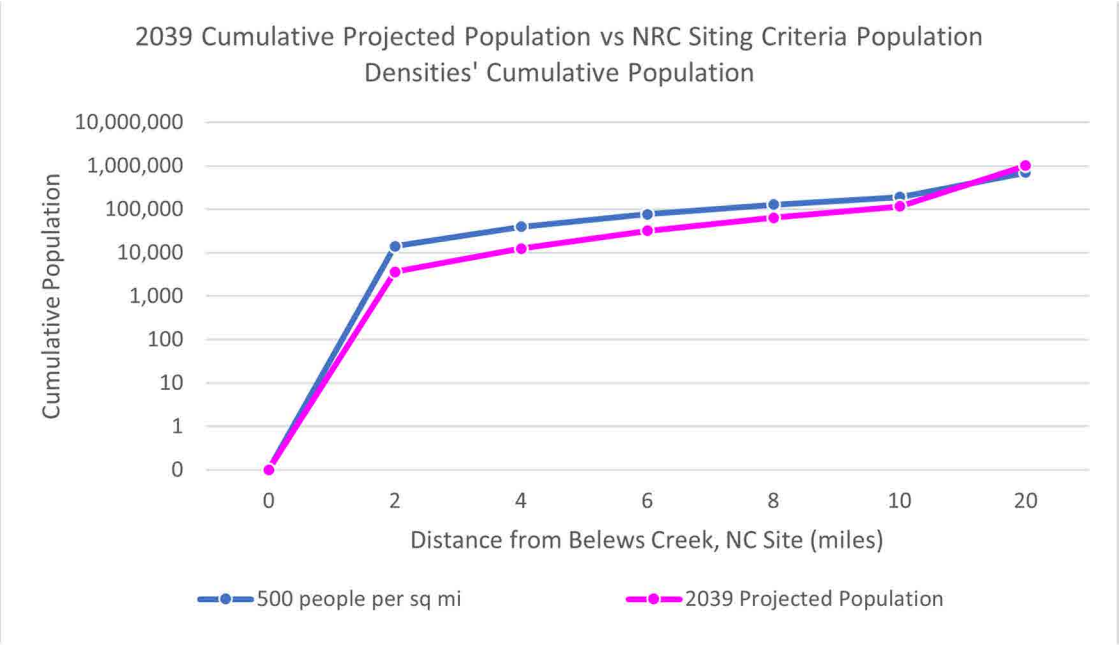


Figure 2.1-21
Project Site Cumulative Populations at Termination of Operating License, 0- to 20-Miles, Compared to NRC Siting Criteria
(Sheet 2 of 2)



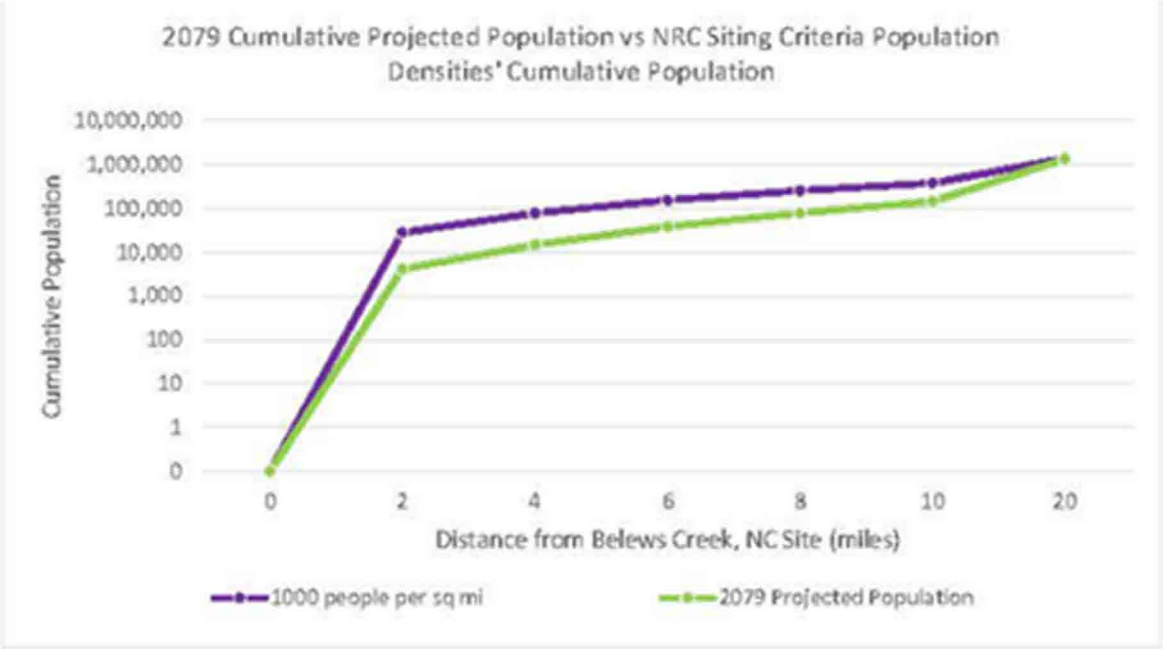


Figure 2.2-1
Notable Facilities Near the Project Site

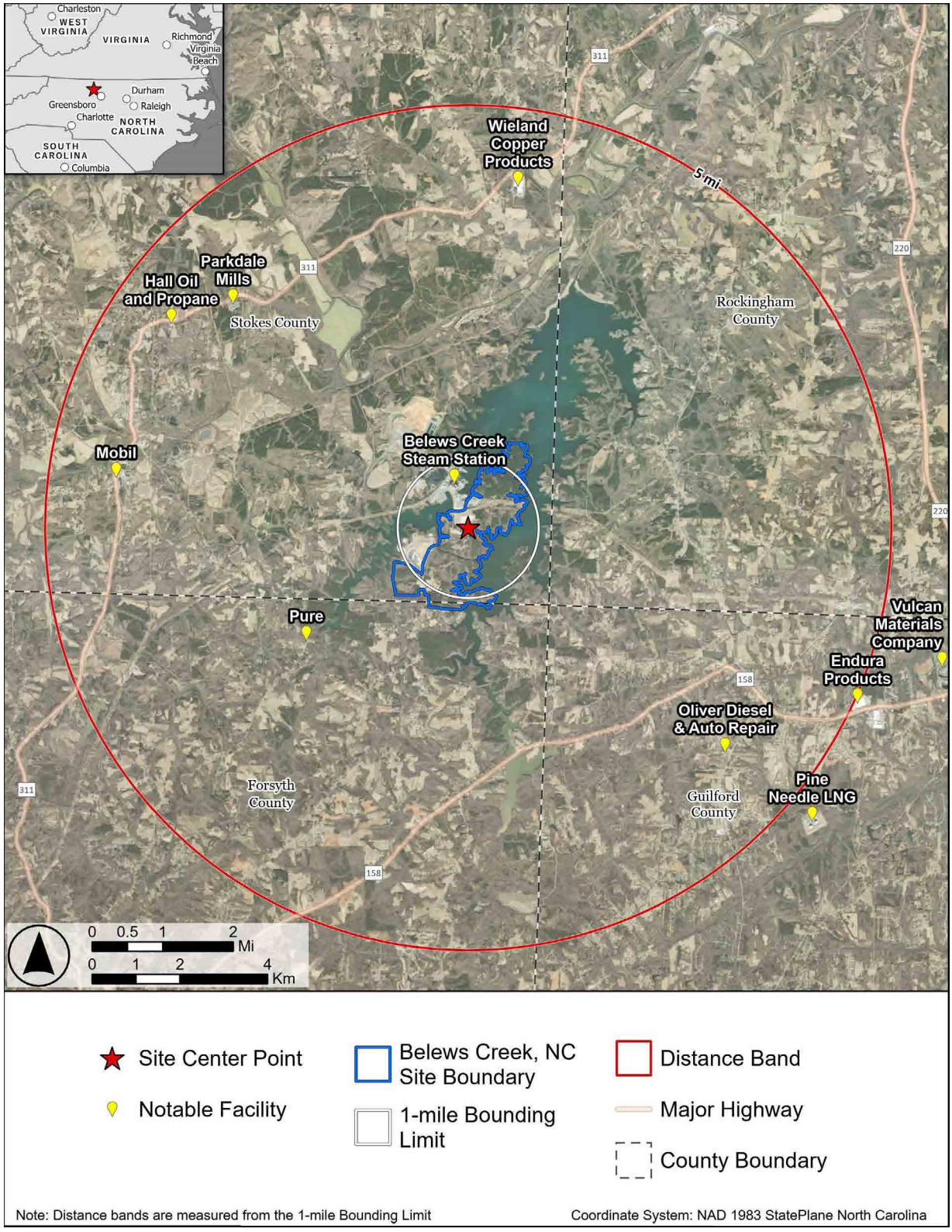


Figure 2.2-2
Transportation Routes within 5 Miles of the Project Site

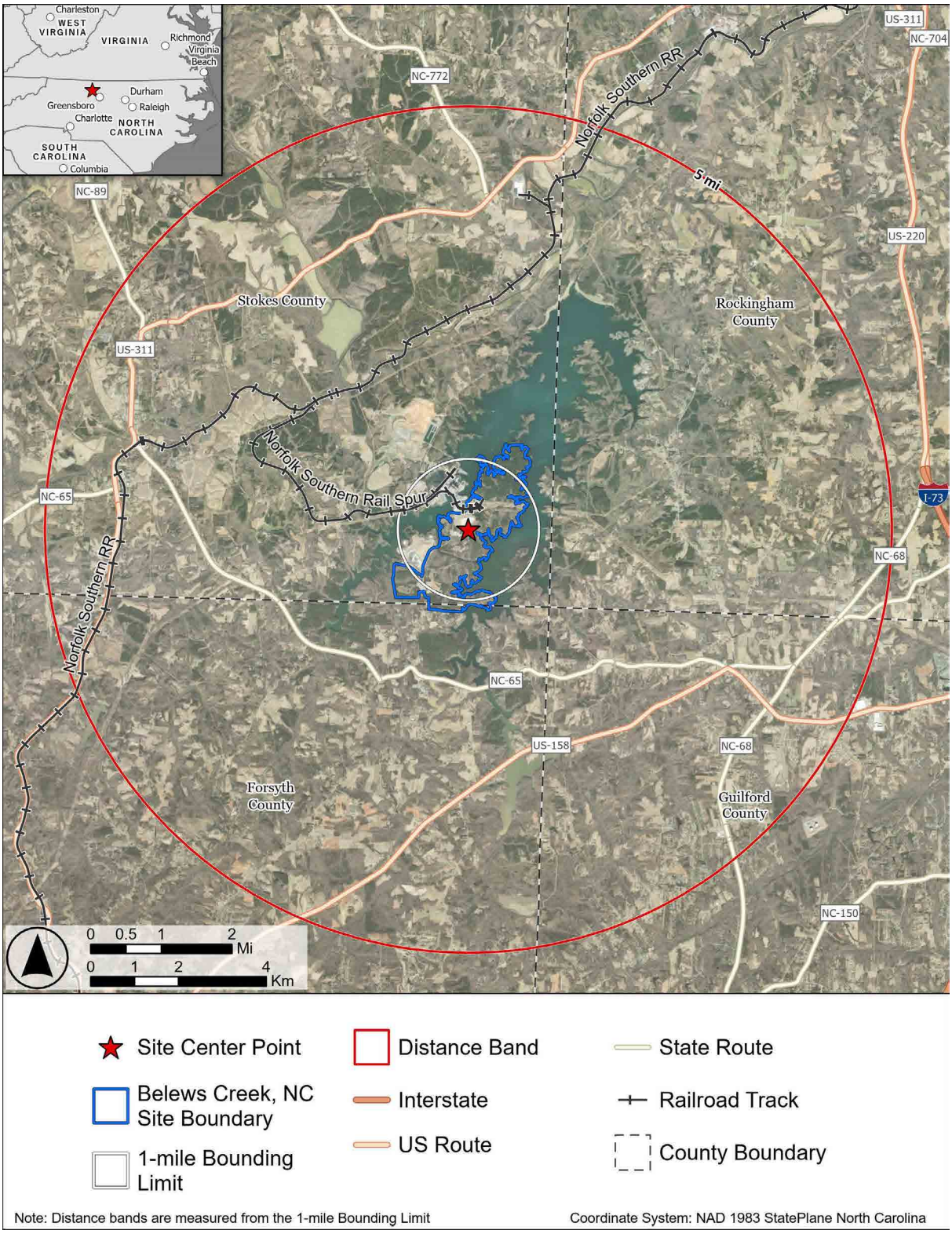


Figure 2.2-3
Pipelines within 5-Miles of the Project Site

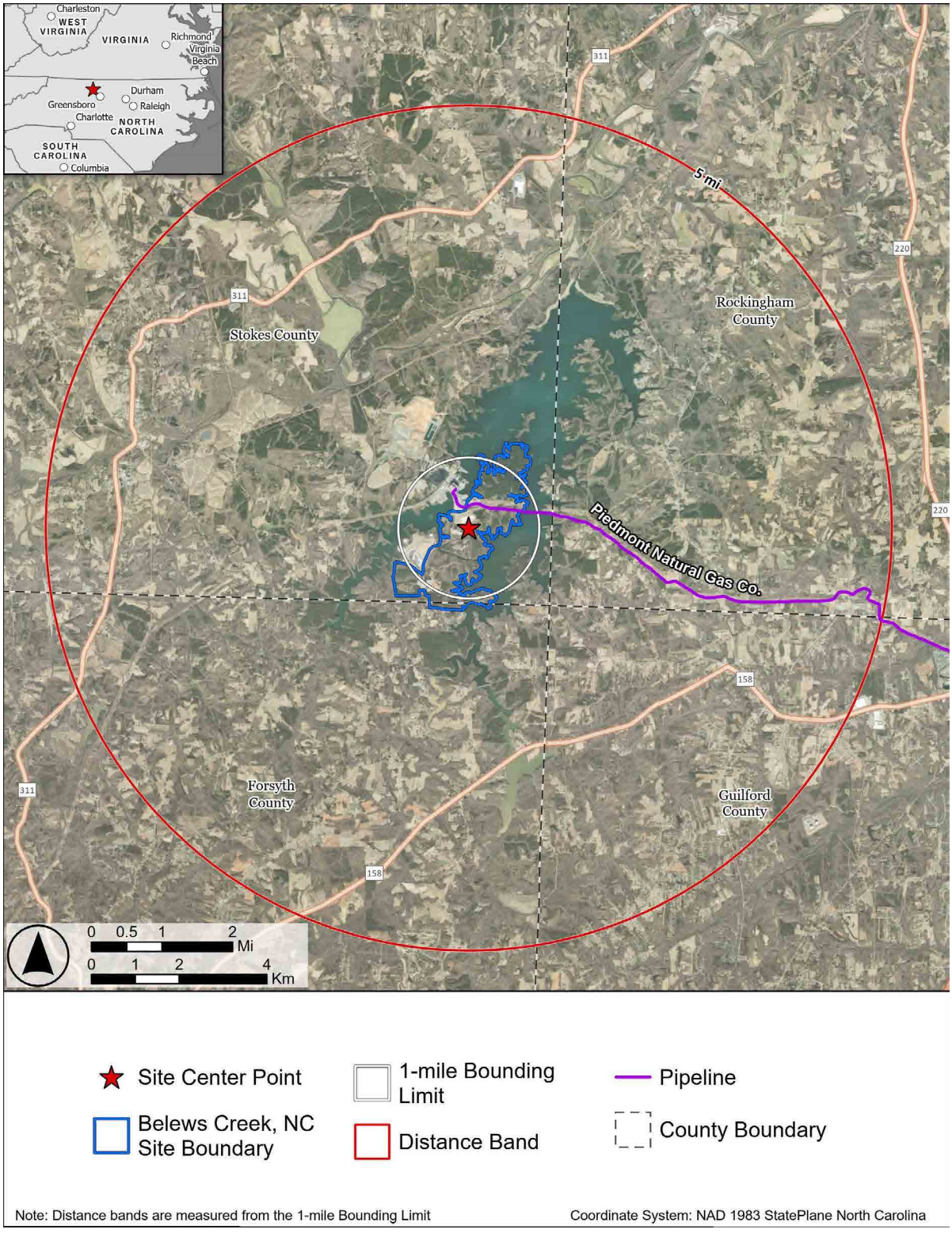


Figure 2.2-4
Airports Within 20-Miles of the Project Site

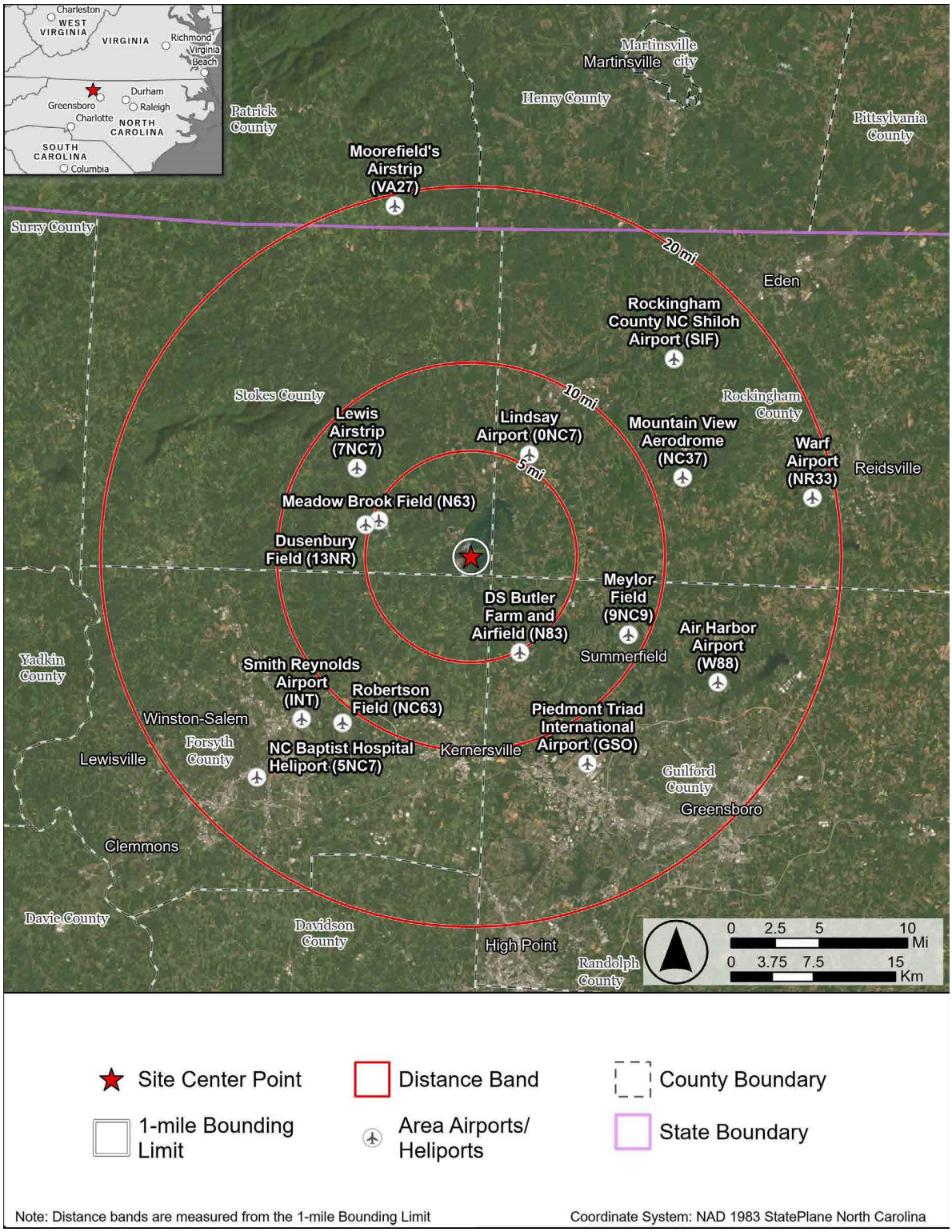


Figure 2.2-5
Airways Within 20-Miles of the Project Site

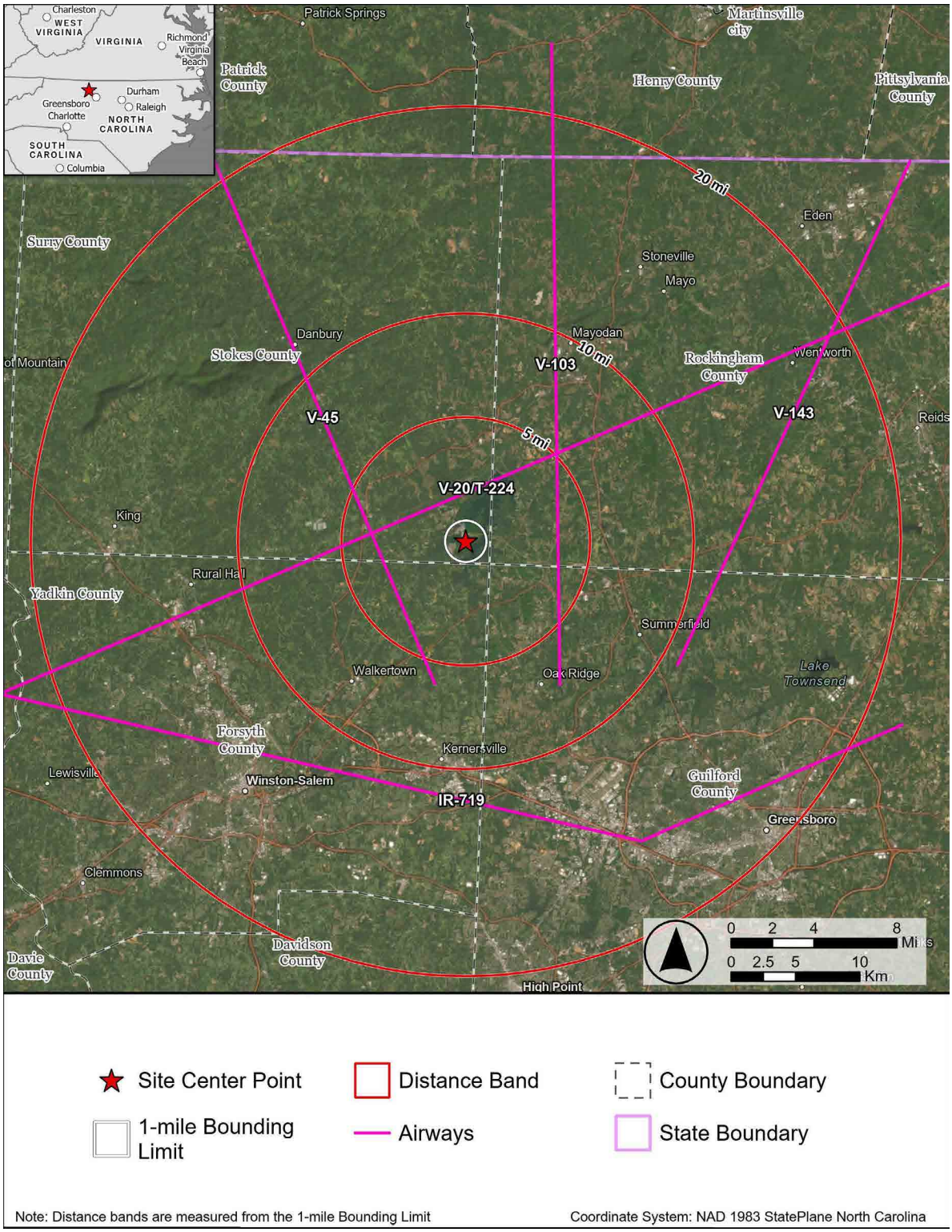
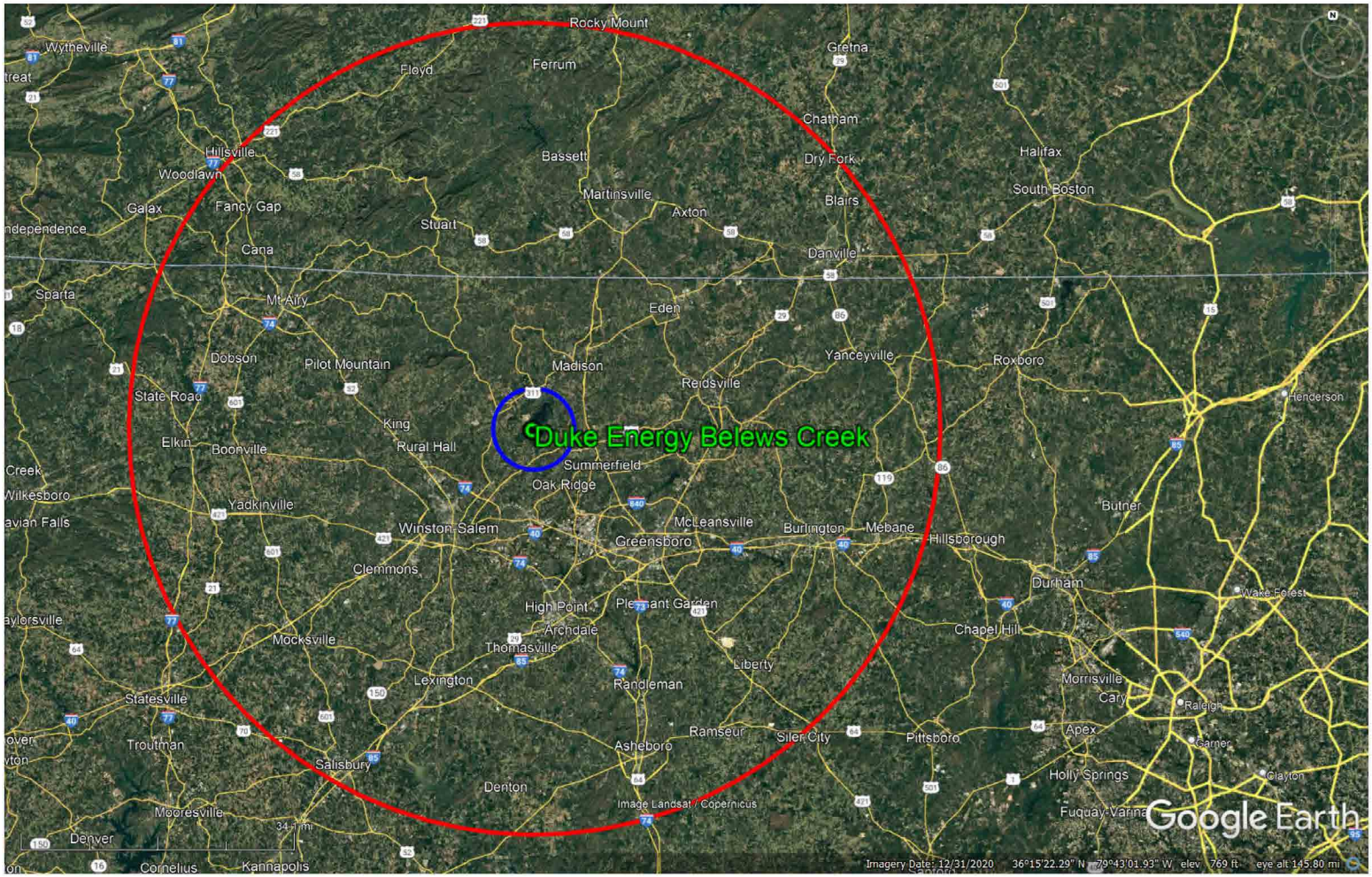


Figure 2.3-1
Aerial Map of the Project Site and Regional Area



Note: The blue circle delineates a region with a radius of 5 mi. centered on the Project site. The red circle delineates a region with a radius of 50 mi. centered on the Project site.

Figure 2.3-2
Topographic Map of the Project Site (5-Miles)

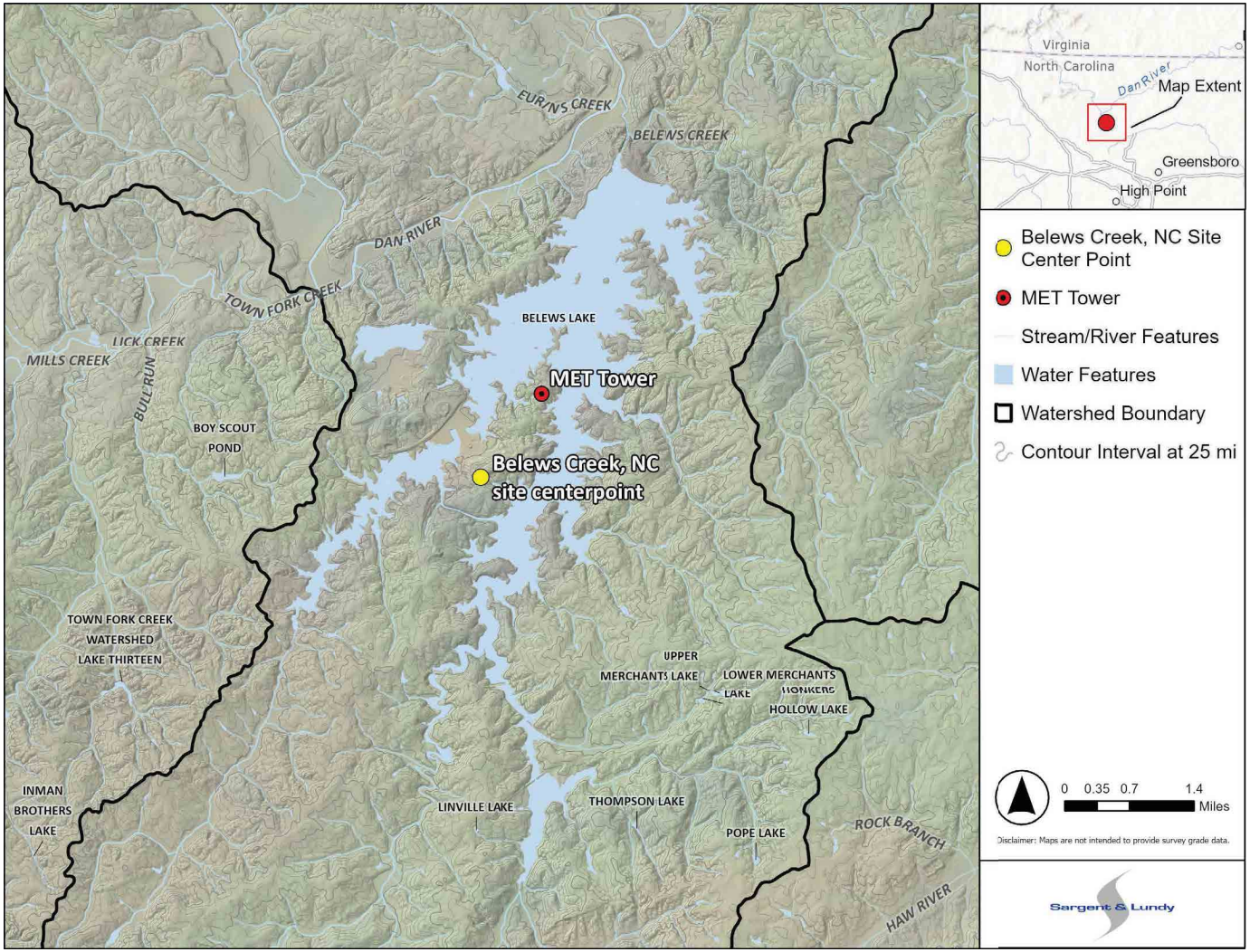
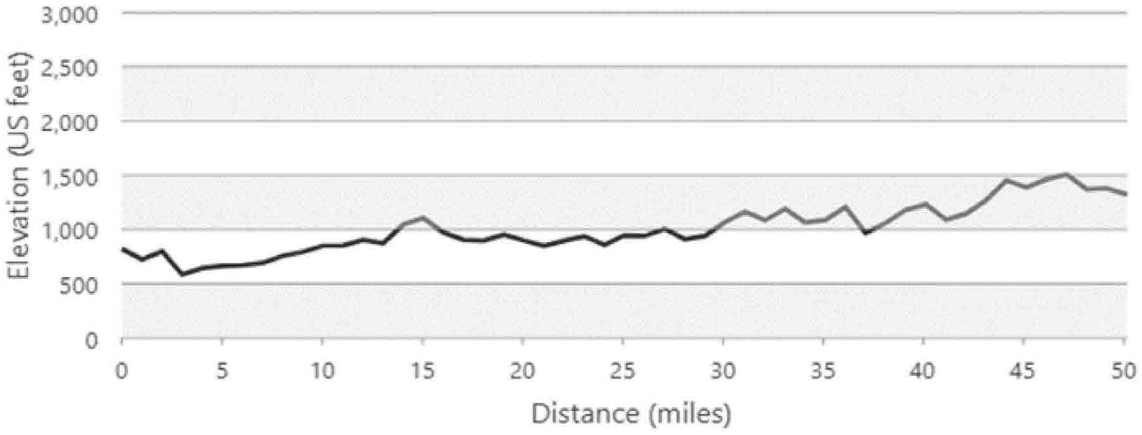
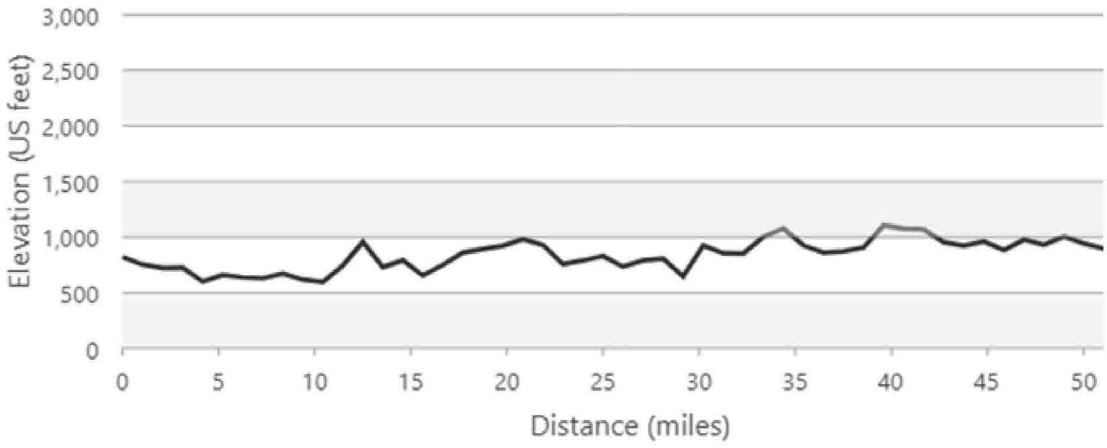


Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site North and North-Northeast
(Sheet 1 of 8)

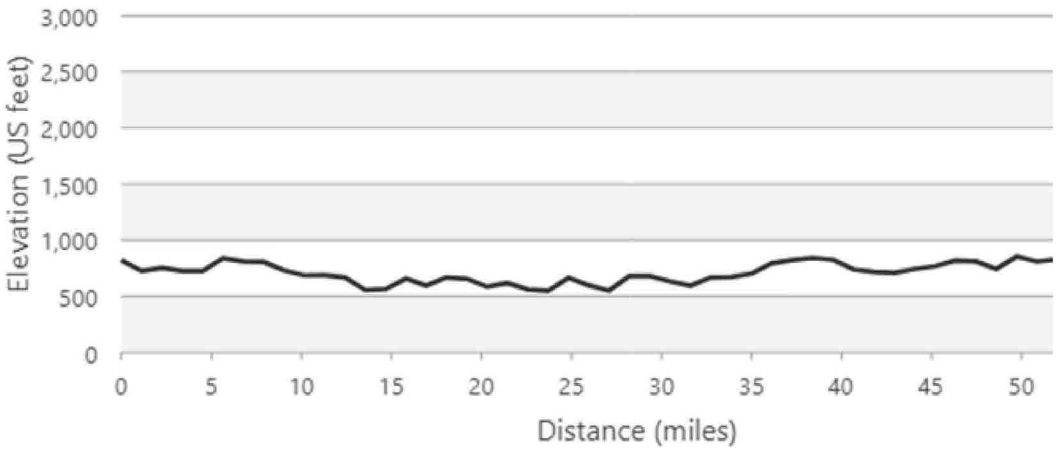


North

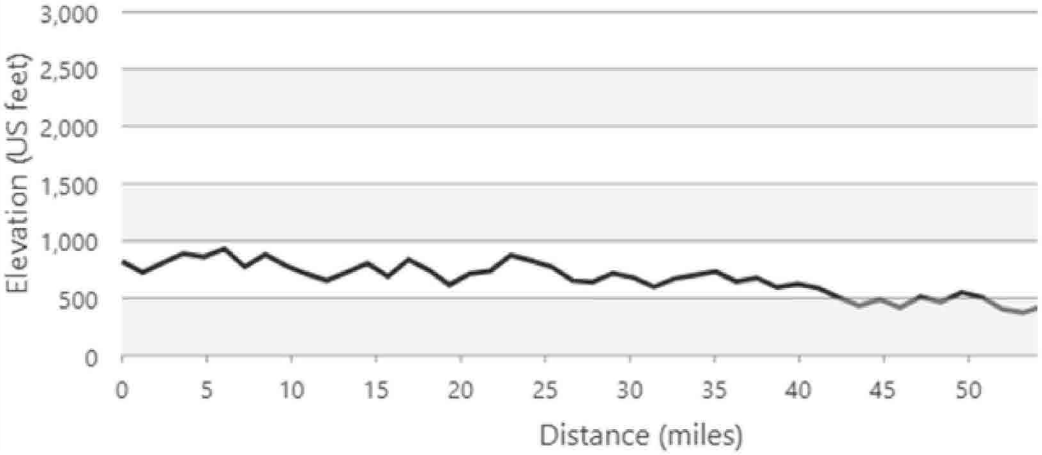


North Northeast

Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site Northeast and East-Northeast
(Sheet 2 of 8)

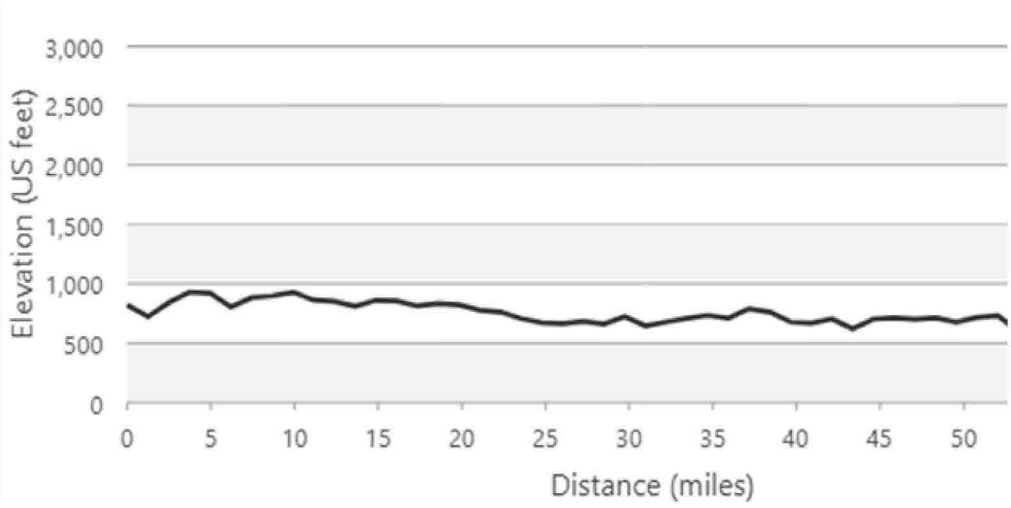


Northeast

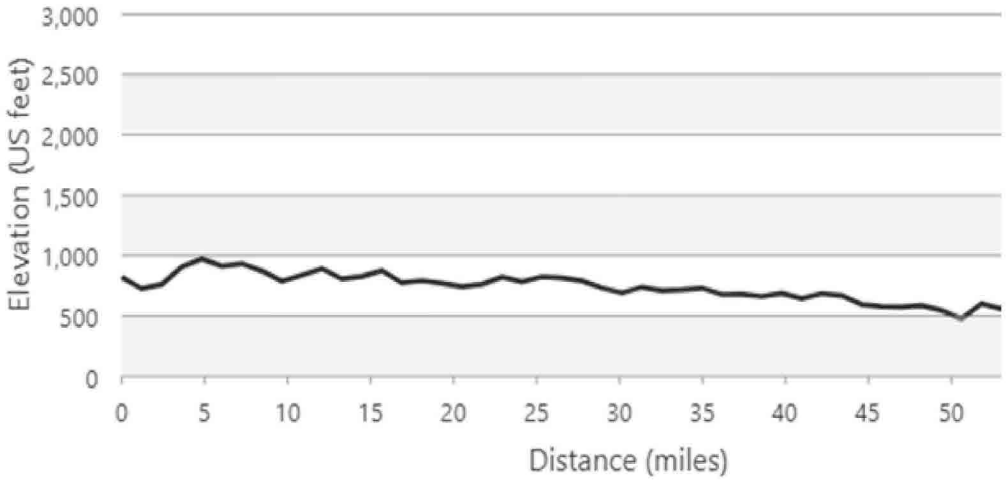


East Northeast

Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site East and East-Southeast
(Sheet 3 of 8)

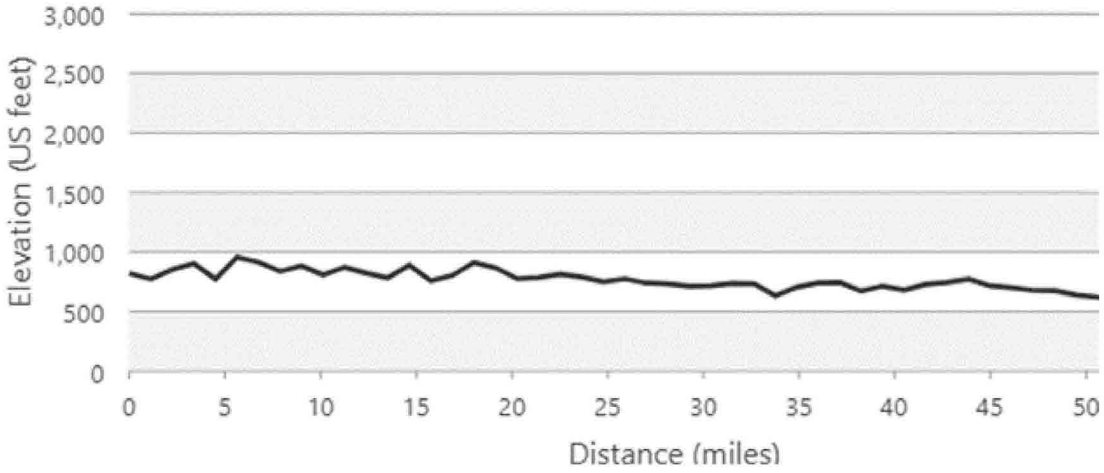


East

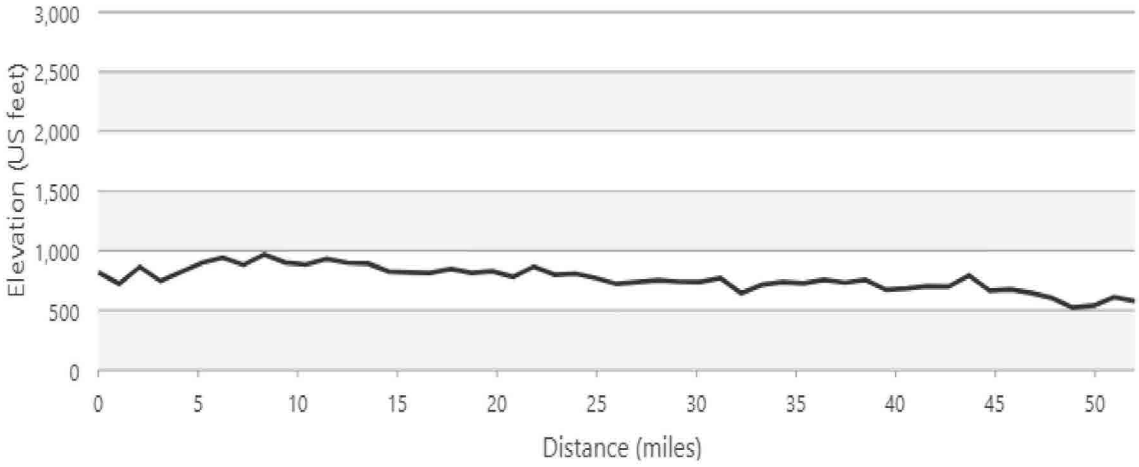


East Southeast

Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site Southeast and South-Southeast (Sheet 4 of 8)

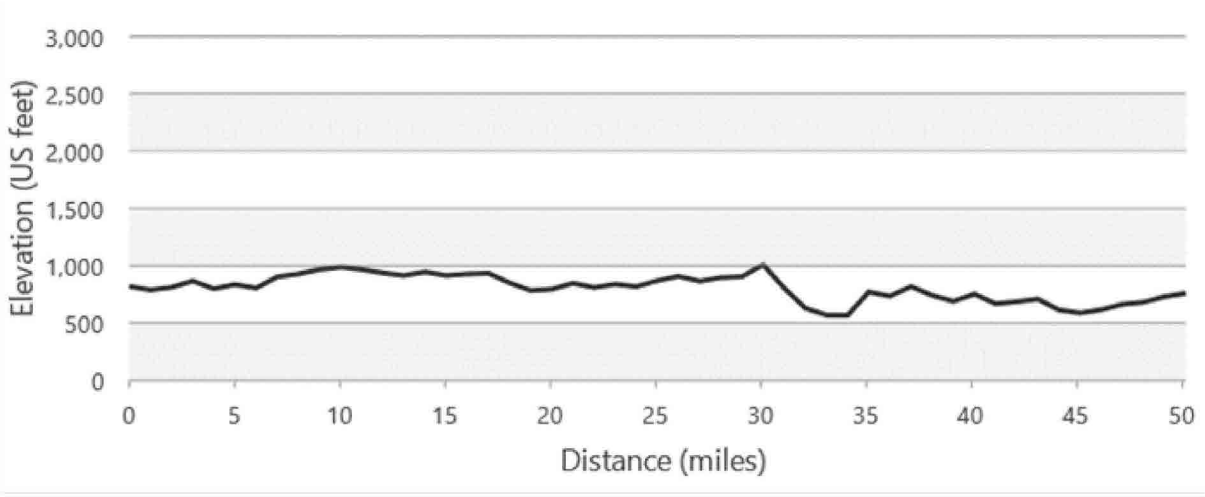


Southeast

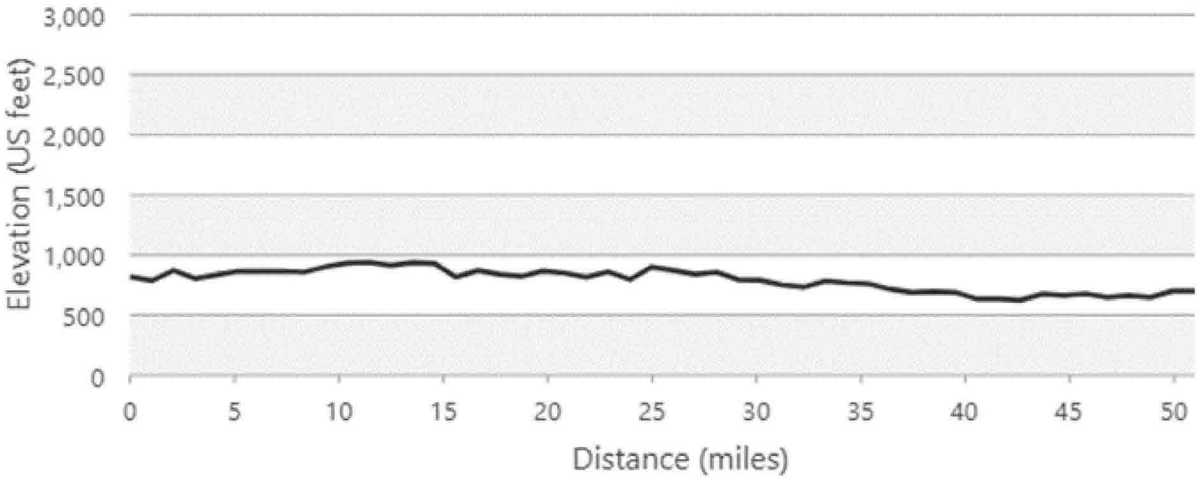


South Southeast

Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site South and South-Southwest
(Sheet 5 of 8)

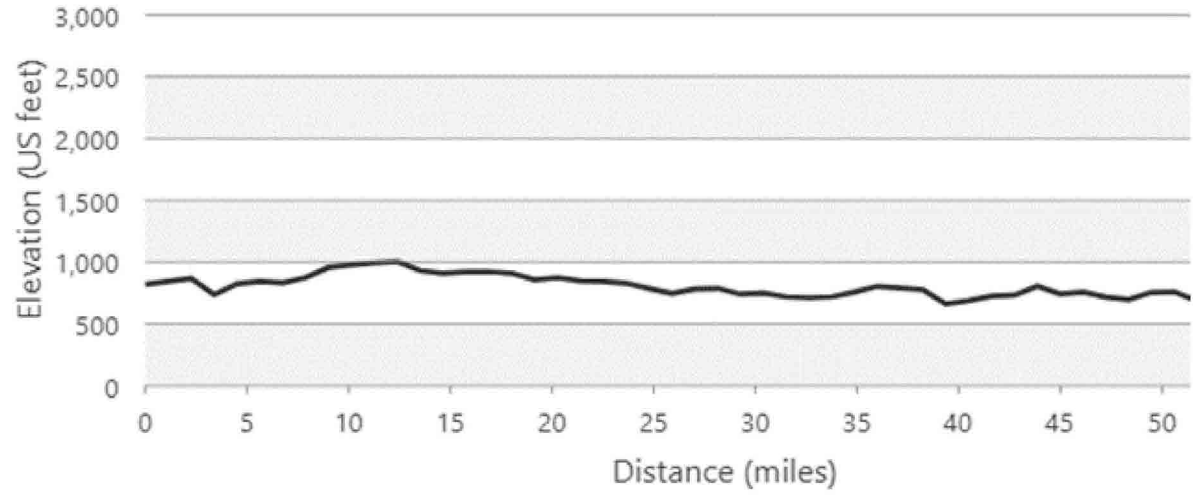


South

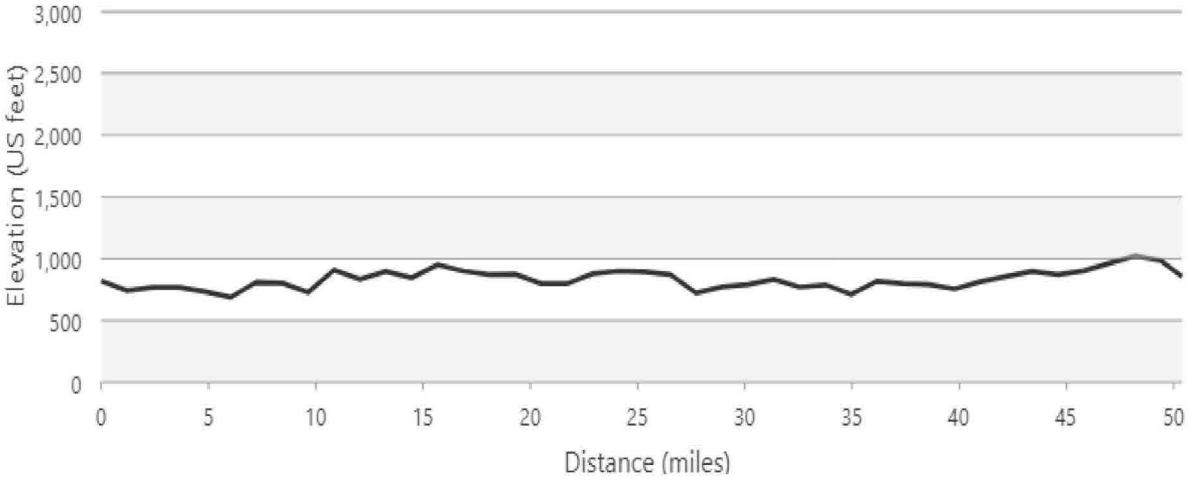


South Southwest

Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site Southwest and West-Southwest
(Sheet 6 of 8)

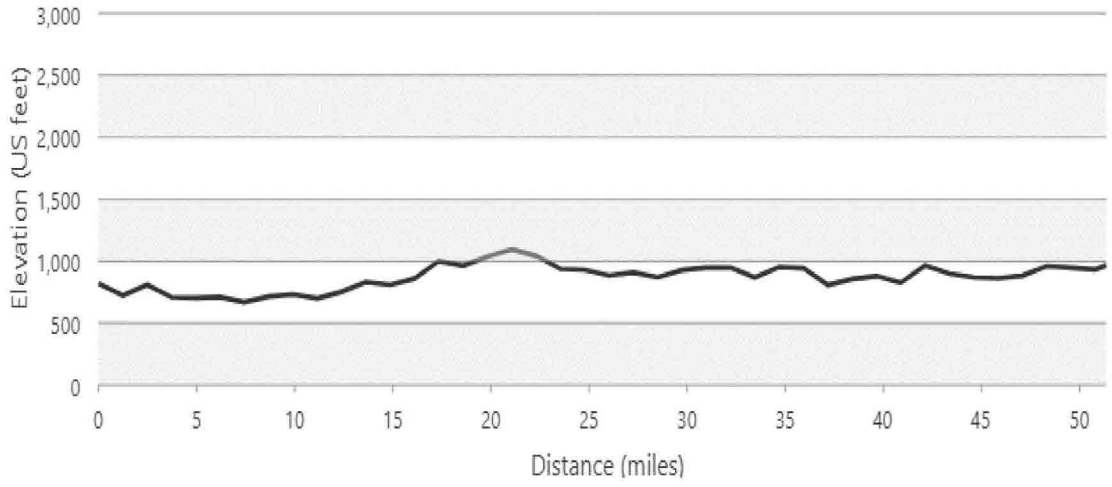


Southwest

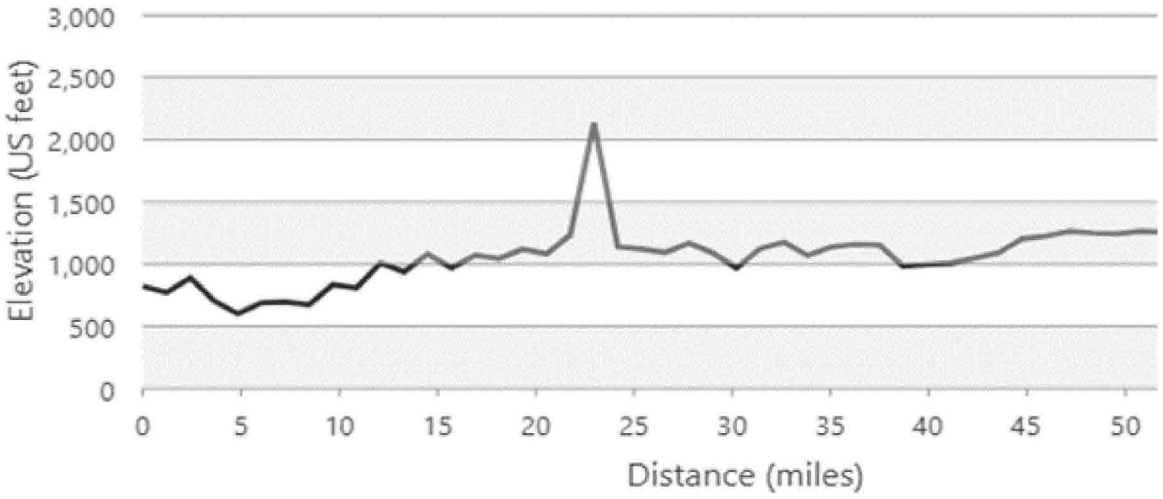


West Southwest

Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site West and West-Northwest
(Sheet 7 of 8)

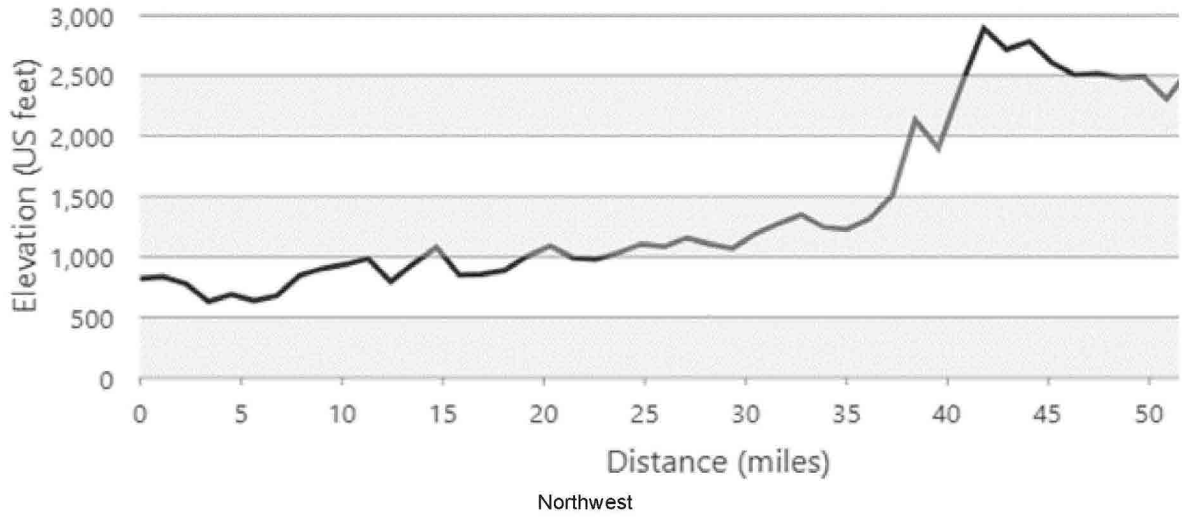


West

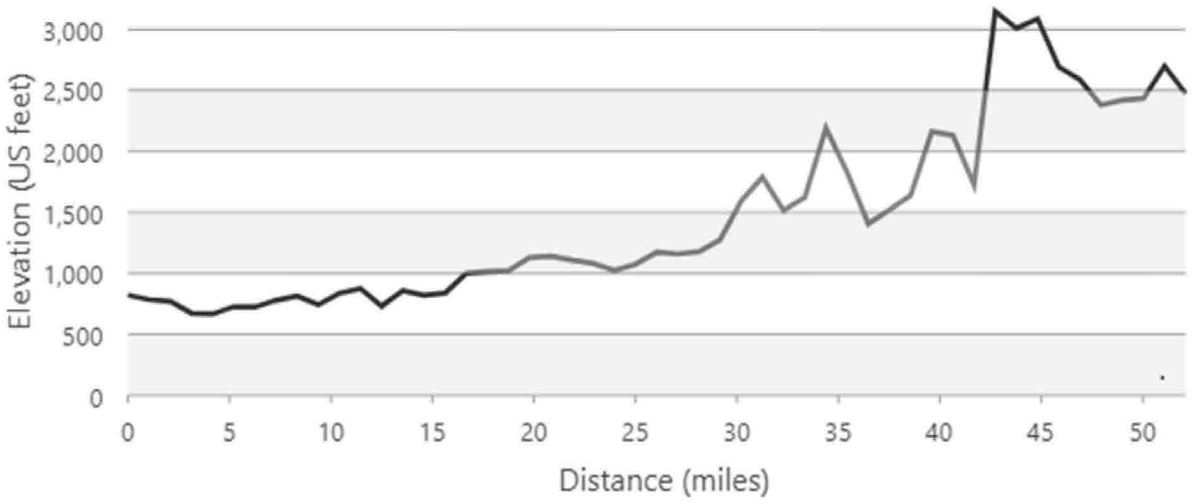


West Northwest

Figure 2.3-3
Elevation Profiles 0- to 50-Miles from the Project Site Northwest and North-Northwest (Sheet 8 of 8)



Northwest



North Northwest

Figure 2.3-4
Radial Directions Emanating from Project Site

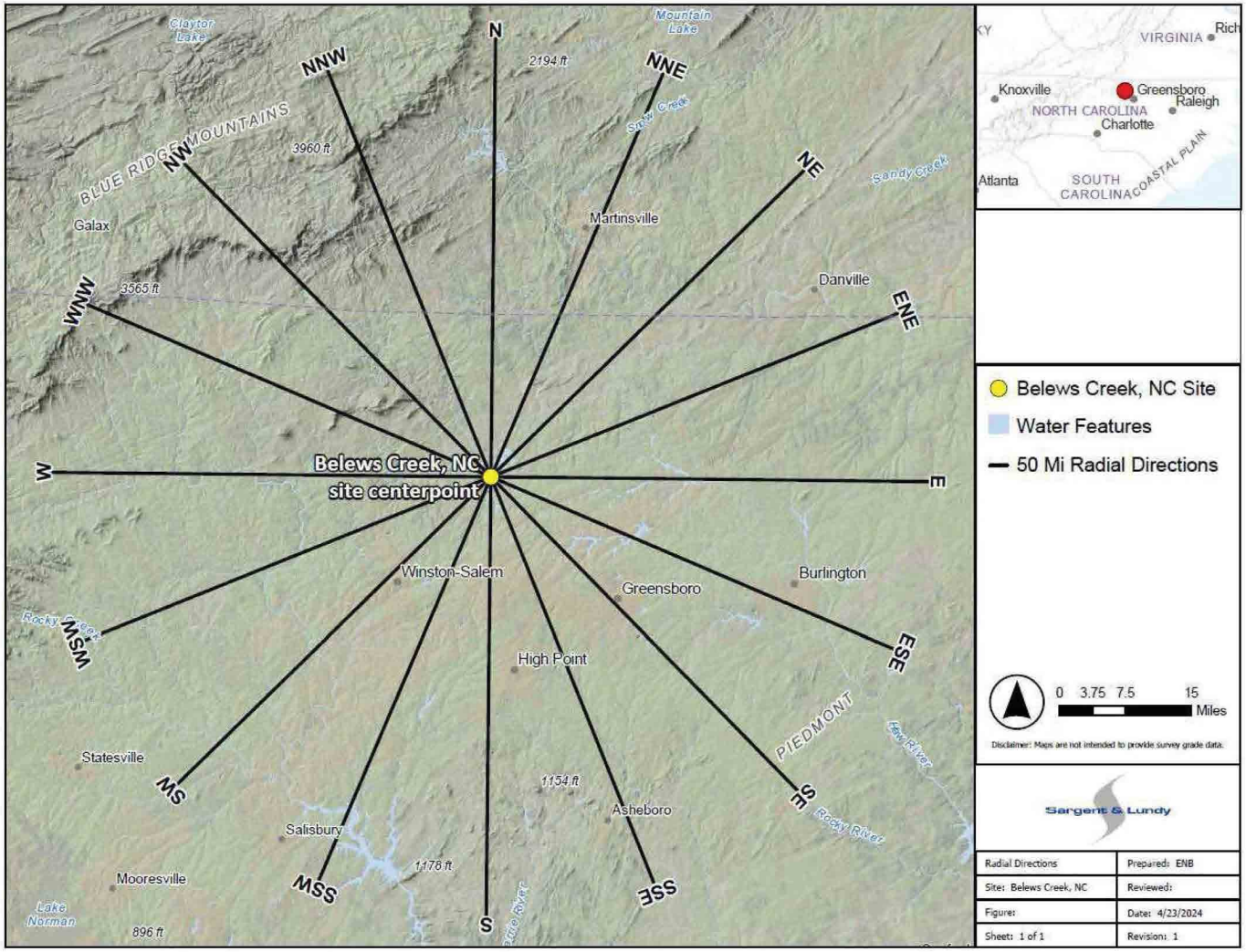


Figure 2.3-5
Wind Rose KGSO (10-Meters) Annual All Data (2013-2023)

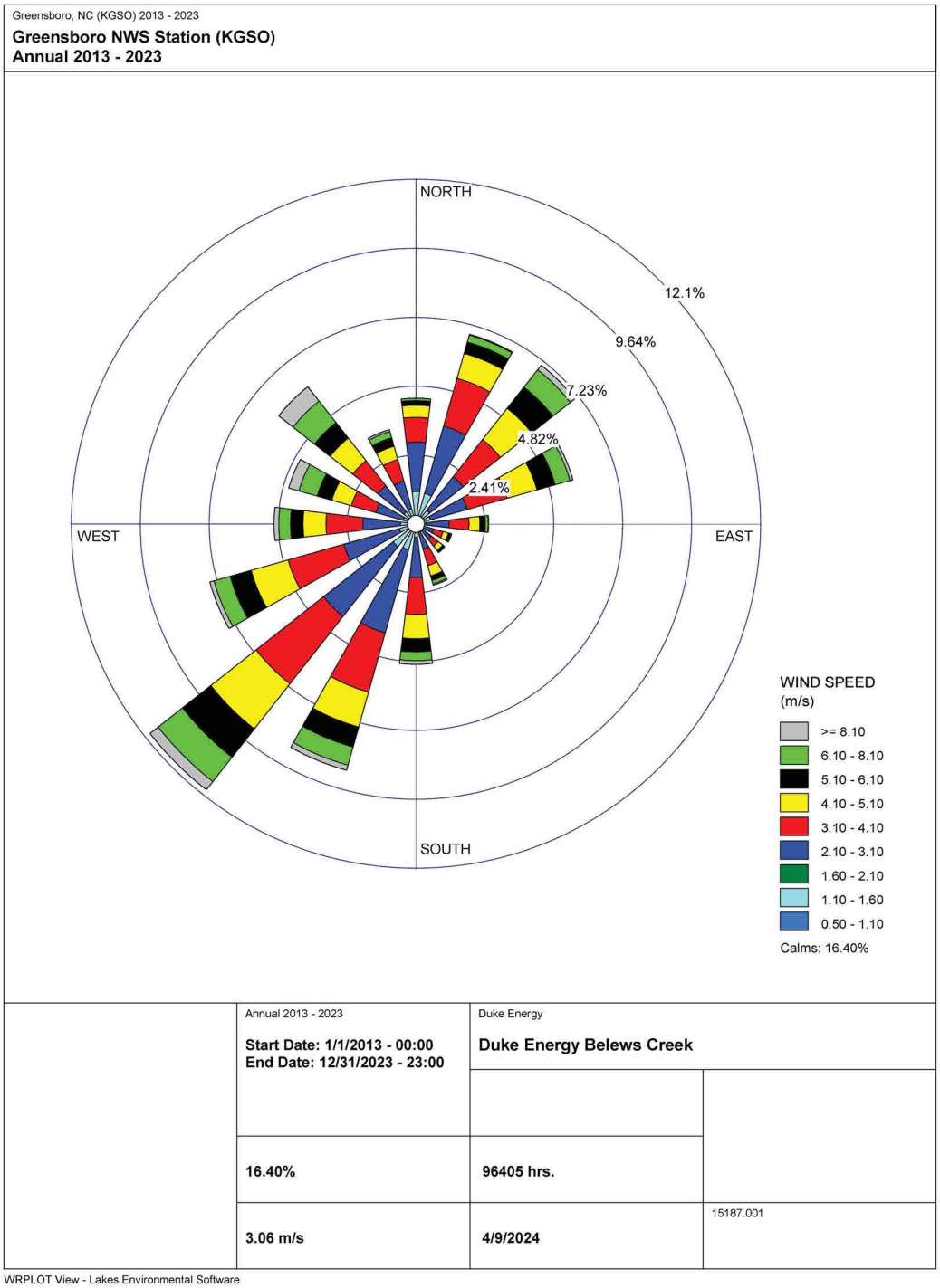


Figure 2.3-6
Wind Rose KGSO (10-Meters) January (2013-2023)

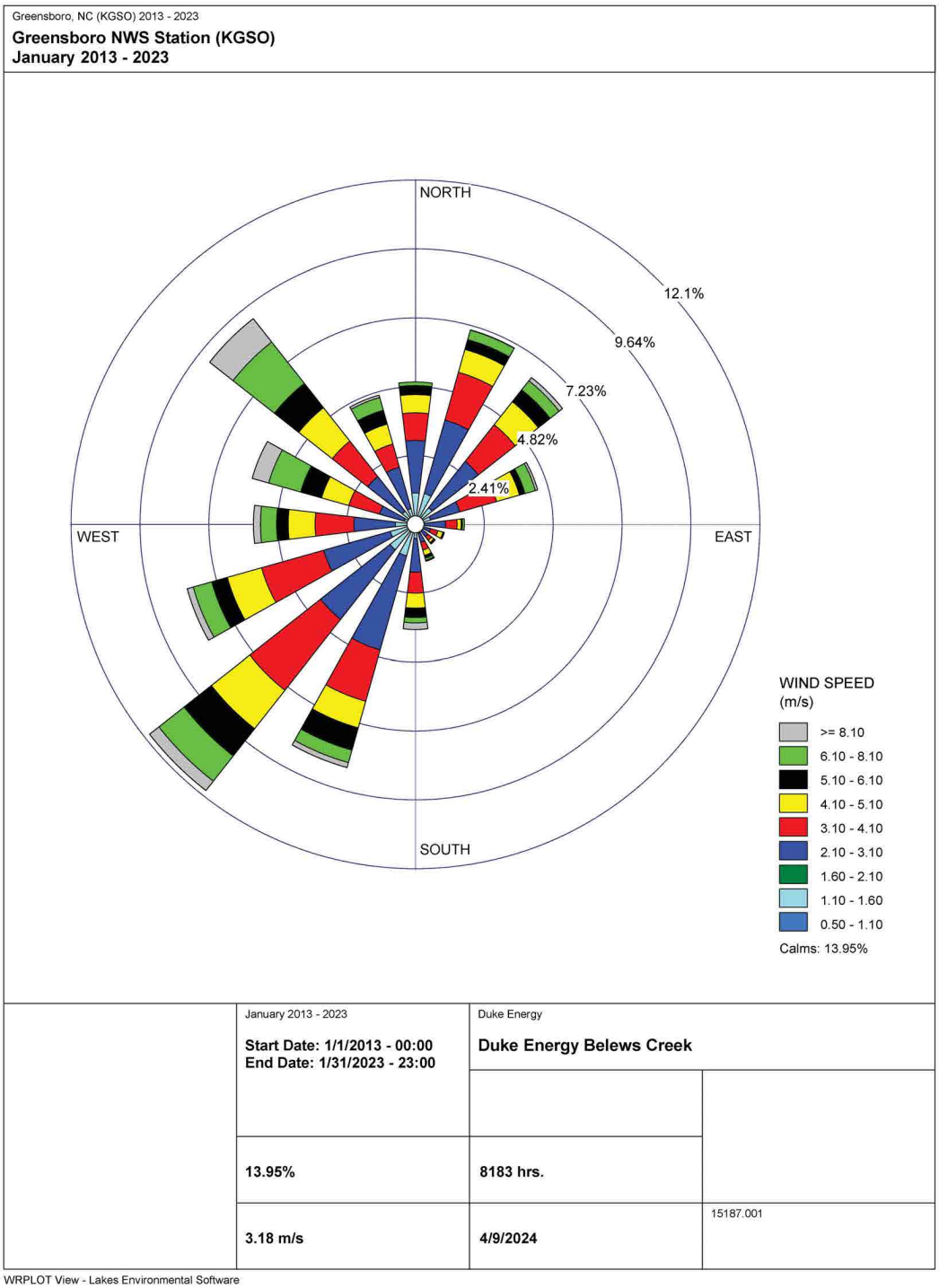


Figure 2.3-7
Wind Rose KGSO (10-Meters) February (2013-2023)

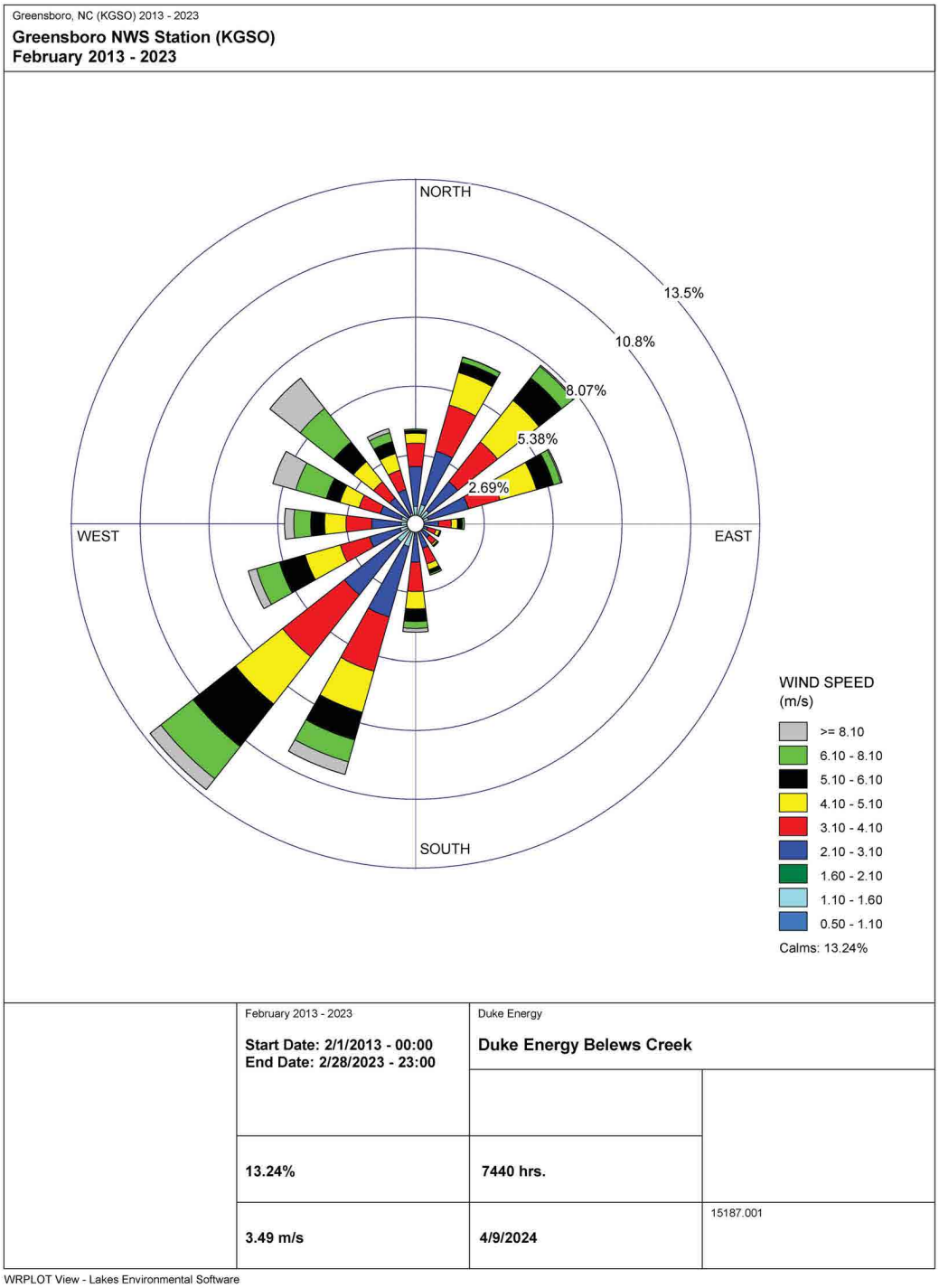


Figure 2.3-8
Wind Rose KGSO (10-Meters) March (2013-2023)

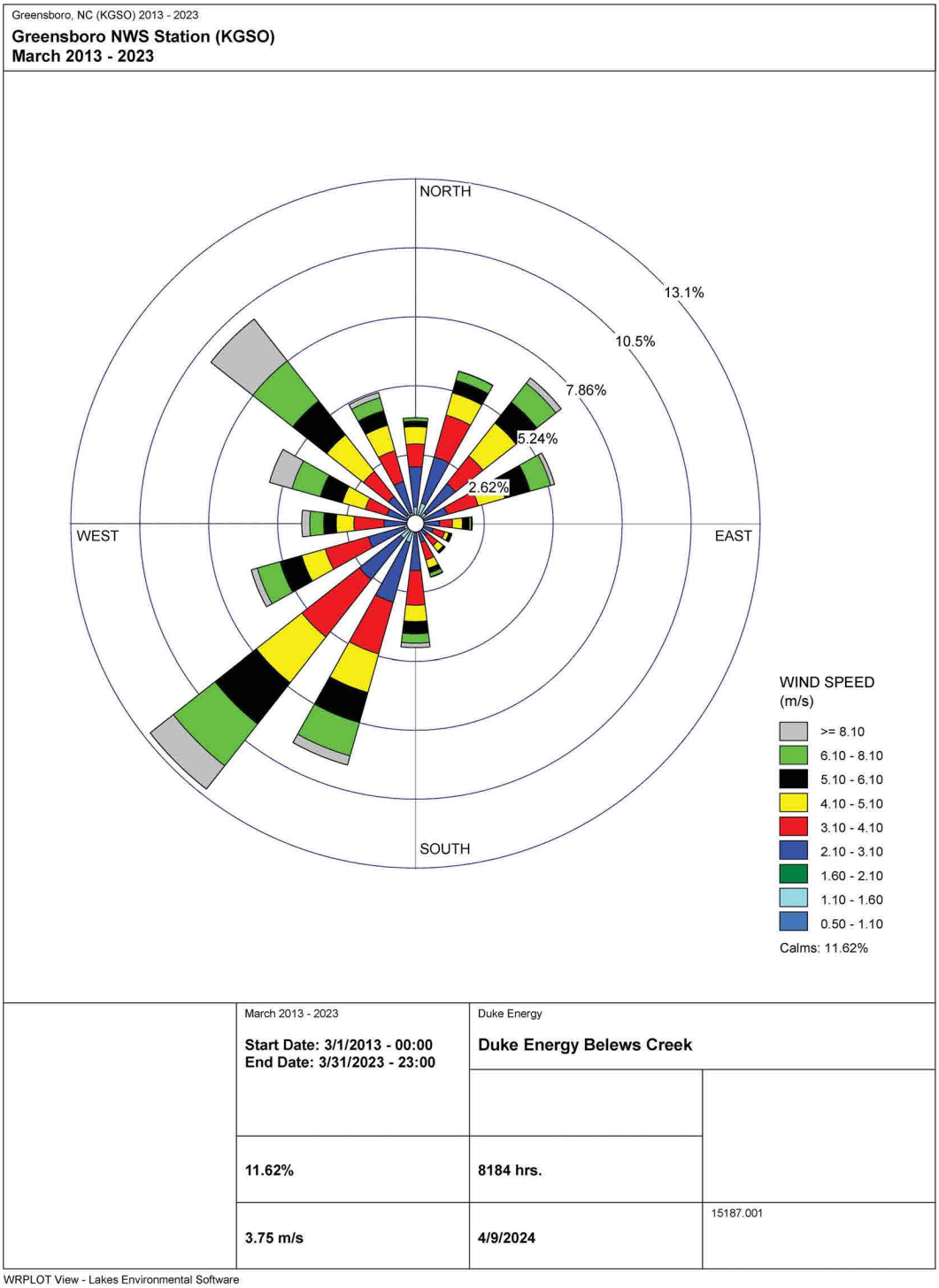


Figure 2.3-9
Wind Rose KGSO (10-Meters) April (2013-2023)

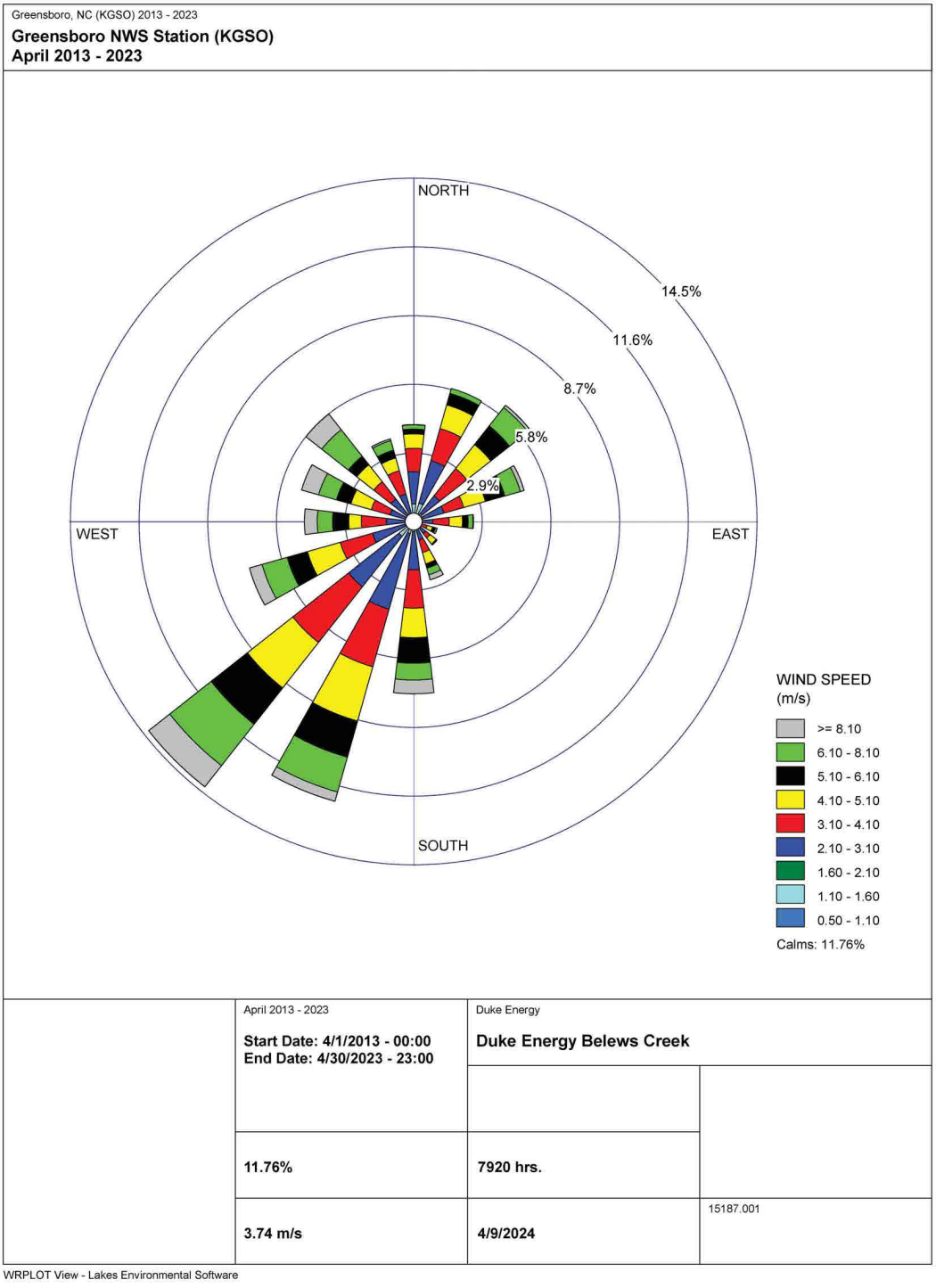


Figure 2.3-10
Wind Rose KGSO (10-Meters) May (2013-2023)

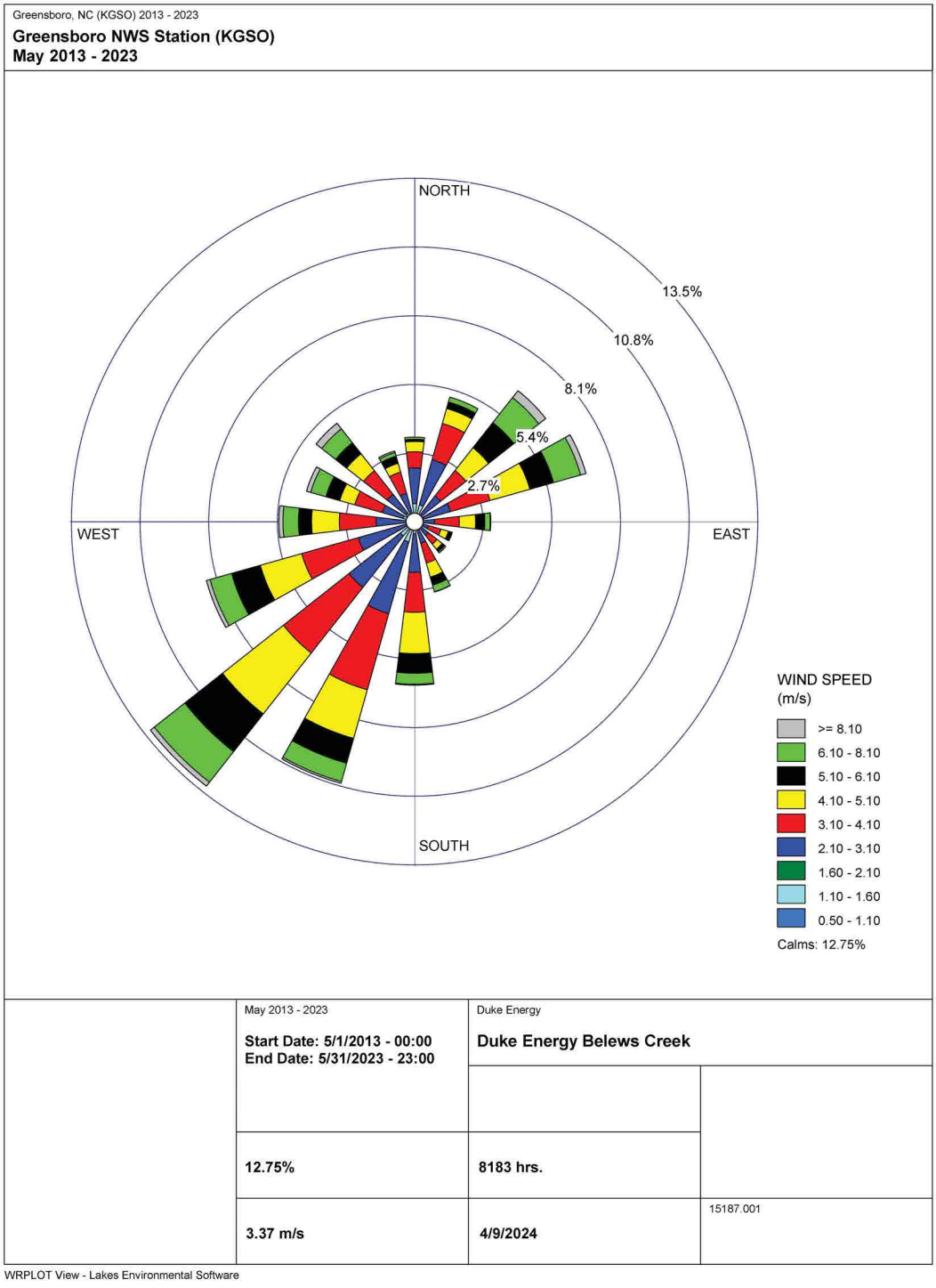


Figure 2.3-11
Wind Rose KGSO (10-Meters) June (2013-2023)

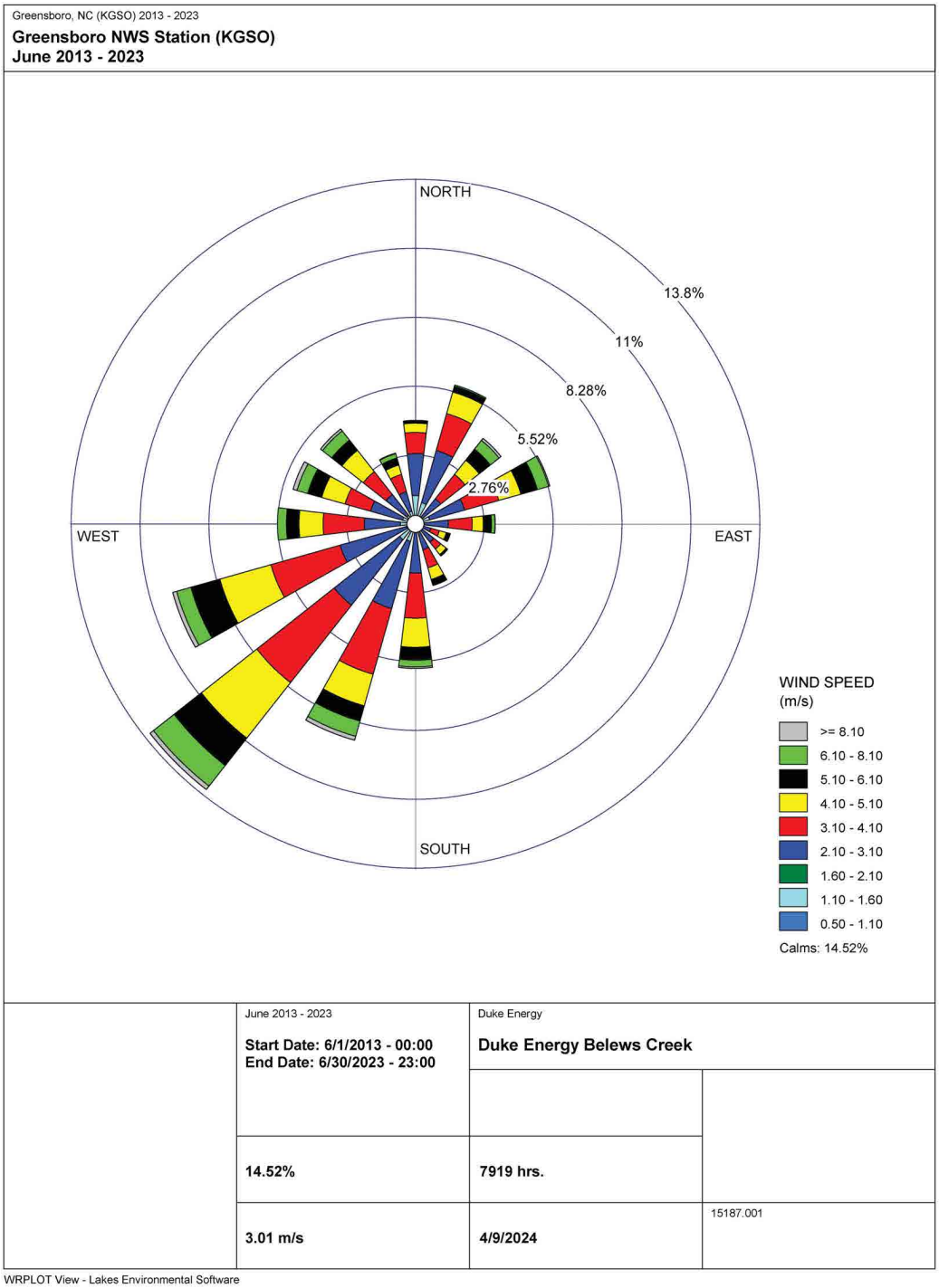


Figure 2.3-12
Wind Rose KGSO (10-Meters) July (2013-2023)

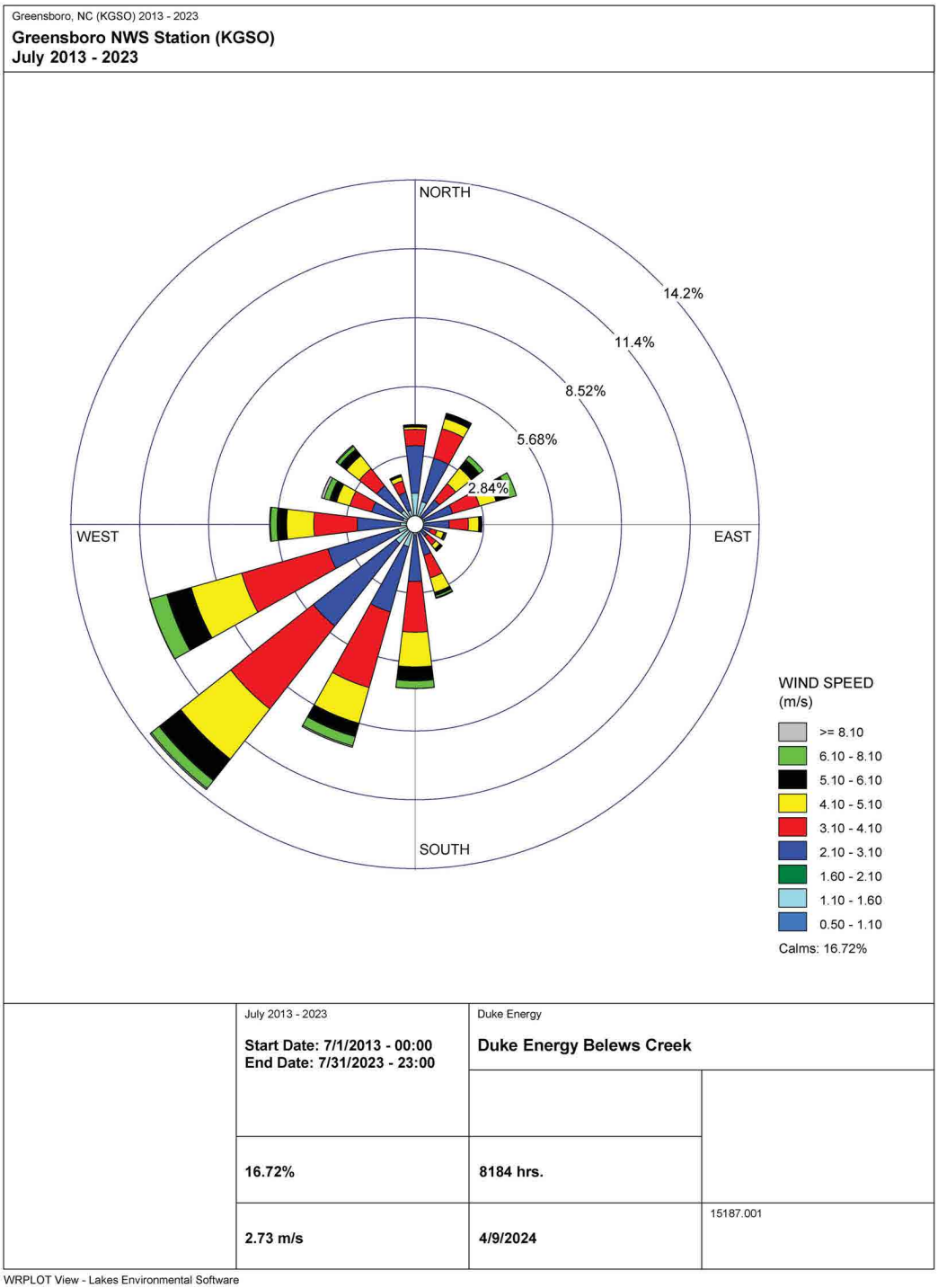


Figure 2.3-13
Wind Rose KGSO (10-Meters) August (2013-2023)

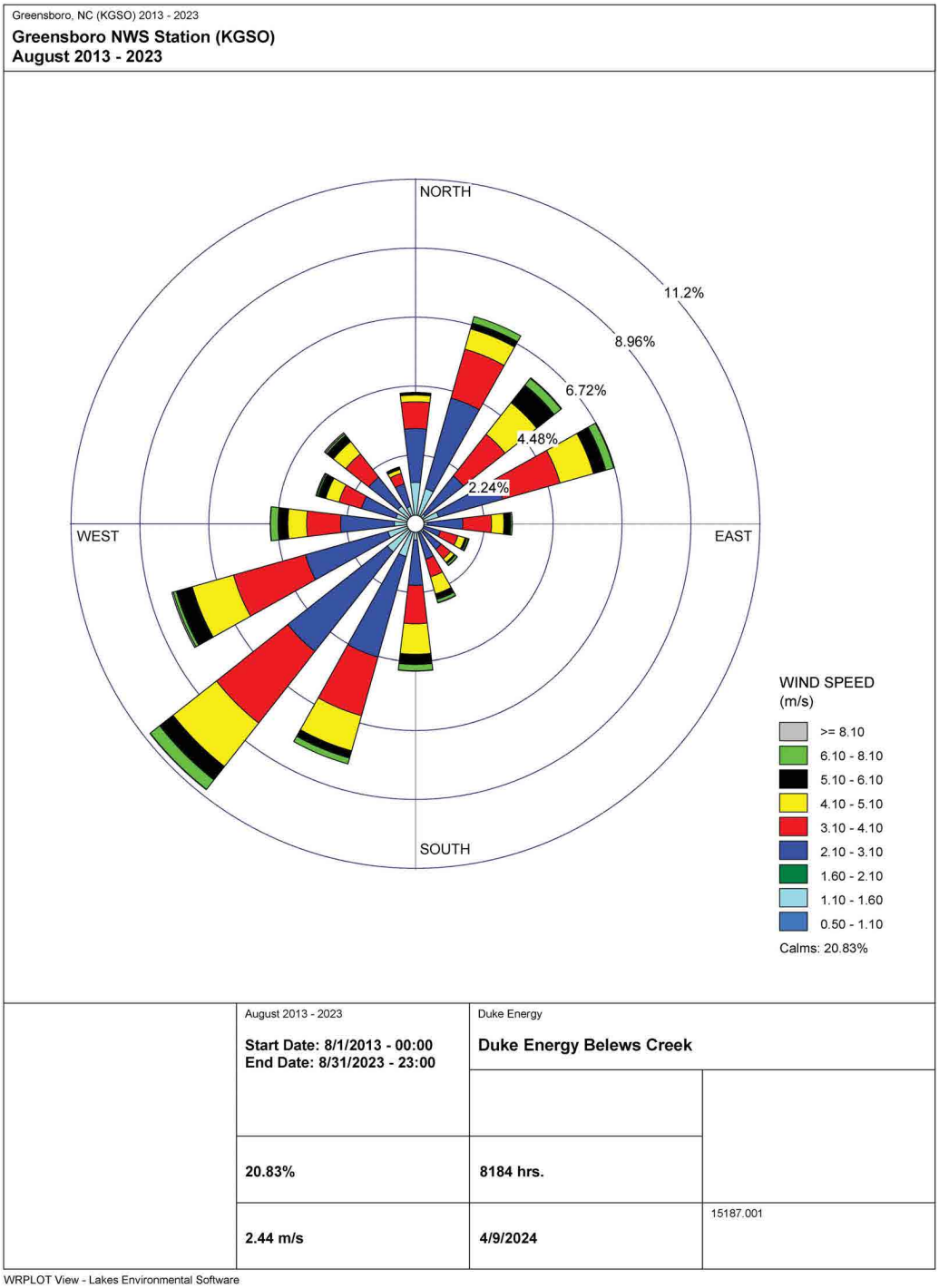


Figure 2.3-14
Wind Rose KGSO (10-Meters) September (2013-2023)

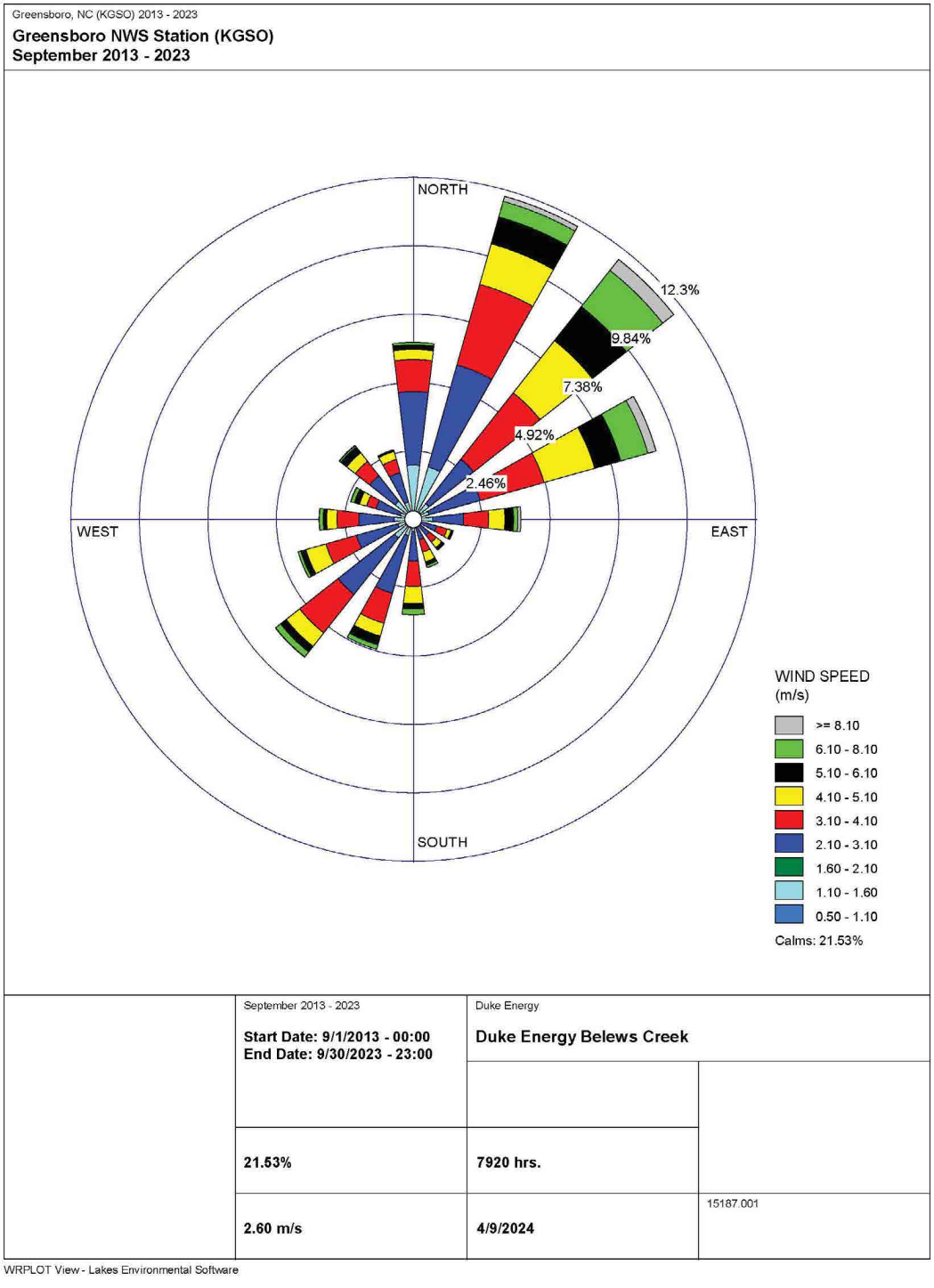


Figure 2.3-15
Wind Rose KGSO (10-Meters) October (2013-2023)

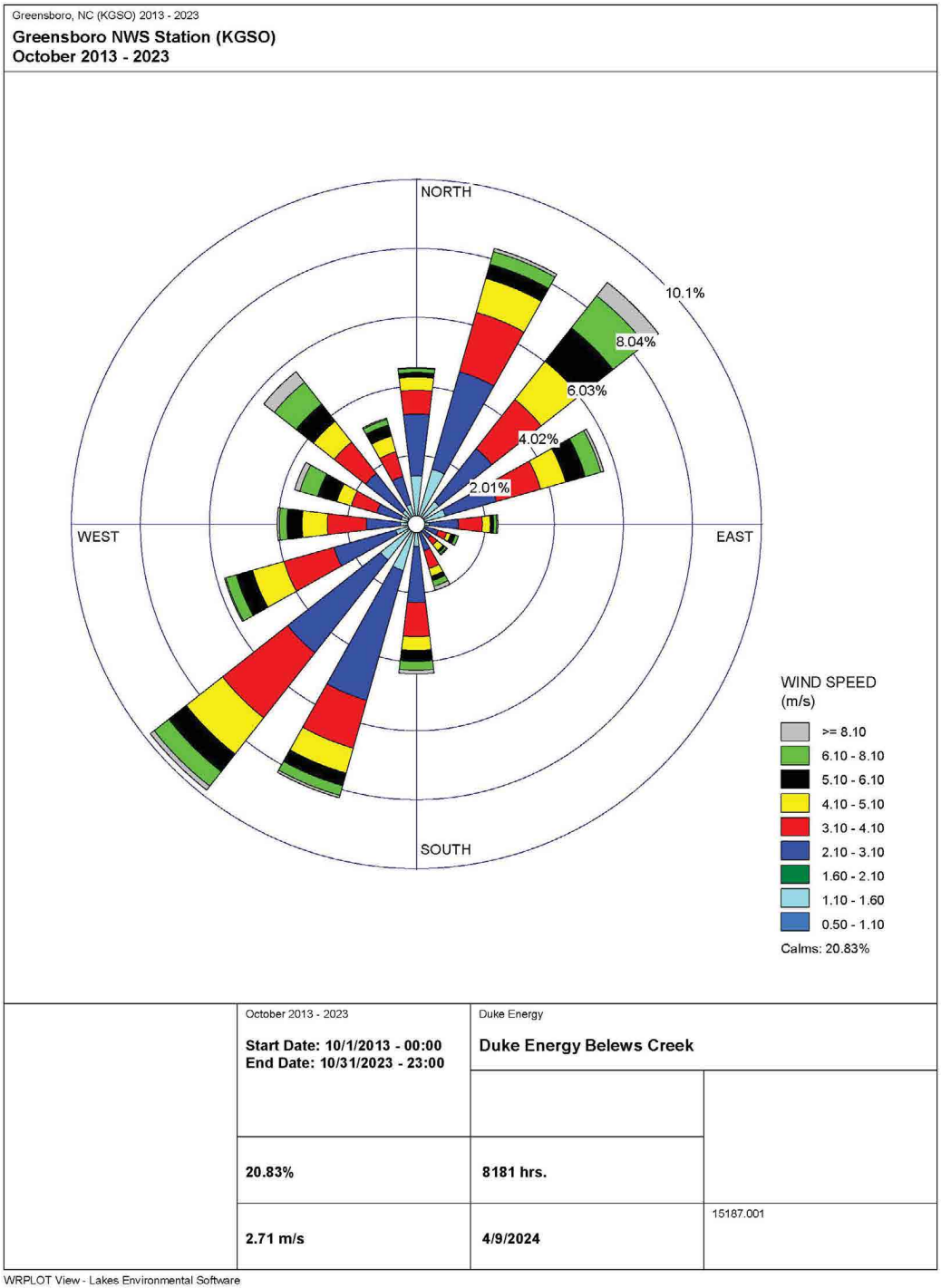


Figure 2.3-16
Wind Rose KGSO (10-Meters) November (2013-2023)

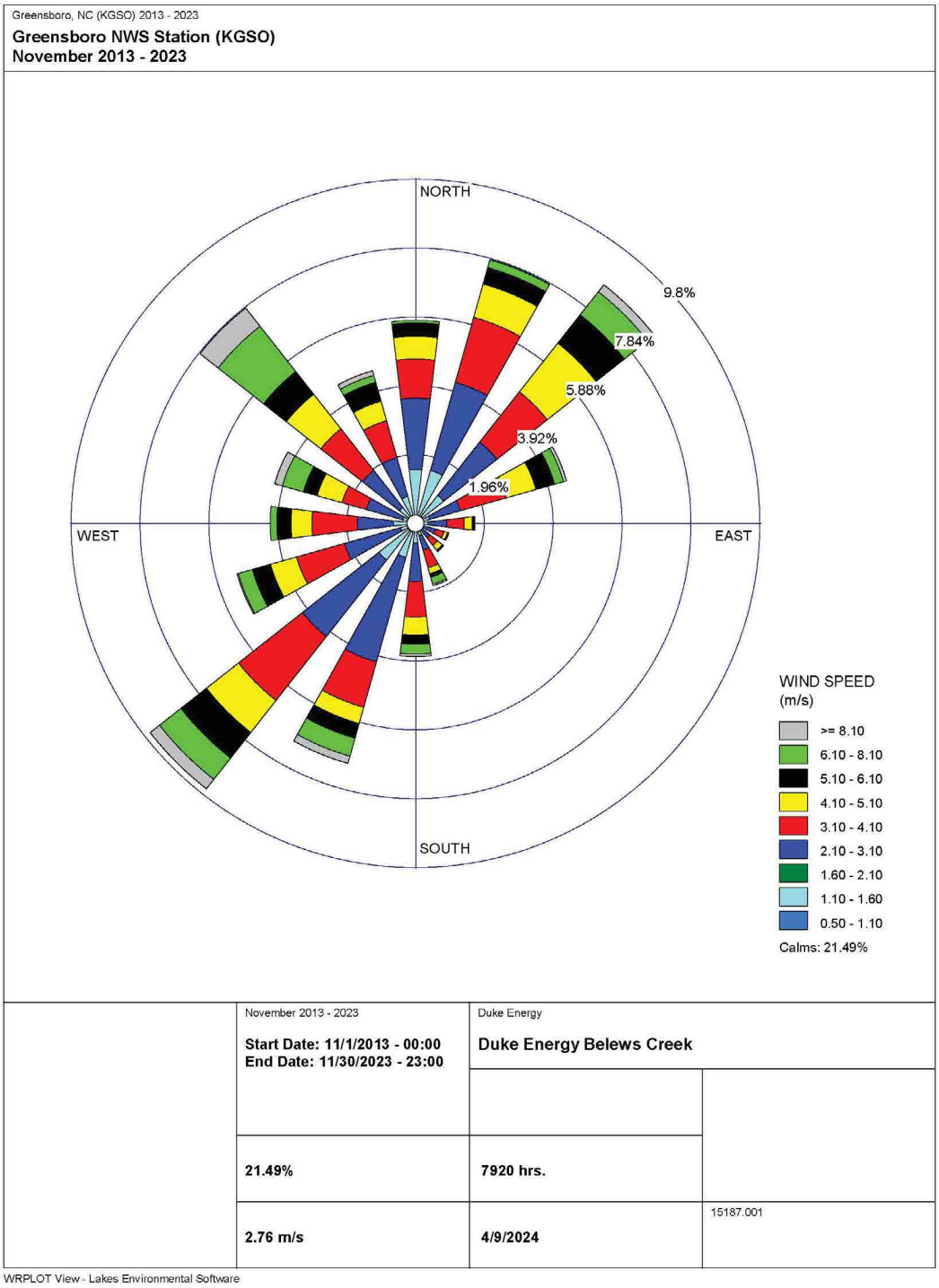


Figure 2.3-17
Wind Rose KGSO (10-Meters) December (2013-2023)

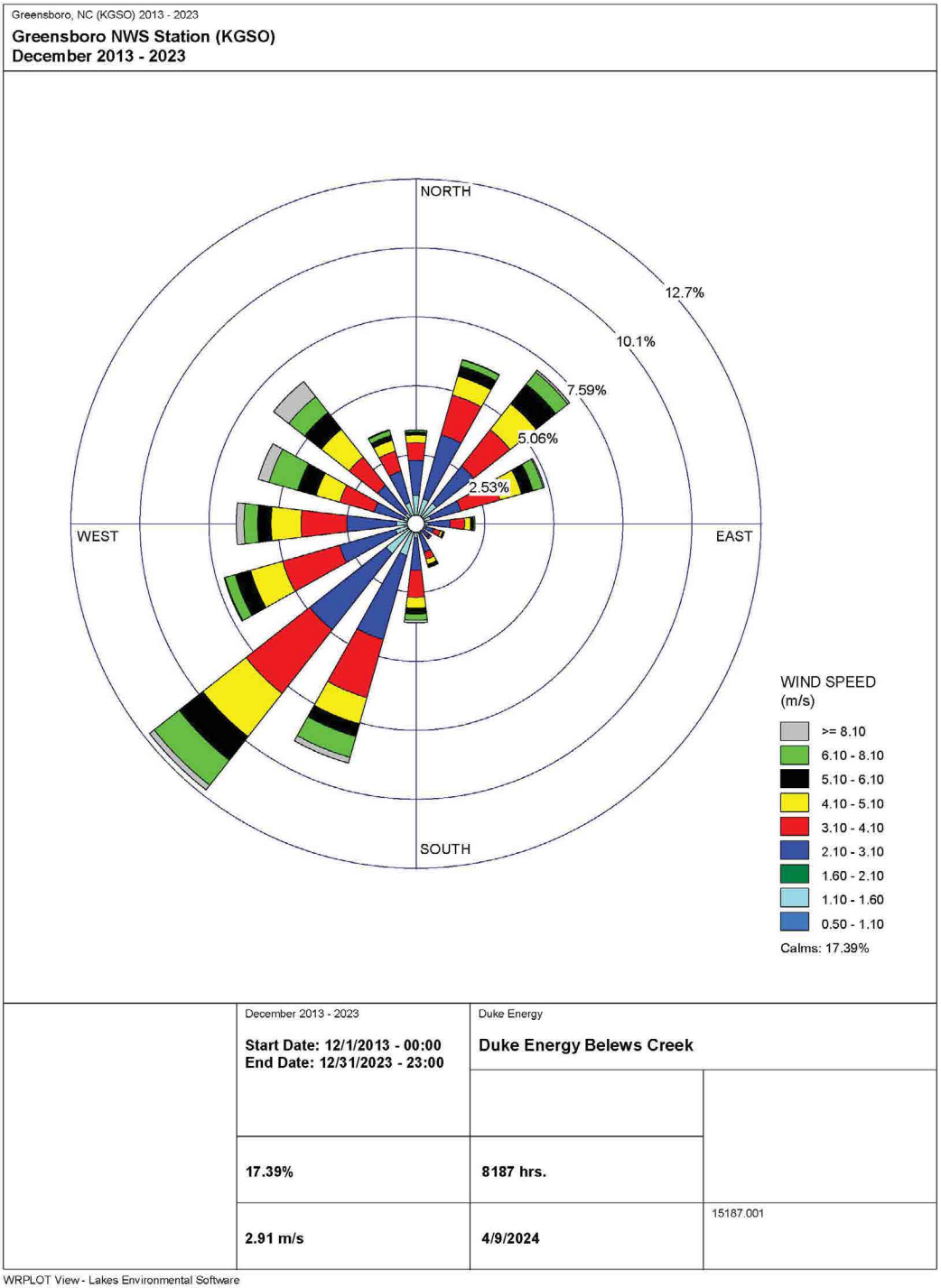


Figure 2.3-18
Wind Rose Project Site (10-Meters) Annual All Data

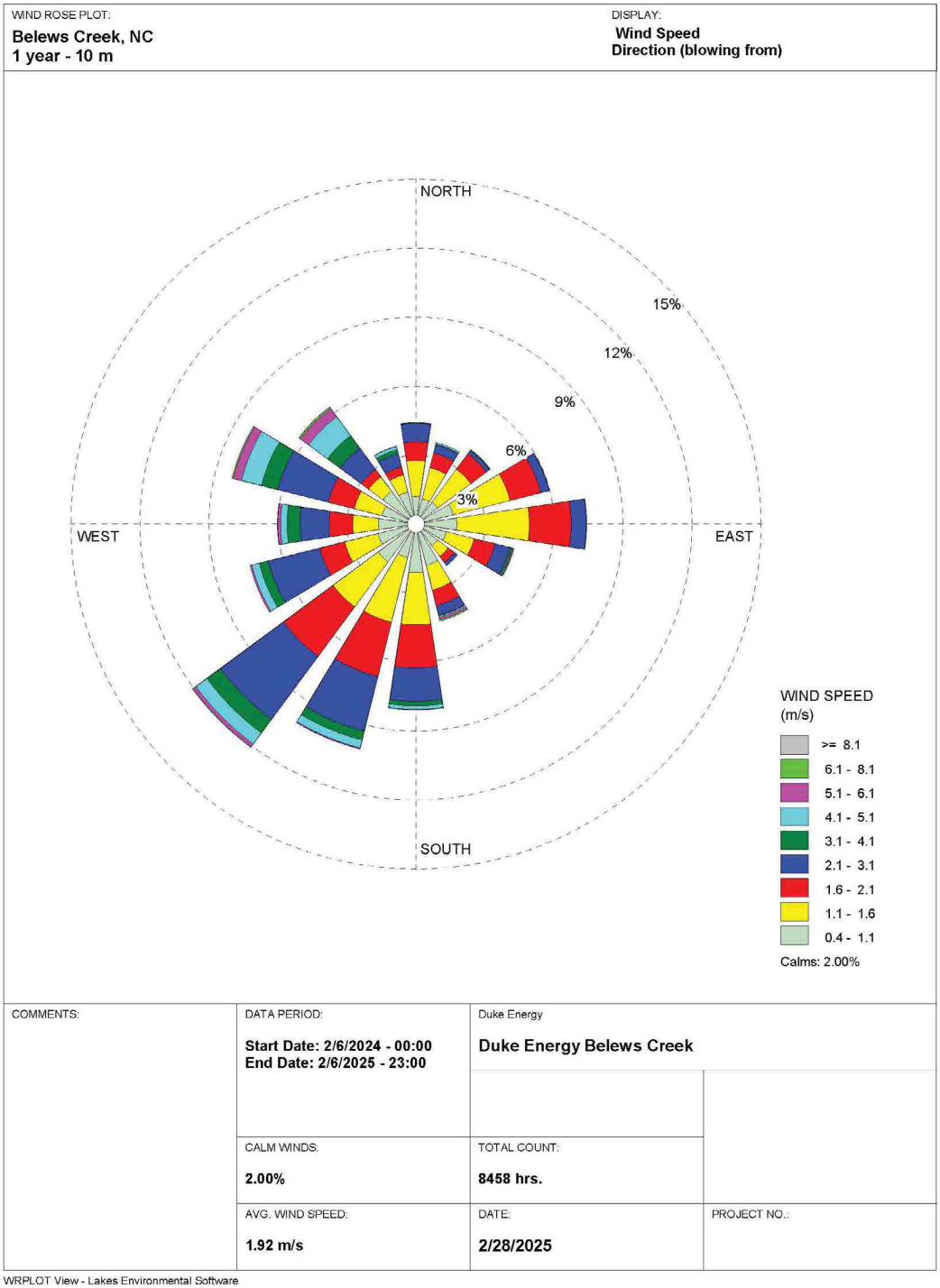


Figure 2.3-19
Wind Rose Project Site (10-Meters) February 2024/2025

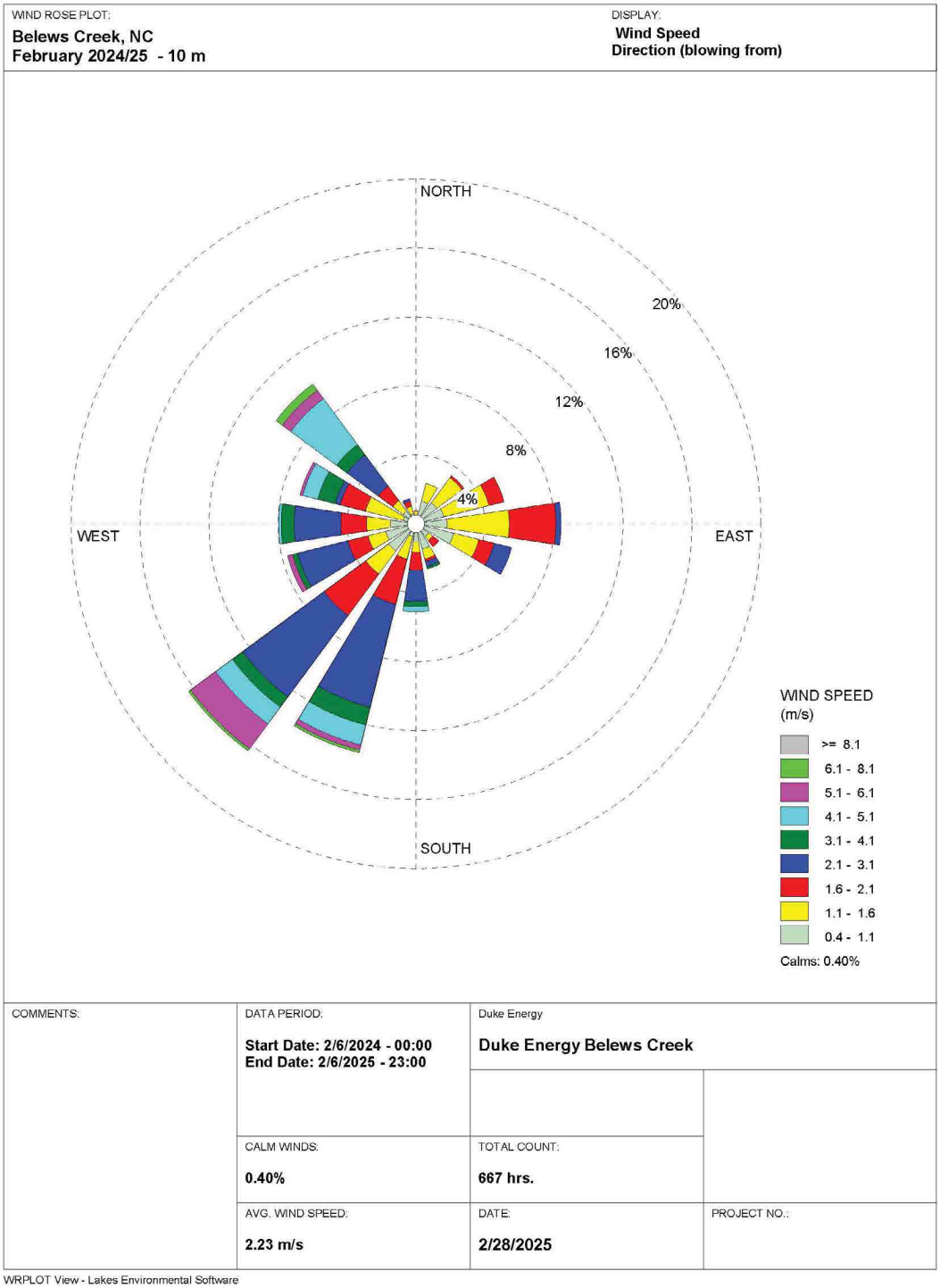


Figure 2.3-20
Wind Rose Project Site (10-Meters) March 2024

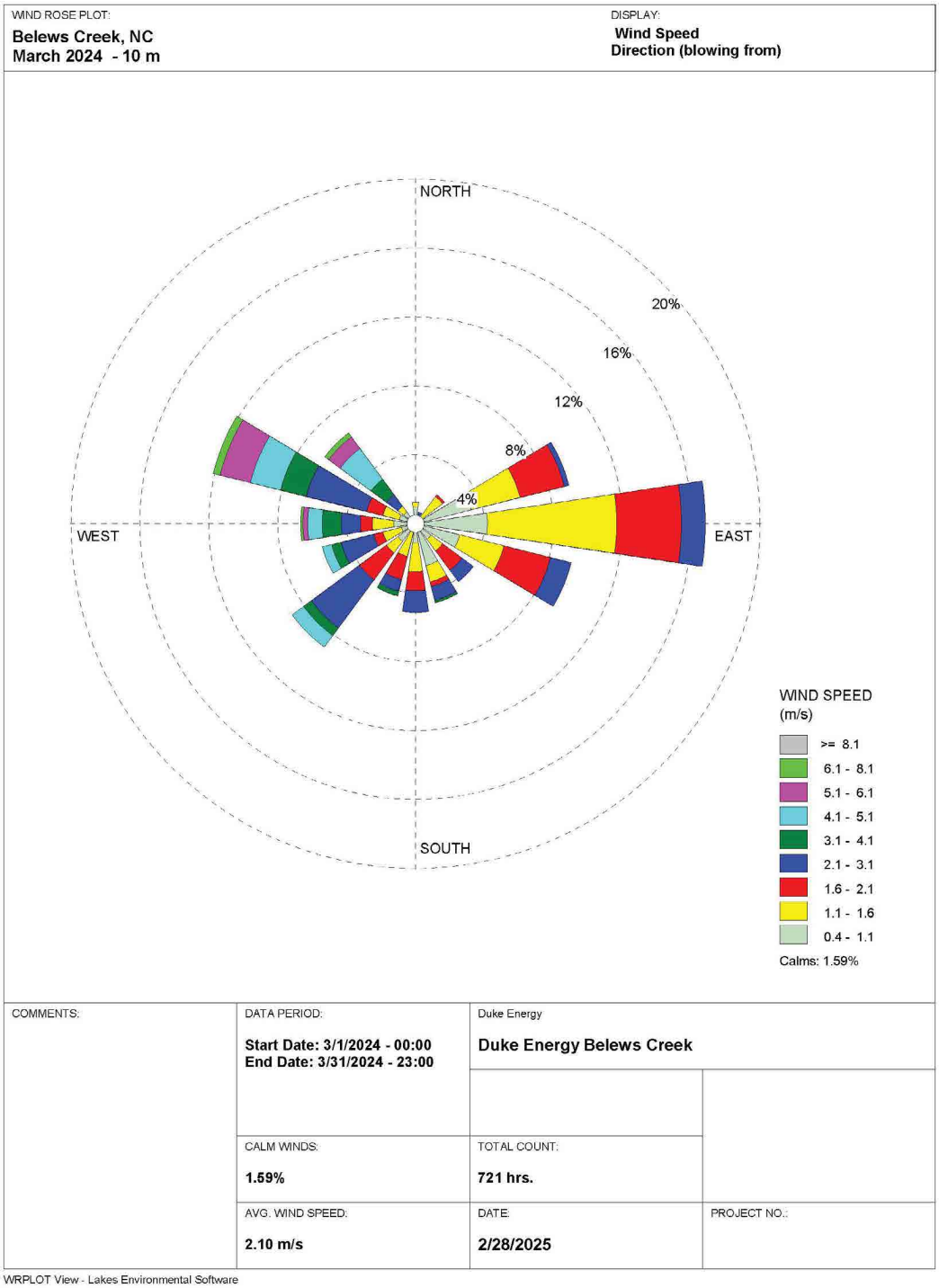


Figure 2.3-21
Wind Rose Project Site (10-Meters) April 2024

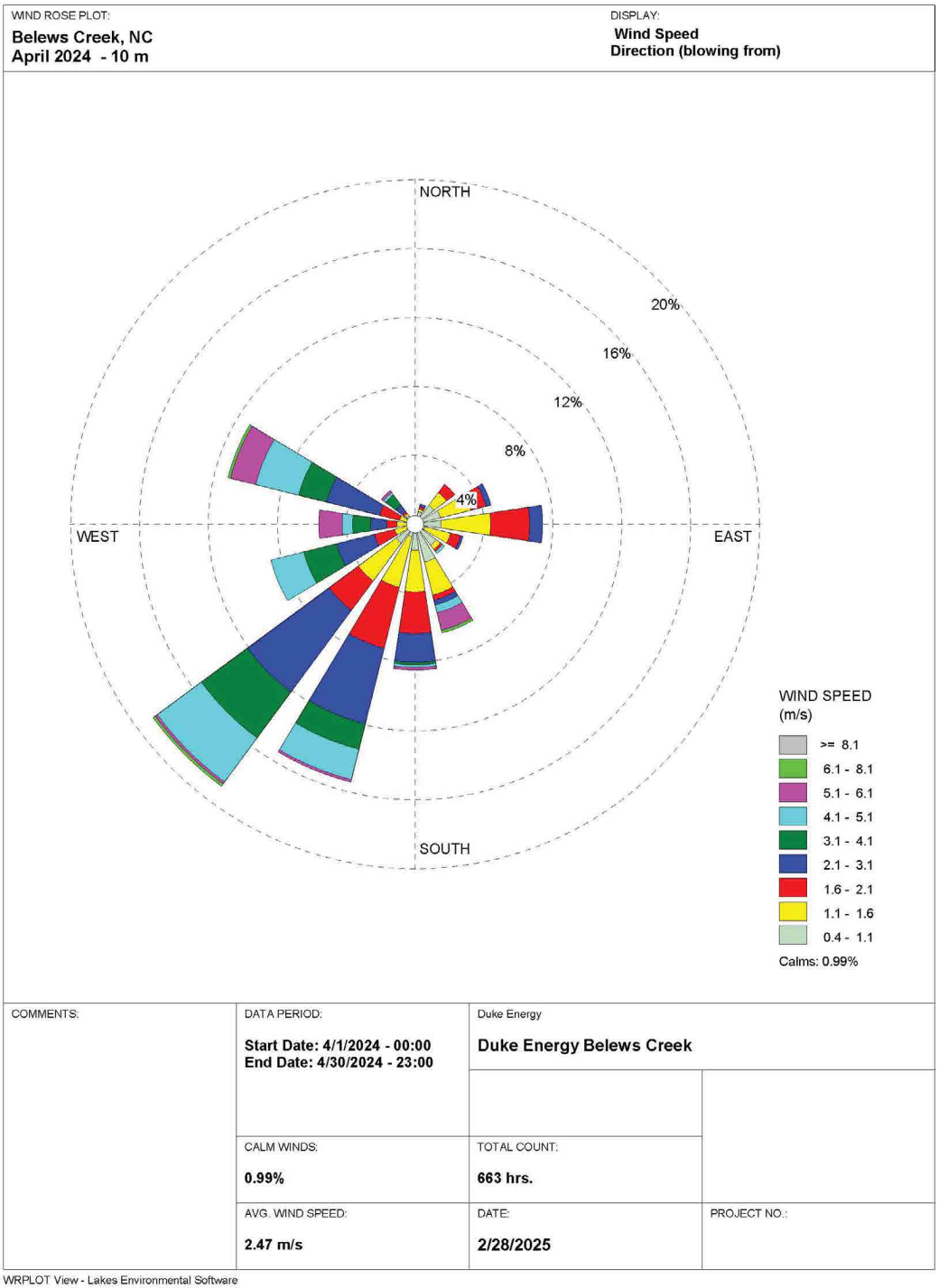


Figure 2.3-22
Wind Rose Project Site (10-Meters) May 2024

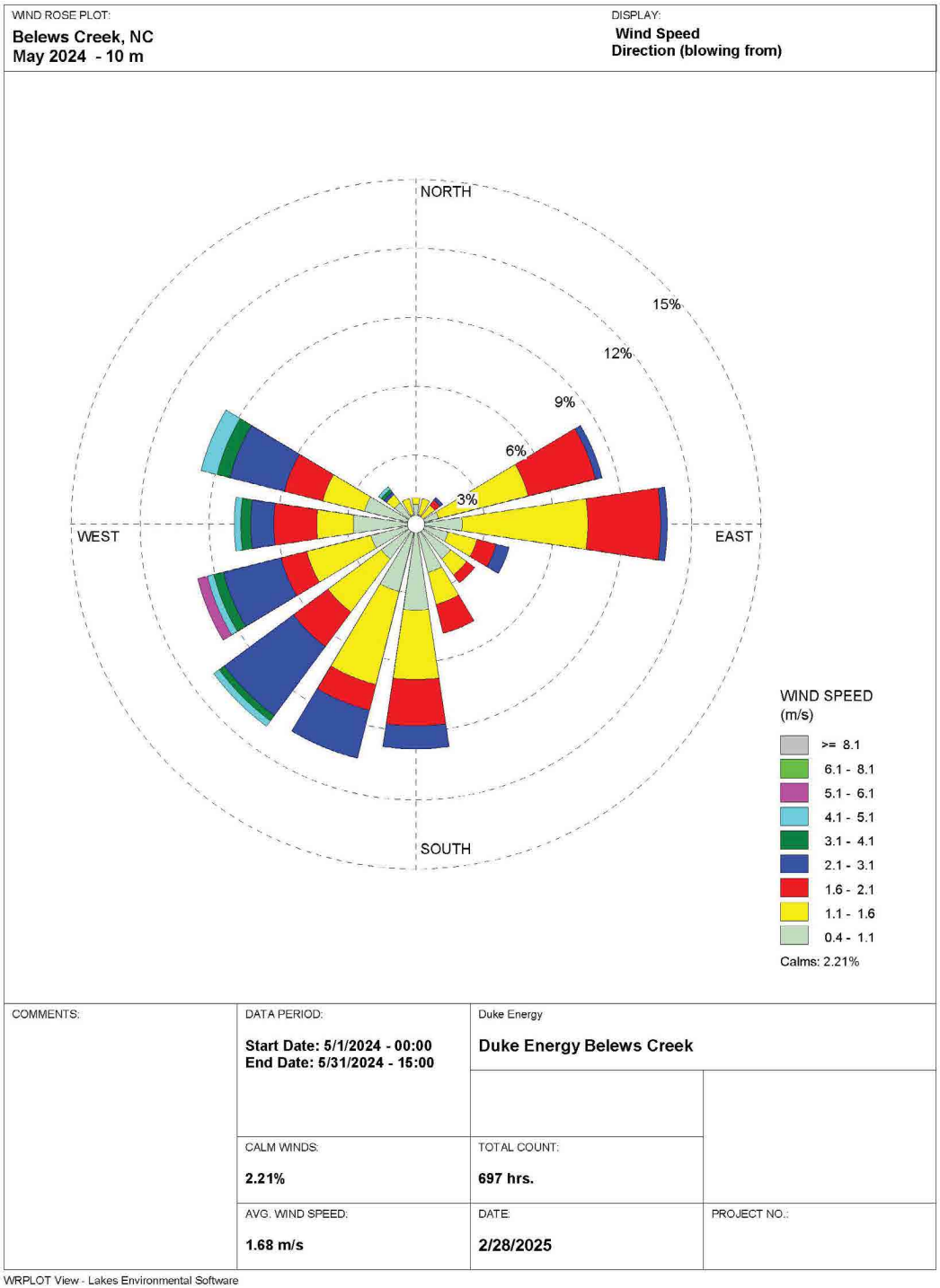


Figure 2.3-23
Wind Rose Project Site (10-Meters) June 2024

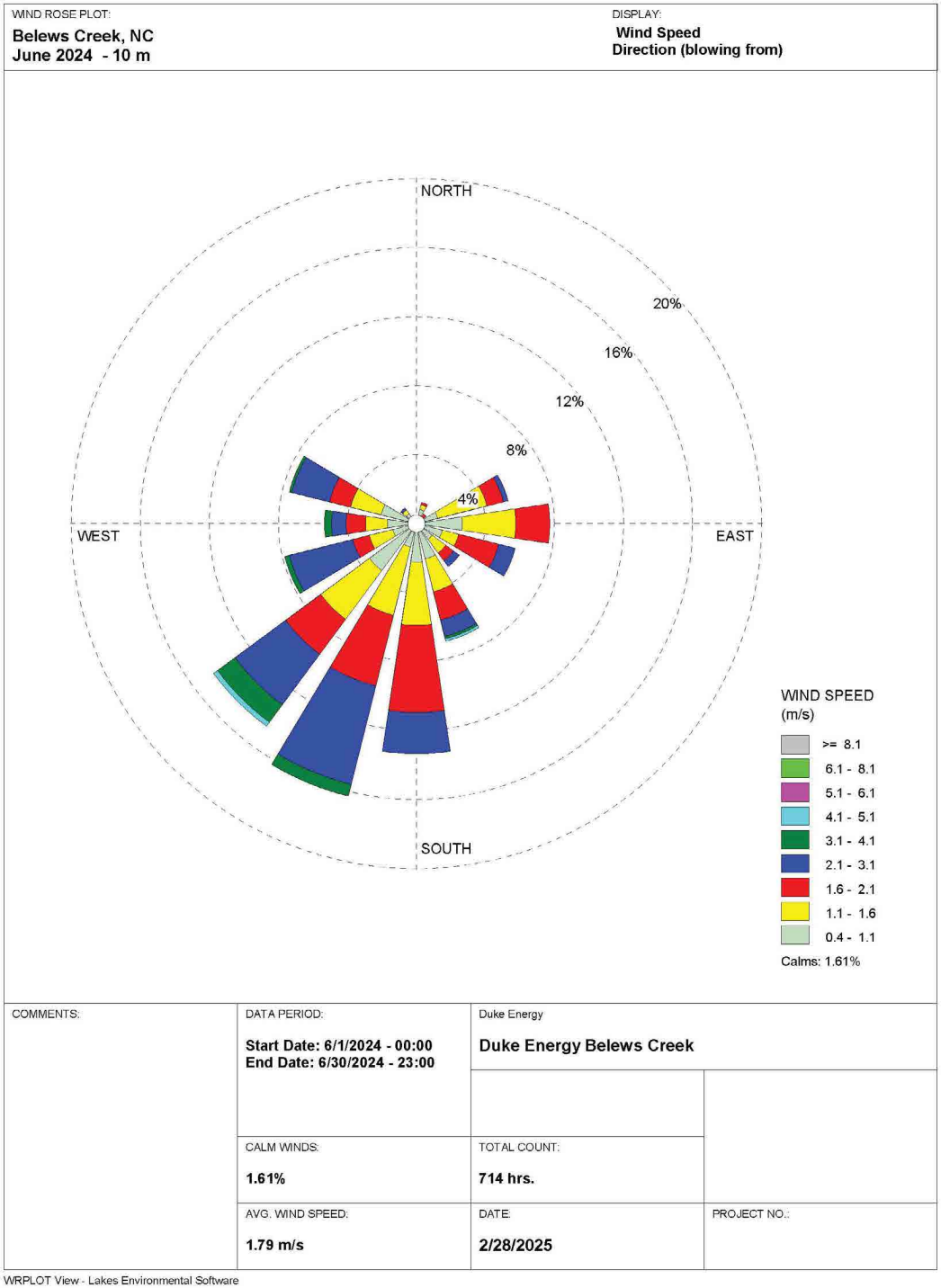


Figure 2.3-24
Wind Rose Project Site (10-Meters) July 2024

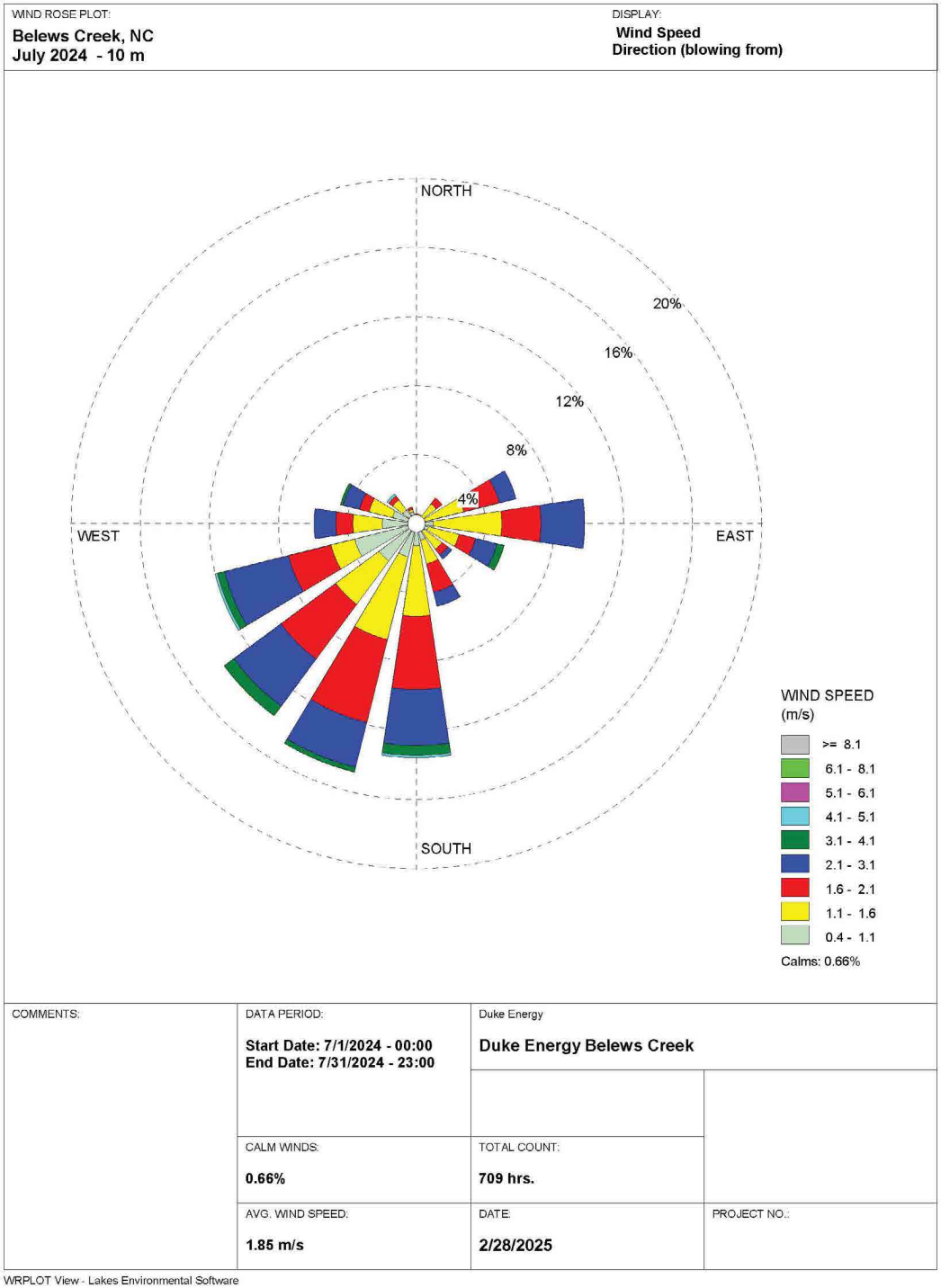


Figure 2.3-25
Wind Rose Project Site (10-Meters) August 2024

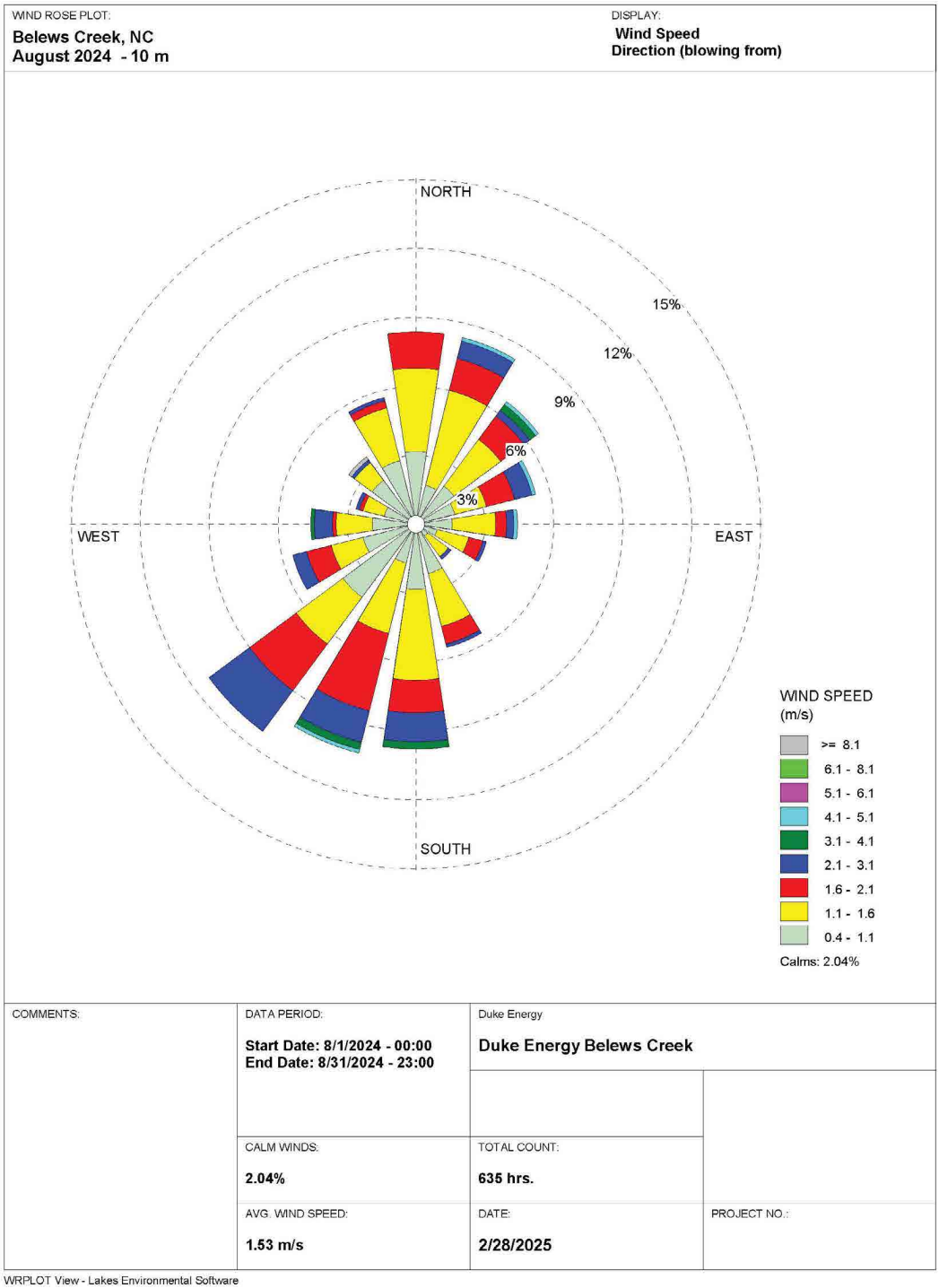


Figure 2.3-26
Wind Rose Project Site (10-Meters) September 2024

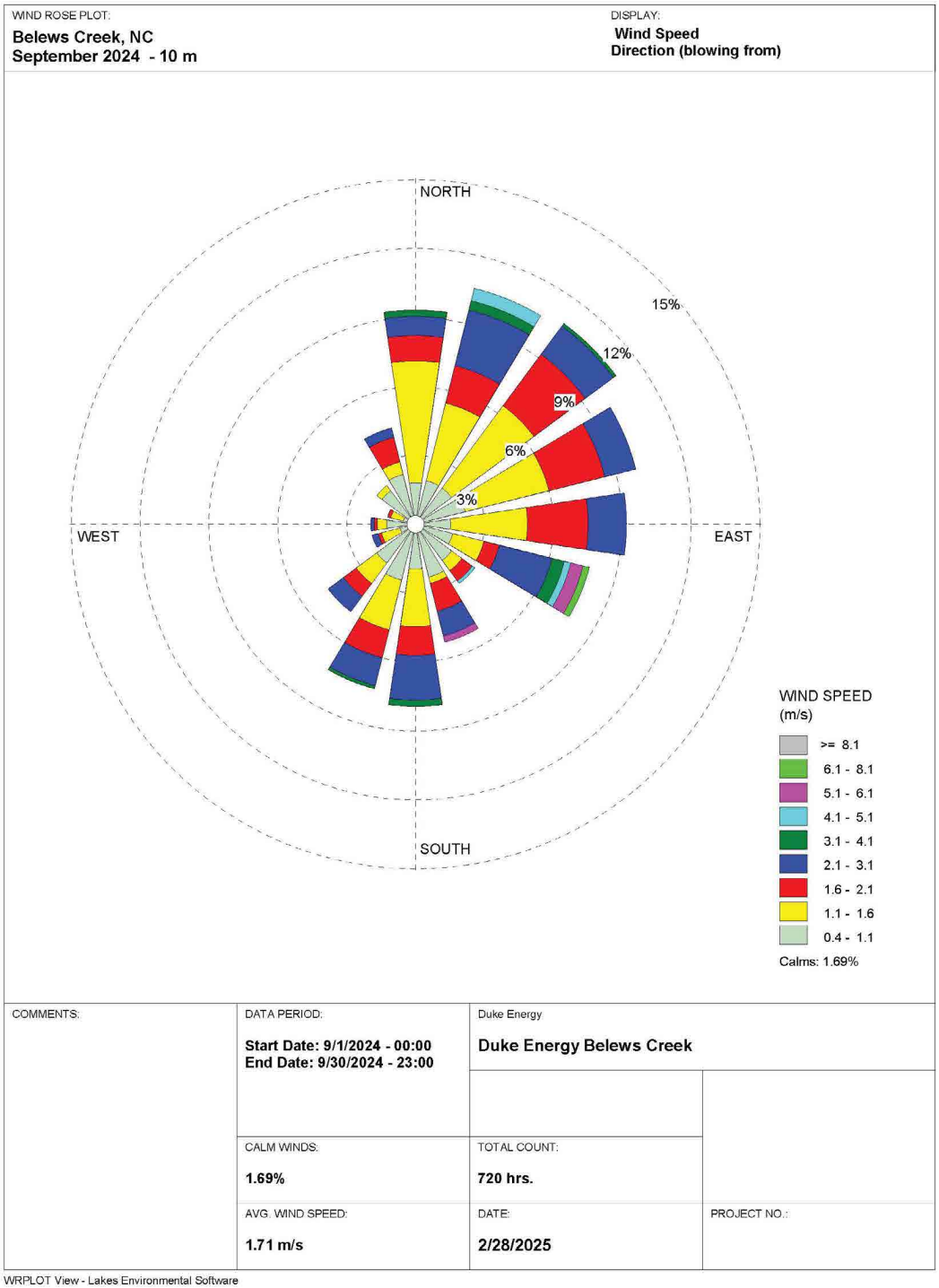


Figure 2.3-27
Wind Rose Project Site (10-Meters) October 2024

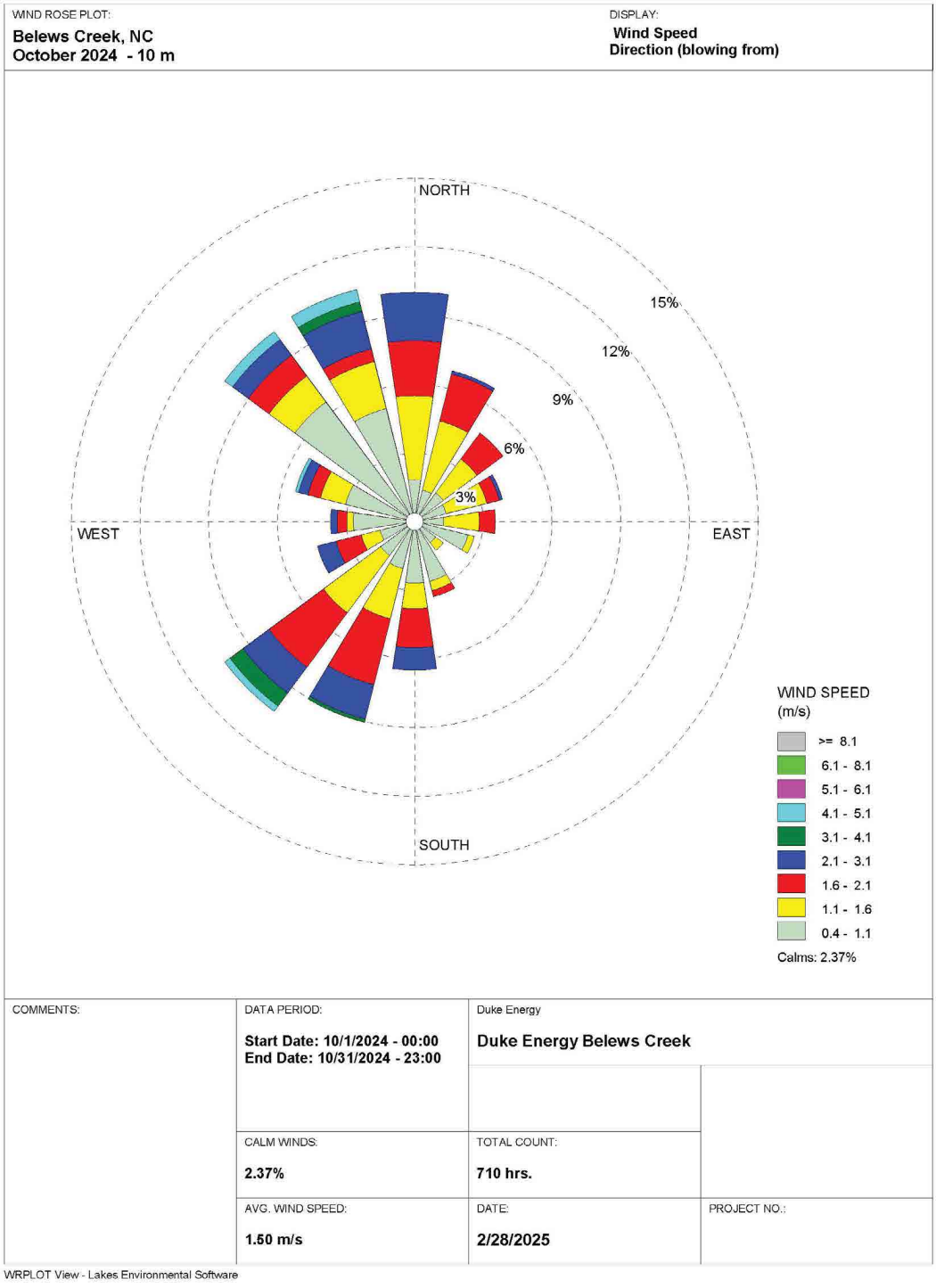


Figure 2.3-28
Wind Rose Project Site (10-Meters) November 2024

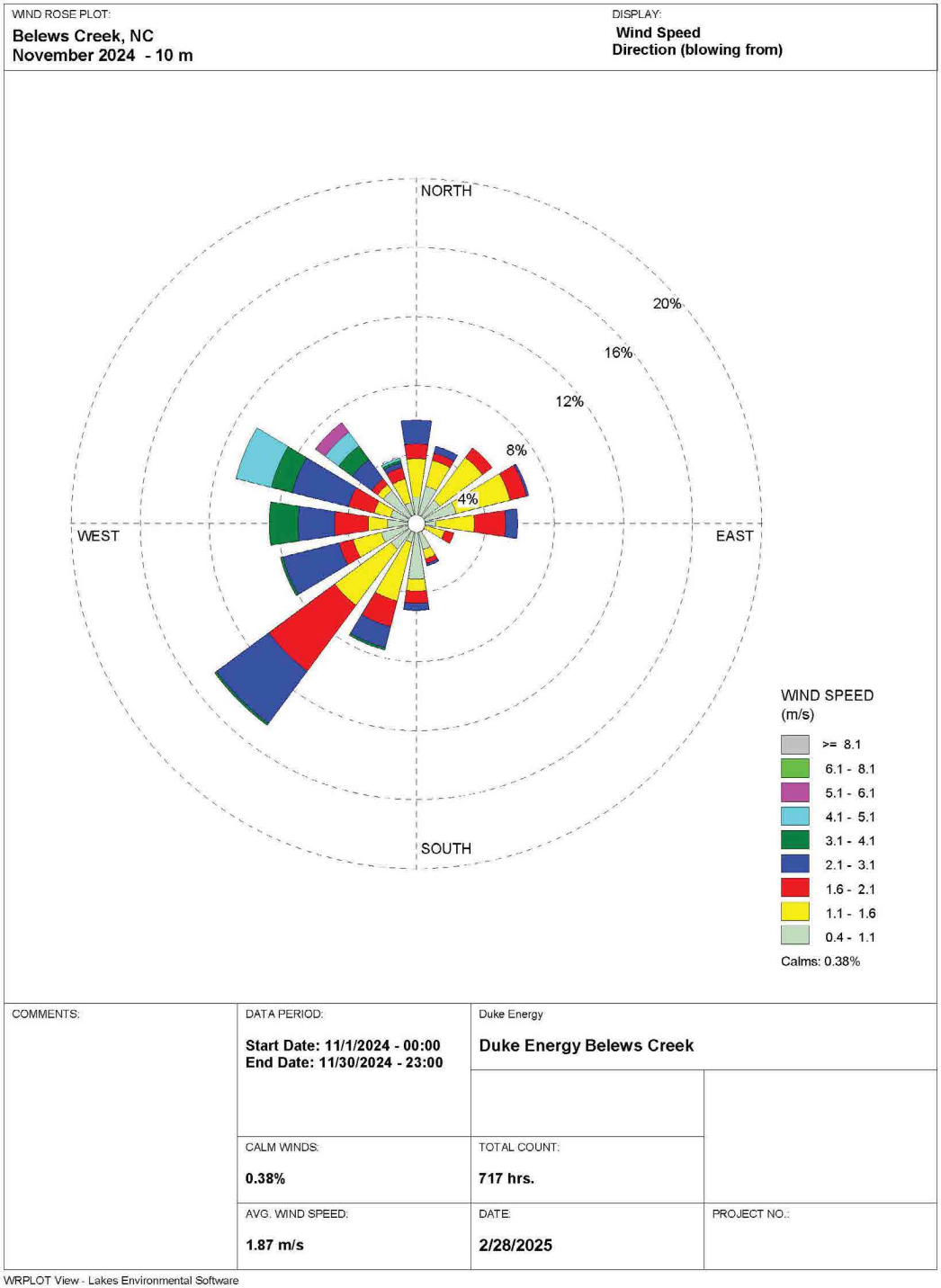


Figure 2.3-29
Wind Rose Project Site (10-Meters) December 2024

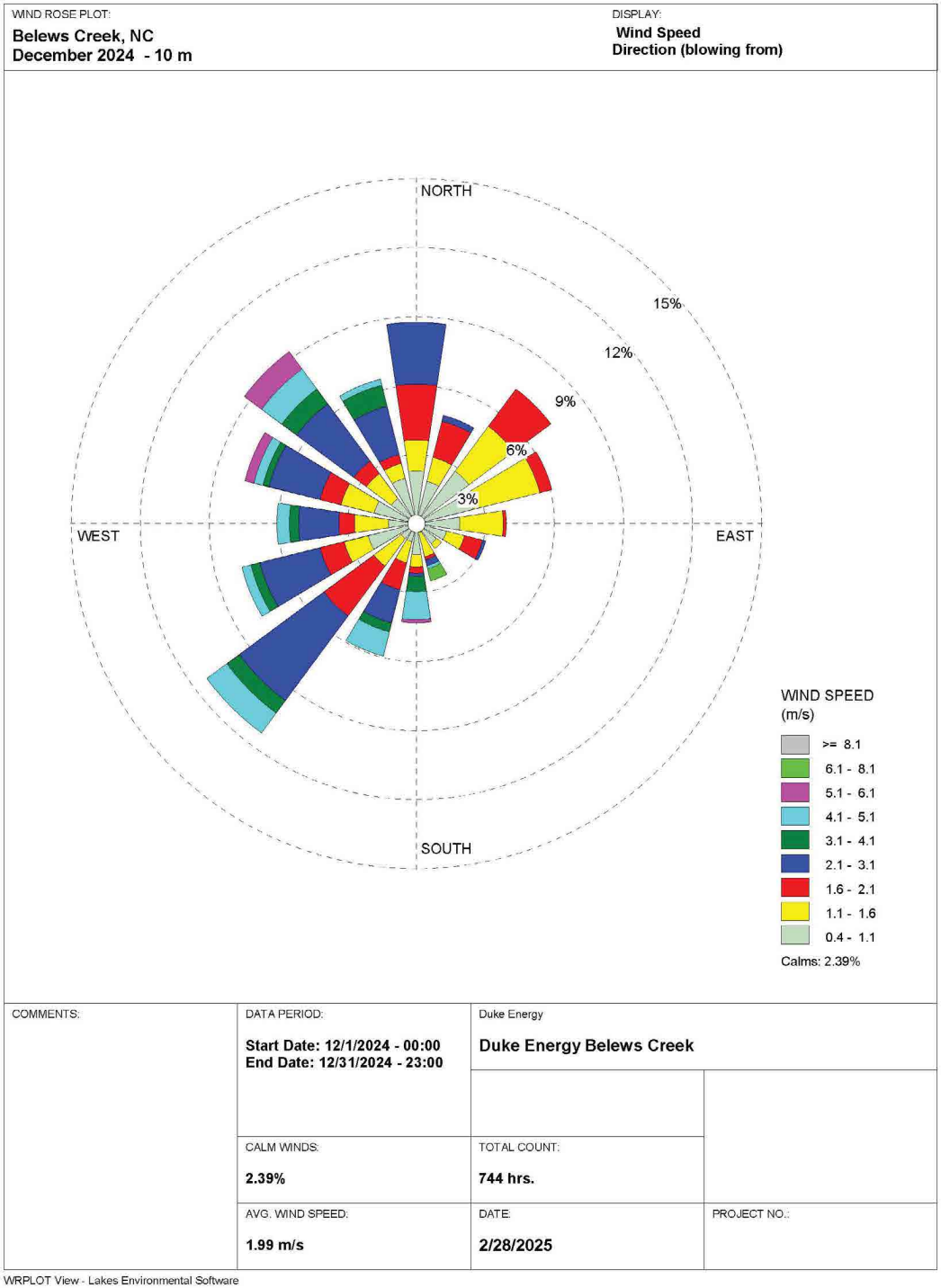


Figure 2.3-30
Wind Rose Project Site (10-Meters) January 2025

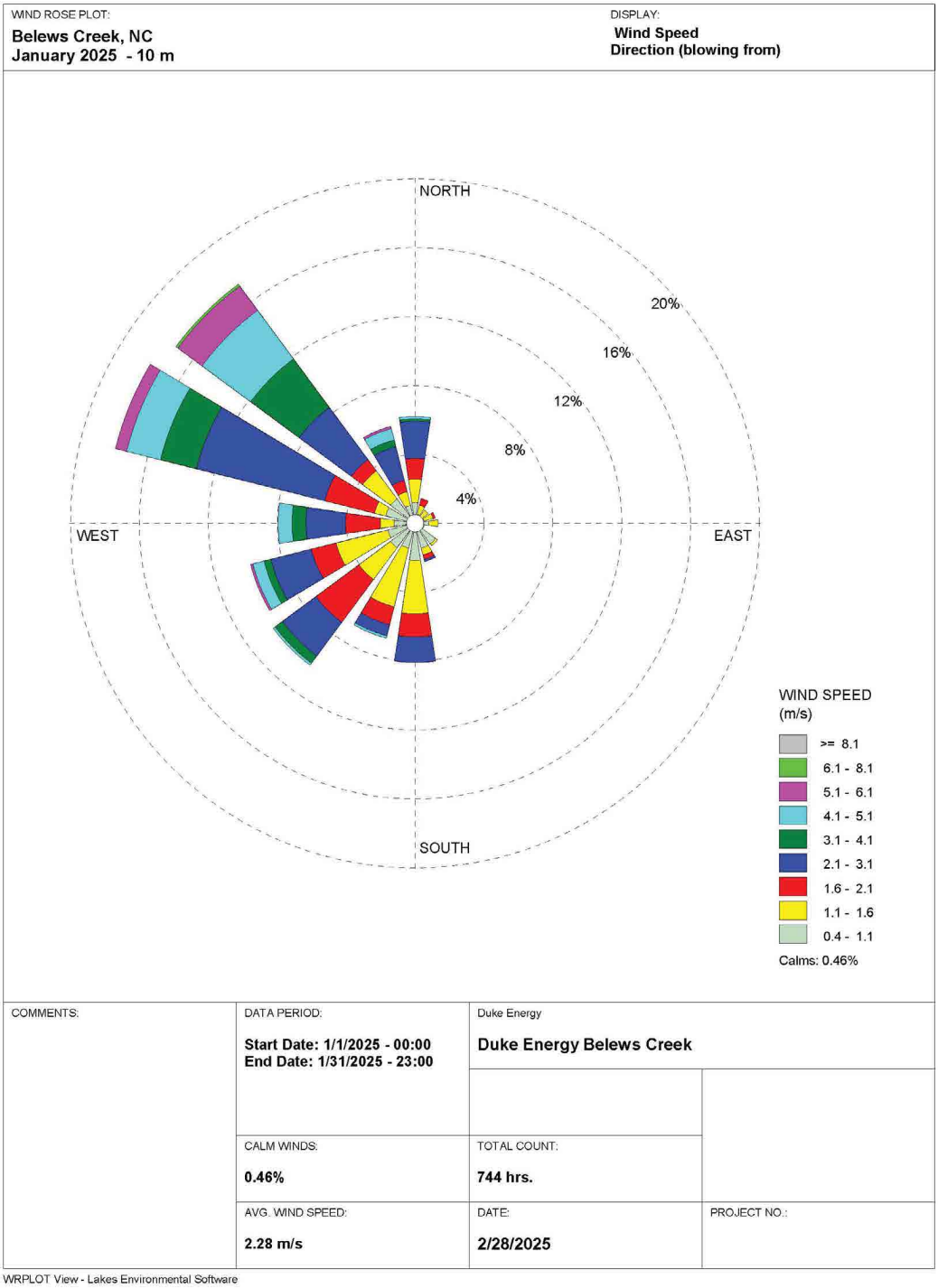


Figure 2.3-31
Wind Rose Project Site (60-Meters) Annual All Data

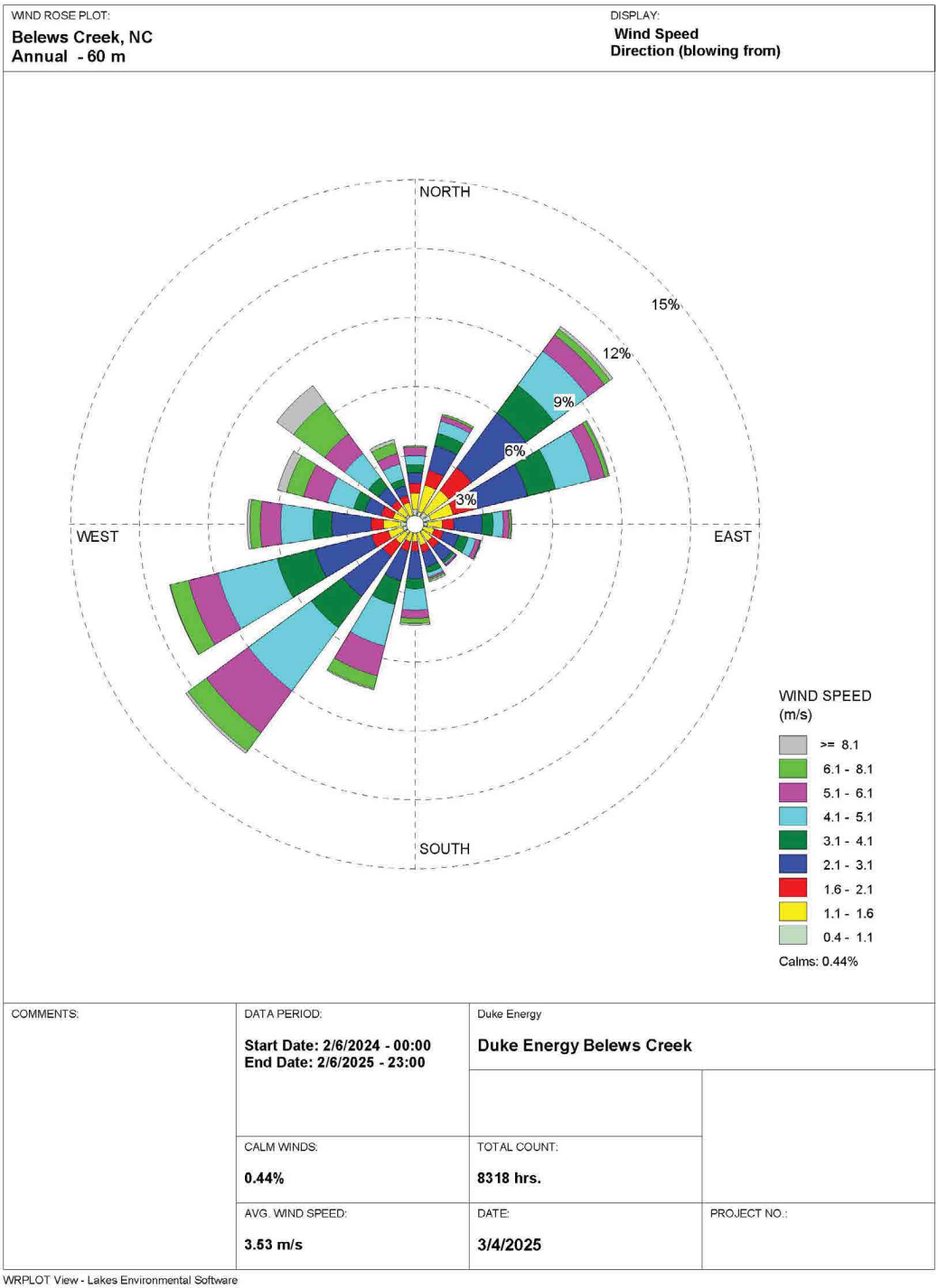


Figure 2.3-32
Wind Rose Project Site (60-Meters) February 2024/2025

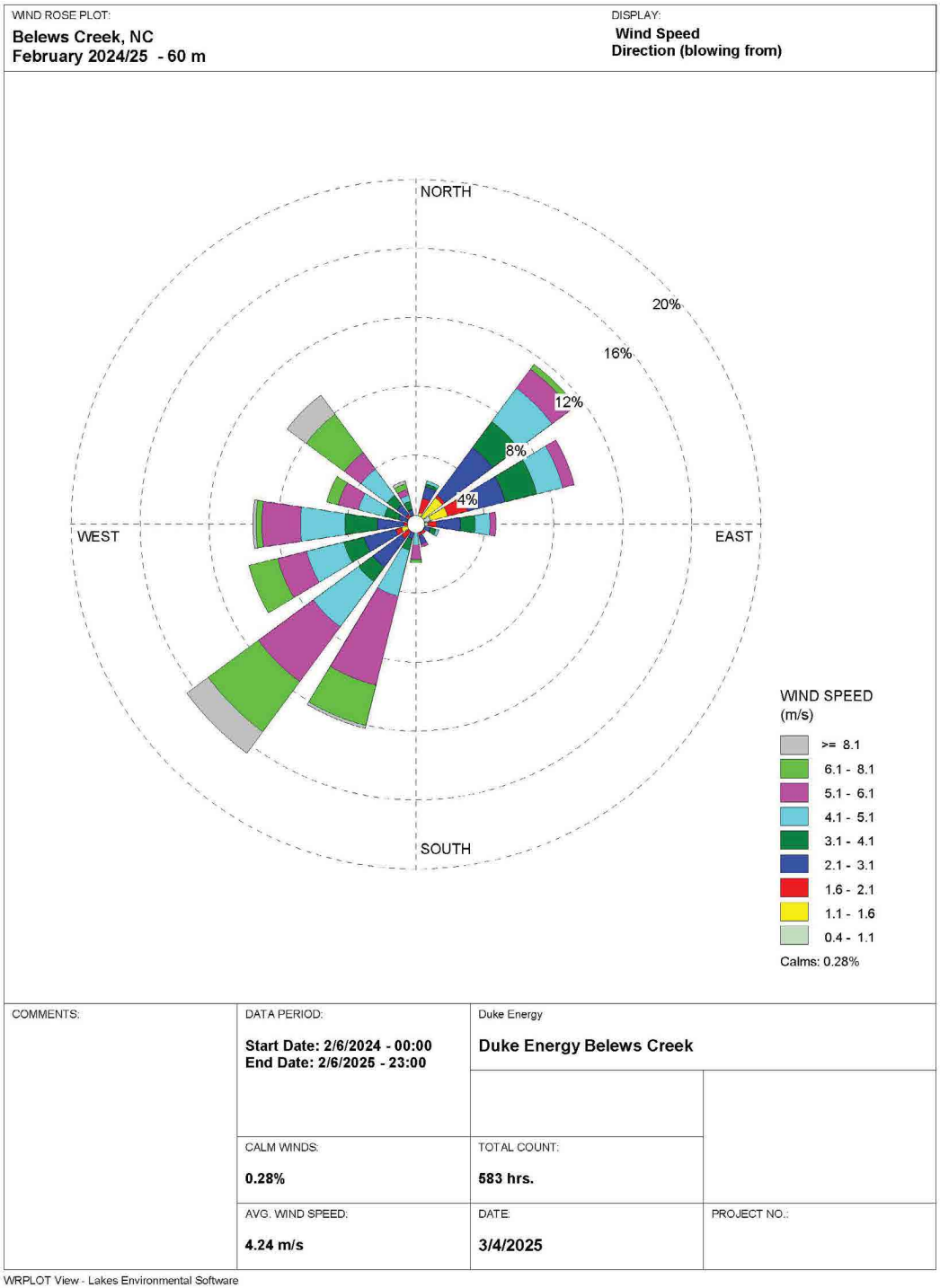


Figure 2.3-33
Wind Rose Project Site (60-Meters) March 2024

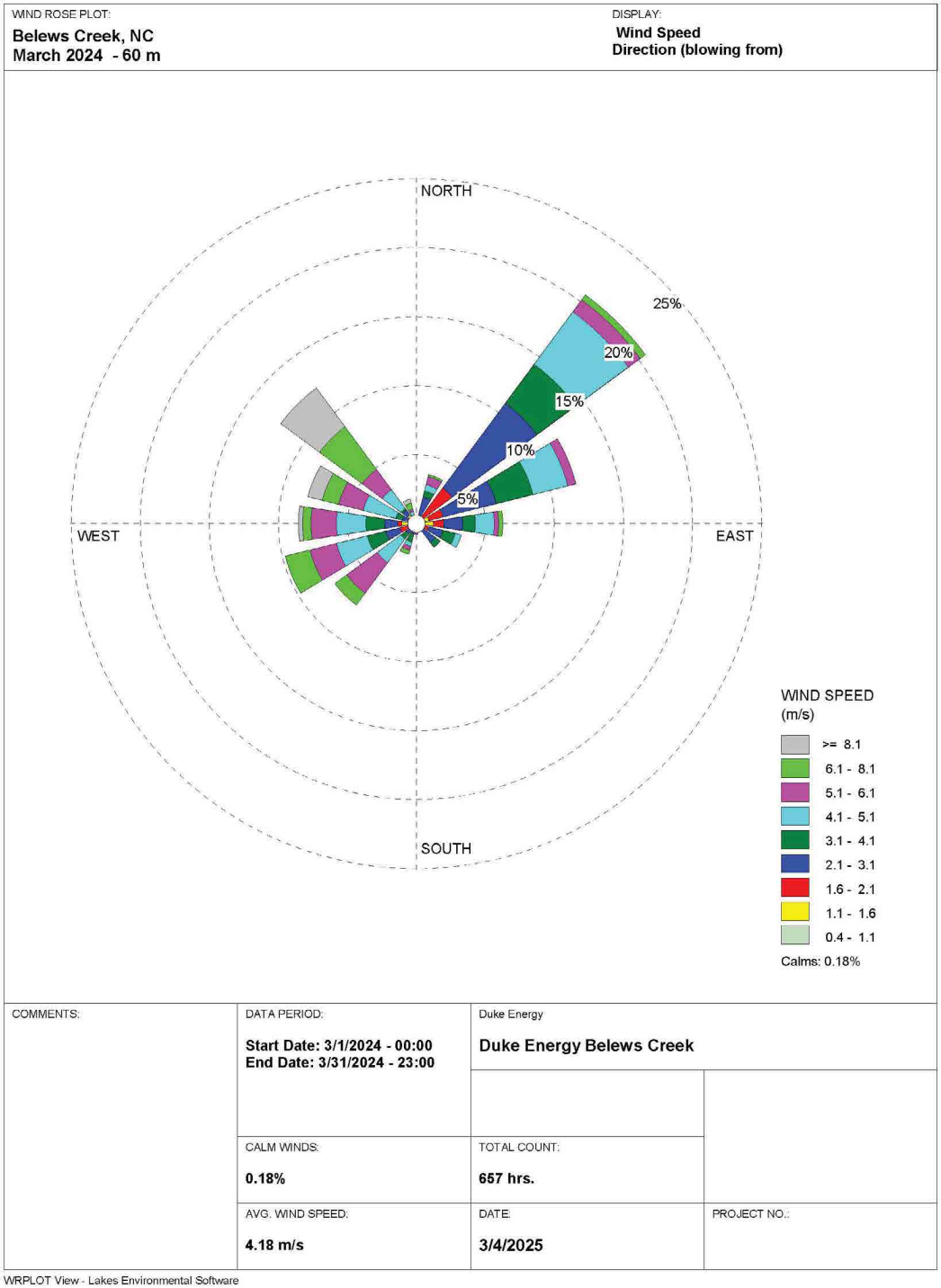


Figure 2.3-34
Wind Rose Project Site (60-Meters) April 2024

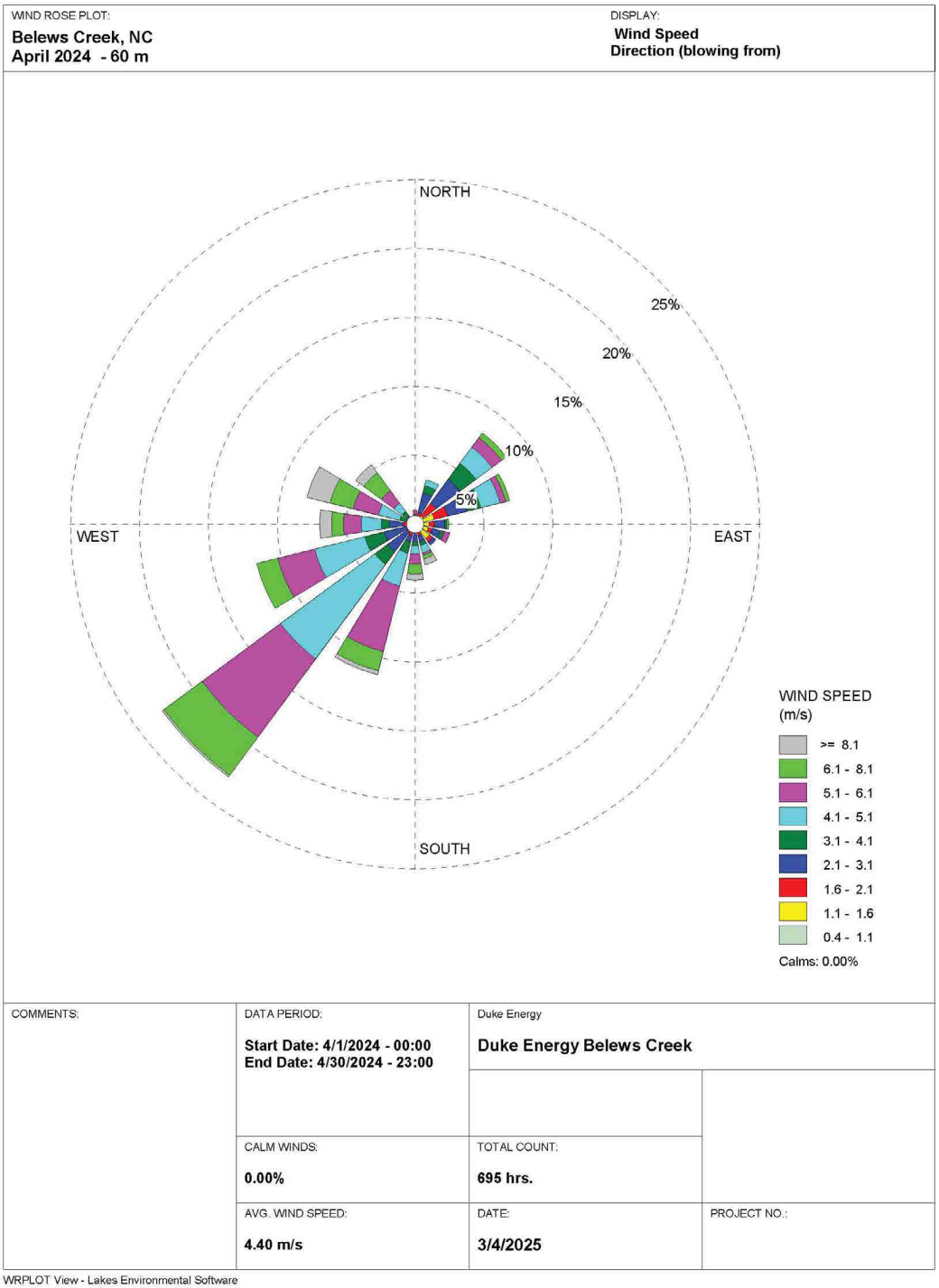


Figure 2.3-35
Wind Rose Project Site (60-Meters) May 2024

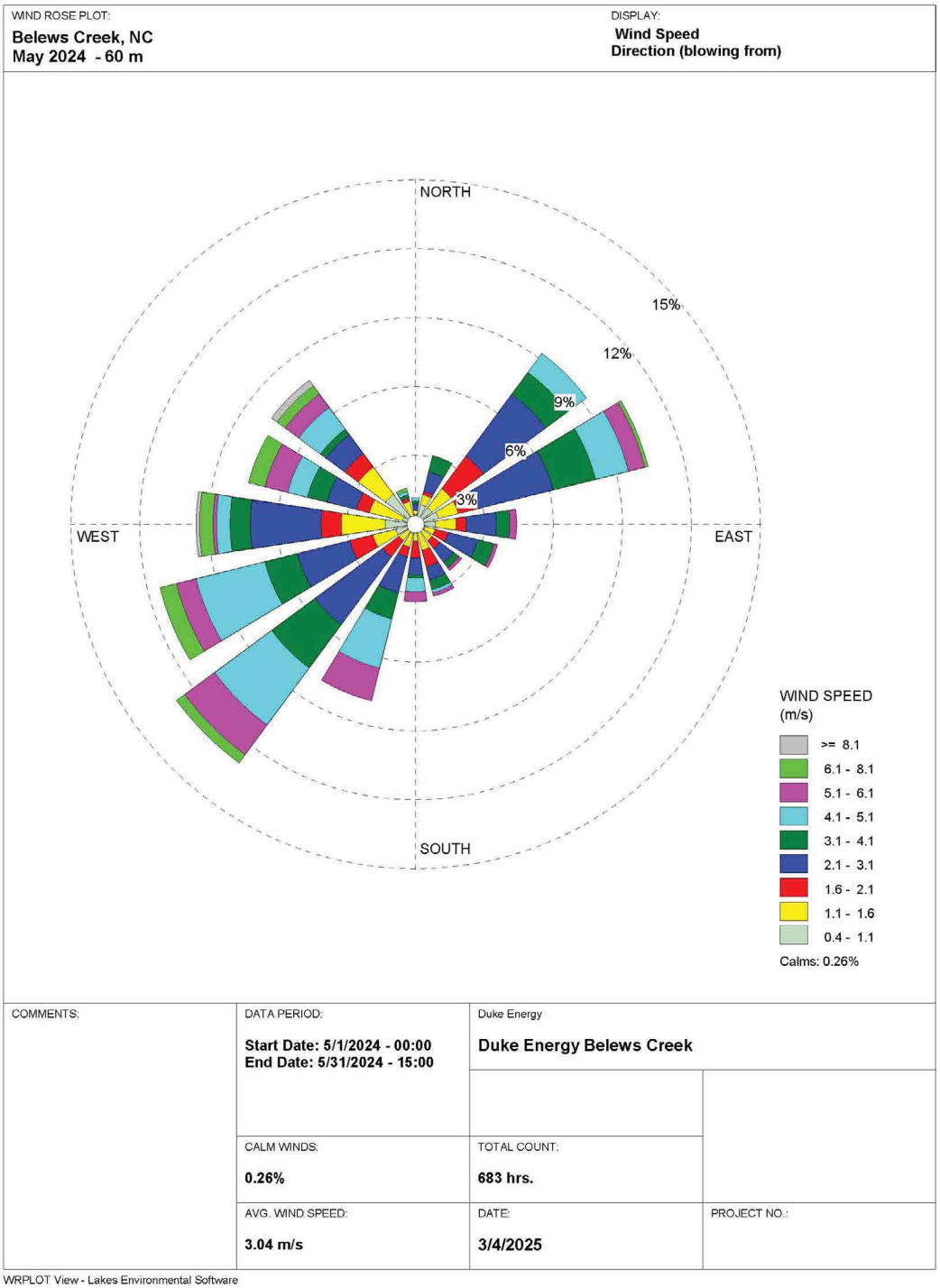


Figure 2.3-36
Wind Rose Project Site (60-Meters) June 2024

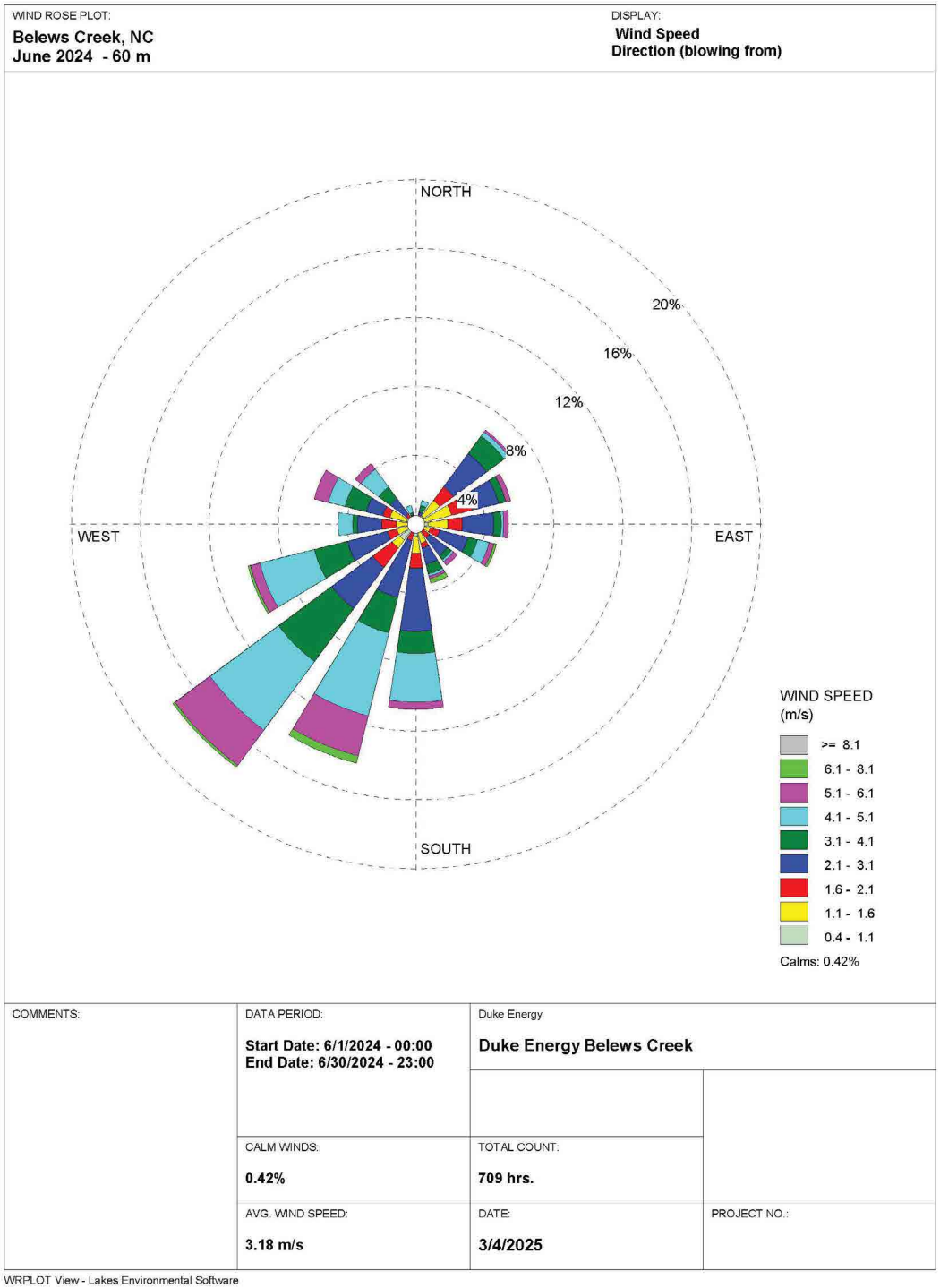


Figure 2.3-37
Wind Rose Project Site (60-Meters) July 2024

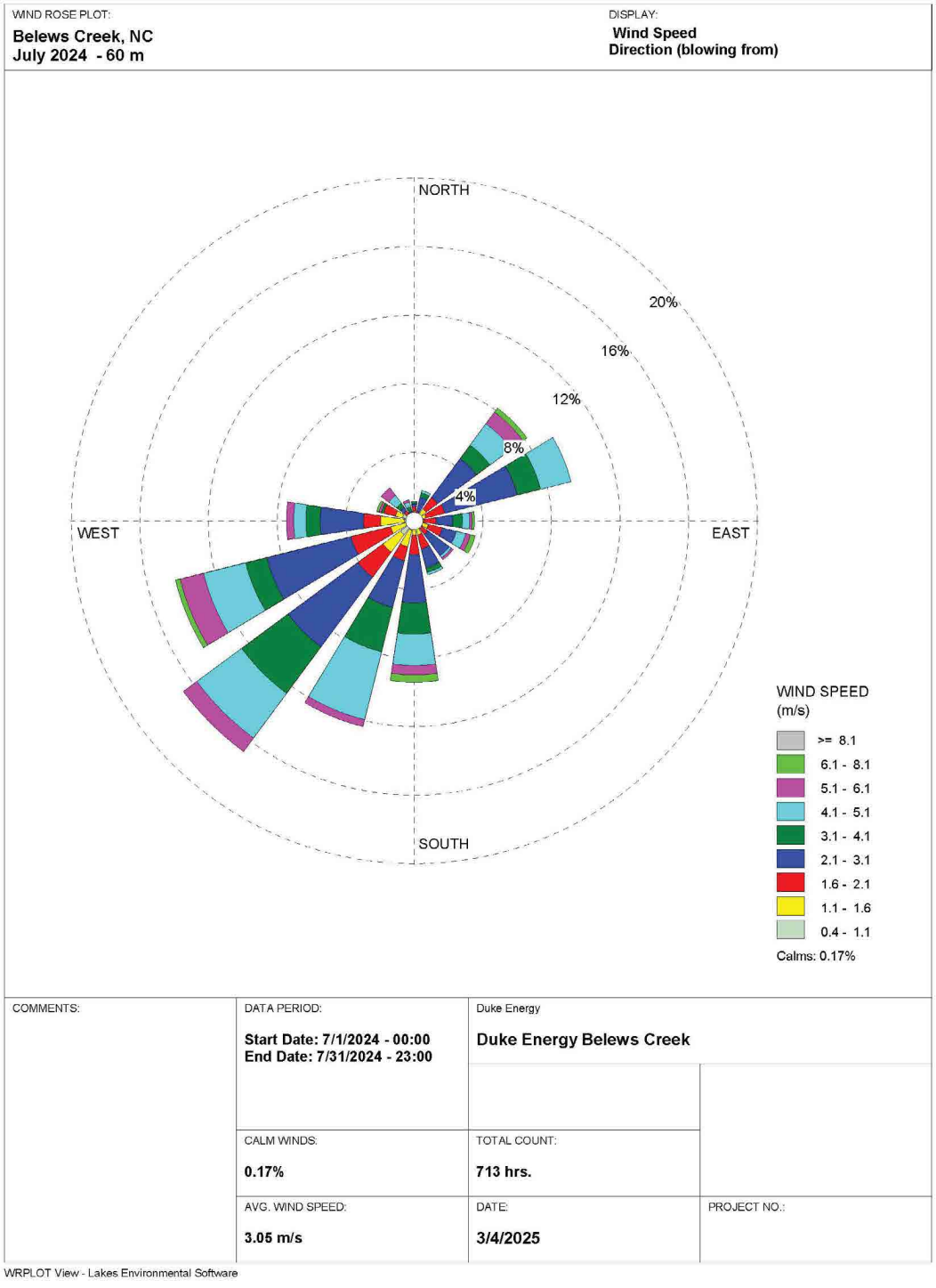


Figure 2.3-38
Wind Rose Project Site (60-Meters) August 2024

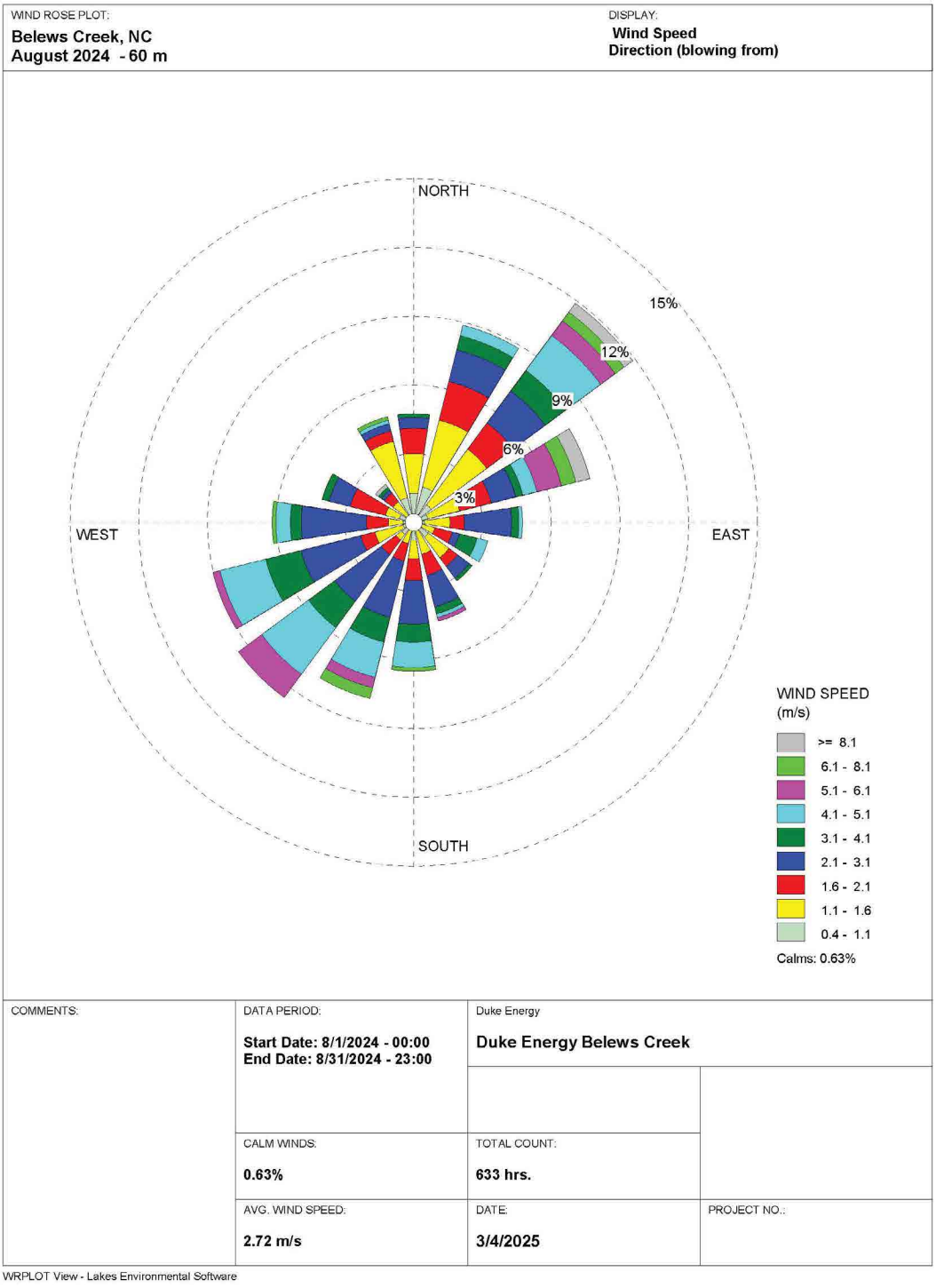


Figure 2.3-39
Wind Rose Project Site (60-Meters) September 2024

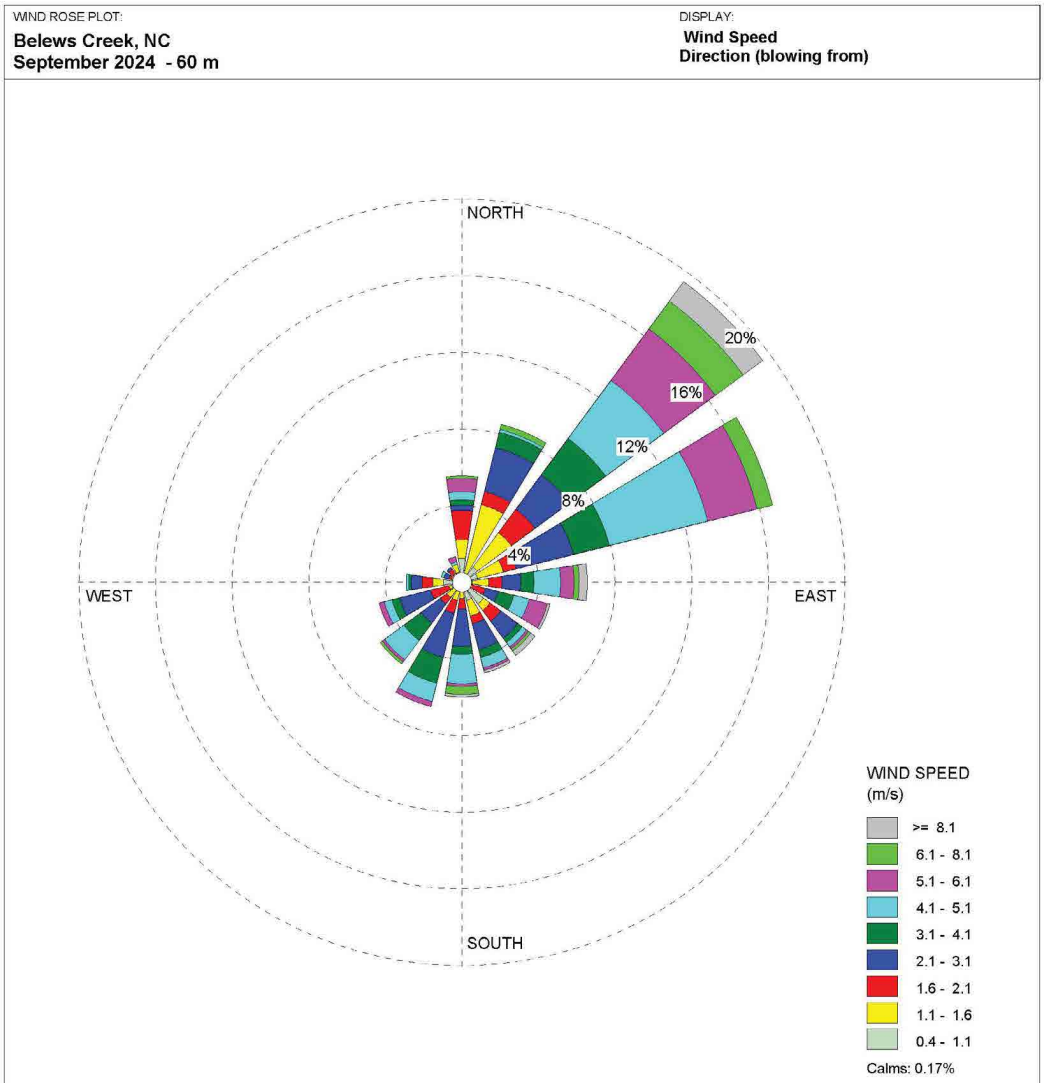


Figure 2.3-40
Wind Rose Project Site (60-Meters) October 2024

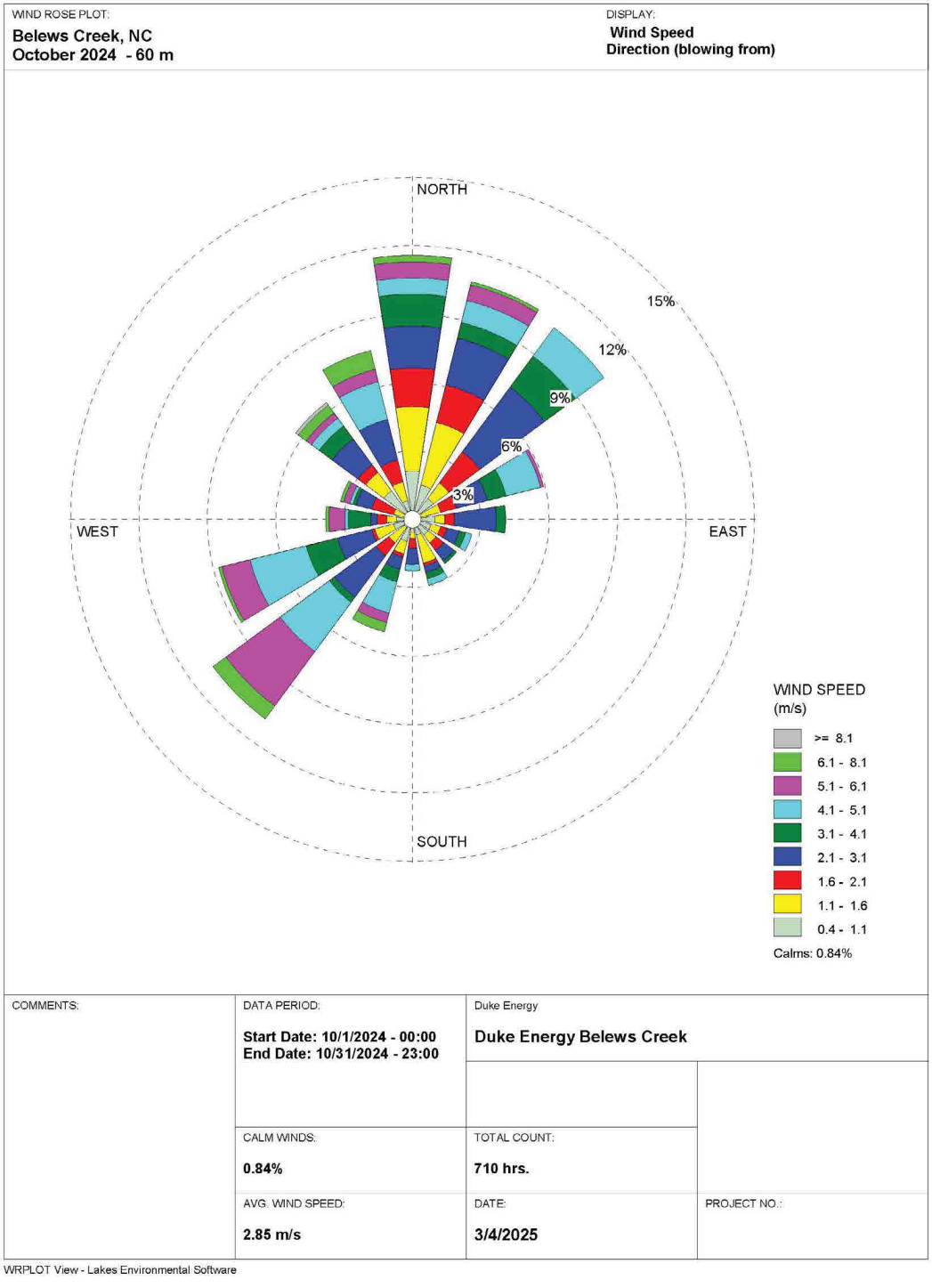


Figure 2.3-41
Wind Rose Project Site (60-Meters) November 2024

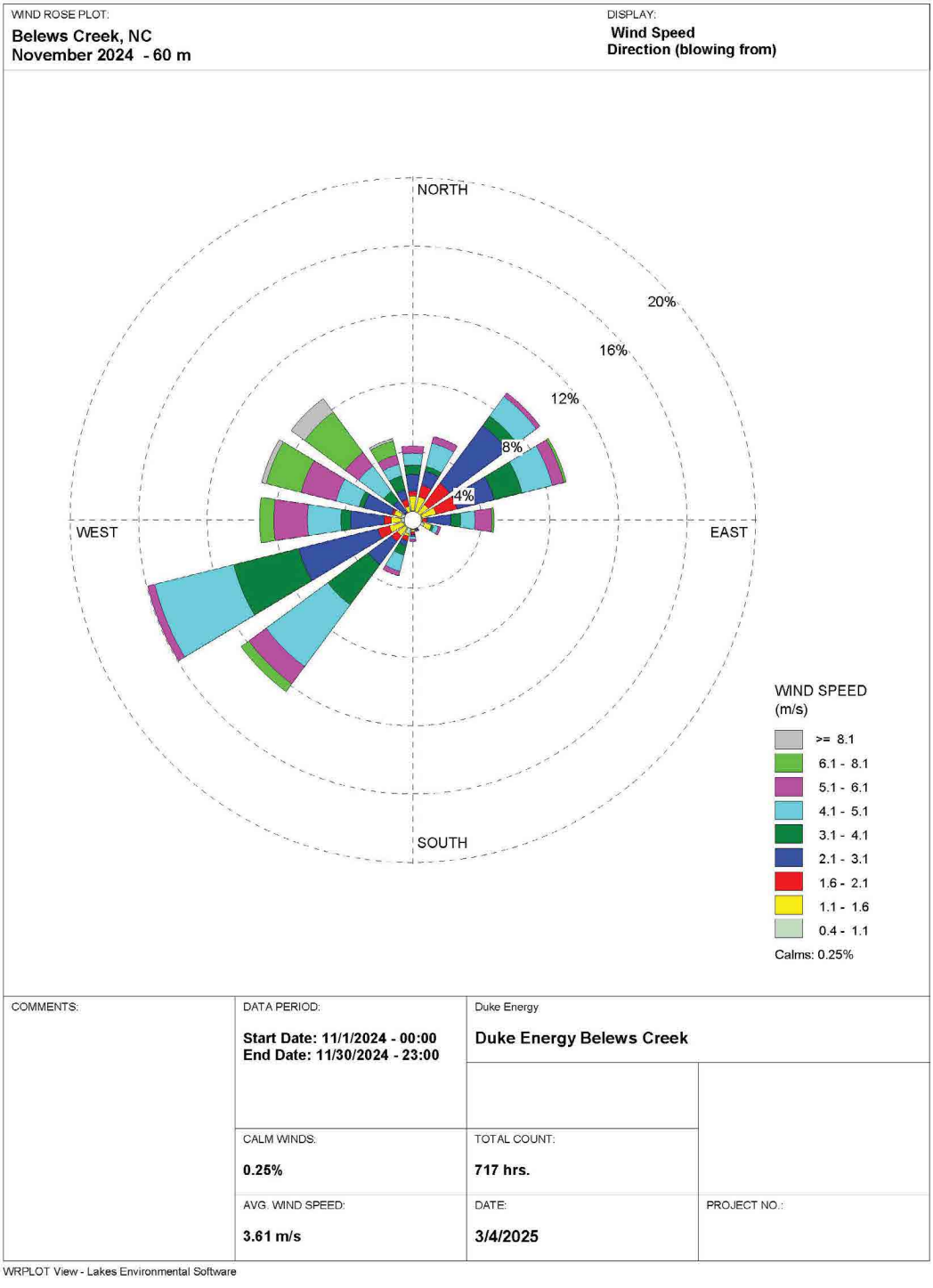


Figure 2.3-42
Wind Rose Project Site (60-Meters) December 2024

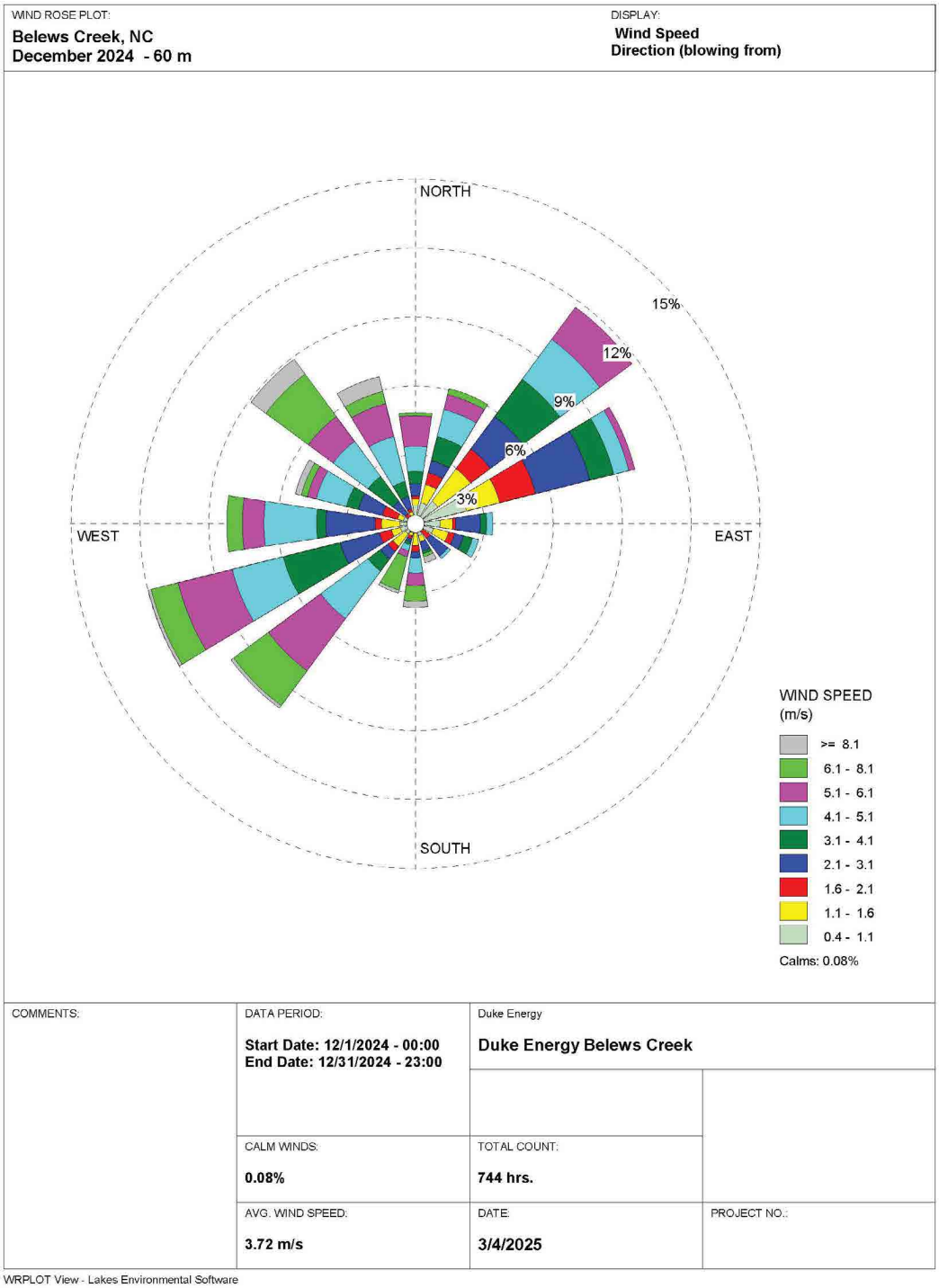


Figure 2.3-43
Wind Rose Project Site (60-Meters) January 2025

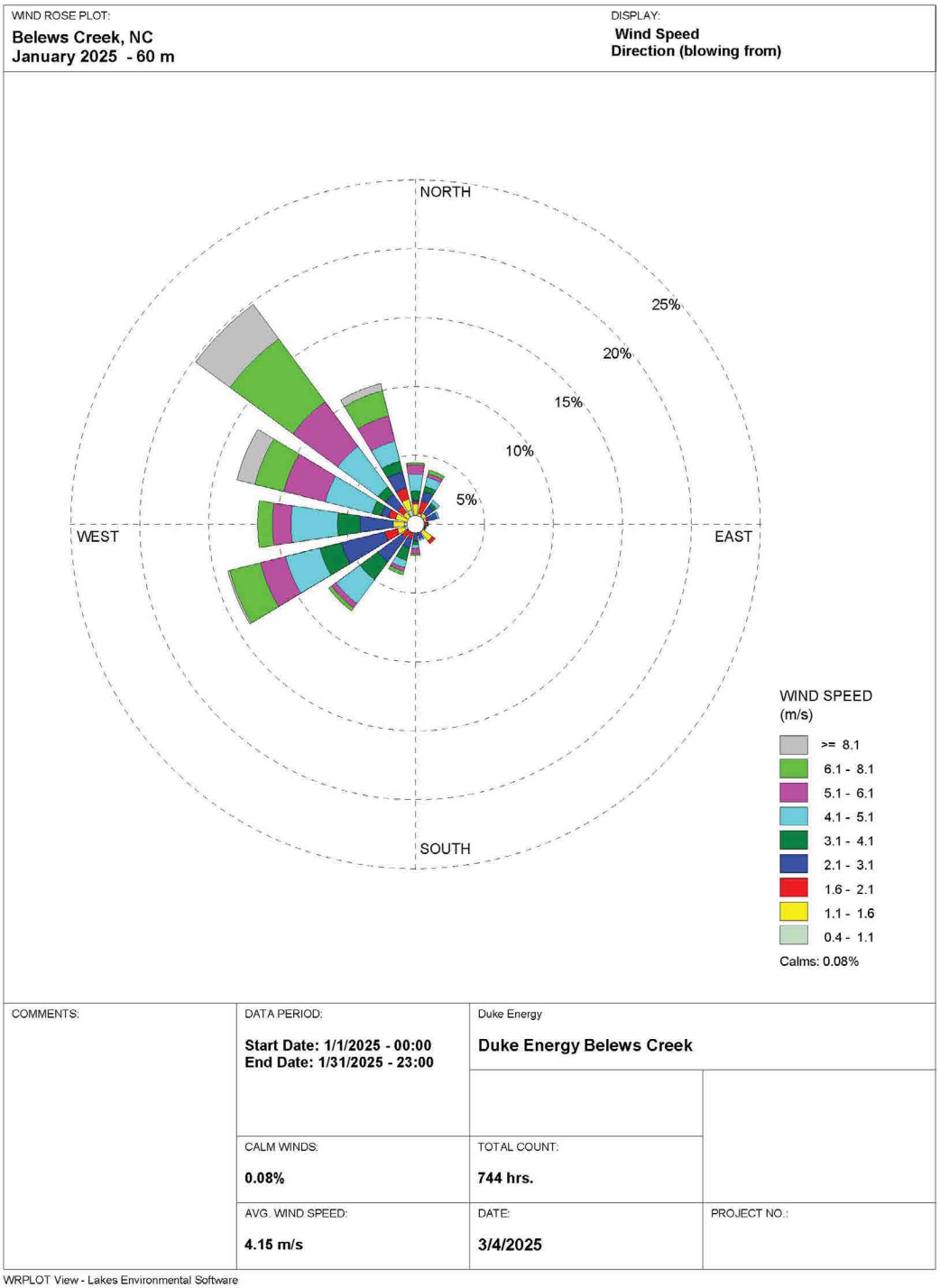


Figure 2.3-44
Wind Rose Project Site (10-Meters) Autumn

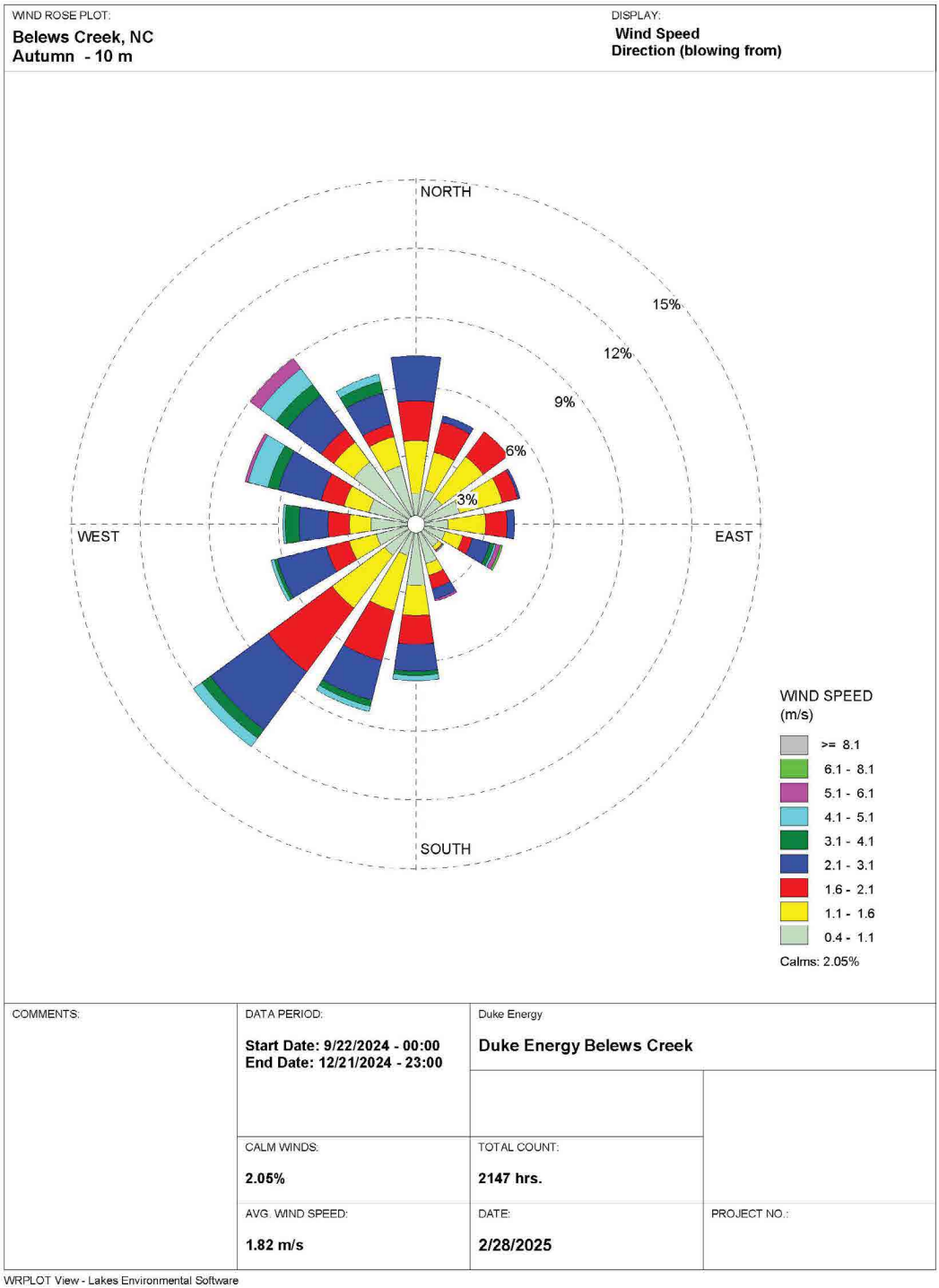


Figure 2.3-45
Wind Rose Project Site (10-Meters) Spring

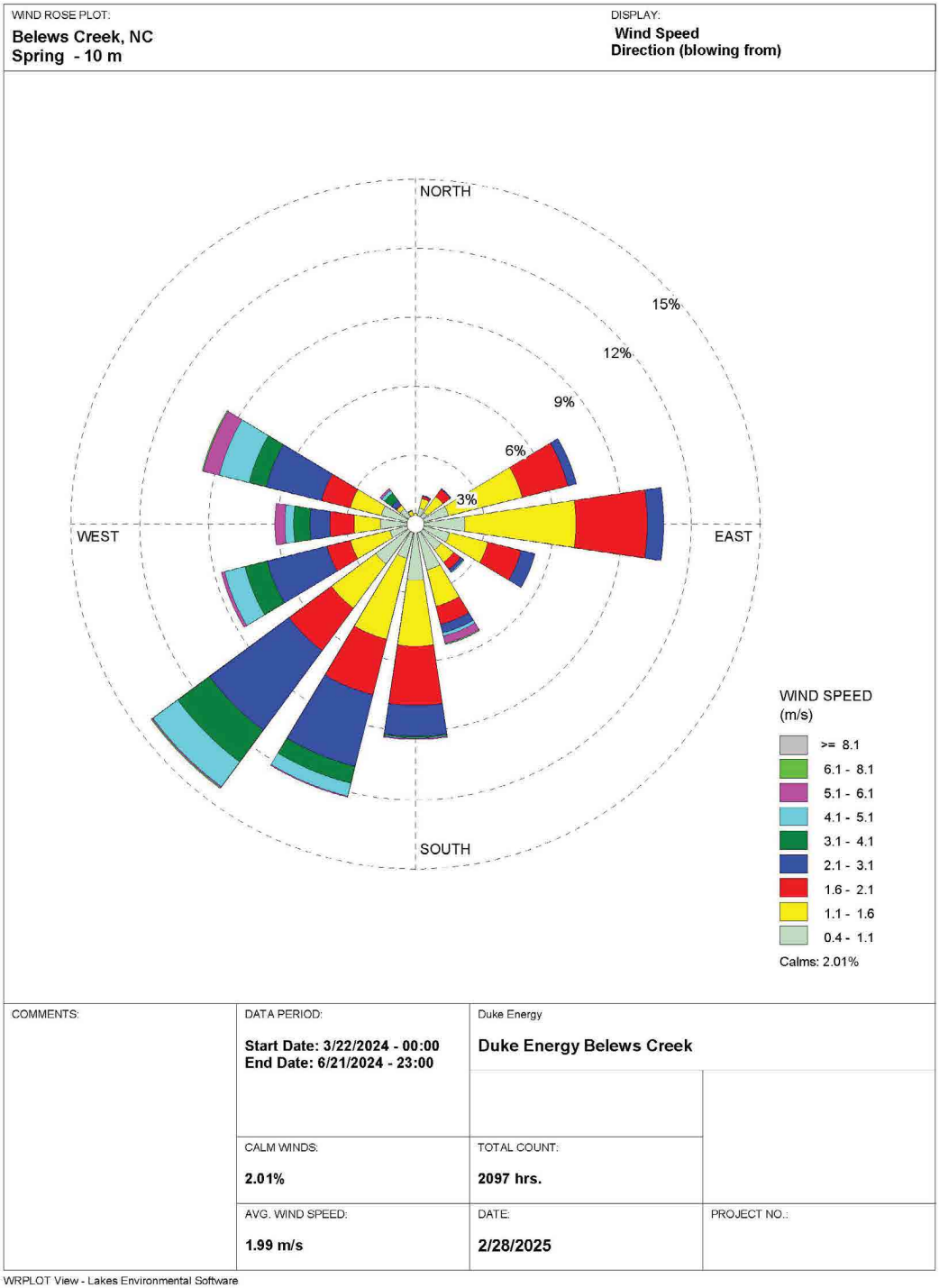


Figure 2.3-46
Wind Rose Project Site (10-Meters) Summer

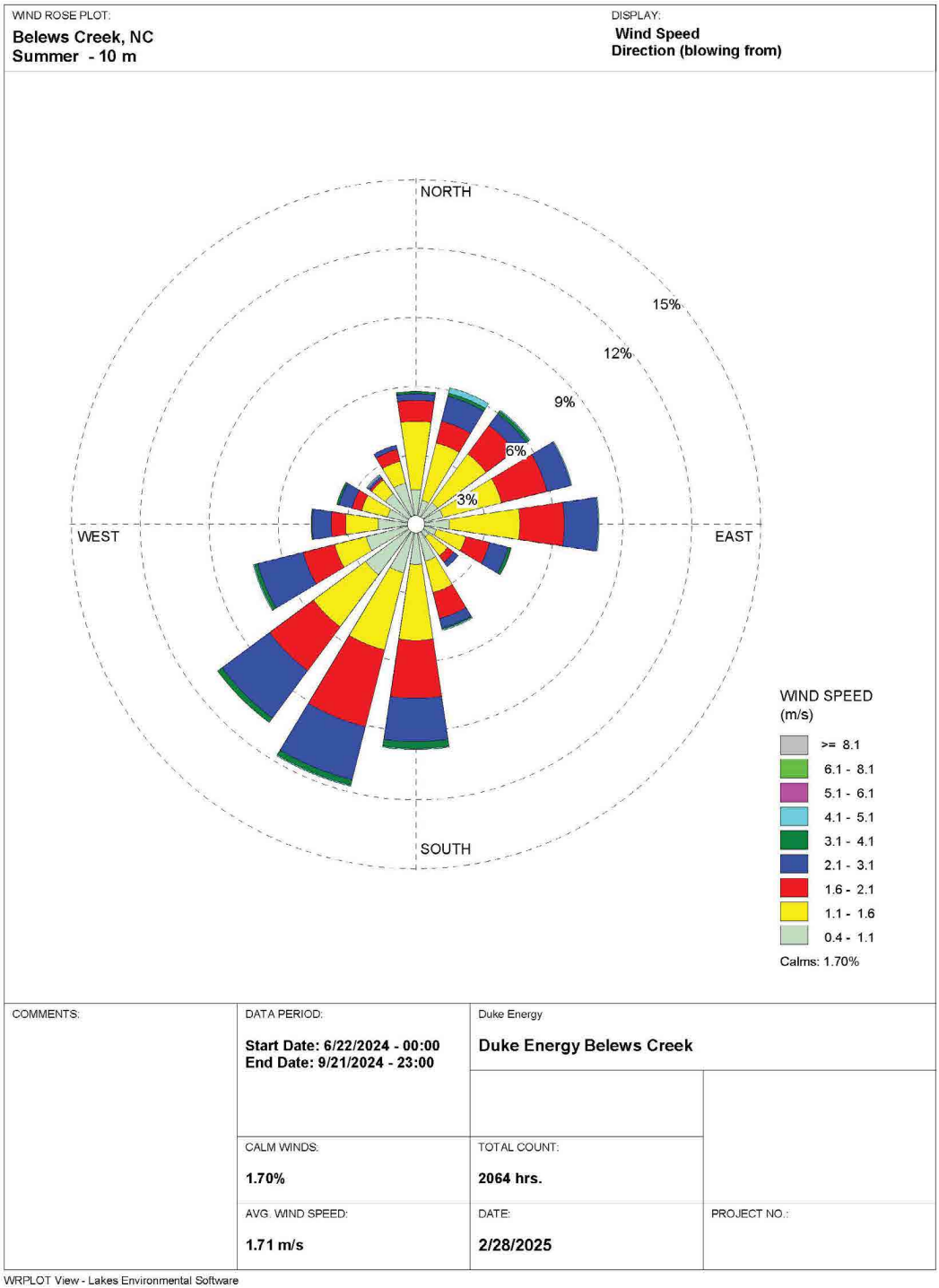


Figure 2.3-47
Wind Rose Project Site (10-Meters) Winter

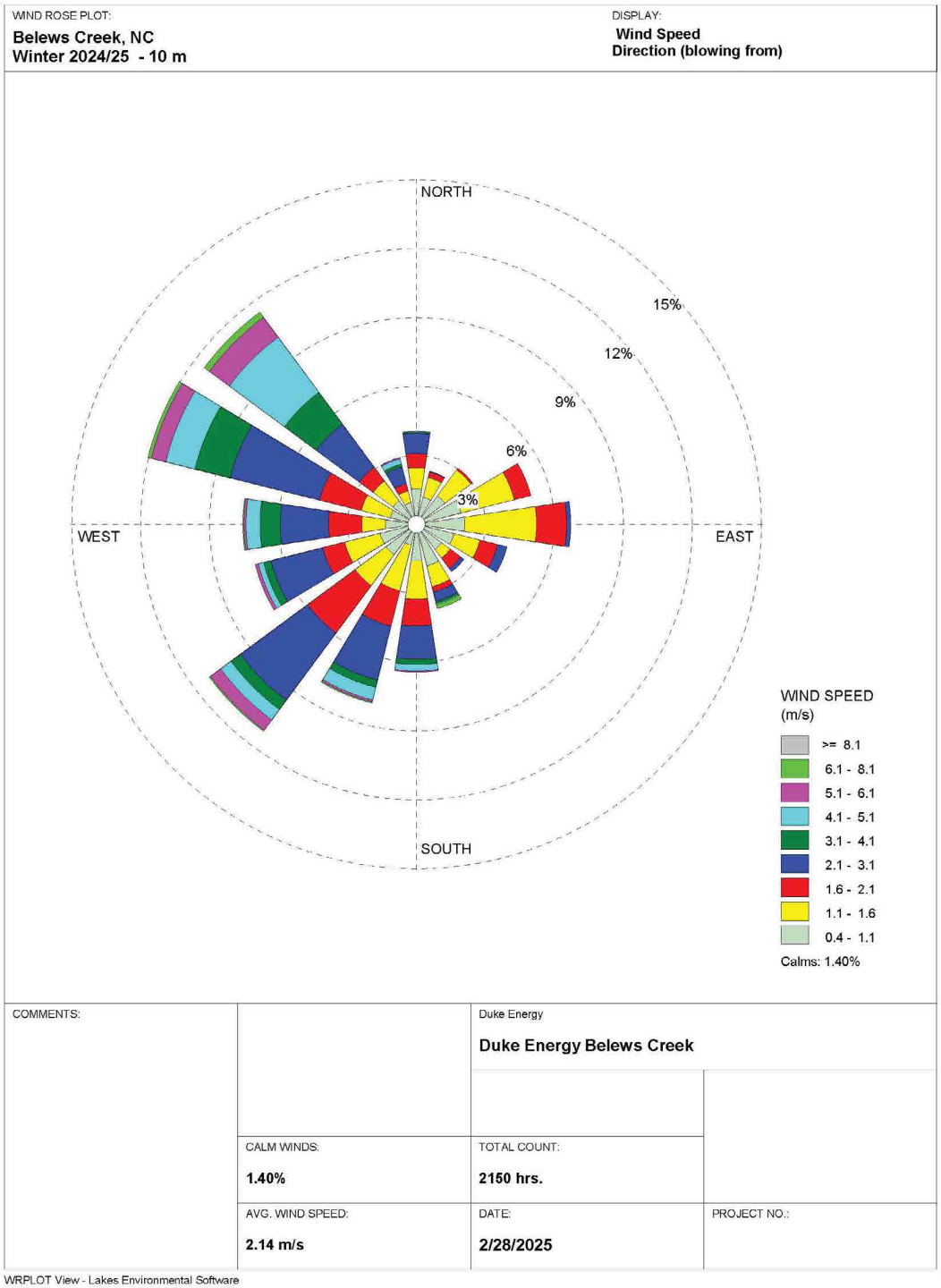


Figure 2.3-48
Wind Rose Project Site (60-Meters) Autumn

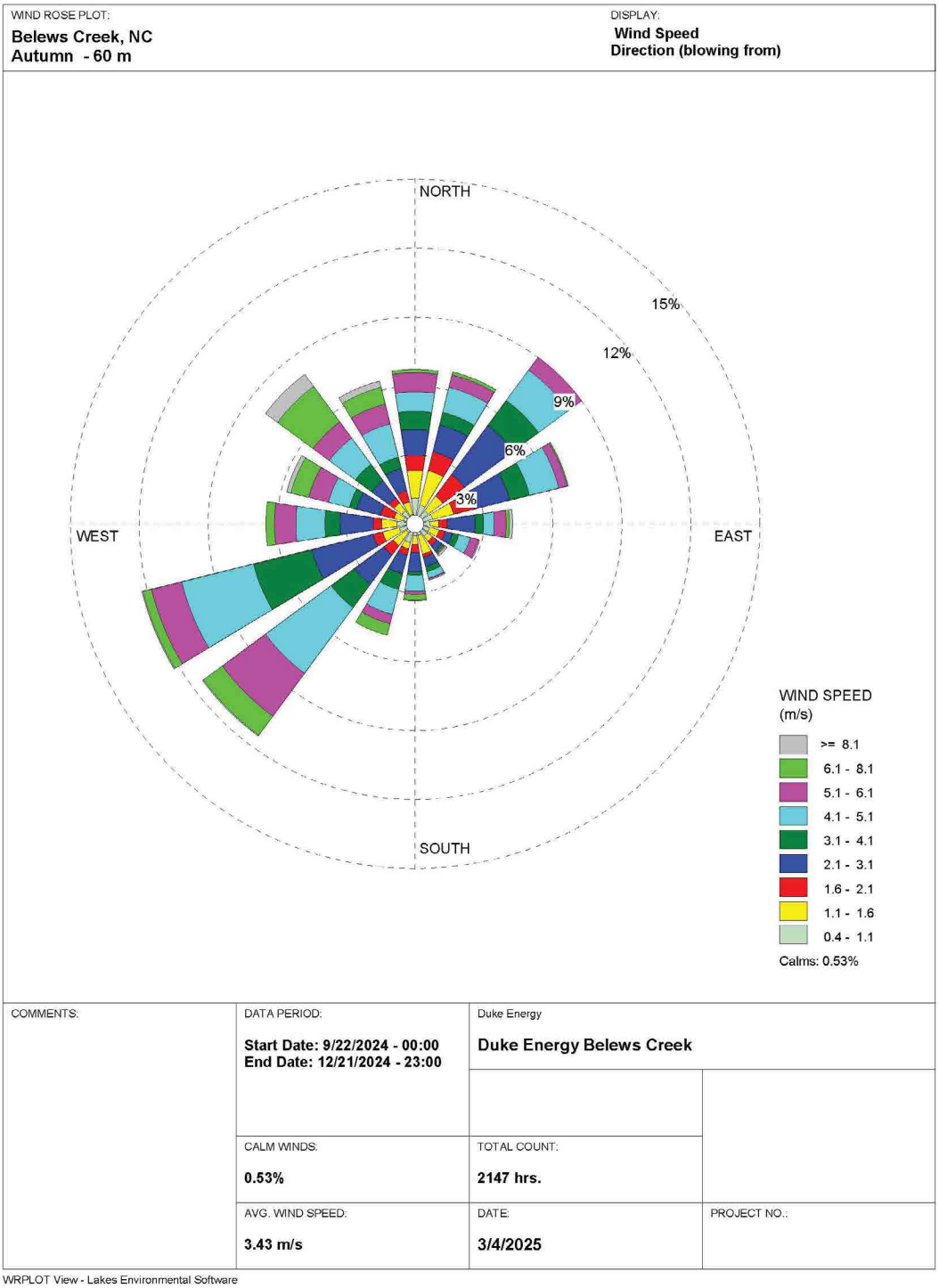


Figure 2.3-49
Wind Rose Project Site (60-Meters) Spring

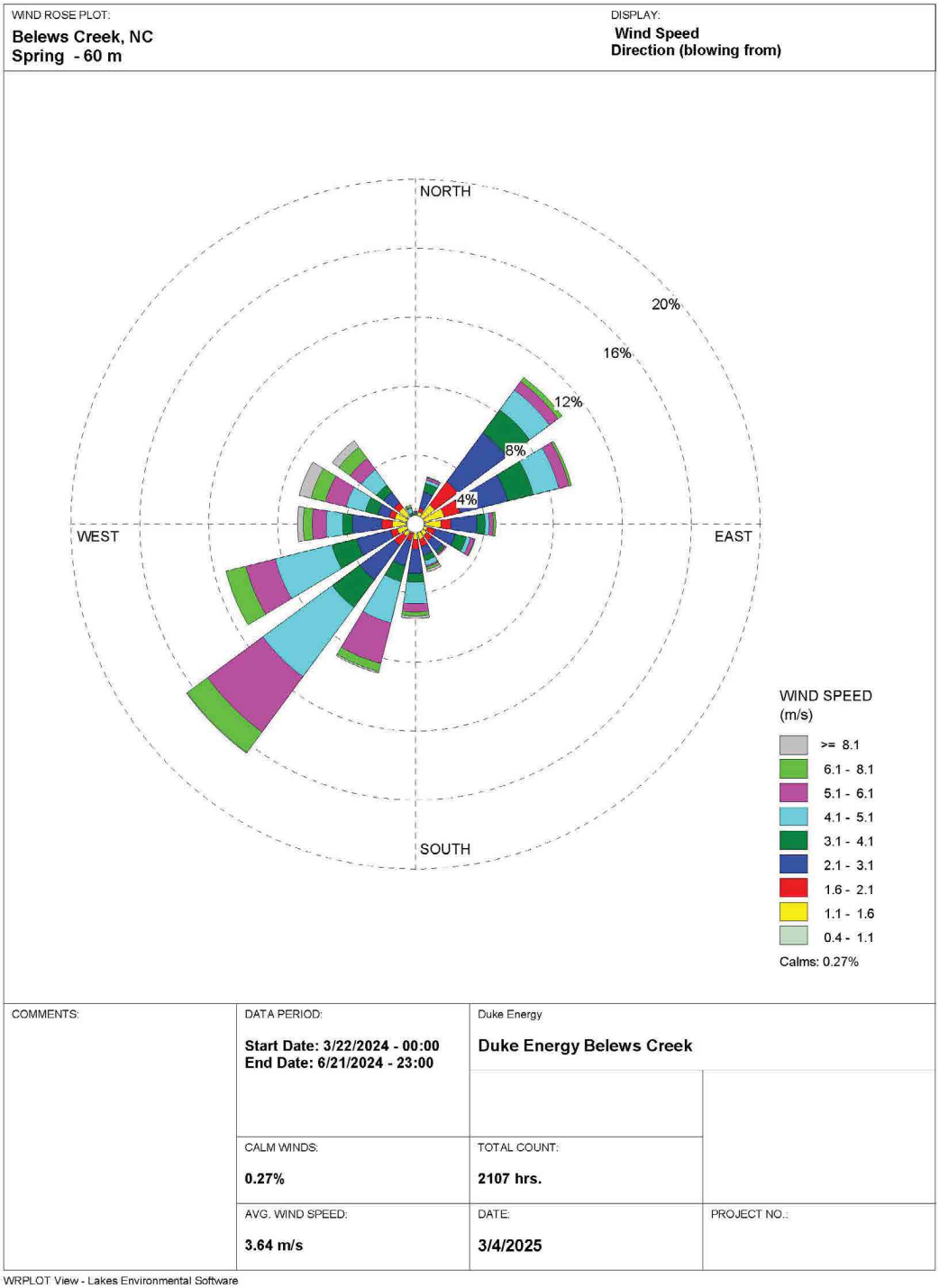


Figure 2.3-50
Wind Rose Project Site (60-Meters) Summer

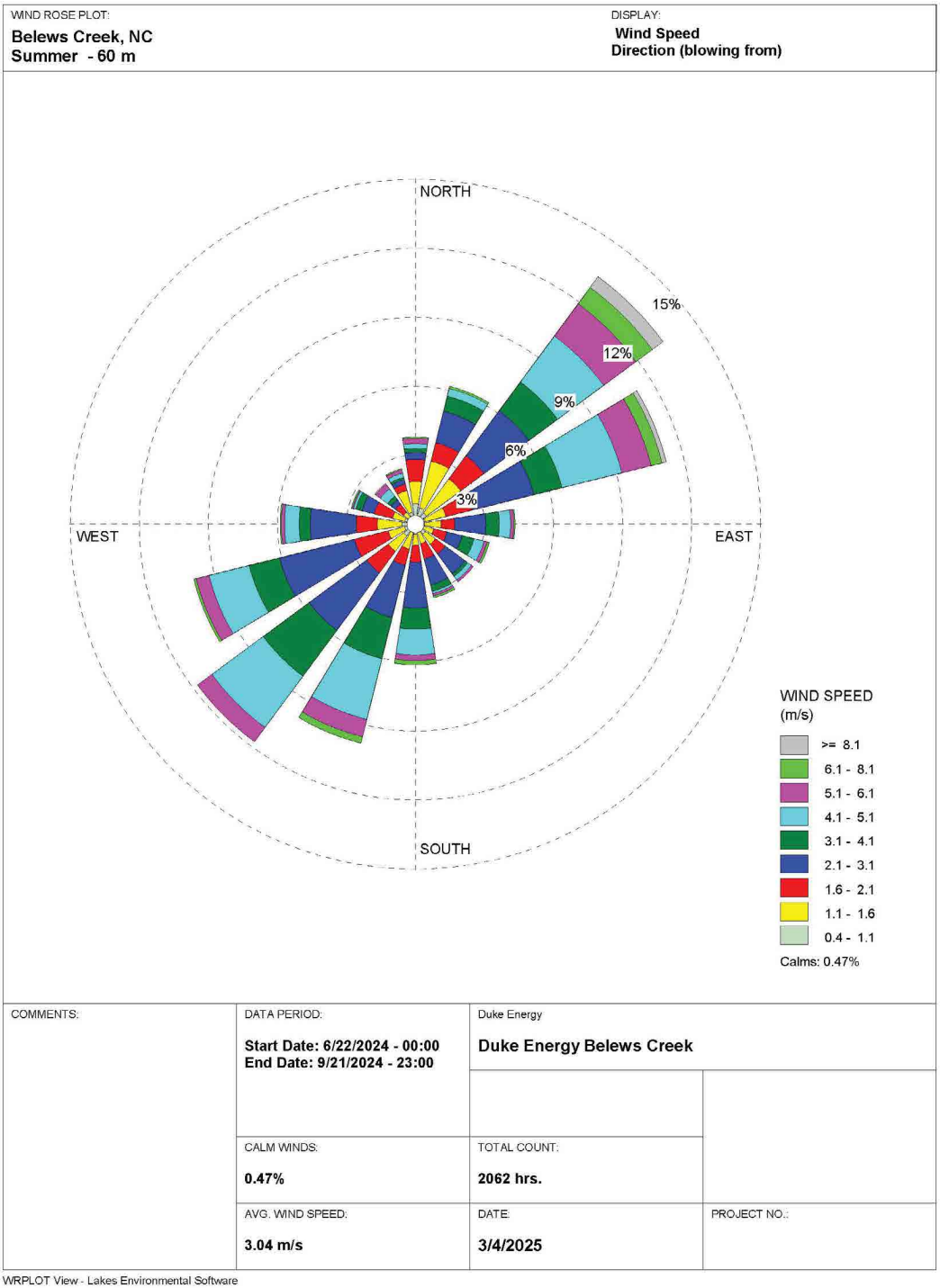


Figure 2.3-51
Wind Rose Project Site (60-Meters) Winter

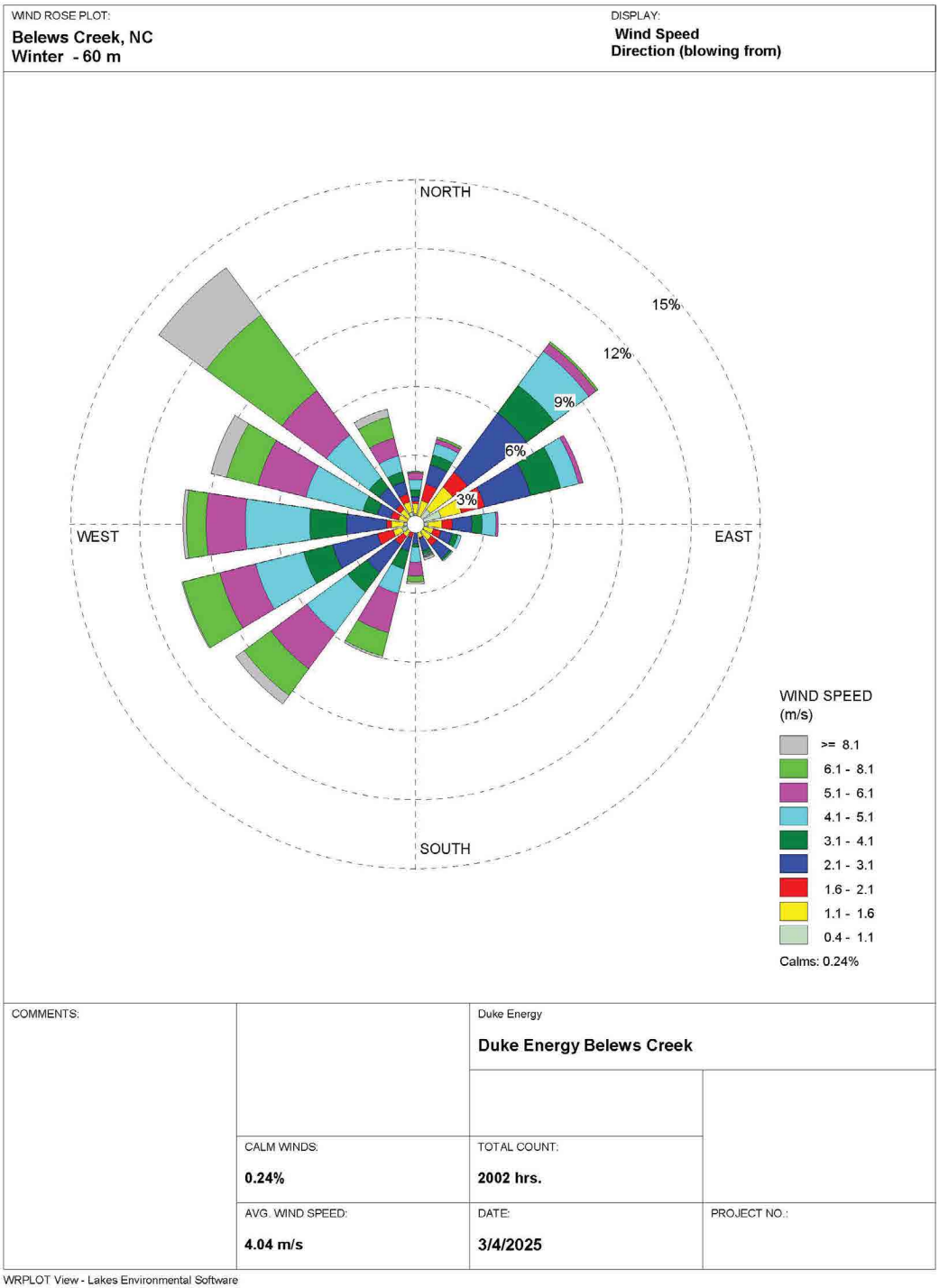


Figure 2.3-52
Precipitation Frequency Wind Rose Project Site (10-Meters) Annual All Data

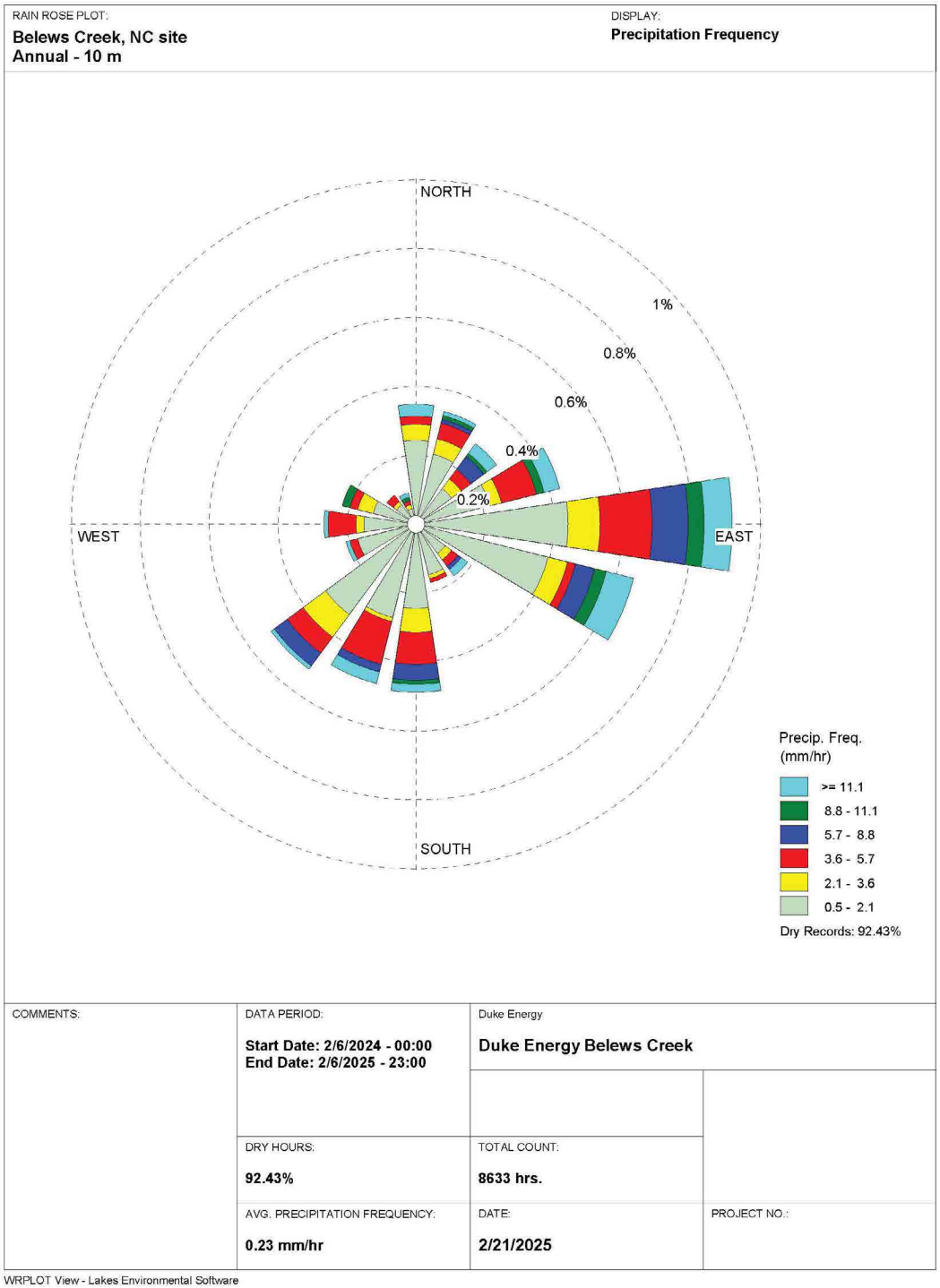


Figure 2.3-53
Precipitation Frequency Wind Rose Project Site (10-Meters) February 2024/2025

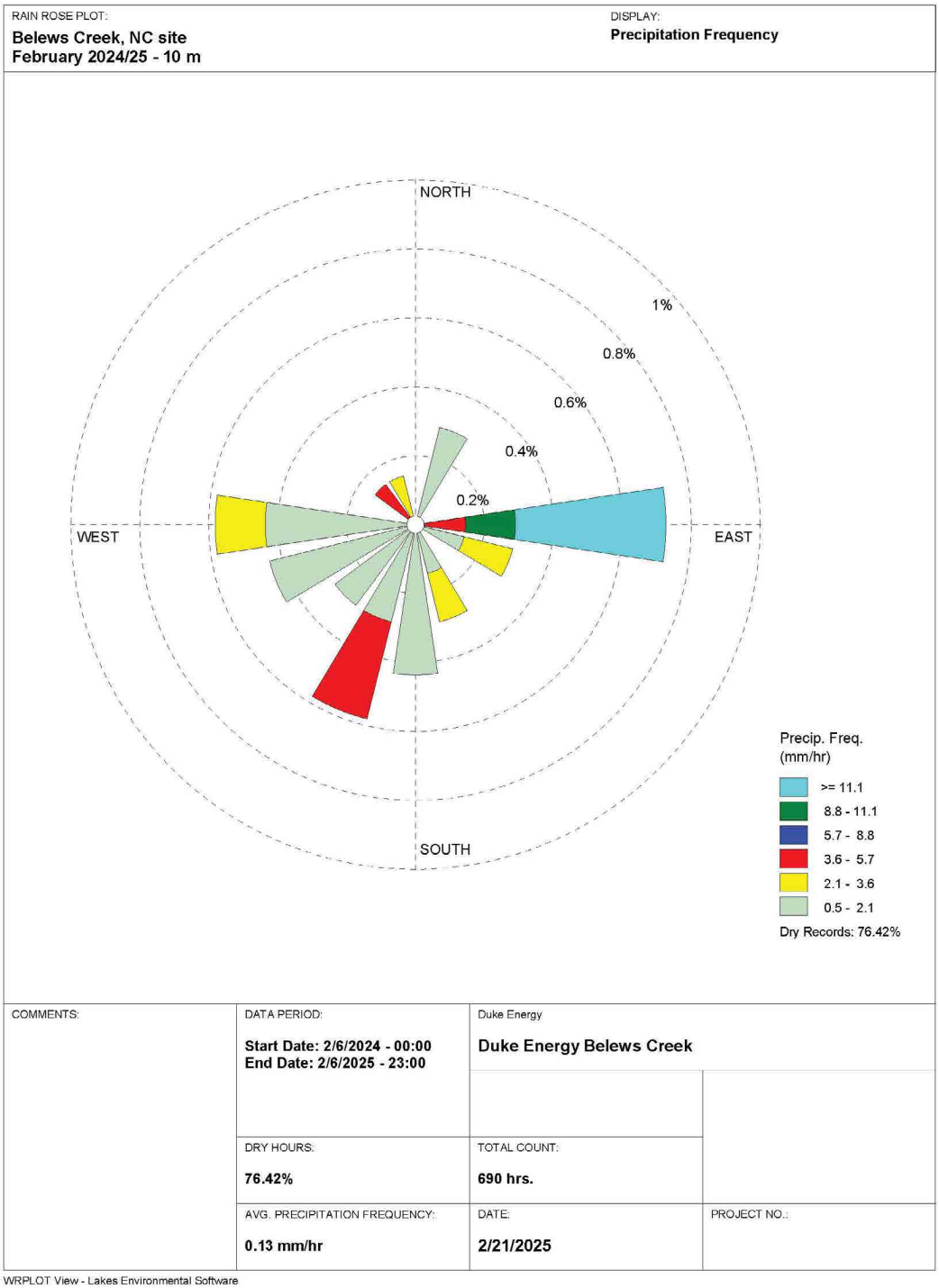


Figure 2.3-54
Precipitation Frequency Wind Rose Project Site (10-Meters) March 2024

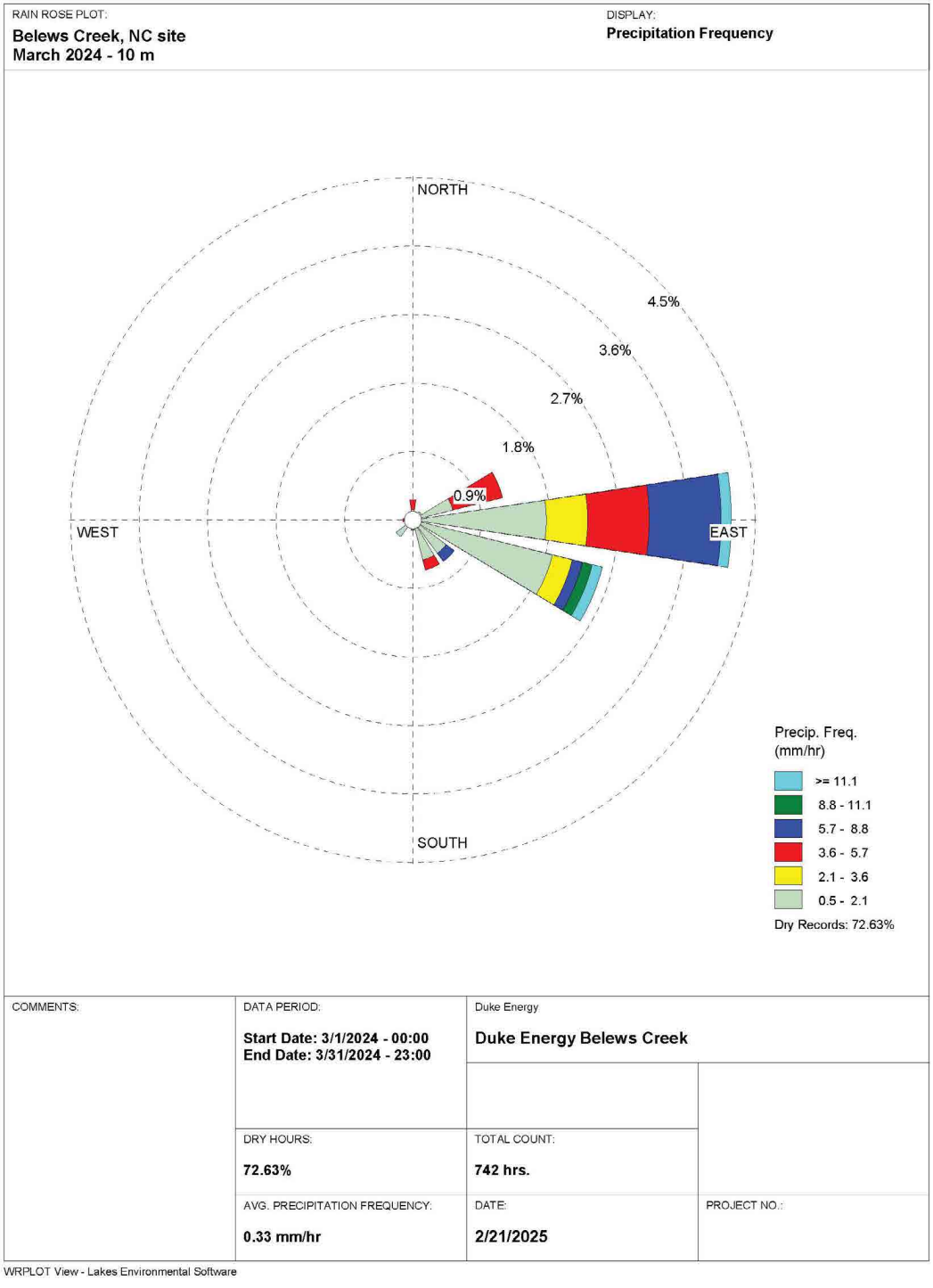


Figure 2.3-55
Precipitation Frequency Wind Rose Project Site (10-Meters) April 2024

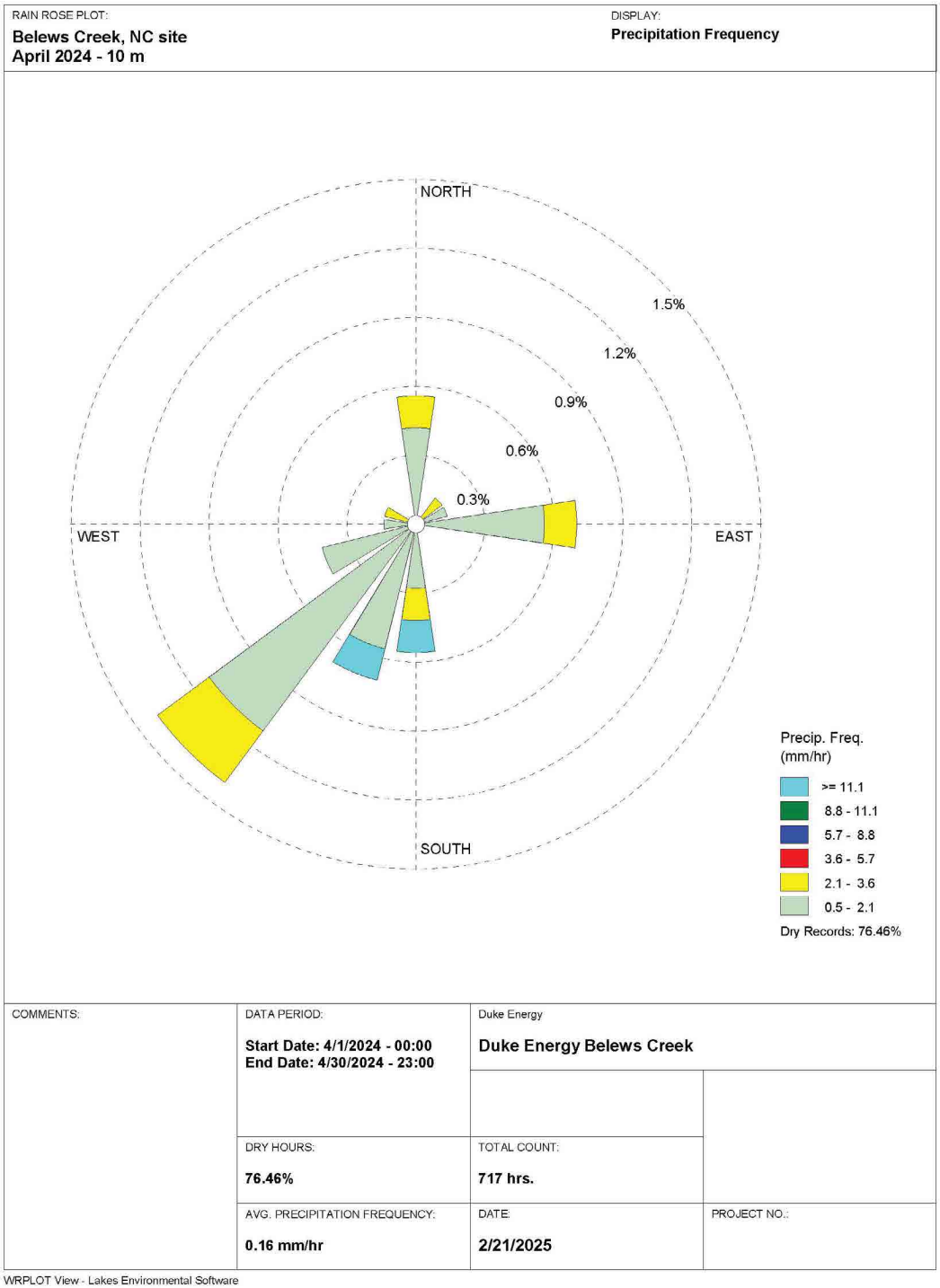


Figure 2.3-56
Precipitation Frequency Wind Rose Project Site (10-Meters) May 2024

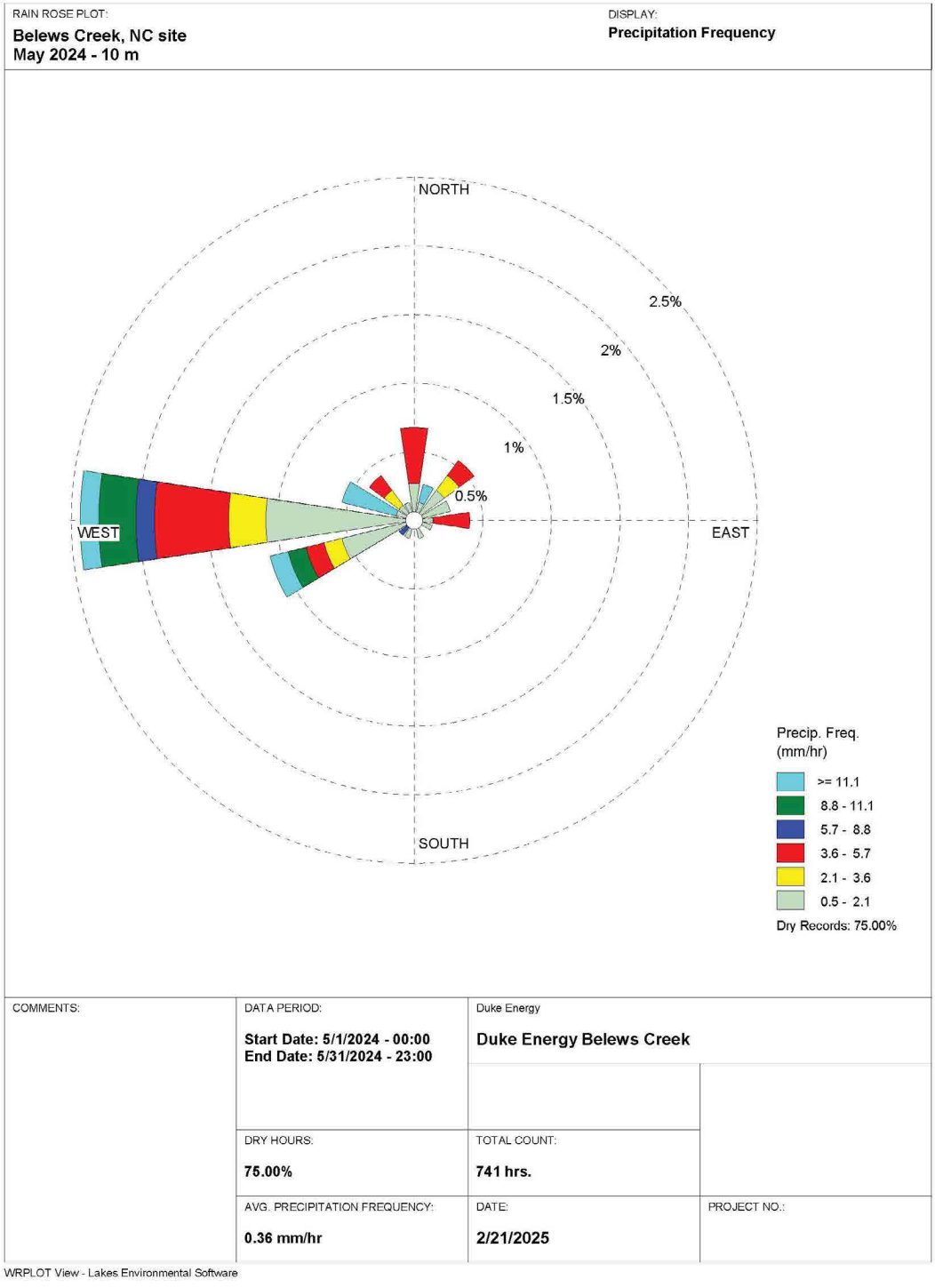


Figure 2.3-57
Precipitation Frequency Wind Rose Project Site (10-Meters) June 2024

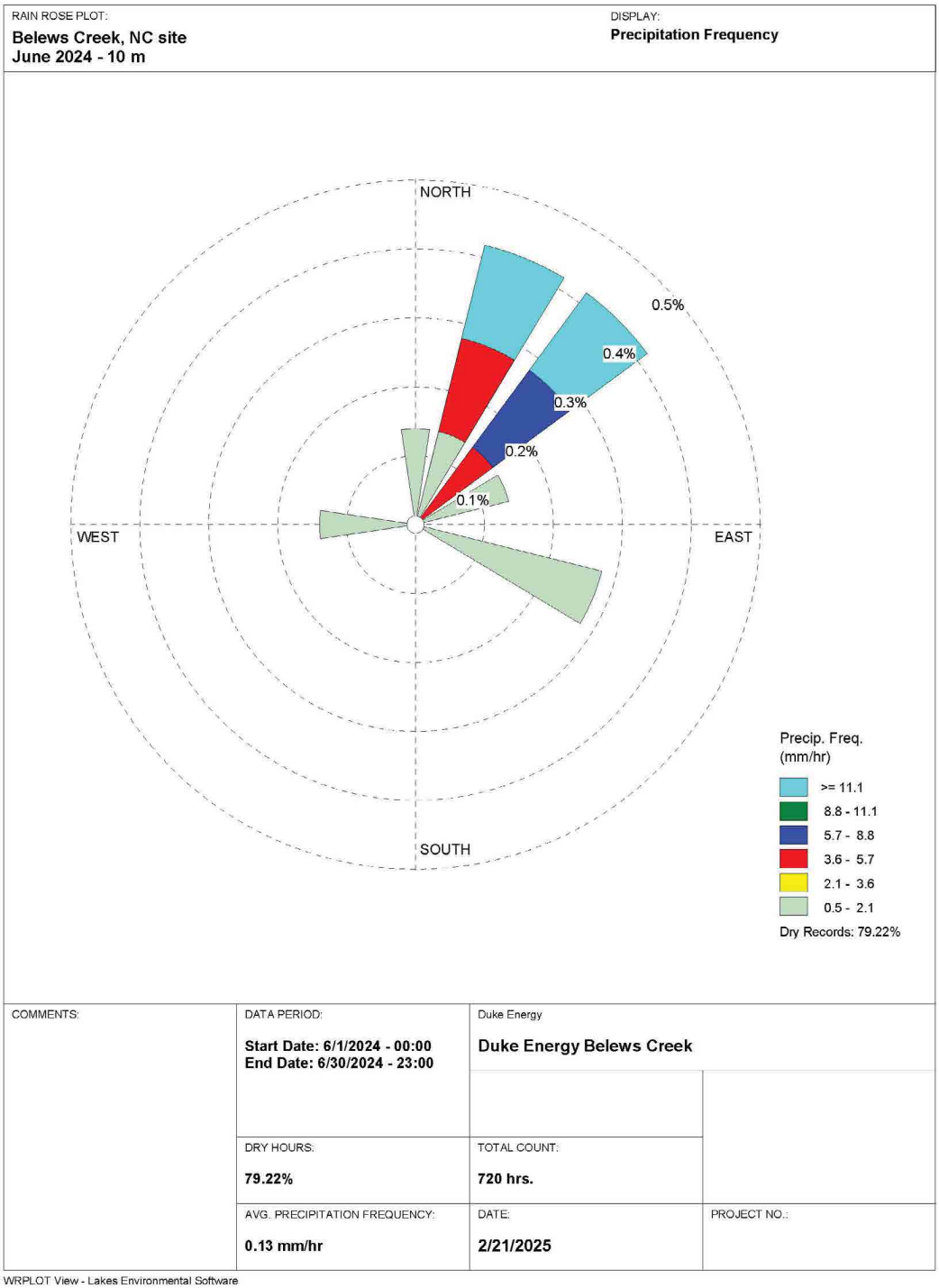


Figure 2.3-58
Precipitation Frequency Wind Rose Project Site (10-Meters) July 2024

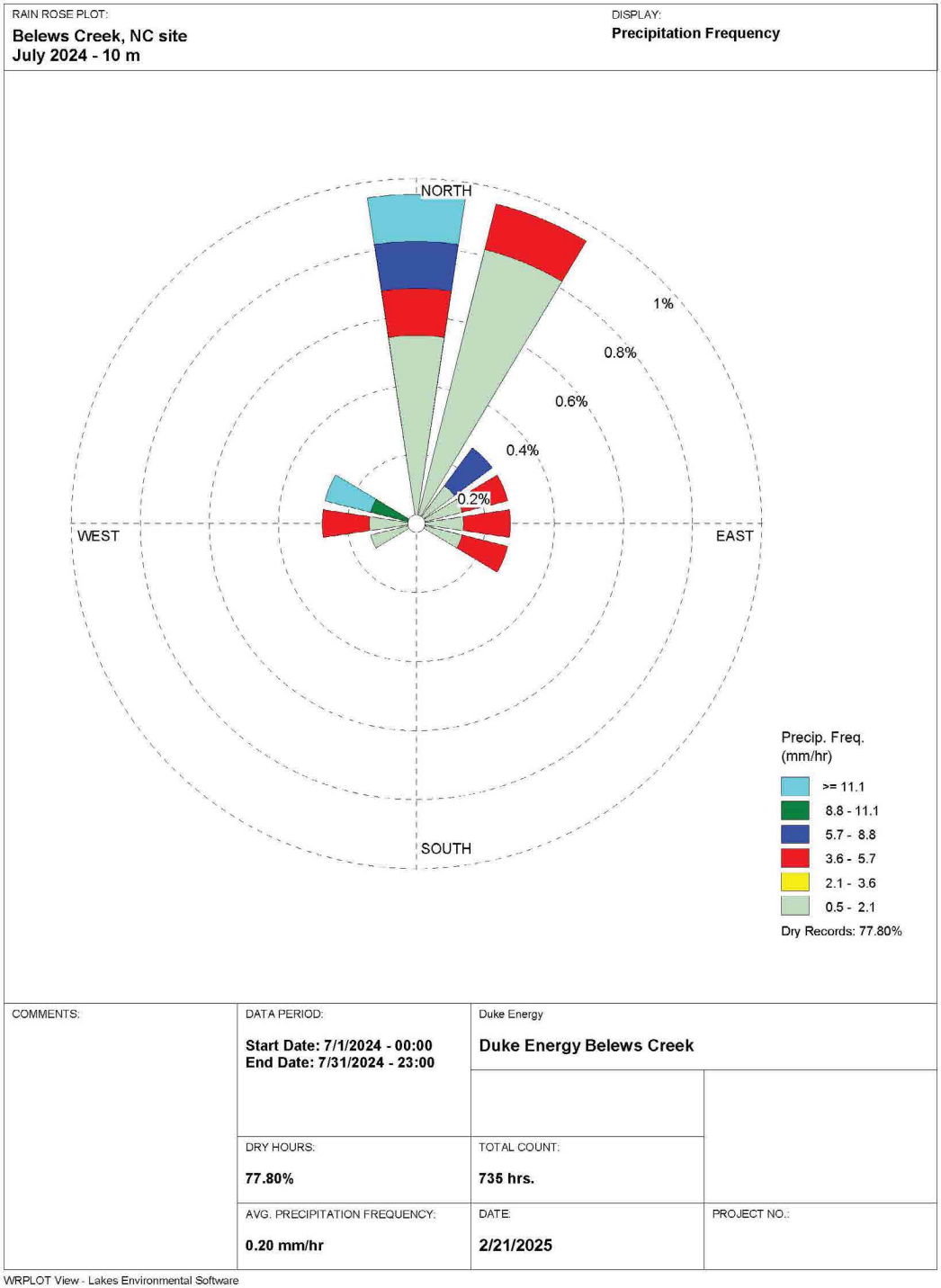


Figure 2.3-59
Precipitation Frequency Wind Rose Project Site (10-Meters) August 2024

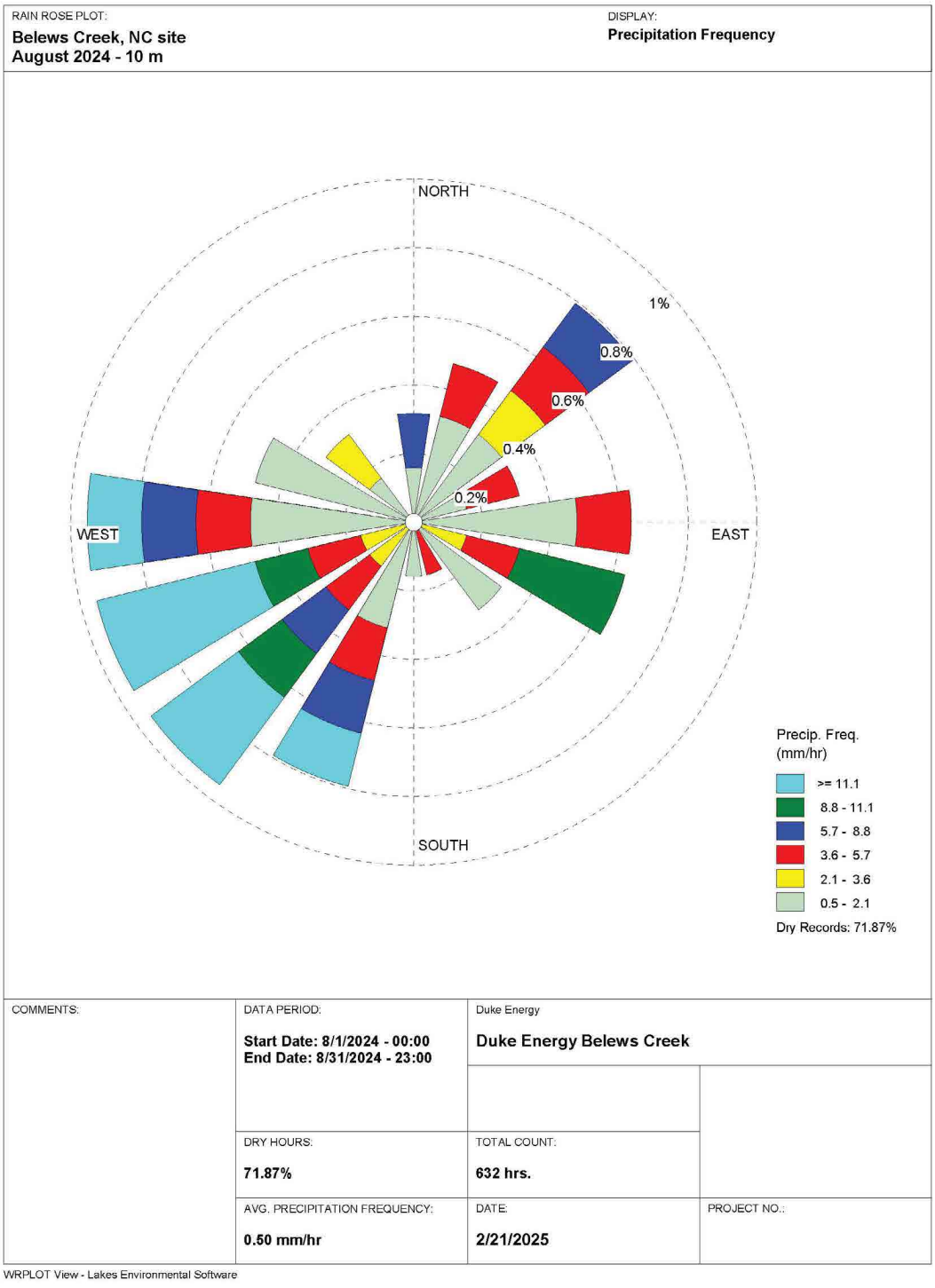


Figure 2.3-60
Precipitation Frequency Wind Rose Project Site (10-Meters) September 2024

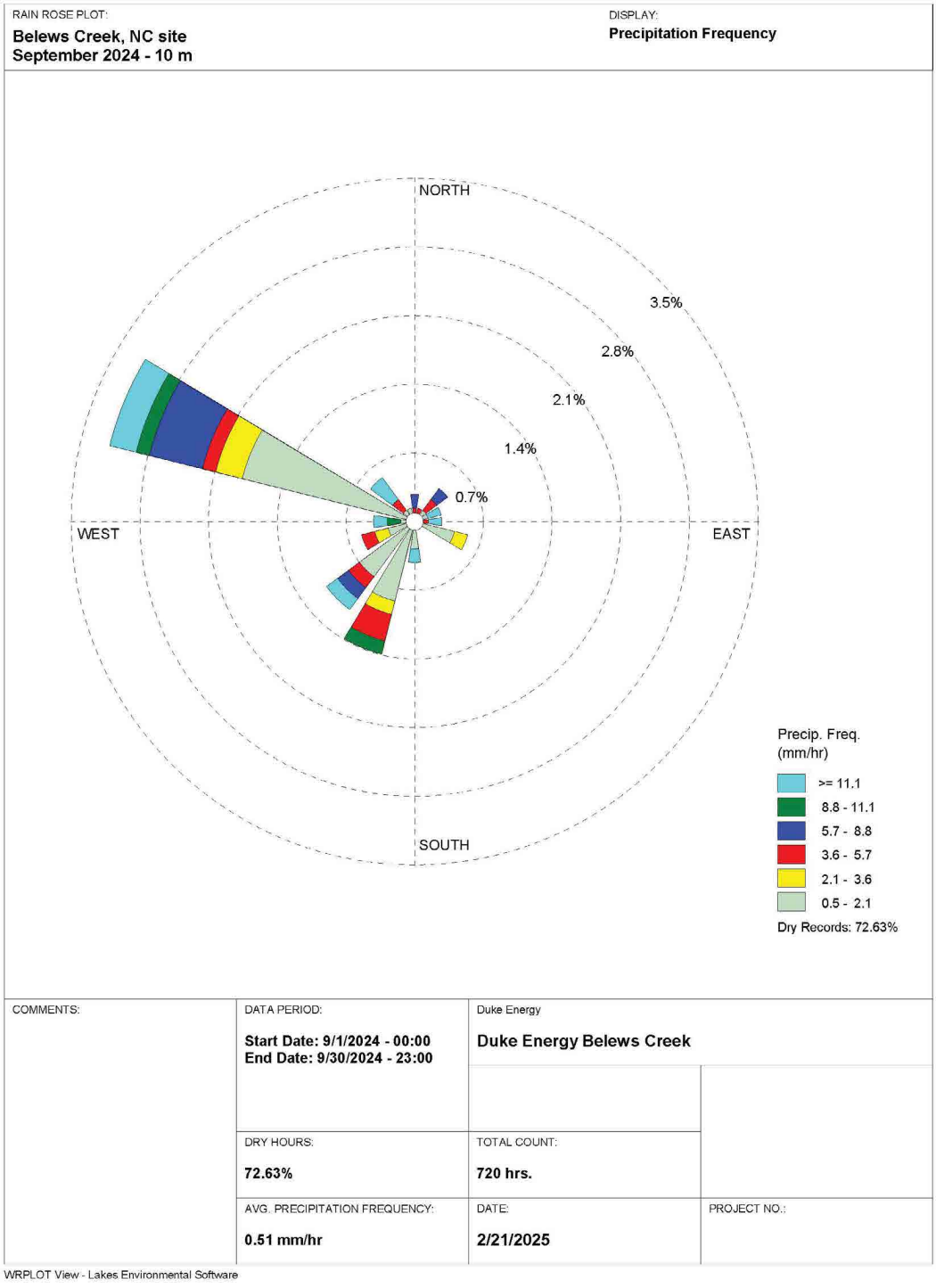


Figure 2.3-61
Precipitation Frequency Wind Rose Project Site (10-Meters) October 2024

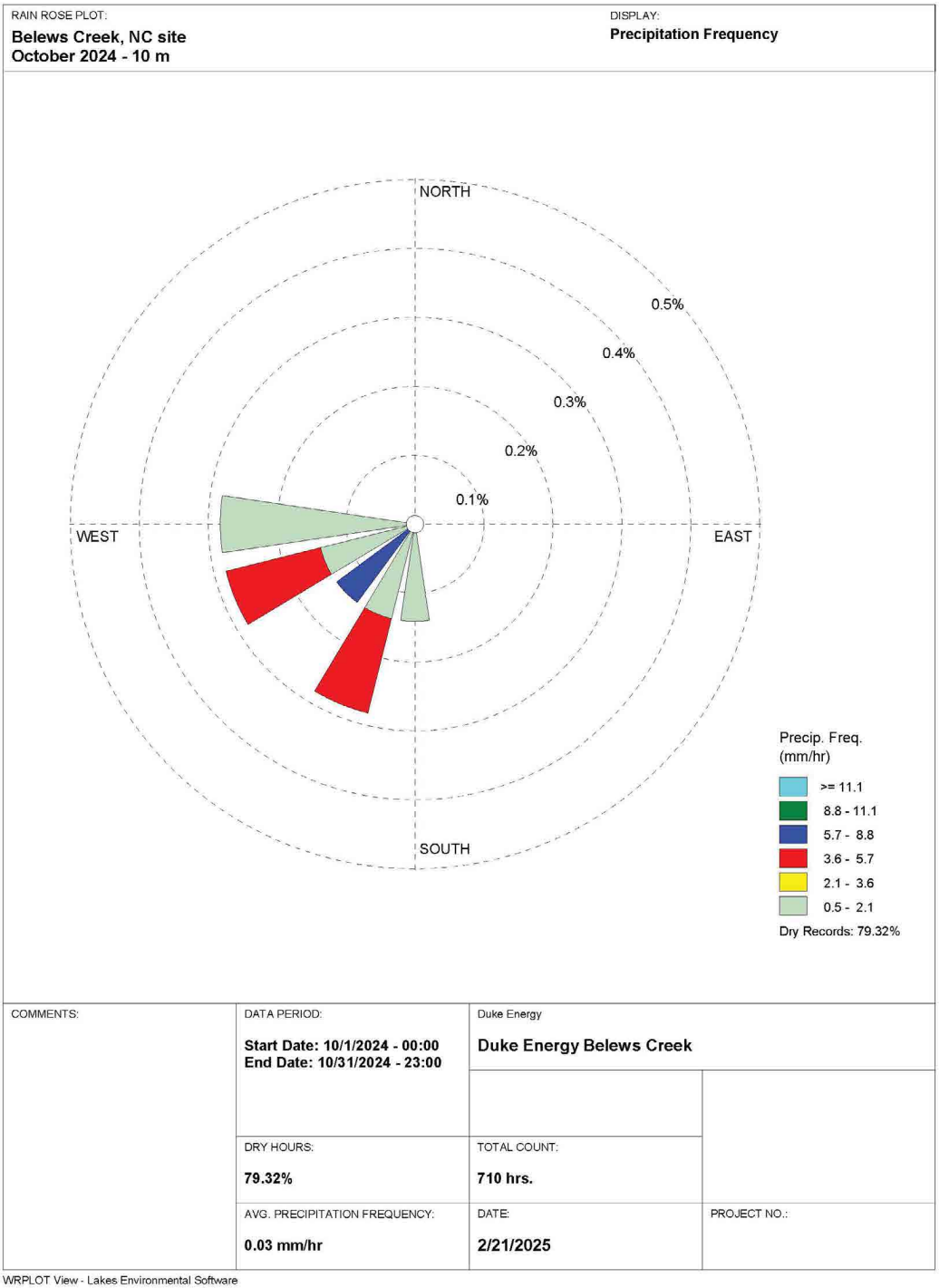


Figure 2.3-62
Precipitation Frequency Wind Rose Project Site (10-Meters) November 2024

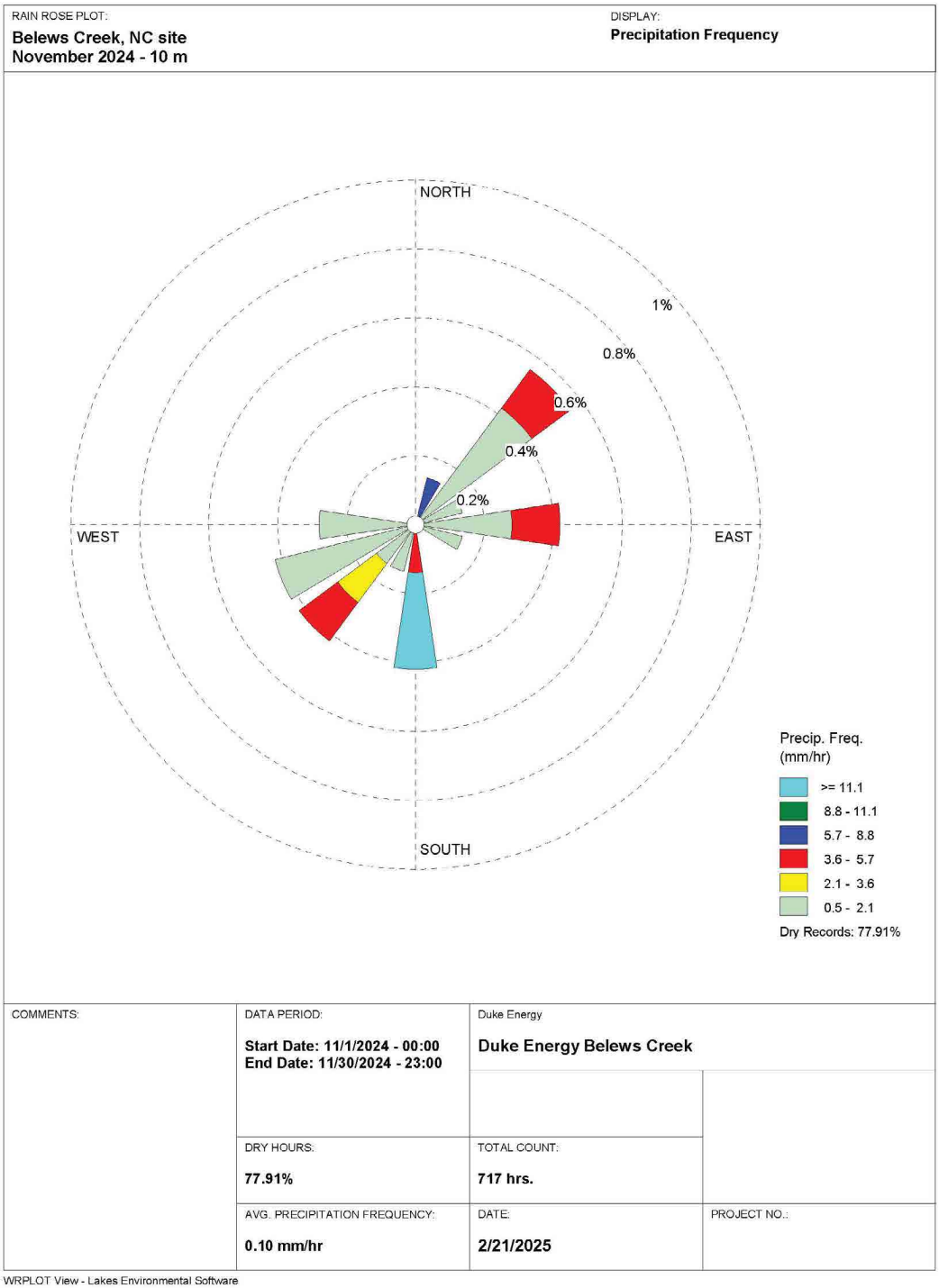


Figure 2.3-63
Precipitation Frequency Wind Rose Project Site (10-Meters) December 2024

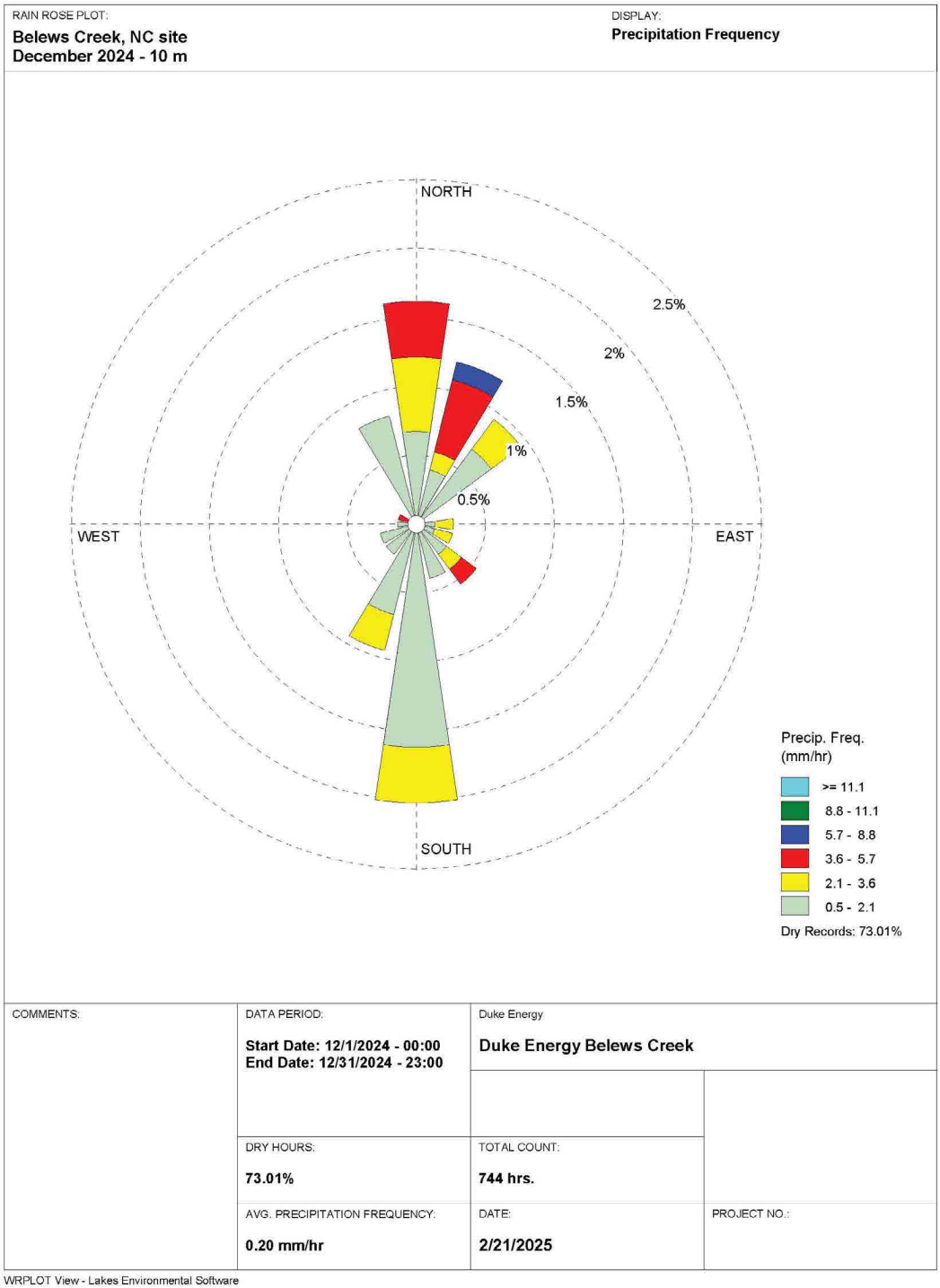


Figure 2.3-64
Precipitation Frequency Wind Rose Project Site (10-Meters) January 2025

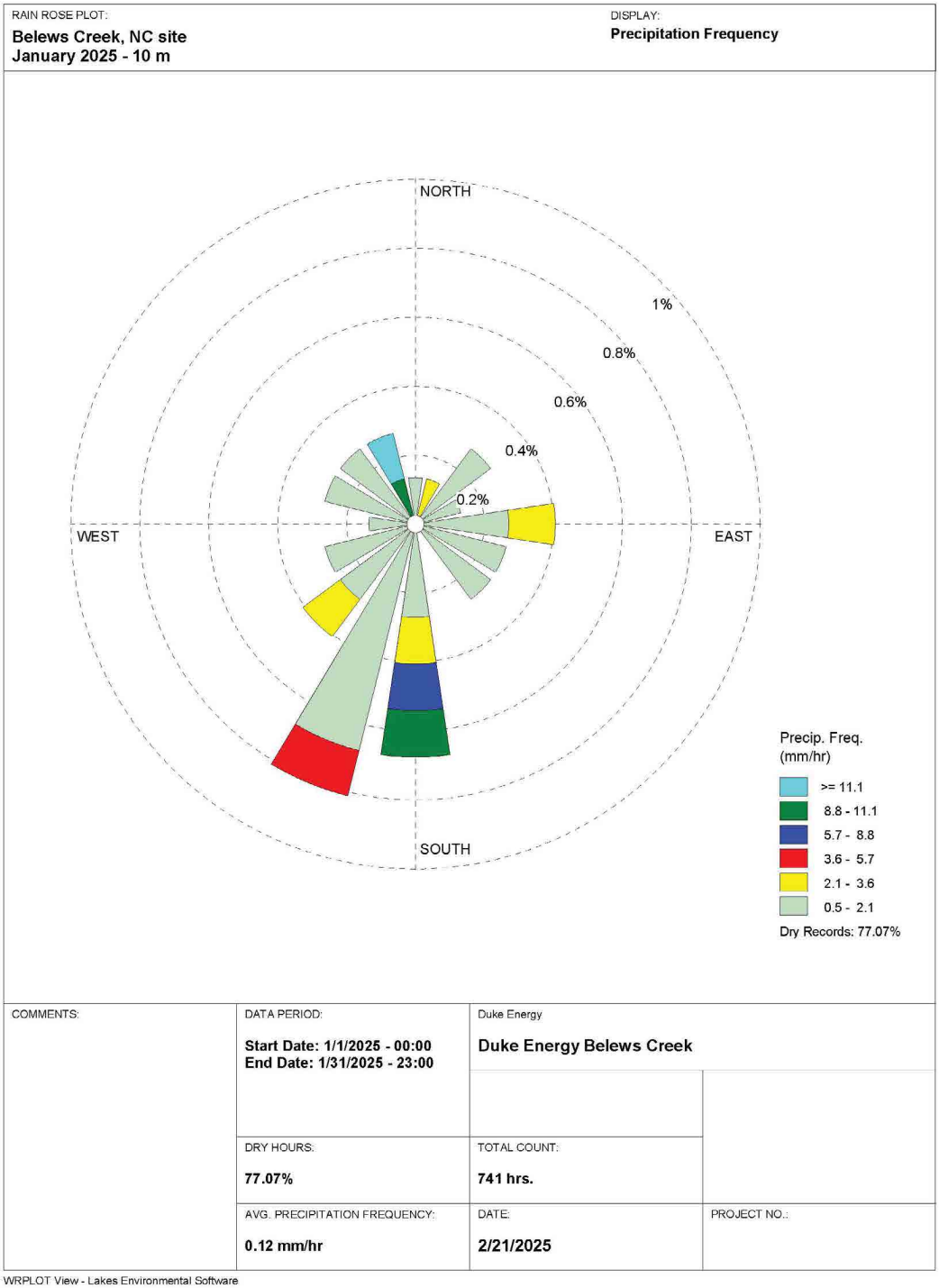


Figure 2.3-65
Precipitation Frequency by Season (10-Meters) Autumn

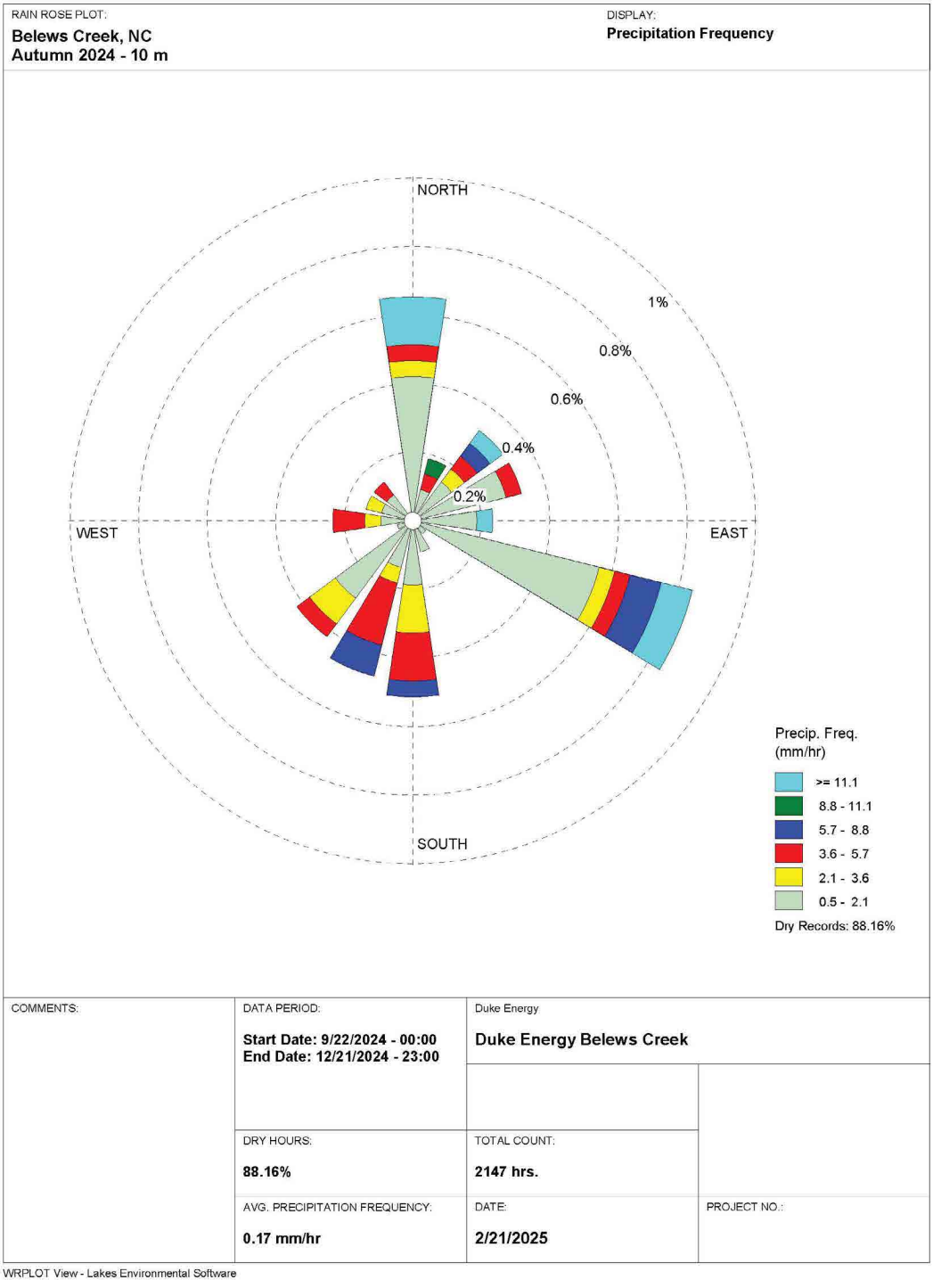


Figure 2.3-66
Precipitation Frequency by Season (10-Meters) Spring

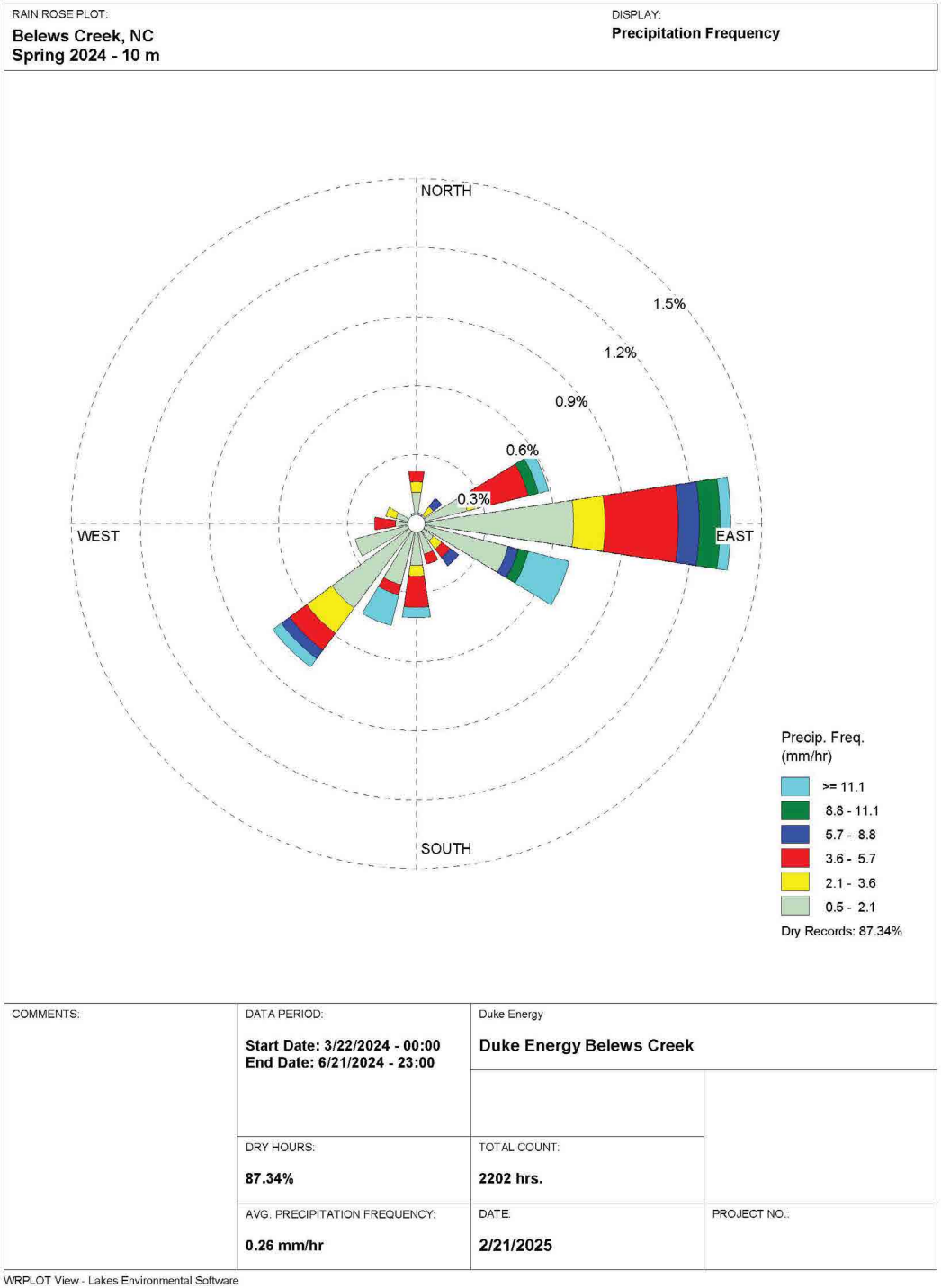


Figure 2.3-67
Precipitation Frequency by Season (10-Meters) Summer

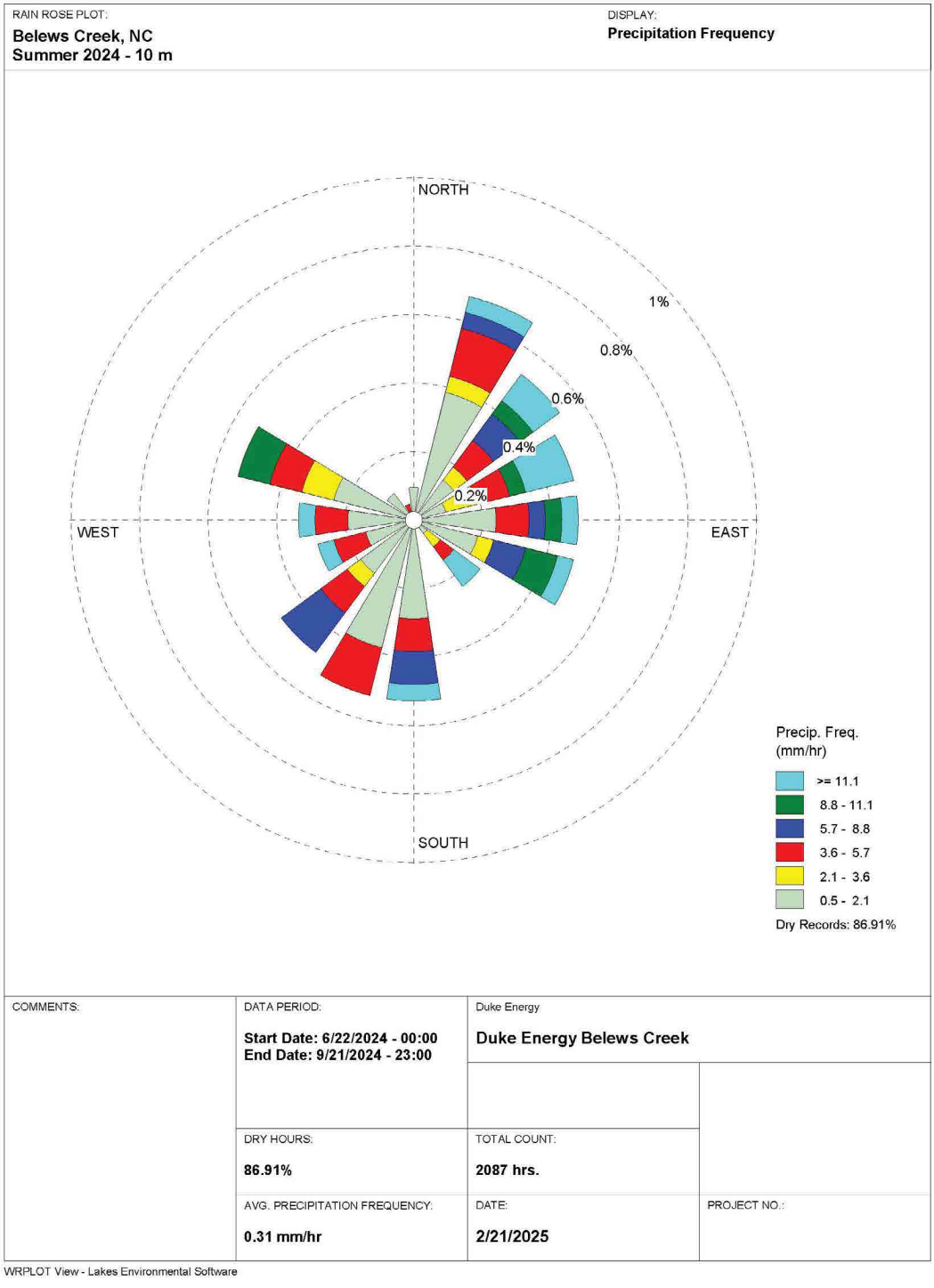


Figure 2.3-68
Precipitation Frequency by Season (10-Meters) Winter

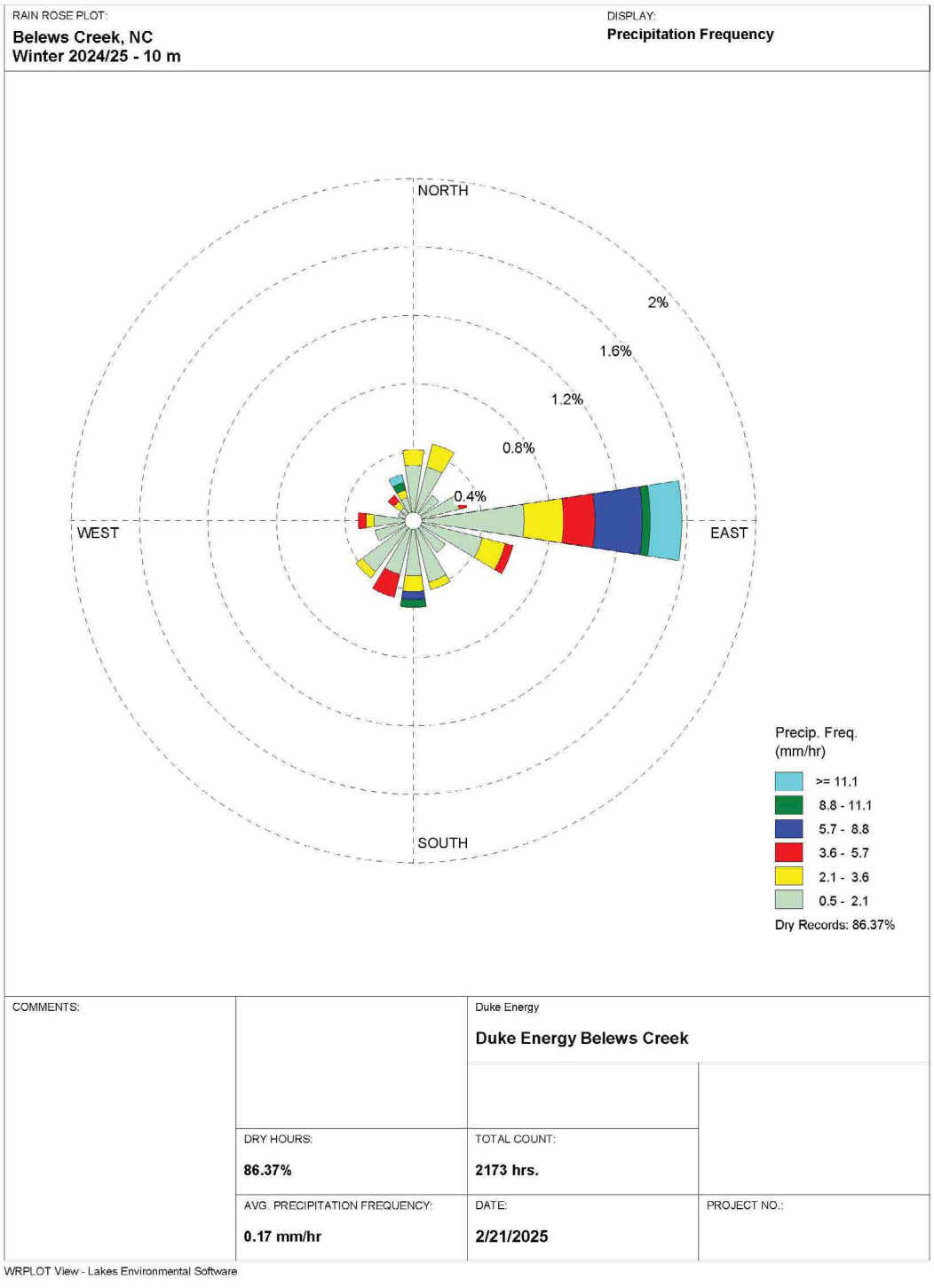


Figure 2.3-69
Maximum Modeled Seasonal Plume Salt Deposition (Summer, kg/km^2/mo)

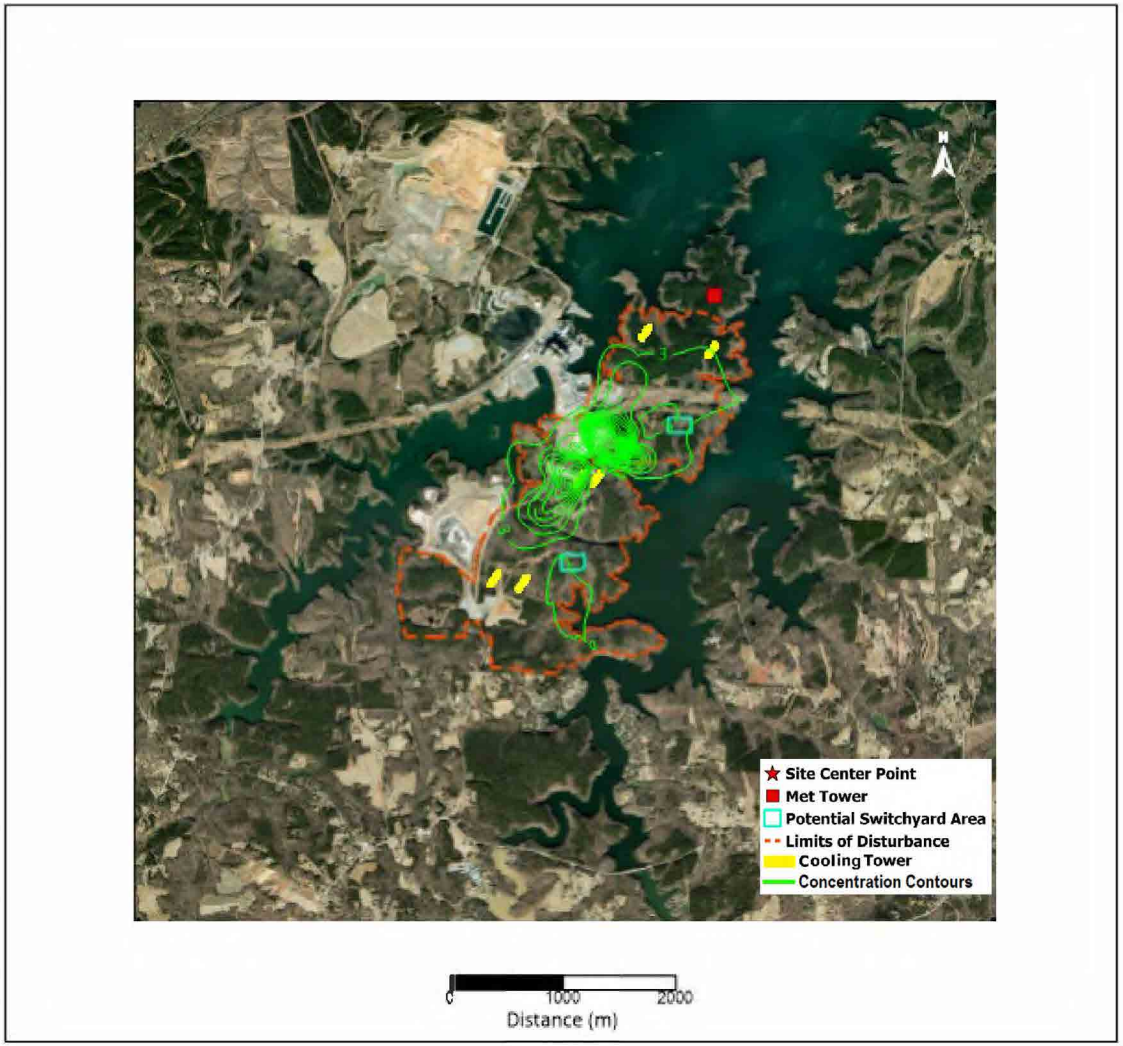


Figure 2.3-70
Modeled Annual Plume Salt Deposition (kg/km^2/mo)

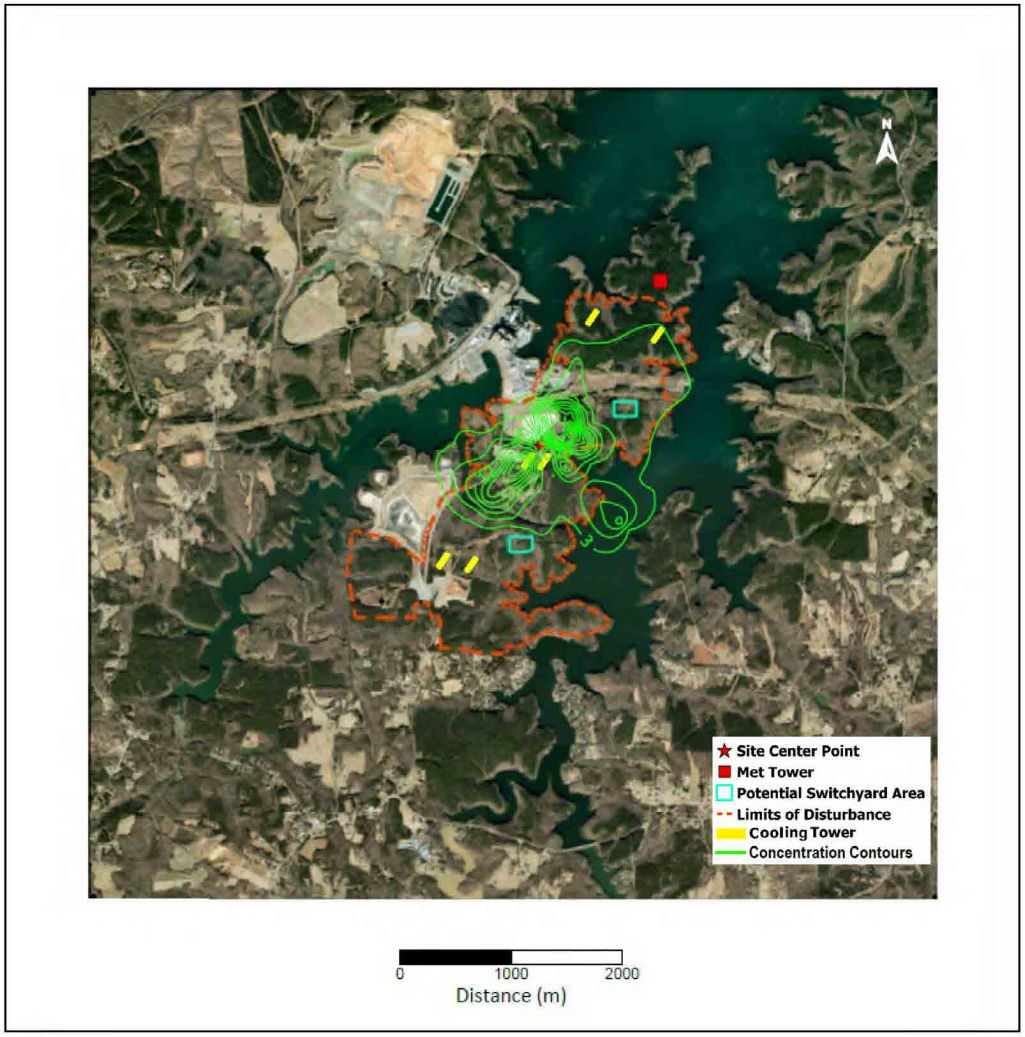


Figure 2.3-71
Belews Creek North Plant Complex Site Boundary Distances

Figure 2.3-72
Belews Creek Middle Plant Complex Site Boundary Distances

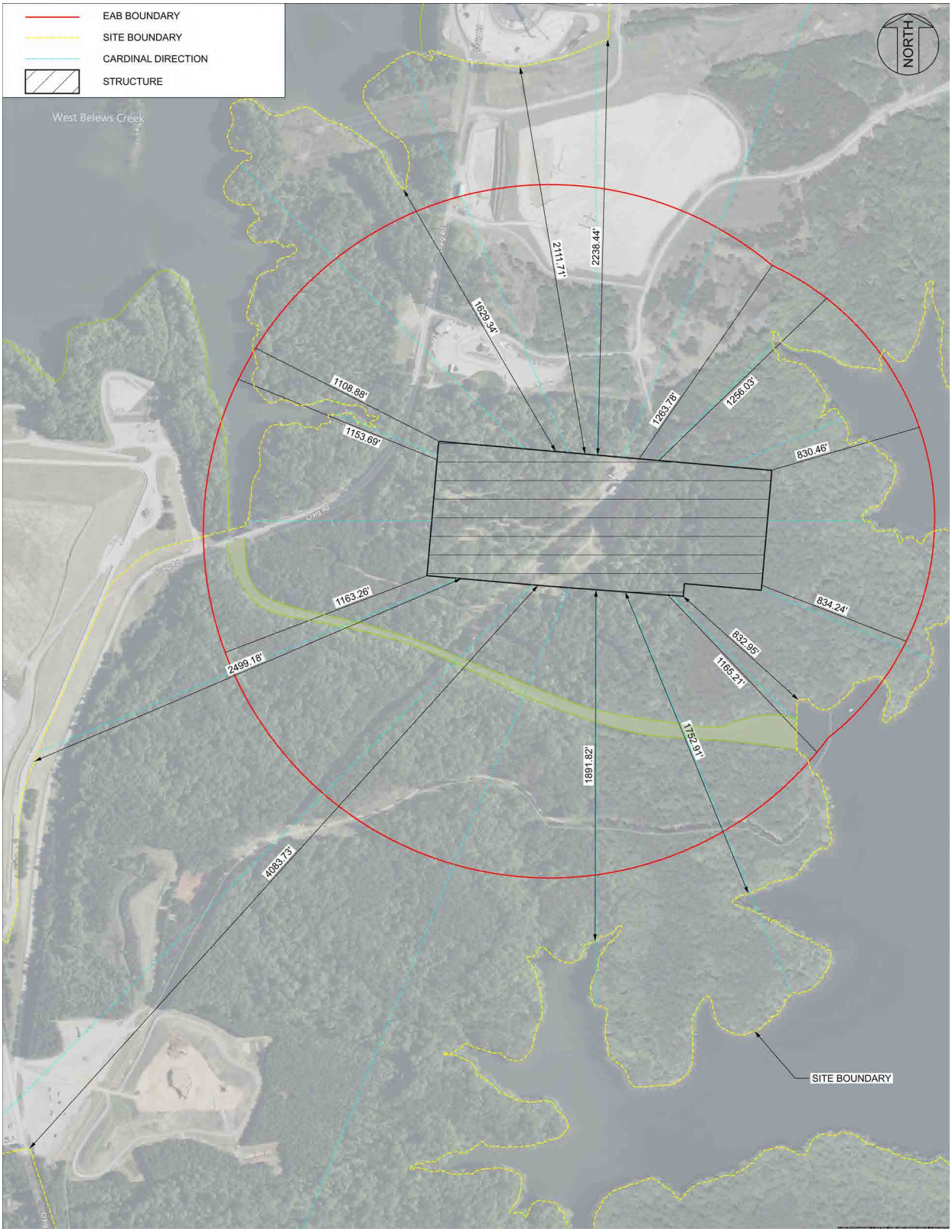


Figure 2.3-73
Belews Creek South Plant Complex Site Boundary Distances

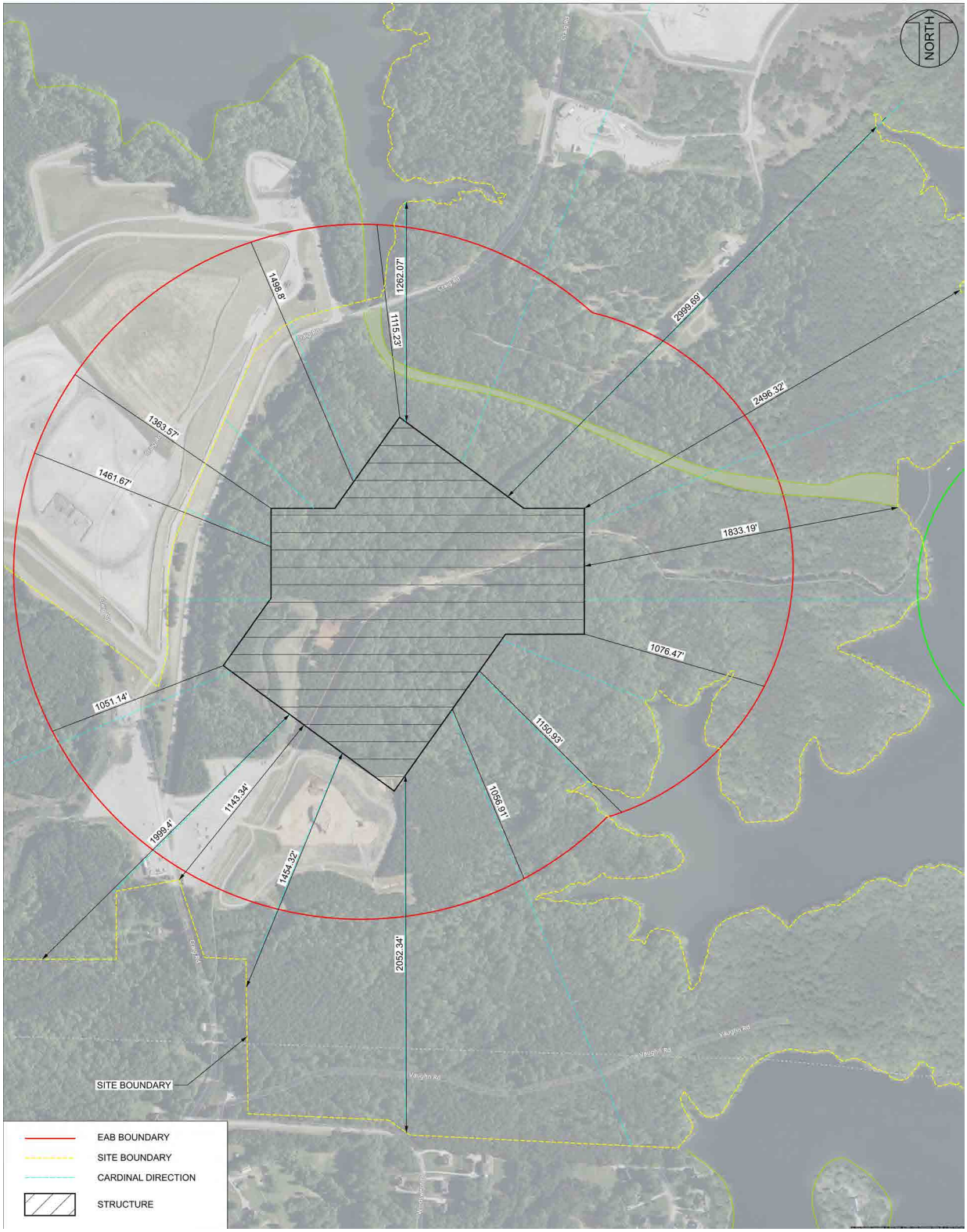


Figure 2.4-1
Project Site Location

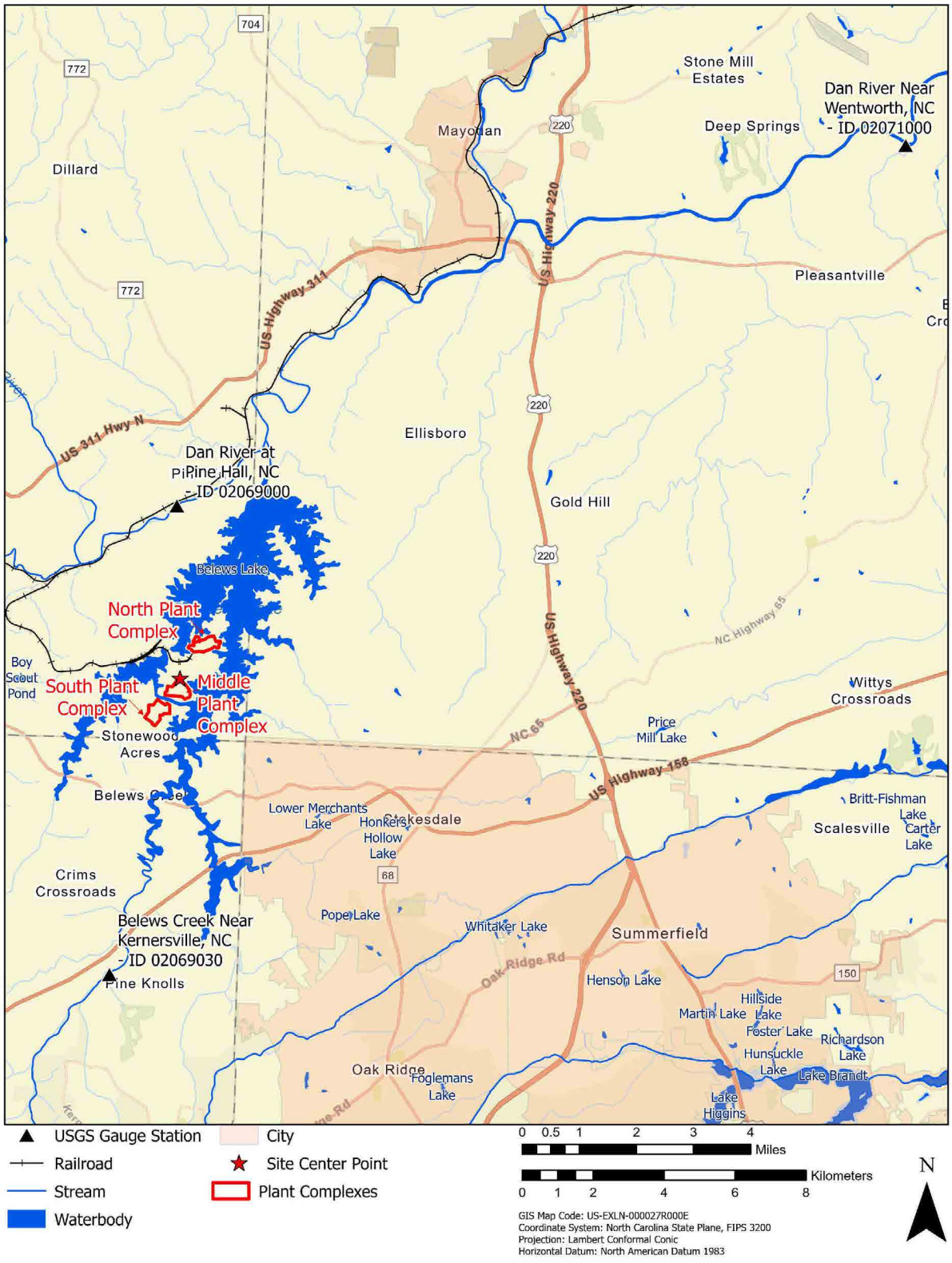
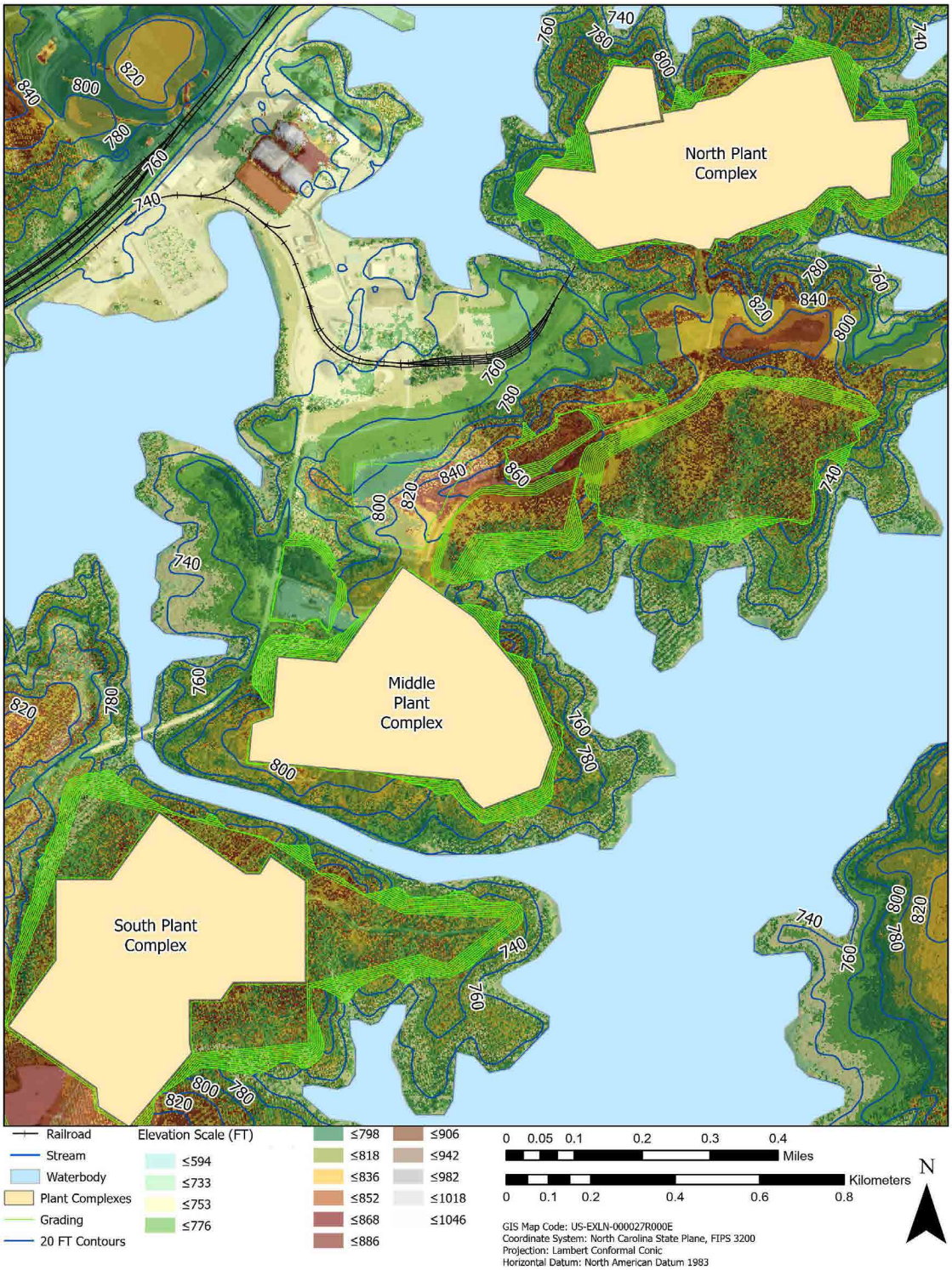


Figure 2.4-2
Project Site Topography



Key: FT = feet

Figure 2.4-3
Stream Gauges in Vicinity of the Project Site

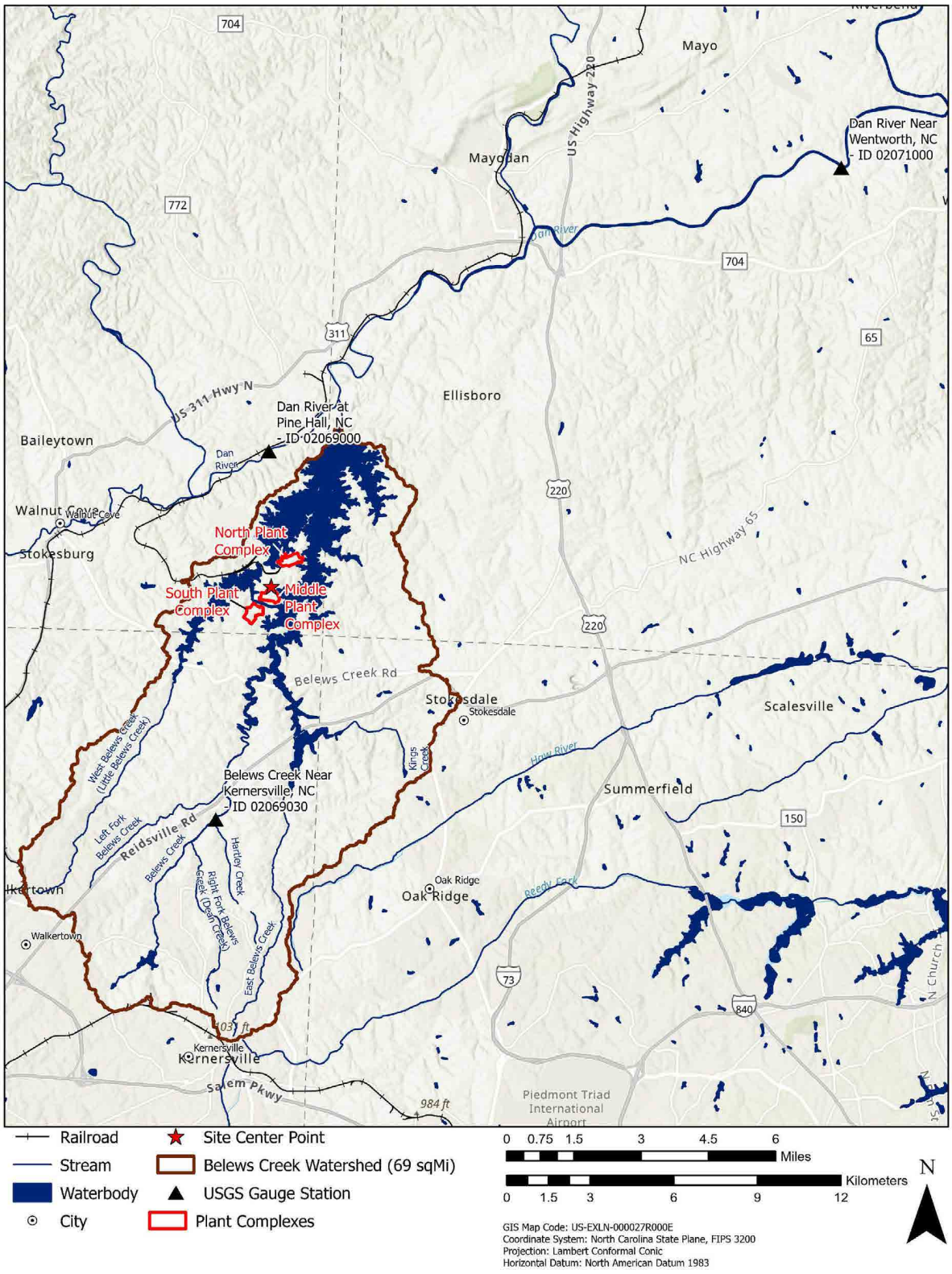
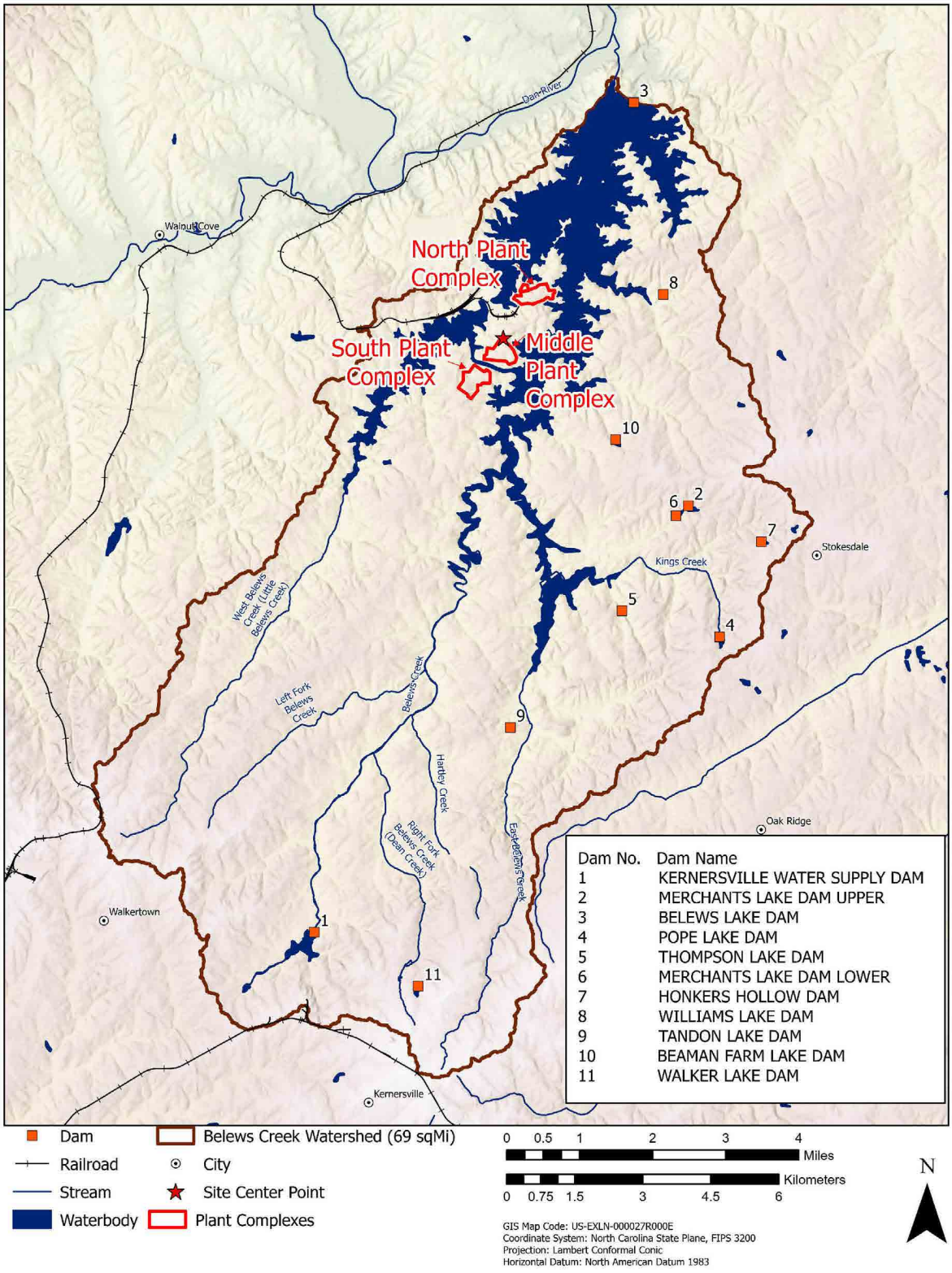


Figure 2.4-4
Belews Creek Watershed Dams



Dam No.	Dam Name
1	KERNERSVILLE WATER SUPPLY DAM
2	MERCHANTS LAKE DAM UPPER
3	BELEWS LAKE DAM
4	POPE LAKE DAM
5	THOMPSON LAKE DAM
6	MERCHANTS LAKE DAM LOWER
7	HONKERS HOLLOW DAM
8	WILLIAMS LAKE DAM
9	TANDON LAKE DAM
10	BEAMAN FARM LAKE DAM
11	WALKER LAKE DAM

Figure 2.4-5
Project Site Floodplain Map

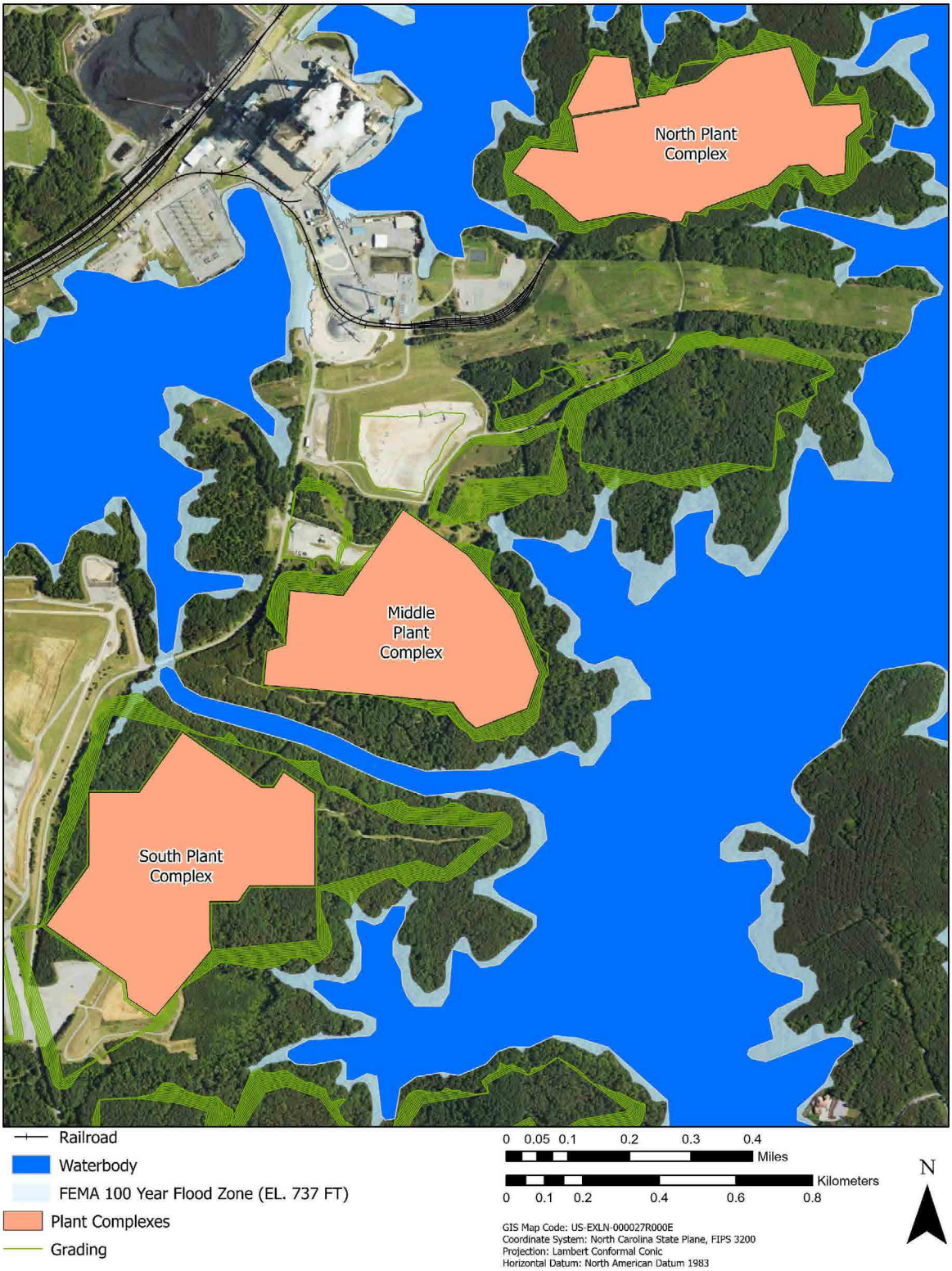


Figure 2.4-6
Belews Creek Watershed

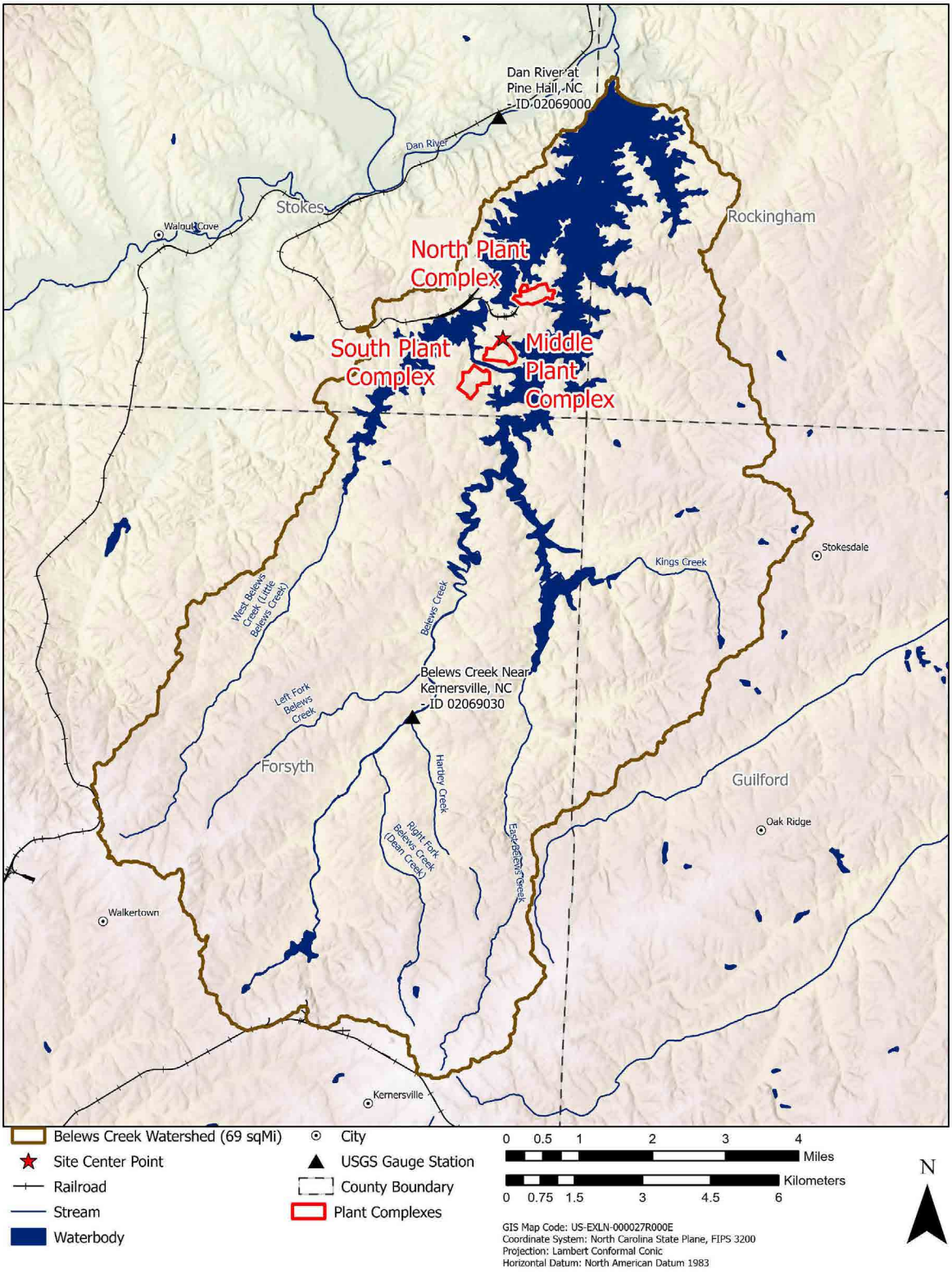


Figure 2.4-7
Waters of the U.S. Identified on the Project Site
(Sheet 1 of 2)

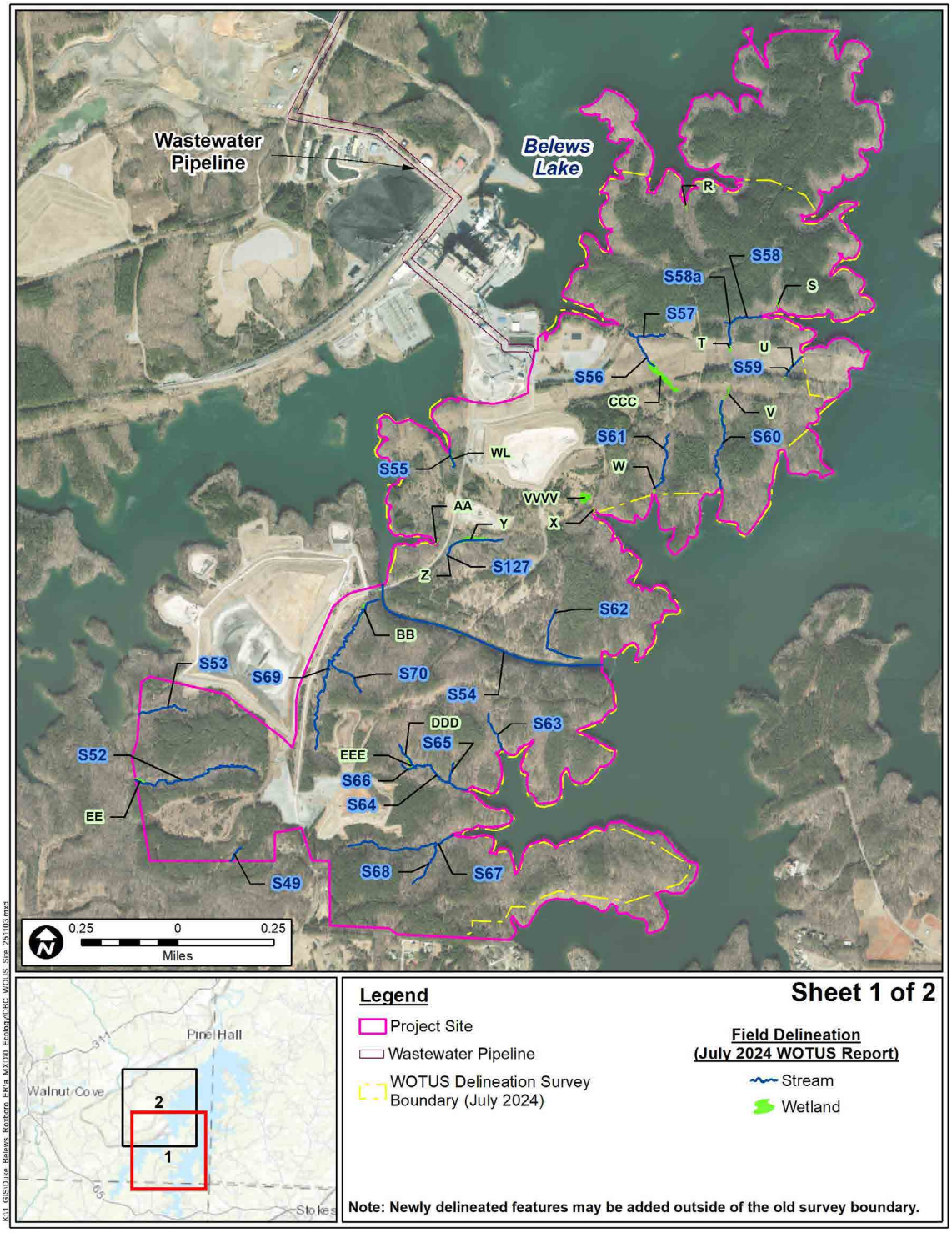


Figure 2.4-7
Waters of the U.S. Identified on the Project Site
(Sheet 2 of 2)

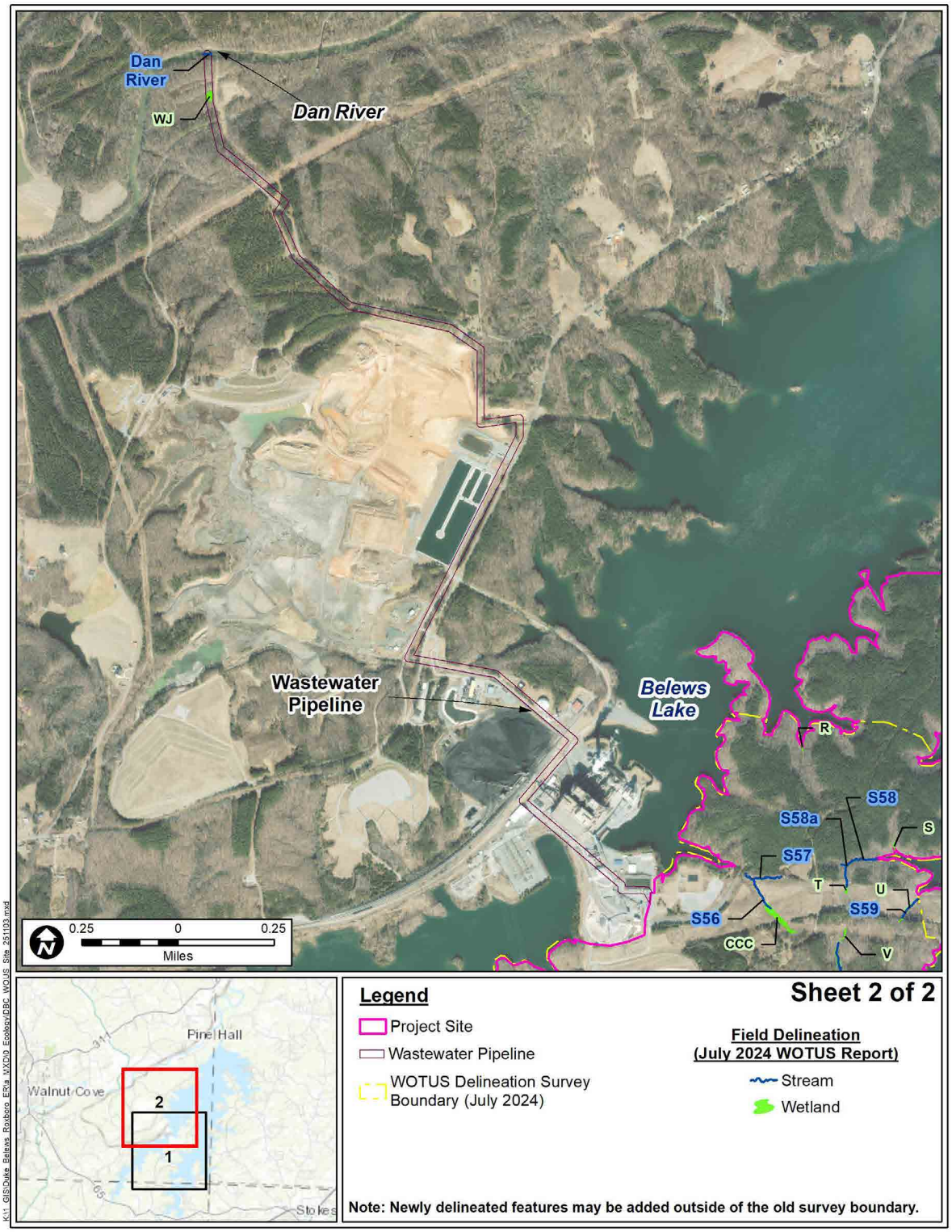


Figure 2.4-8
BCSS Existing Intake, Outfall, and Pump Station

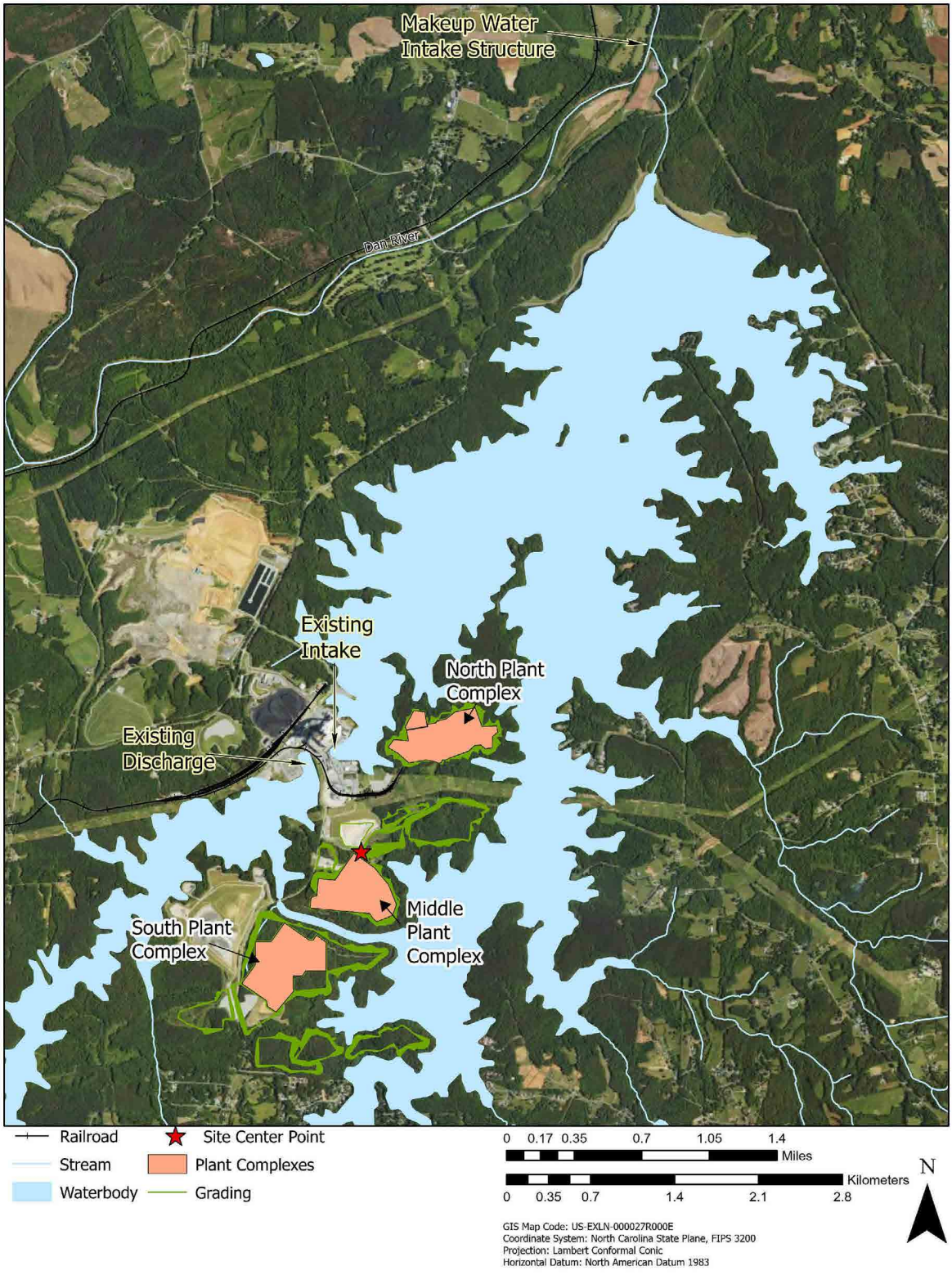


Figure 2.4-9
Project Site Proposed Intake Options

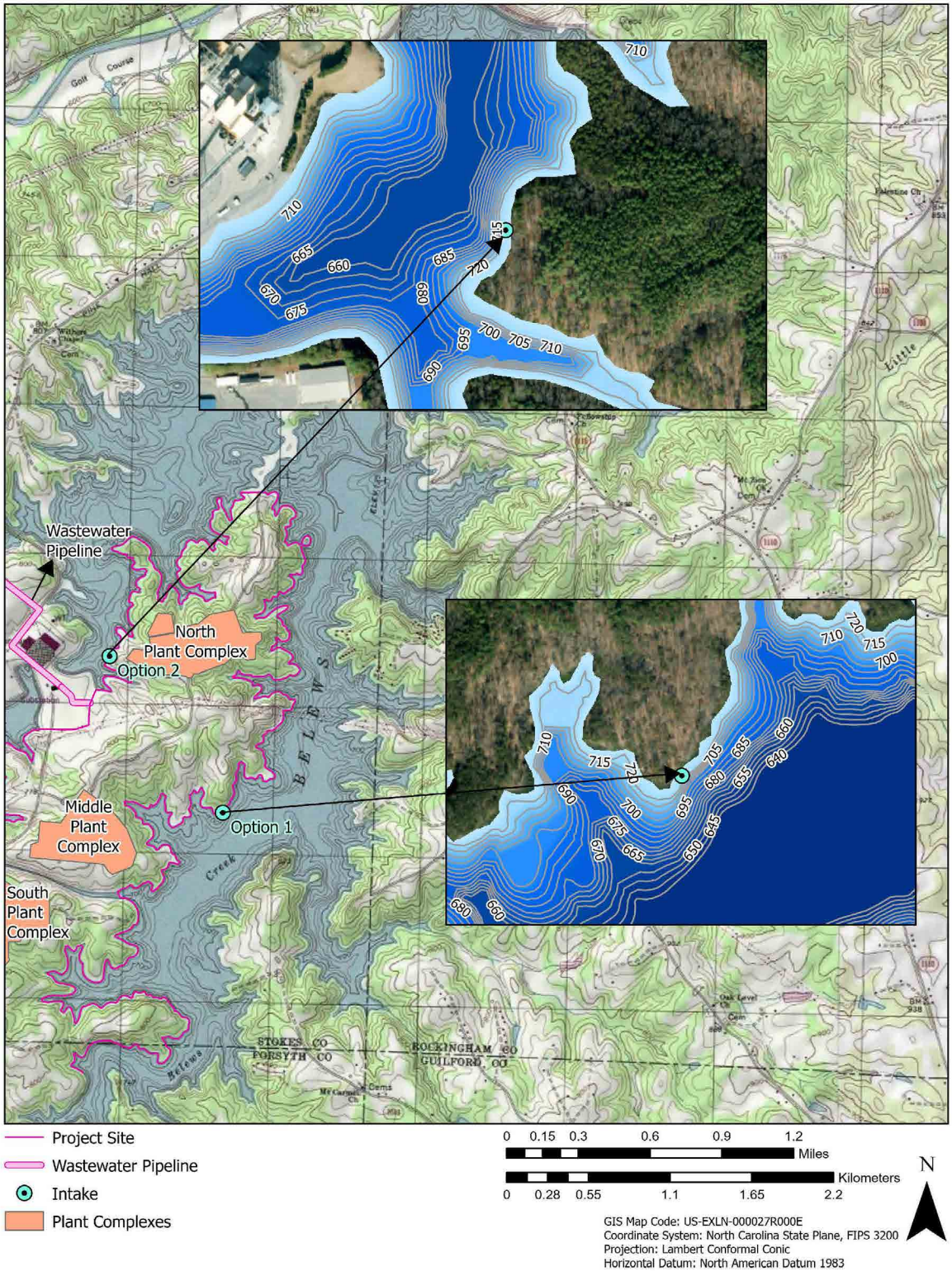


Figure 2.4-10
Project Site Proposed Outfall Options

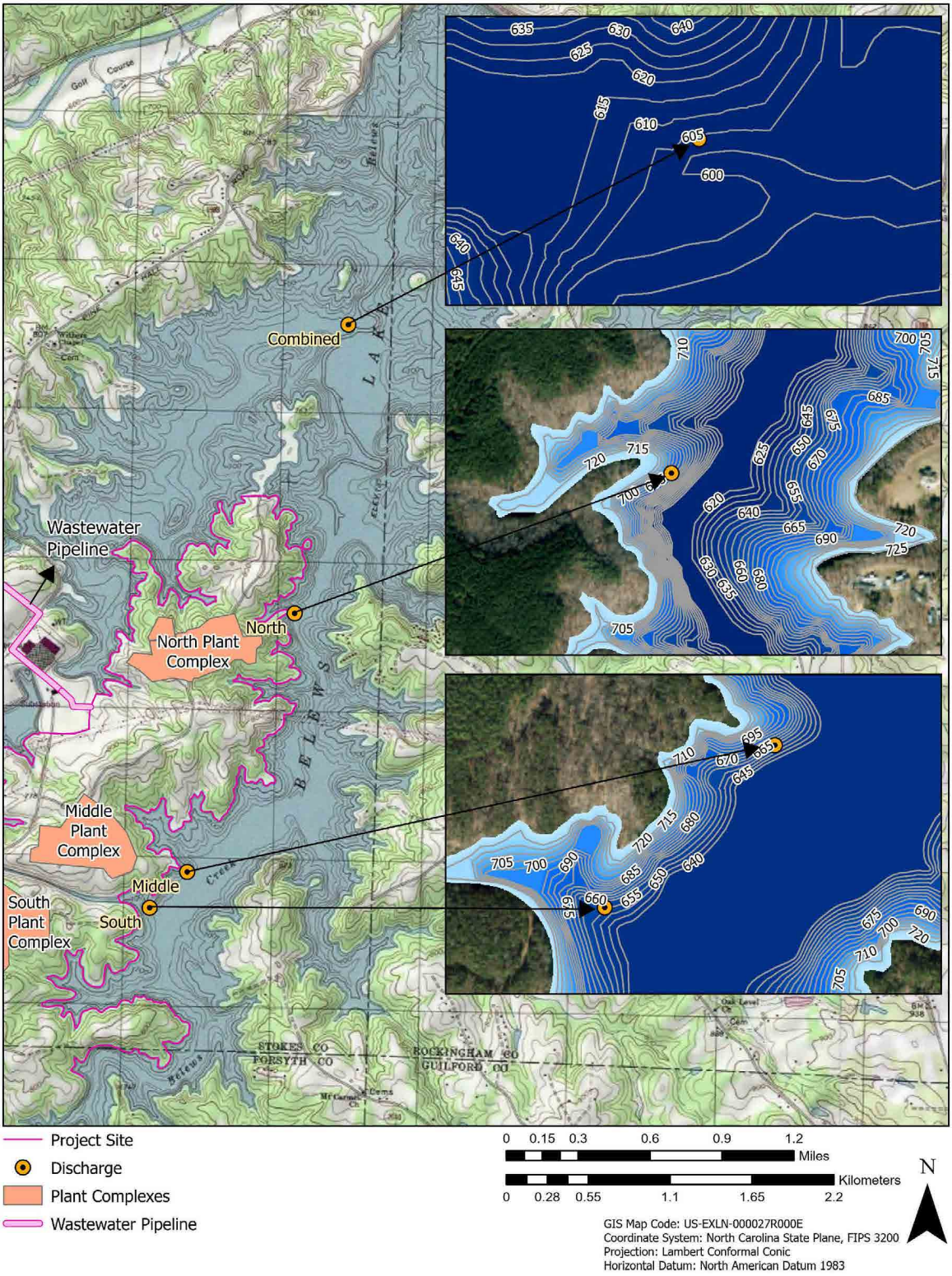


Figure 2.4-11
Not Used

Figure 2.4-12
Annual Peak Discharges in Belews Creek Near Kernersville, NC, USGS 2069030

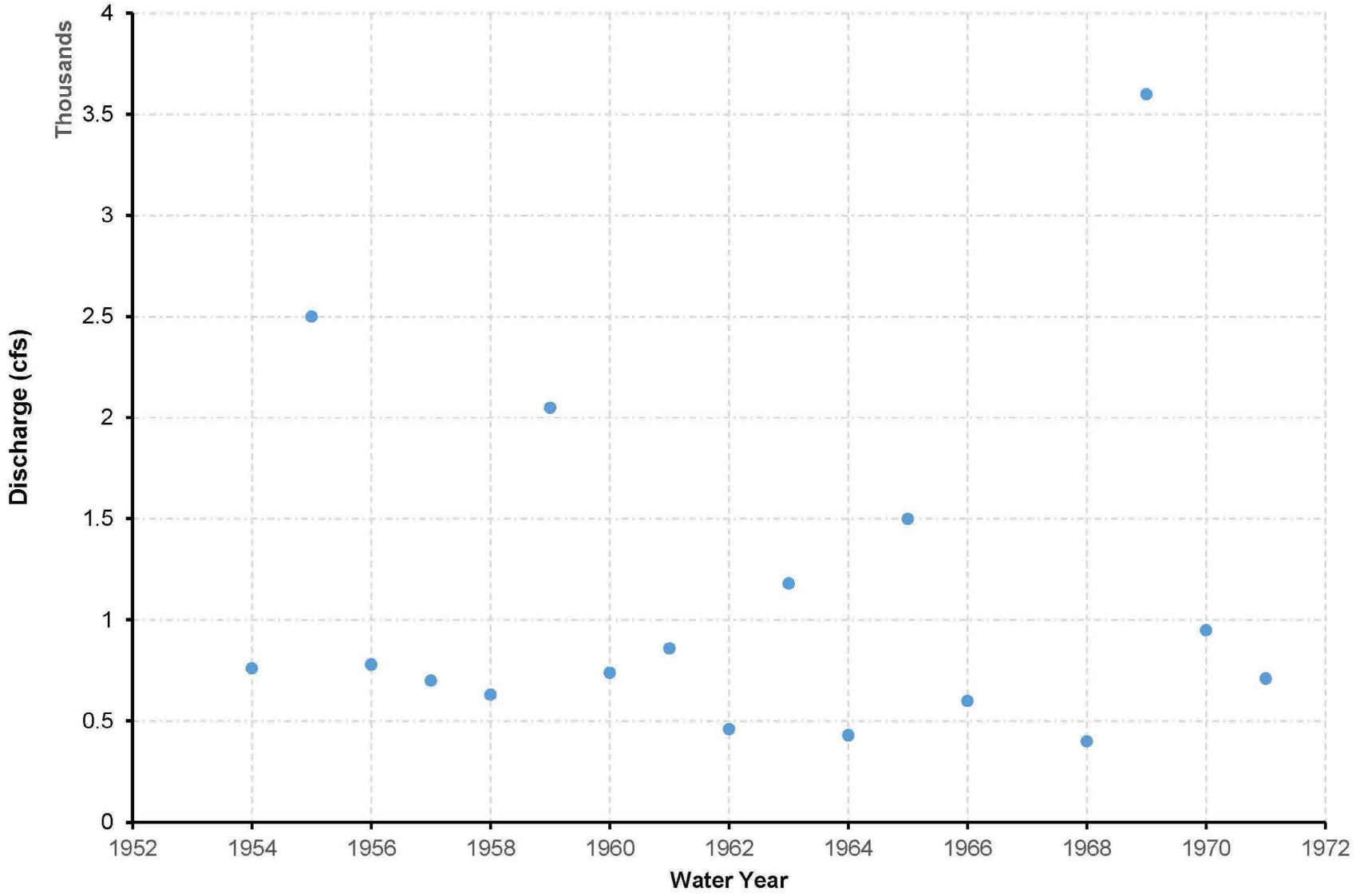
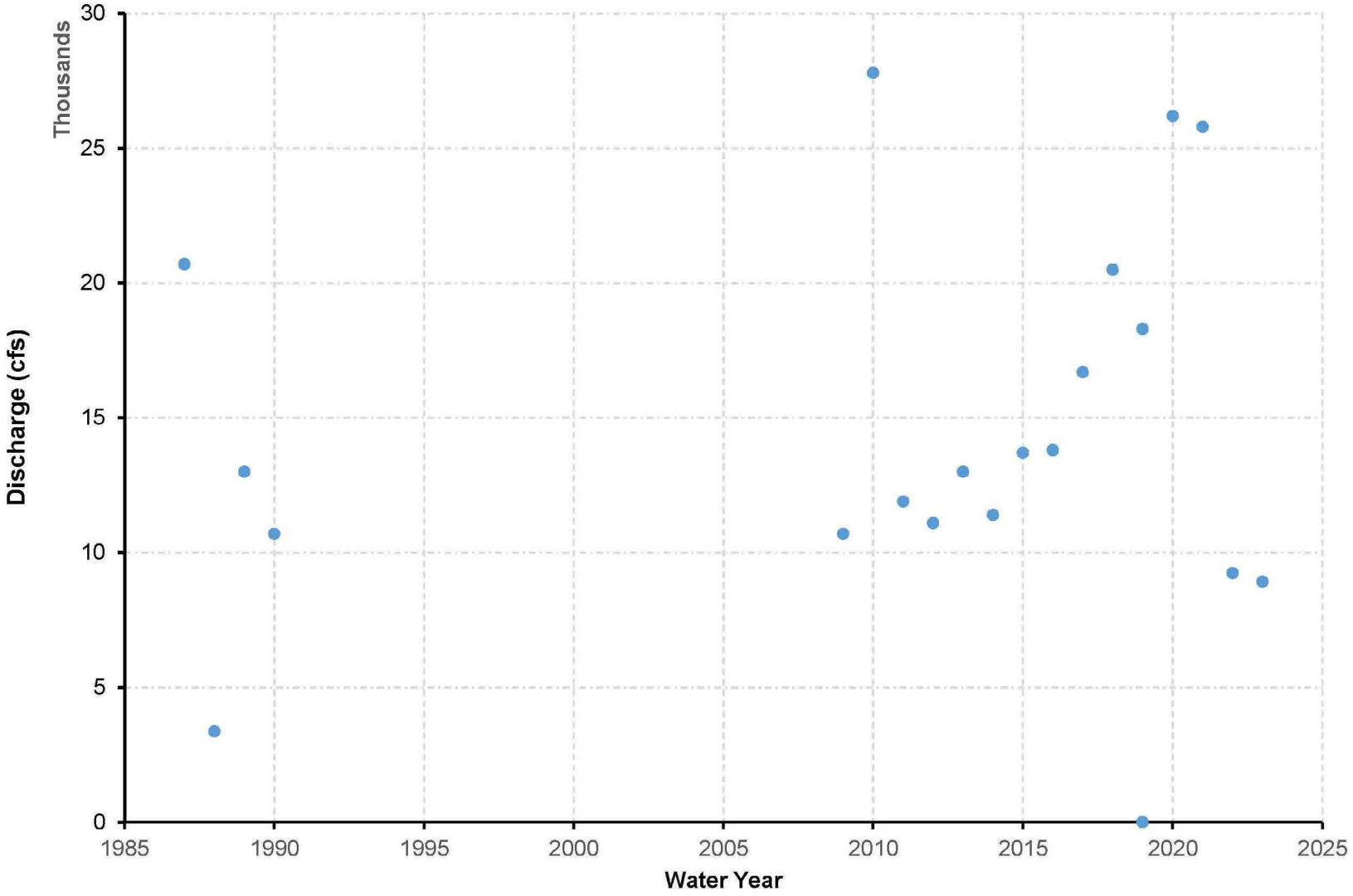


Figure 2.4-13
Annual Peak Discharges in the Dan River at Pine Hall, NC, USGS 2069000



Note: No data from water years 1991 to 2008.

Figure 2.4-14
Annual Peak Discharges in the Dan River Near Wentworth, NC, USGS 2071000

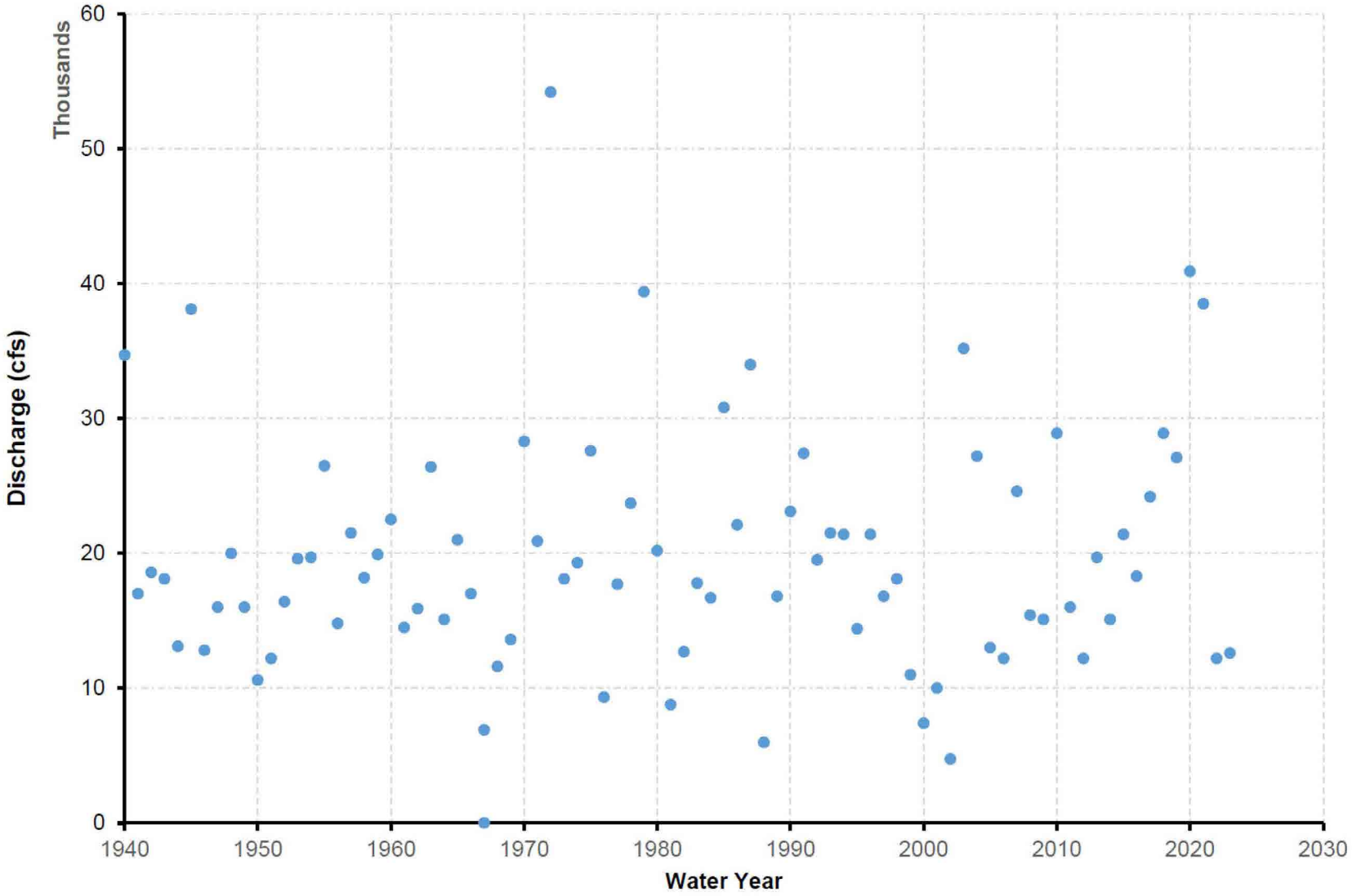
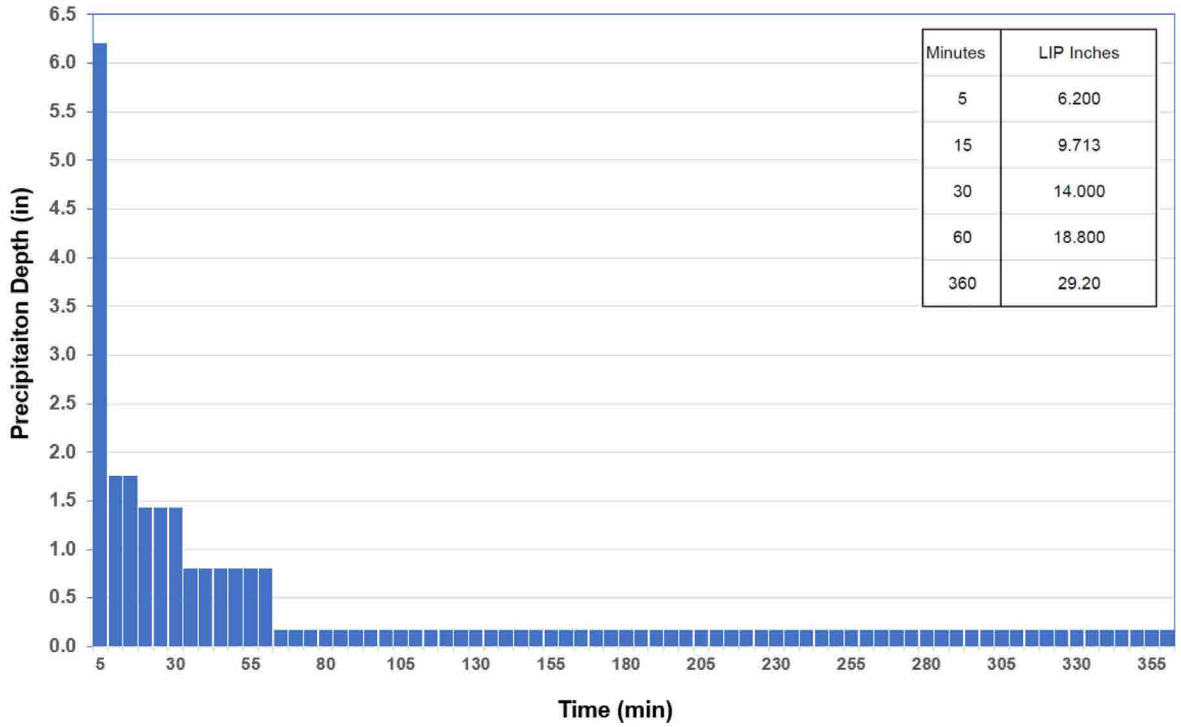


Figure 2.4-15
Project Site Local PMP Intensity-Duration Plot



Key: PMP = probable maximum precipitation; LIP = local intense precipitation; in = inches; min = minutes

Figure 2.4-16
Not Used

Figure 2.4-17
Extent of FLO-2D Model for LIP Analysis – North Plant Complex

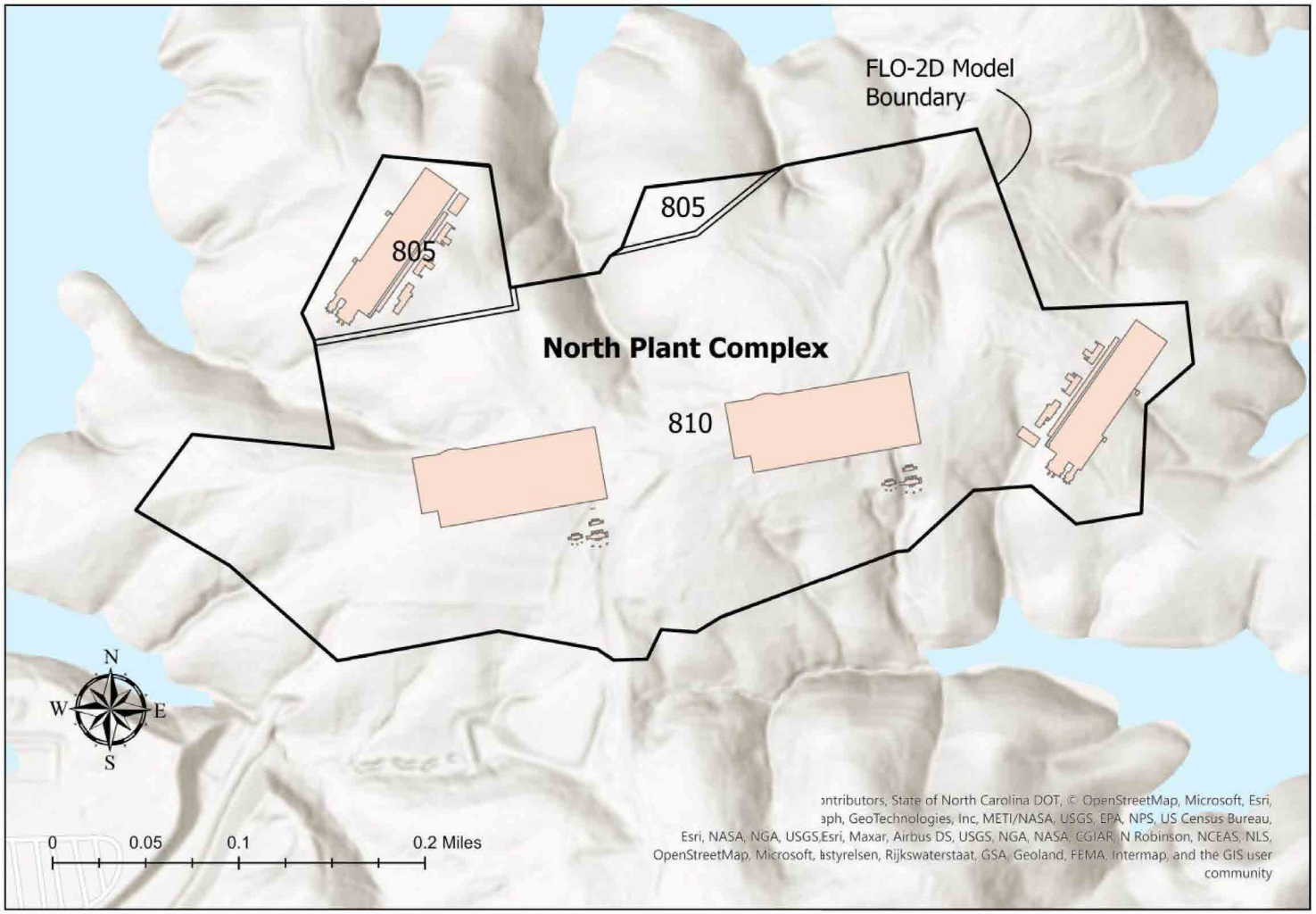


Figure 2.4-18
Extent of FLO-2D Model for LIP Analysis – Middle Plant Complex

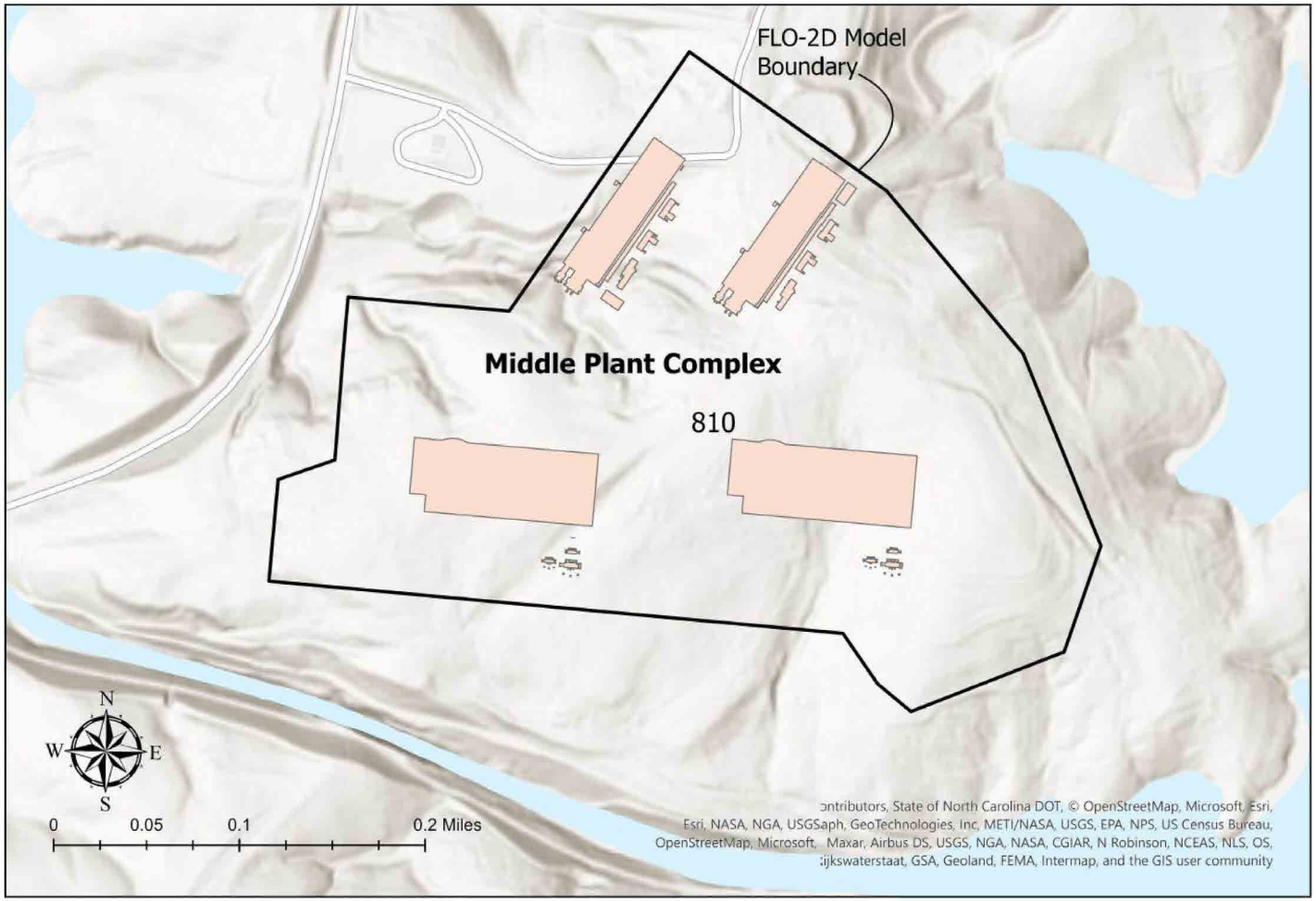


Figure 2.4-19
Extent of FLO-2D Model for LIP Analysis – South Plant Complex

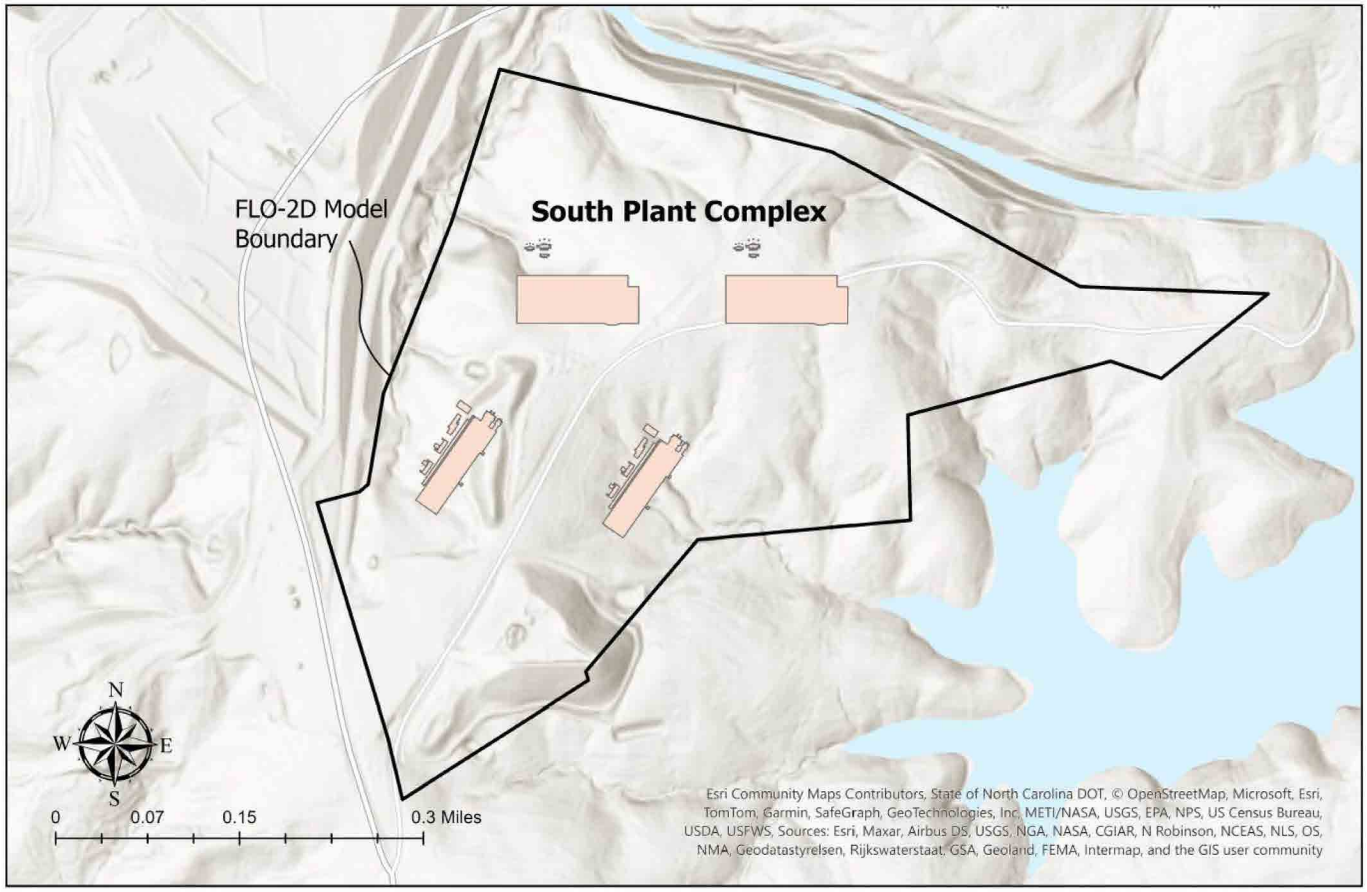


Figure 2.4-20
Belews Creek Watershed Land Use

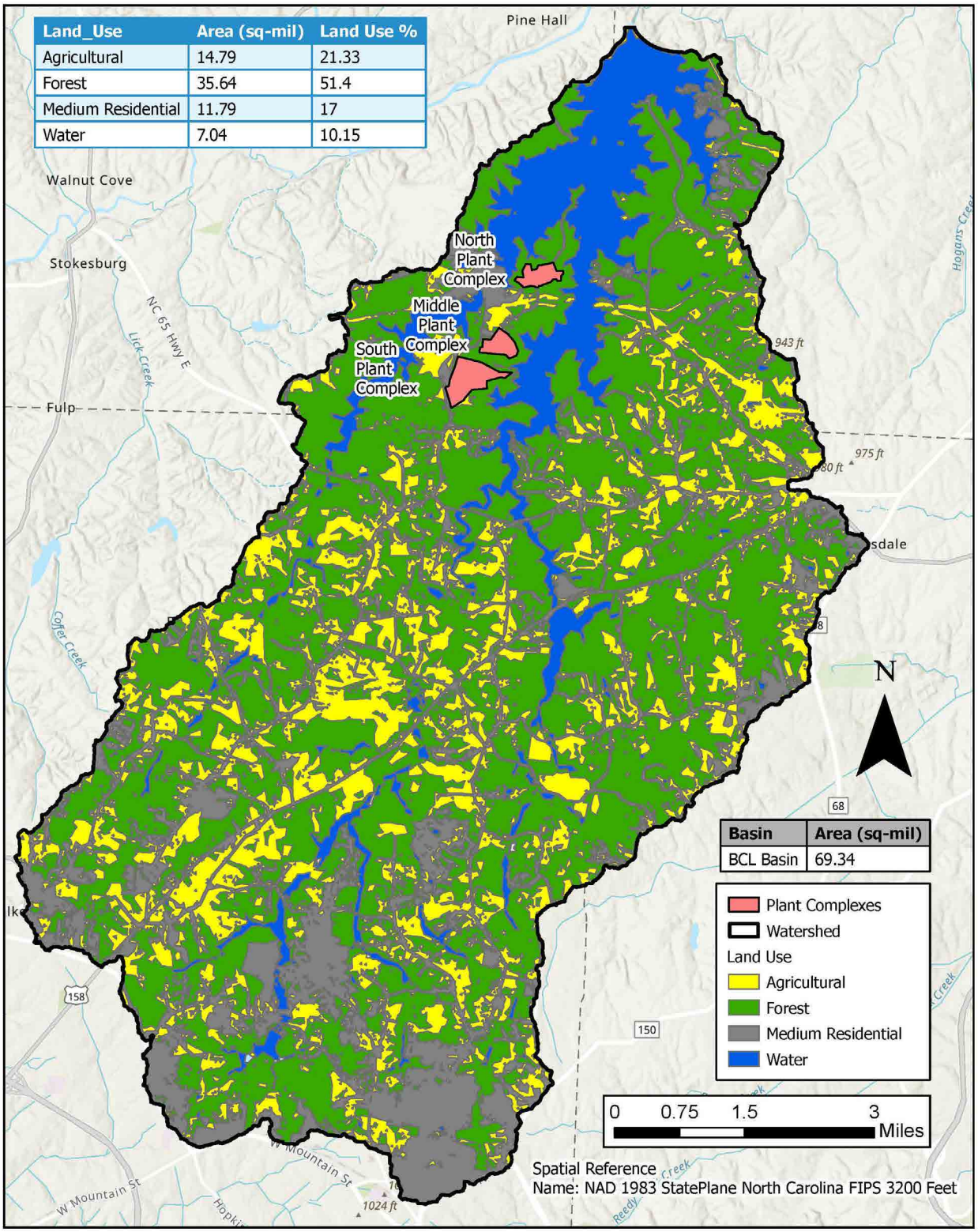
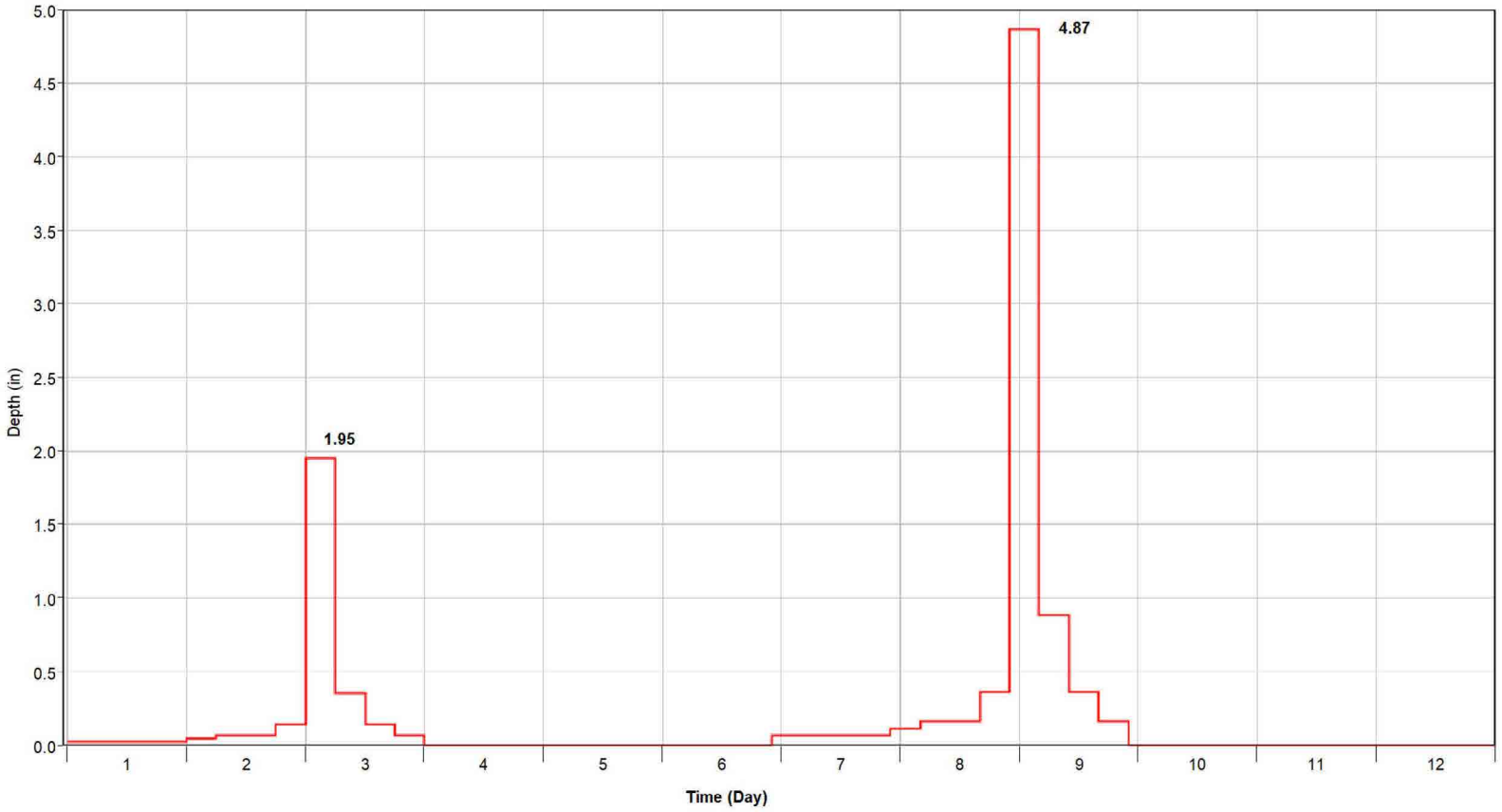


Figure 2.4-21
PMP Hyetograph for PMF over Belews Creek Watershed



Key in = inch

Figure 2.4-22
Belews Creek Watershed Hydrologic Soil Groups

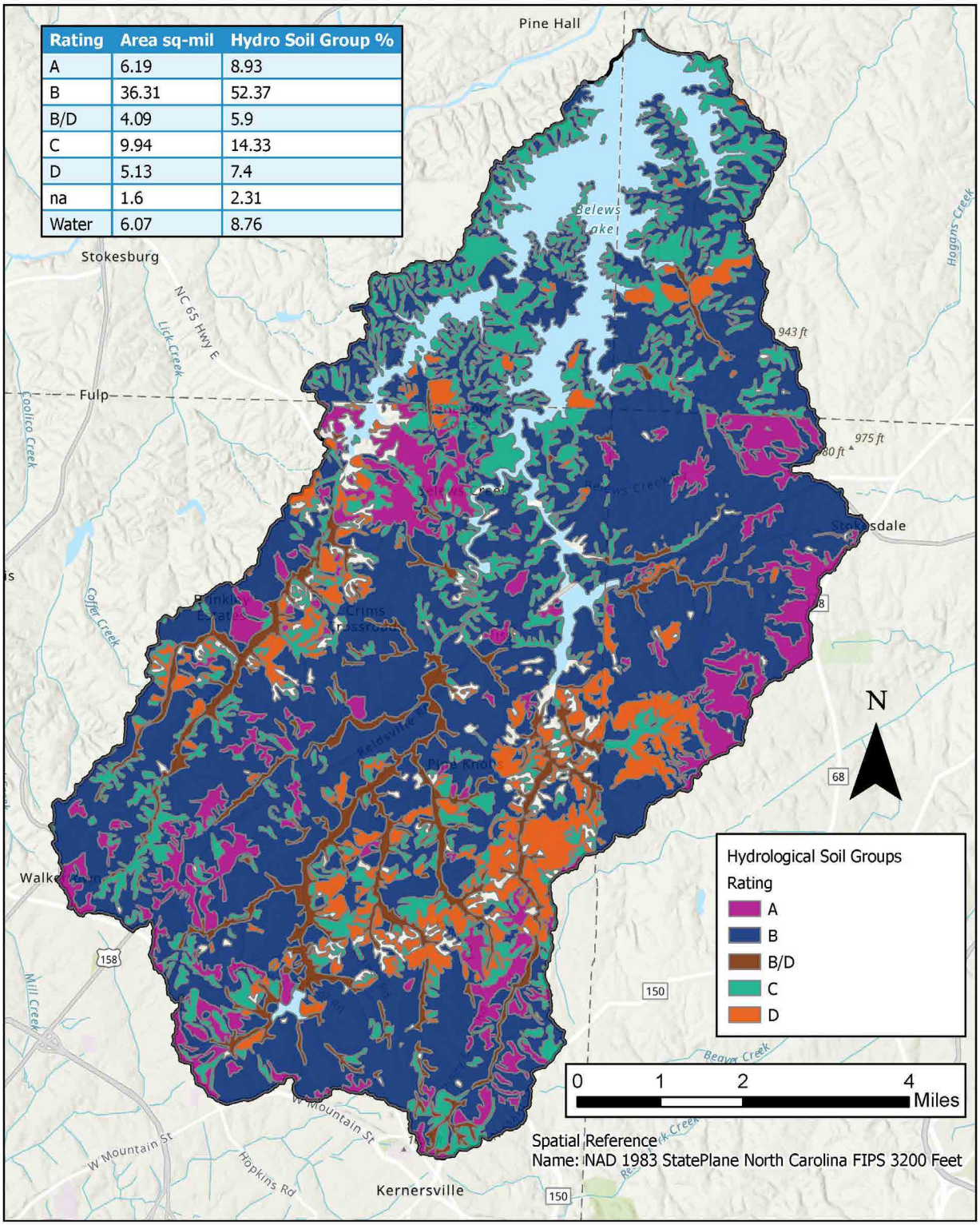
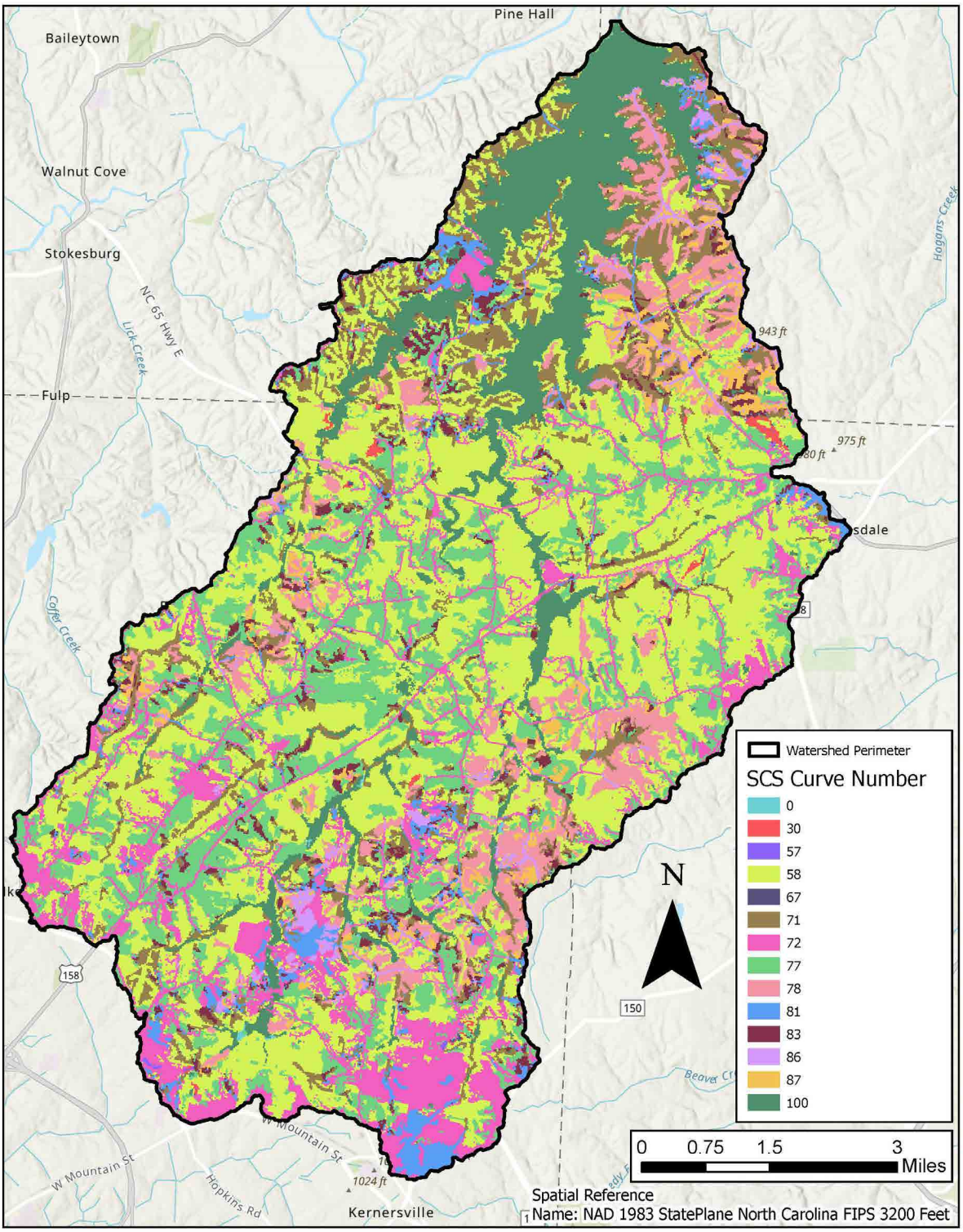


Figure 2.4-23
Belews Creek Watershed SCS Curve Numbers



Key: SCC = Soil Conservation Service

Figure 2.4-24
Belews Creek Watershed and Topography

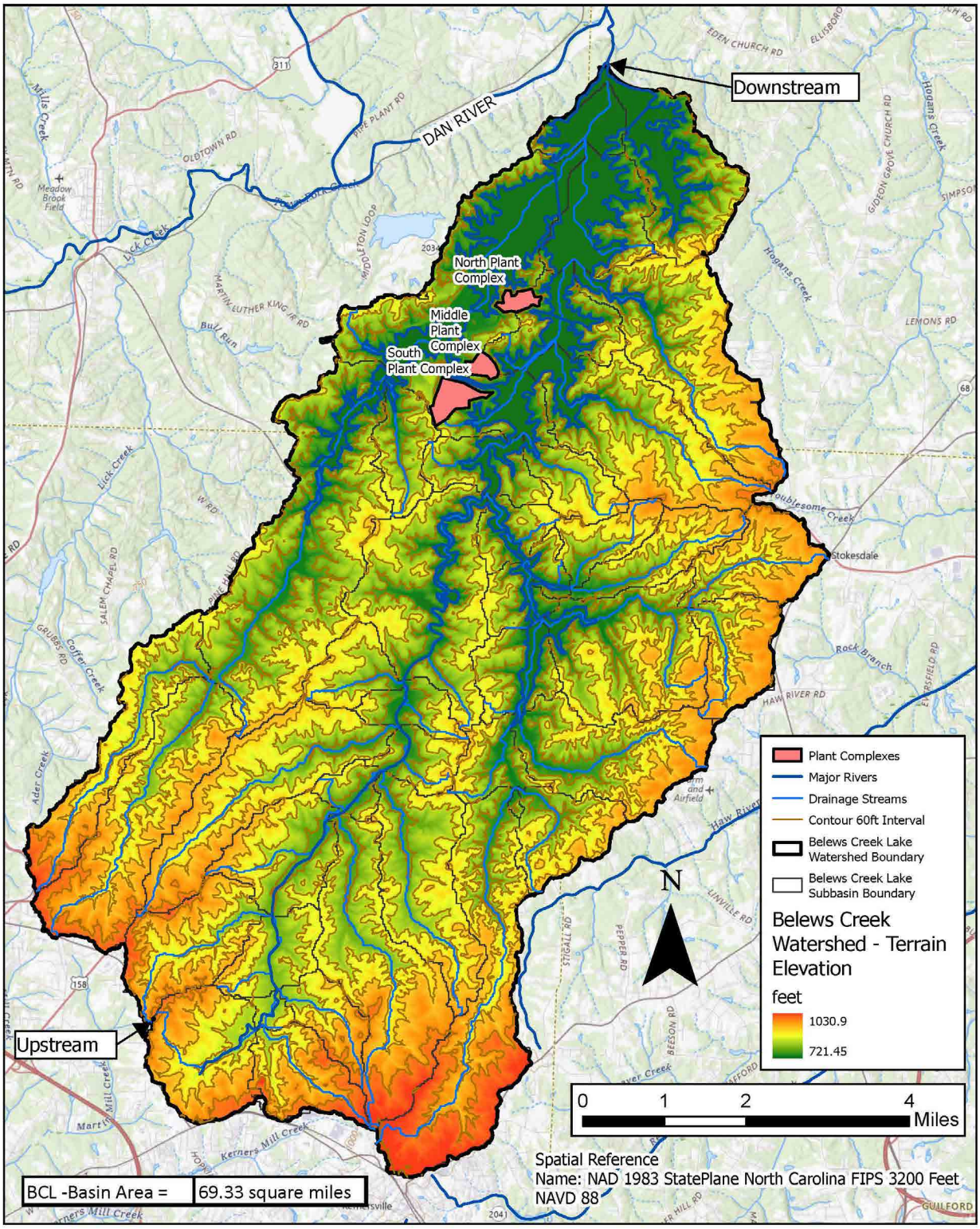


Figure 2.4-25
Belews Creek Watershed Terrain

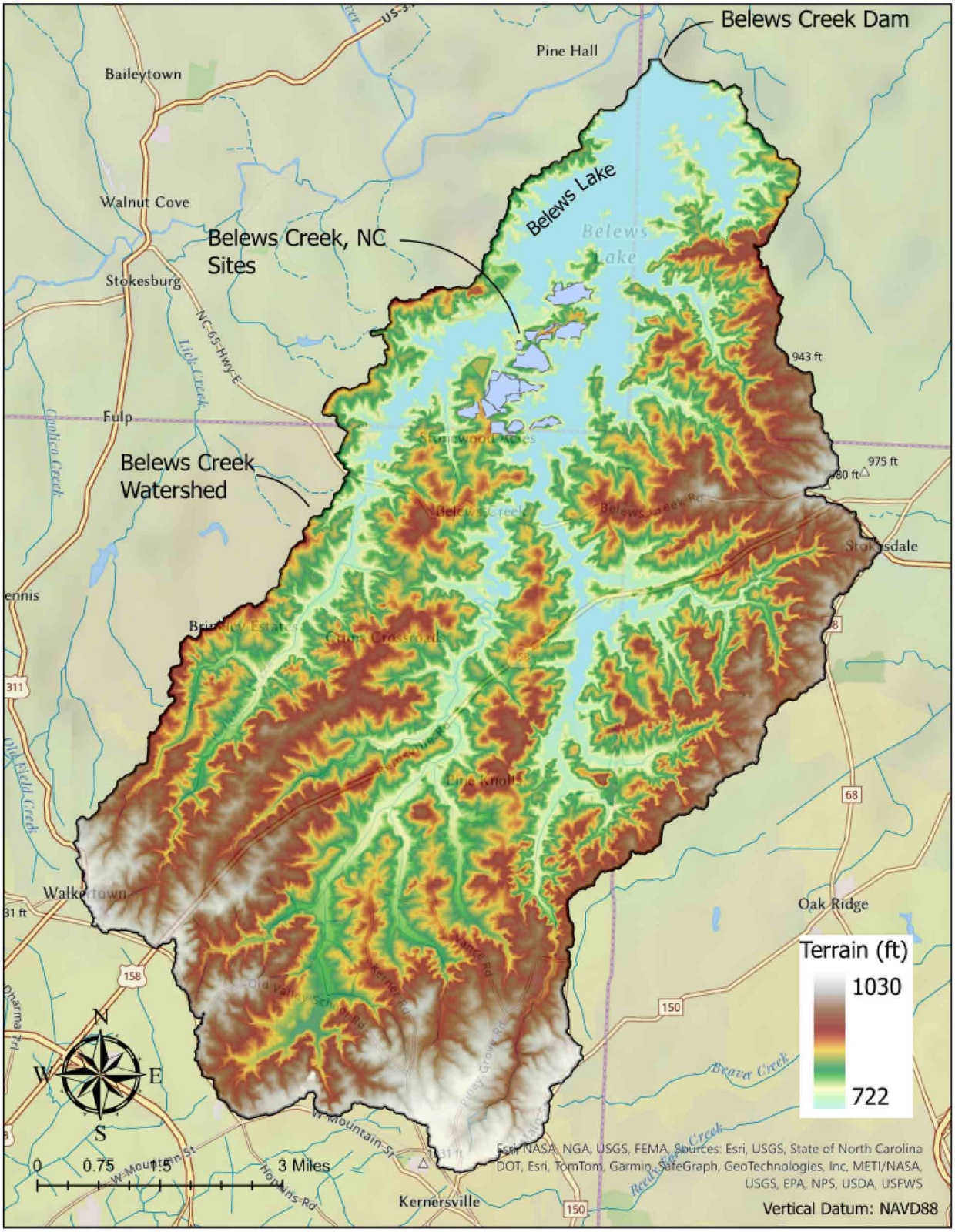


Figure 2.4-26
HEC-RAS Model Domain and Grid Cells

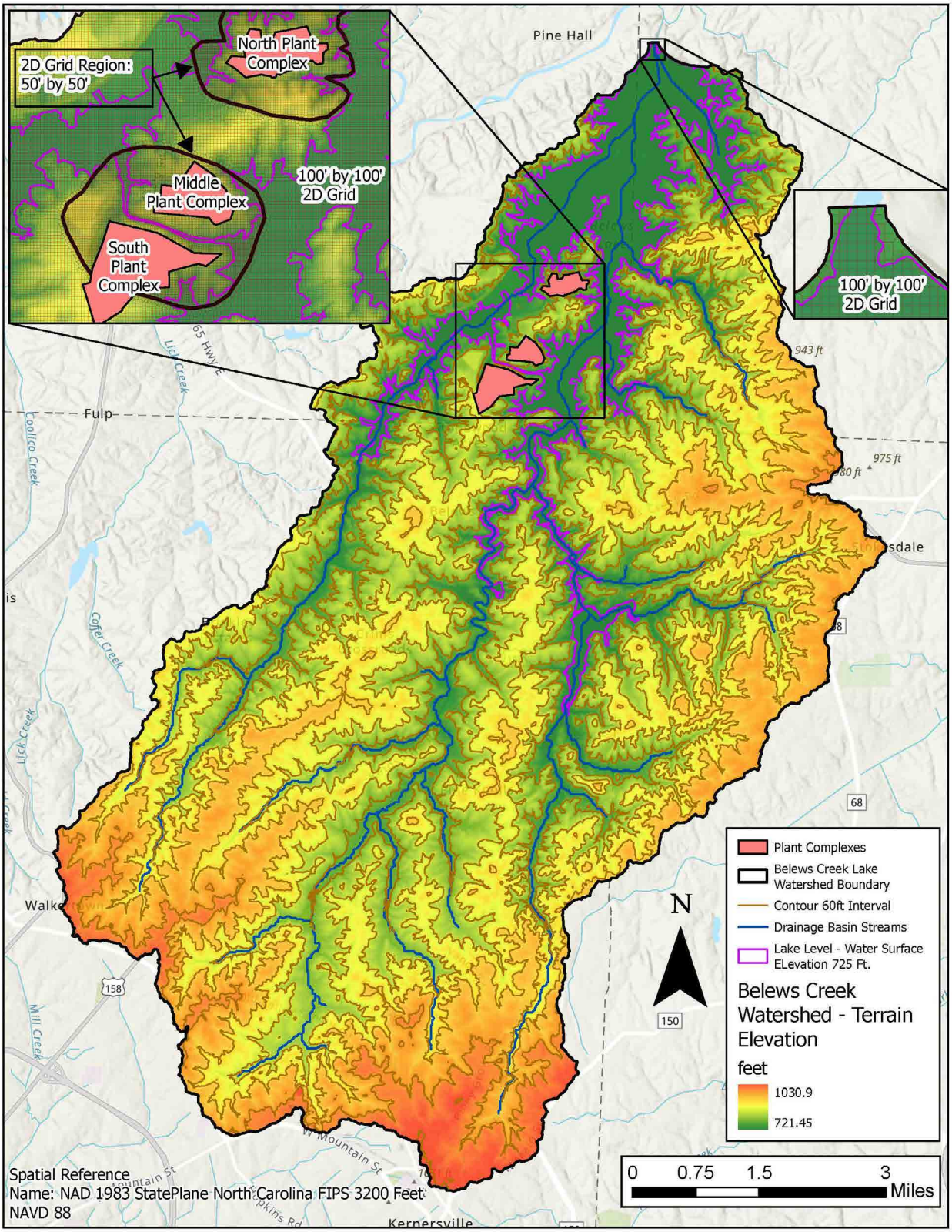
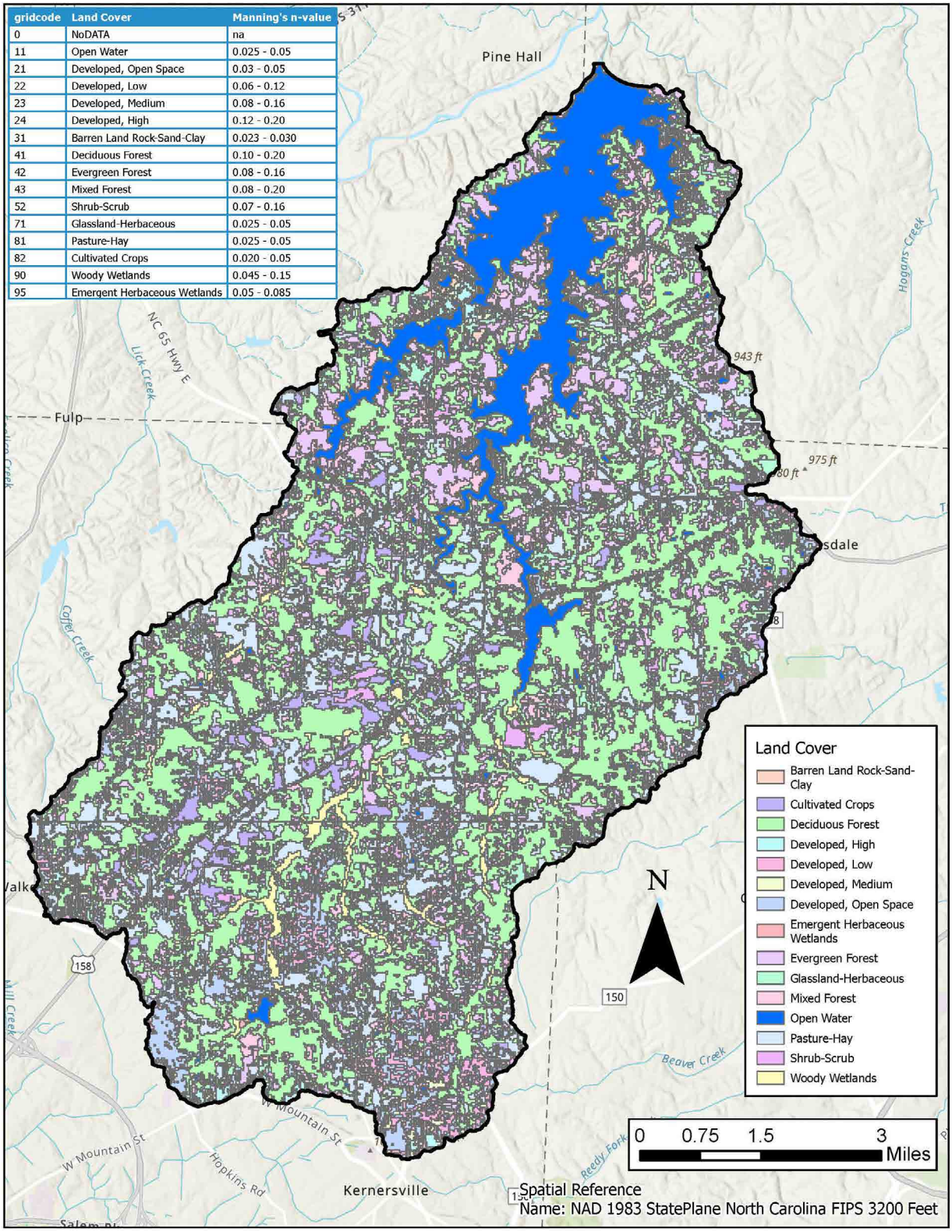
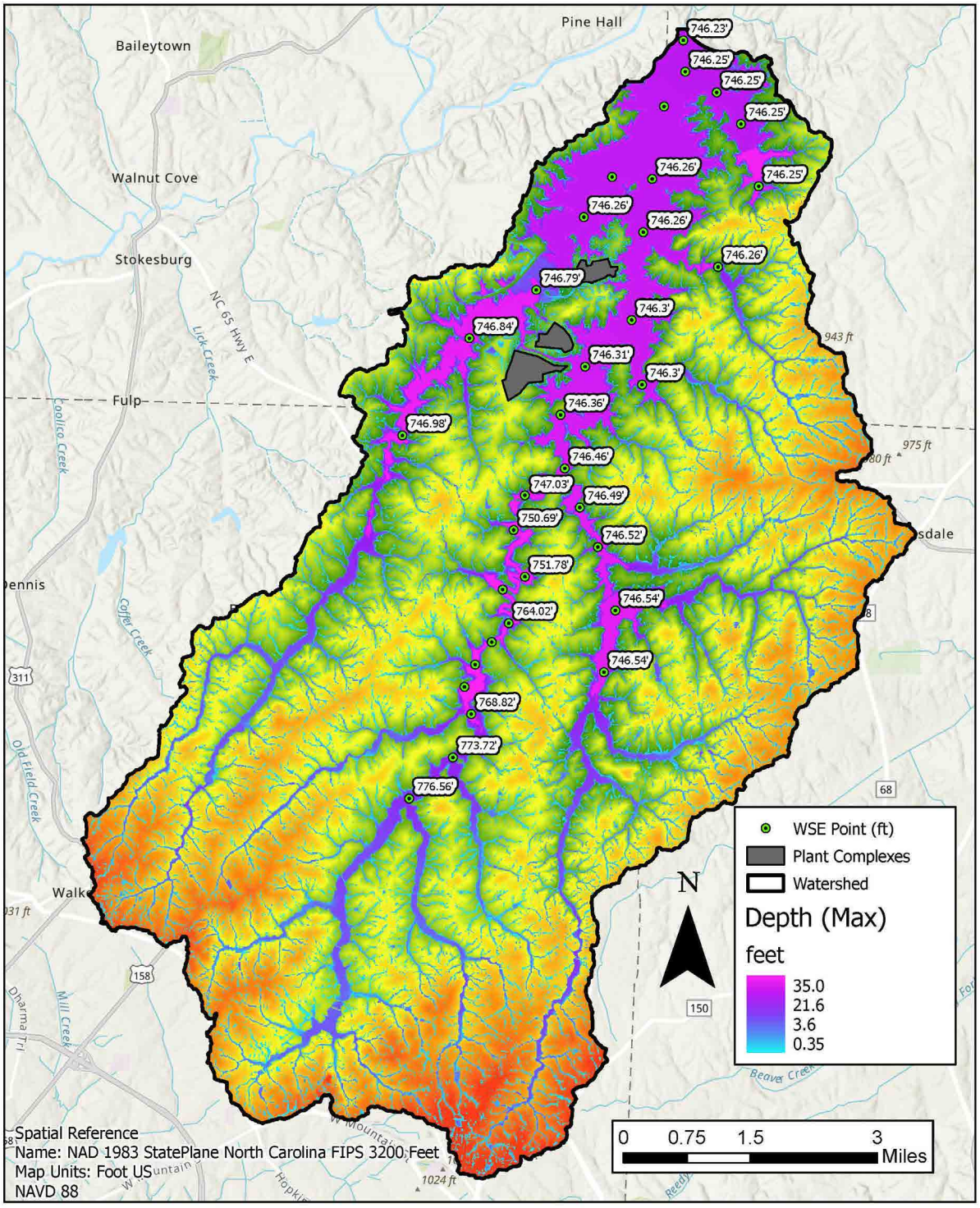


Figure 2.4-27
HEC-RAS Model Domain Land Cover Manning's N Value



gridcode	Land Cover	Manning's n-value
0	NoDATA	na
11	Open Water	0.025 - 0.05
21	Developed, Open Space	0.03 - 0.05
22	Developed, Low	0.06 - 0.12
23	Developed, Medium	0.08 - 0.16
24	Developed, High	0.12 - 0.20
31	Barren Land Rock-Sand-Clay	0.023 - 0.030
41	Deciduous Forest	0.10 - 0.20
42	Evergreen Forest	0.08 - 0.16
43	Mixed Forest	0.08 - 0.20
52	Shrub-Scrub	0.07 - 0.16
71	Glassland-Herbaceous	0.025 - 0.05
81	Pasture-Hay	0.025 - 0.05
82	Cultivated Crops	0.020 - 0.05
90	Woody Wetlands	0.045 - 0.15
95	Emergent Herbaceous Wetlands	0.05 - 0.085

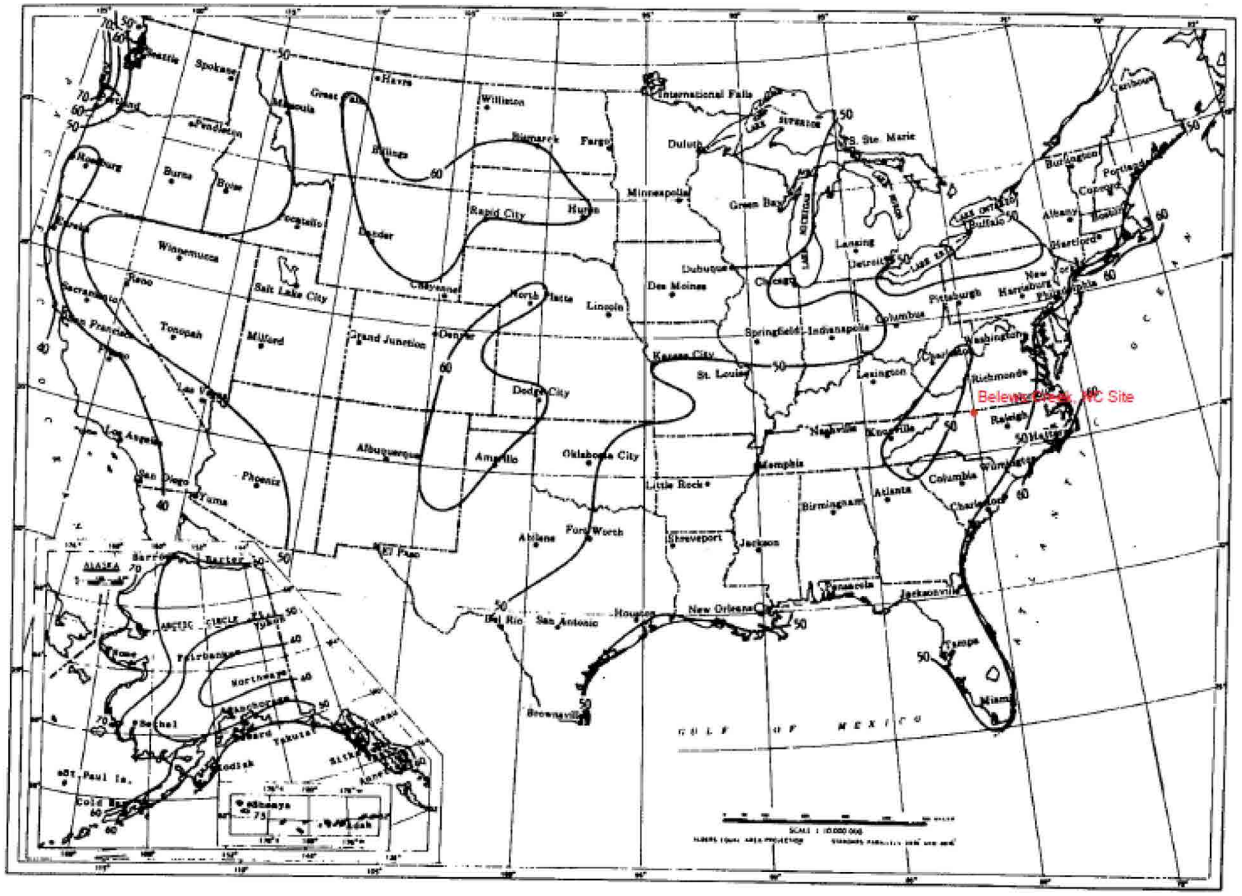
Figure 2.4-28
HEC-RAS 2D Model Results – Maximum Water Surface Elevation for PMF



Key: PMF = probable maximum flood; WSE = water surface elevation

Figure 2.4-29
2-Year Mean Recurrence Interval Wind Speed

Isotach 0.50 Quantiles (in miles per hour):
Annual Extreme-Mile, 30 ft Above Ground, 2-yr Mean Recurrence Interval



Source: Reference 2.4-2

Figure 2.4-30
Wave Runup – Maximum Fetch

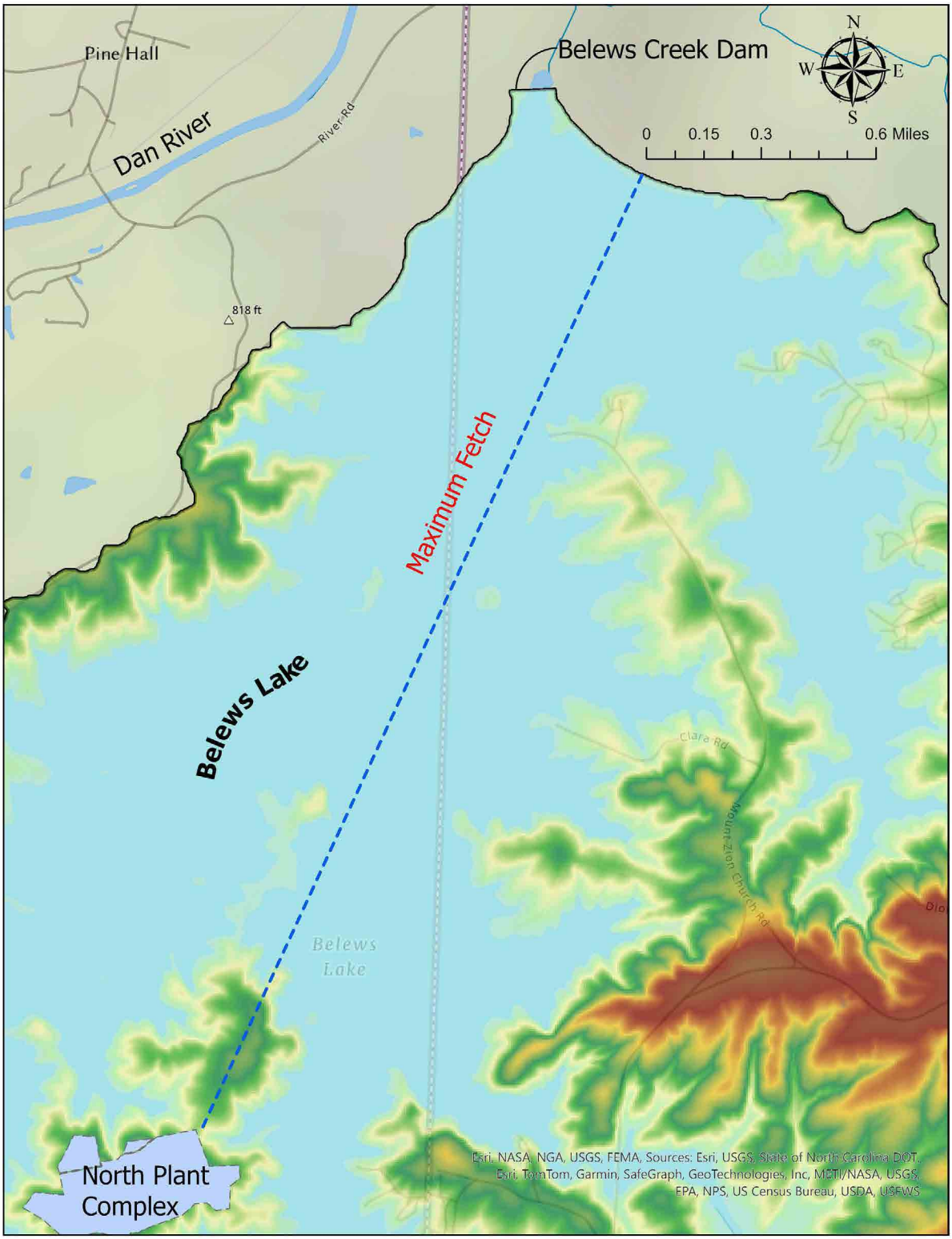


Figure 2.4-31
HEC-RAS Model Domain, Grid Cells, and NID Dams

[[

]]CEII

Key: NID = National Inventory of Dams; BCLW = Belews Creek Lake Watershed; Elv. = elevation; 60ft_Intv = 60-foot interval

Figure 2.4-32a
NID Dam Breach Hydrographs – NID 5140 & NID 5294

[[

]]CEII
Key: cfs = cubic feet per second; hr = hour; NID = National Inventory of Dams

Figure 2.4-32b
NID Dam Breach Hydrographs – Cluster 1 & Cluster 2

[[

]]CEII
Key: cfs = cubic feet per second; hr = hour; NID = National Inventory of Dams

Figure 2.4-32c
NID Dam Breach Hydrographs – NID 5291 & NID 277

[[

]]CEII

Key: cfs = cubic feet per second; hr = hour; NID = National Inventory of Dams

Figure 2.4-32d
NID Dam Breach Hydrographs – NID 5327

[[

]]CEII

Key: cfs = cubic feet per second; hr = hour; NID = National Inventory of Dams

Figure 2.4-33
Maximum Still Water Surface Elevation and Peak Discharge

[[

]]CEII

Key: WSEL = water surface elevation; ft. = feet; NAVD 88 = North American Vertical Datum of 1988

Figure 2.4-34
HEC-RAS 2D Model Results – Maximum Water Surface Elevation for Dam Failure

[[

]]CEII

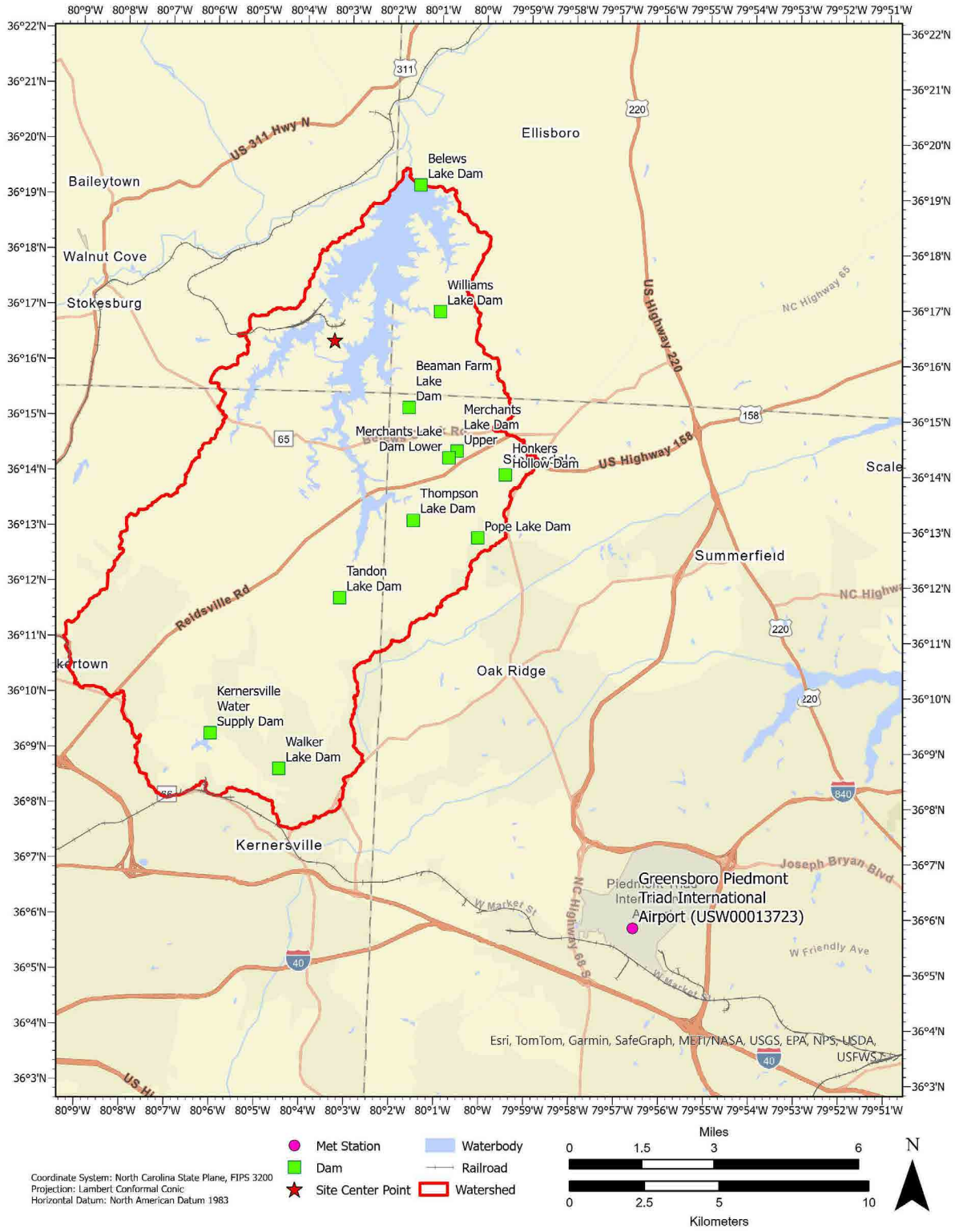
Key: Max = maximum

Figure 2.4-35
Belews Creek Elevation-Area and Elevation-Volume Curves

[[

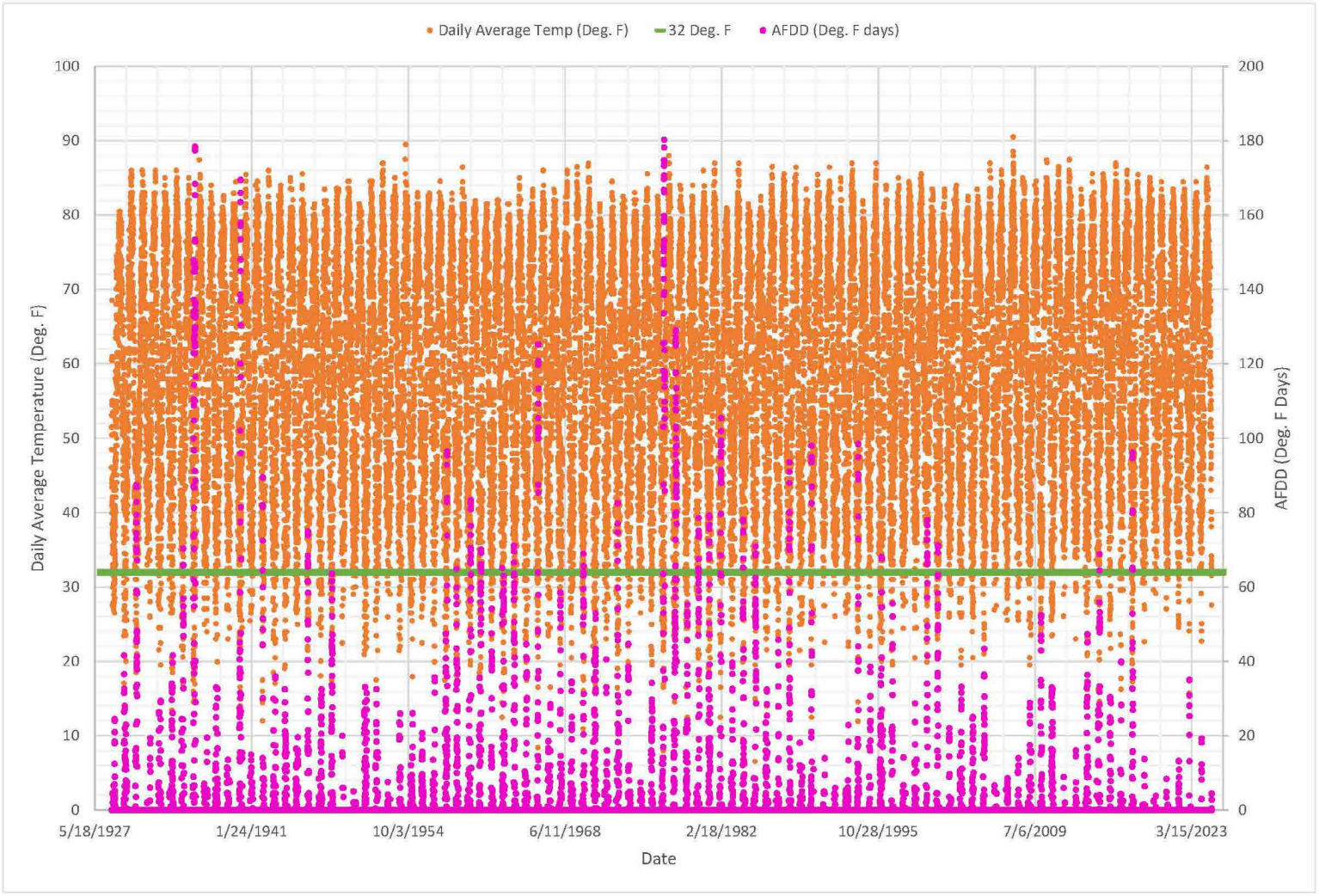
]]CEII

Figure 2.4-36
Location of the Project Site, PTI Meteorological Station, and Area Dams



Key: PTI: Greensboro Piedmont Triad International Airport

Figure 2.4-37
Temporal Variations of Daily Average Temperature and Accumulated Freezing Degree-Days (AFDD) for Approximate 96-Year Period of Record



Key: Deg. F = degrees Fahrenheit; AFDD = accumulated freezing degree-days

Figure 2.4-38
Temporal Variations of Estimated Ice Thickness for Approximate 96-Year Period of Record

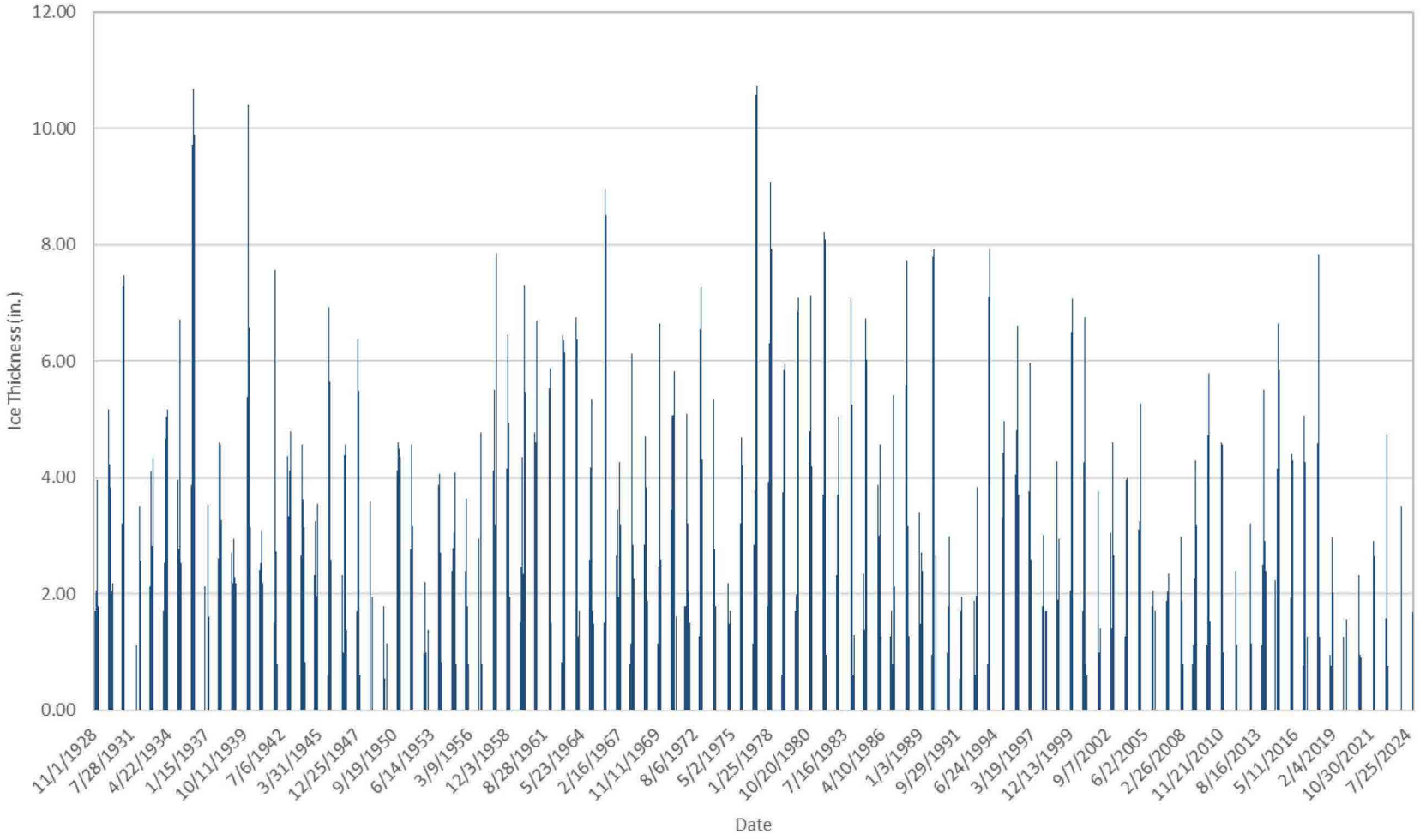
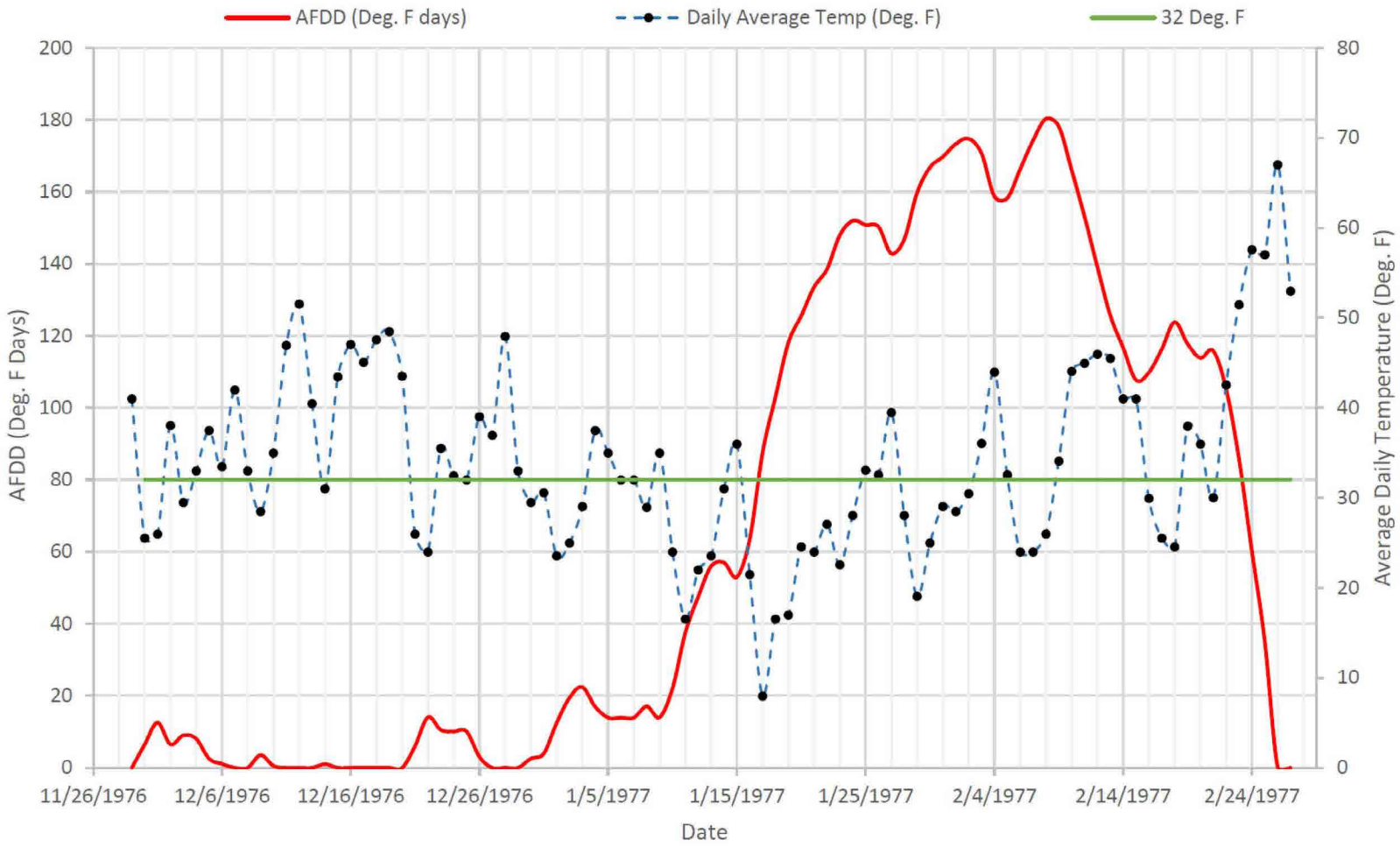


Figure 2.4-39
Temporal Variations of Daily Average Temperature and Accumulated Freezing Degree-Days for Winter of 1976/1977



Key: AFDD = accumulated freezing degree-days; Deg. F = degrees Fahrenheit

Figure 2.4-40
Temporal Variations of Estimated Maximum Ice Thickness for Winter of 1976/1977

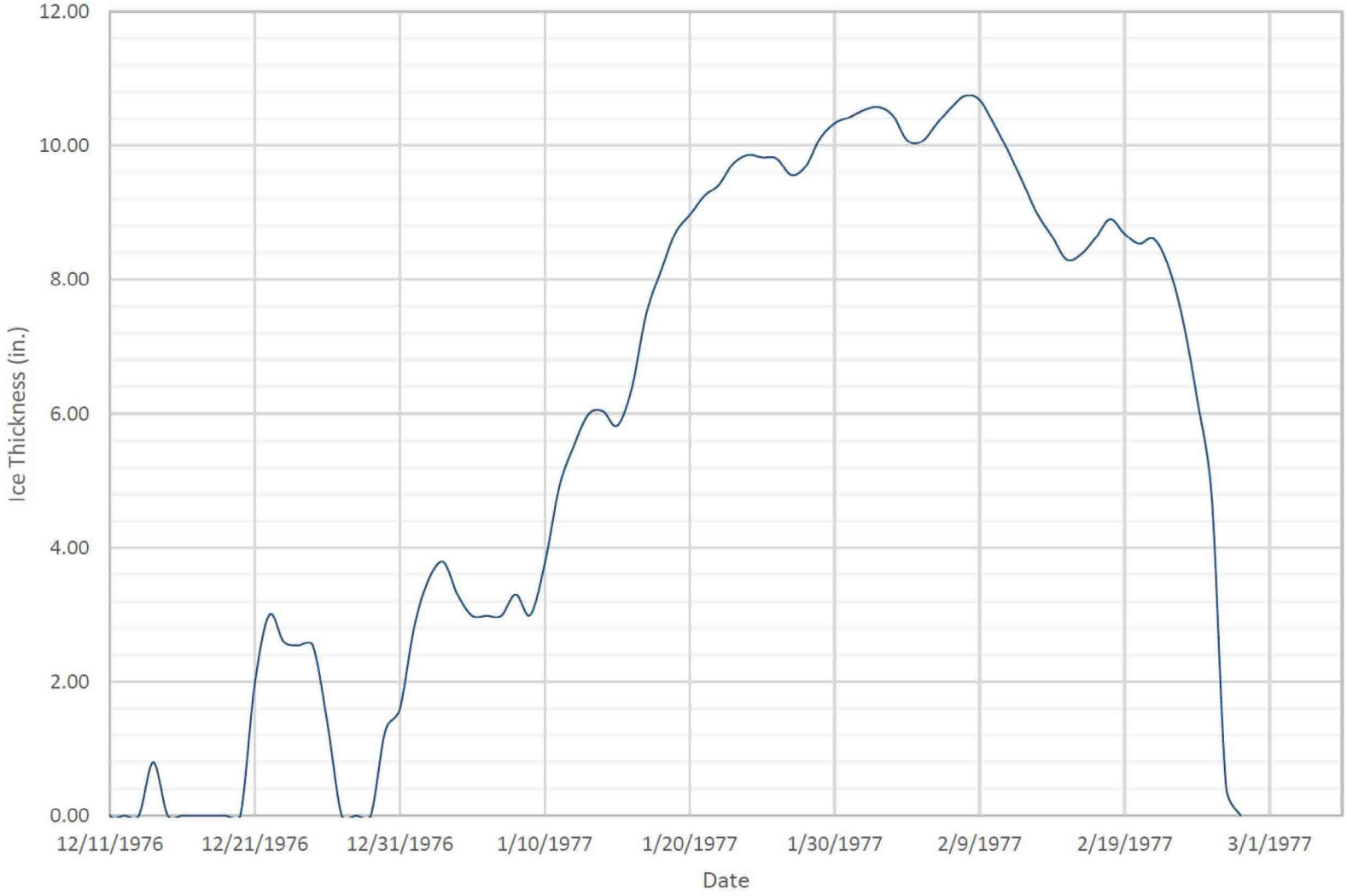


Figure 2.4-41
Estimated Yearly Maximum Ice Thickness for Approximate 96-Year Period of Record

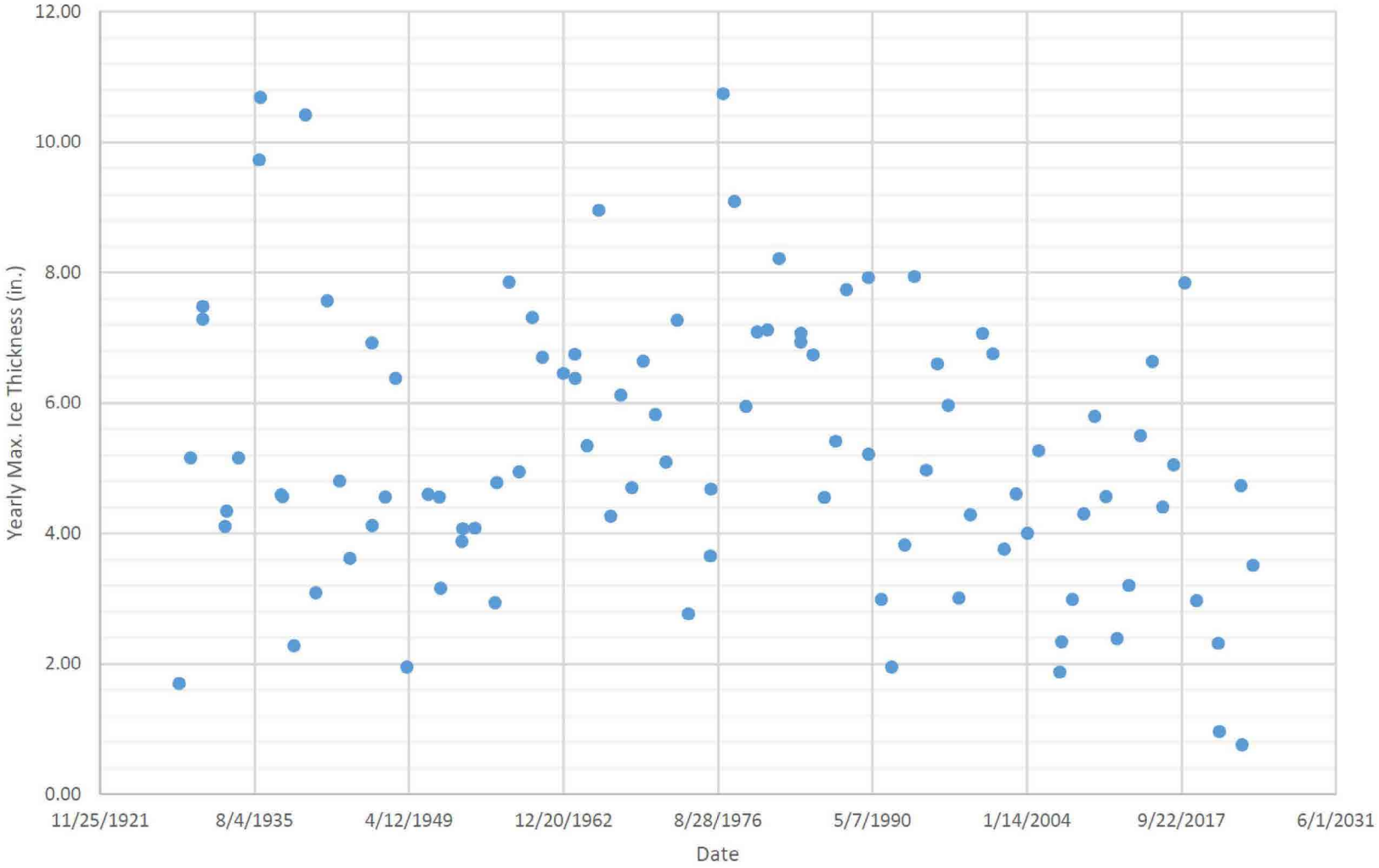


Figure 2.4-42
Belews Creek Potential Ice Jam Locations

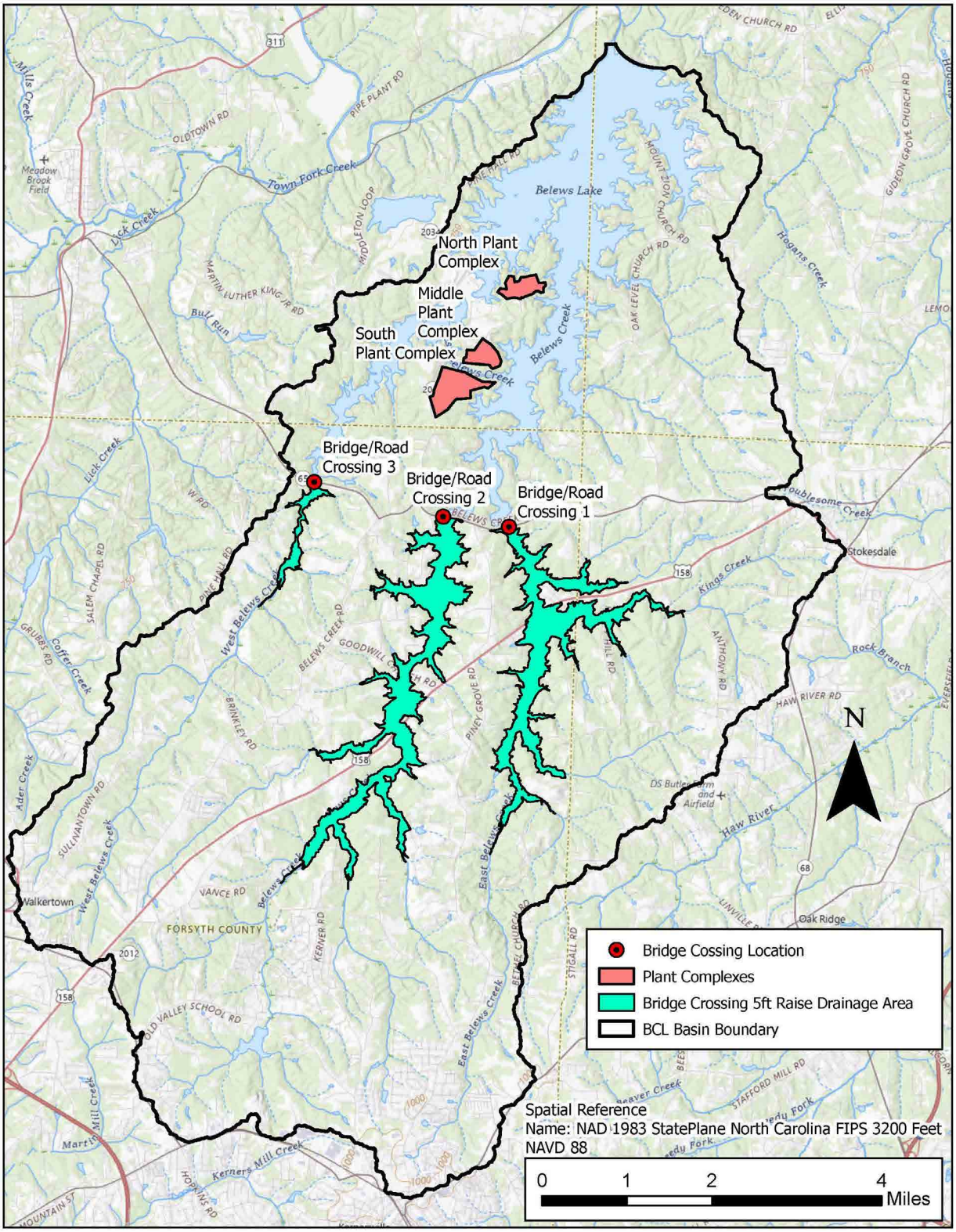


Figure 2.4-43
Vicinity Map of Project Site

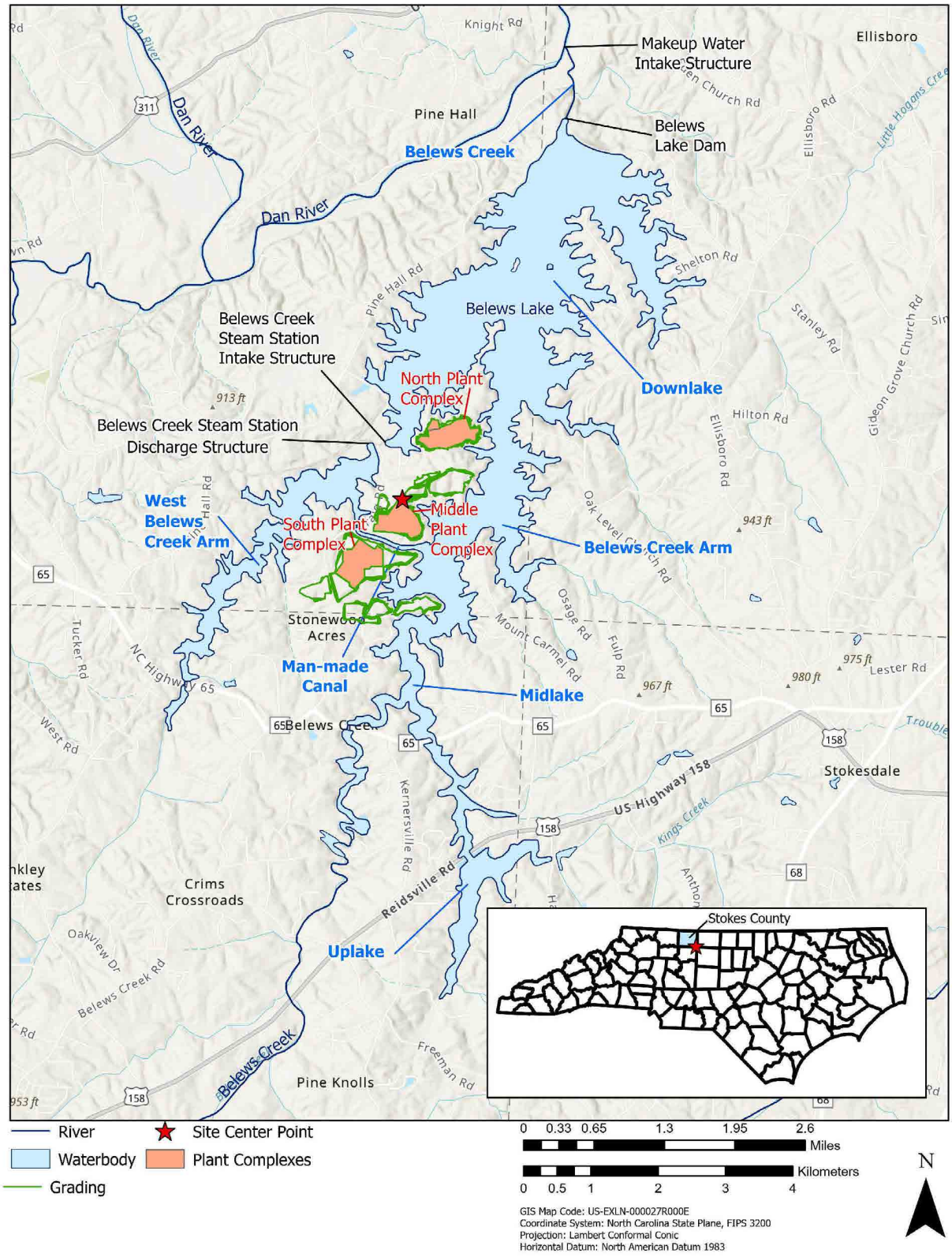


Figure 2.4-44
Dan River Trajectory and Makeup Water Intake Structure

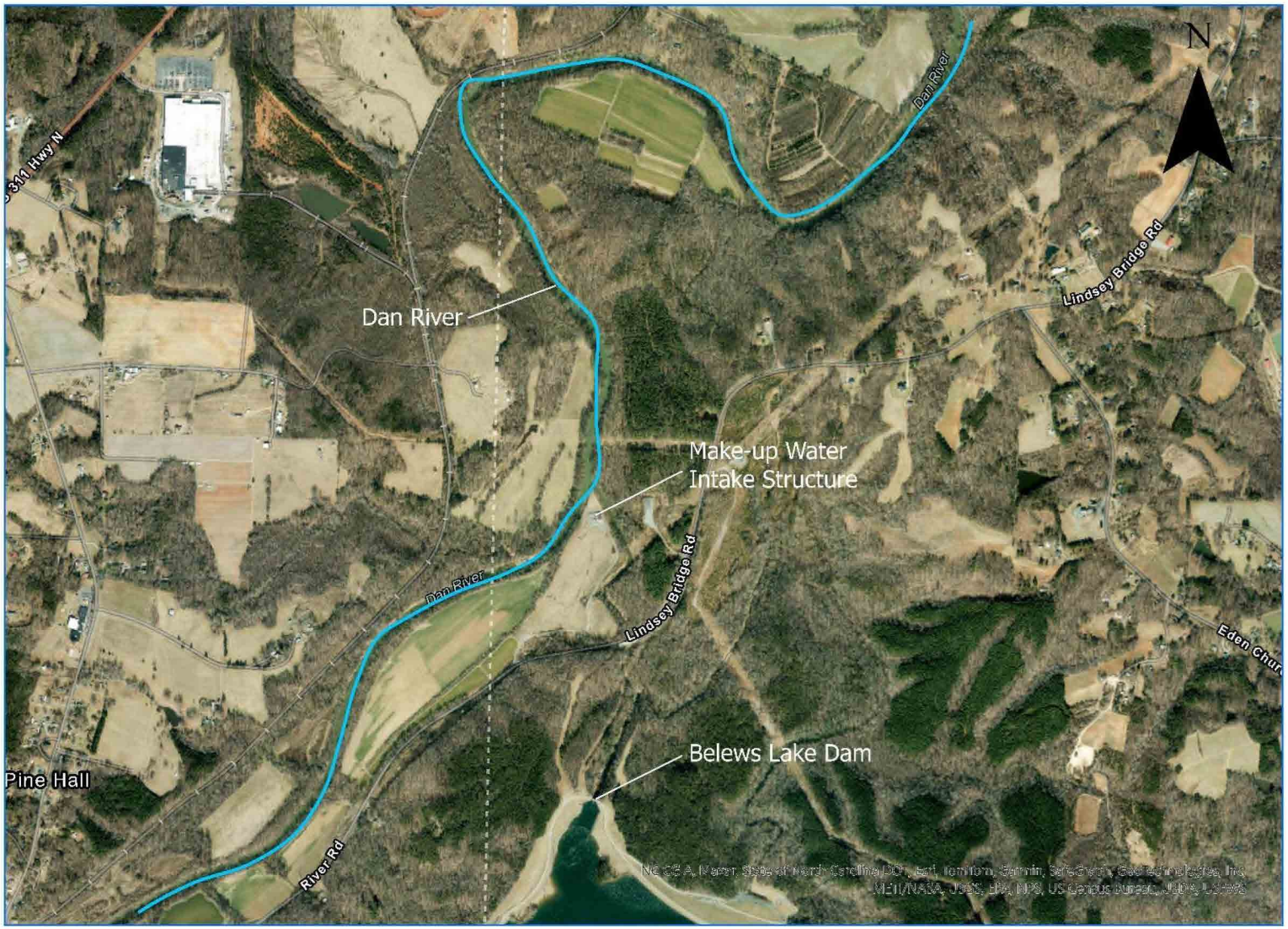
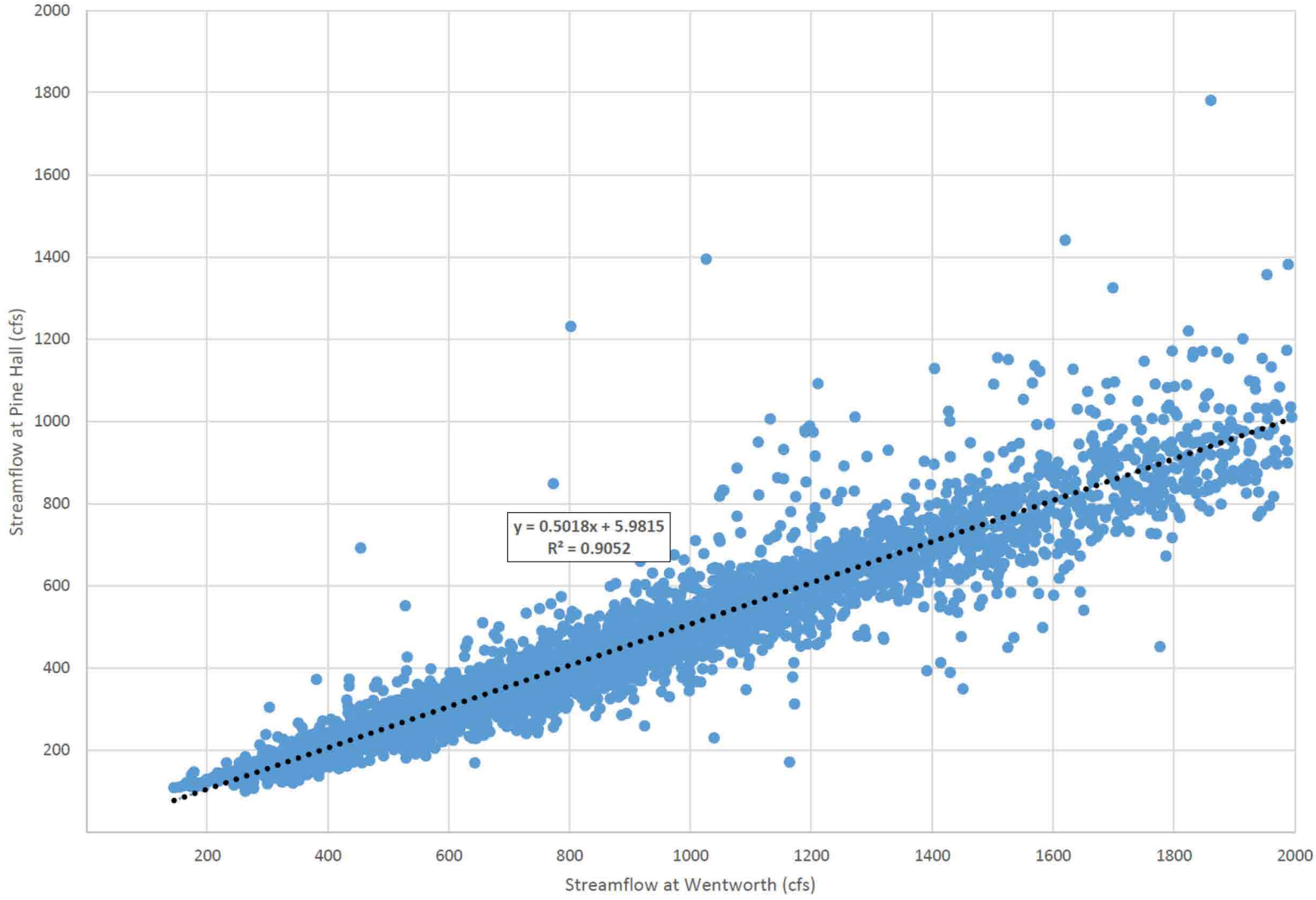


Figure 2.4-45
Streamflow at Wentworth vs Pine Hall Gauges



Key: cfs = cubic feet per second

Figure 2.4-46
Proposed Intake and Discharge Locations

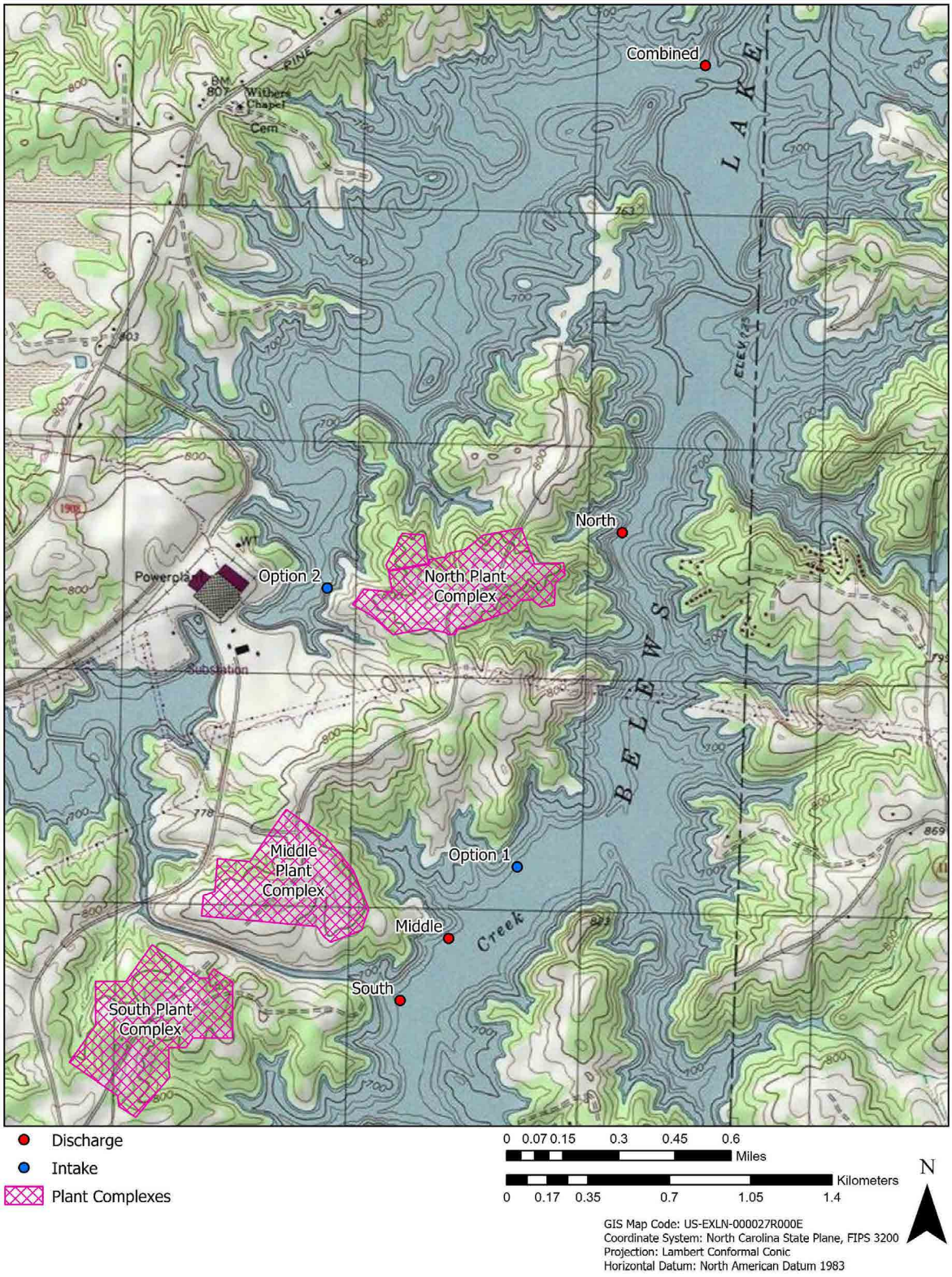
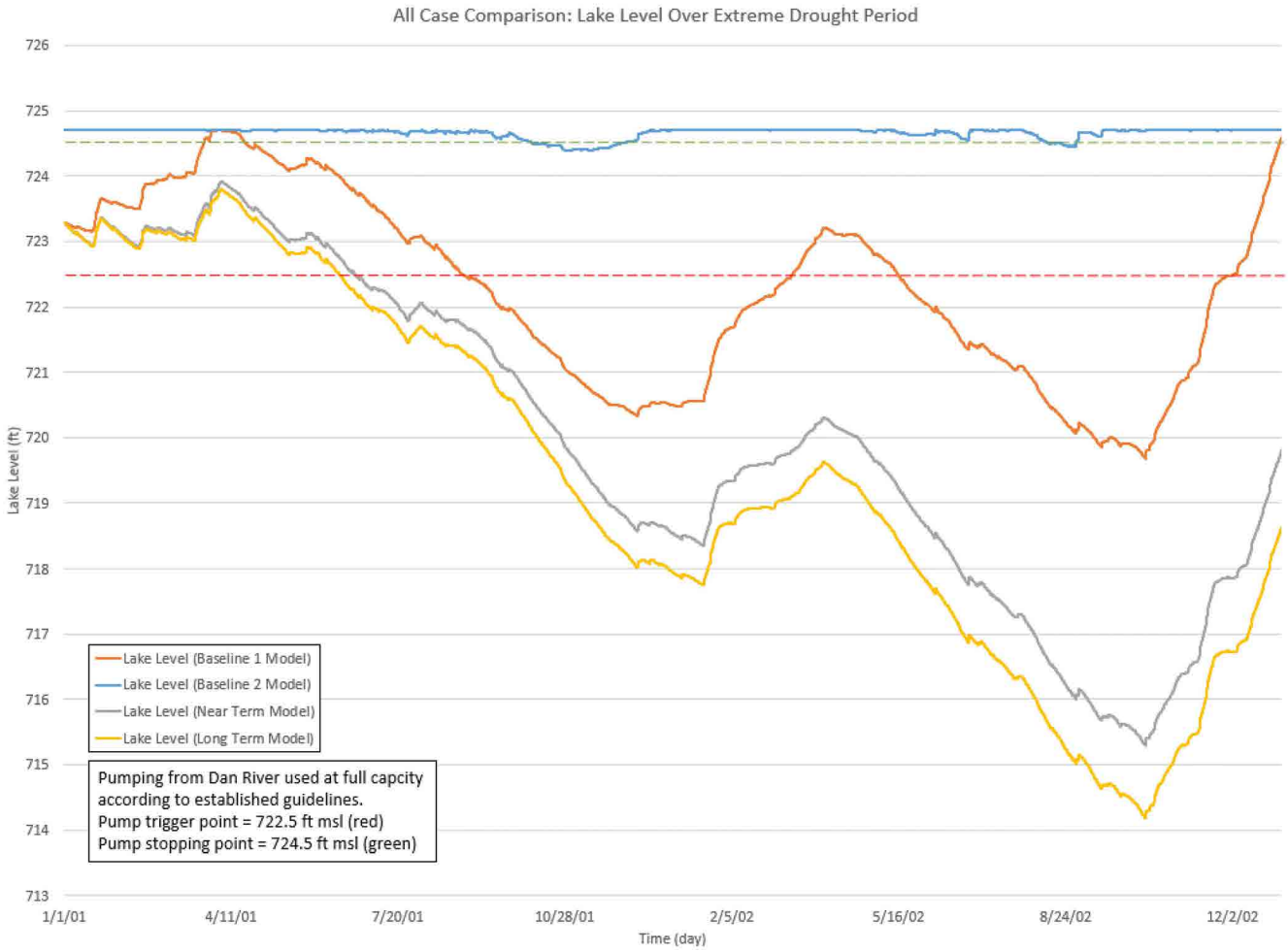
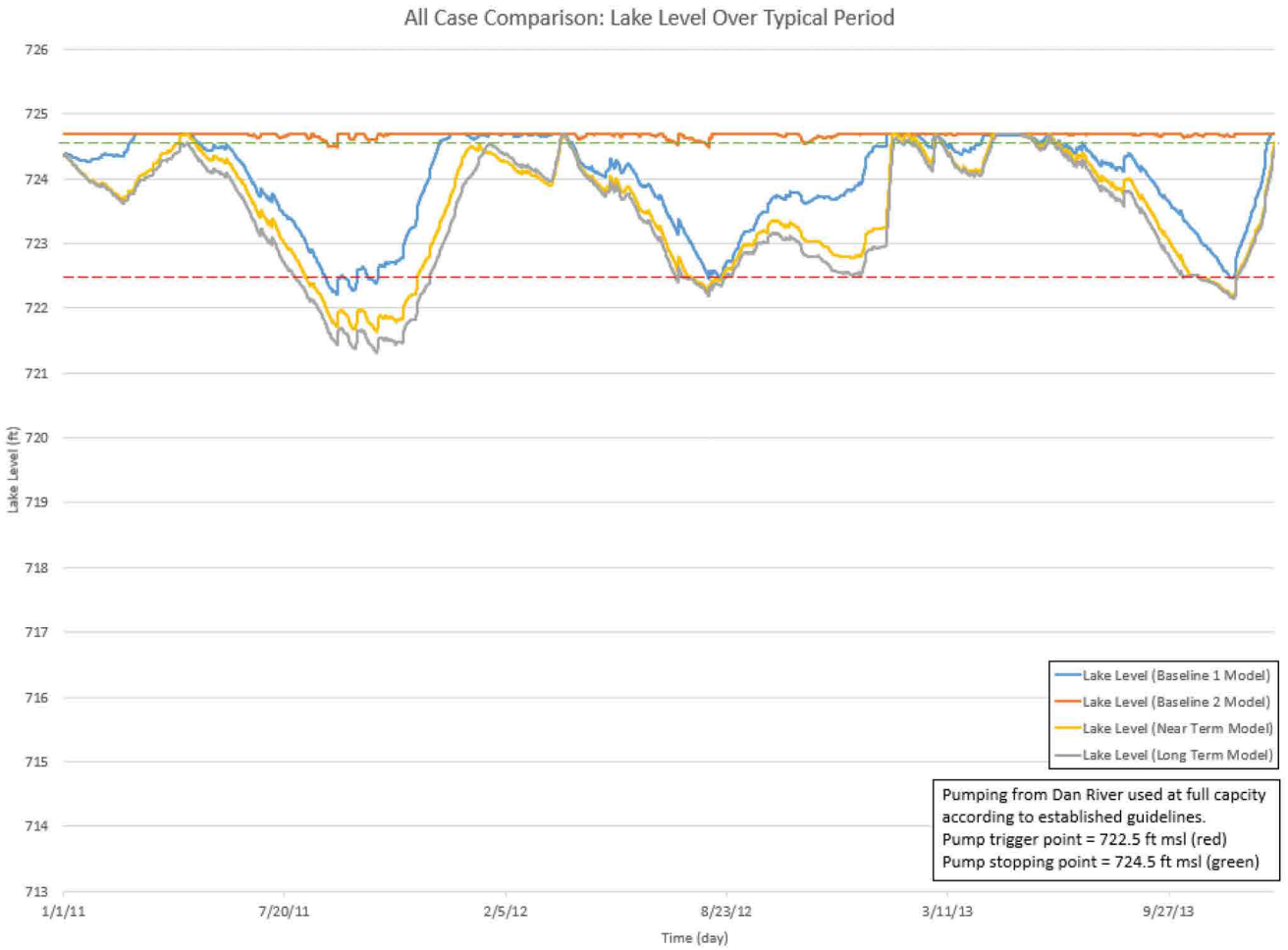


Figure 2.4-47
All Case Comparison, Extreme Drought Period Lake Level



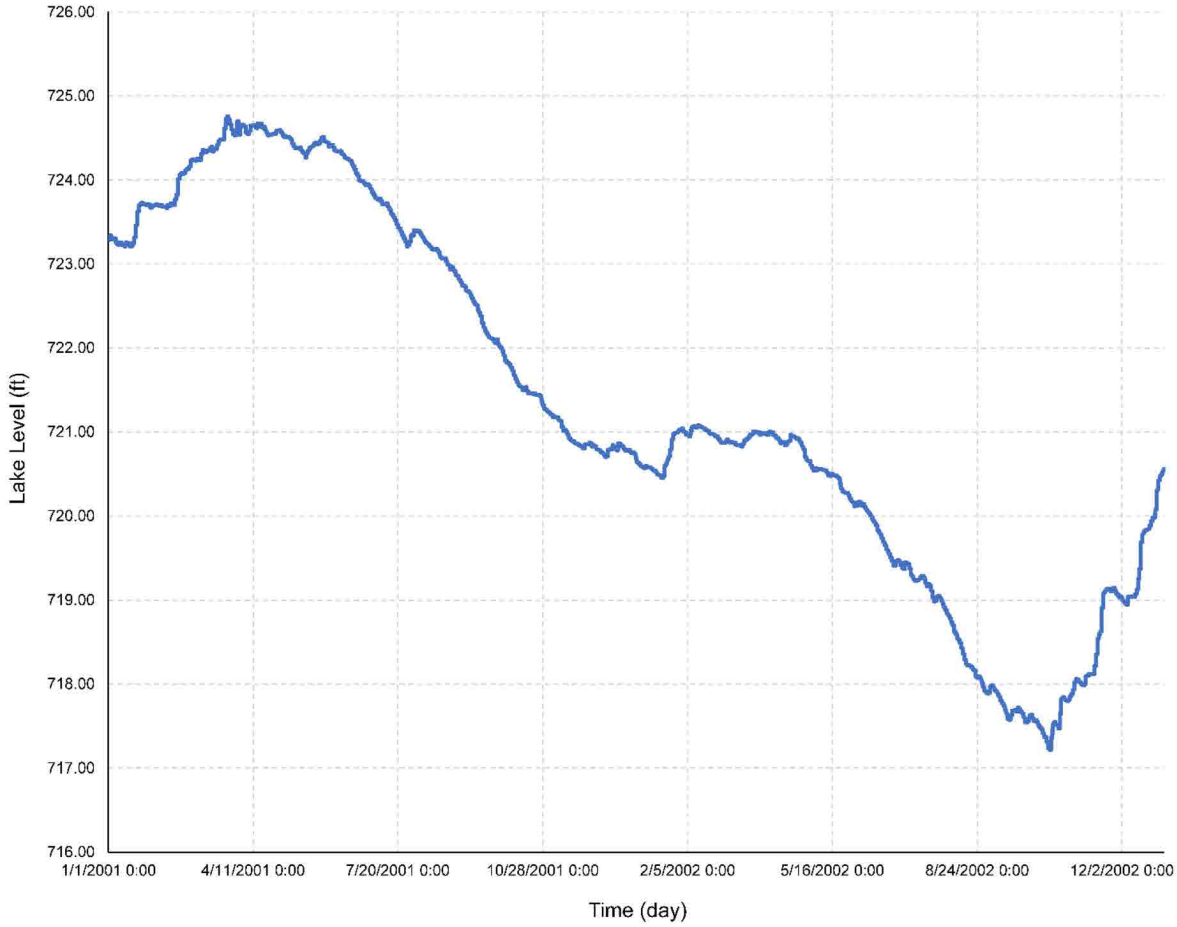
Key: msl = mean sea level; ft. = feet

Figure 2.4-48
All Case Comparison, Typical Period Lake Level



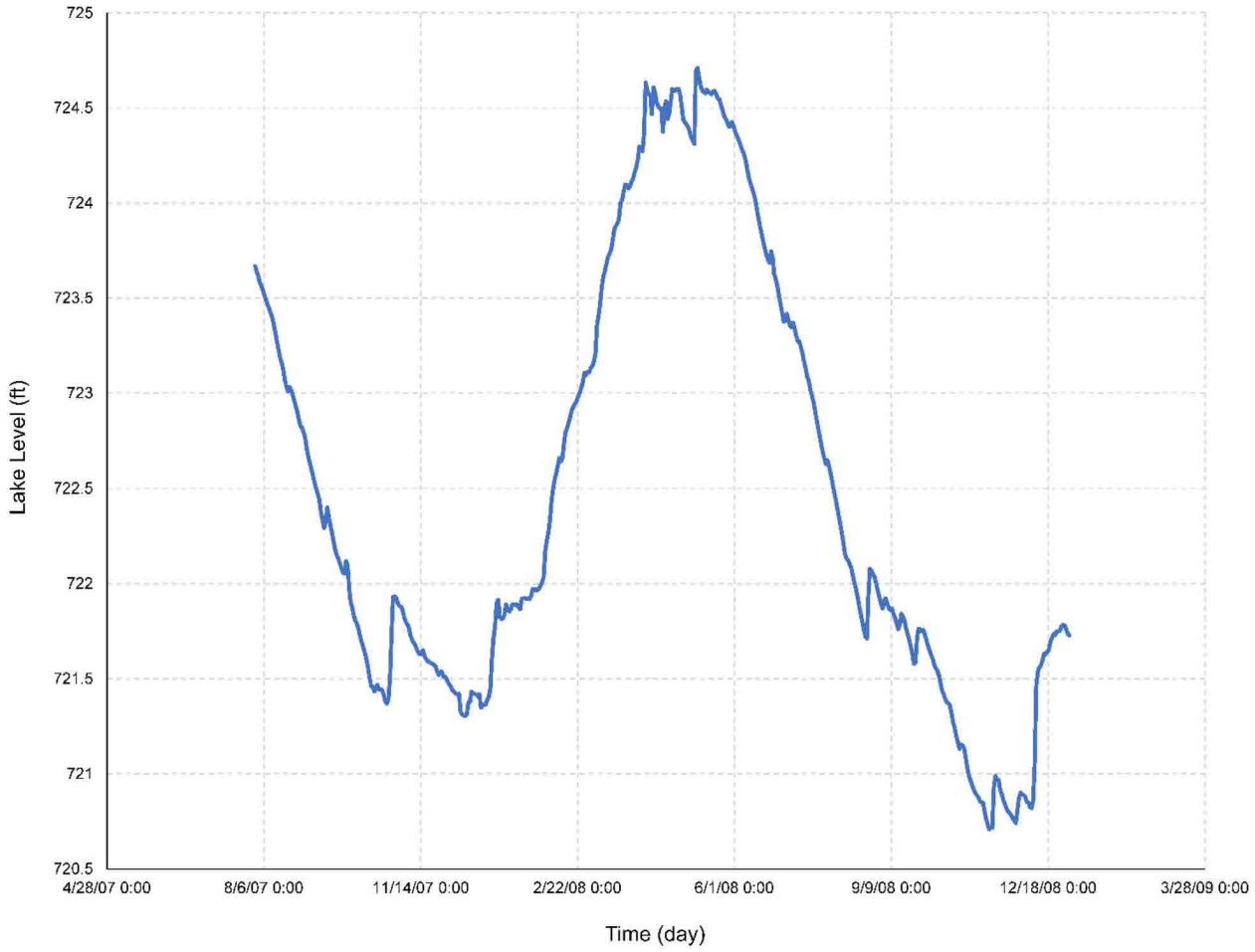
Key: msl = mean sea level; ft. = feet

Figure 2.4-49
Historical Lake Level in 2001-2002



Key: ft = feet

Figure 2.4-50
Historical Lake Level in 2007-2008



Key: ft. = feet

Figure 2.4-51
Project Site Location Map

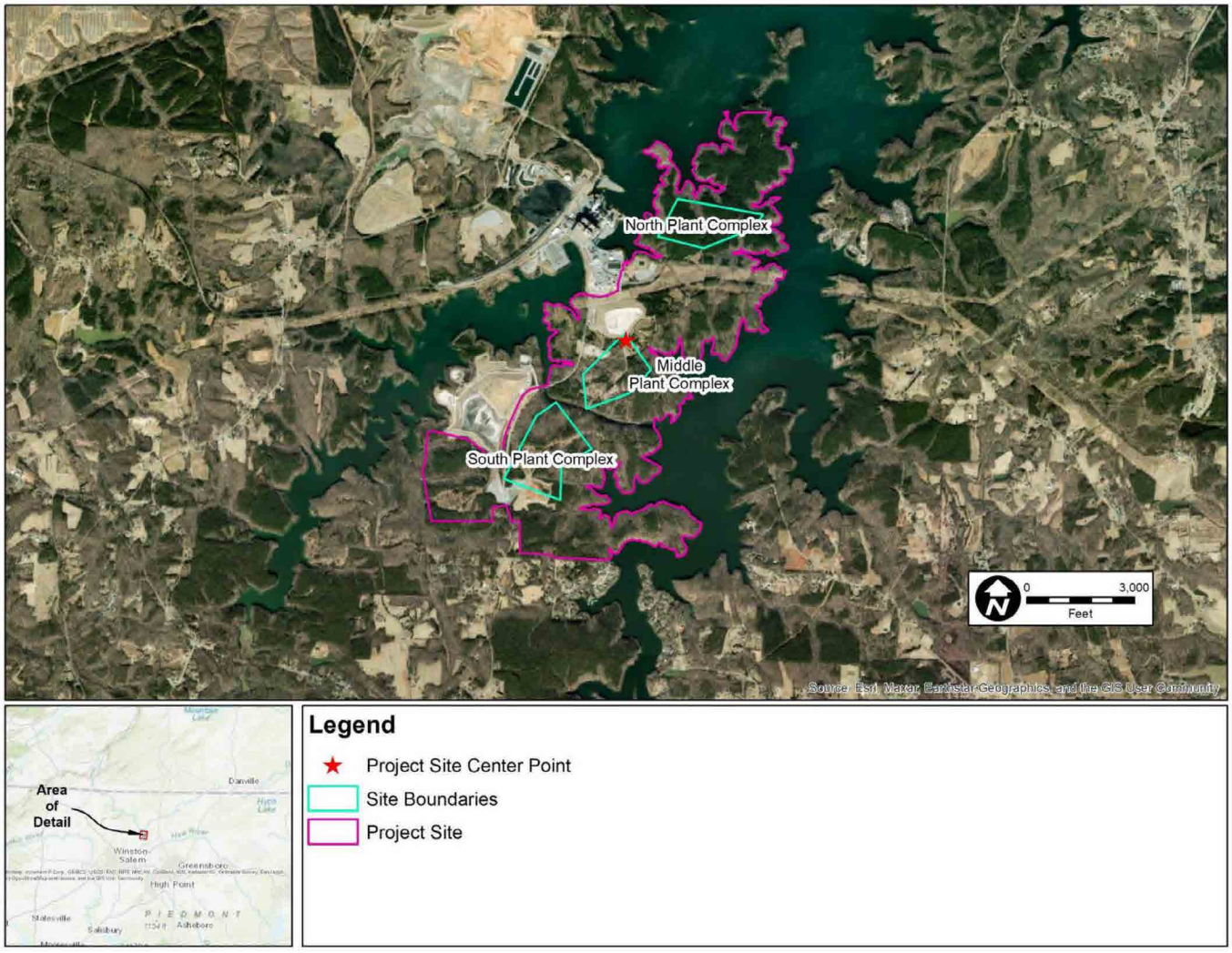
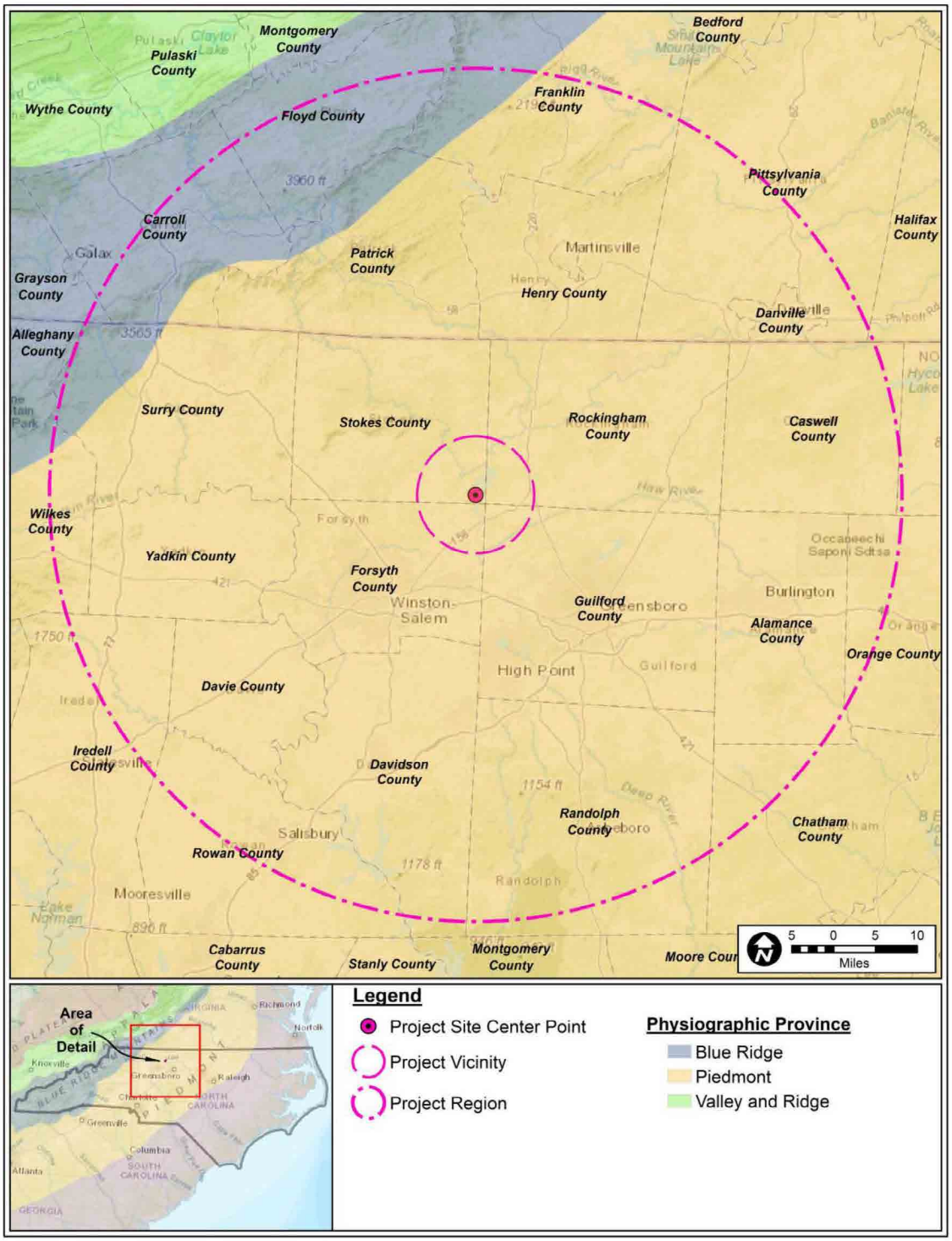


Figure 2.4-52
Physiographic Provinces Near Belews Creek



Source: Reference 2.4-54

Figure 2.4-53
Major Surface Water Features

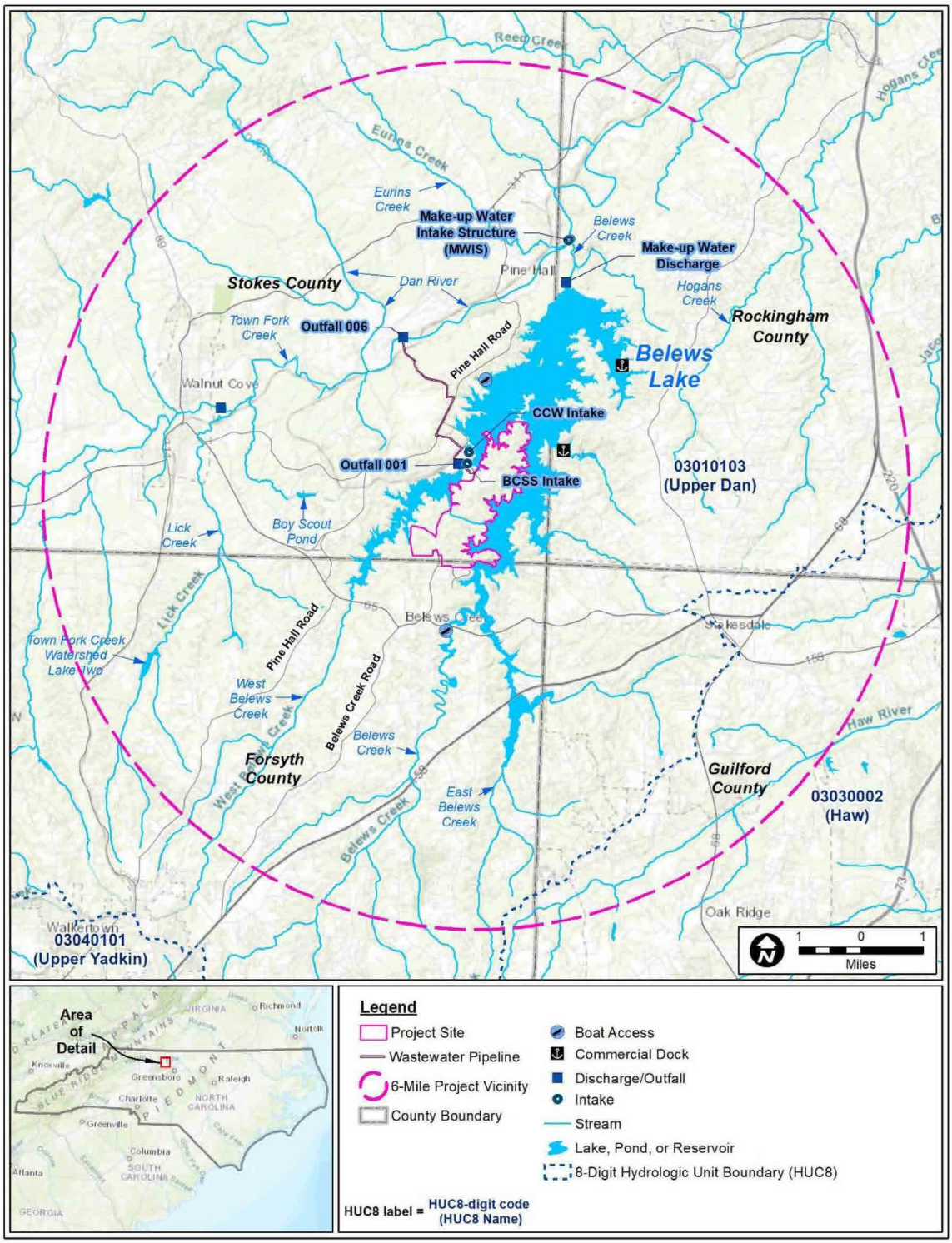
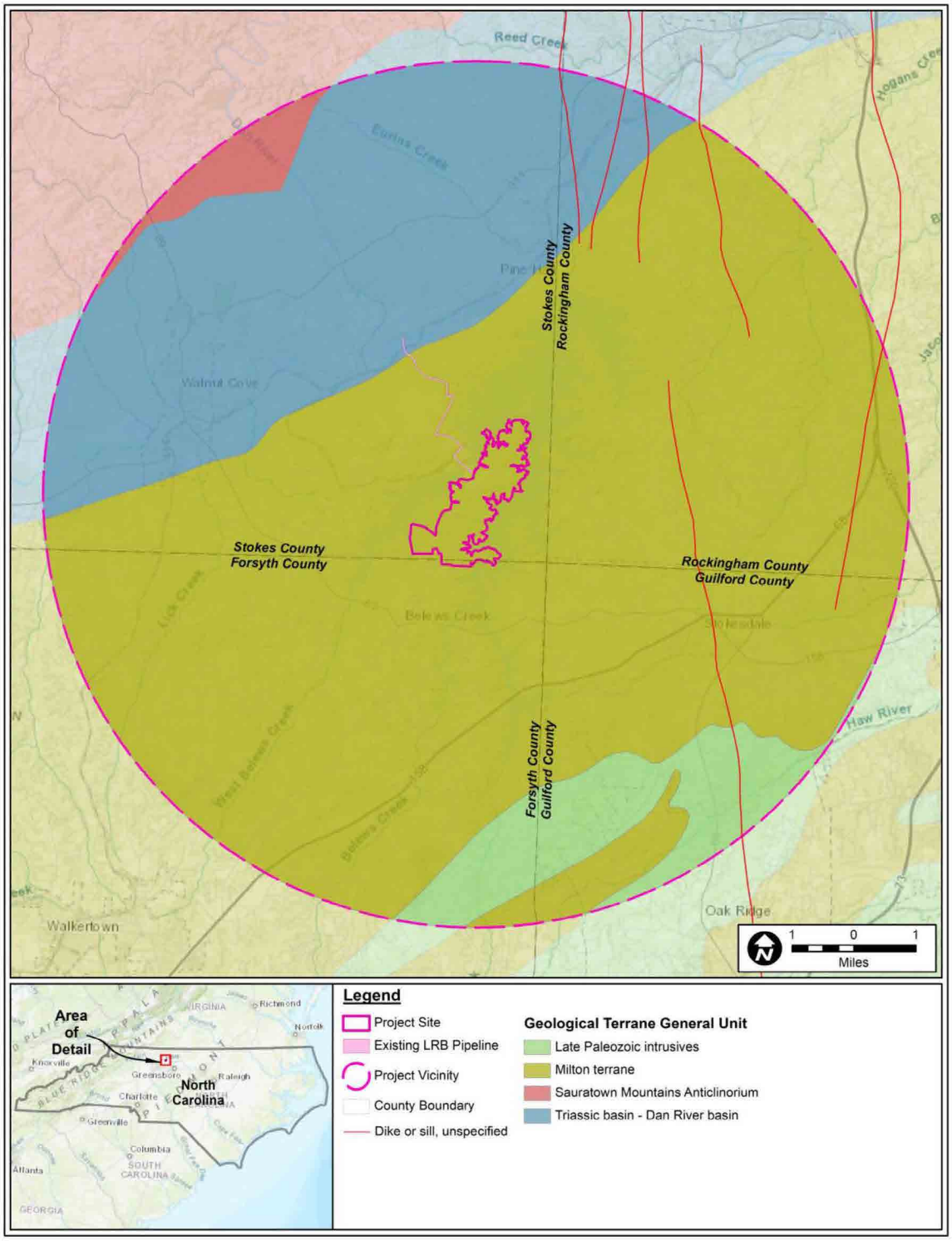
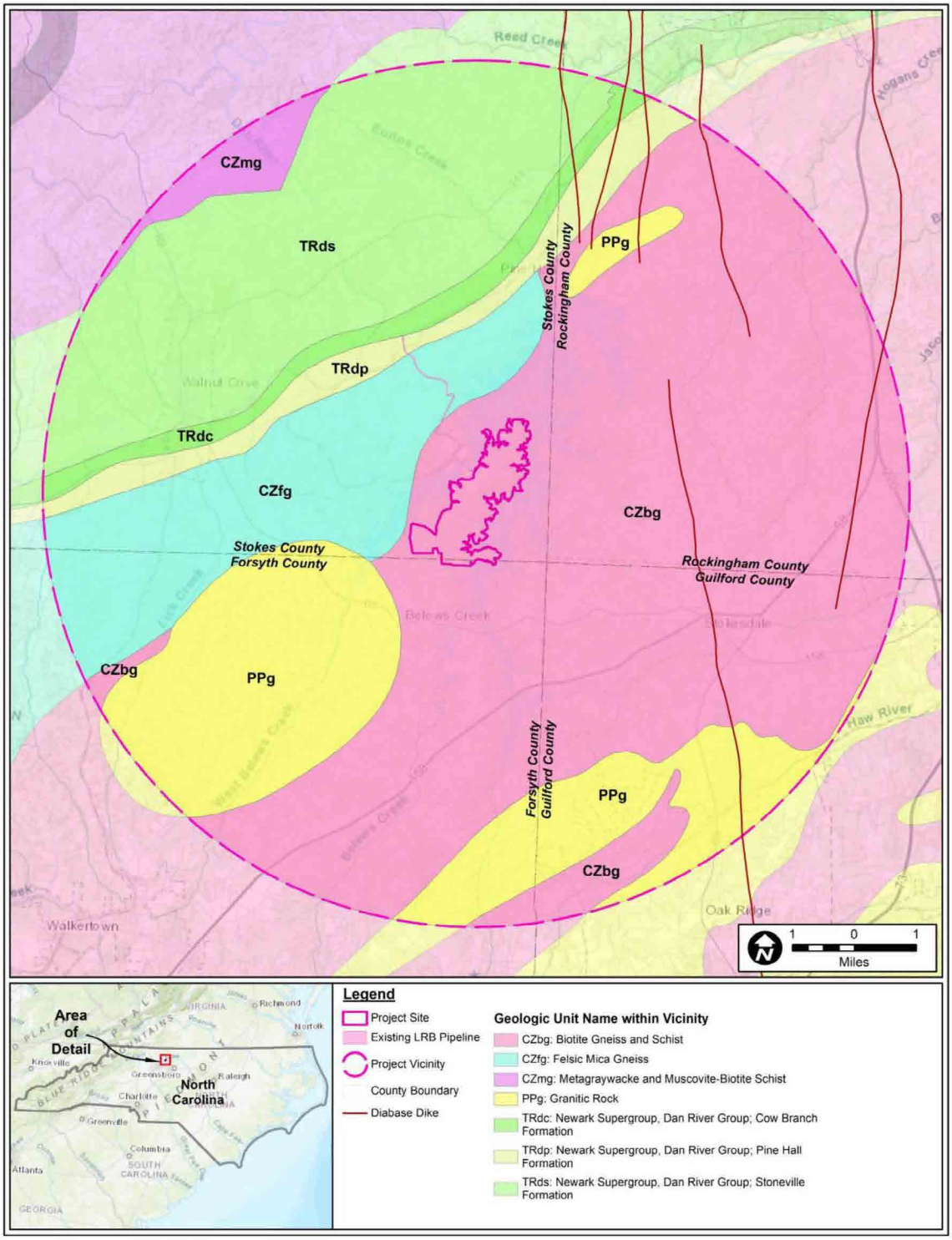


Figure 2.4-54
Geologic Terranes



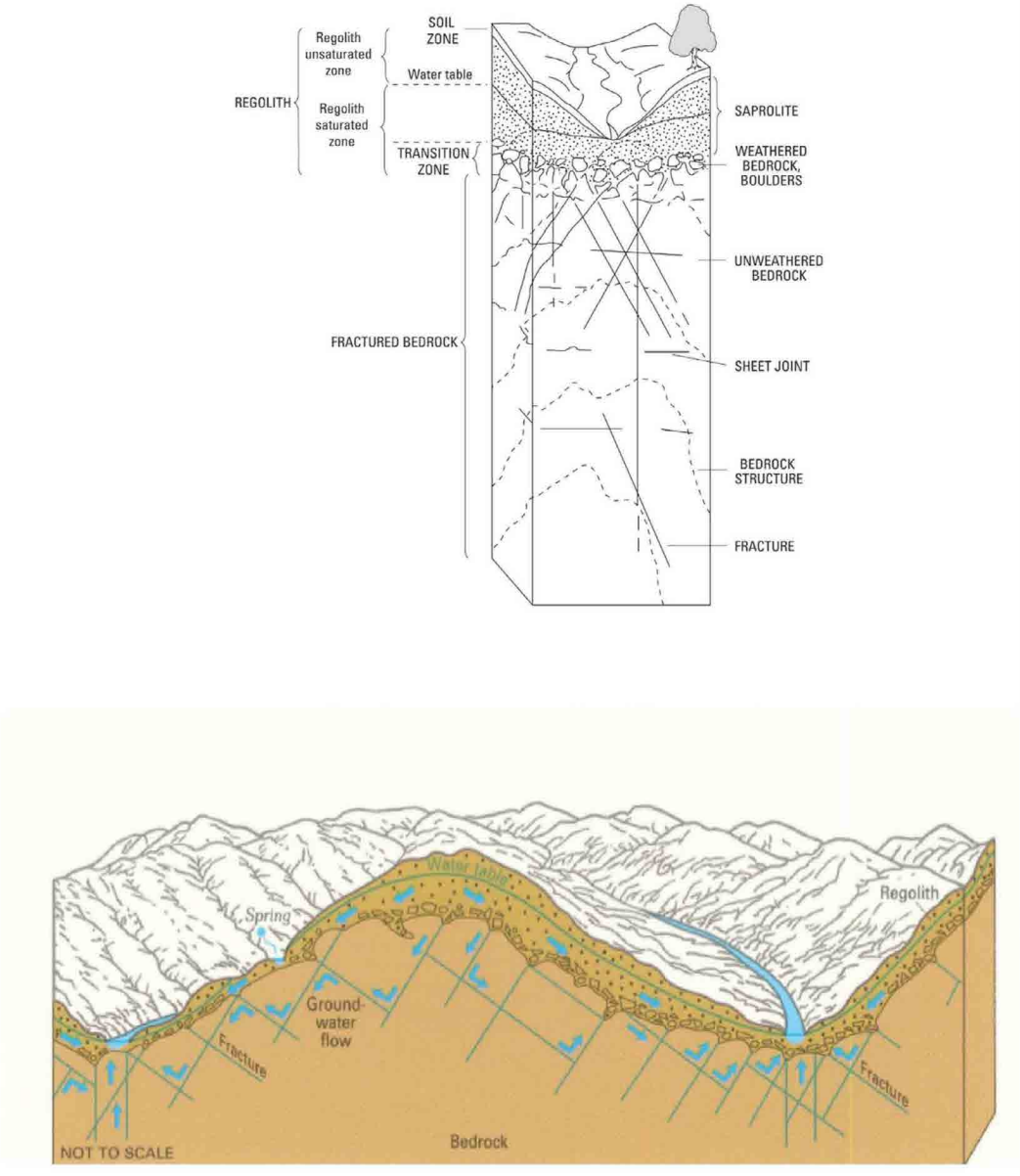
Source: Reference 2.4-64

Figure 2.4-55
Geology Map



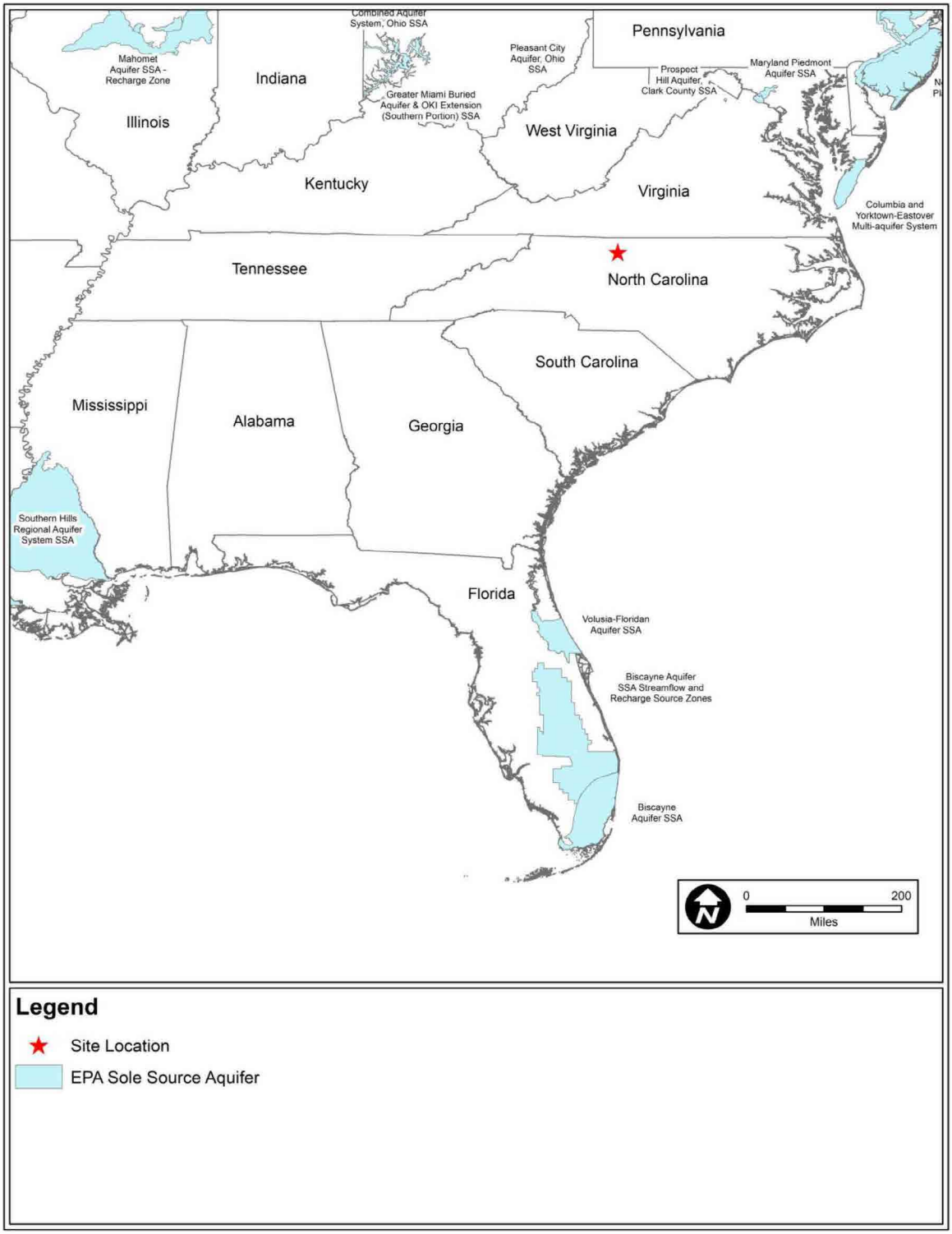
Source: Reference 2.4-68

Figure 2.4-56
Typical Piedmont Hydrogeologic Components



Source: Reference 2.4-70; Reference 2.4-71

Figure 2.4-57
Sole-Source Aquifers



Source: Reference: 2.4-75

Figure 2.4-58
Well and Boring Location Map

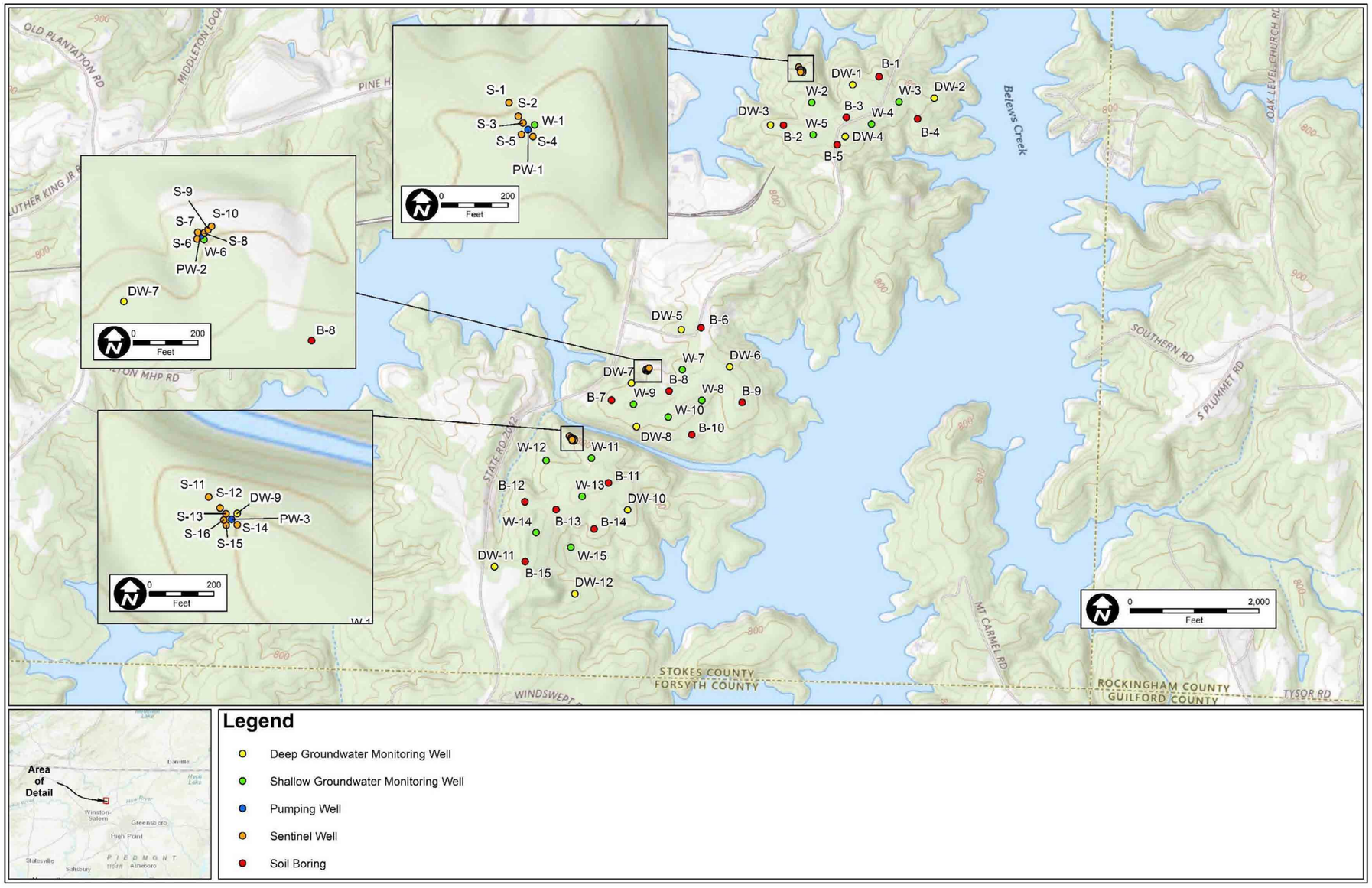


Figure 2.4-59
Cross Section Location Map

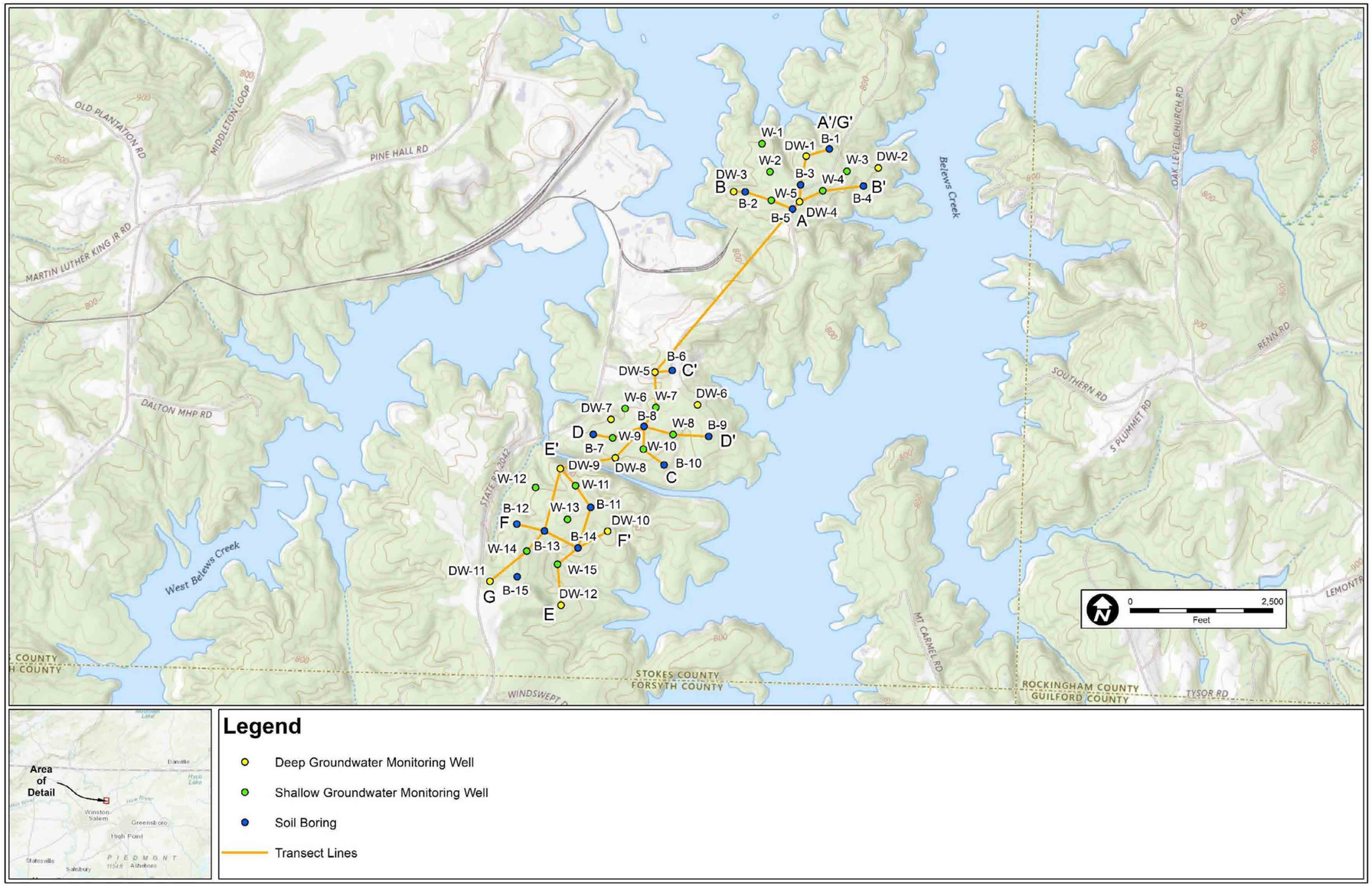


Figure 2.4-60
Cross Section A to A' – North Plant Complex

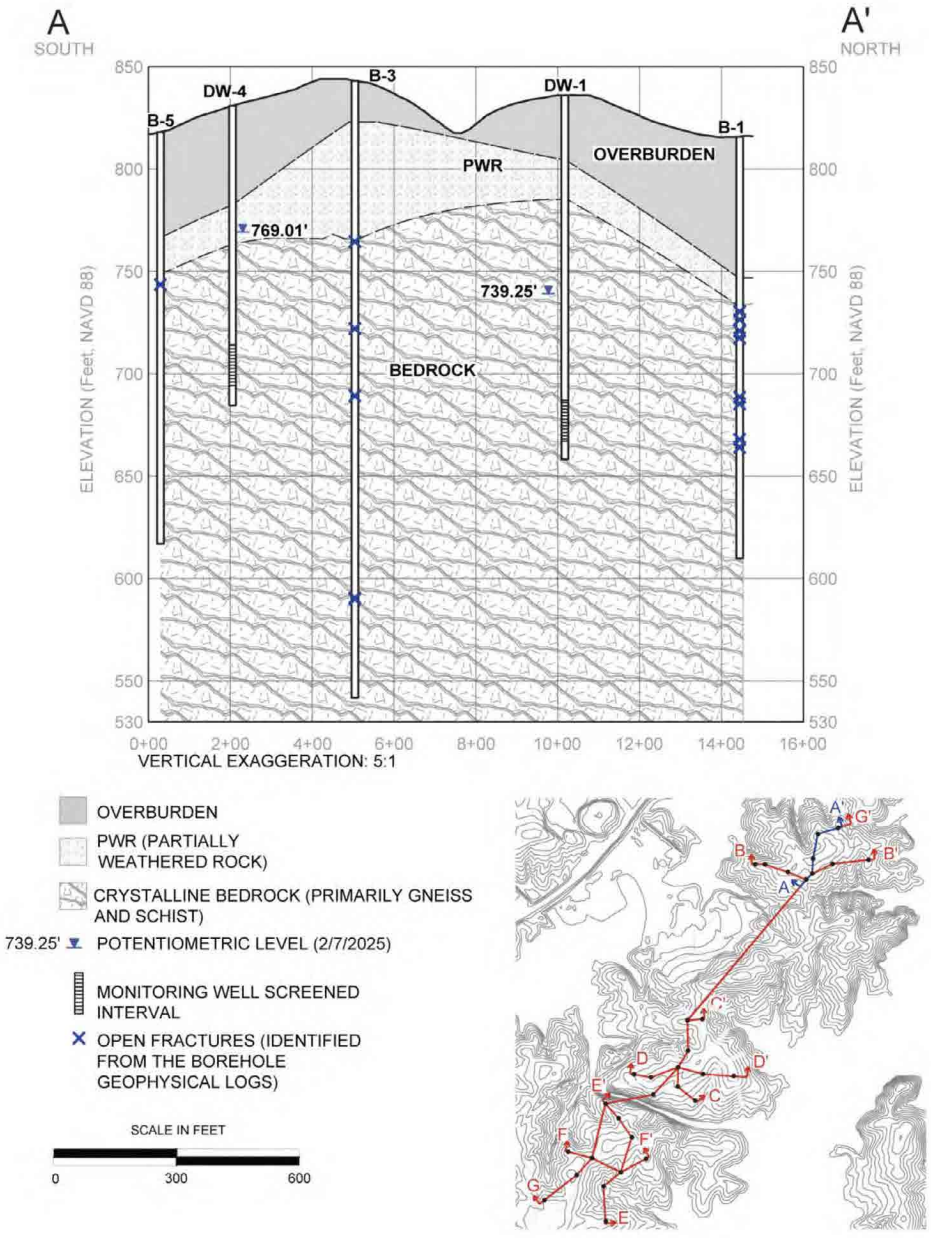


Figure 2.4-61
Cross Section B to B' – North Plant Complex

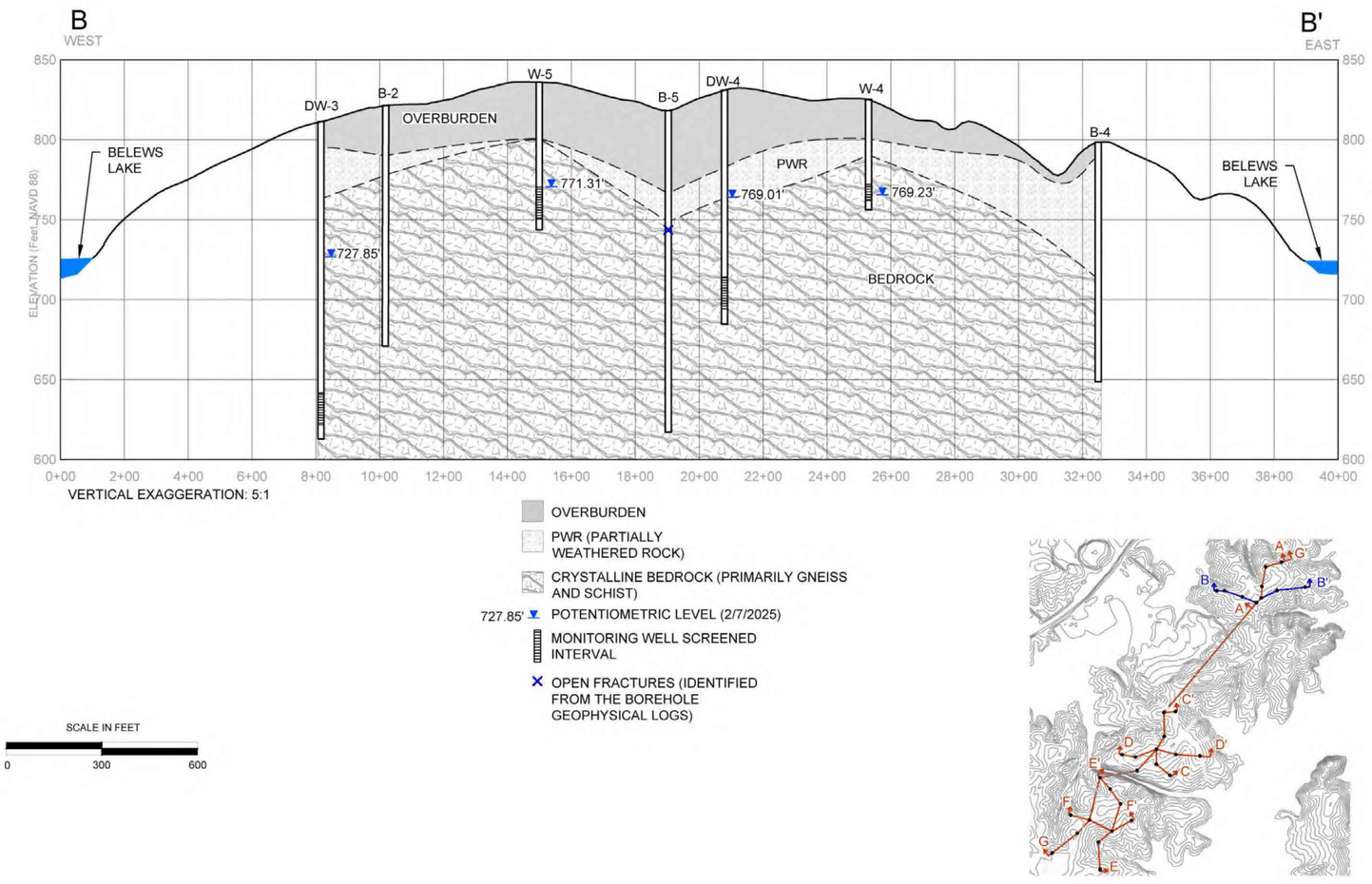
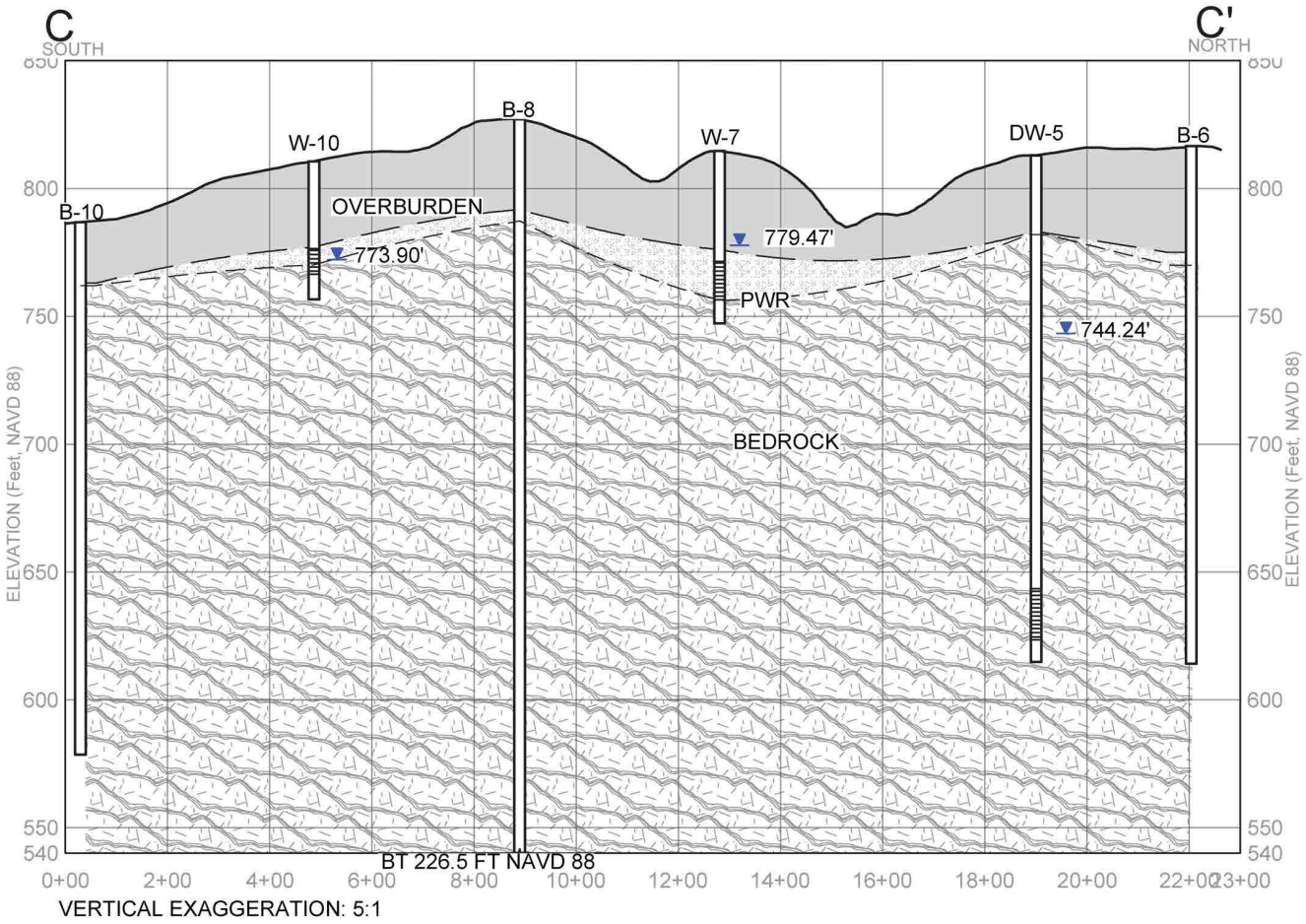
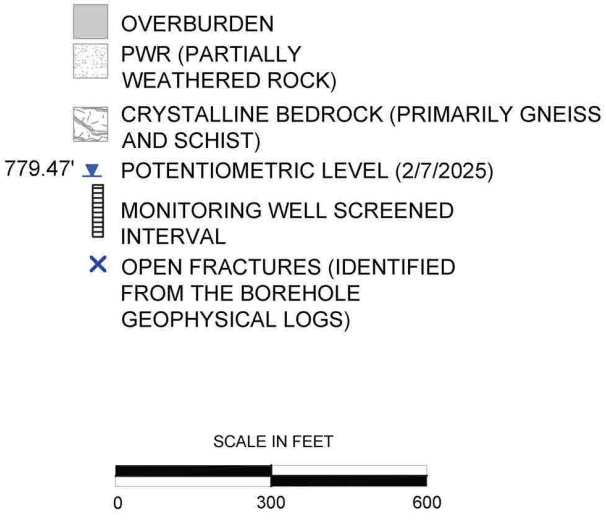


Figure 2.4-62
Cross Section C to C' – Middle Plant Complex





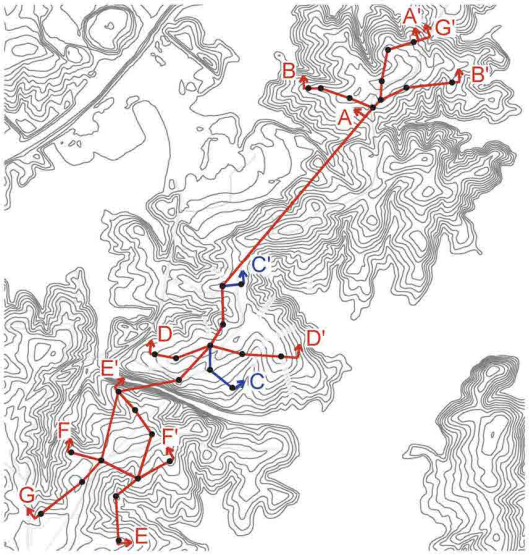


Figure 2.4-63
Cross Section D to D' – Middle Plant Complex

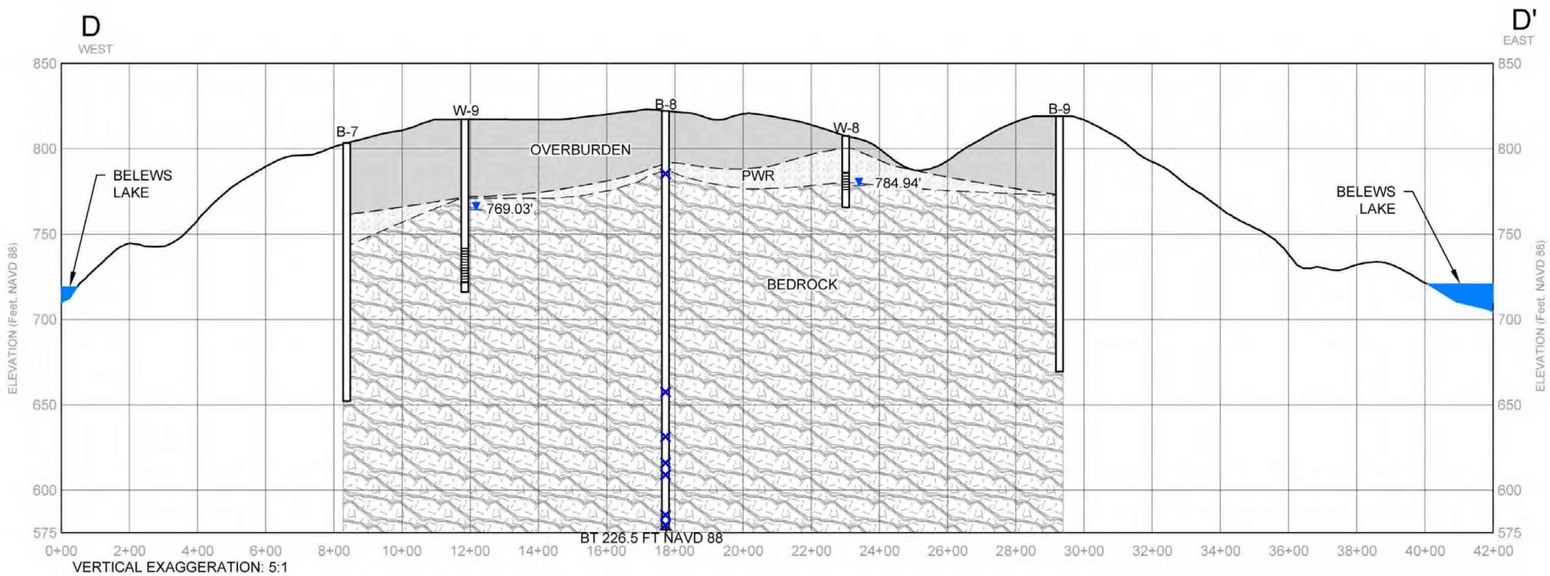


Figure 2.4-64
Cross Section E to E' – South Plant Complex

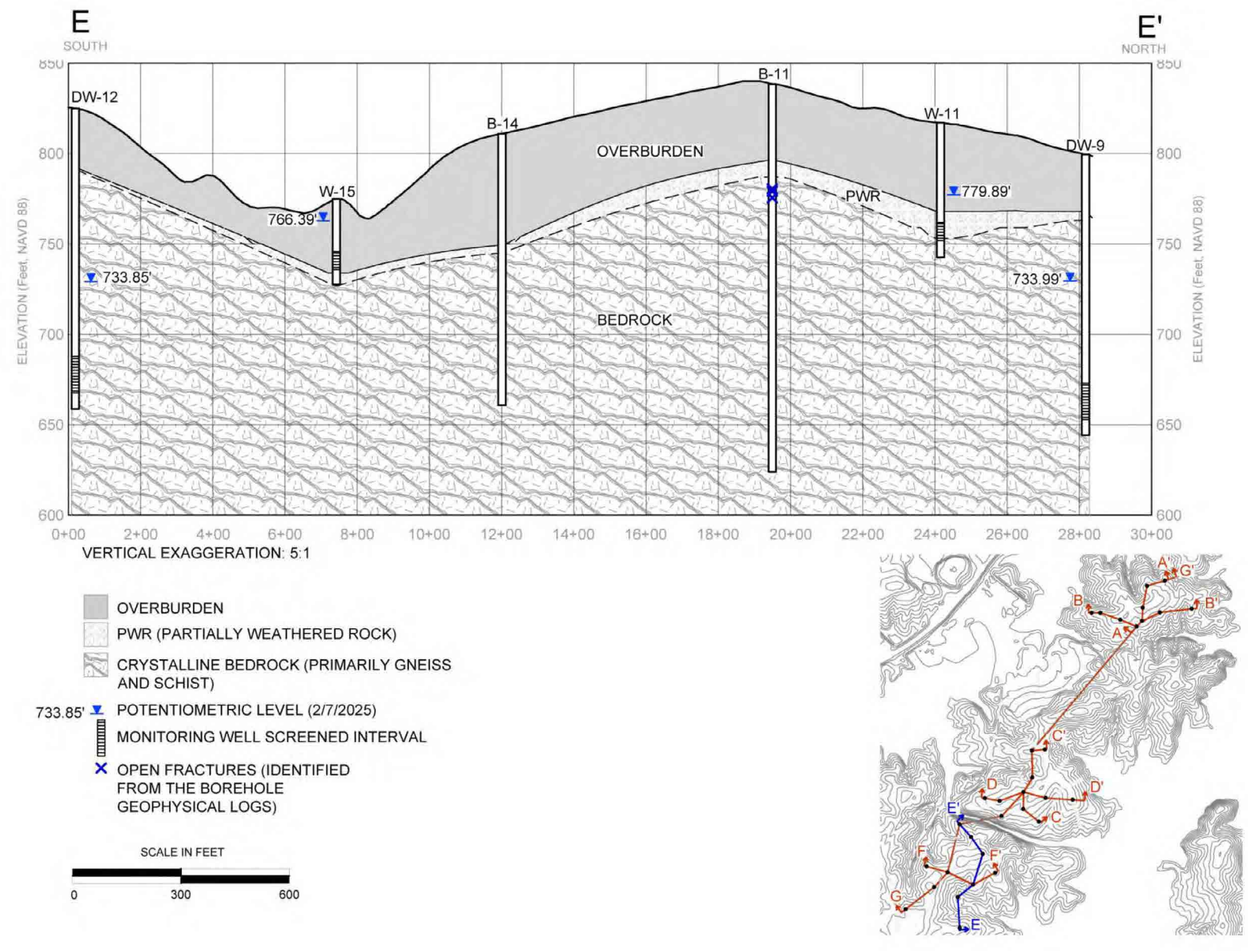


Figure 2.4-65
Cross Section F to F' – South Plant Complex

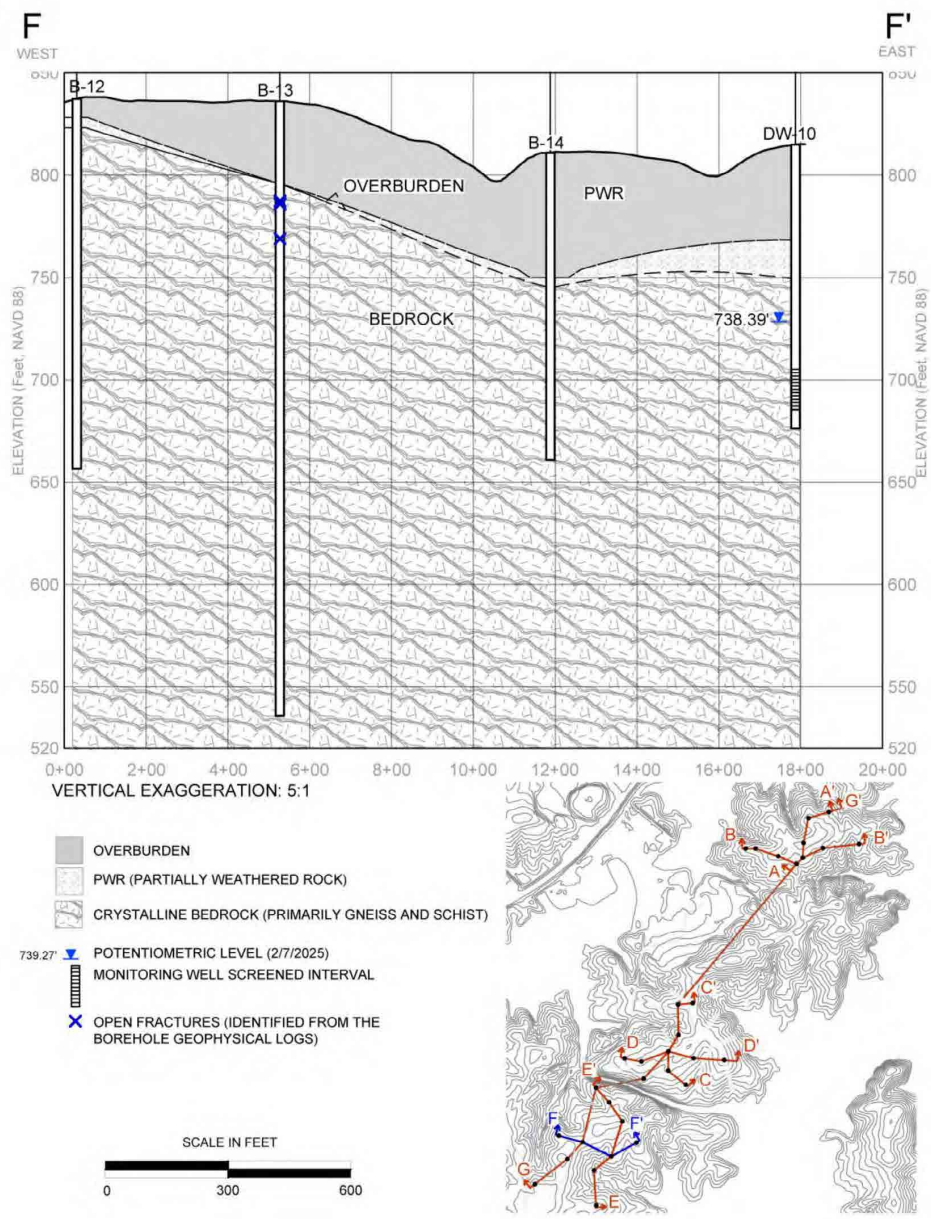
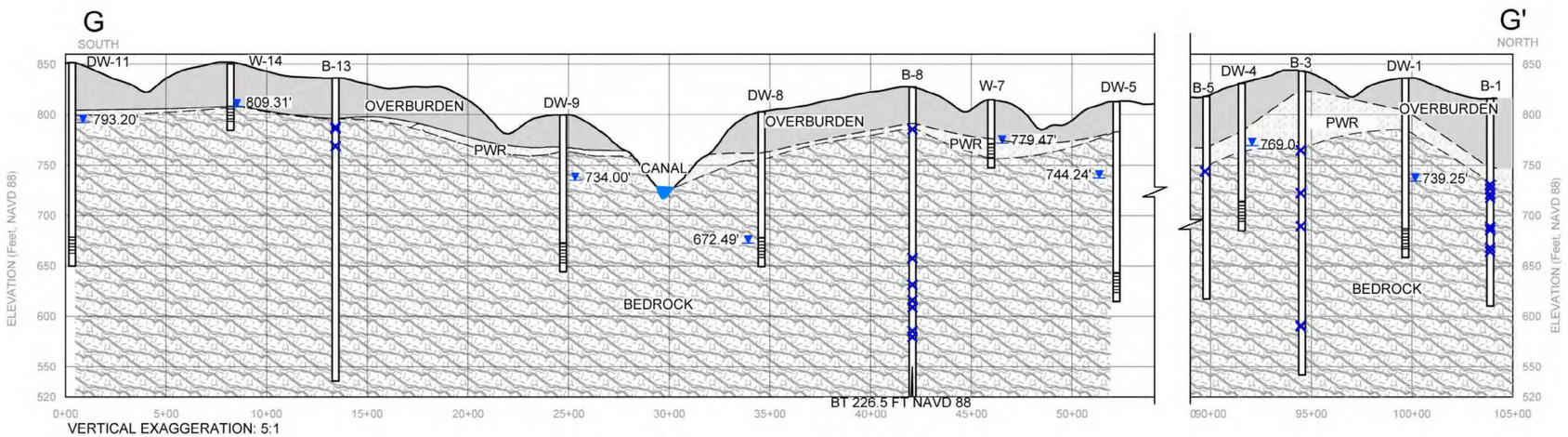


Figure 2.4-66
Cross Section G to G' – South Plant Complex to North Plant Complex



OVERBURDEN
PWR (PARTIALLY WEATHERED ROCK)
CRYSTALLINE BEDROCK (PRIMARILY GNEISS AND SCHIST)
793.20' POTENTIOMETRIC LEVEL (2/7/2025)
MONITORING WELL SCREENED INTERVAL
OPEN FRACTURES (IDENTIFIED FROM THE BOREHOLE GEOPHYSICAL LOGS)

SCALE IN FEET
0 500 1000

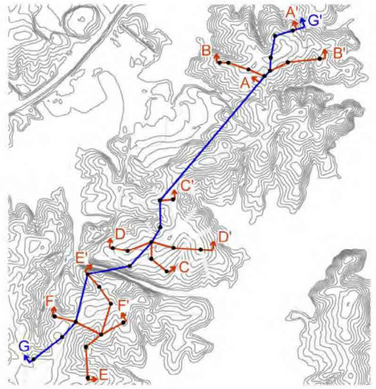
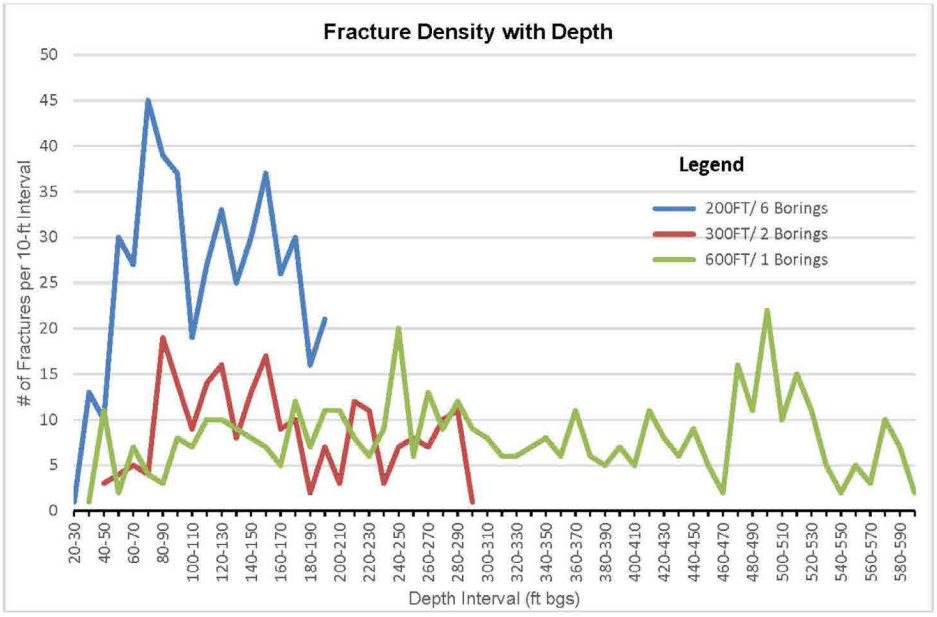


Figure 2.4-67
Bedrock Fracture Frequency



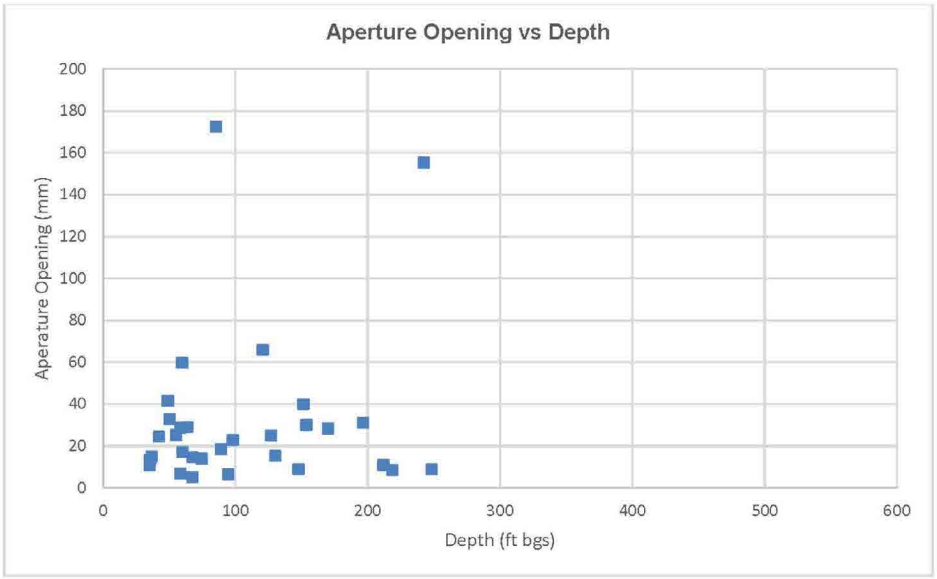


Figure 2.4-68
Remote-Sensing Lineament Map

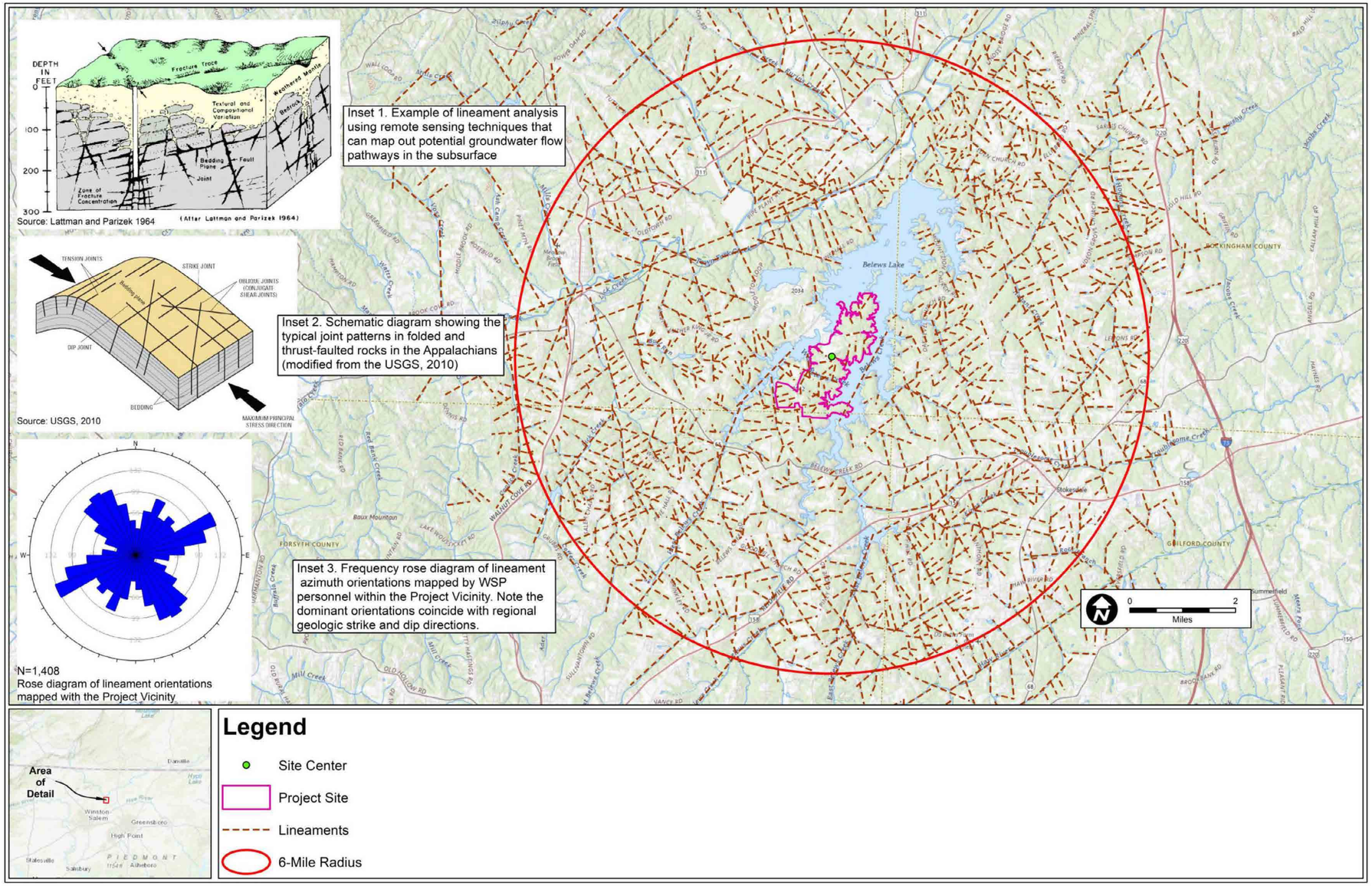


Figure 2.4-69
Potentiometric Surface Map Flow Direction for July 15, 2024 (Shallow Zone)
(Sheet 1 of 24)

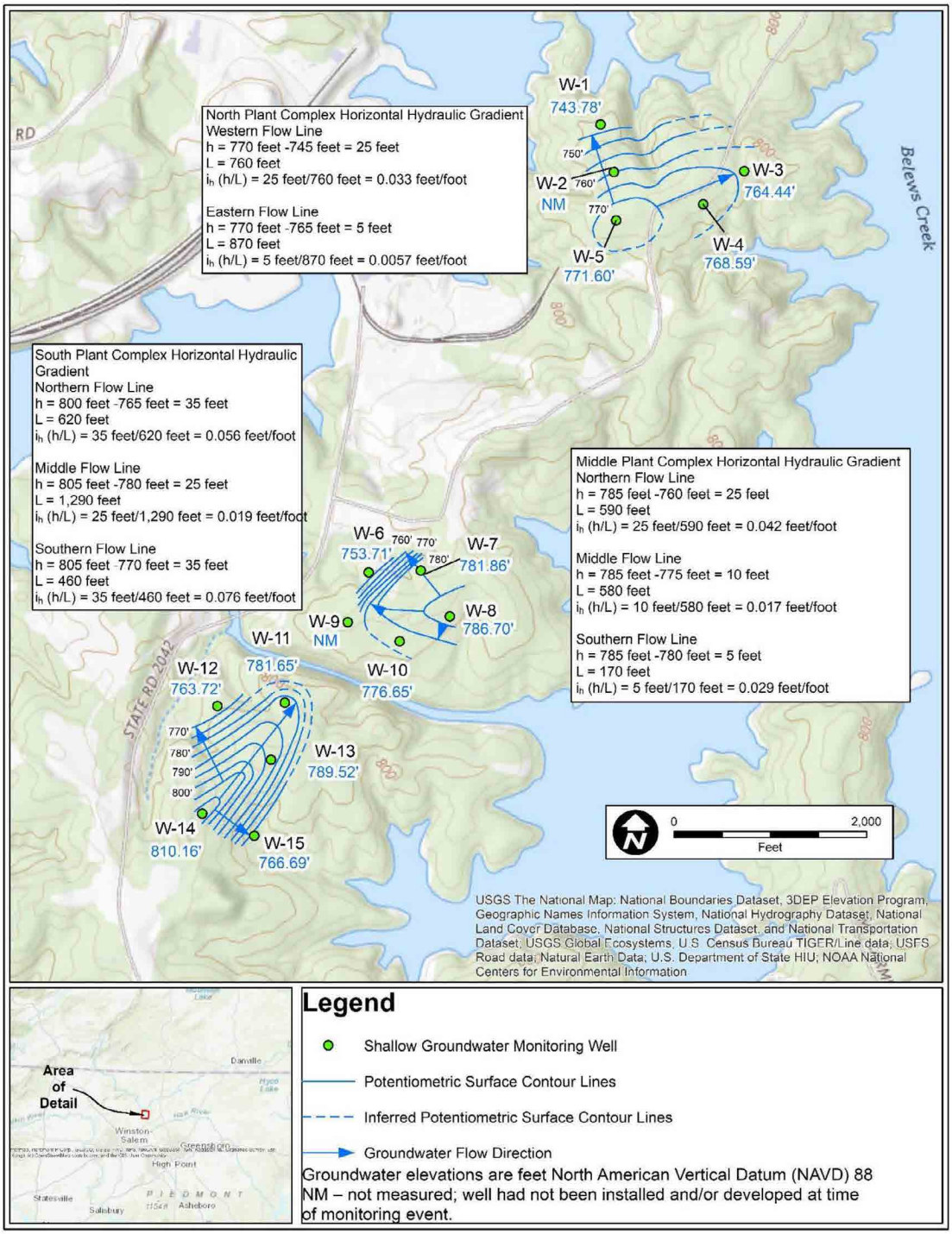


Figure 2.4-69
Potentiometric Surface Map Flow Direction for July 15, 2024 (Deep Zone)
(Sheet 2 of 24)

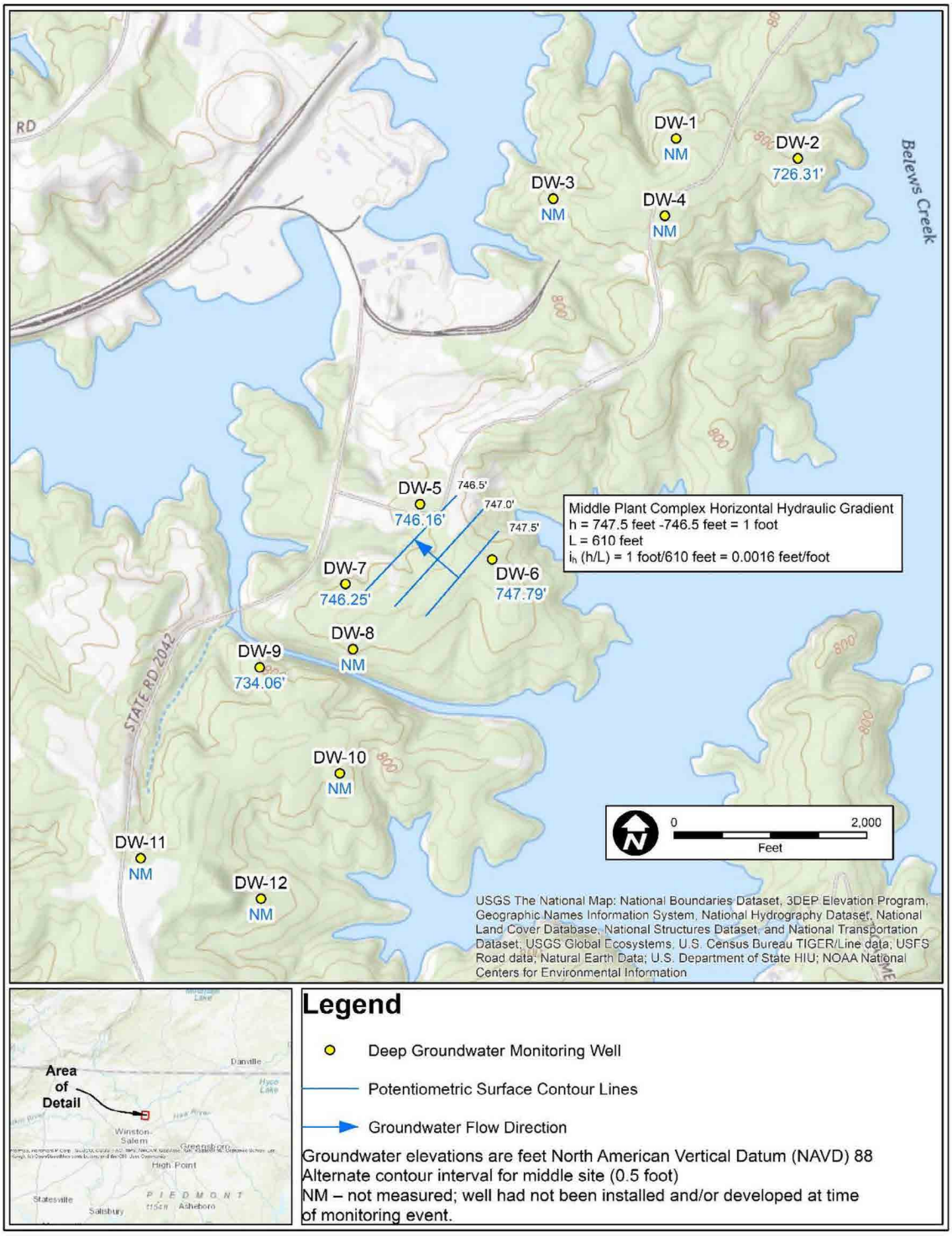


Figure 2.4-69
Potentiometric Surface Map Flow Direction for August 19, 2024 (Shallow Zone)
(Sheet 3 of 24)

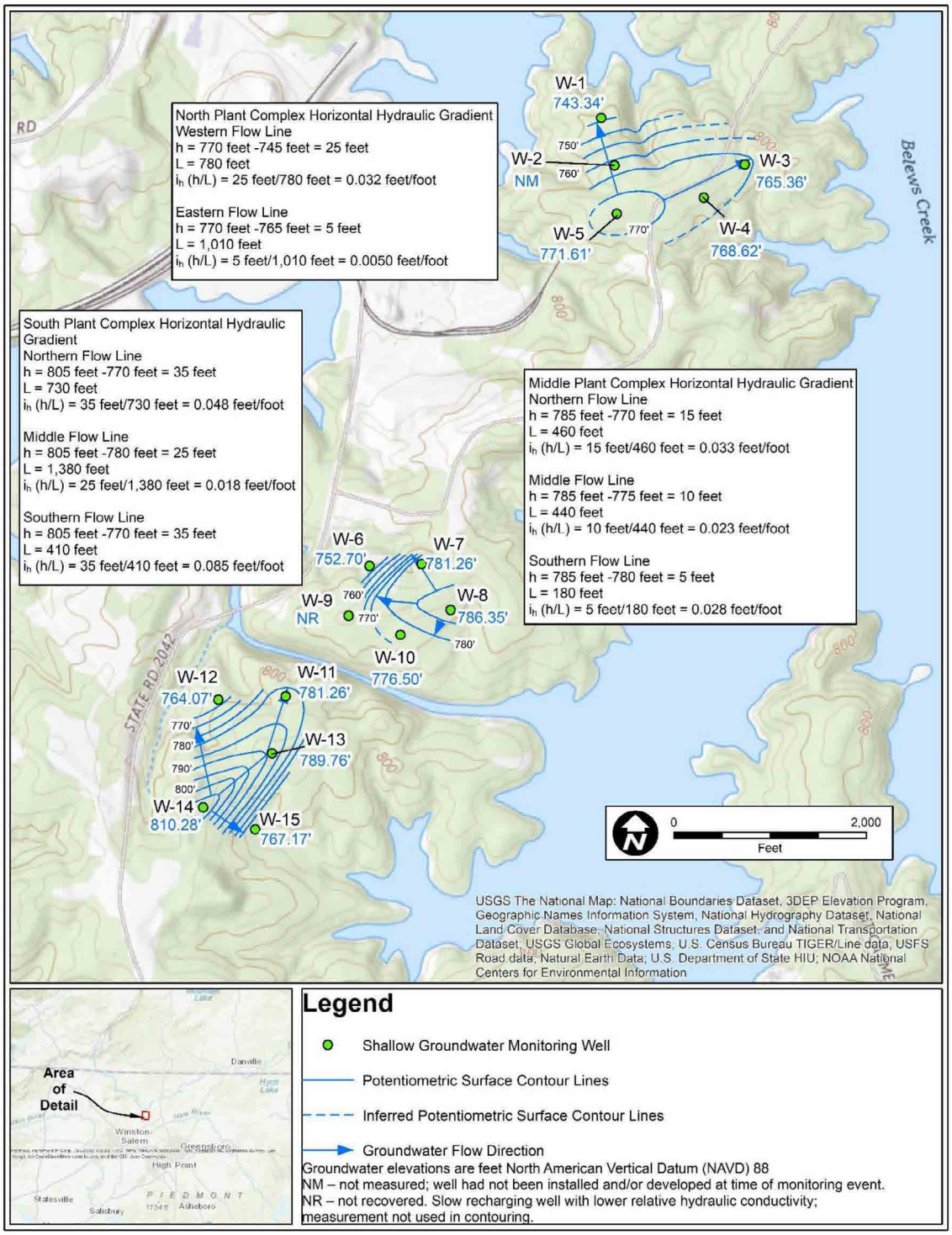


Figure 2.4-69
Potentiometric Surface Map Flow Direction for August 19, 2024 (Deep Zone)
(Sheet 4 of 24)

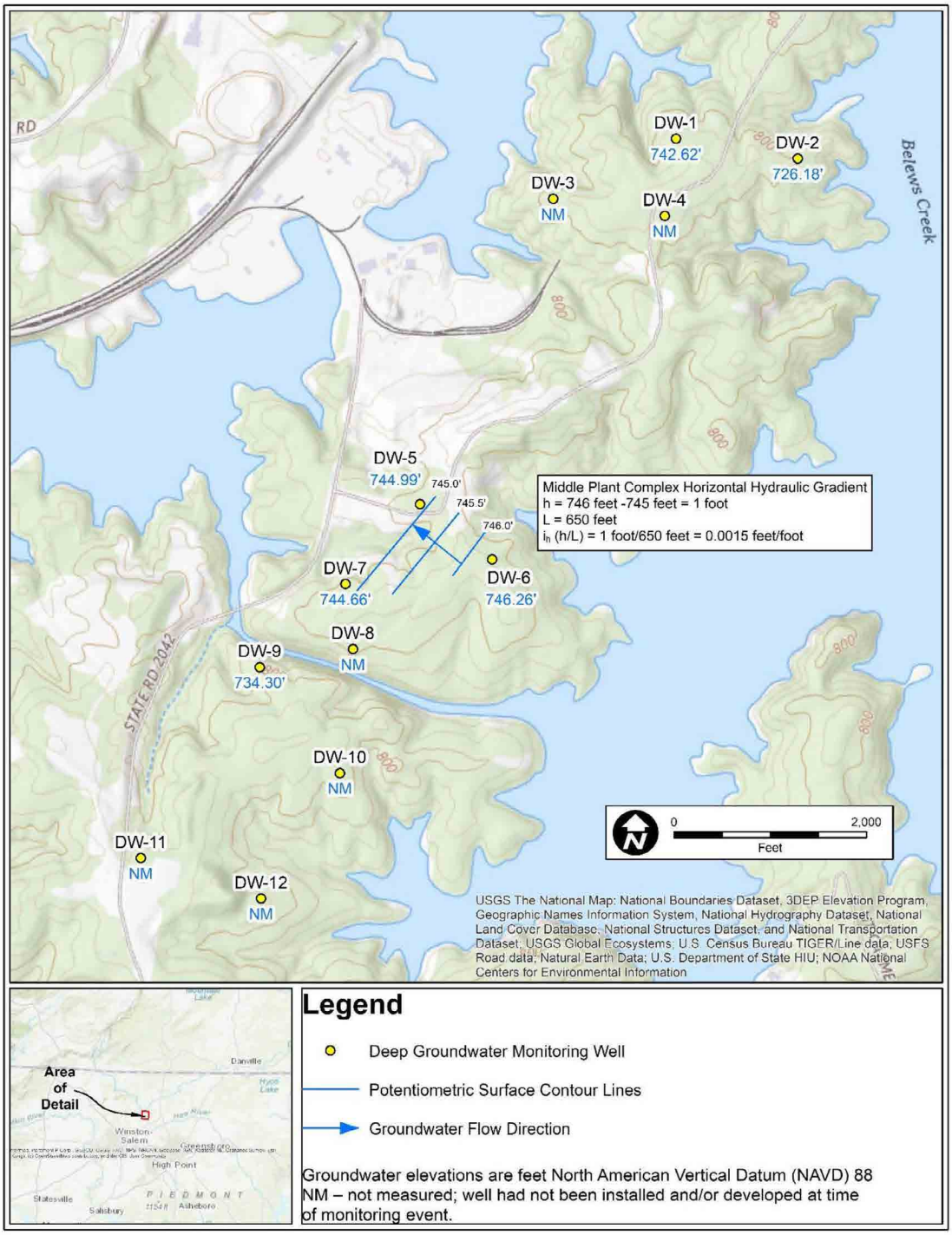


Figure 2.4-69
Potentiometric Surface Map Flow Direction for September 22, 2024 (Shallow Zone)
(Sheet 5 of 24)

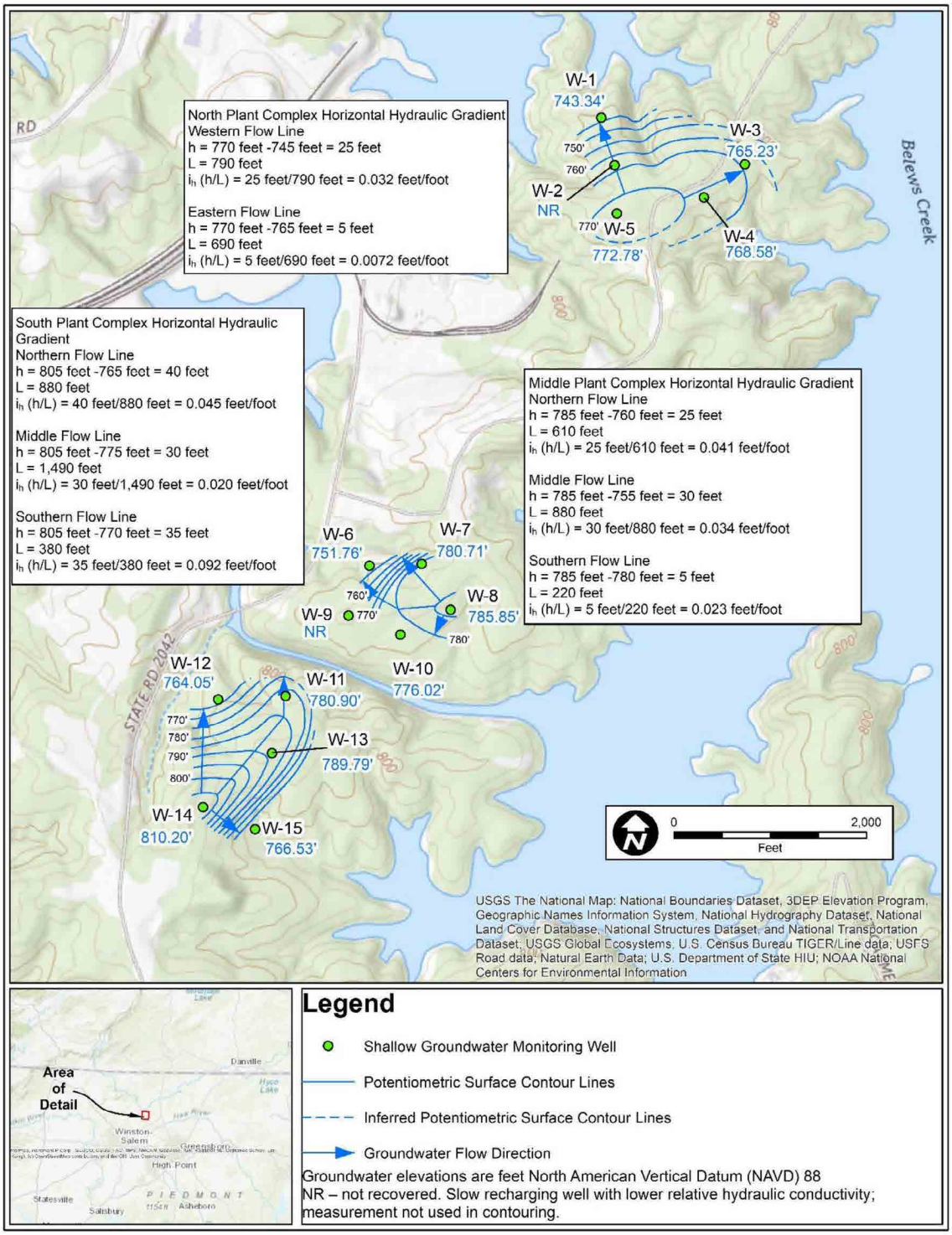


Figure 2.4-69
Potentiometric Surface Map Flow Direction for September 22, 2024 (Deep Zone)
(Sheet 6 of 24)

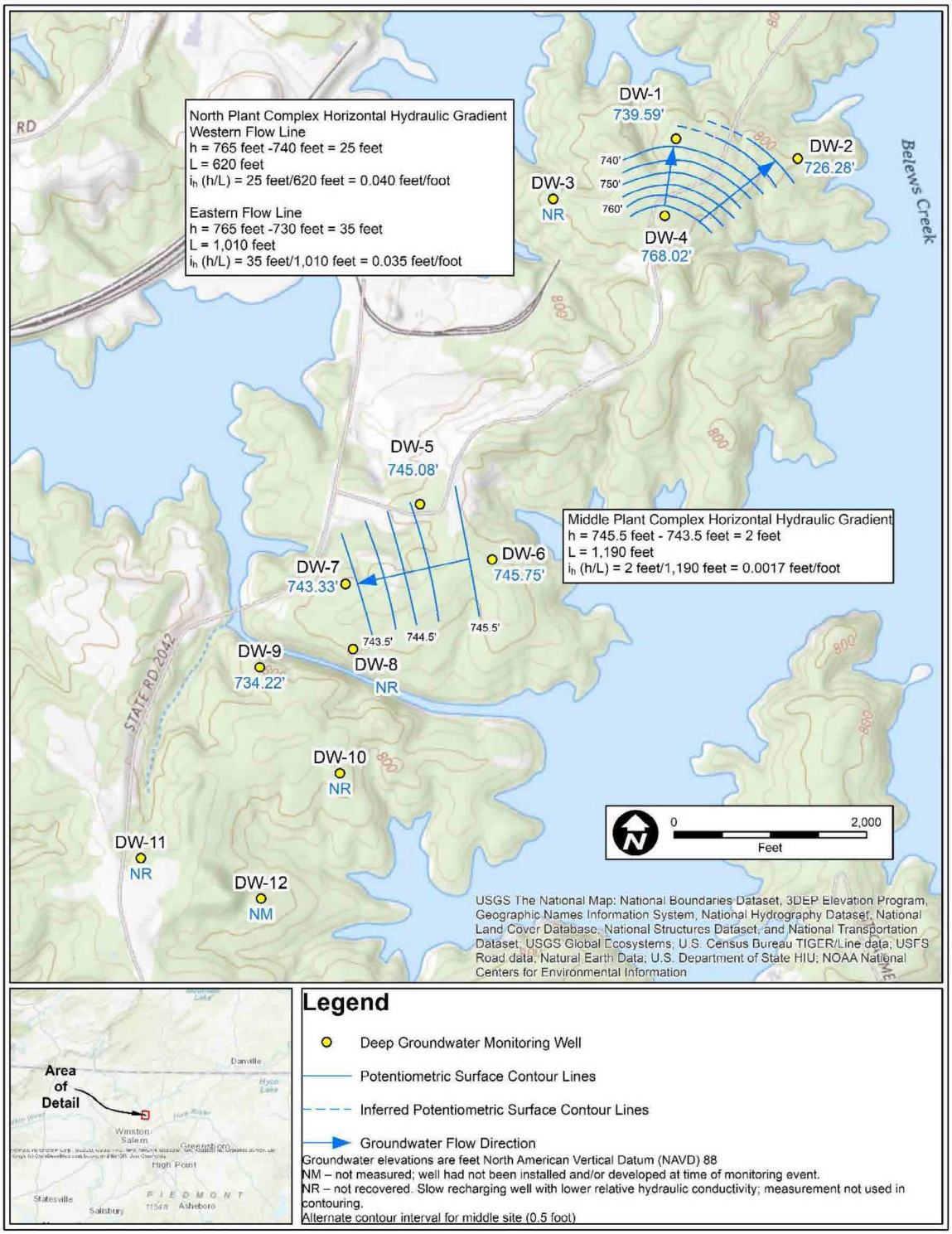


Figure 2.4-69
Potentiometric Surface Map Flow Direction for October 11, 2024 (Shallow Zone)
(Sheet 7 of 24)

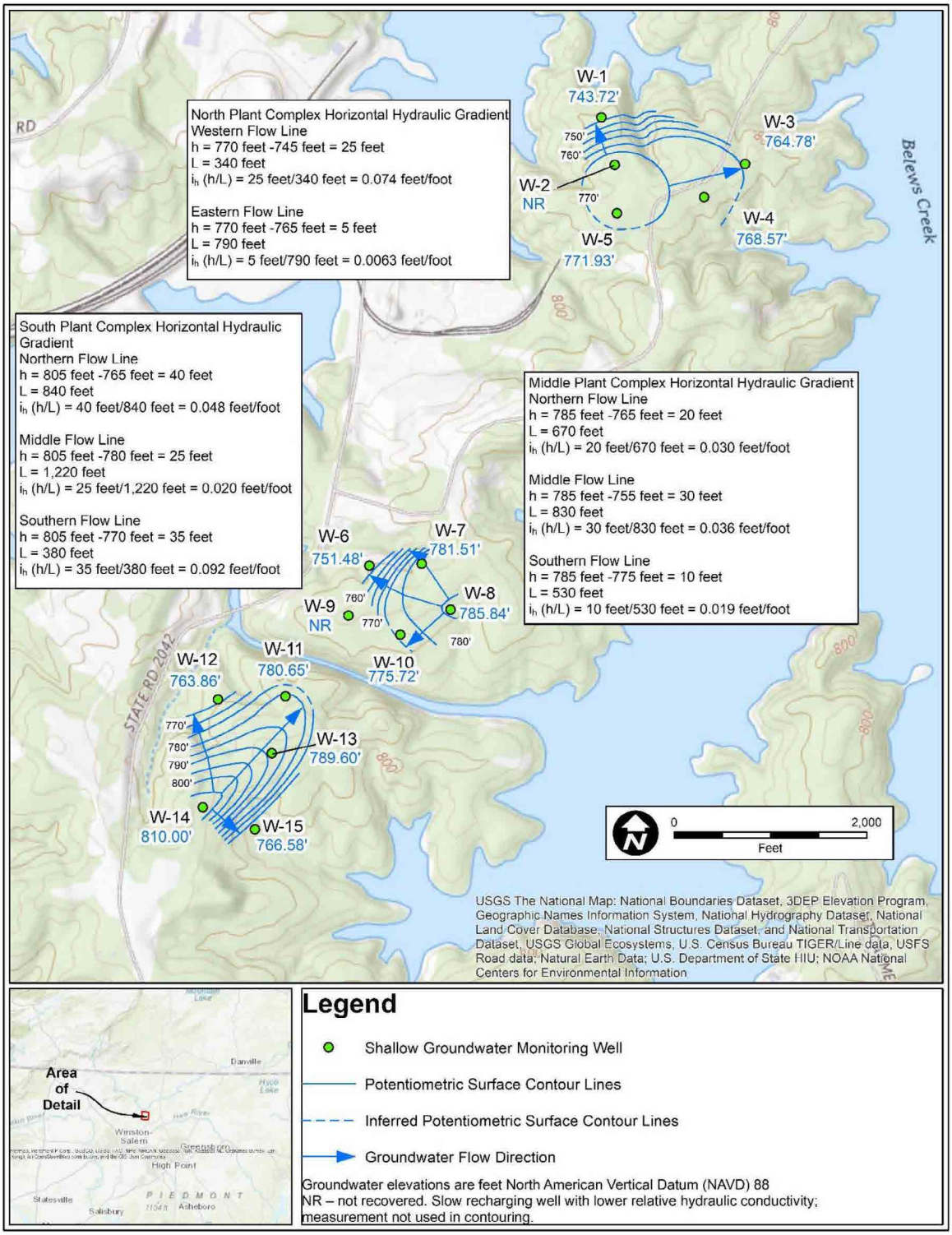


Figure 2.4-69
Potentiometric Surface Map Flow Direction for October 11, 2024 (Deep Zone)
(Sheet 8 of 24)

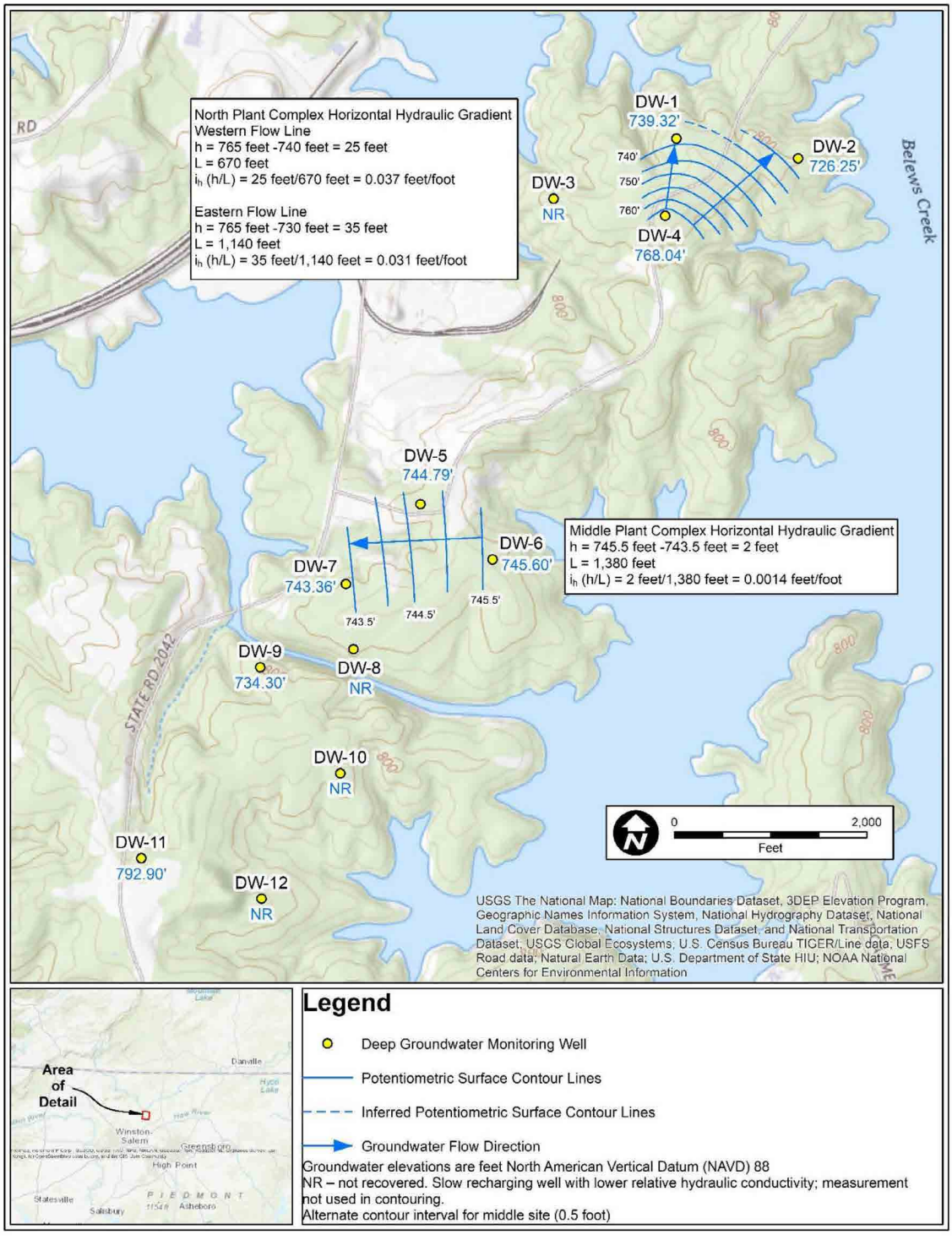


Figure 2.4-69
Potentiometric Surface Map Flow Direction for November 10, 2024 (Shallow Zone)
(Sheet 9 of 24)

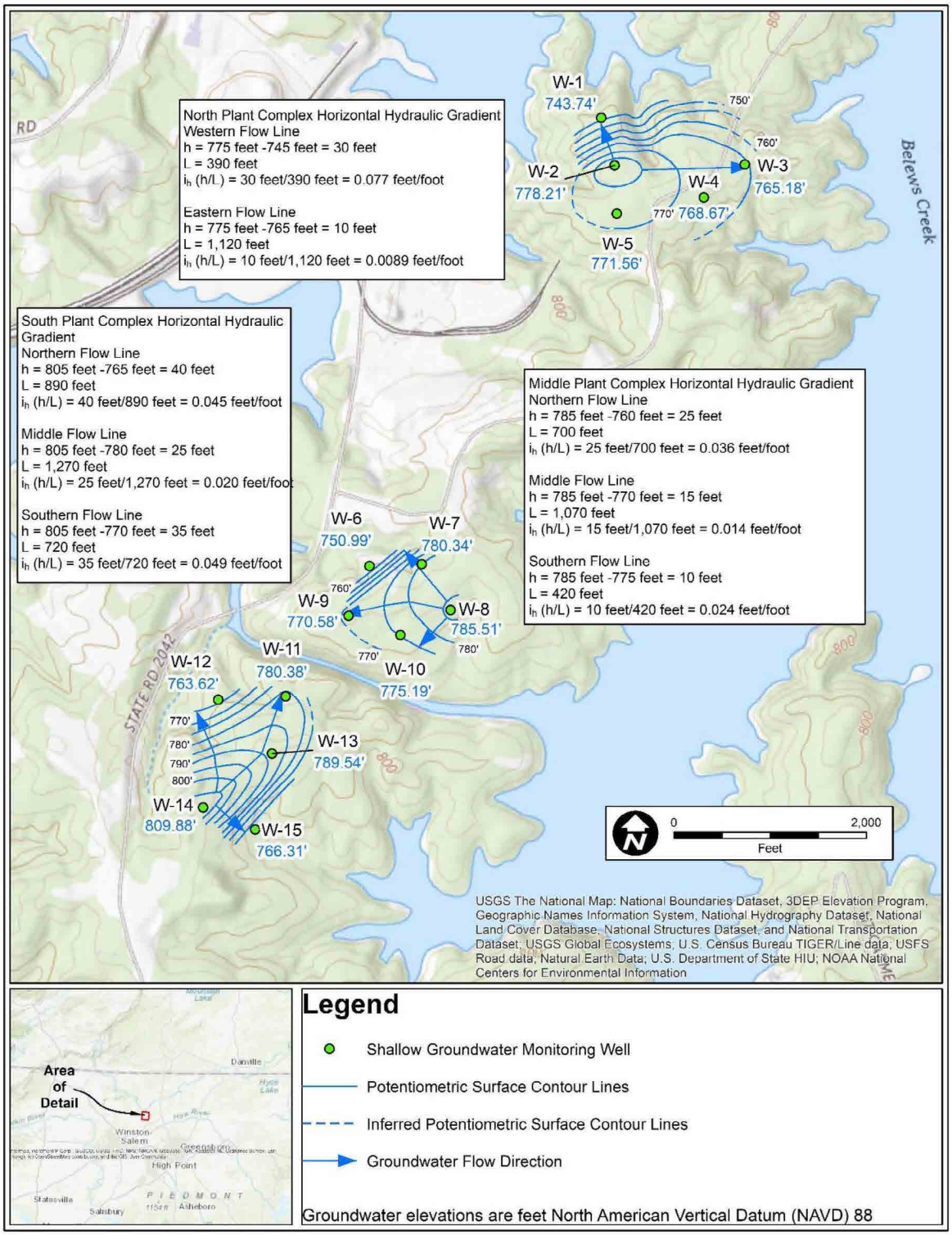


Figure 2.4-69
Potentiometric Surface Map Flow Direction for November 10, 2024 (Deep Zone)
(Sheet 10 of 24)

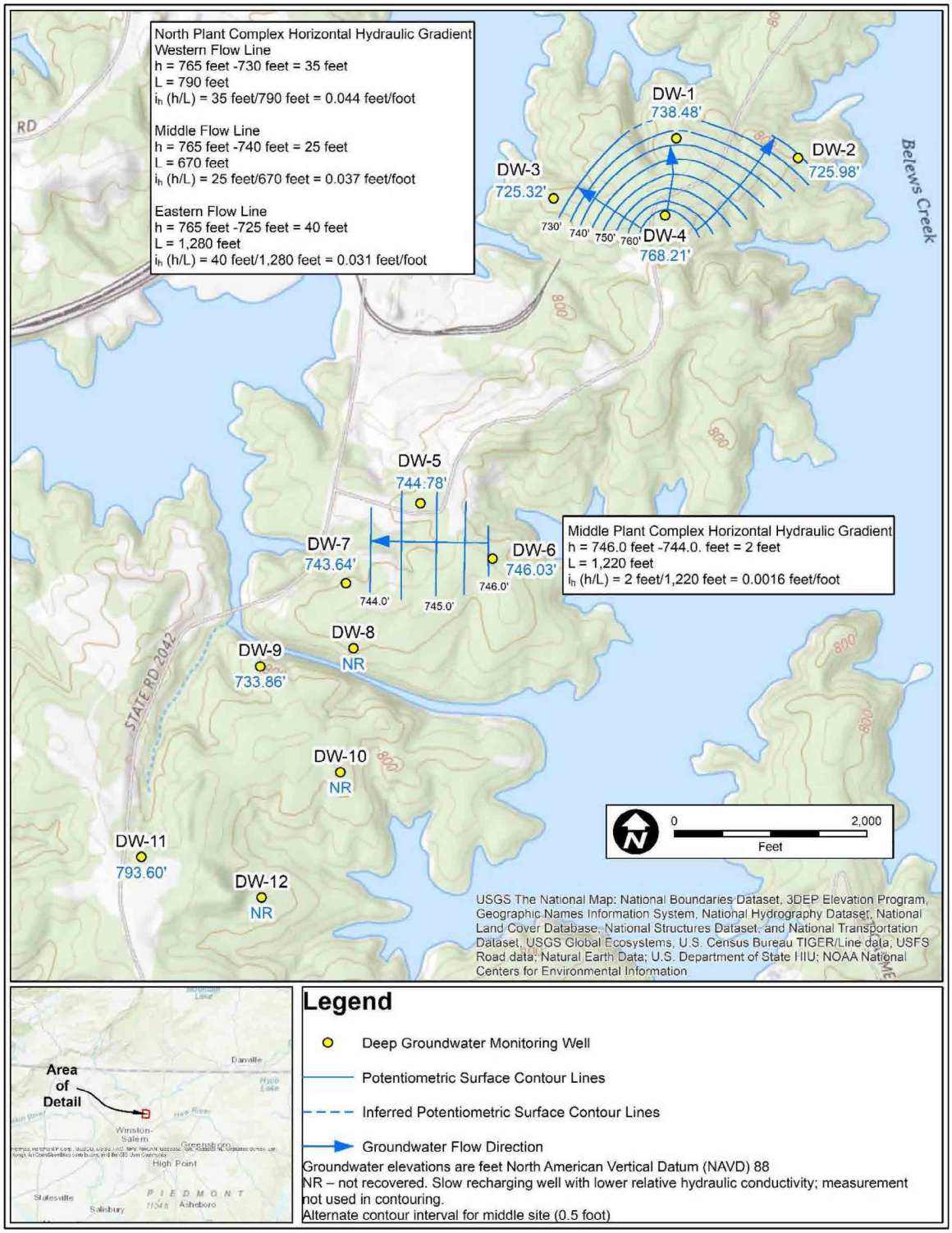


Figure 2.4-69
Potentiometric Surface Map Flow Direction for December 7, 2024 (Shallow Zone)
(Sheet 11 of 24)

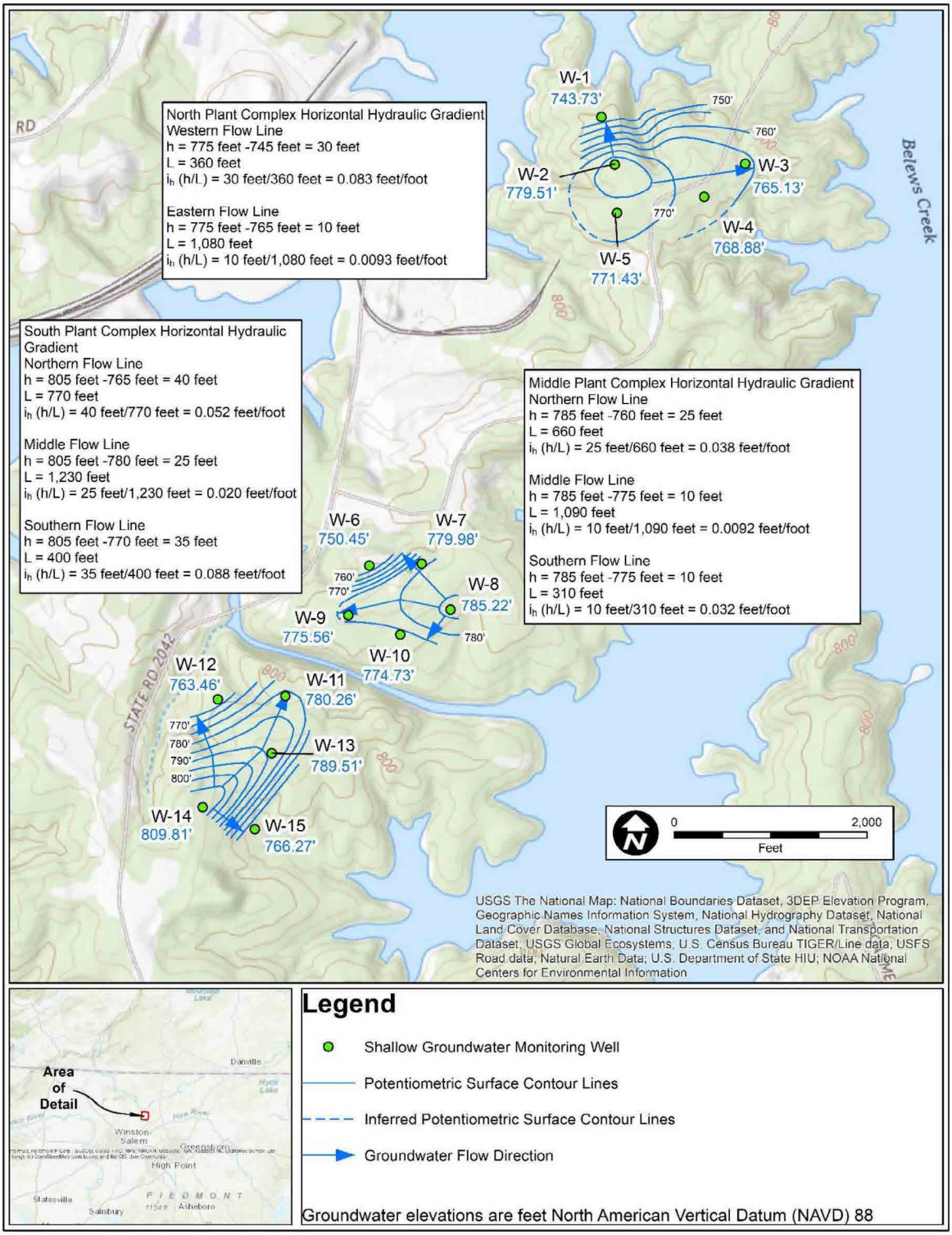


Figure 2.4-69
Potentiometric Surface Map Flow Direction for December 7, 2024 (Deep Zone)
(Sheet 12 of 24)

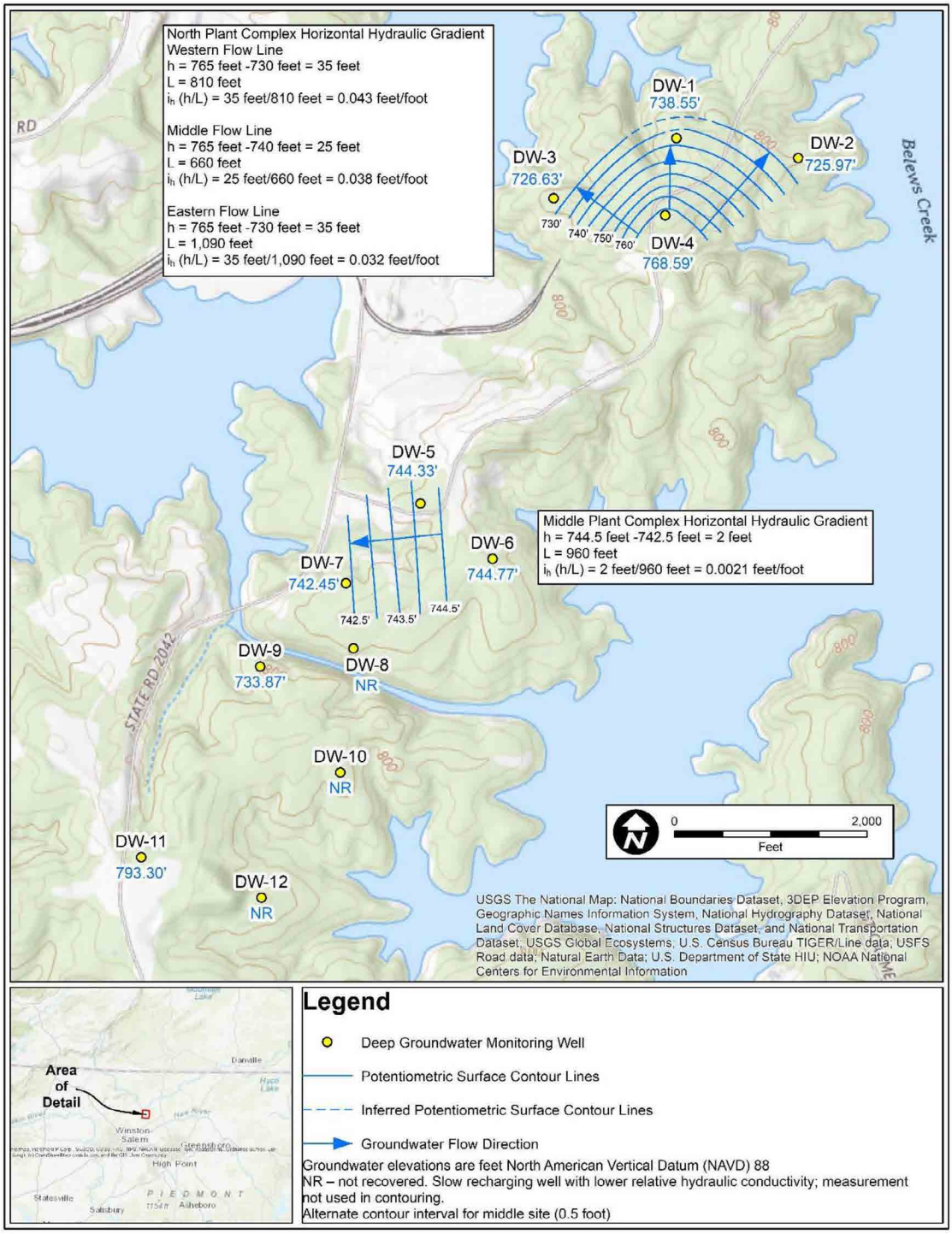


Figure 2.4-69
Potentiometric Surface Map Flow Direction for January 8, 2025 (Shallow Zone)
(Sheet 13 of 24)

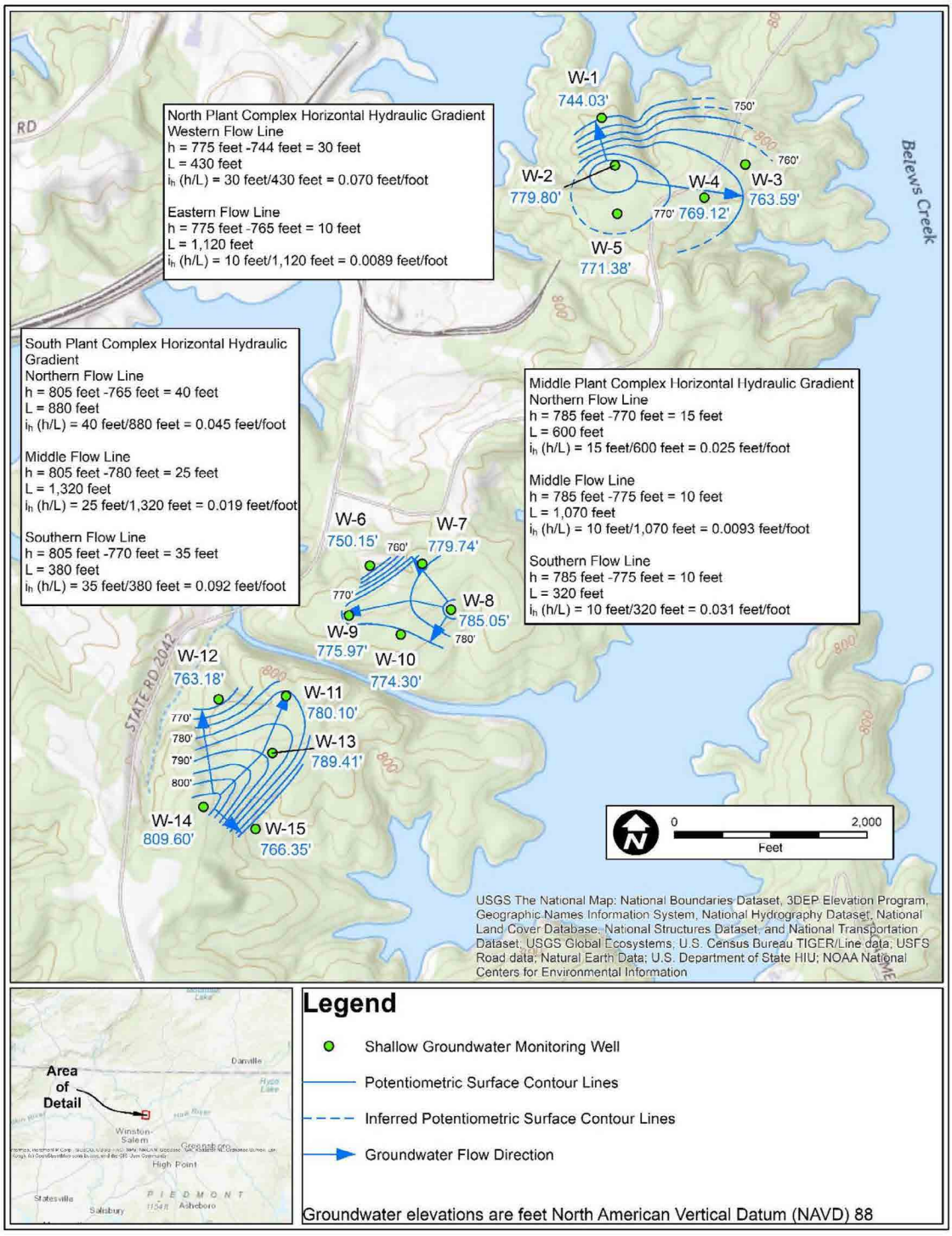


Figure 2.4-69
Potentiometric Surface Map Flow Direction for January 8, 2025 (Deep Zone)
(Sheet 14 of 24)

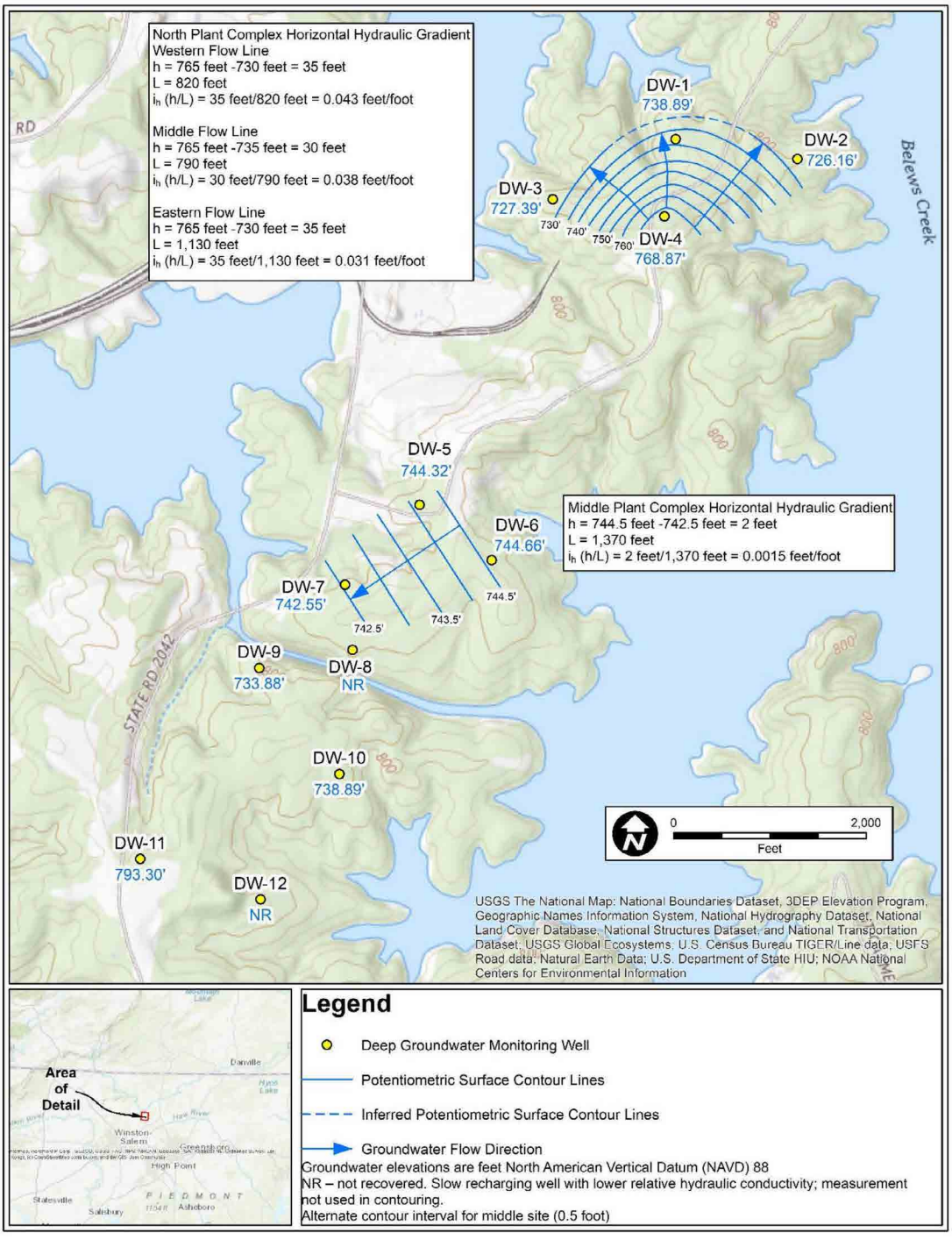


Figure 2.4-69
Potentiometric Surface Map Flow Direction for February 7, 2025 (Shallow Zone)
(Sheet 15 of 24)

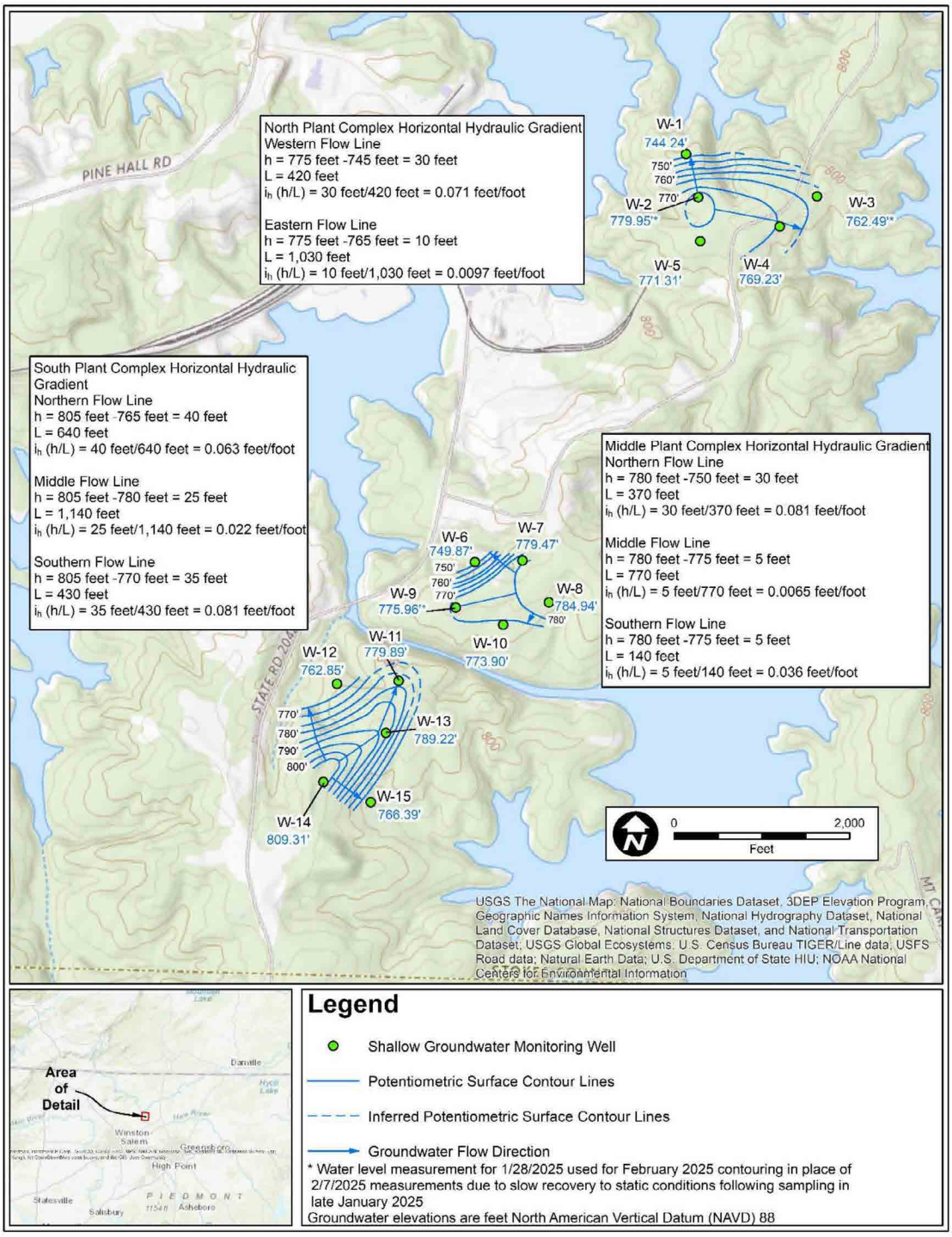


Figure 2.4-69
Potentiometric Surface Map Flow Direction for February 7, 2025 (Deep Zone)
(Sheet 16 of 24)

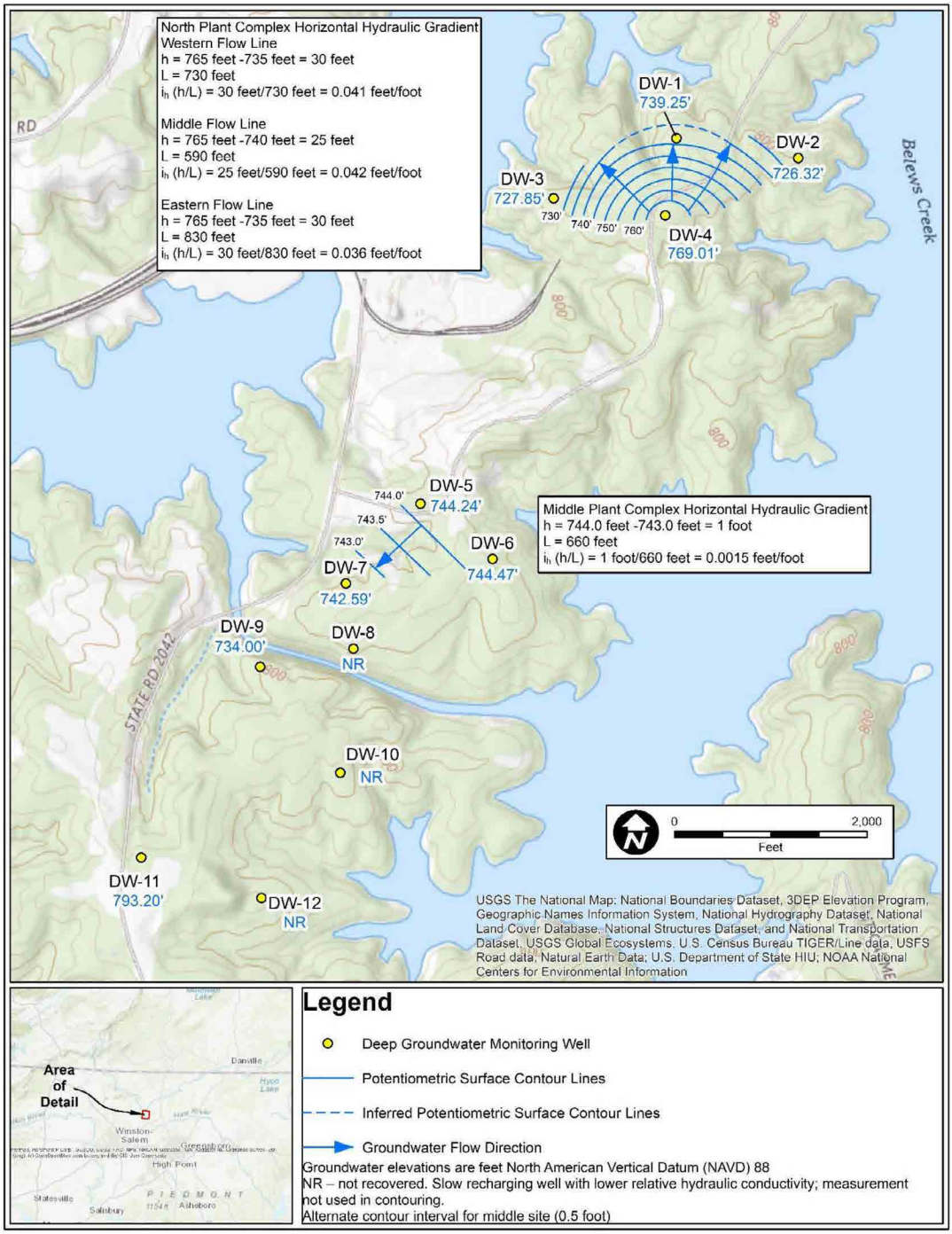


Figure 2.4-69
Potentiometric Surface Map Flow Direction for March 7, 2025 (Shallow Zone)
(Sheet 17 of 24)

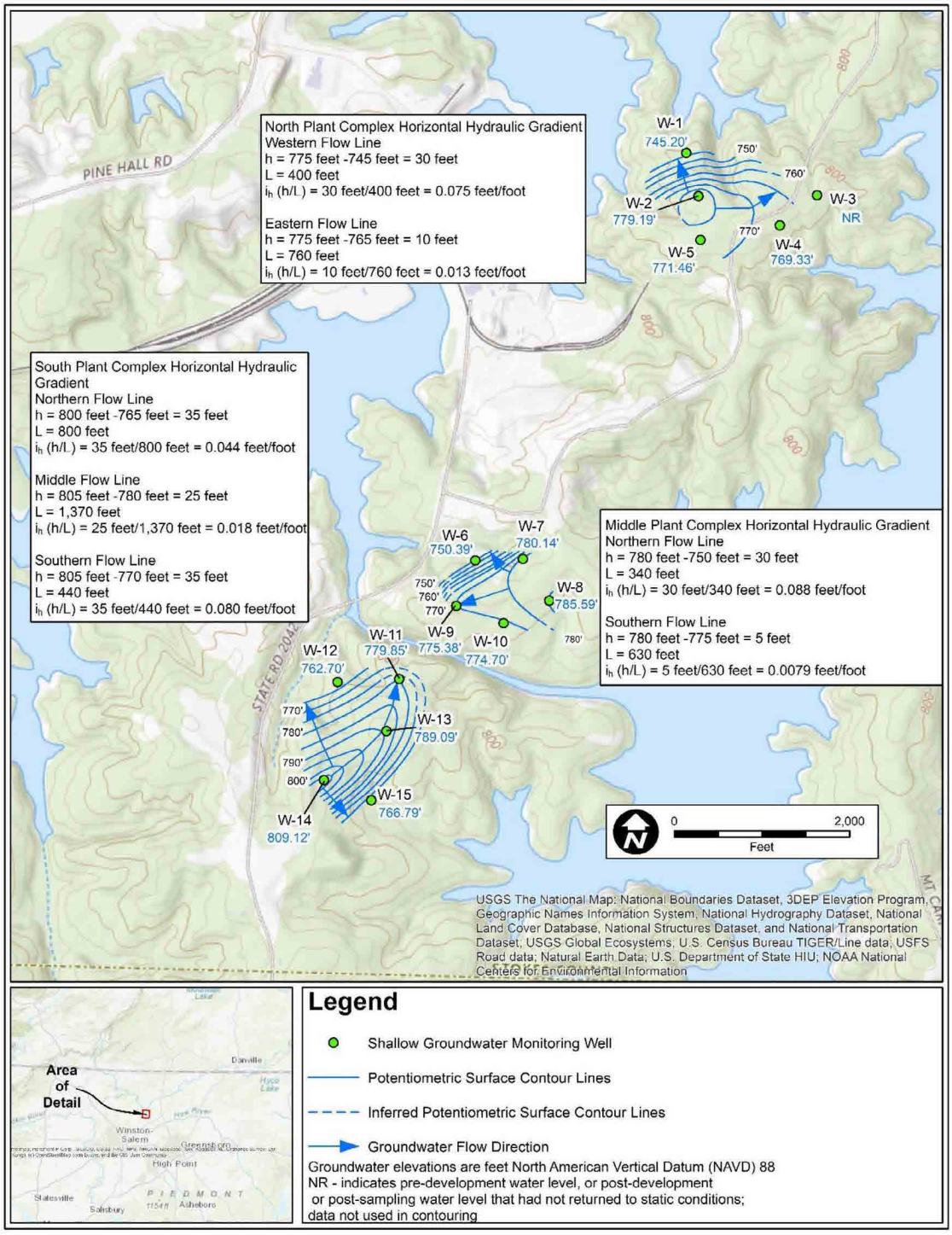


Figure 2.4-69
Potentiometric Surface Map Flow Direction for March 7, 2025 (Deep Zone)
(Sheet 18 of 24)

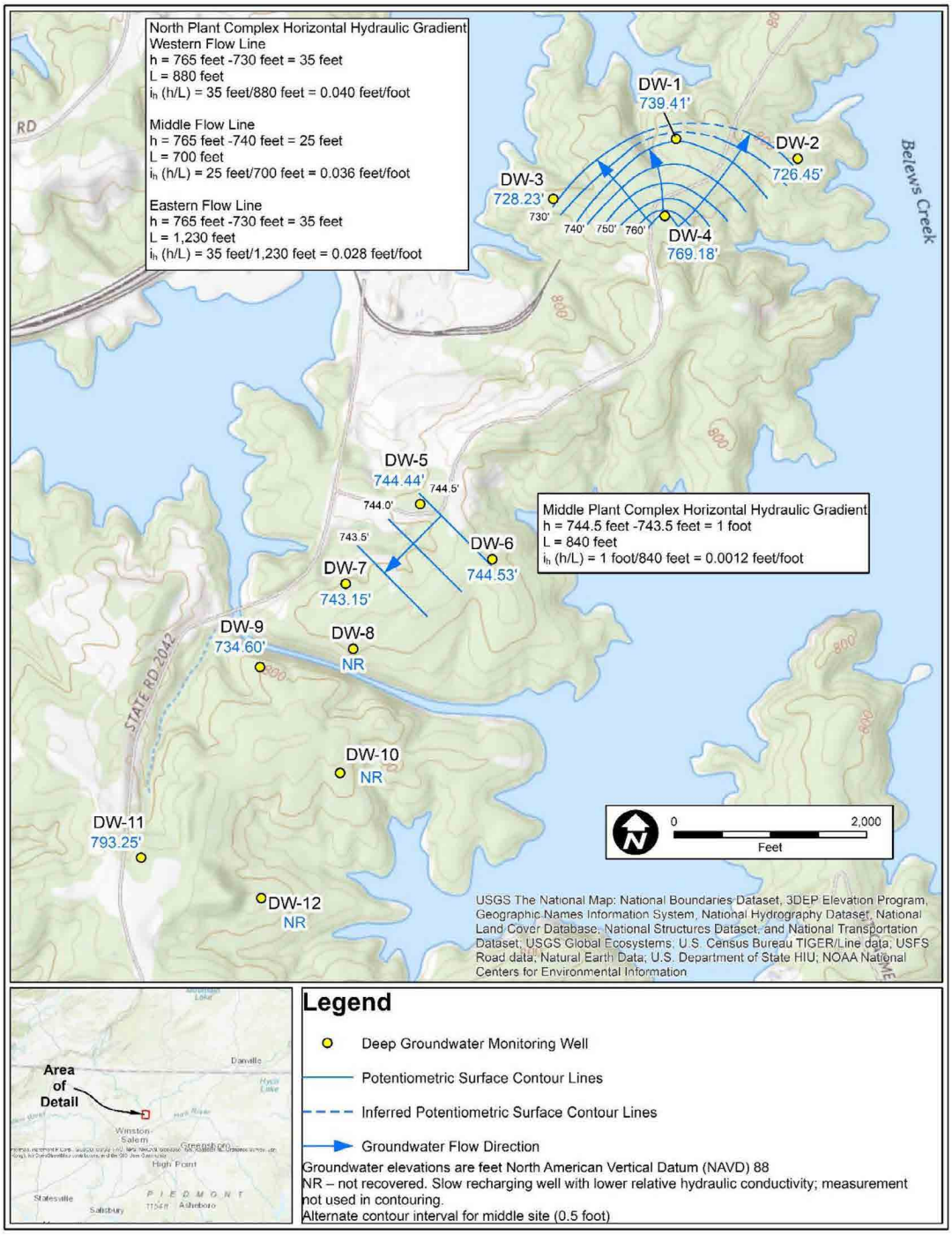


Figure 2.4-69
Potentiometric Surface Map Flow Direction for April 14, 2025 (Shallow Zone)
(Sheet 19 of 24)

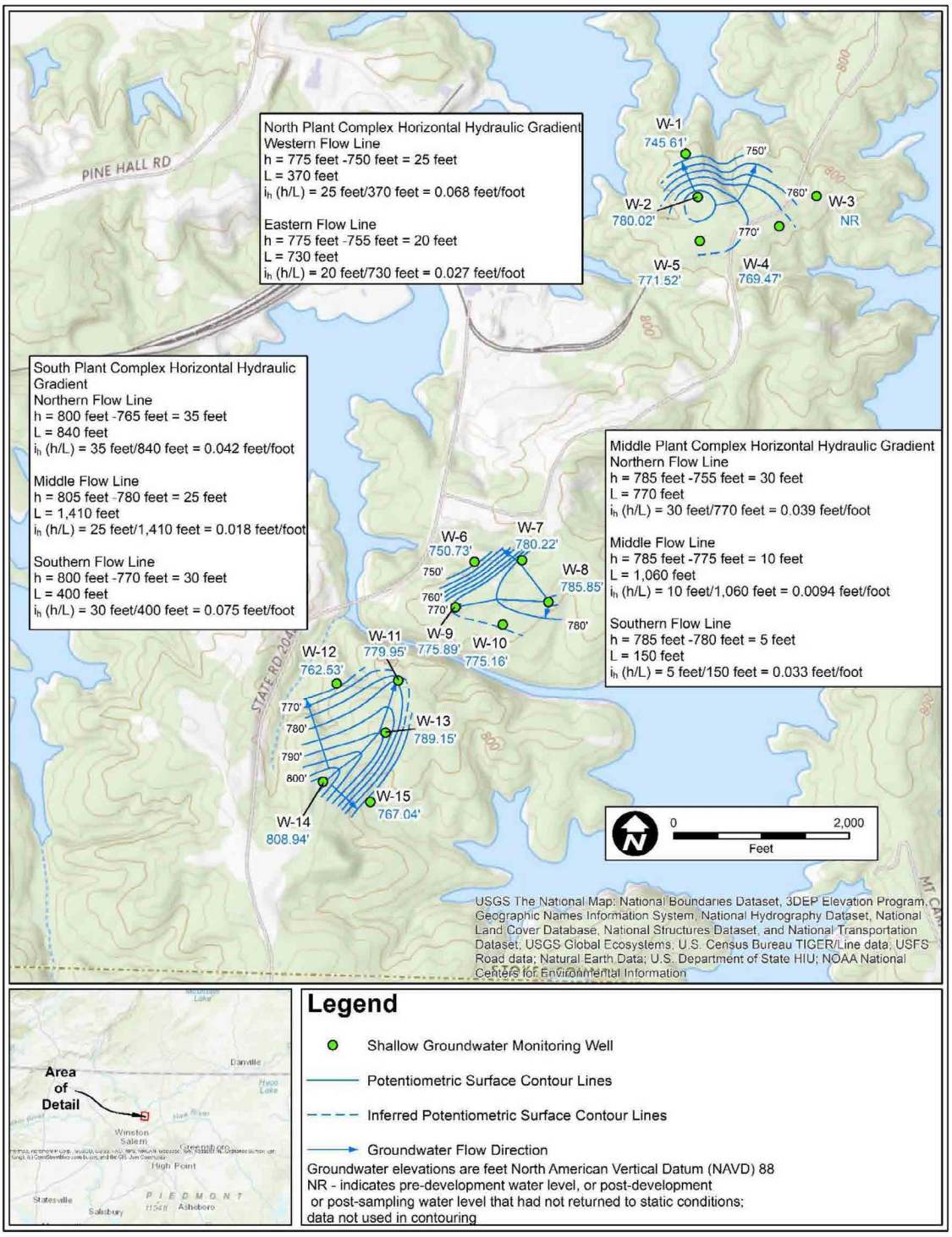


Figure 2.4-69
Potentiometric Surface Map Flow Direction for April 14, 2025 (Deep Zone)
(Sheet 20 of 24)

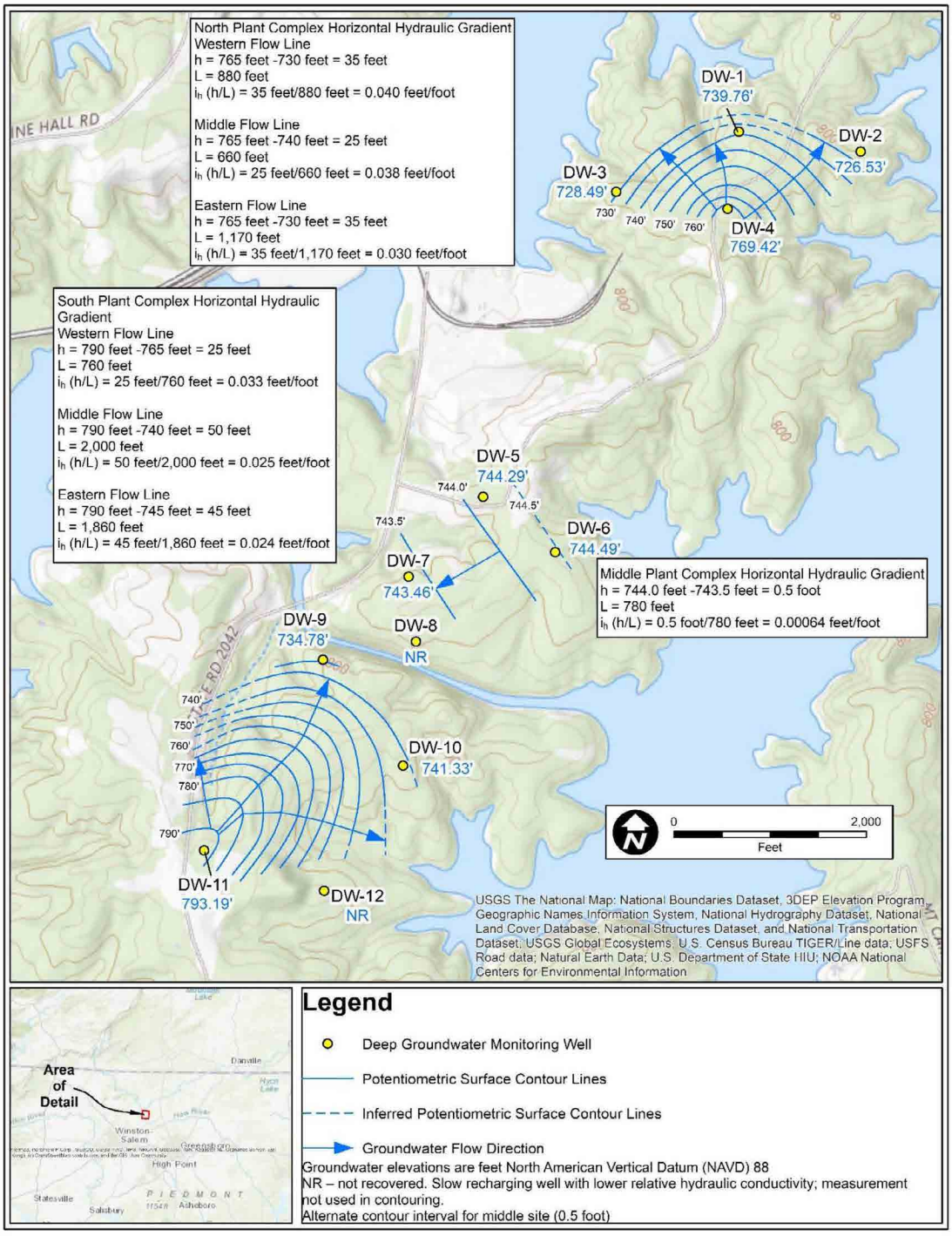


Figure 2.4-69
Potentiometric Surface Map Flow Direction for May 15, 2025 (Shallow Zone)
(Sheet 21 of 24)

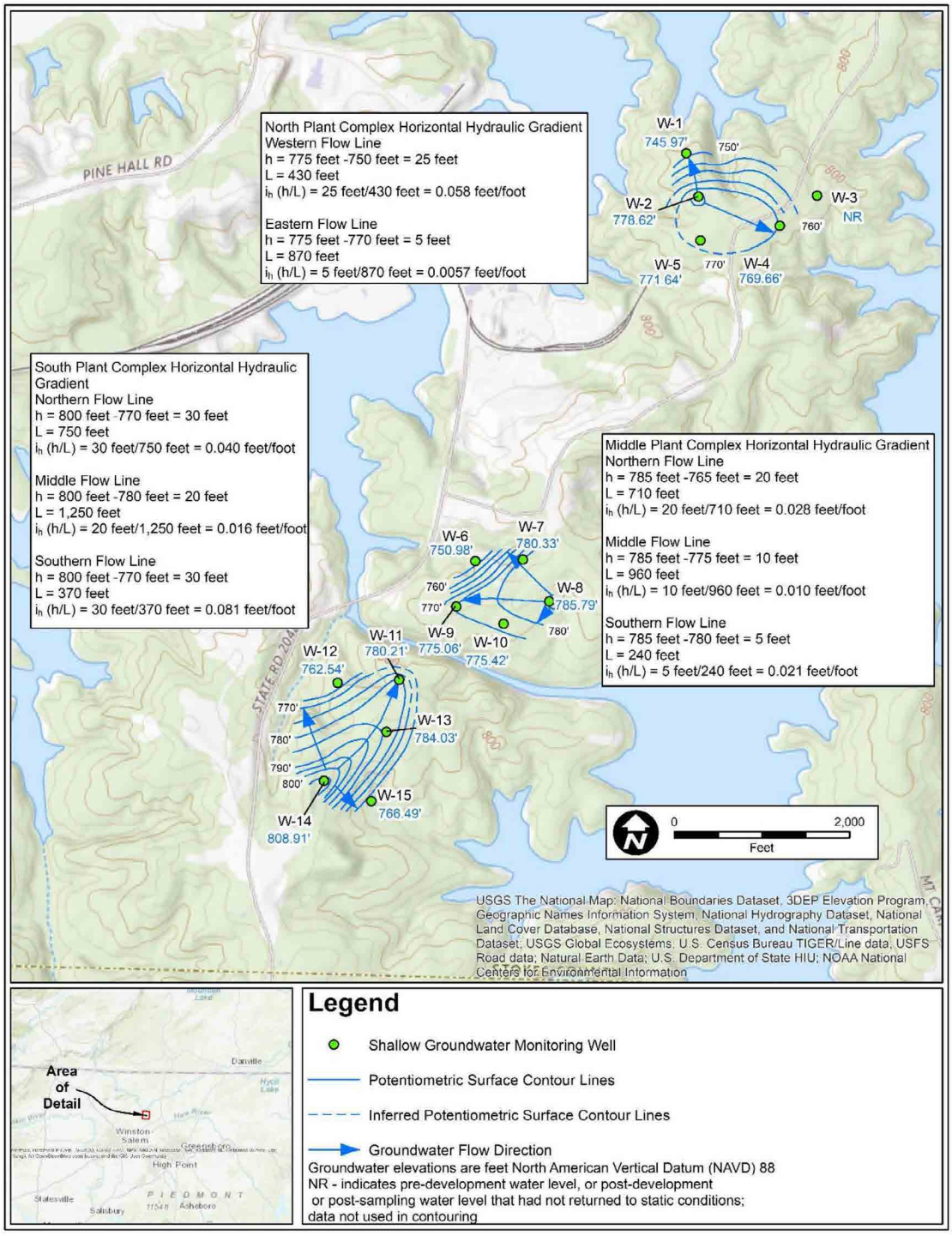


Figure 2.4-69
Potentiometric Surface Map Flow Direction for May 15, 2025 (Deep Zone)
(Sheet 22 of 24)

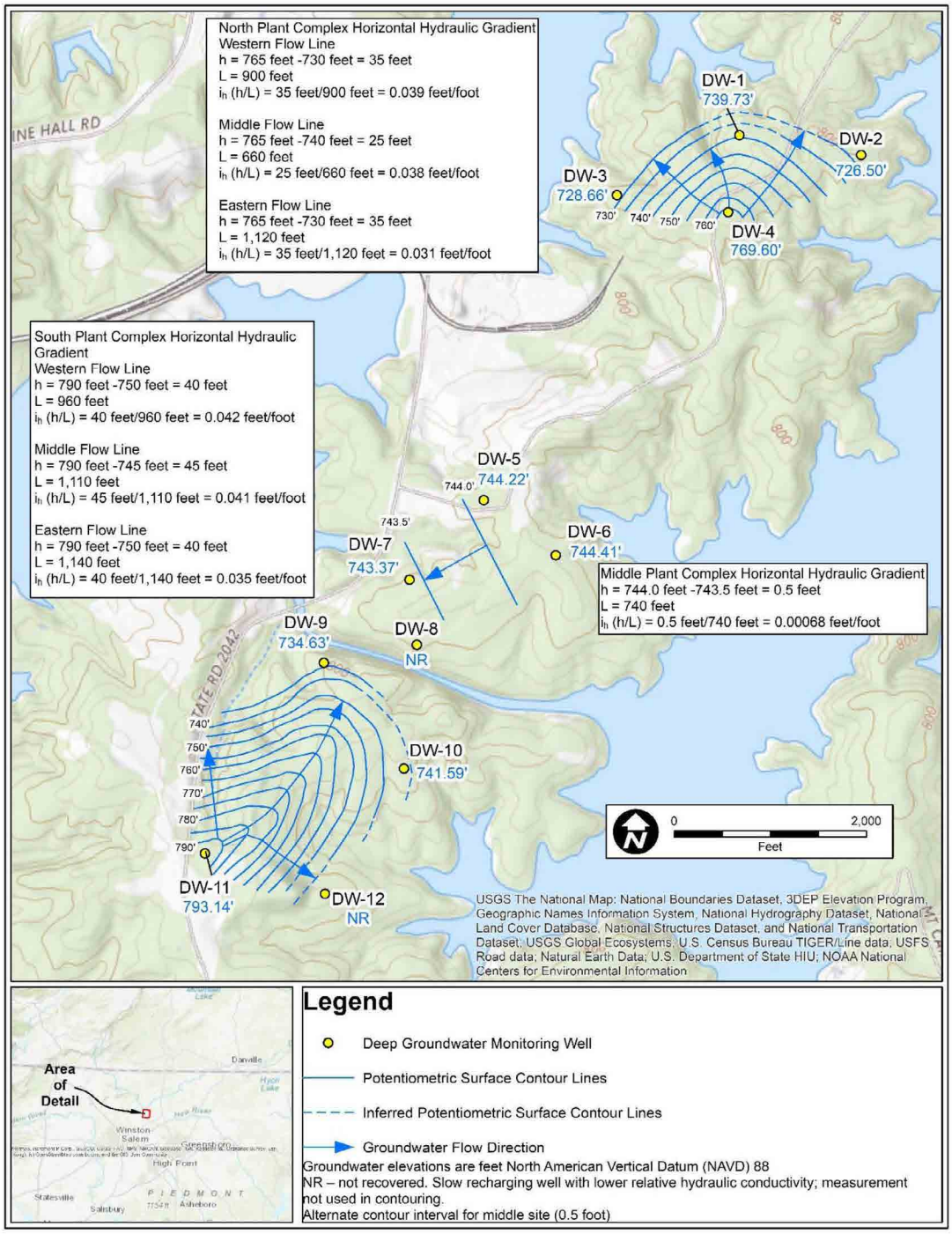


Figure 2.4-69
Potentiometric Surface Map Flow Direction for June 24, 2025 (Shallow Zone)
(Sheet 23 of 24)

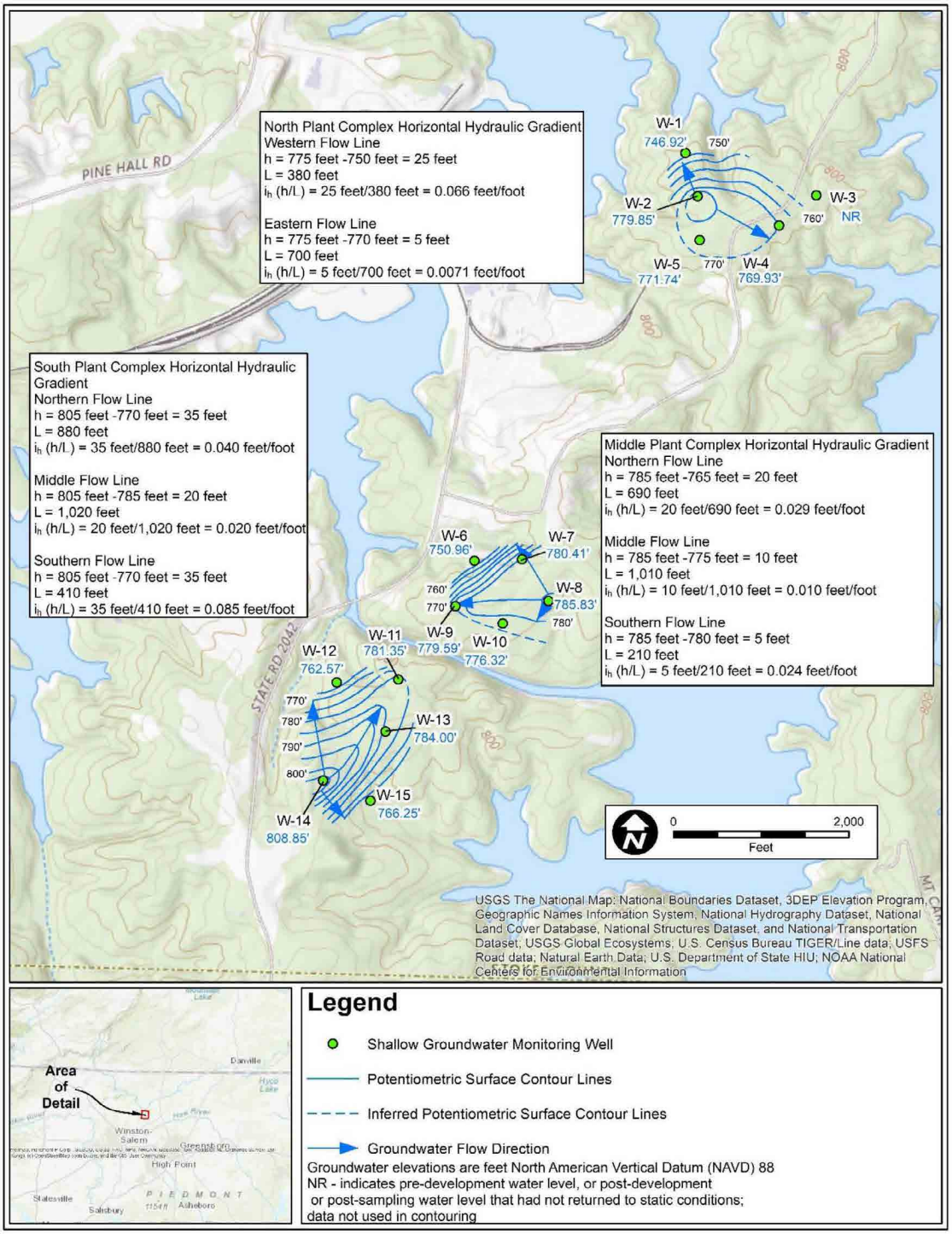


Figure 2.4-69
Potentiometric Surface Map Flow Direction for June 24, 2025 (Deep Zone)
(Sheet 24 of 24)

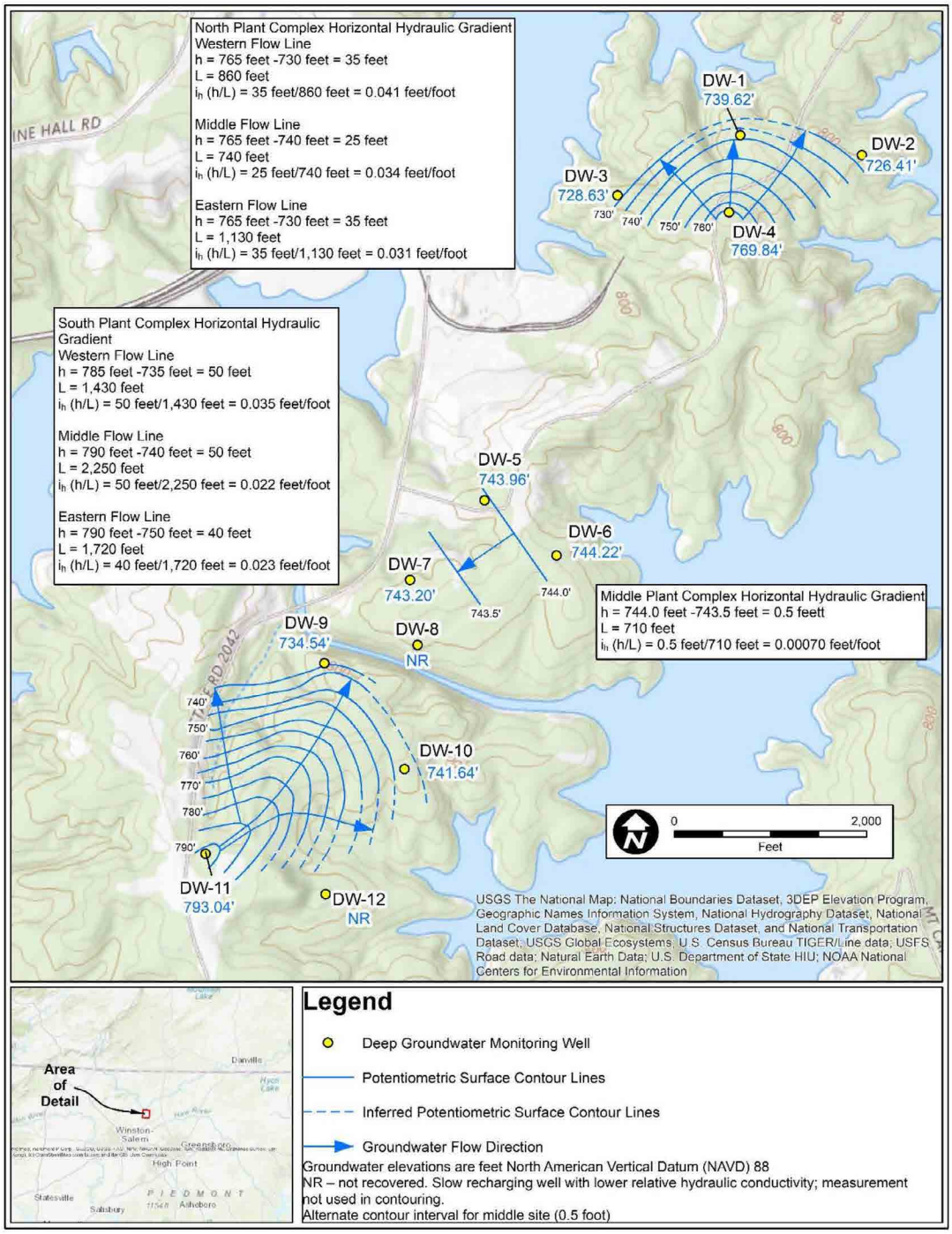


Figure 2.4-70
Modeled Vertical Hydraulic Gradients for February 7, 2025

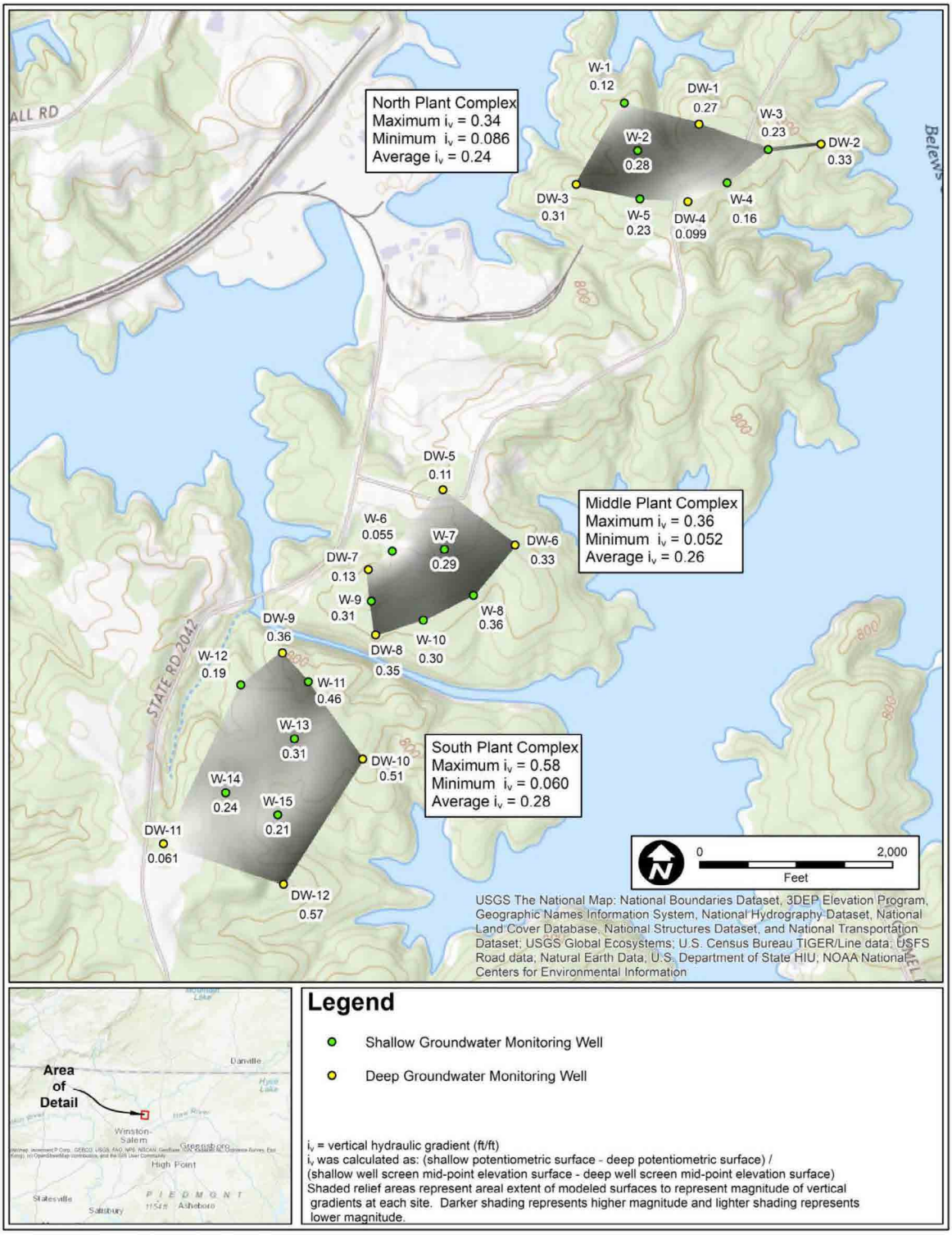


Figure 2.4-71
Hydrograph for North Plant Complex
(Sheet 1 of 3)

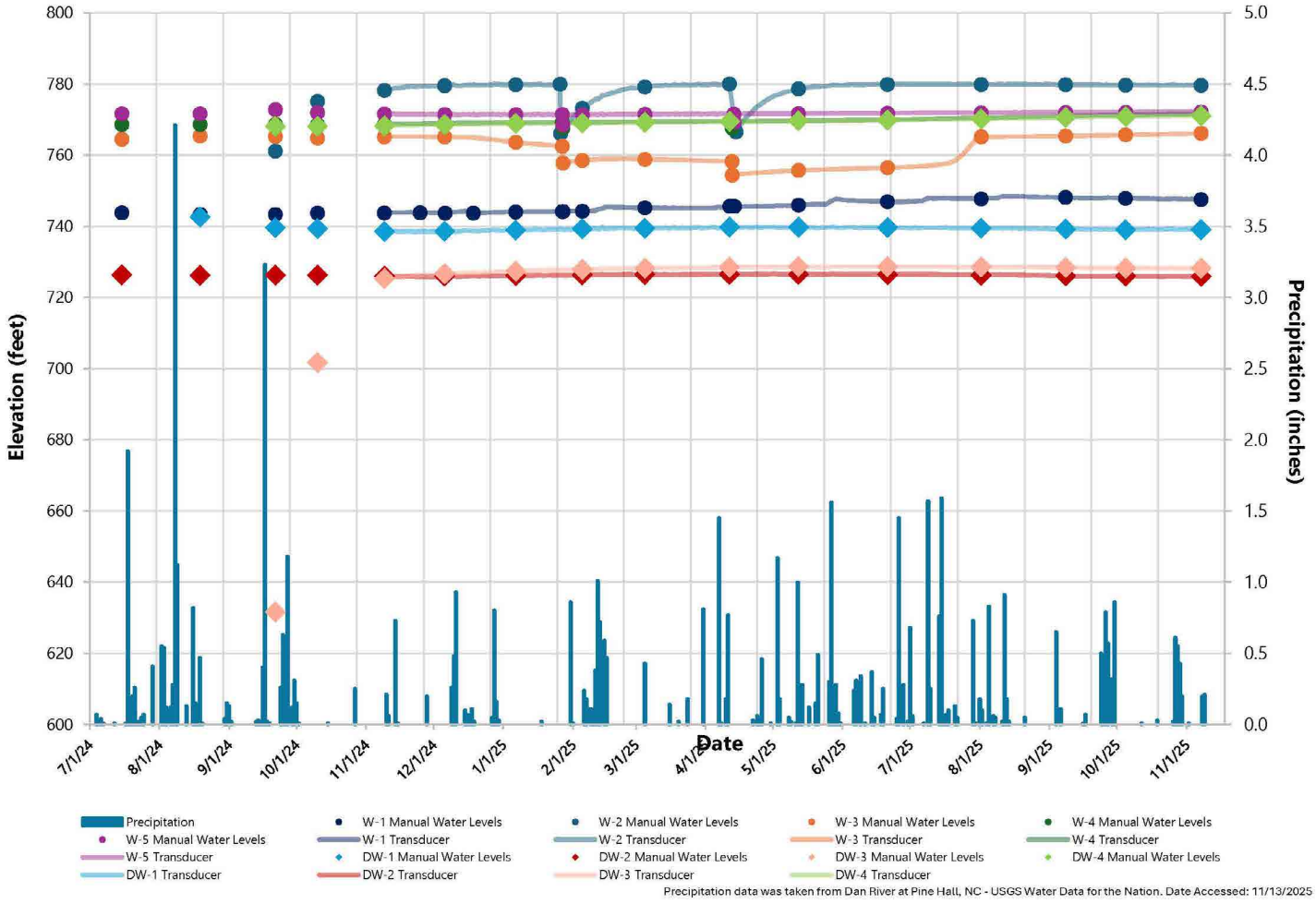
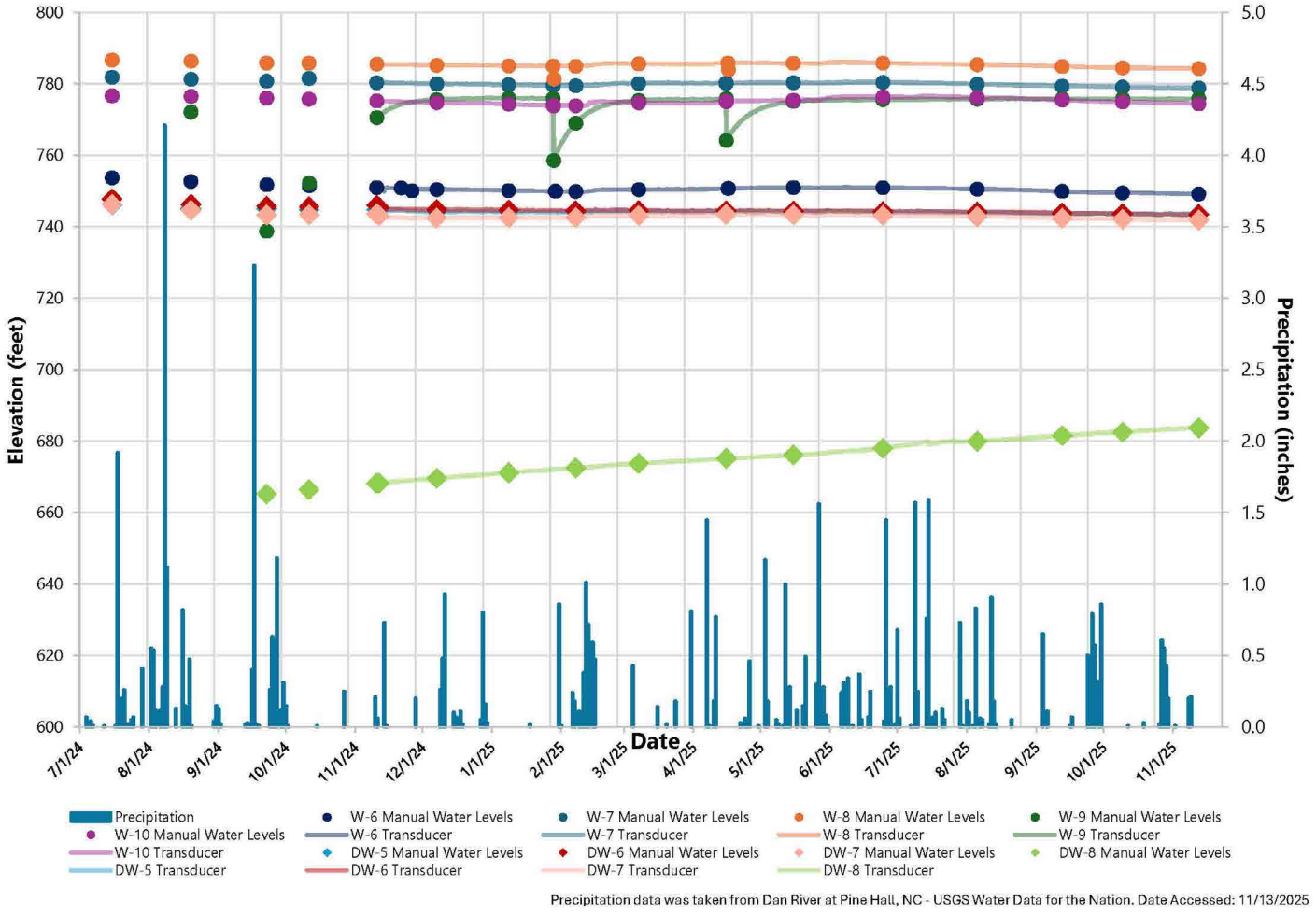
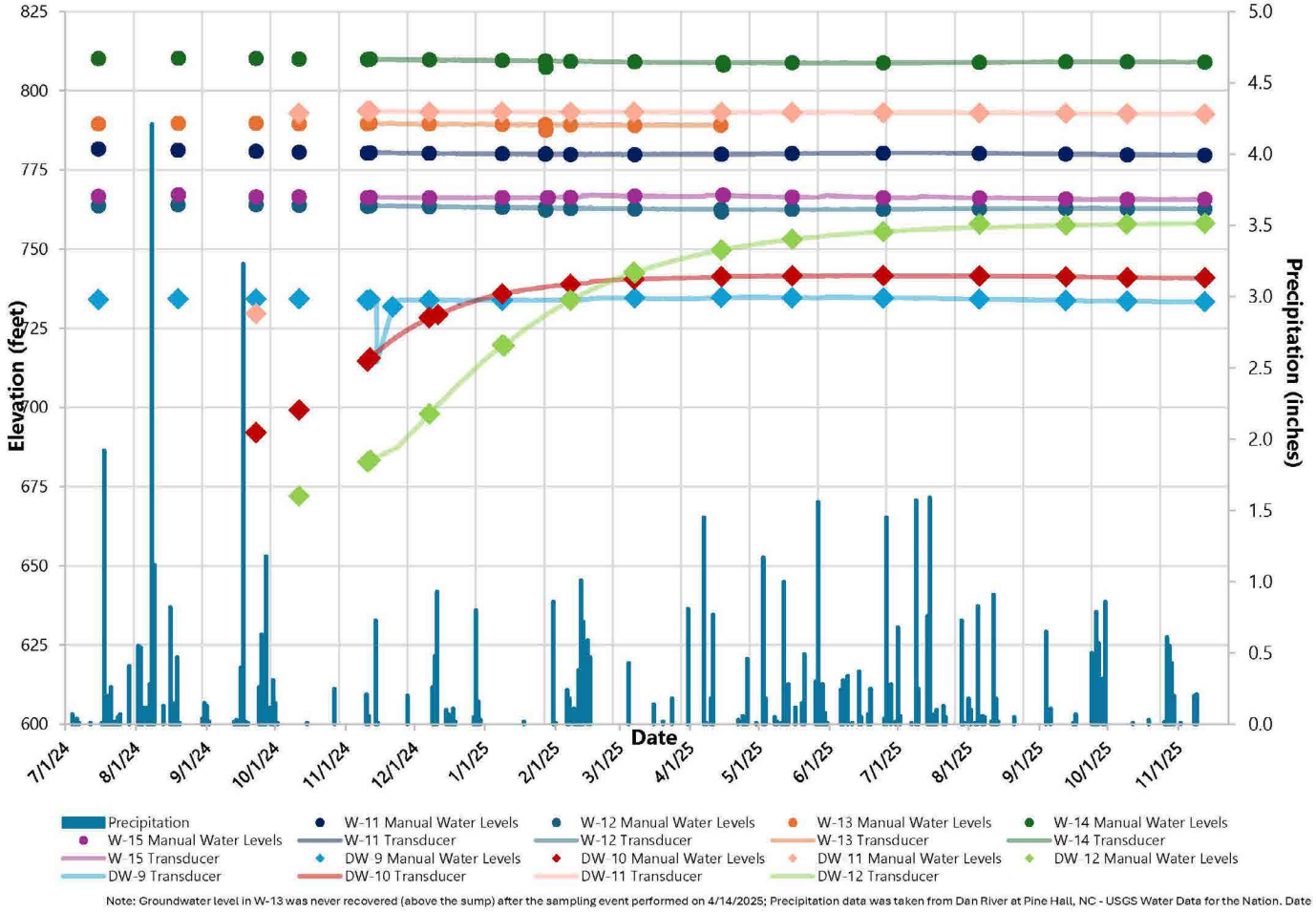


Figure 2.4-71
Hydrograph for Middle Plant Complex
(Sheet 2 of 3)



Precipitation data was taken from Dan River at Pine Hall, NC - USGS Water Data for the Nation. Date Accessed: 11/13/2025

Figure 2.4-71
Hydrograph for South Plant Complex
(Sheet 3 of 3)



Note: Groundwater level in W-13 was never recovered (above the sump) after the sampling event performed on 4/14/2025; Precipitation data was taken from Dan River at Pine Hall, NC - USGS Water Data for the Nation. Date

Figure 2.4-72
Hydraulic Conductivity (K) Distribution Map (Shallow Zone)
(Sheet 1 of 2)

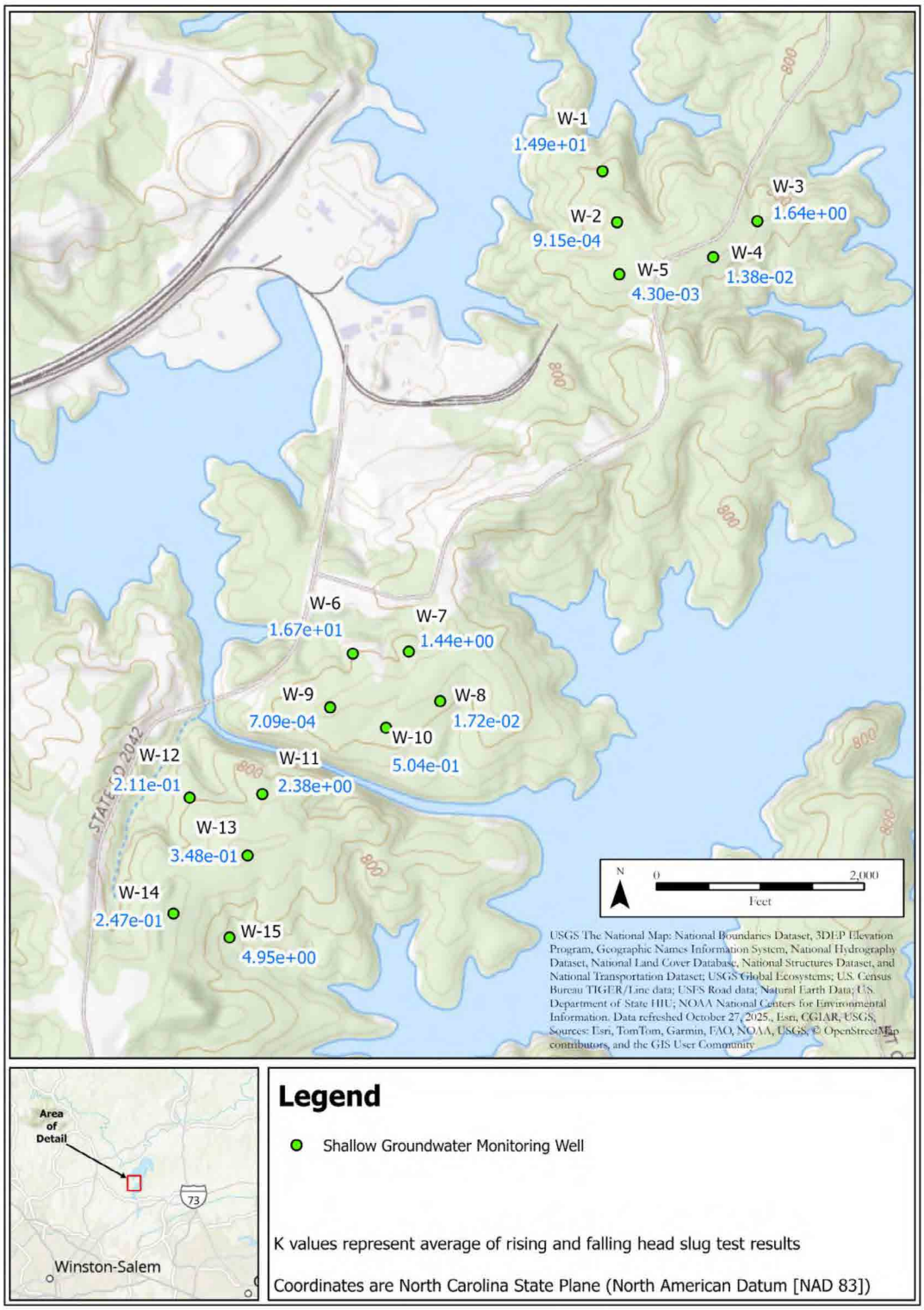


Figure 2.4-72
Hydraulic Conductivity (K) Distribution Map (Deep Zone)
(Sheet 2 of 2)

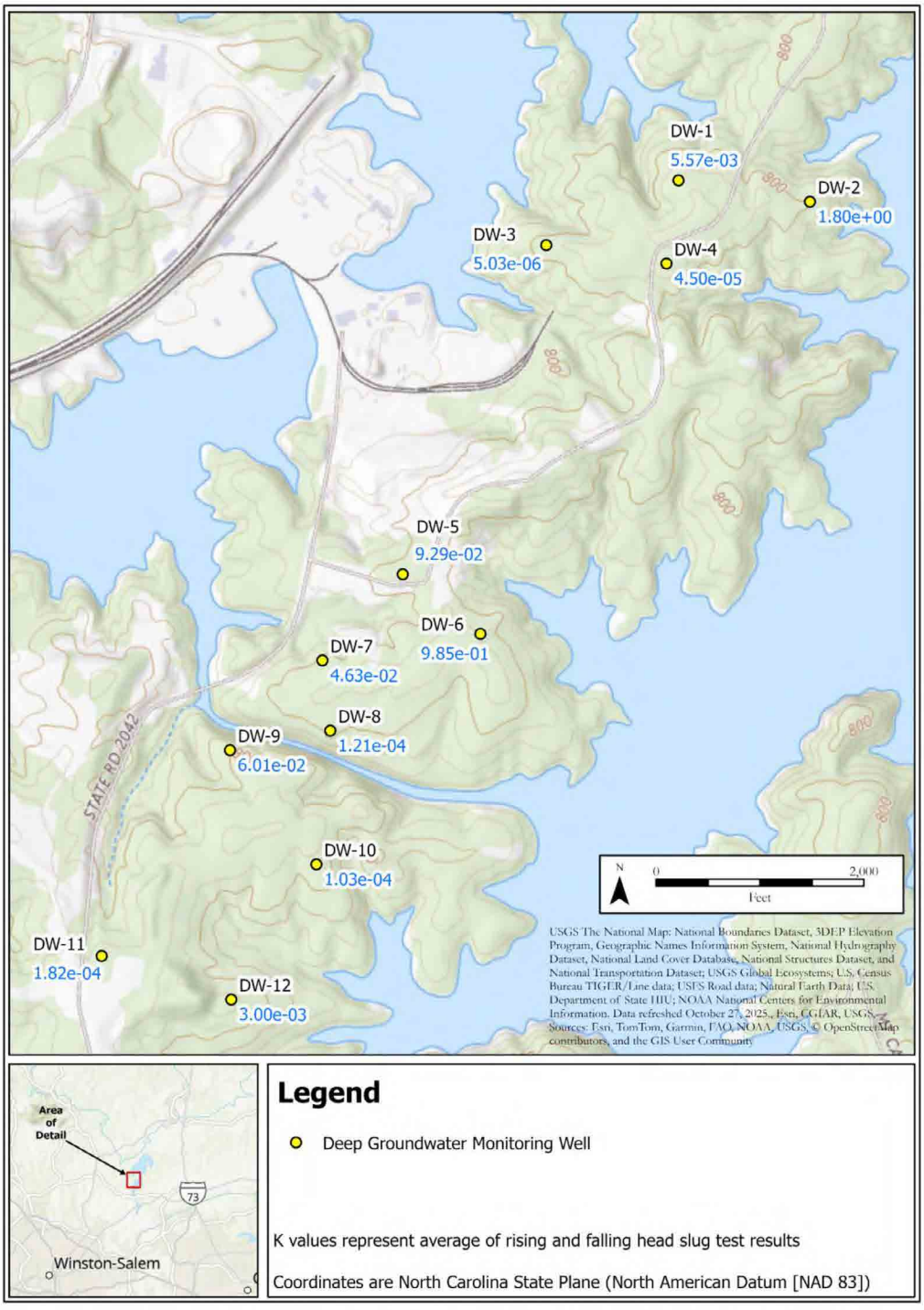


Figure 2.4-73
Vicinity Groundwater Withdrawals by Use

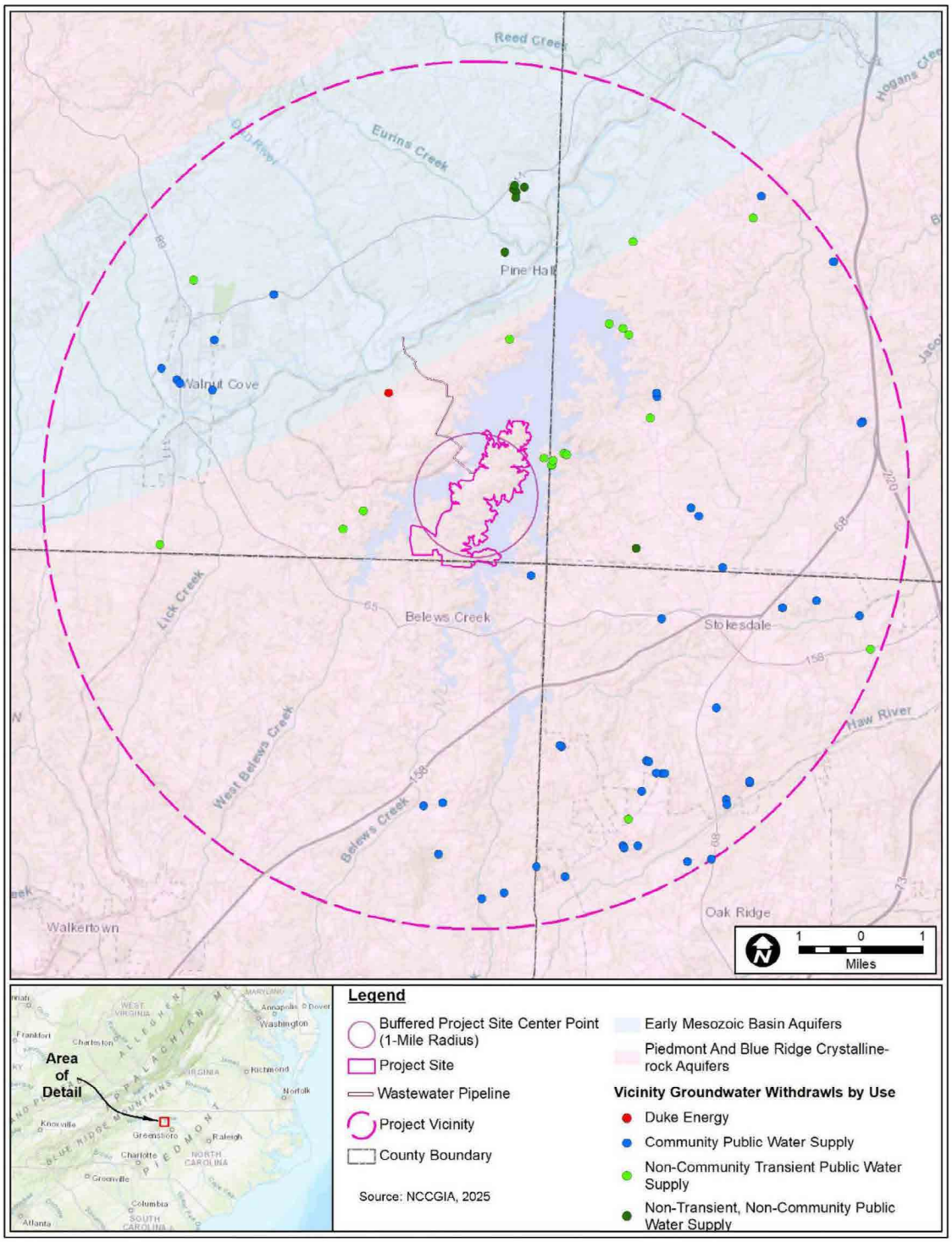
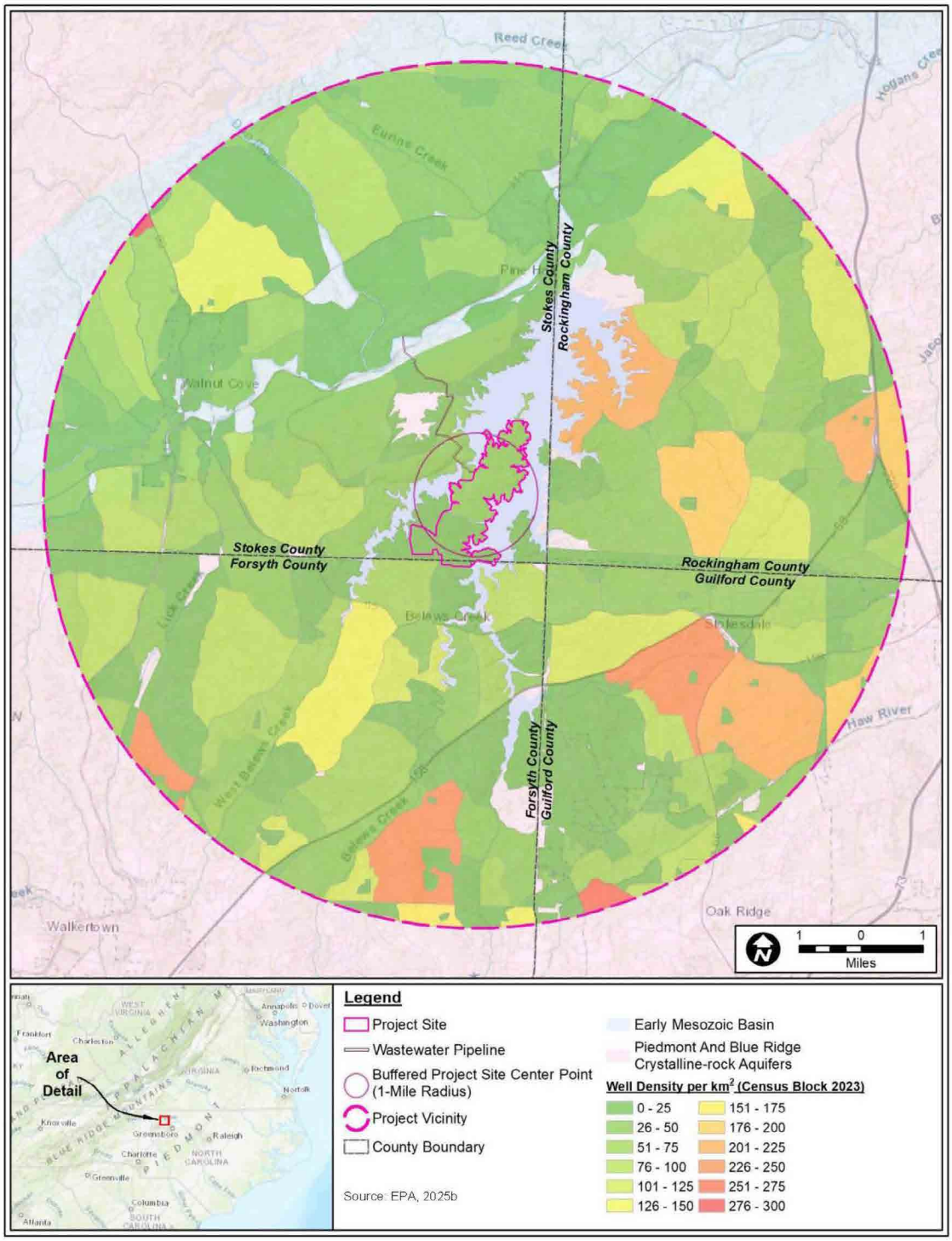


Figure 2.4-74
Vicinity Private Well Inventory (Rockingham and Guilford Counties)

[[

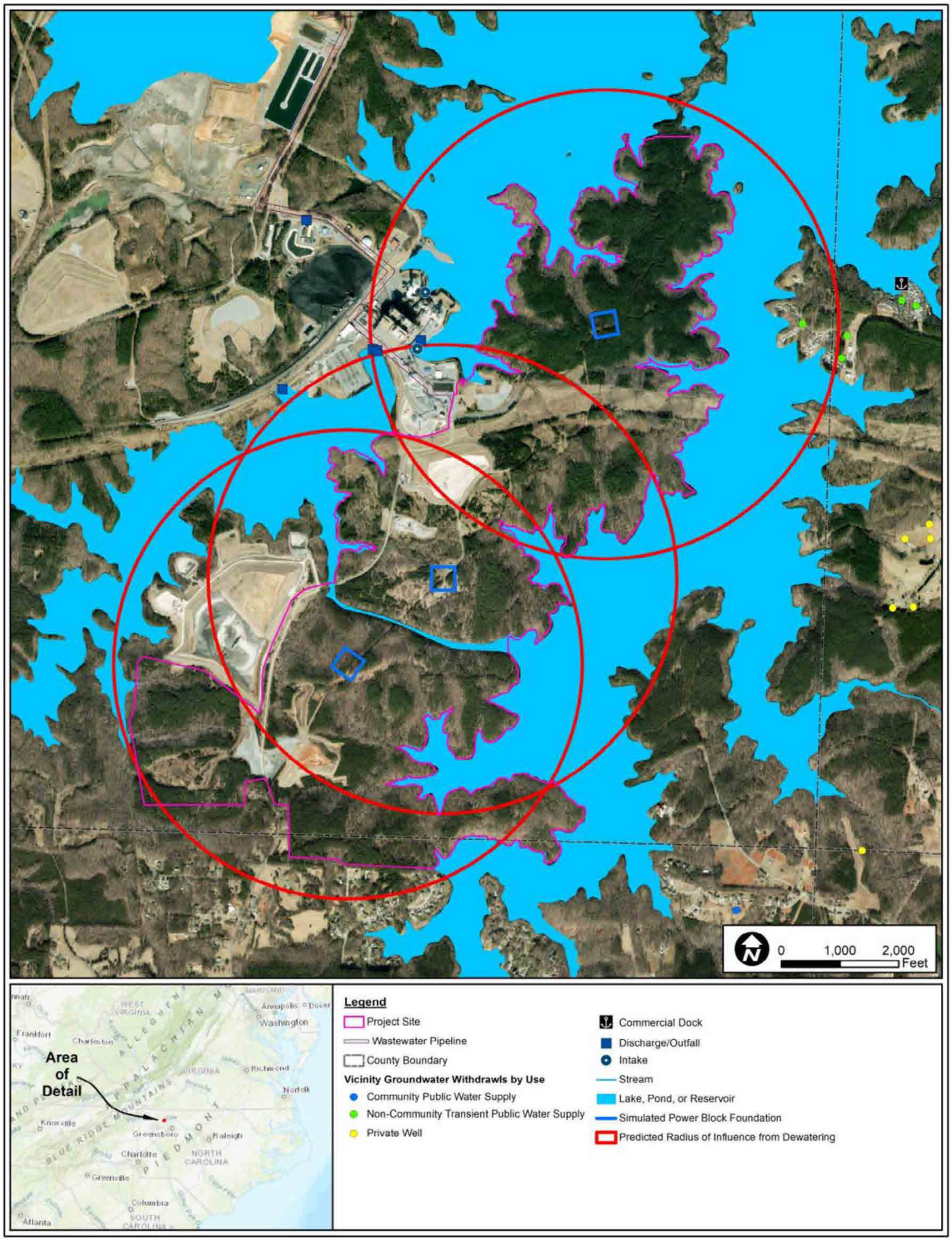
]]WI

Figure 2.4-75
Private Well Density Estimate (Forsyth, Stokes, Guilford, and Rockingham Counties)



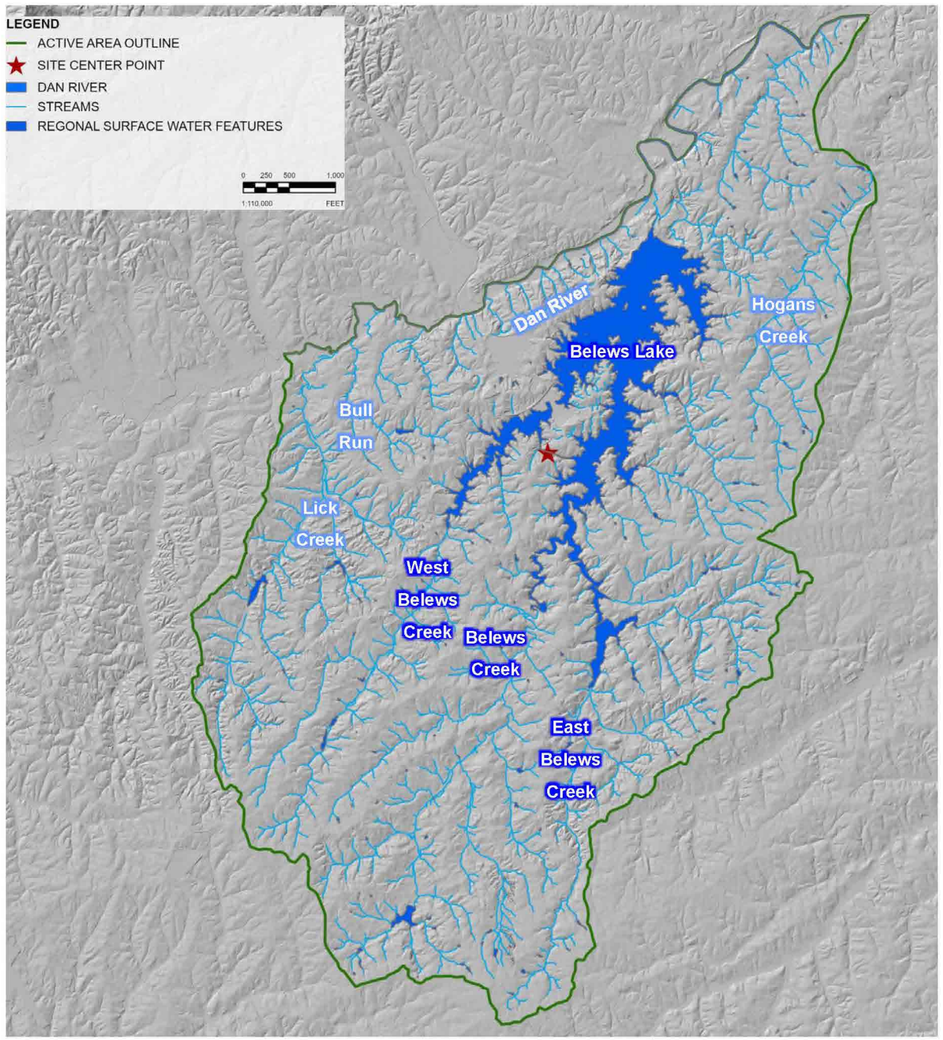
Source: Reference 2.4-95

Figure 2.4-76
Estimated Maximum Radius of Influence from Dewatering



Source: Reference 2.4-92

Figure 2.4-77
Numerical Model Domain and Boundary Conditions



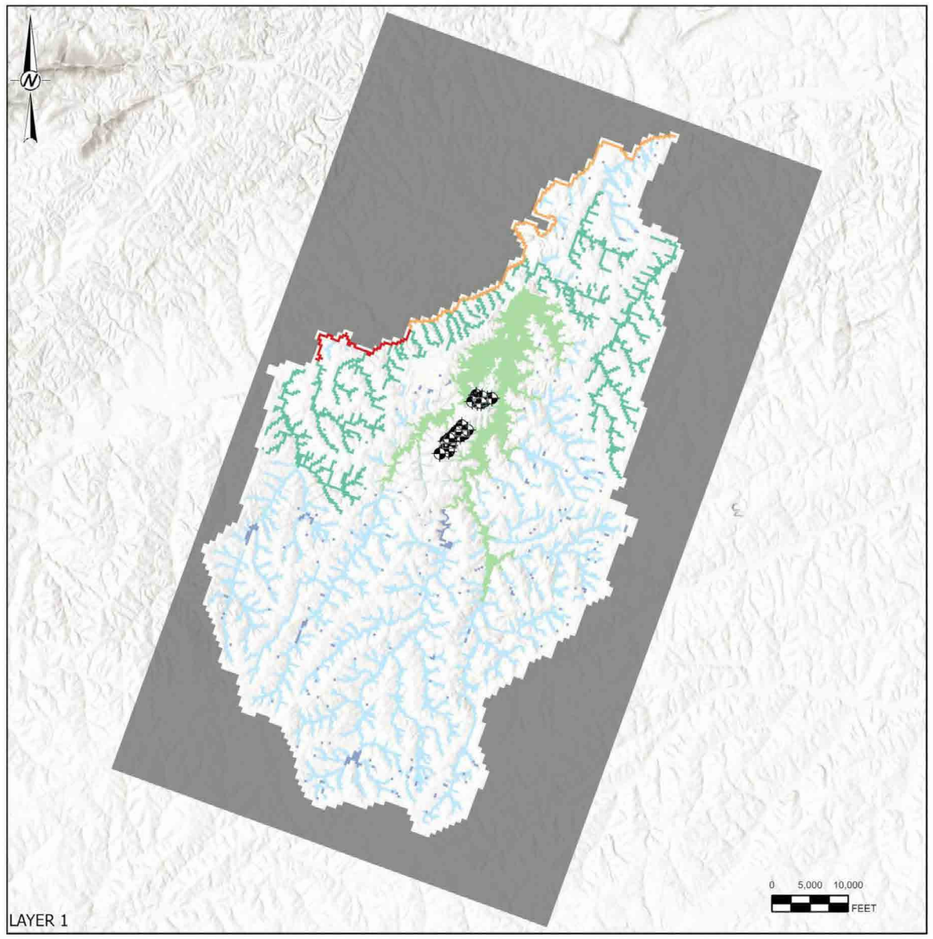


Figure 2.4-78
Numerical Model Cross Section A-A'
(Sheet 1 of 2)

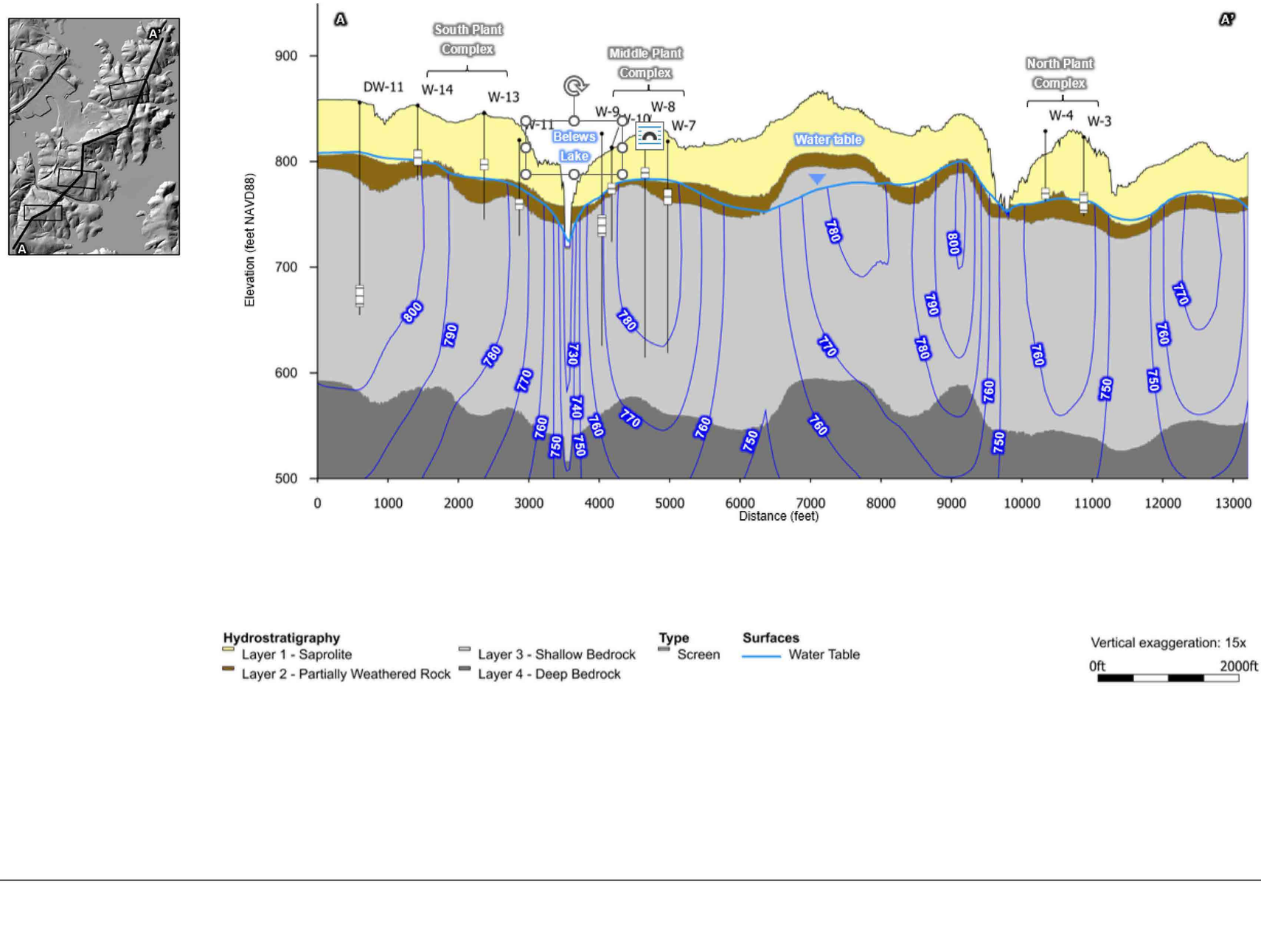
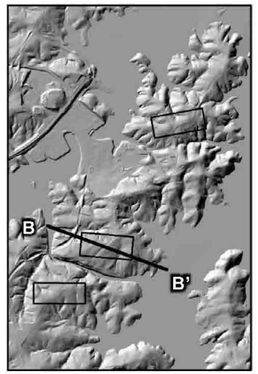


Figure 2.4-78
Numerical Model Cross Section B-B'
(Sheet 2 of 2)



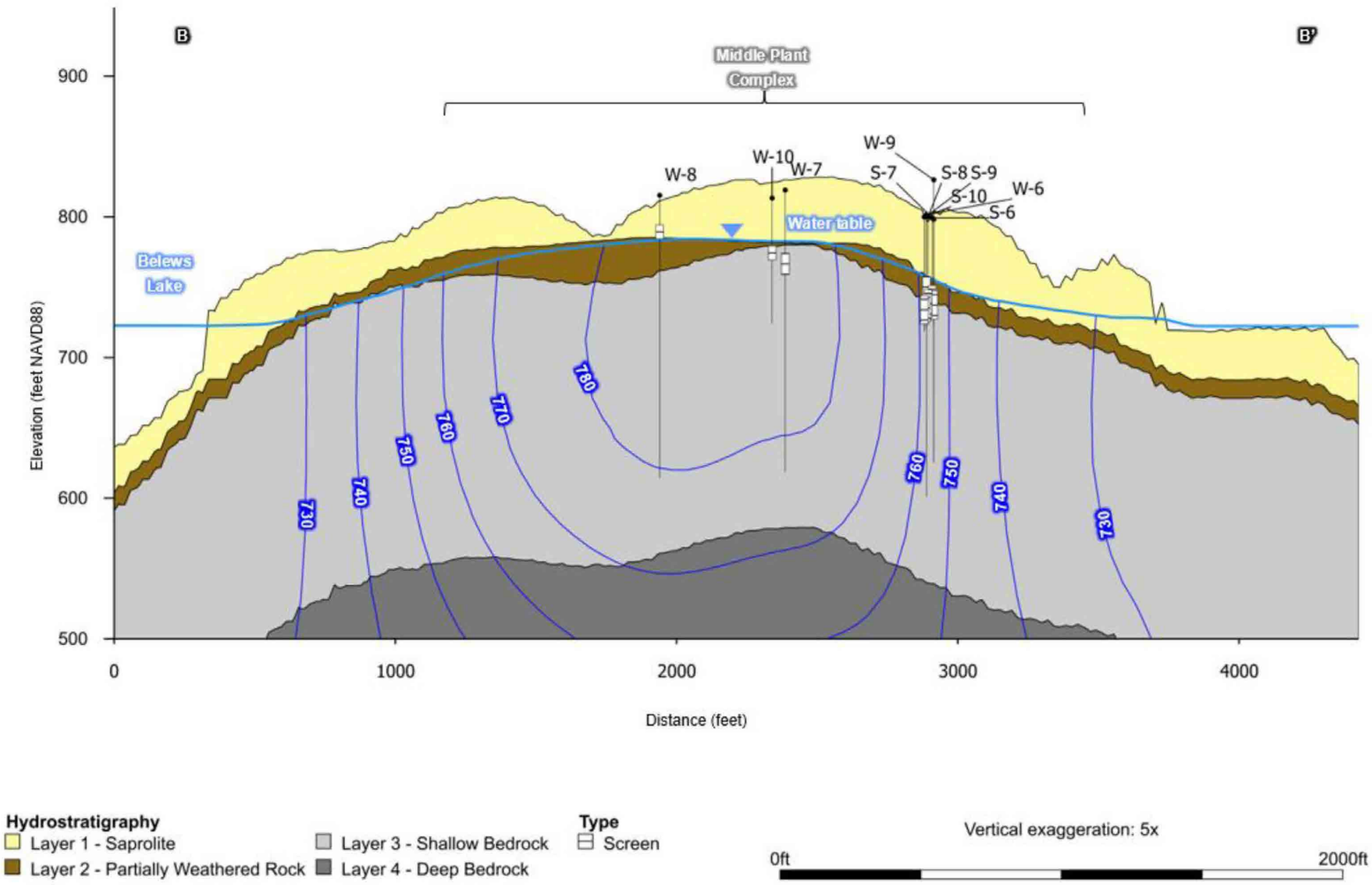
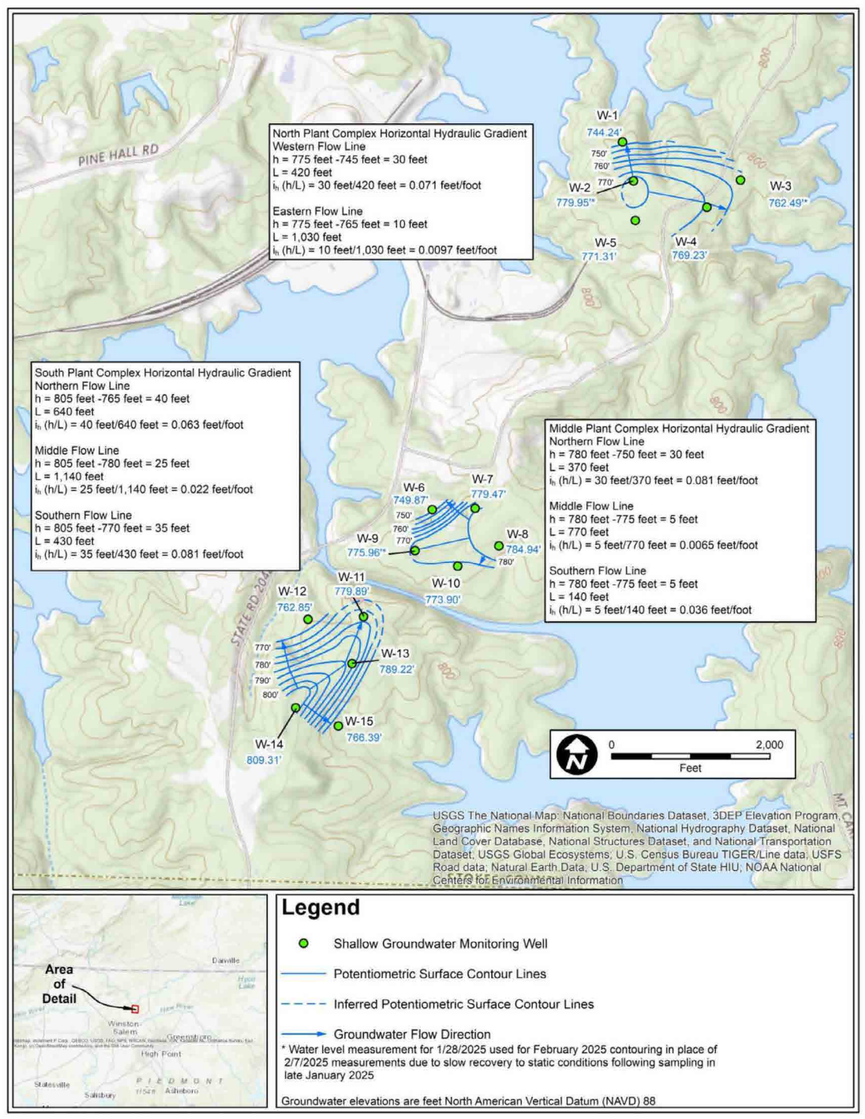


Figure 2.4-79
Interpreted and Simulated Water Table Elevation Contour Map, February 2025



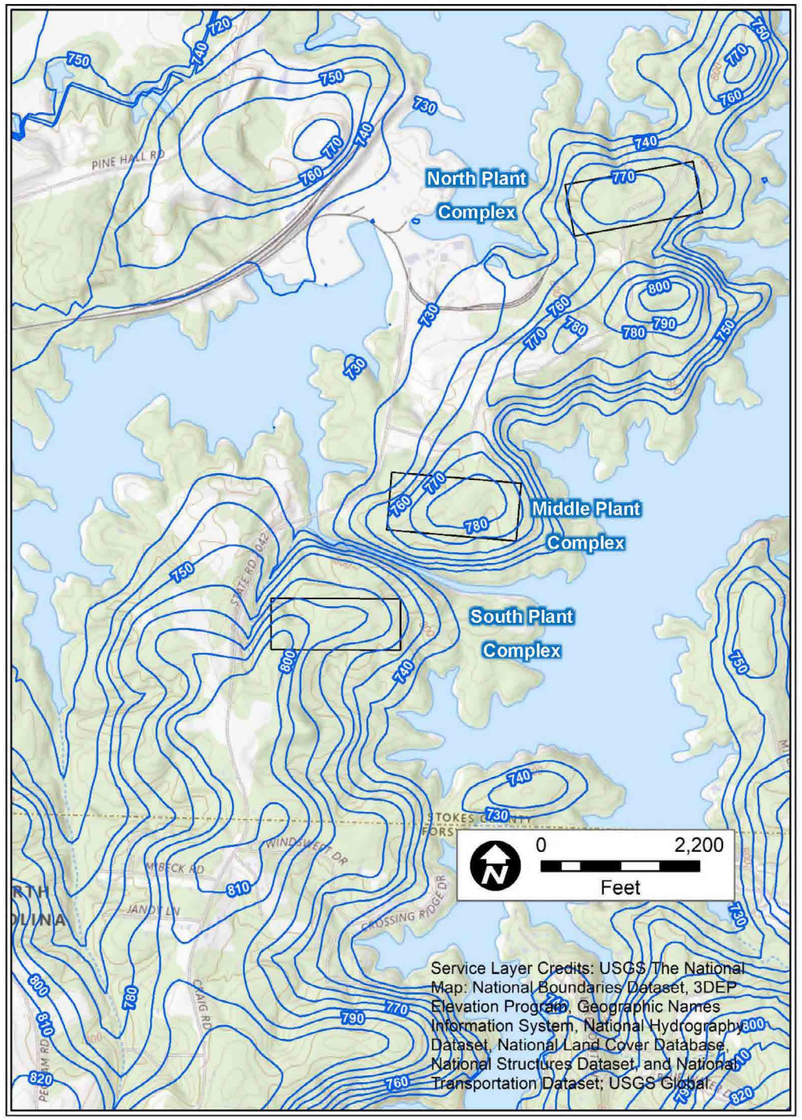


Figure 2.4-80
Measured vs Simulated Groundwater Elevations & Modeled Residual Bubble Maps

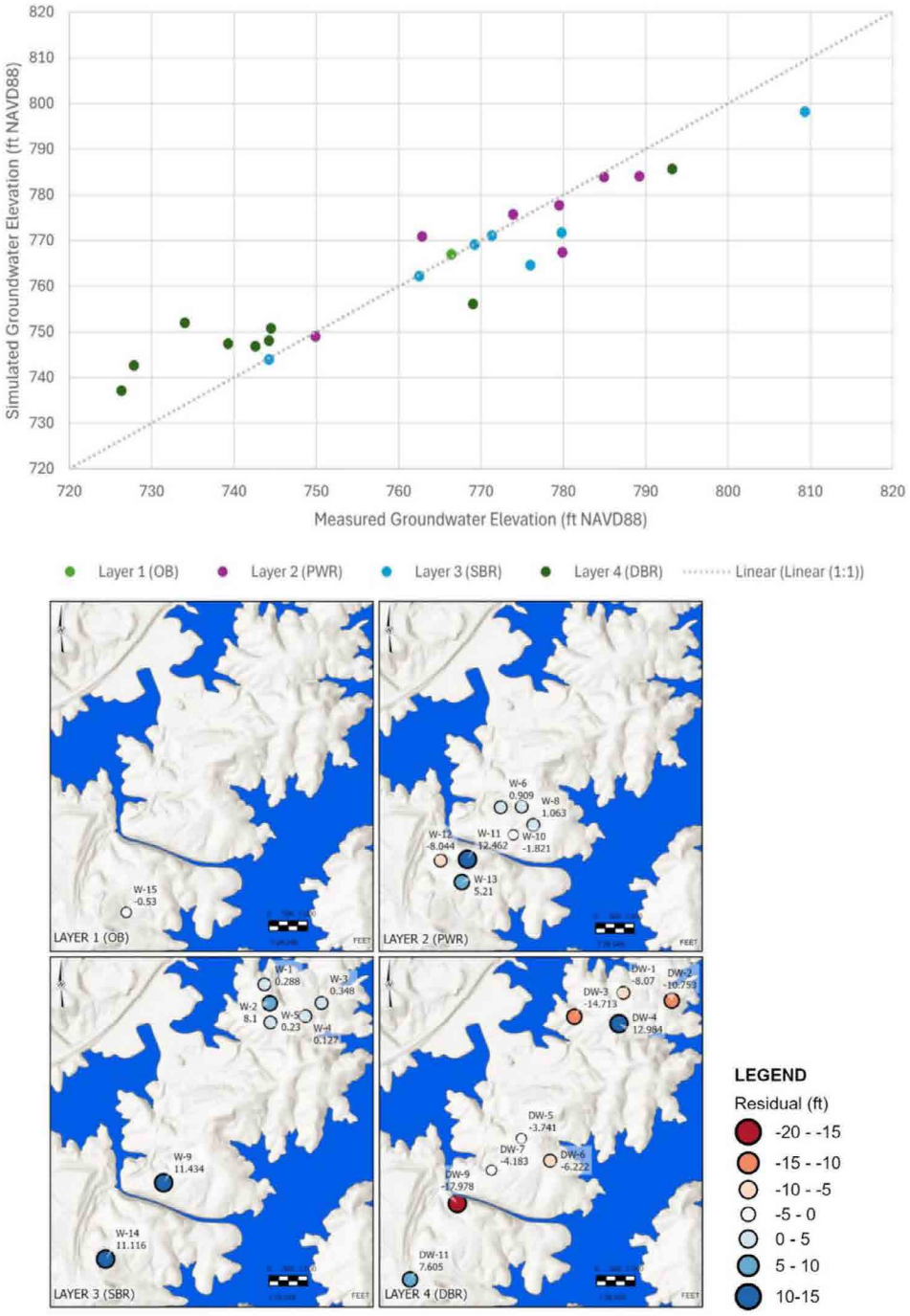


Figure 2.4-81
Particle Tracking Map

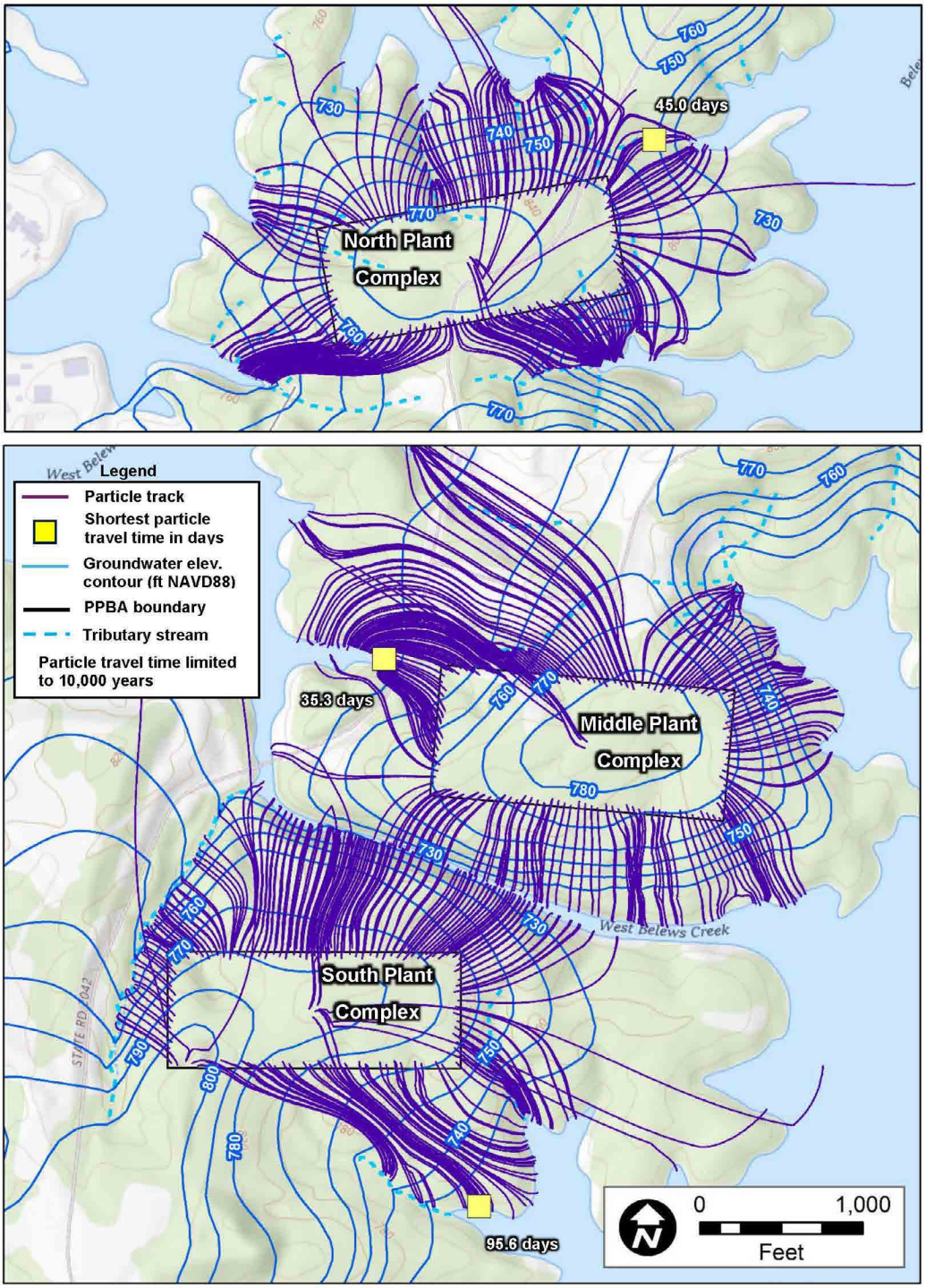
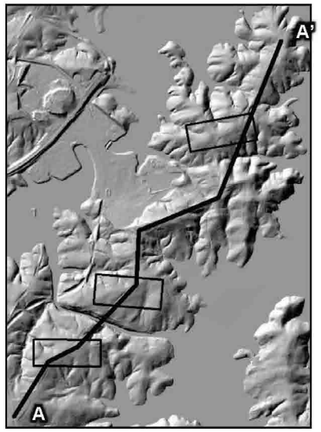


Figure 2.4-82
Particle Tracking Cross Section A-A'
(Sheet 1 of 2)



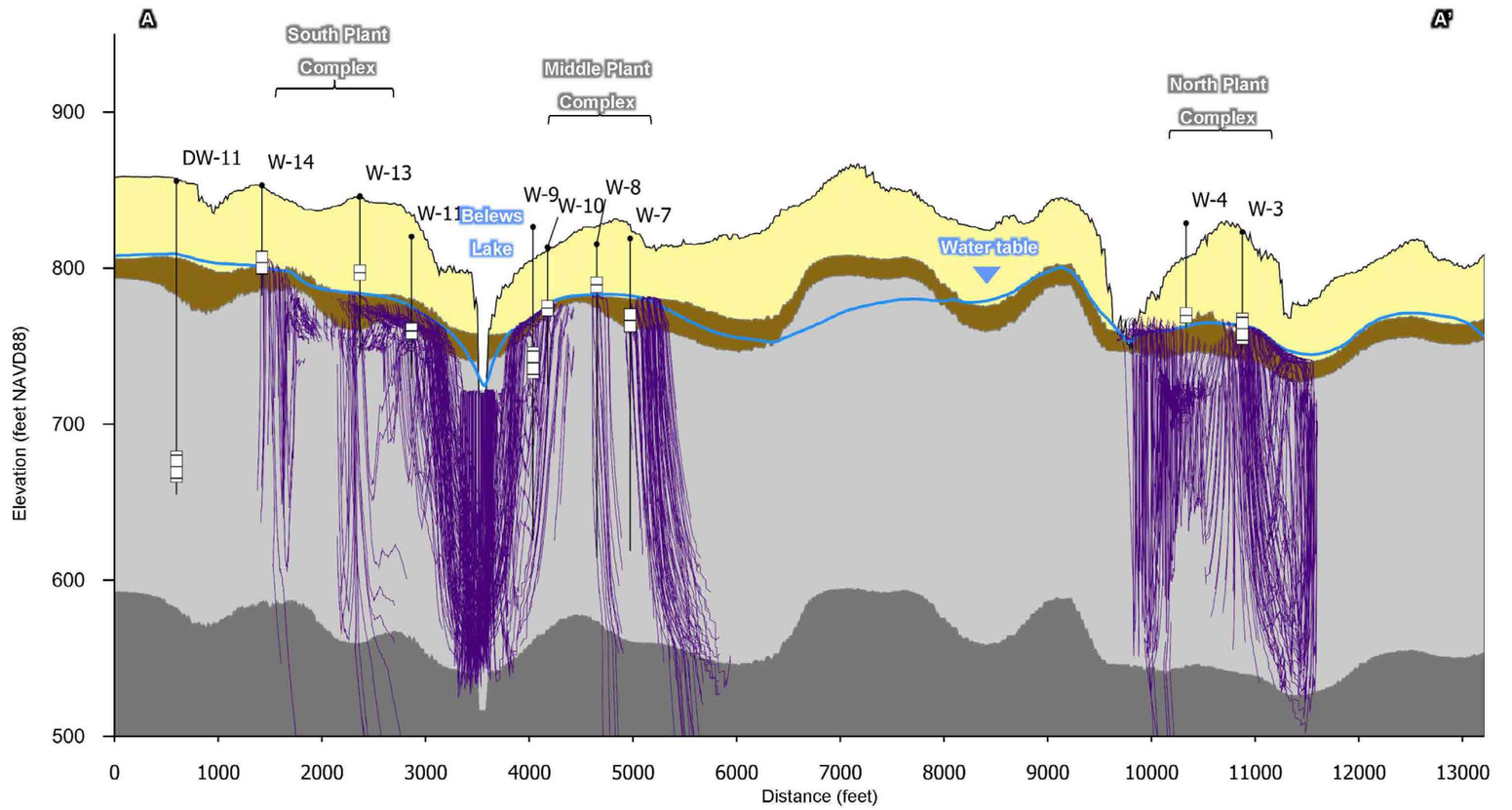


Figure 2.4-82
Particle Tracking Cross Section B-B'
(Sheet 2 of 2)

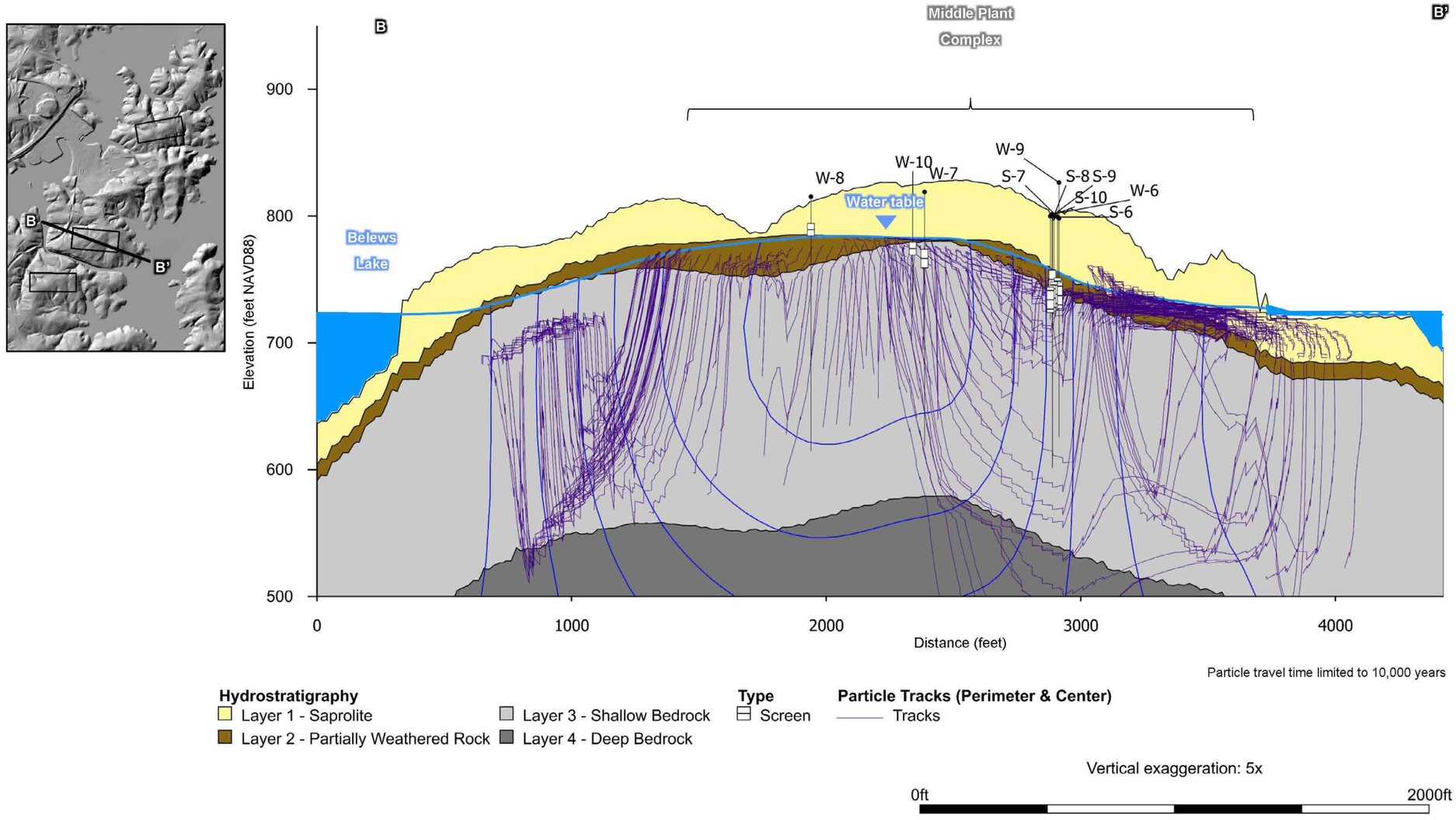
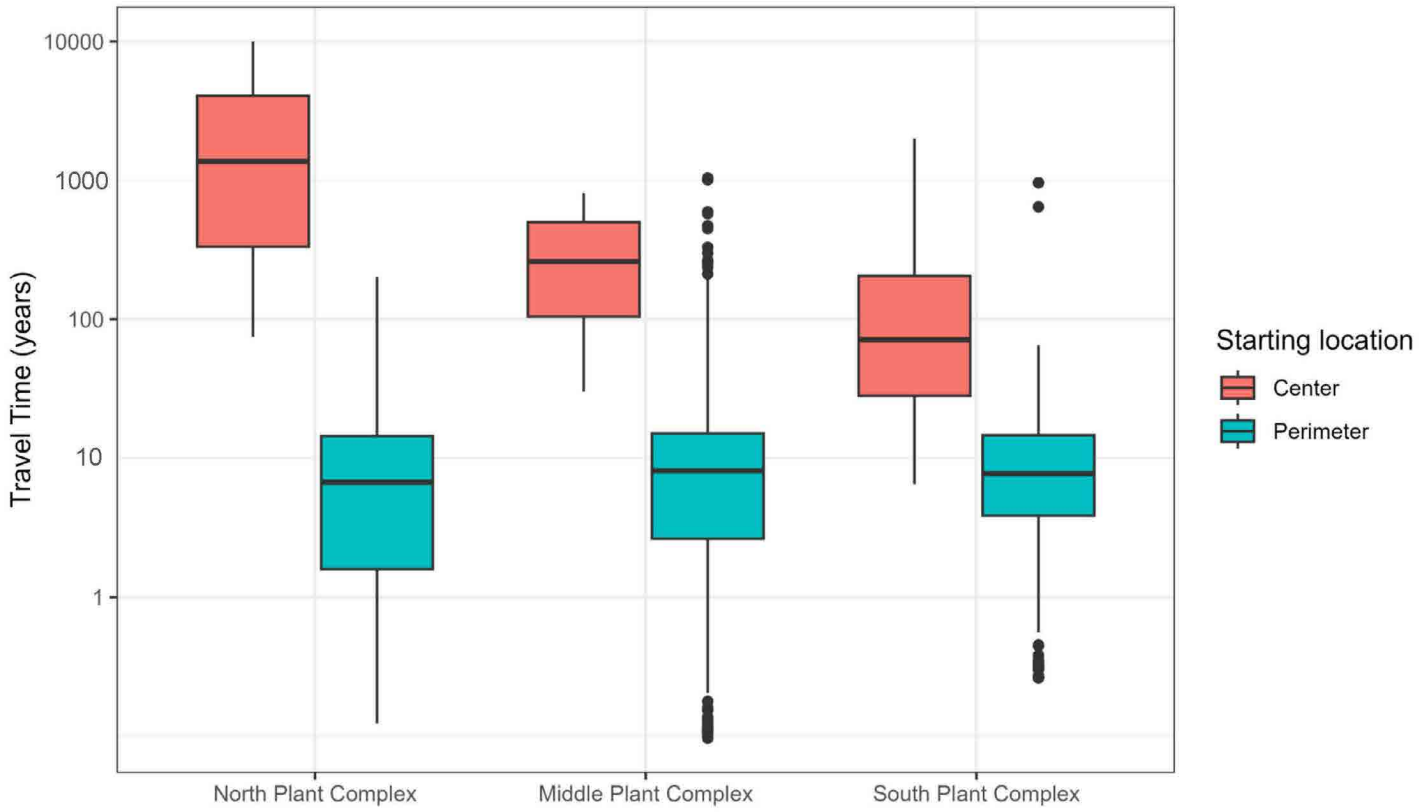
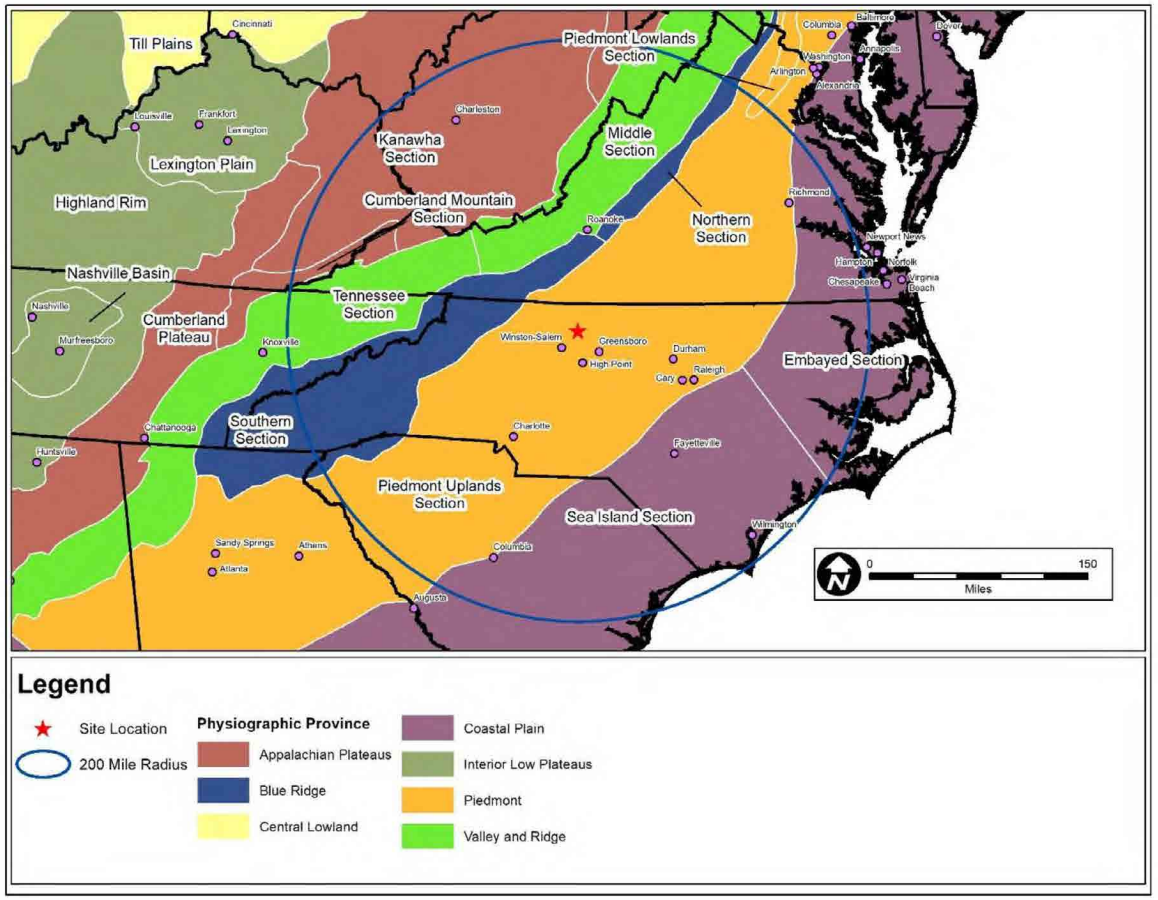


Figure 2.4-83
Particle Tracking Travel Time Distribution



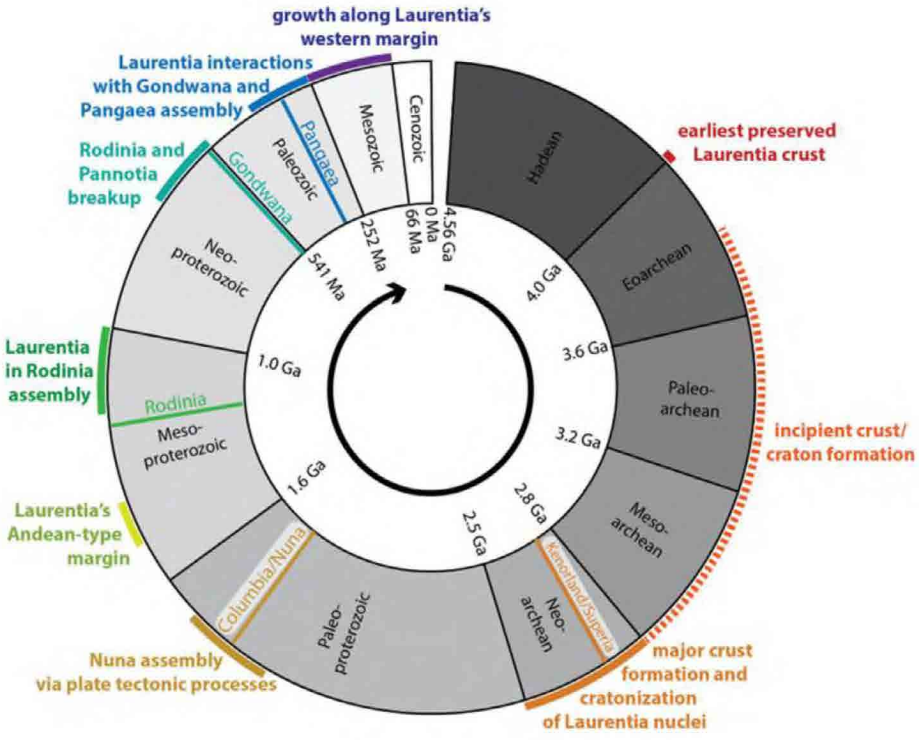
Note: Travel time of saturated groundwater flow from perimeter and center of PPBA in years. Does not include travel time through vadose zone to the water table interface.

Figure 2.5-1
Physiographic Provinces of the Site Region



Source: Physiographic provinces from Reference 2.5-1

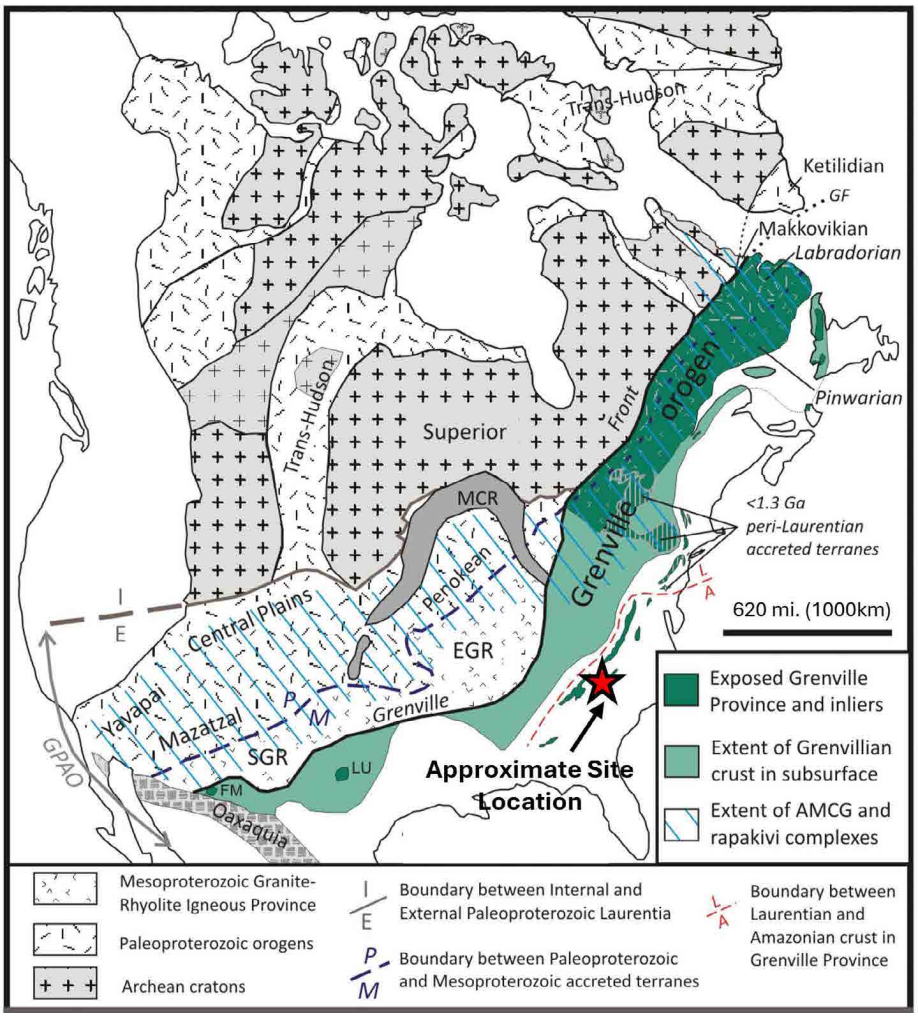
Figure 2.5-2
Geological Time Wheel Showing Major Geological Events Involving Laurentia



Source: Modified from Reference 2.5-11

Key: Ga = giga-annum; Ma = Mega-annum

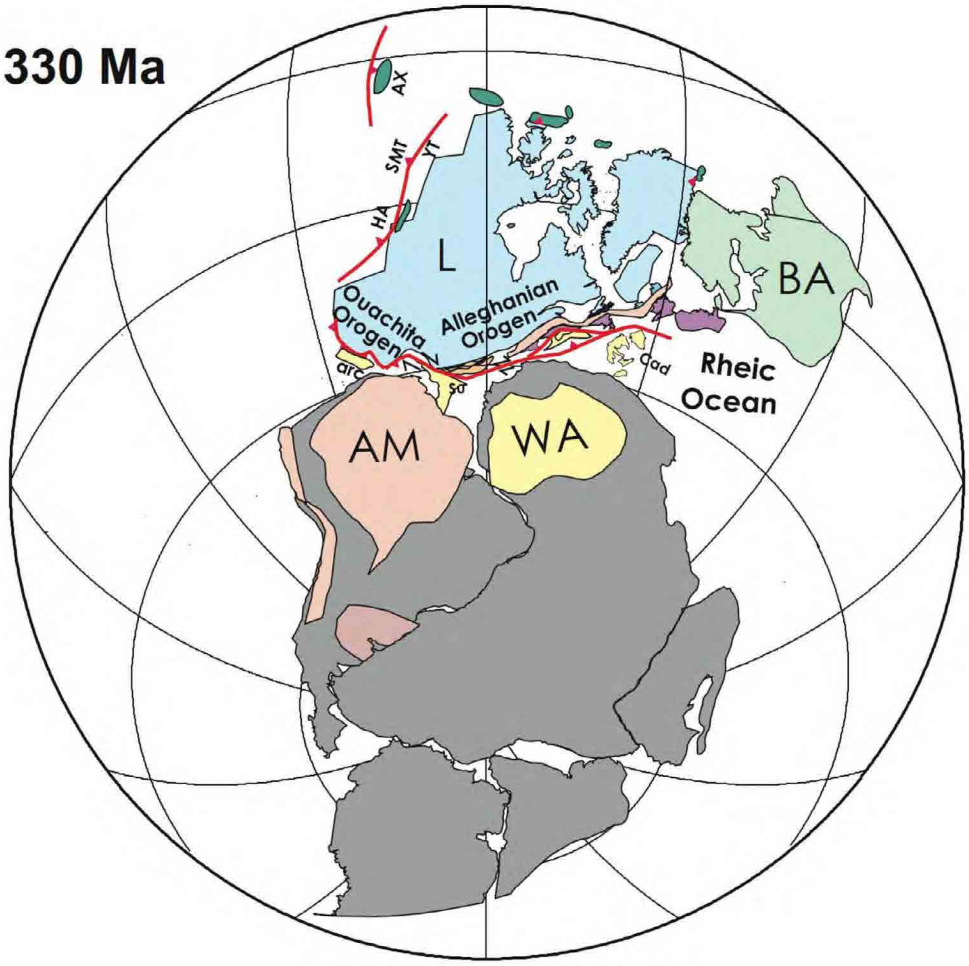
Figure 2.5-3
Extent of the Grenville Orogeny (1090 to 980 Ma)



Source: Modified from Reference 2.5-13

Key: AMCG = anorthosite-mangerite-charnockite-granite; EGR = Eastern Granite-Rhyolite Province; GF = Grenville Front; GPAO = Great Proterozoic accretionary orogen; km = kilometers; MCR = Midcontinent Rift; mi. = miles; SGR = Souther Granite-Rhyolite Province

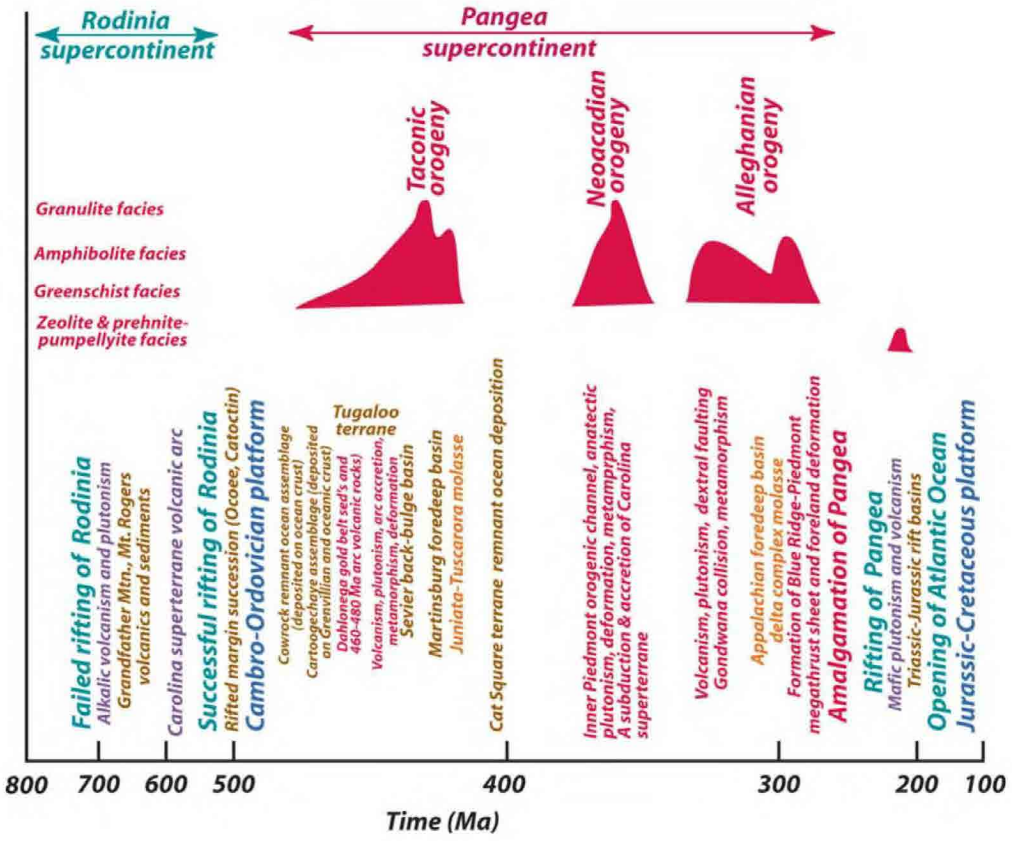
Figure 2.5-4
Paleogeographic Reconstruction Illustrating the Docking of West Africa (West Gondwana) with Laurentia During the Alleghanian Orogeny at 330 Ma



Source: Modified from Reference 2.5-16

Key: AX = Alexander Terrane; AM = Amazonia; BA = Baltica; CAD = Cadomia; HA = Havallah Basin; L = Laurentia; Ma = mega-annum; SMT = Slide Mountain Terrane; WA = West Africa

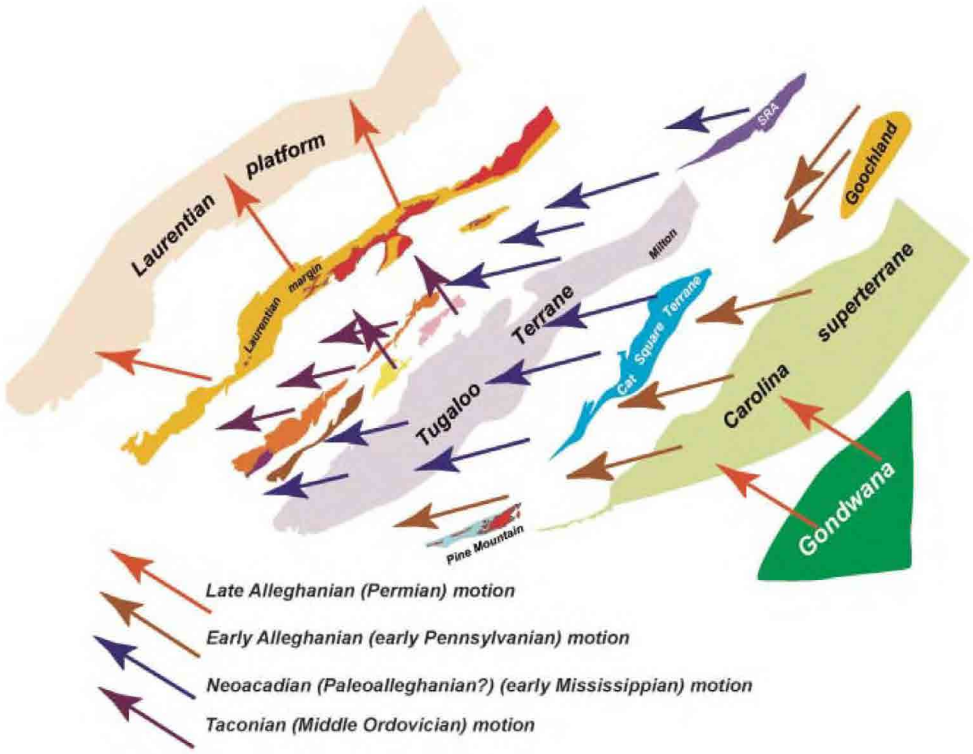
Figure 2.5-5
Late Neoproterozoic, Paleozoic, and Mesozoic Tectonic History for Eastern North America



Source: Modified from Reference 2.5-10

Key: Ma = Mega-annum

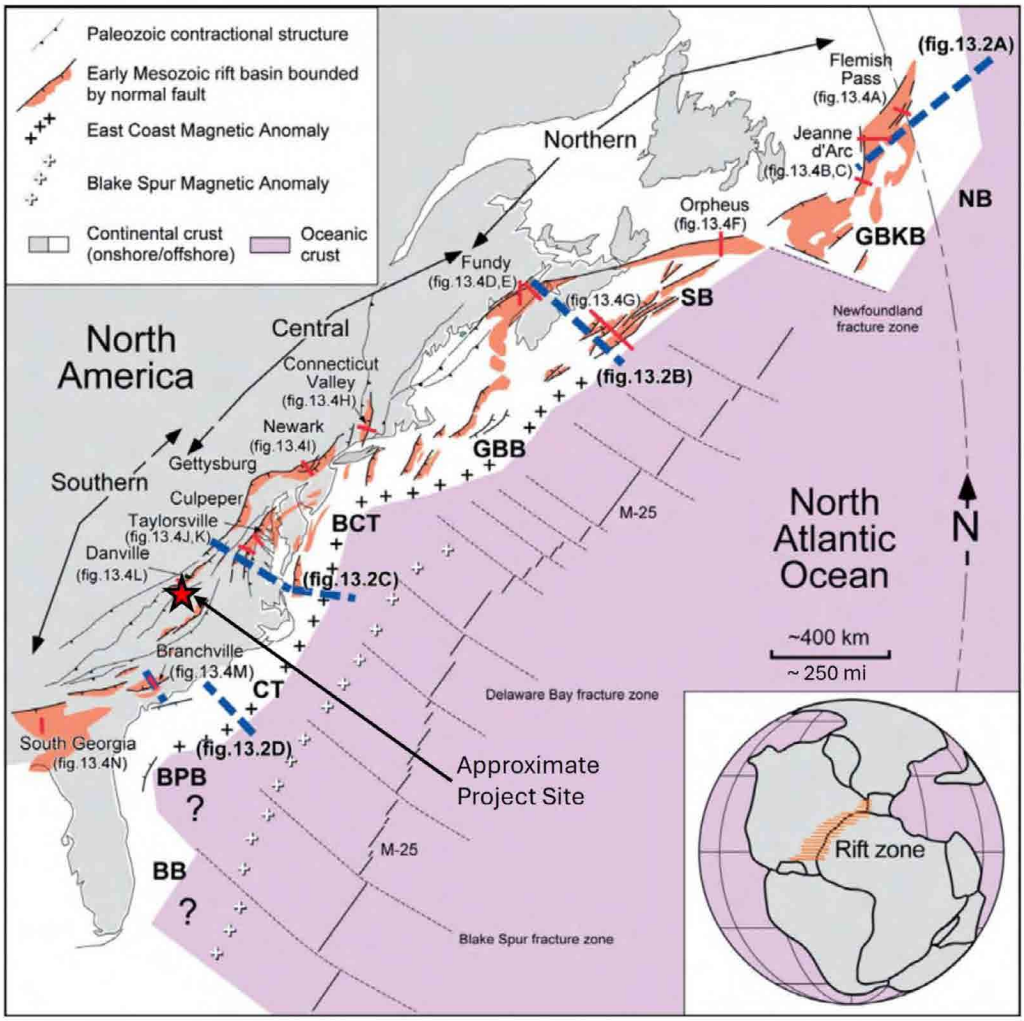
Figure 2.5-6
Sequence of Paleozoic Terrane Accretions for the Middle-Atlantic Region



Source: Modified from Reference 2.5-10

Key: SRA = Smith River allochton

Figure 2.5-7
Mesozoic Rift Zone Formation in Eastern North America

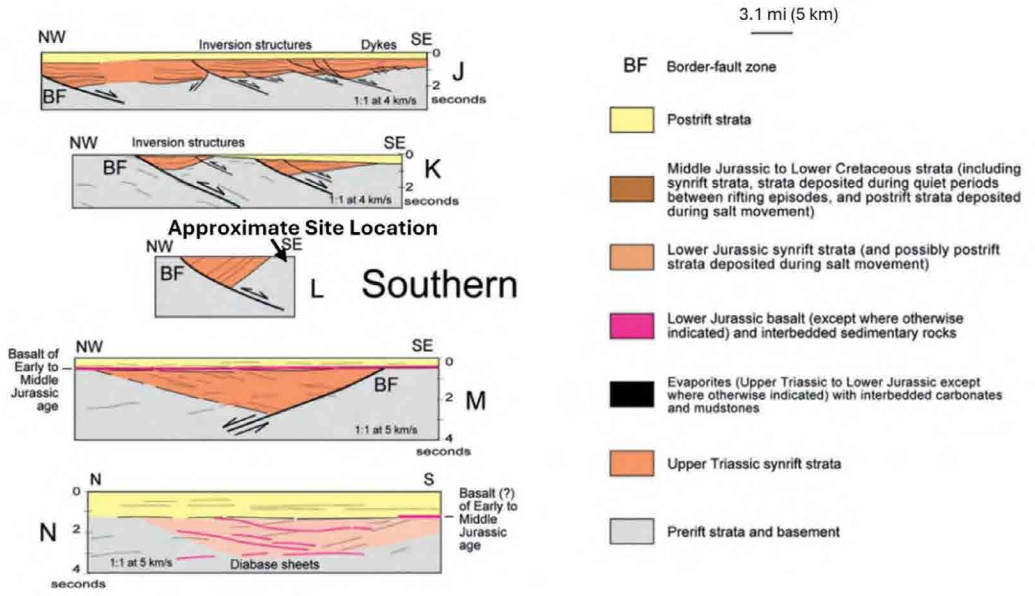


Source: Modified from Reference 2.5-20

Note: On the above figure, the labels fig 13.4J,K, fig 13.4L, fig 13.4M, and fig 13.4N correspond to the labels J, K, L, M, and N in Figure 2.5-8. All other figure labels above are not presented in this document.

Key: BB = Bahamas Basin; BPB = Blake Plateau Basin; CT = Carolina Trough; BCT = Baltimore Canyon Trough; BB = Georges Bank Basin; GBKB = Grand Banks Basin; km = kilometers; mi. = miles; SB = Scotian Basin; NB = Newfoundland Basin

Figure 2.5-8
Cross Sections of Rift Basins in the Southeastern United States; J and K – Taylorsville Basin; L – Danville Basin, NC, VA; M – Branchville Basin; N – South Georgia Basin

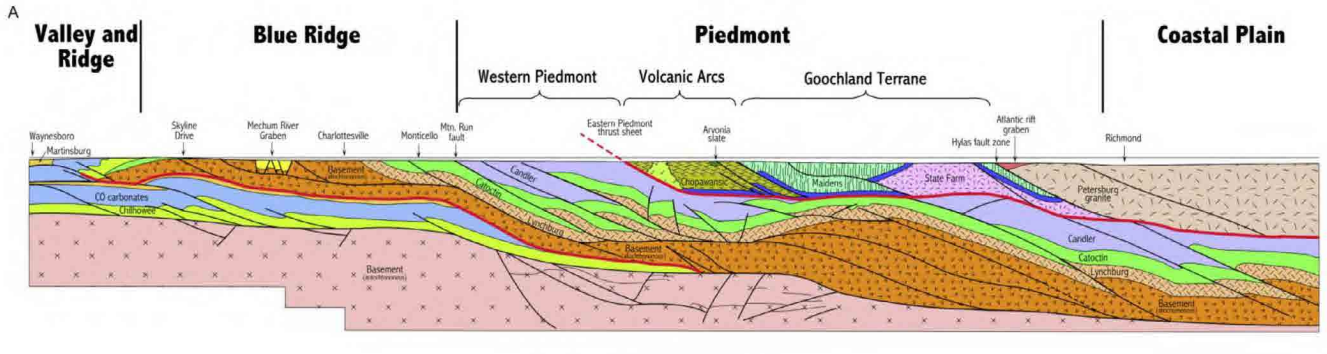


Source: Modified from Reference 2.5-20

Notes: J is interpreted time-migrated seismic line 88SD9/88TG-1; K is interpreted time-migrated seismic line TX85T10; M is interpreted line drawing of unmigrated seismic line S4; N is interpreted line drawing of time-migrated seismic line COCORP Georgia Line 11. Locations of cross-sections are depicted on Figure 2.5-7.

Key: km = kilomters; mi. = miles; NW = northwest; SE = southeast

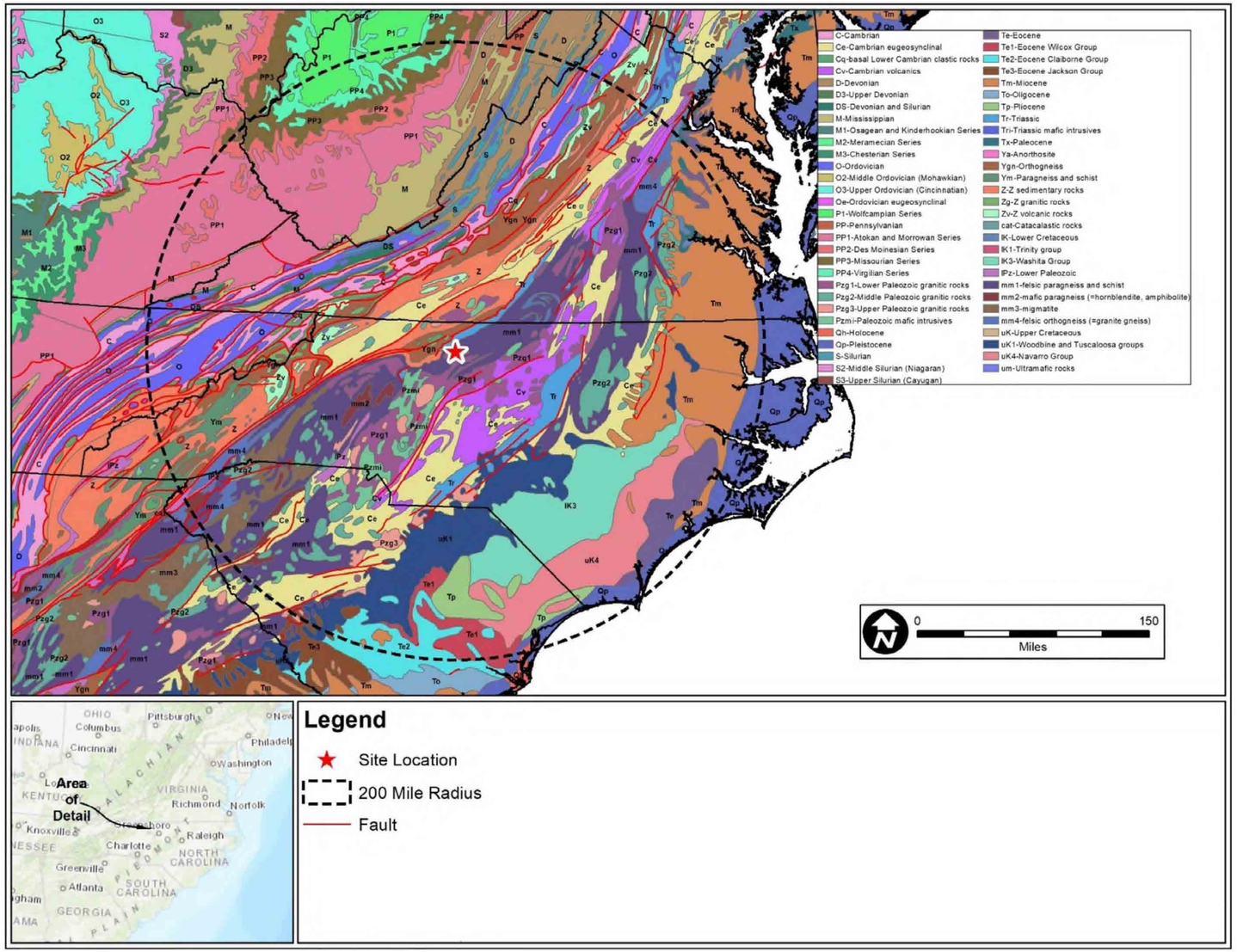
Figure 2.5-9
Schematic Geological Model of the Mid-Atlantic Foreland Fold-Thrust Belt from the Valley and Ridge to the Coastal Plain Provinces



Source: Modified from Reference 2.5-24

Key: CO = Cambrian-Ordovician

Figure 2.5-10
Geologic Map of the Site Region



Source: Reference 2.5-132

Figure 2.5-11
Major Terranes in the Site Region
(Sheet 1 of 2)

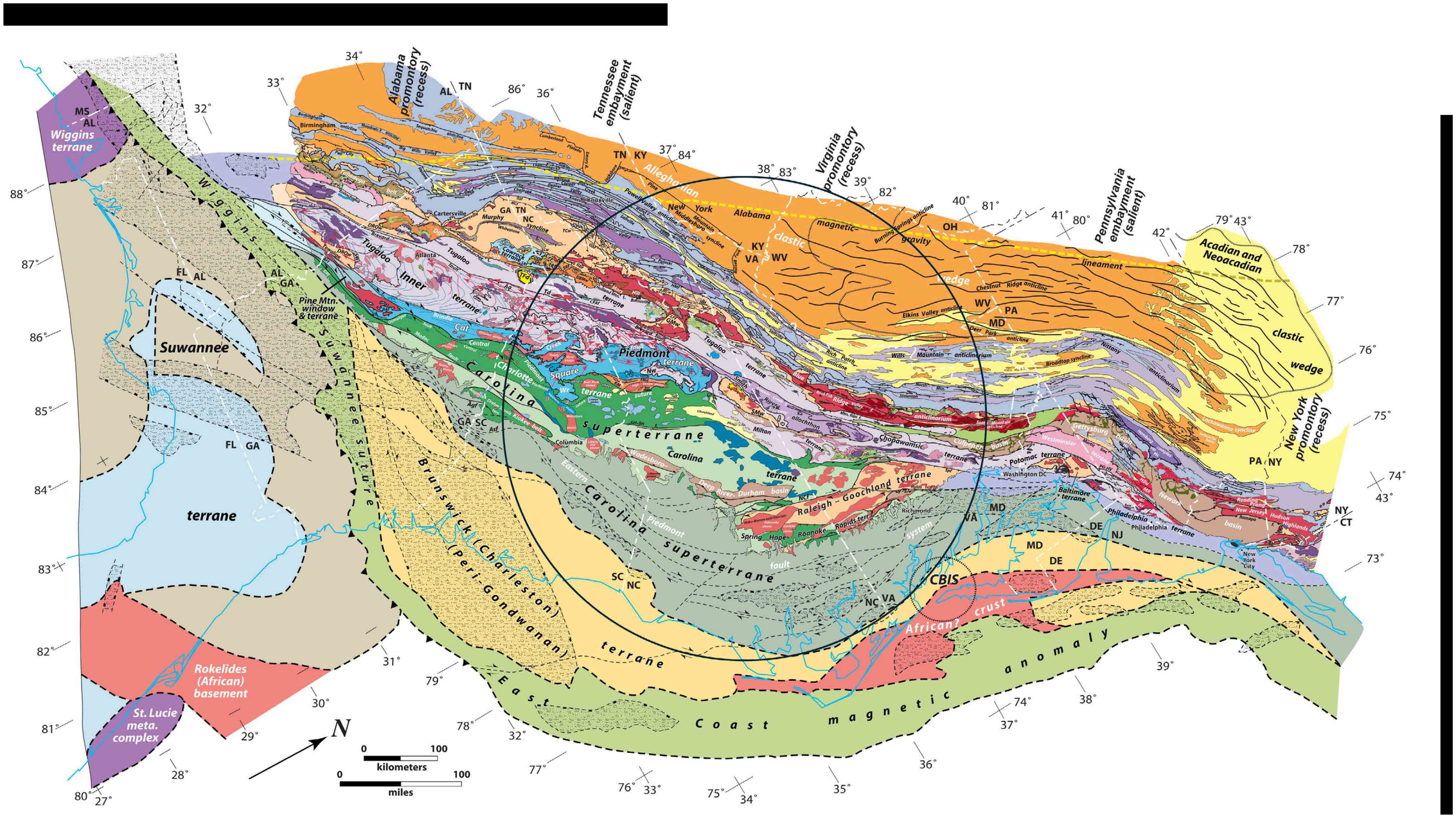
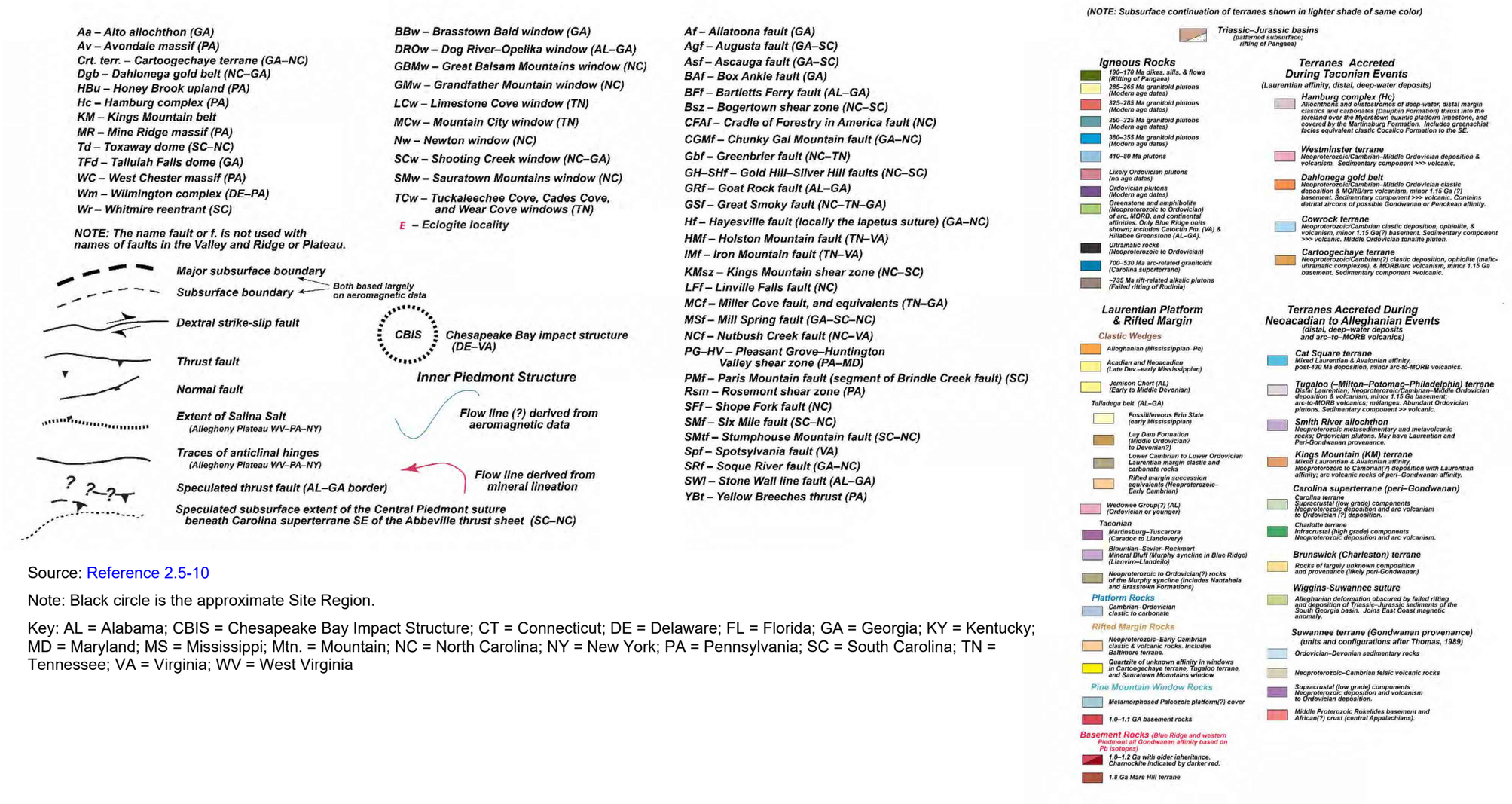


Figure 2.5-11
Major Terranes in the Site Region
(Sheet 2 of 2)

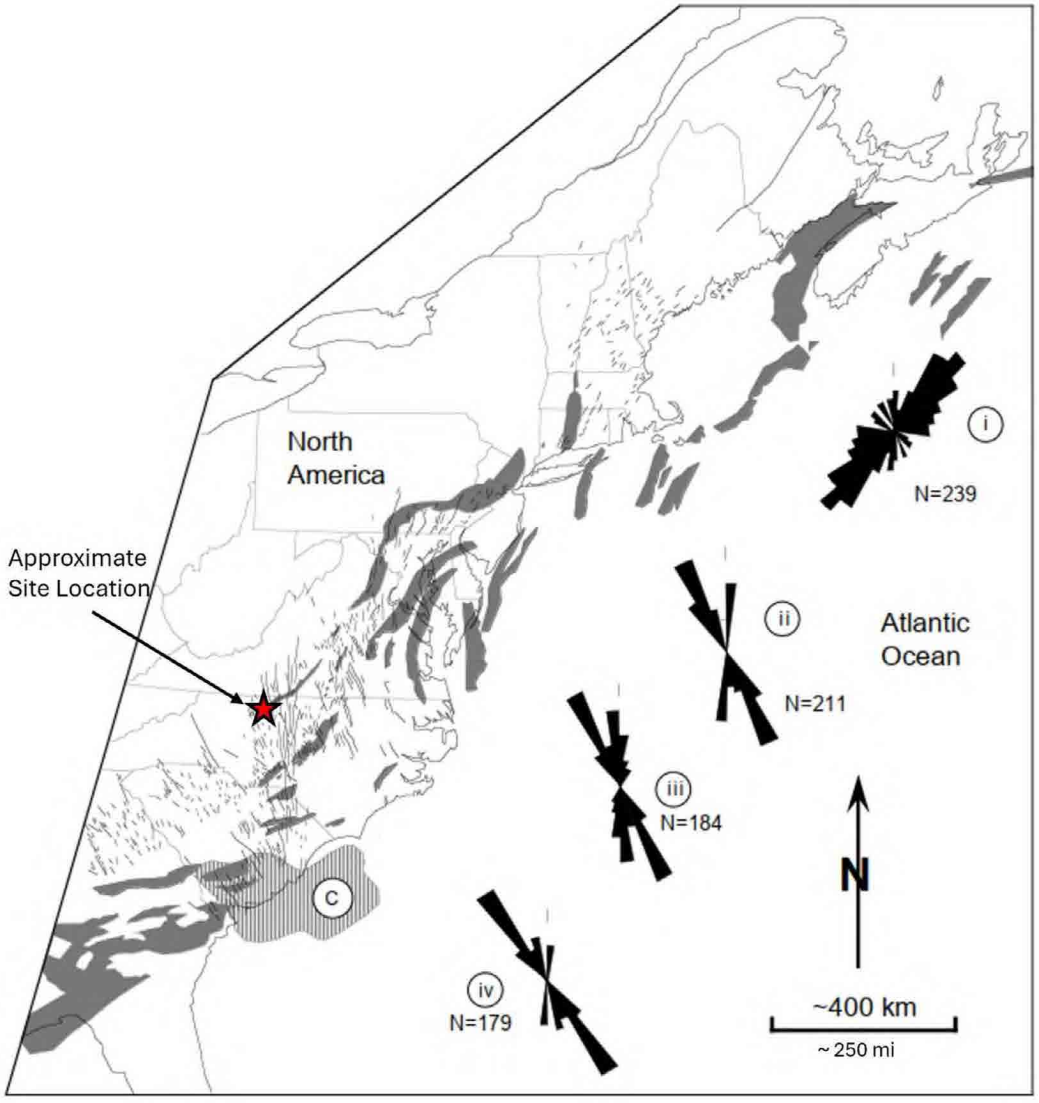


Source: Reference 2.5-10

Note: Black circle is the approximate Site Region.

Key: AL = Alabama; CBIS = Chesapeake Bay Impact Structure; CT = Connecticut; DE = Delaware; FL = Florida; GA = Georgia; KY = Kentucky; MD = Maryland; MS = Mississippi; Mtn. = Mountain; NC = North Carolina; NY = New York; PA = Pennsylvania; SC = South Carolina; TN = Tennessee; VA = Virginia; WV = West Virginia

Figure 2.5-12
Locations and Orientations of Areas of Diabase Dikes and Proximity to Rift Basins

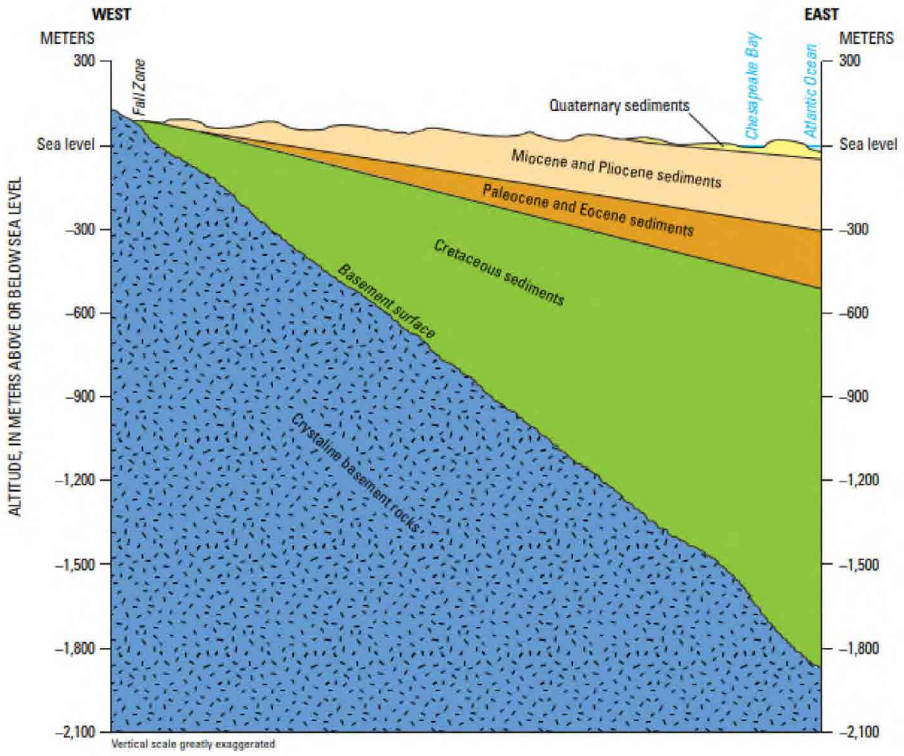


Source: Reference 2.5-21

Note: Rose diagrams of dike orientations for (i Maritime Canada, New England, and New Jersey; (ii Pennsylvania, Maryland and Virginia; (iii North Carolina; (iv South Carolina and Georgia.

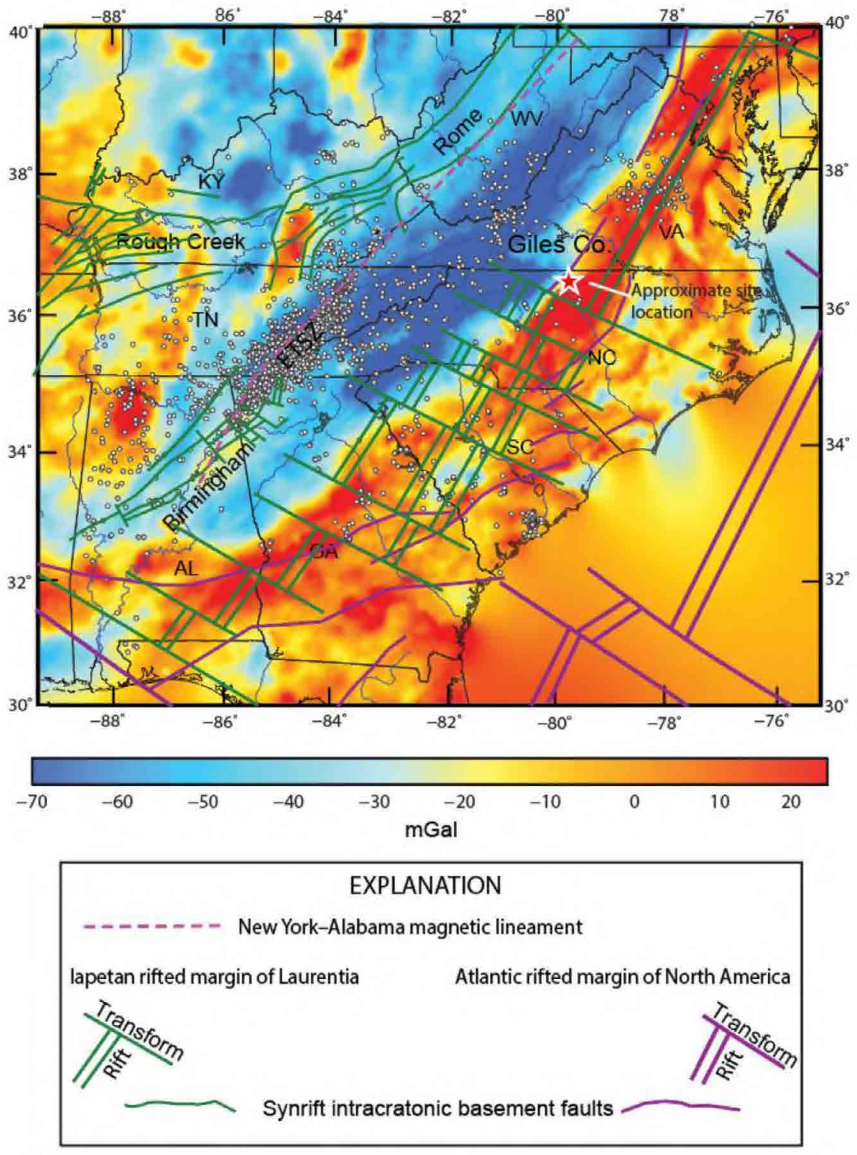
Key: km = kilometers; mi = miles

Figure 2.5-13
Simplified Geologic Cross Section Through the Coastal Plain in Virginia



Source: Reference 2.5-8

Figure 2.5-14
Map of Bouguer Gravity Anomalies and Iapetan-Rifted Continental Crust



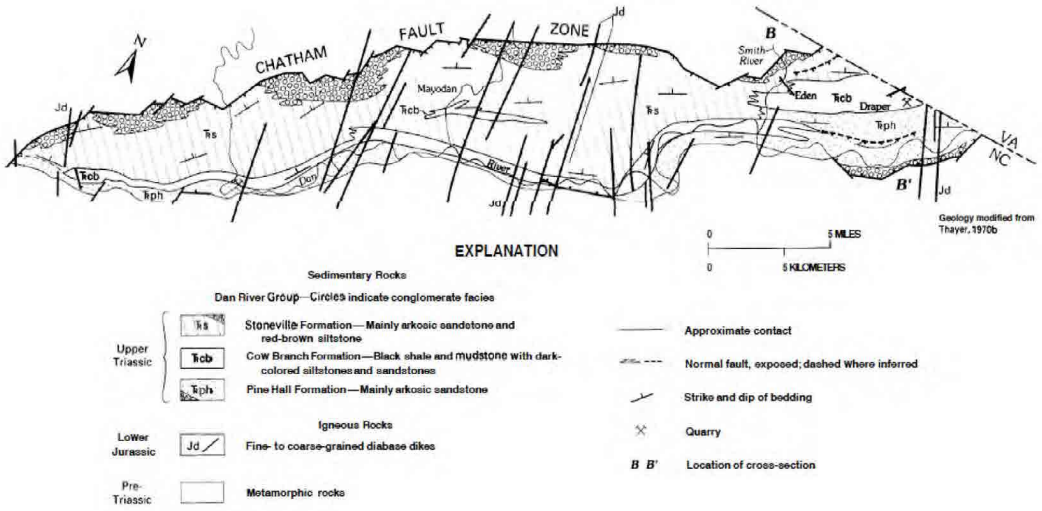
Source: Modified from Reference 2.5-39

Note: Earthquake epicenters (white dots taken from the Advanced National Seismic System Comprehensive Earthquake Catalog from 2007 to 2017.

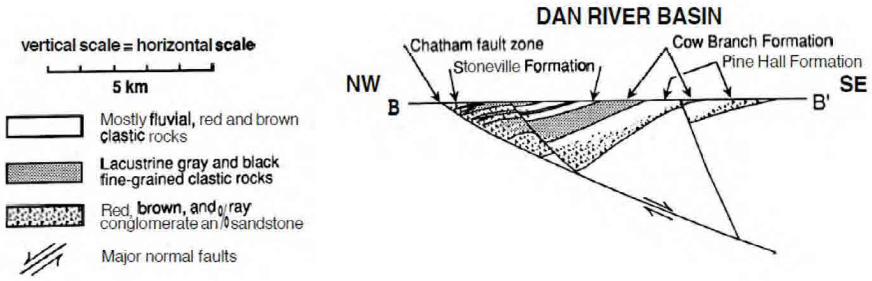
Key: AL = Alabama; ETSZ = Eastern Tennessee seismic zone; KY = Kentucky; mGal = milligal; NC = North Carolina; SC = South Carolina; VA = Virginia; WV = West Virginia

Figure 2.5-15
Generalized (A) Geologic Map and (B) Cross Section of the Dan River Mesozoic Basin

(a)



(b)



Source: Reference 2.5-48

Figure 2.5-16
(A) Geologic Map and (B) Cross Section B-B' near Site Area
(Sheet 1 of 2)

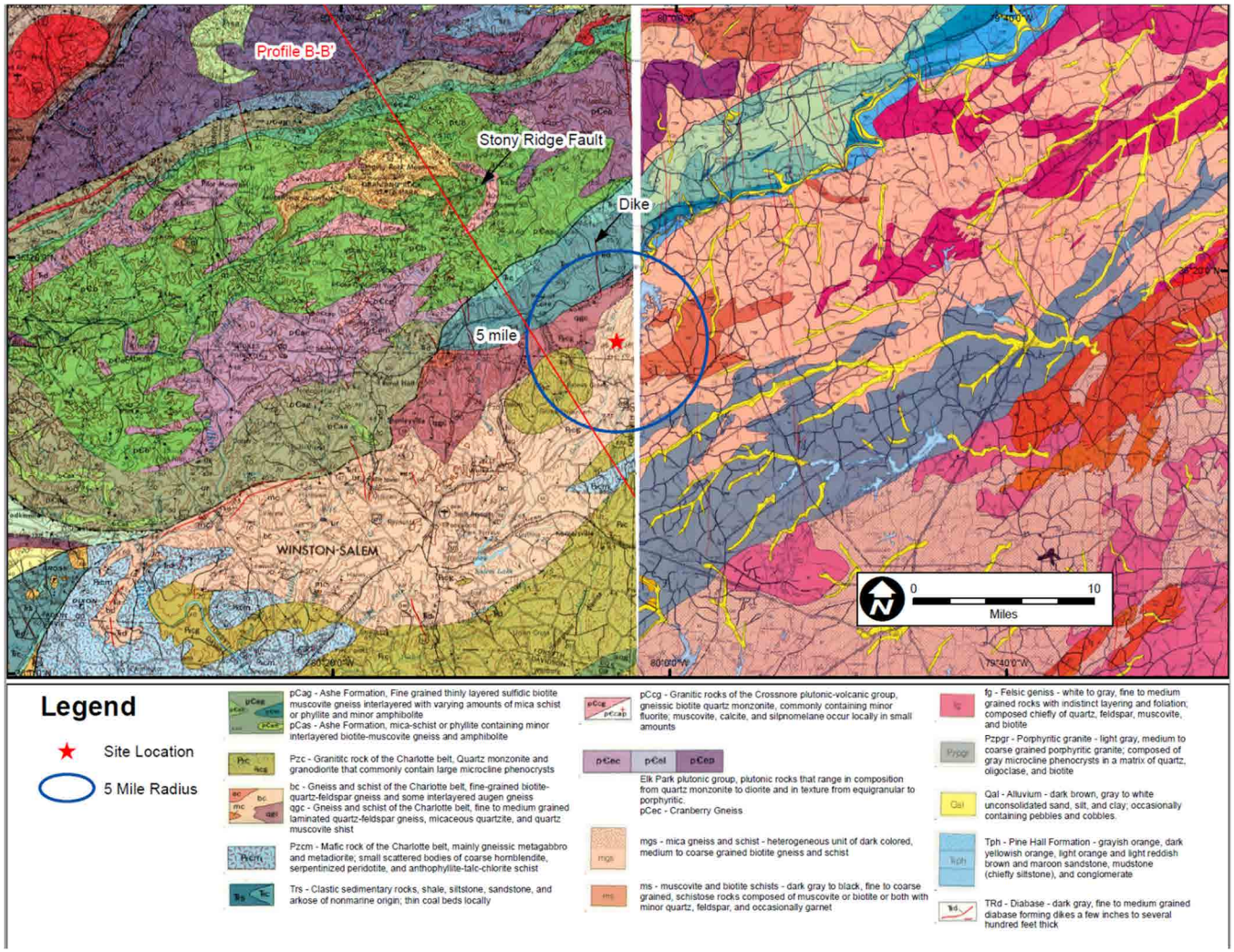
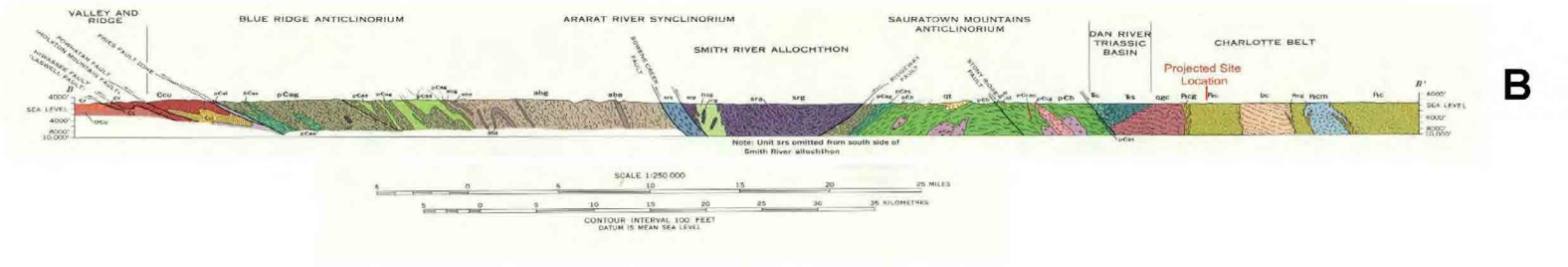


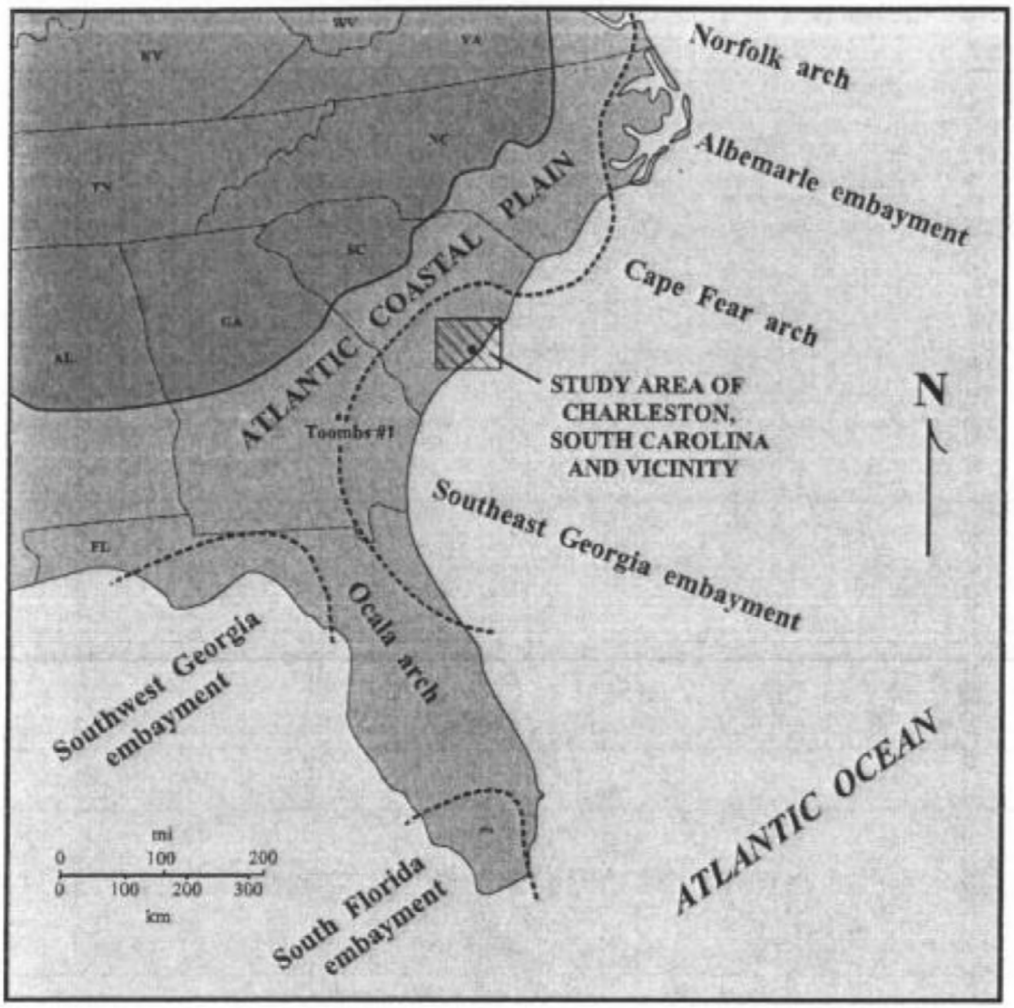
Figure 2.5-16
(A) Geologic Map and (B) Cross Section B-B' near Site Area
(Sheet 2 of 2)



Source: Modified from Reference 2.5-51; Reference 2.5-133

Note: Cross section B-B' is from Reference 2.5-51 and is located on the left panel of (A).

Figure 2.5-17
Locations of Major Arches and Embayments Along the U.S. Atlantic Coast



Source: Reference 2.5-54

Key: AL = Alabama; FL = Florida; GA = Georgia; KY = Kentucky; NC = North Carolina; SC = South Carolina; TN = Tenneessee; VA = Virginia; WV = West Virgina

Figure 2.5-18
Seismic Sources from the 2023 U.S. Geological Survey National Seismic Hazard Map and Other Regions Discussed

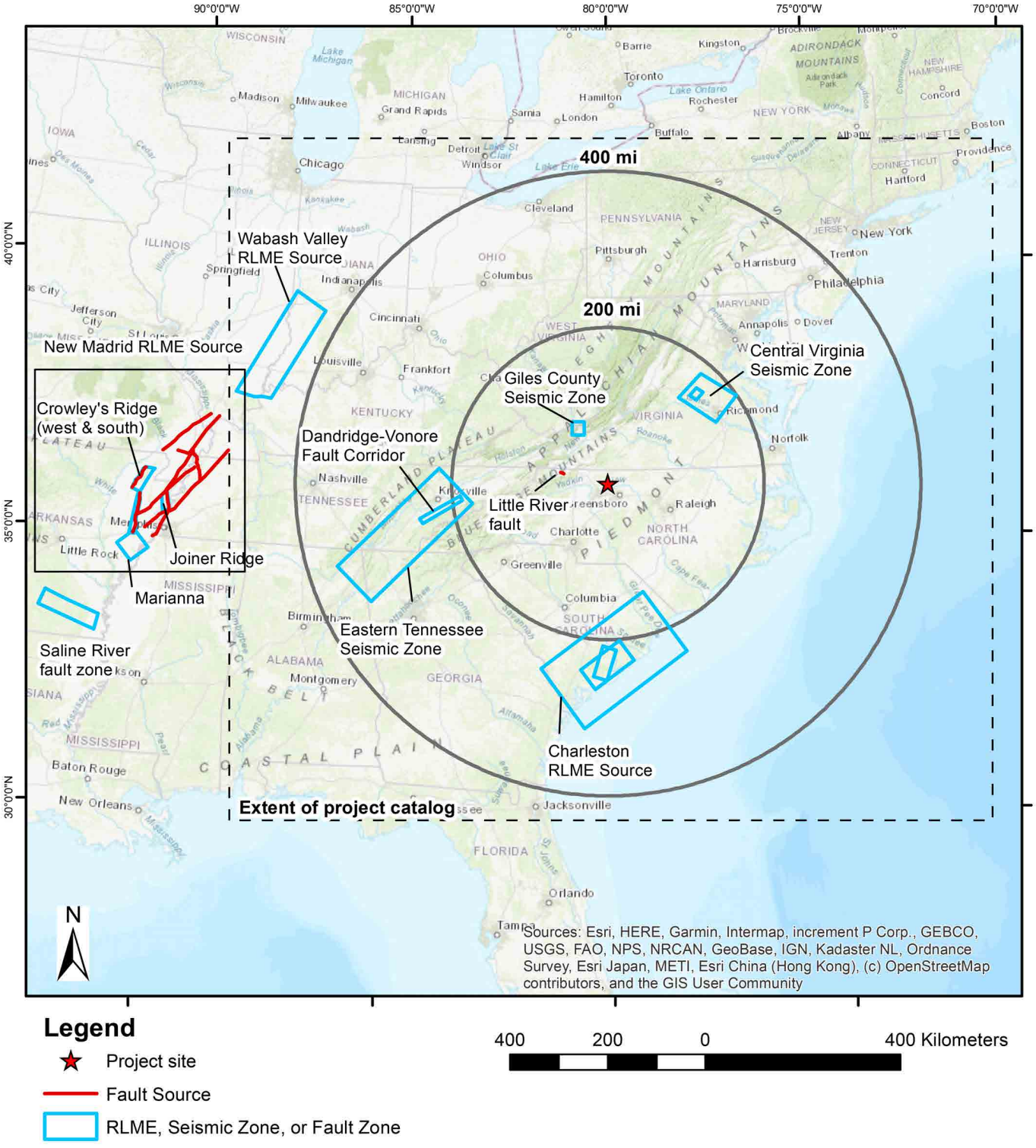
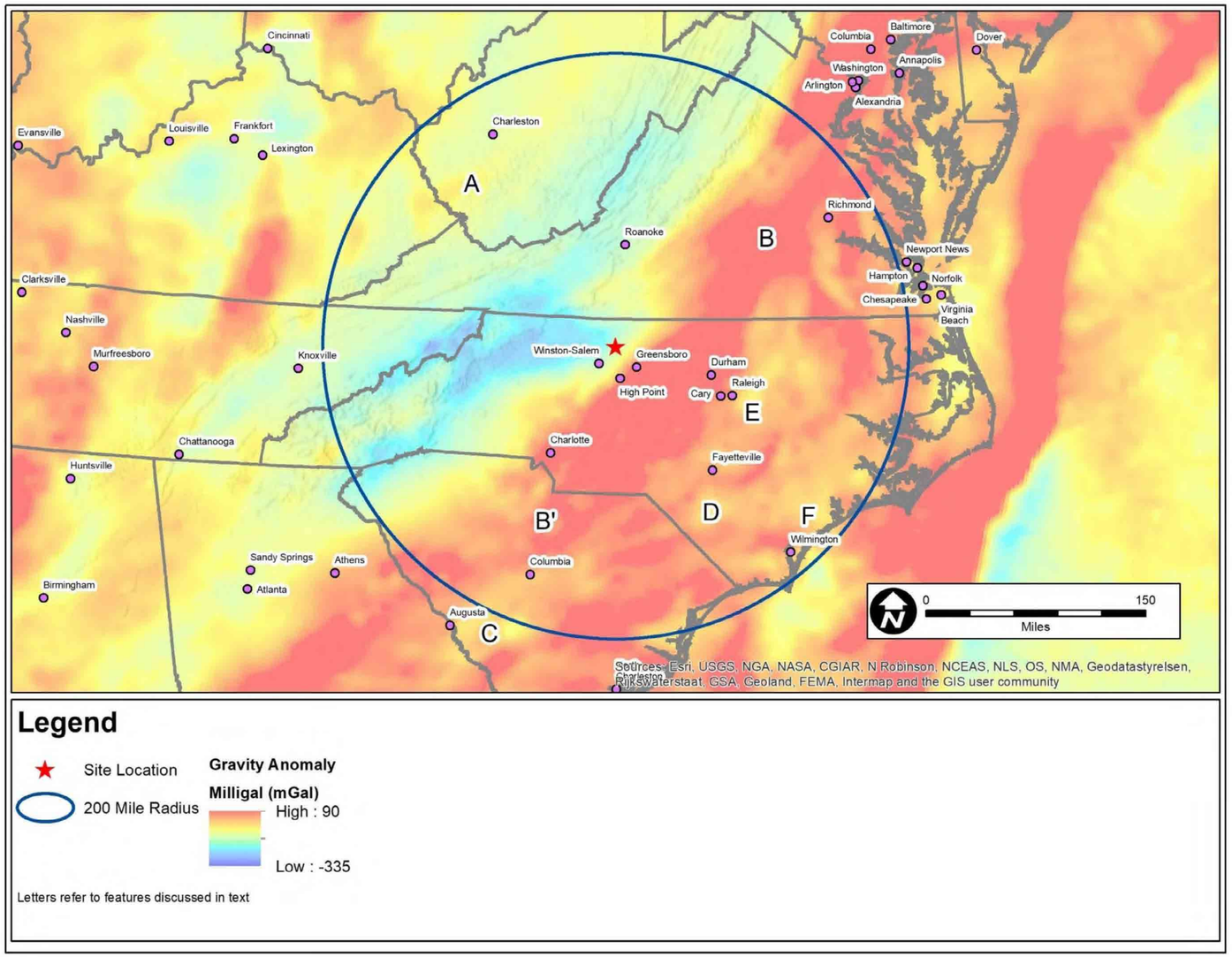
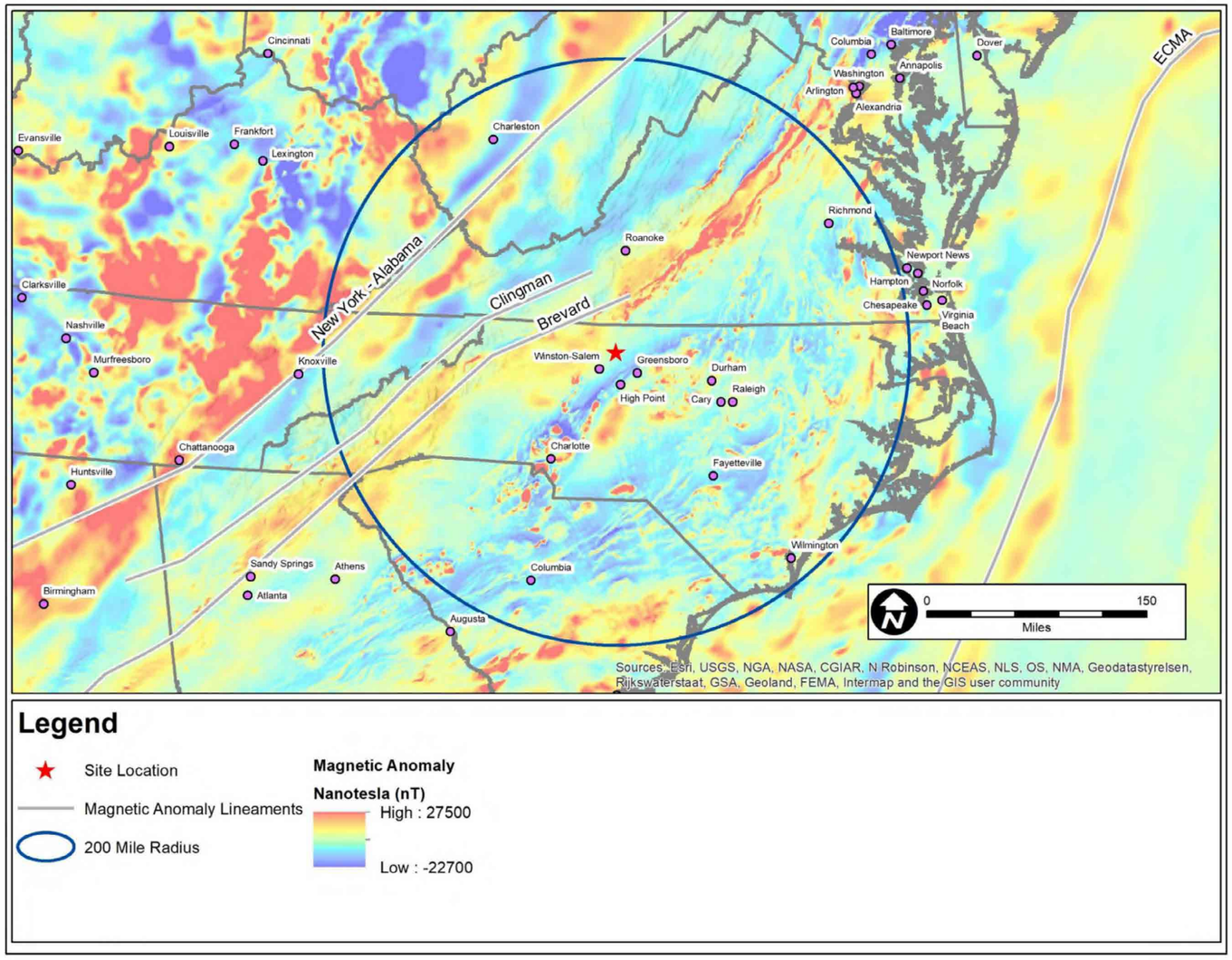


Figure 2.5-19
Regional Bouguer Gravity Anomaly Map of Site Region and Surroundings



Source: Reference 2.5-86

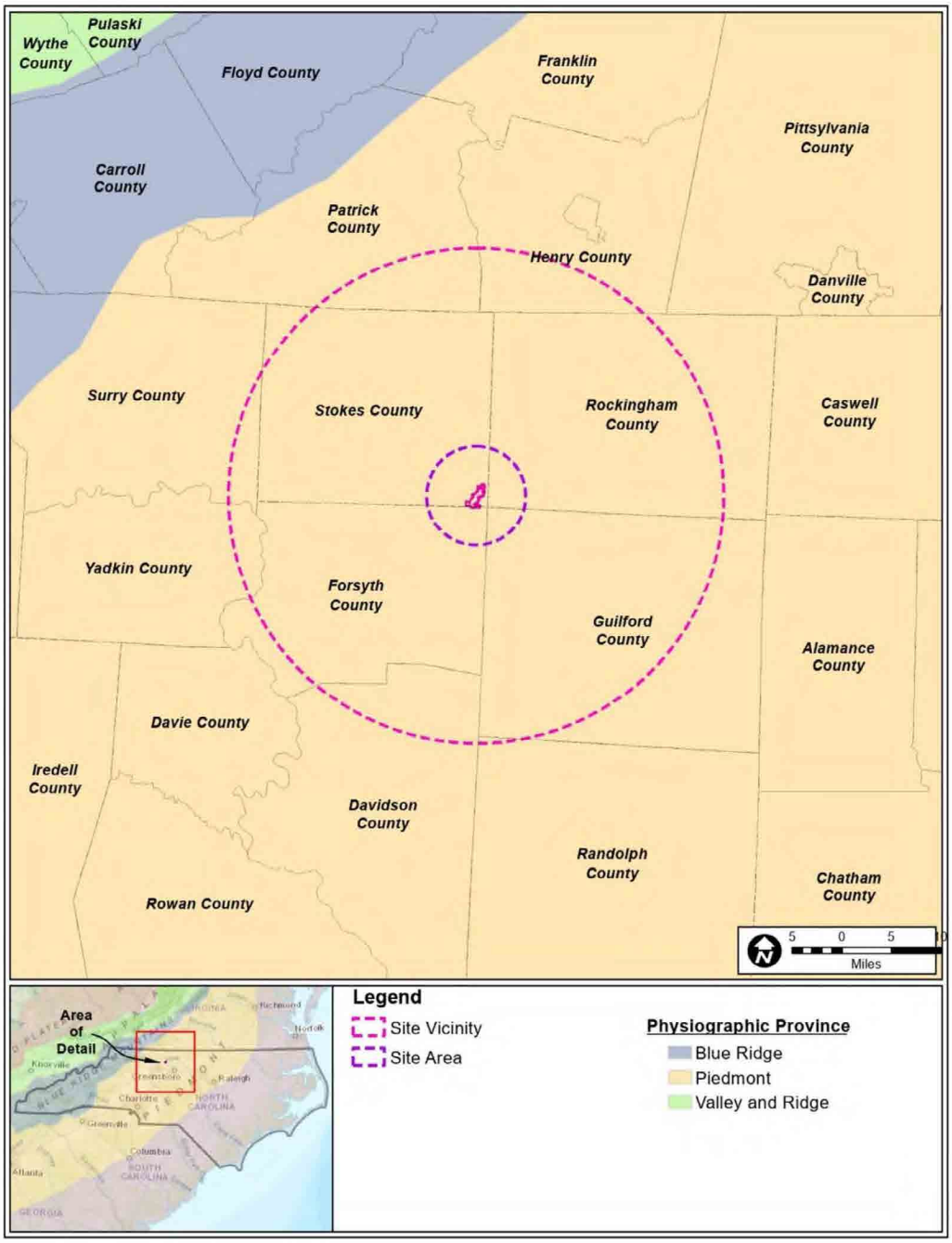
Figure 2.5-20
Regional Magnetic Anomaly Map of Site Region and Surroundings



Source: Reference 2.5-87

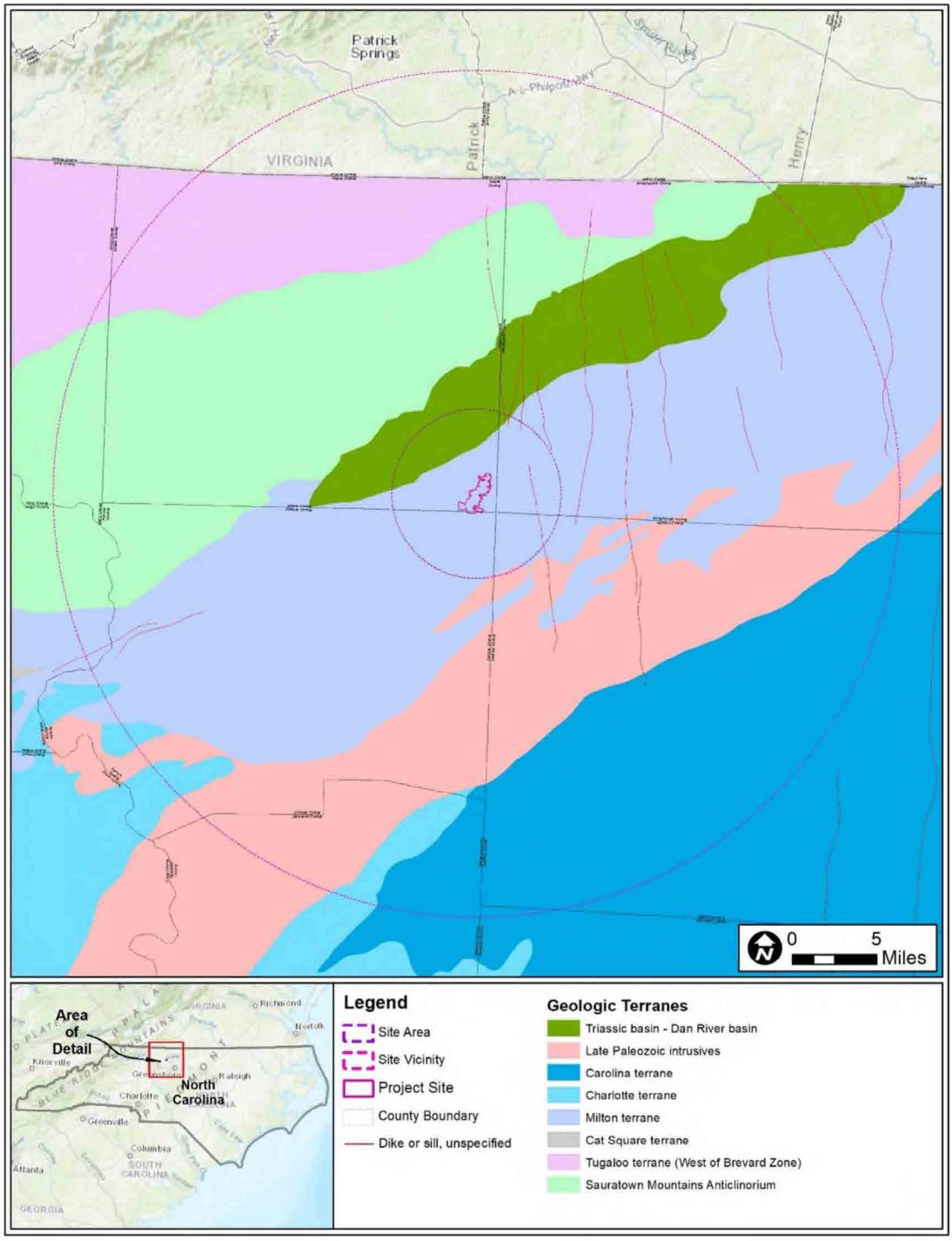
Note: Lineaments interpreted from Reference 2.5-97.

Figure 2.5-21
Physiographic Provinces of the Site Vicinity and Site Area and Surroundings



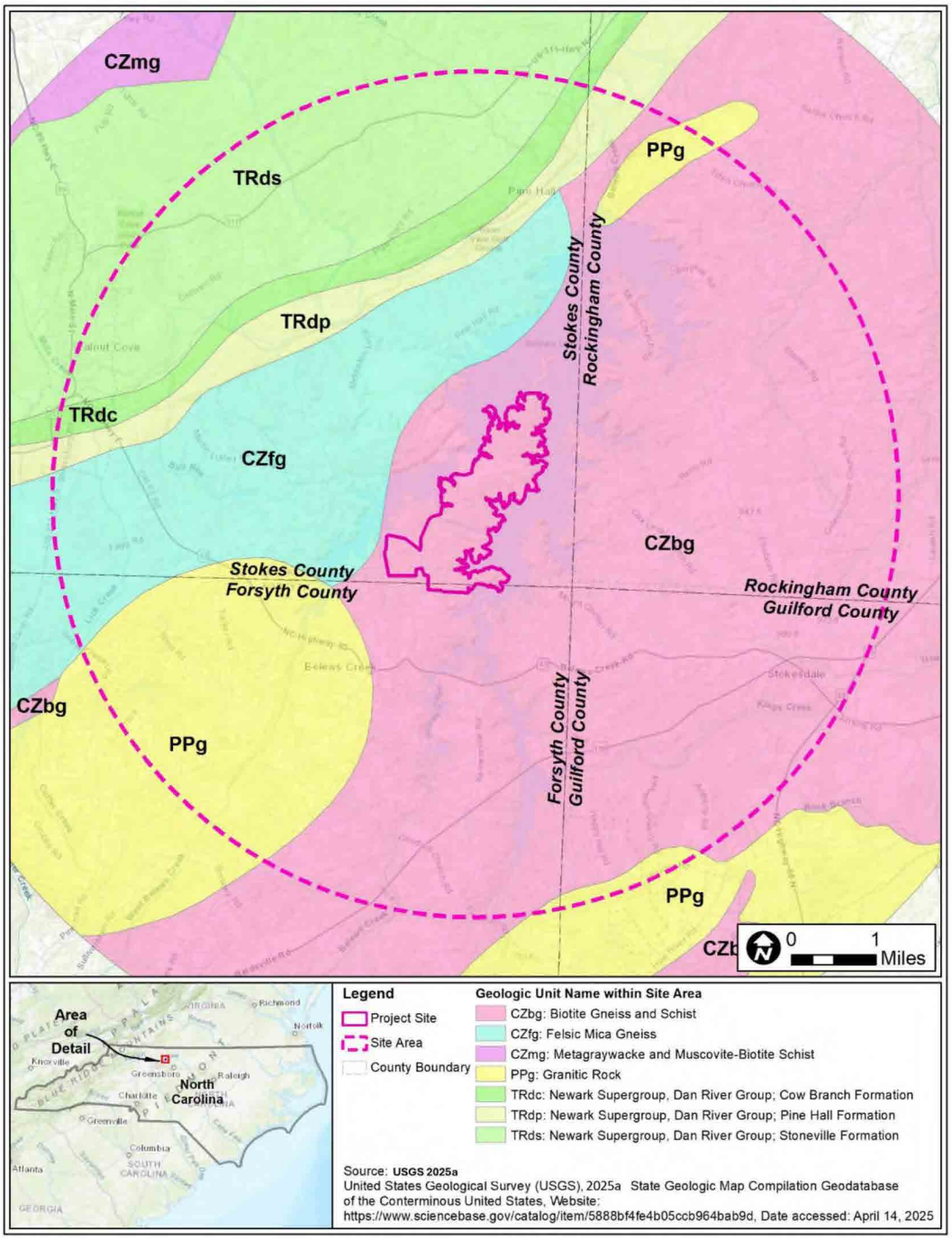
Source: Physiographic provinces from Reference 2.5-1

Figure 2.5-22
Geologic Terranes of the Site Vicinity



Source: Reference 2.5-29

Figure 2.5-23
Bedrock Geology of the Site Area



Source: Reference 2.5-117

Figure 2.5-24
Cross Section Location Map

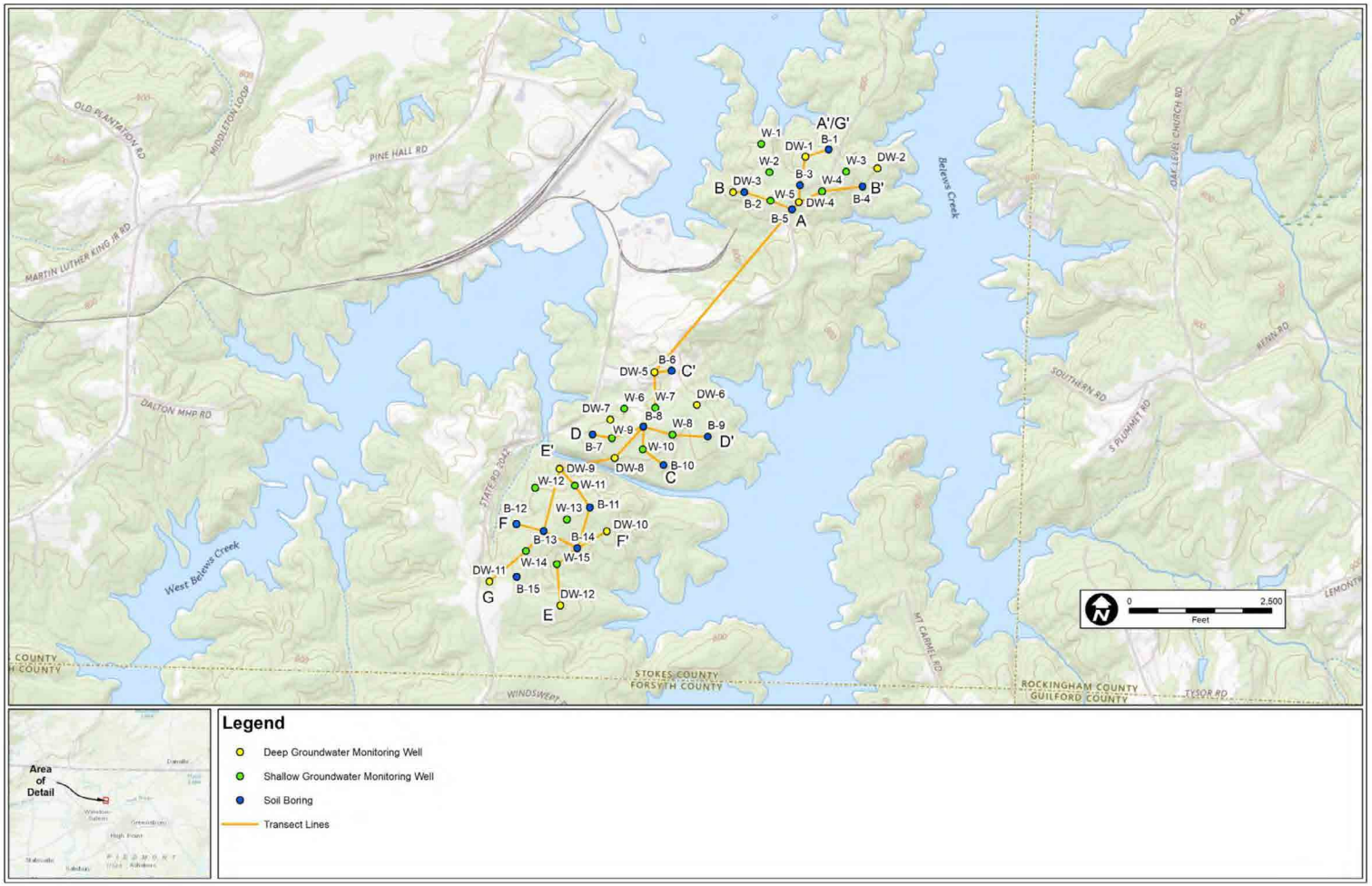
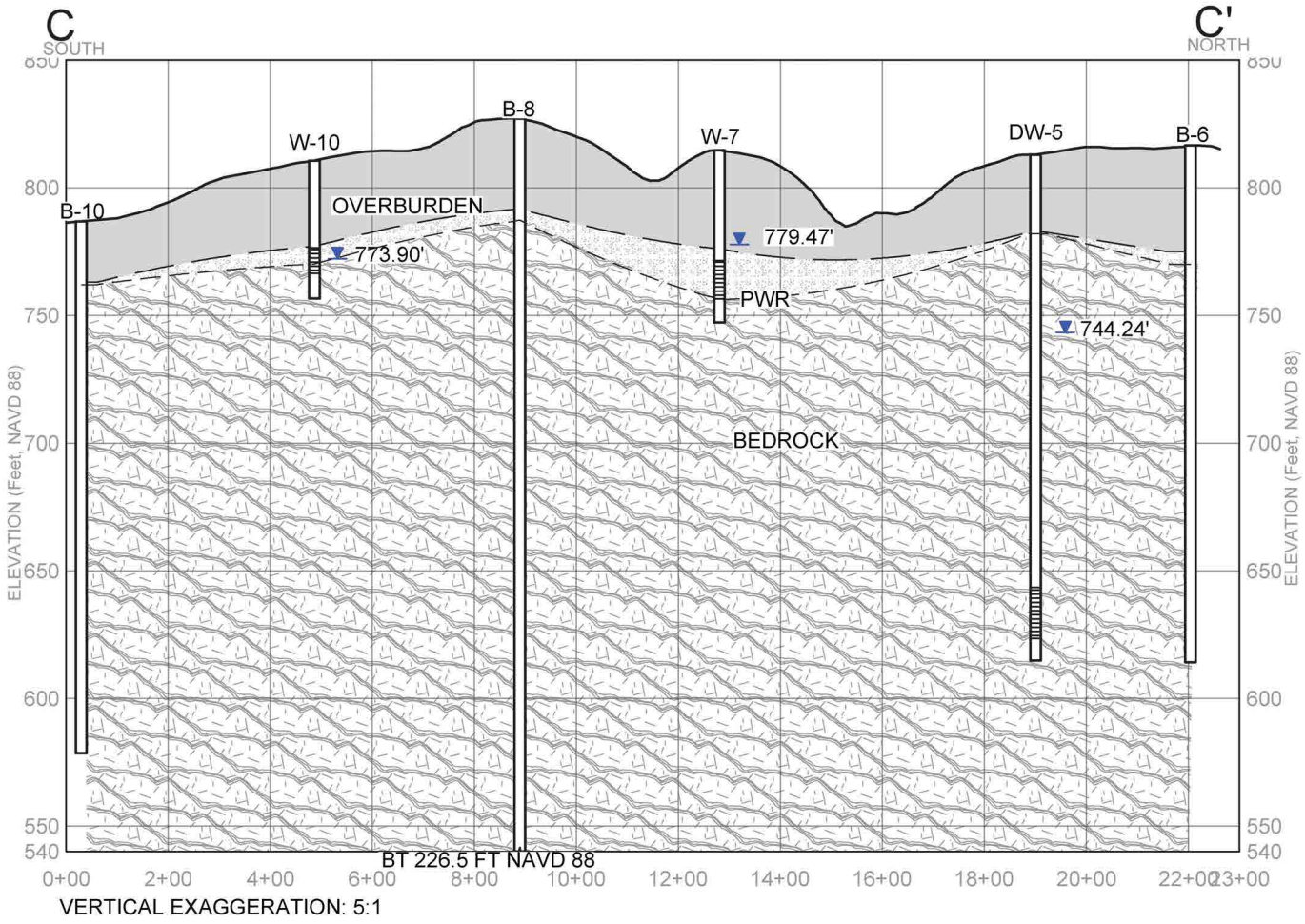
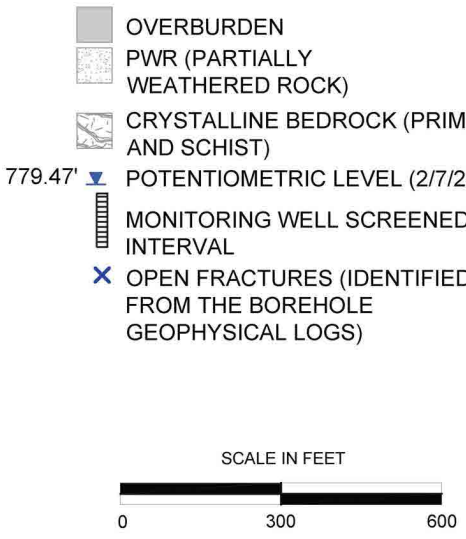


Figure 2.5-25
Cross Section A to A' – North Plant Complex
(Sheet 1 of 7)





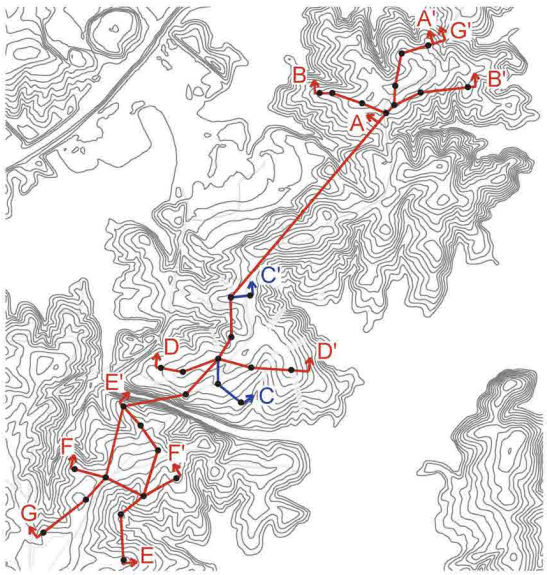


Figure 2.5-25
Cross Section B to B' – North Plant Complex
(Sheet 2 of 7)

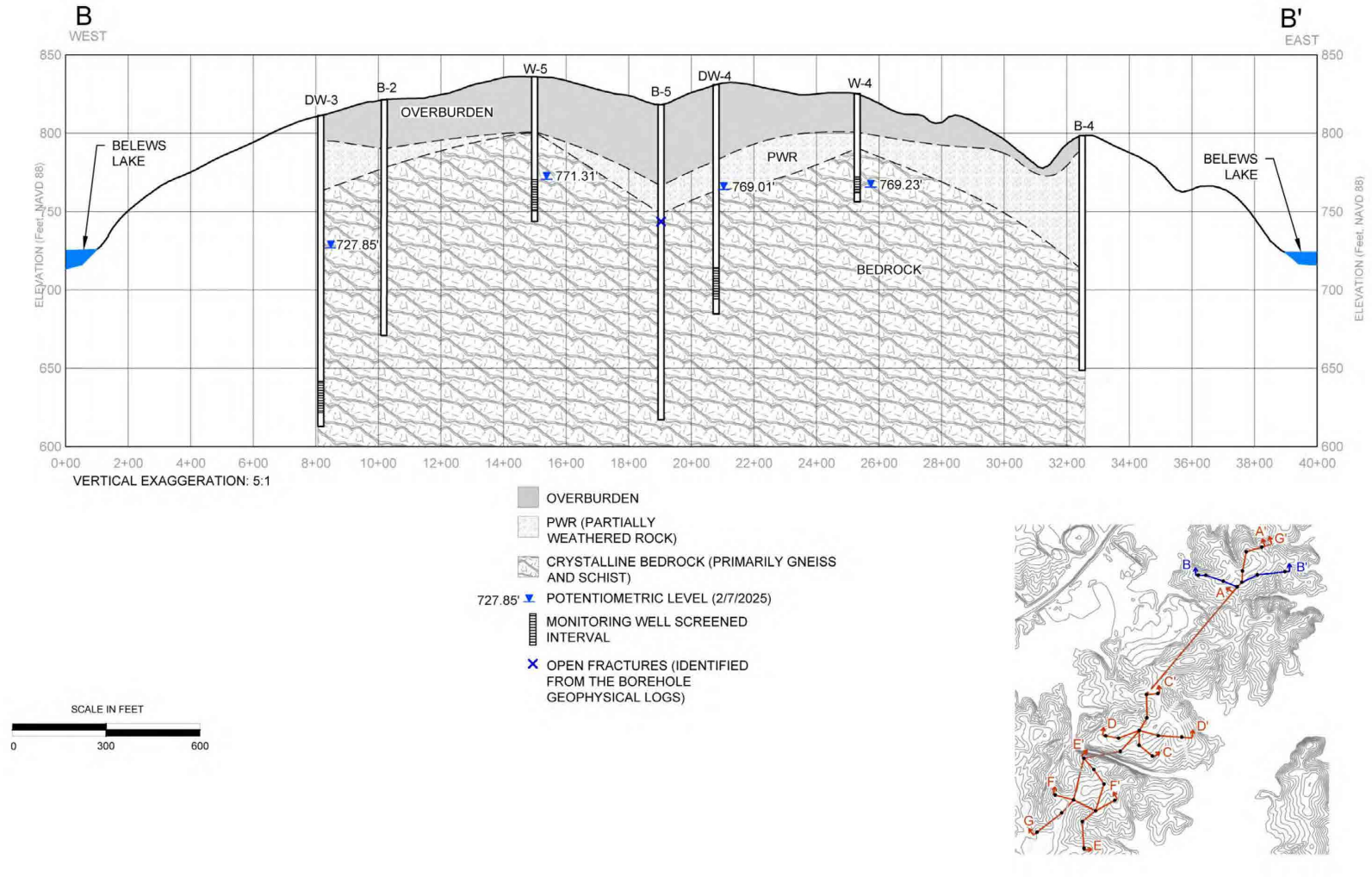
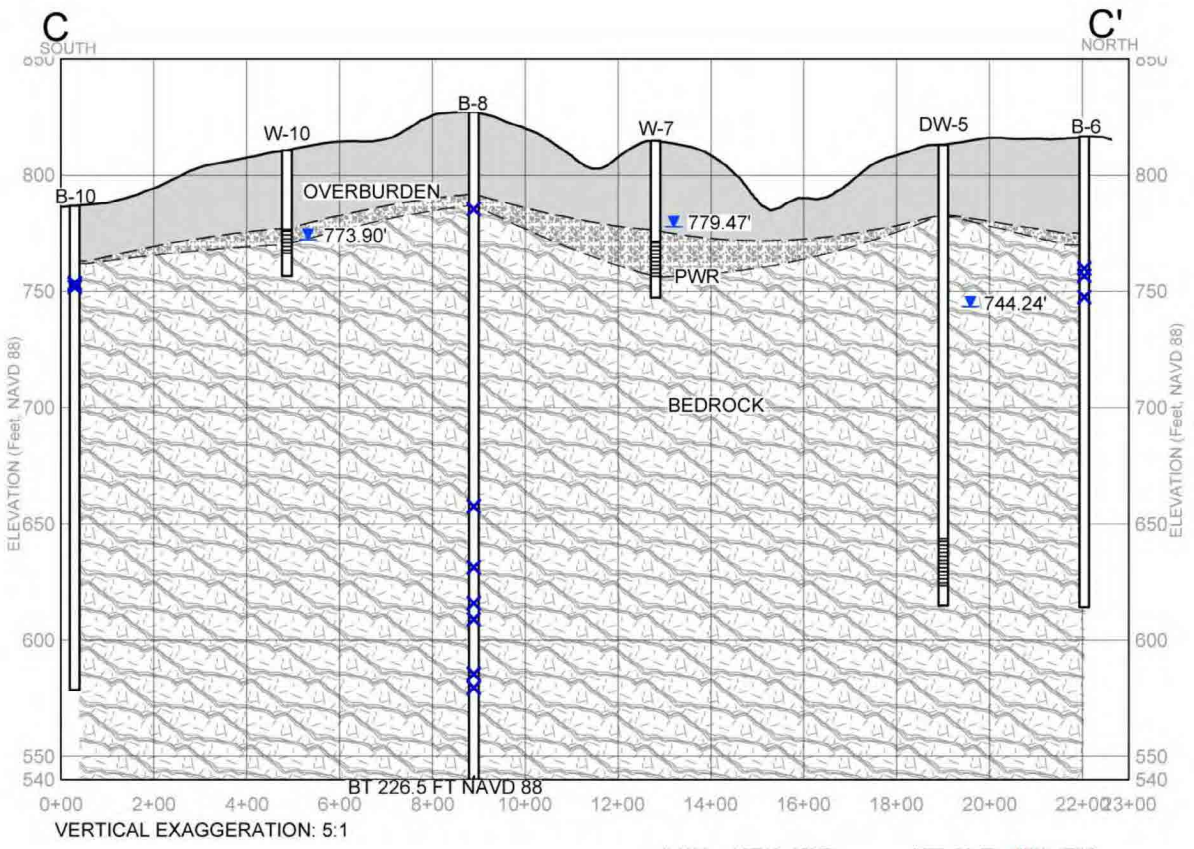
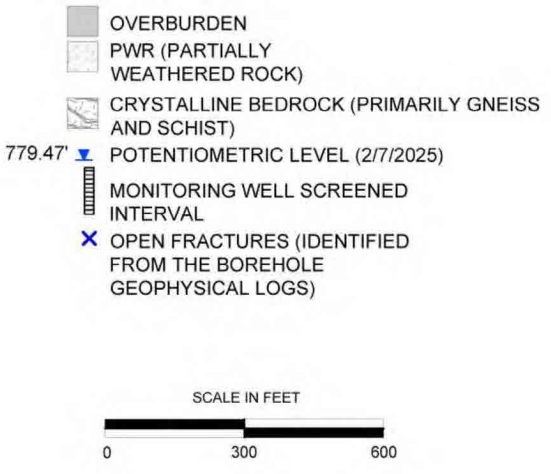


Figure 2.5-25
Cross Section C to C' – Middle Plant Complex
(Sheet 3 of 7)





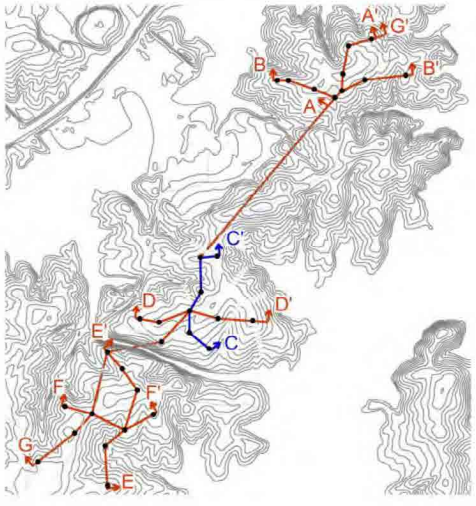


Figure 2.5-25
Cross Section D to D' – Middle Plant Complex
(Sheet 4 of 7)

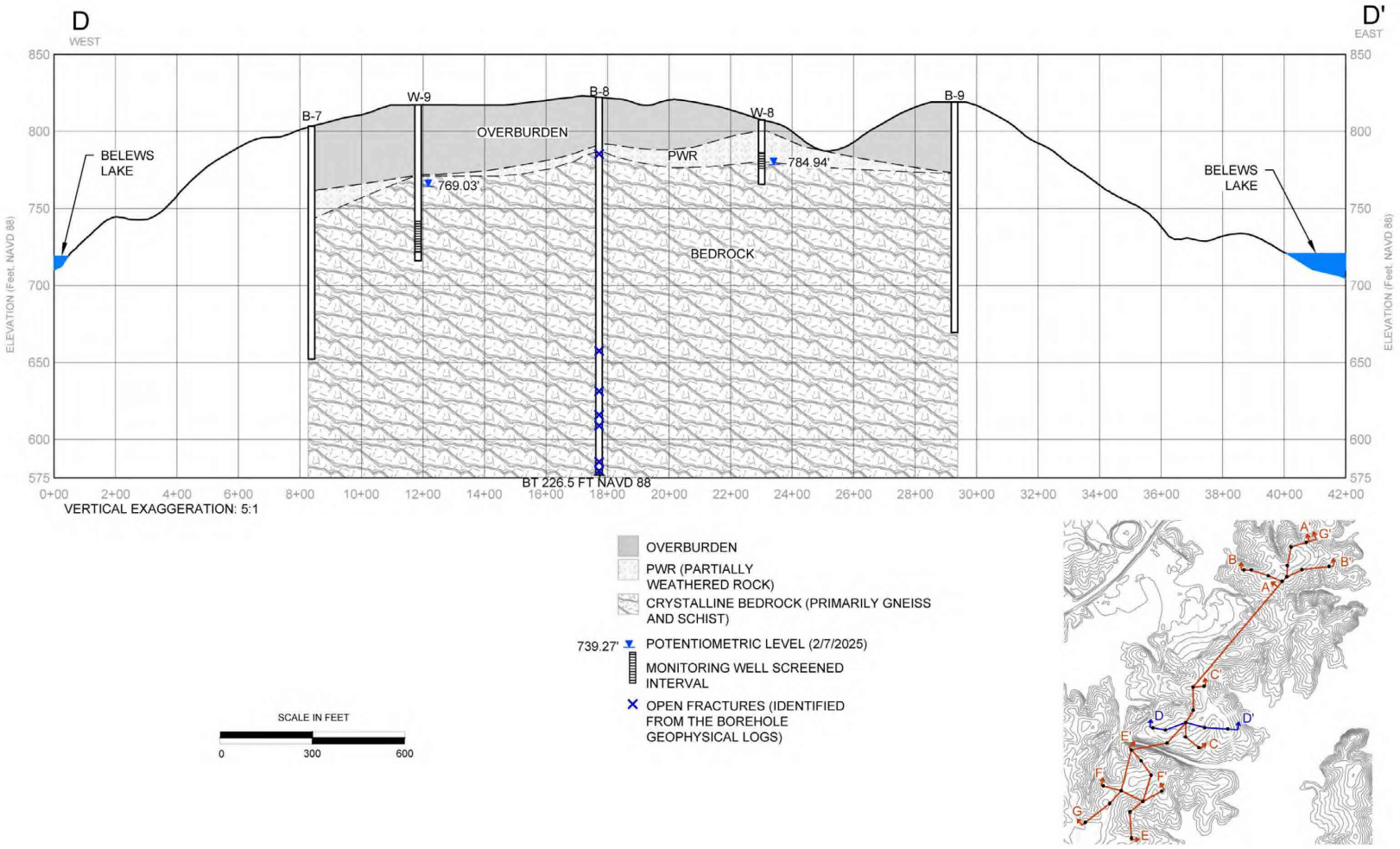


Figure 2.5-25
Cross Section E to E' – South Plant Complex
(Sheet 5 of 7)

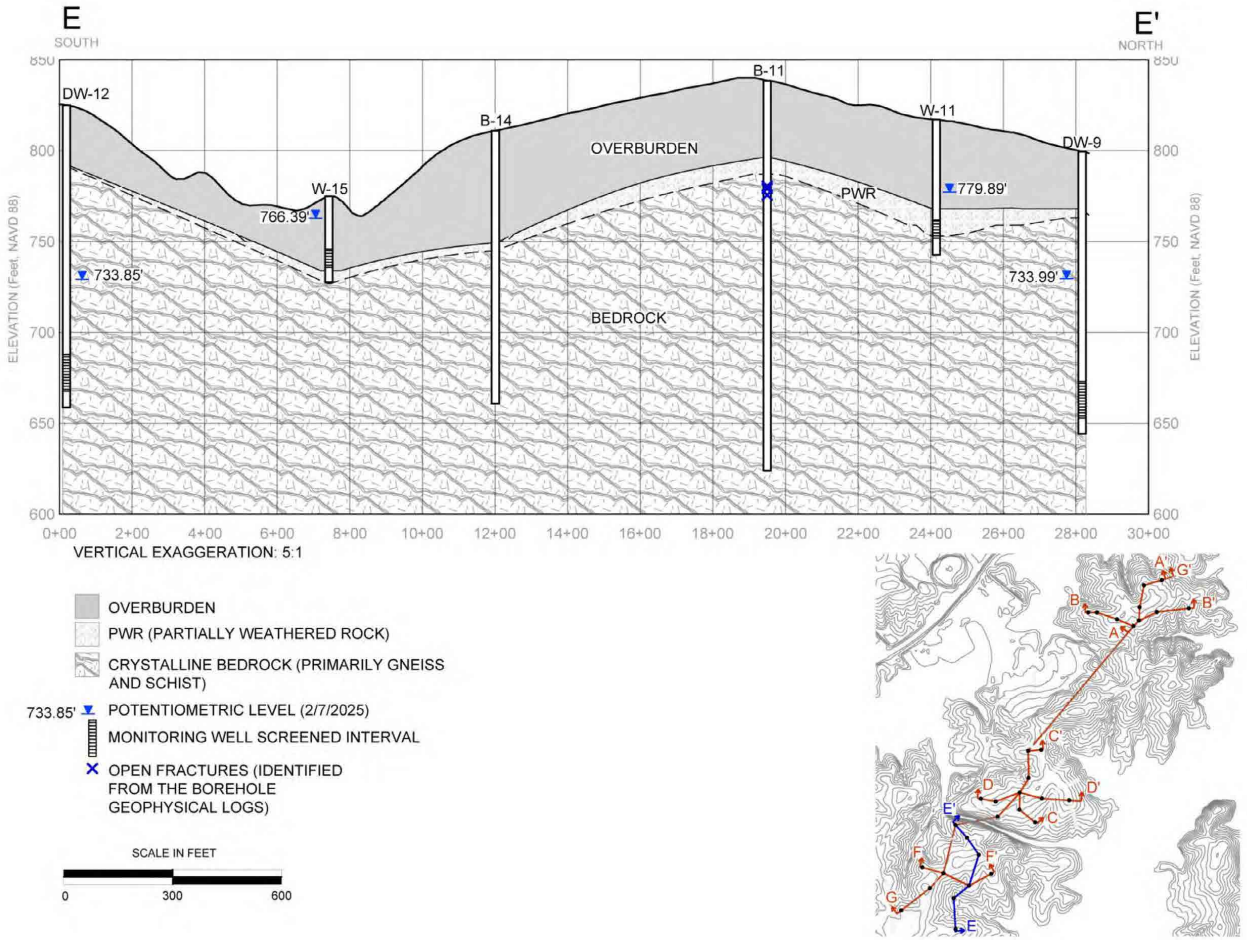


Figure 2.5-25
Cross Section F to F' – South Plant Complex
(Sheet 6 of 7)

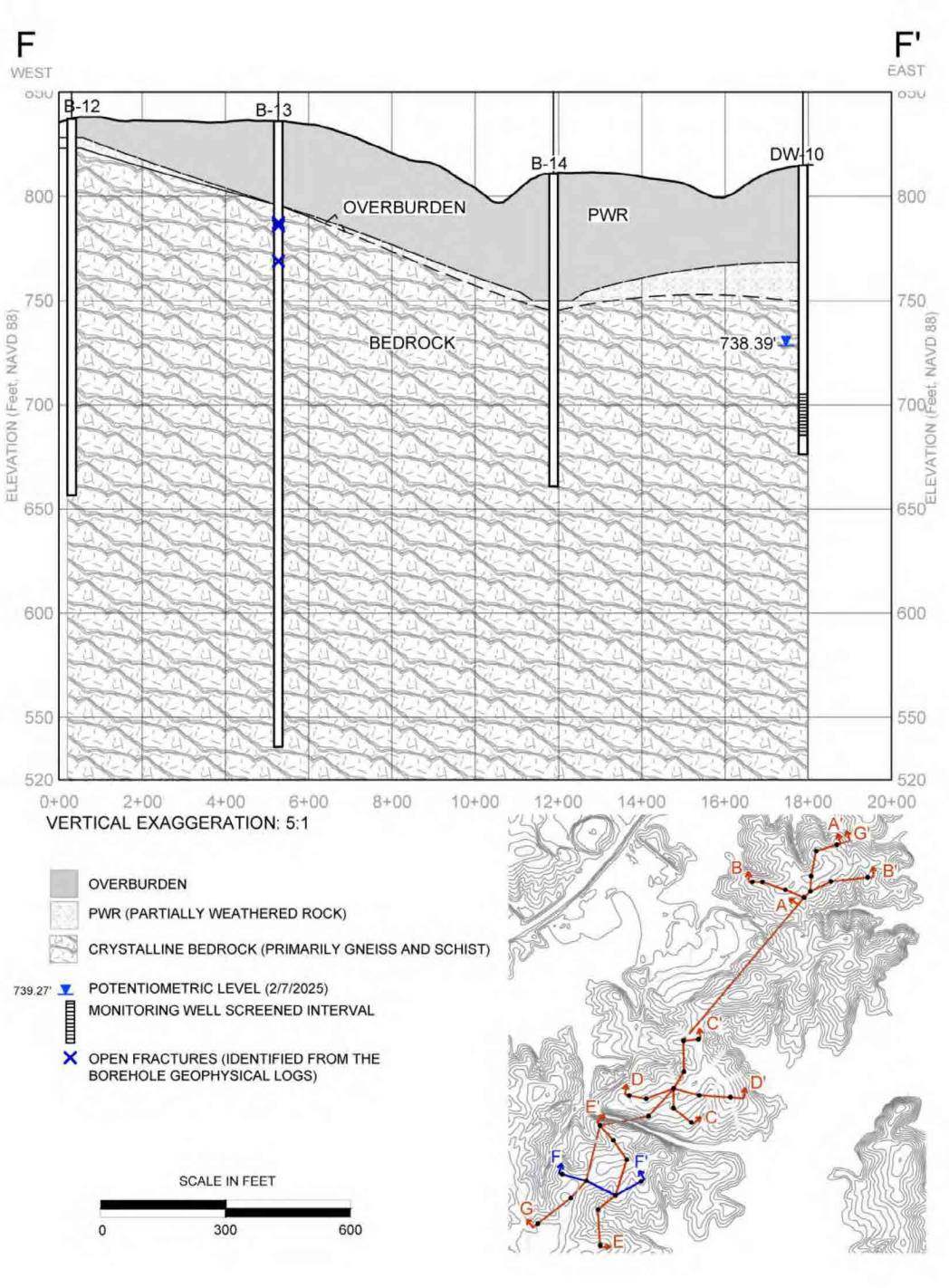
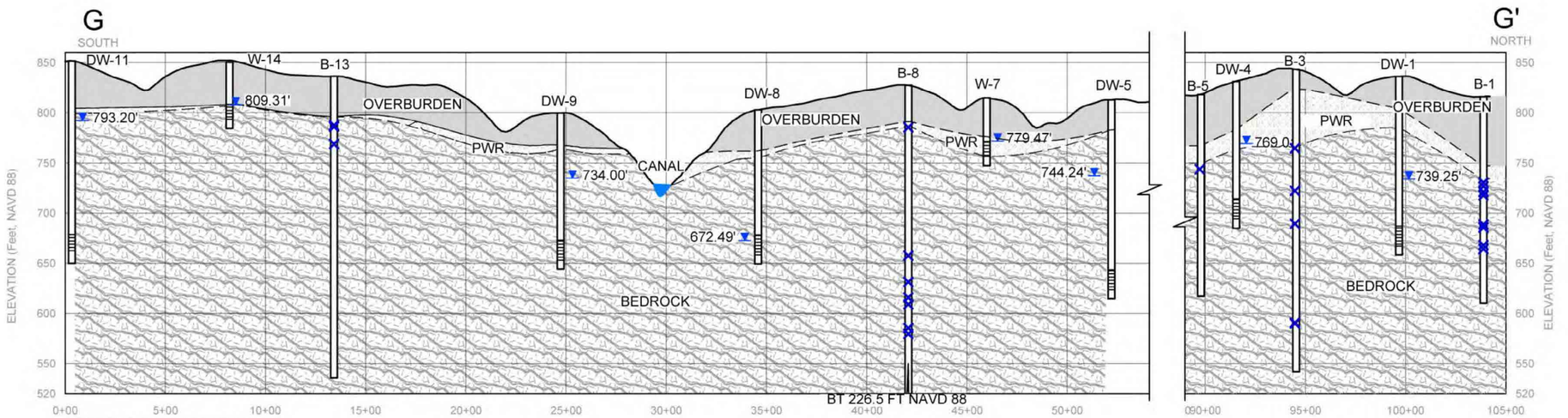


Figure 2.5-25
Cross Section G to G' – South Plant Complex to North Plant Complex
(Sheet 7 of 7)



VERTICAL EXAGGERATION: 5:1

OVERBURDEN

PWR (PARTIALLY WEATHERED ROCK)

CRYSTALLINE BEDROCK (PRIMARILY GNEISS AND SCHIST)

793.20' POTENTIOMETRIC LEVEL (2/7/2025)

MONITORING WELL SCREENED INTERVAL

OPEN FRACTURES (IDENTIFIED FROM THE BOREHOLE GEOPHYSICAL LOGS)

SCALE IN FEET

0 500 1000

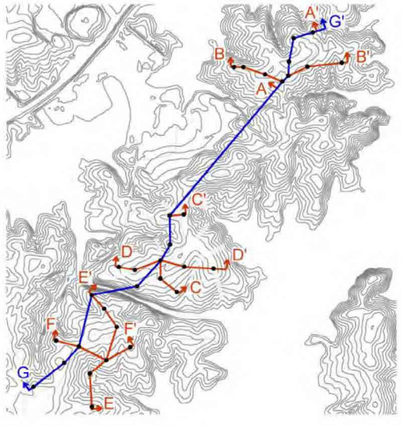
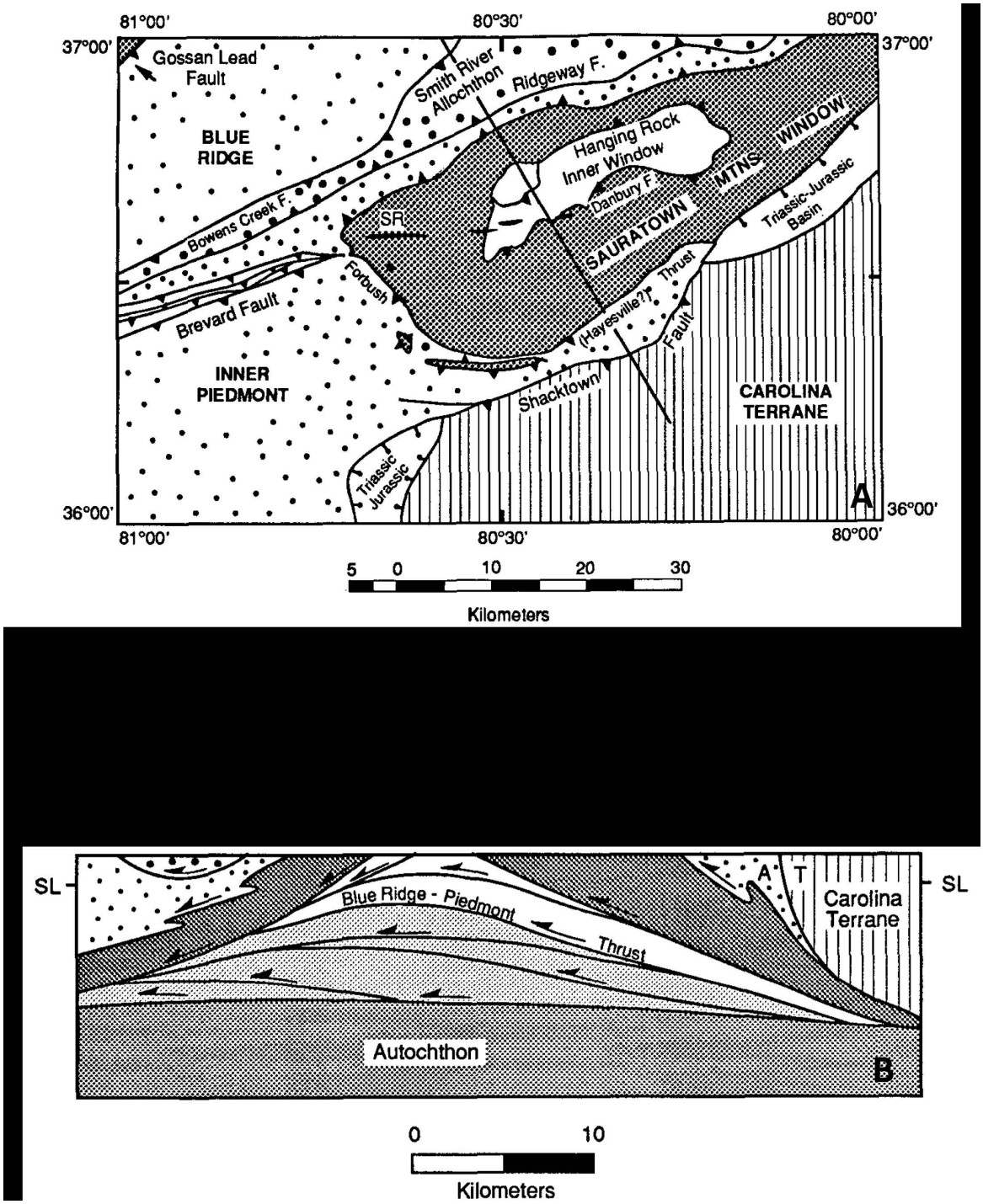


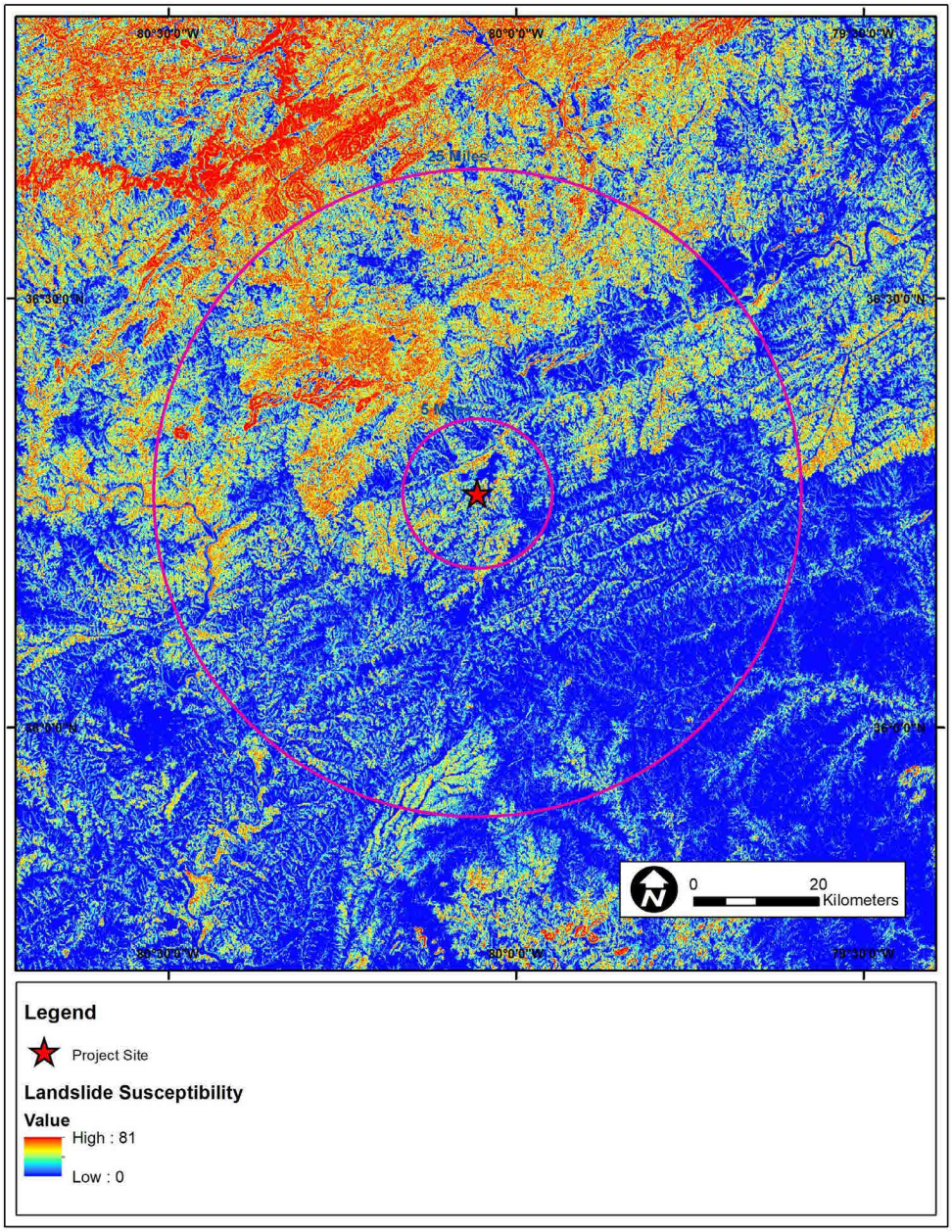
Figure 2.5-26
(A) Terrane Map and (B) Cross Section of the Sauratown Mountains Window



Source: Reference 2.5-120

Note: The Site Area is just off the eastern edge of panel A (at approximately 36.3 degrees latitude.

Figure 2.5-27
Landslide Relative Susceptibility Map of the Site Vicinity (25 Mi. [40 Km])

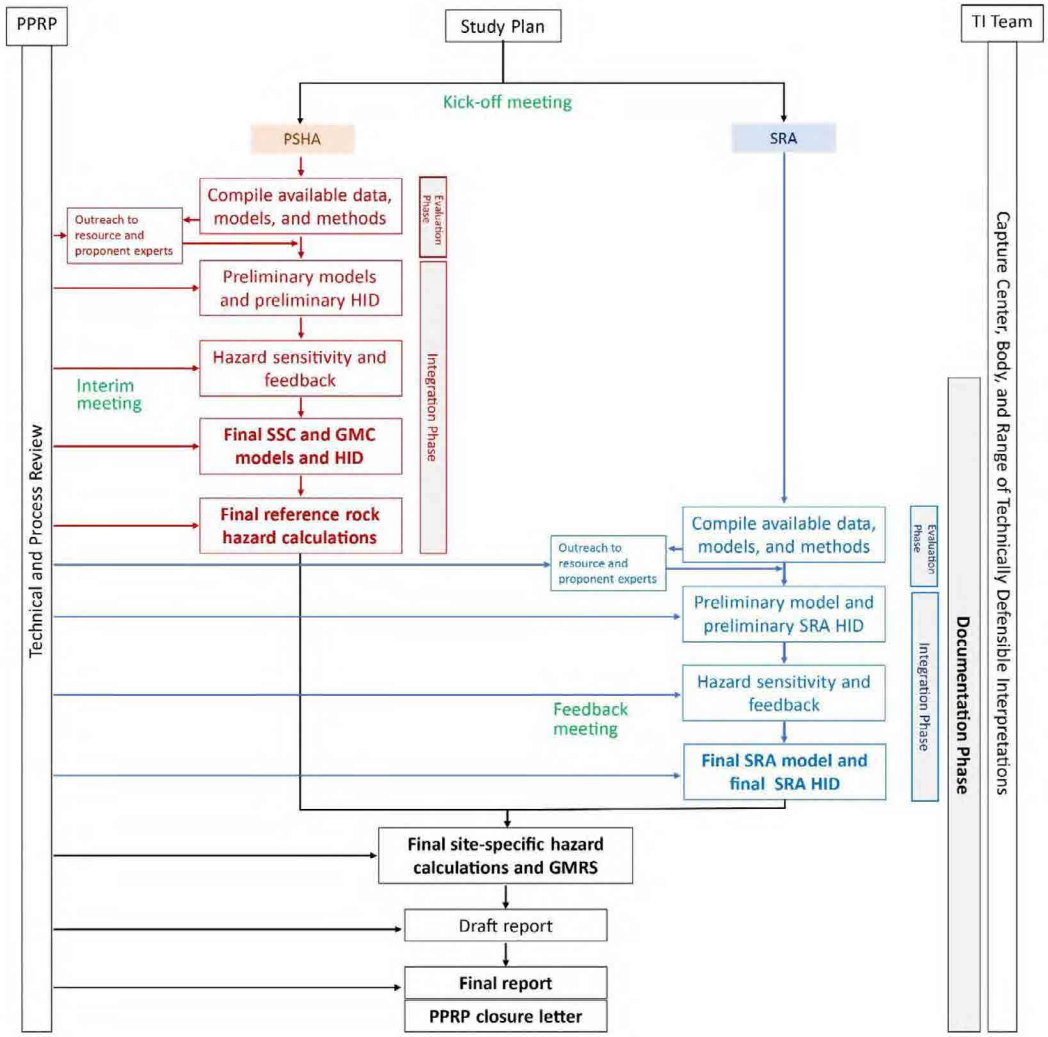


Source: Reference 2.5-124

Note: 90 m cells are assigned a value of 0-81 based on how many 10 m cells within it are calculated to be susceptible to landslides. Red circles are Site Area (25 mi. [40 km] and Site Vicinity (5 mi. [8km].

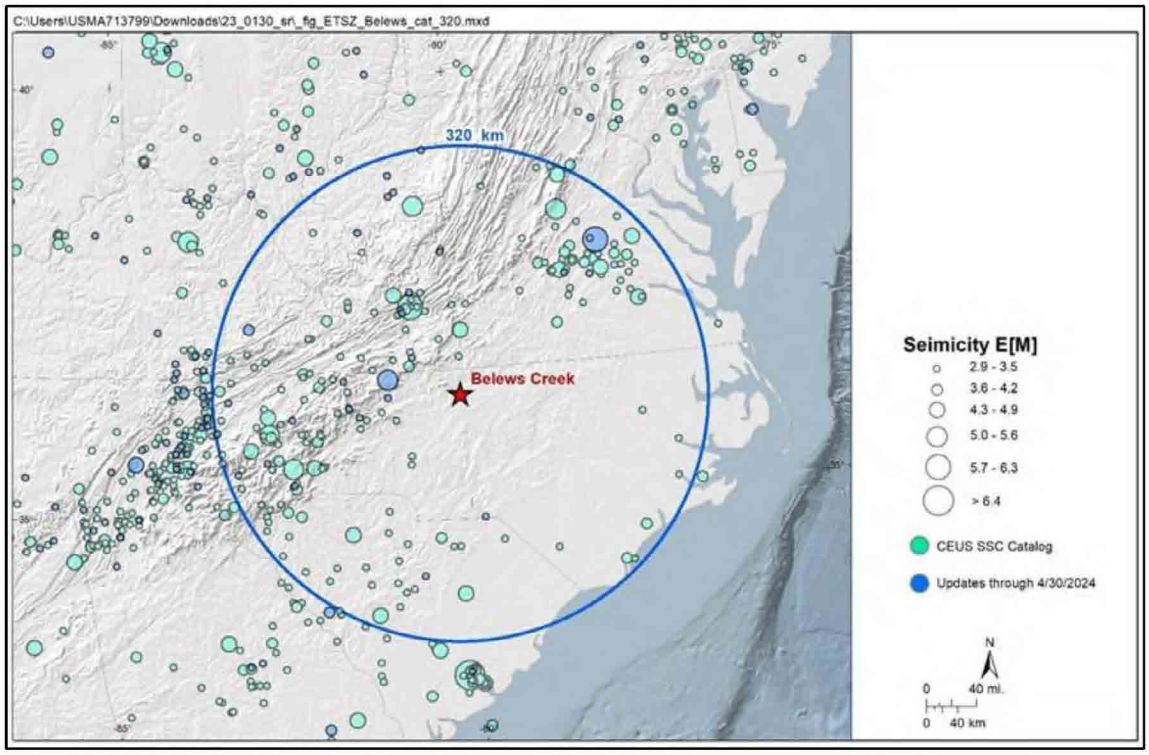
Key: km = kilometers; mi. = miles

Figure 2.5-28
Senior Seismic Hazard Analysis Committee (SSHAC) Level 2 Workflow Diagram



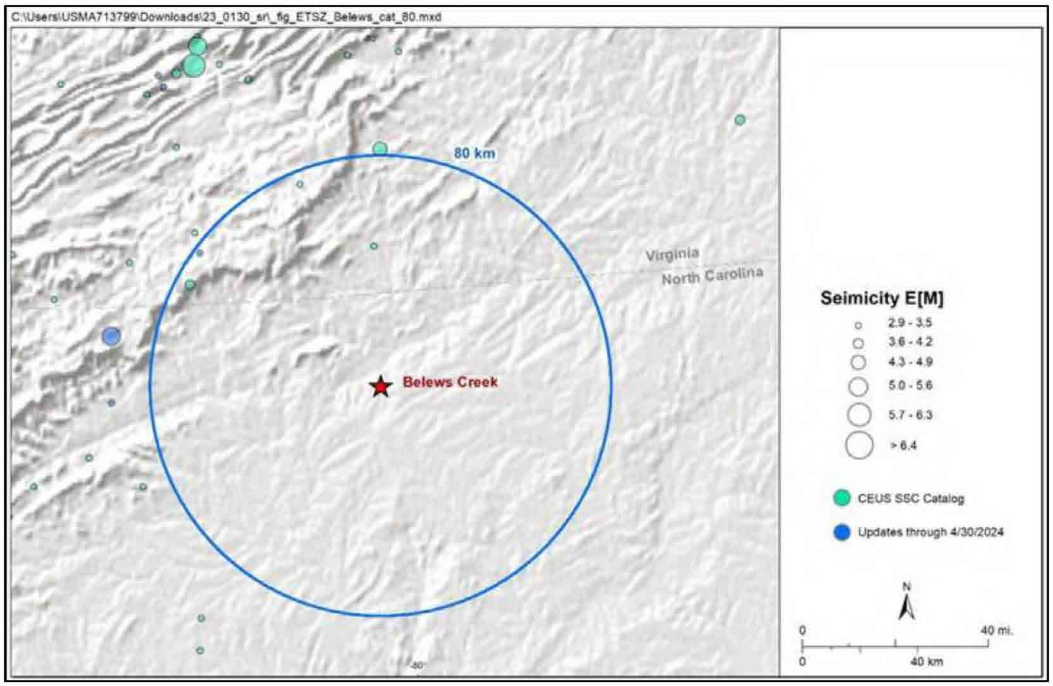
Key: GMRS = ground motion response spectrum; HID = hazard input document; PPRP = participatory peer review panel; PSHA = Probabilistic Seismic Hazard Analysis; SRA = Site Response Analysis; TI Team = Technical Integration Team

Figure 2.5-29
Locations of Earthquakes (Mainshocks) Within 200 Mi. (320 Km) of the Project Site



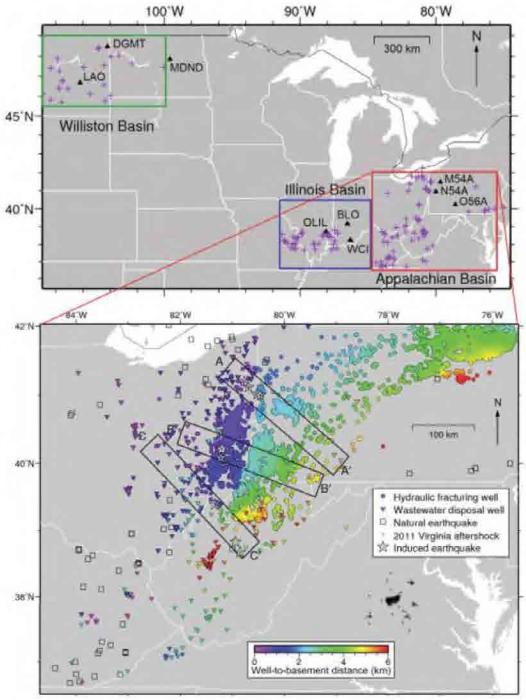
Key: CEUS SSC = Central and Easter United States Seismic Source Characterization; E[**M**] = expected magnitude; km = kilometer; mi. = miles

Figure 2.5-30
Location of Earthquakes Within 50 Mi. (80 Km) of the Project Site

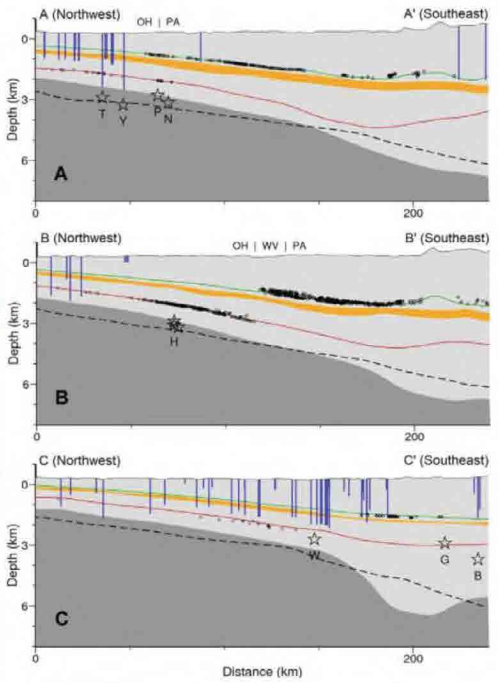


Key: CEUS SSC = Central and Easter United States Seismic Source Characterization; E[**M**] = expected magnitude; km = kilometer; mi. = miles

Figure 2.5-31
Correlation Between Wells and Induced Seismic Events



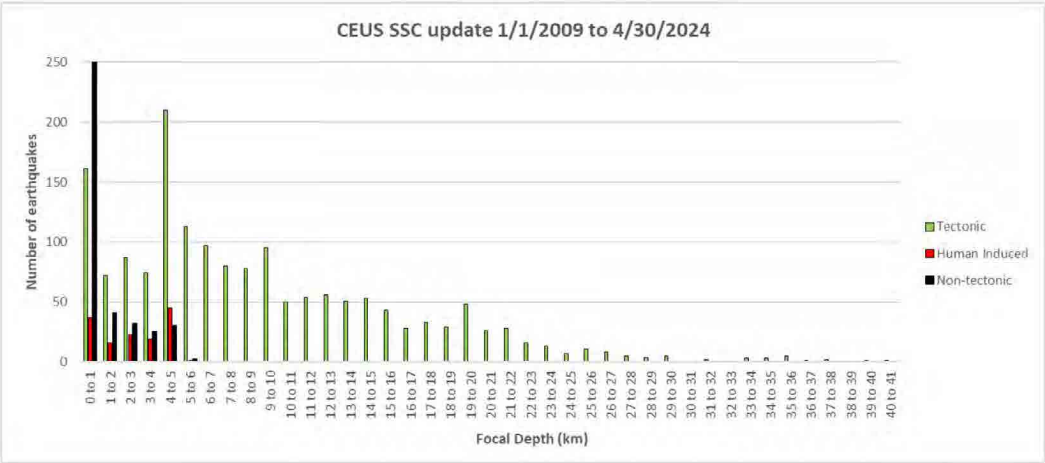
(a) Location of wells and earthquakes (natural and induced).



(b) Simplified geologic cross sections showing the Marcellus Shale (green), Salina Group (orange), Utica Shale (red), and Precambrian basement (dark gray). Small circles mark the depth of and location of hydraulic fracture stimulations, blue are wastewater disposal wells; stars are induced earthquake sequences.

Source: Reference 2.5-148

Figure 2.5-32
Focal Depth Histogram



Key: CEUS SSC = Central and Easter United States Seismic Source Characterization; km = kilometer

Figure 2.5-33
Time of Day (Local Time) of Earthquake Occurrence

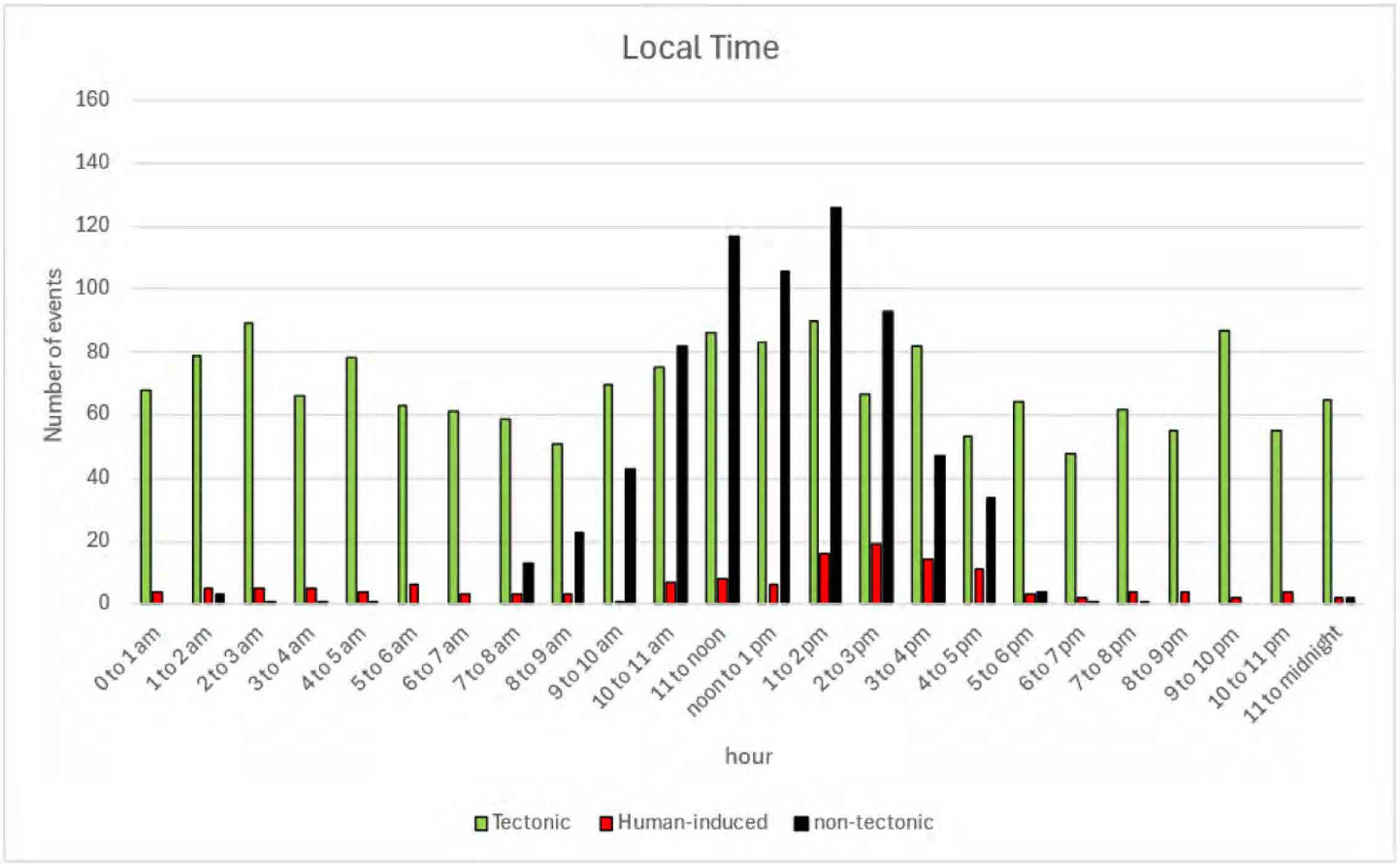
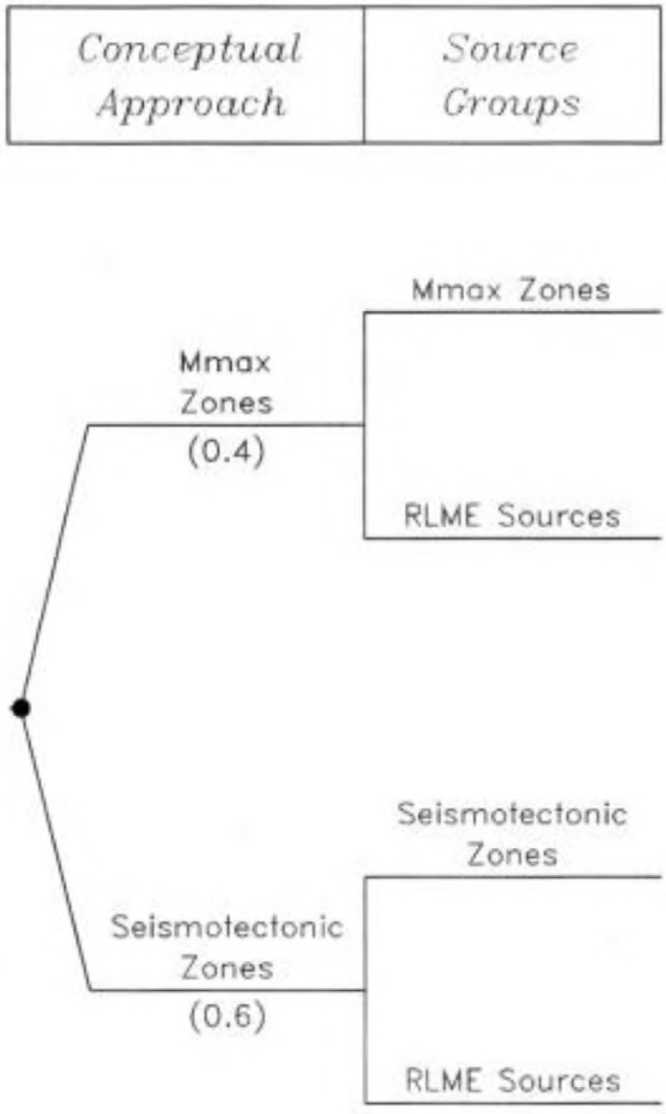


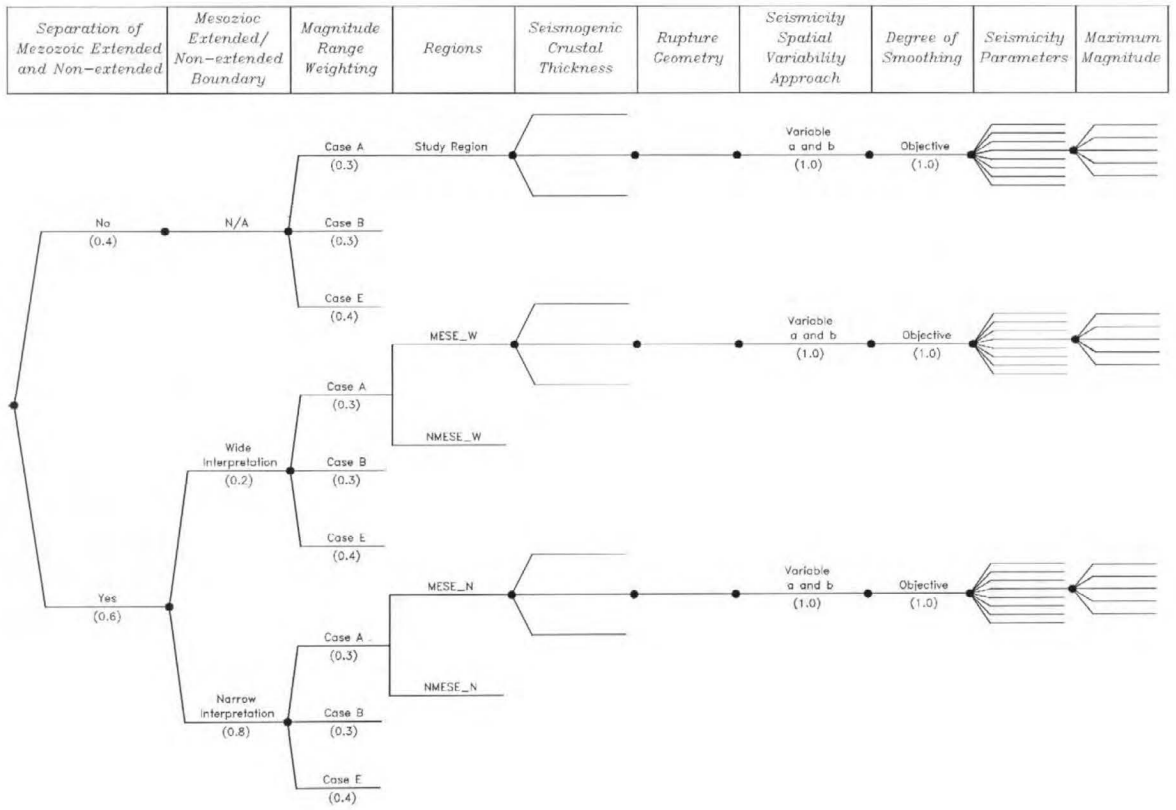
Figure 2.5-34
CEUS SSC Master Logic Tree



Source: Reference 2.5-60

Key: CEUS SSC = Central and Eastern United States Seismic Source Characterization; Mmax = maximum magnitude; RLME = repeated large-magnitude earthquake

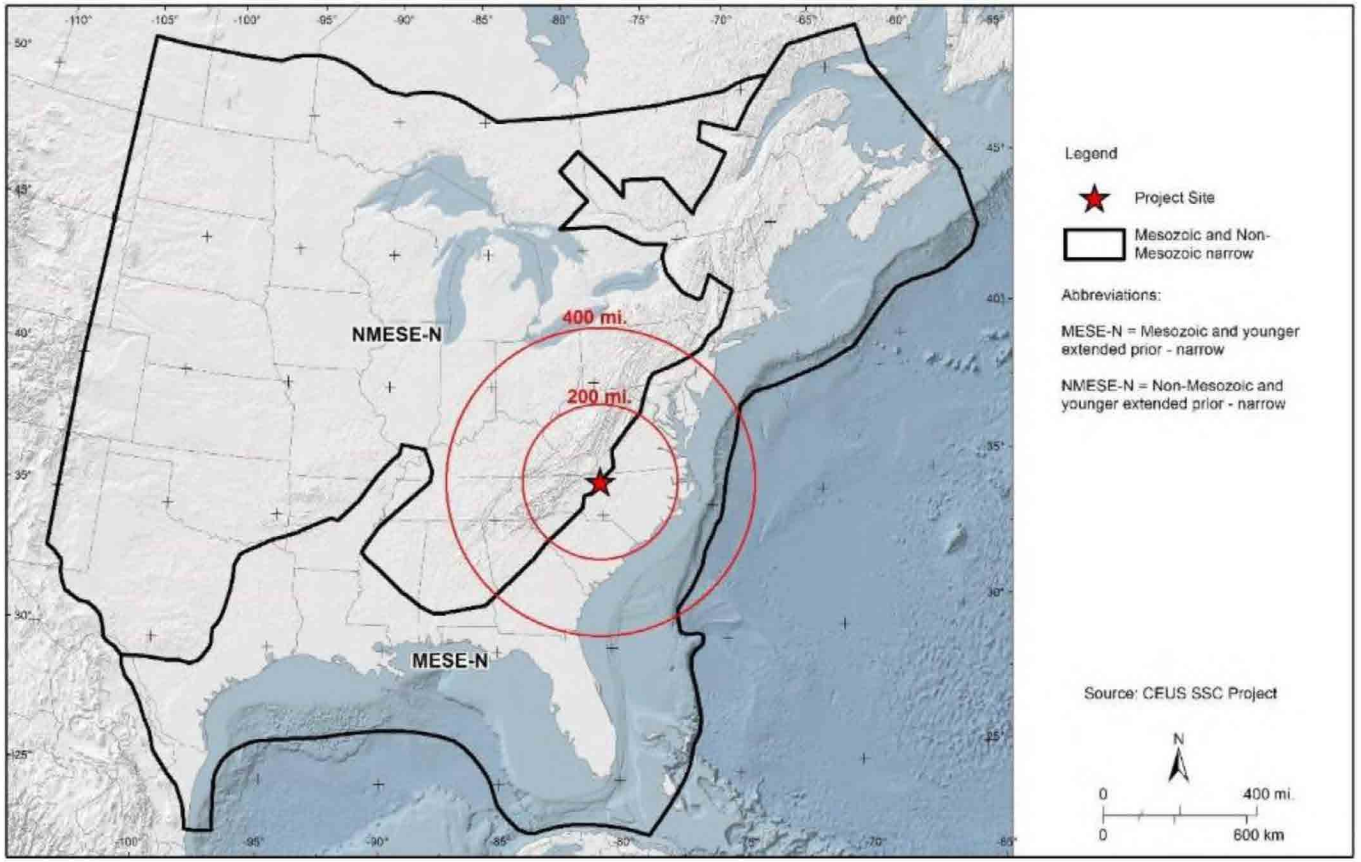
Figure 2.5-35
Logic Tree for the Mmax Zones Branch of the Master Logic Tree



Source: Reference 2.5-60

Key: Mmax = maximum magnitude; MESE-N = Mesozoic and younger extended crust-narrow; MESE-W = Mesozoic and younger extended crust-wide; NMESE-N = Non-extended crust or crust where the most recent extension occurred before the Mesozoic-narrow; NMESE-W = Non-extended crust or crust where the most recent extension occurred before the Mesozoic-wide

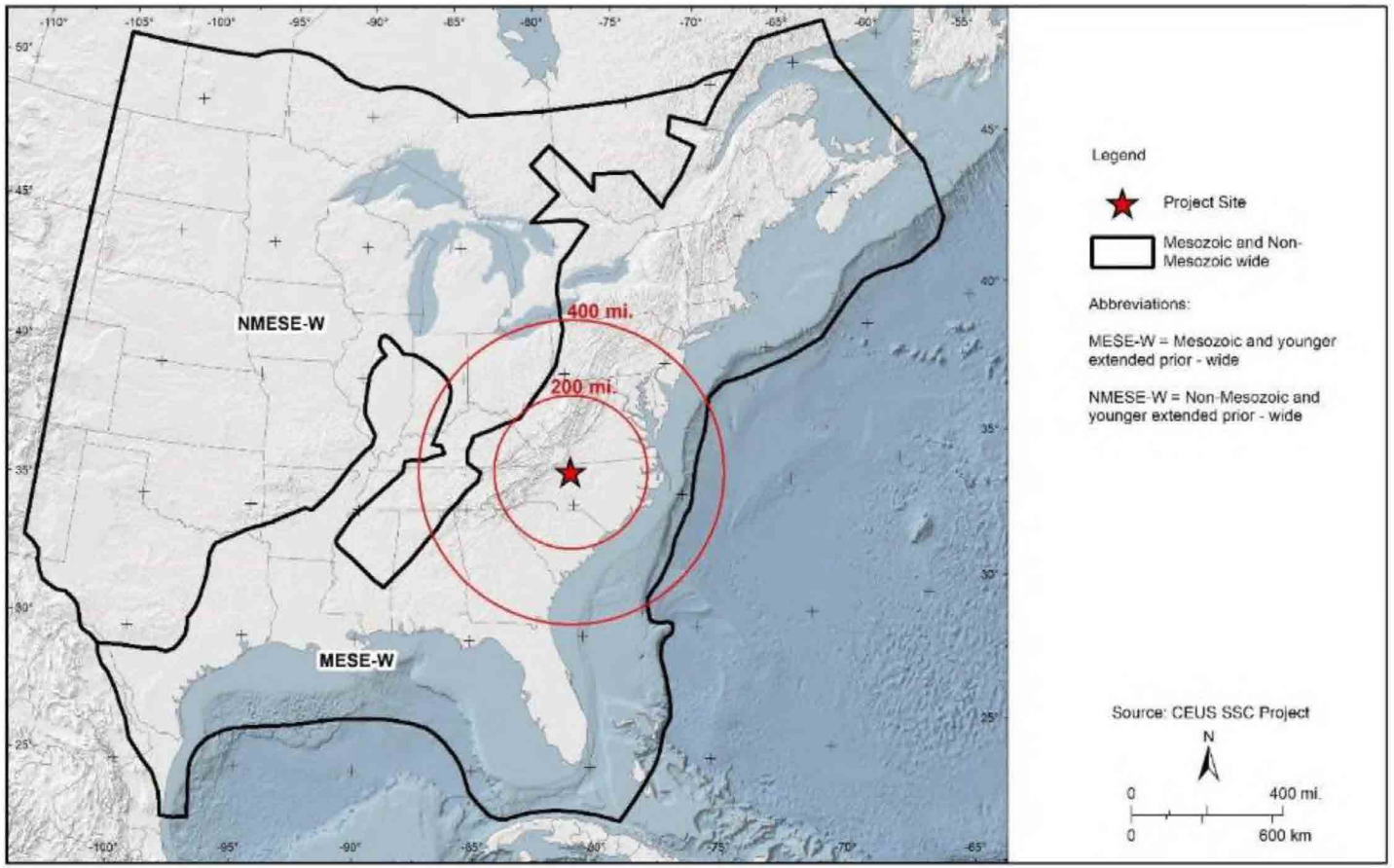
Figure 2.5-36
Subdivision Used in the Mmax Zone Branch of the Master Logic Tree: Narrow Interpretation



Source: Reference 2.5-60

Key: Mmax = maximum magnitude

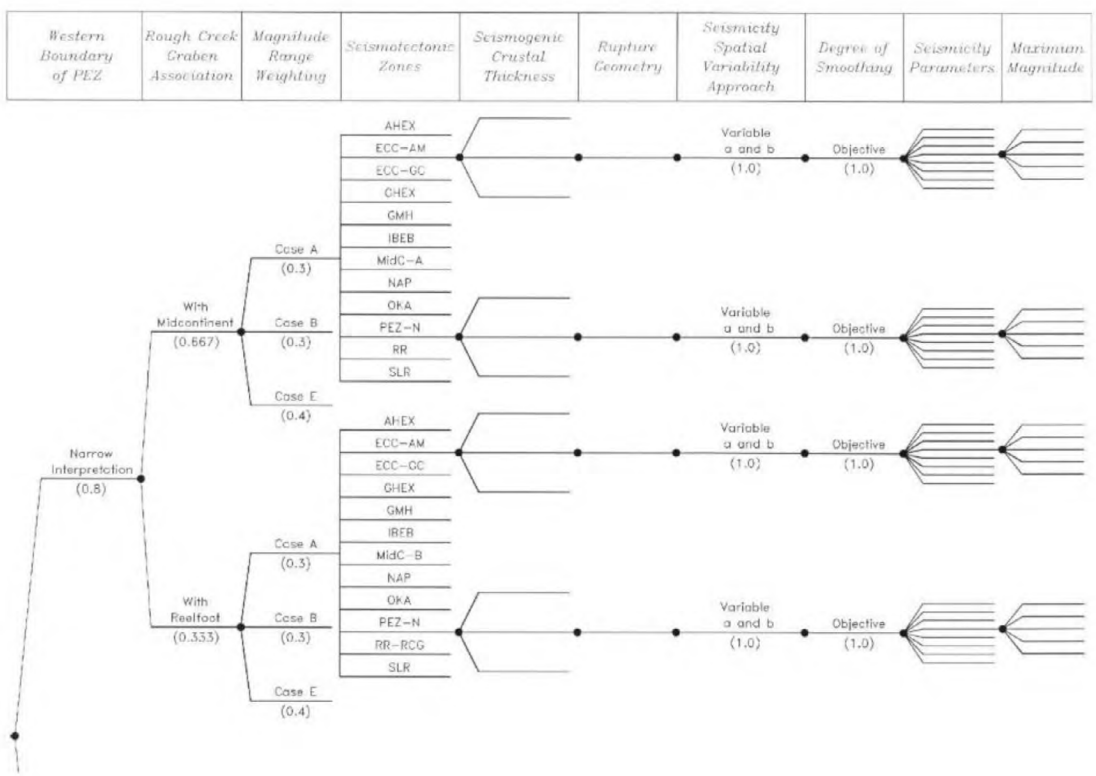
Figure 2.5-37
Subdivision Used in the Mmax Zone Branch of the Master Logic Tree: Wide Interpretation



Source: Reference 2.5-60

Key: mi. = miles; Mmax = maximum magnitude

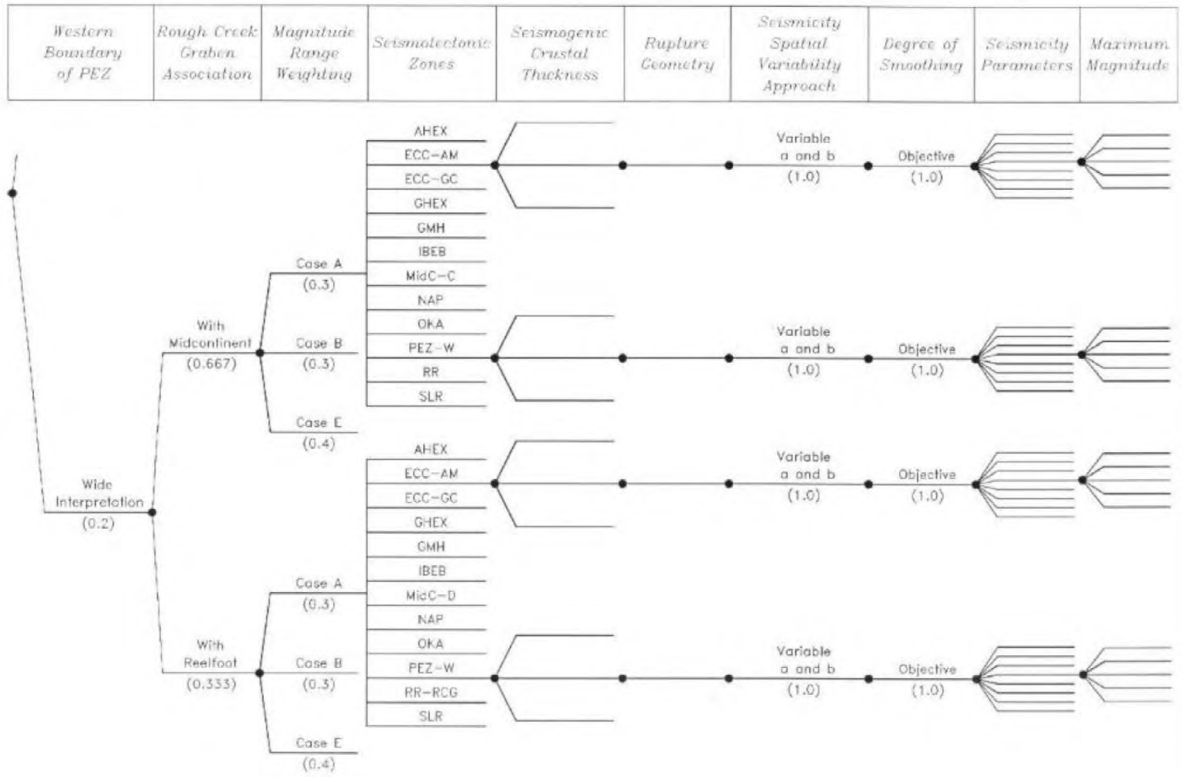
Figure 2.5-38
Logic Tree for the Seismotectonic Zone Branch of the Master Logic Tree
(Sheet 1 of 2)



Source: Reference 2.5-60

Key: AHEX = Advanced National Seismic System Comprehensive Earthquake Catalog; ECC-AM = Extended Continental Crust-Atlantic Margin; ECC-GC = Extended Continental Crust-Gulf Coast; GHEX = Gulf Coast Highly Extended; GMH = Great Meteor Hotspot; IBEB = Illinois Basin Extended Basement; MidC – Midcontinent-Craton; NAP = Northern Appalachian; OKA = Oklahoma Aulacogen; PEZ = Paleozoic Extended Zone; PEZ-W = Paleozoic Extended Zone-Wide; RR-RCG = Reelfoot Rift with Rough Creek Graben; SLR = St. Lawrence Rift

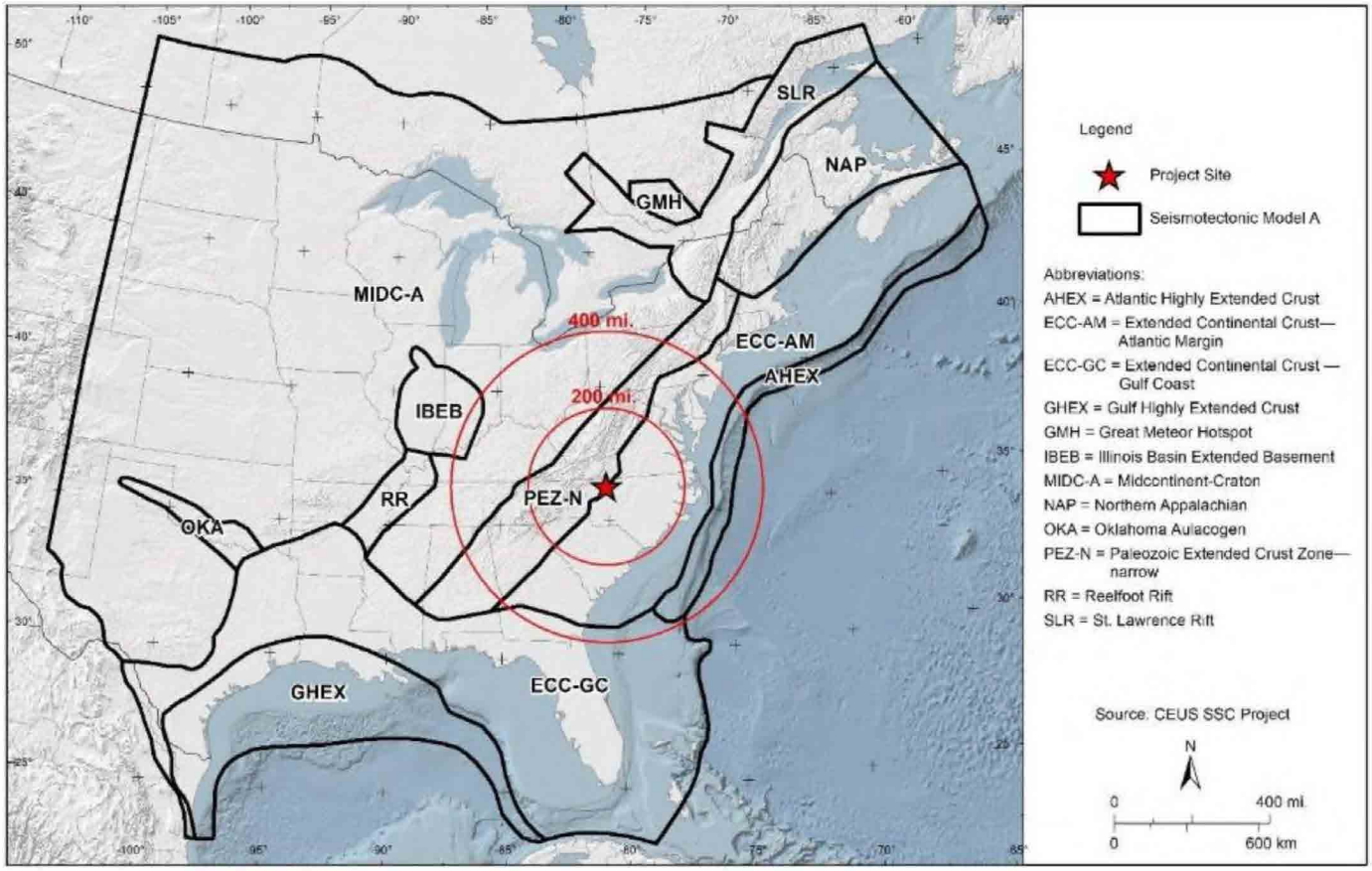
Figure 2.5-38
Logic Tree for the Seismotectonic Zone Branch of the Master Logic Tree
(Sheet 2 of 2)



Source: Reference 2.5-60

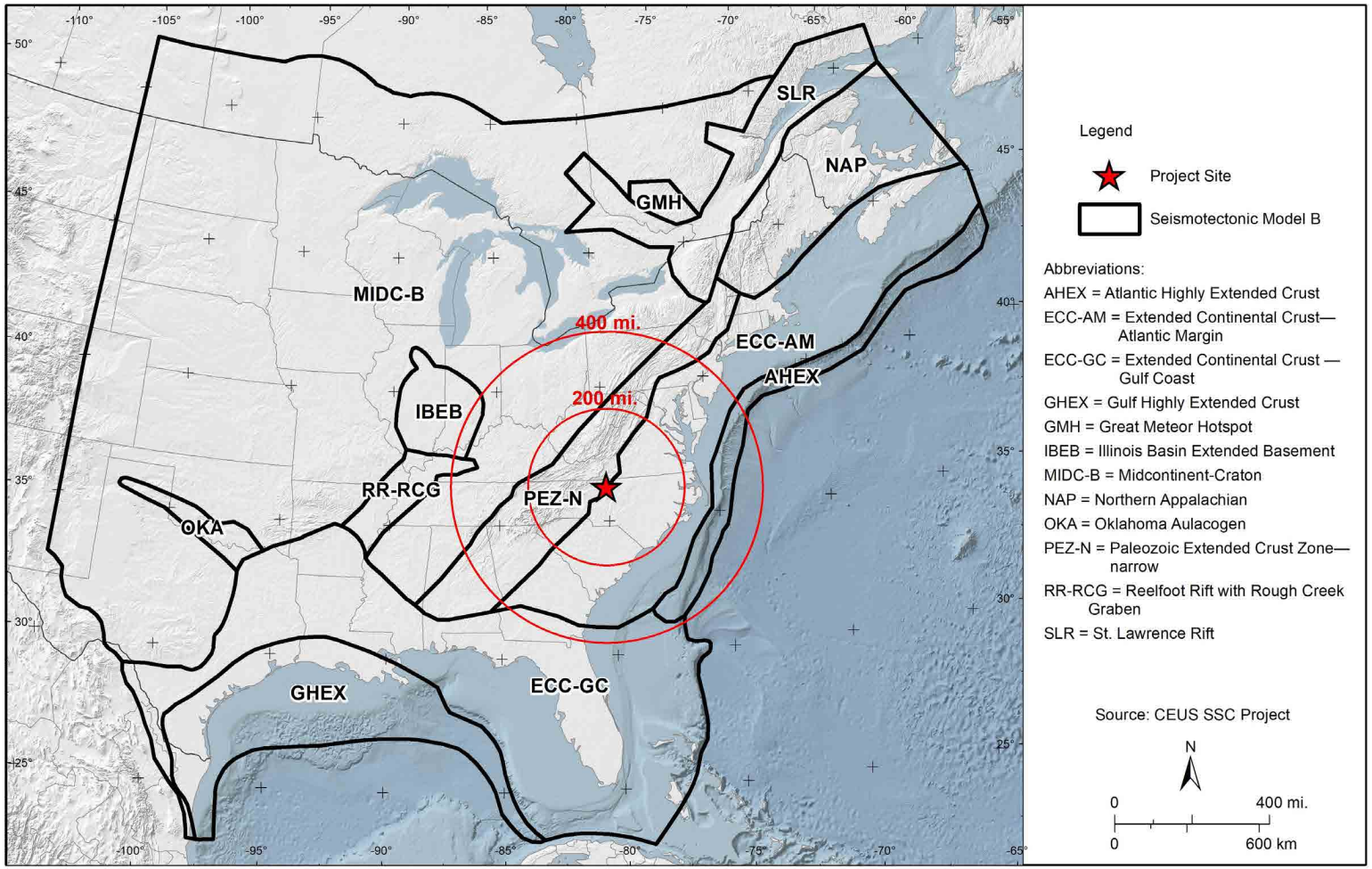
Key: AHEX = Advanced National Seismic System Comprehensive Earthquake Catalog; ECC-AM = Extended Continental Crust-Atlantic Margin; ECC-GC = Extended Continental Crust-Gulf Coast; GHEX = Gulf Coast Highly Extended; GMH = Great Meteor Hotspot; IBEB = Illinois Basin Extended Basement; MidC – Midcontinent-Craton; NAP = Northern Appalachian; OKA = Oklahoma Aulacogen; PEZ = Paleozoic Extended Zone; PEZ-W = Paleozoic Extended Zone-Wide; RR-RCG = Reelfoot Rift with Rough Creek Graben; SLR = St. Lawrence Rift

Figure 2.5-39
Seismotectonic Zones Shown in the Case Where the Rough Creek Graben Is Not Part of the Reelfoot Rift and the Paleozoic Extended Zone Is Narrow



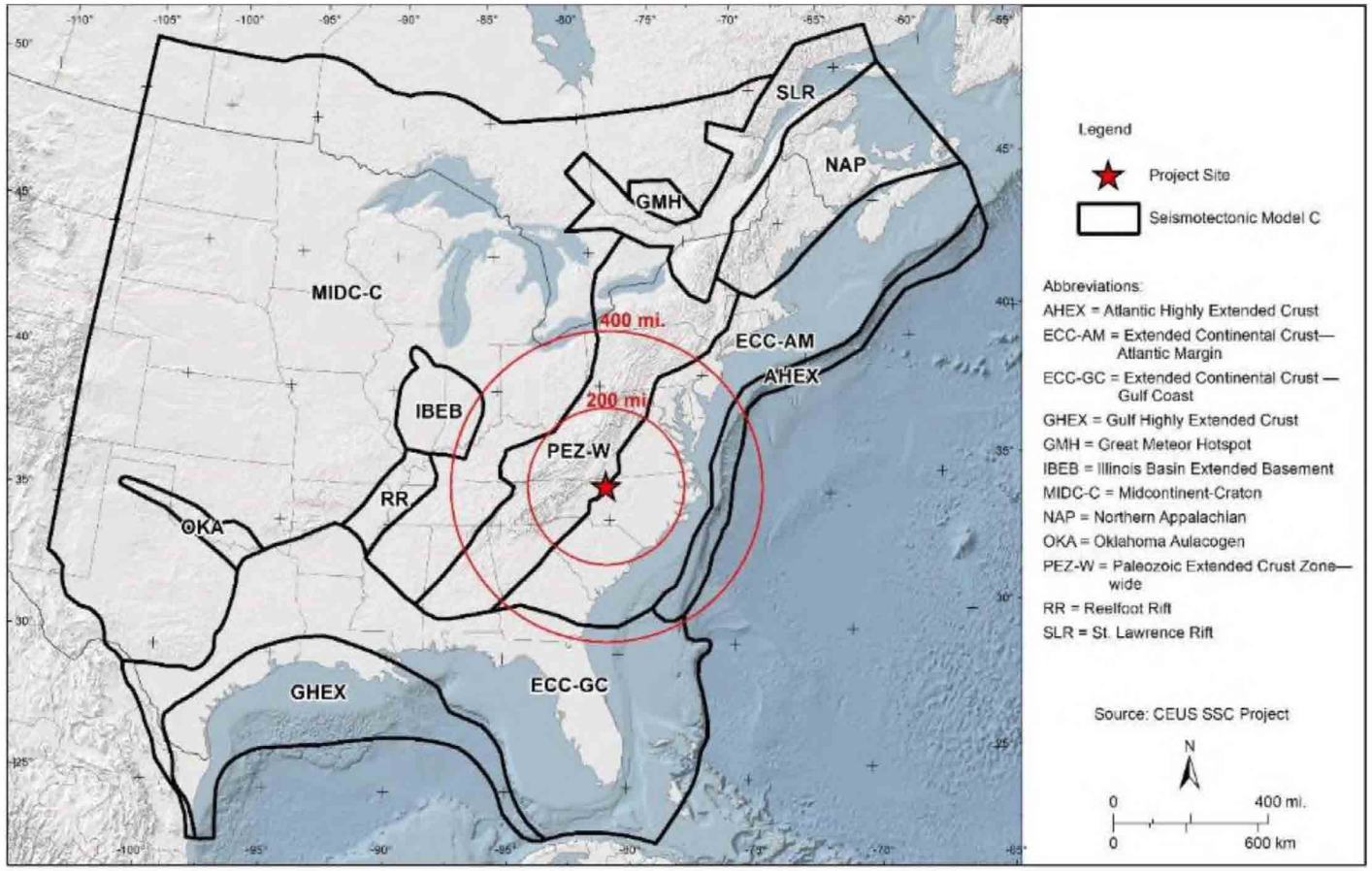
Source: Reference 2.5-60

Figure 2.5-40
Seismotectonic Zones Shown in the Case Where the Rough Creek Graben Is Part of the Reelfoot Rift and the Paleozoic Extended Zone Is Narrow



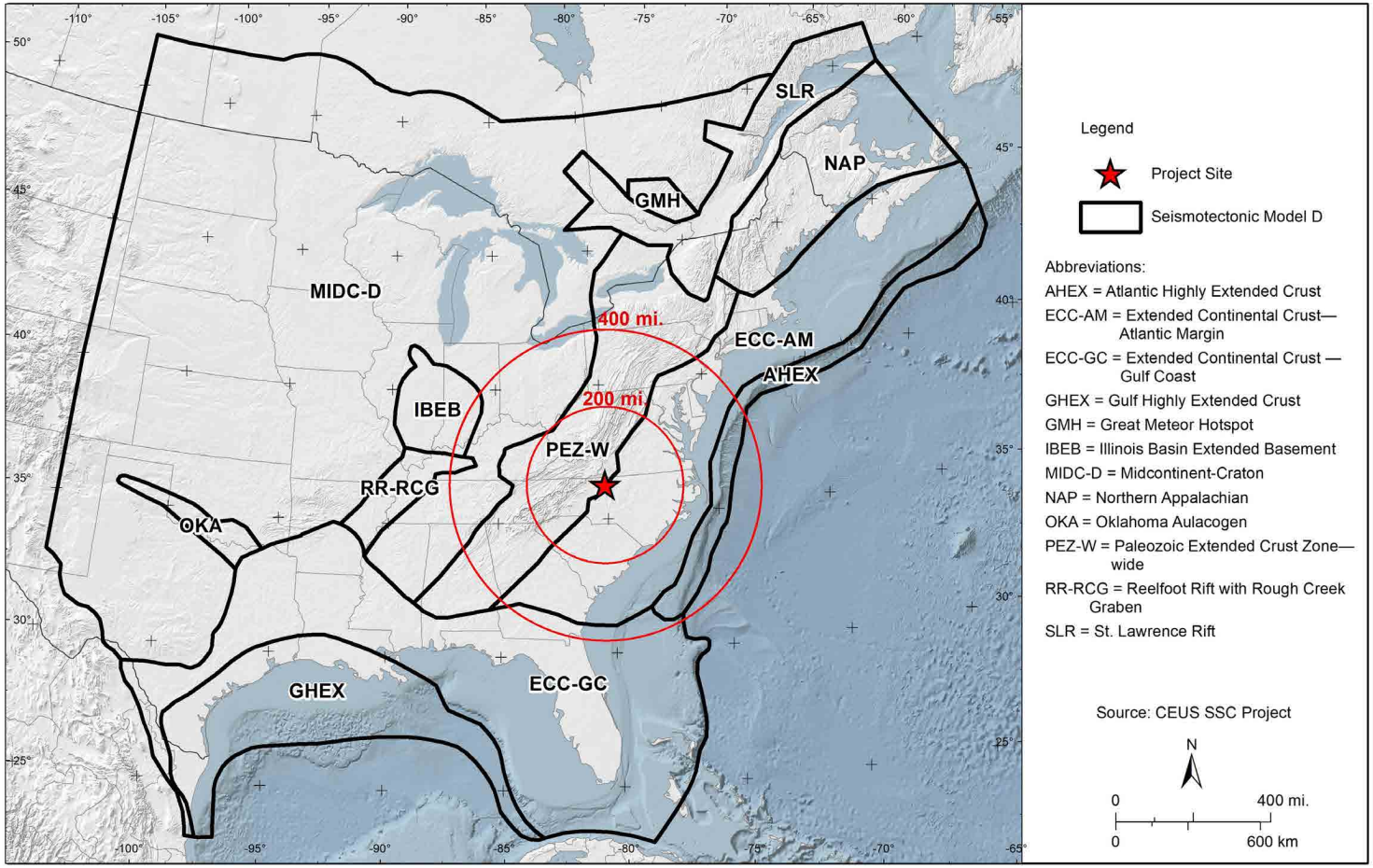
Source: Reference 2.5-60

Figure 2.5-41
Seismotectonic Zones Shown in the Case Where the Rough Creek Graben Is Not Part of the Reelfoot Rift and the Paleozoic Extended Zone Is Wide



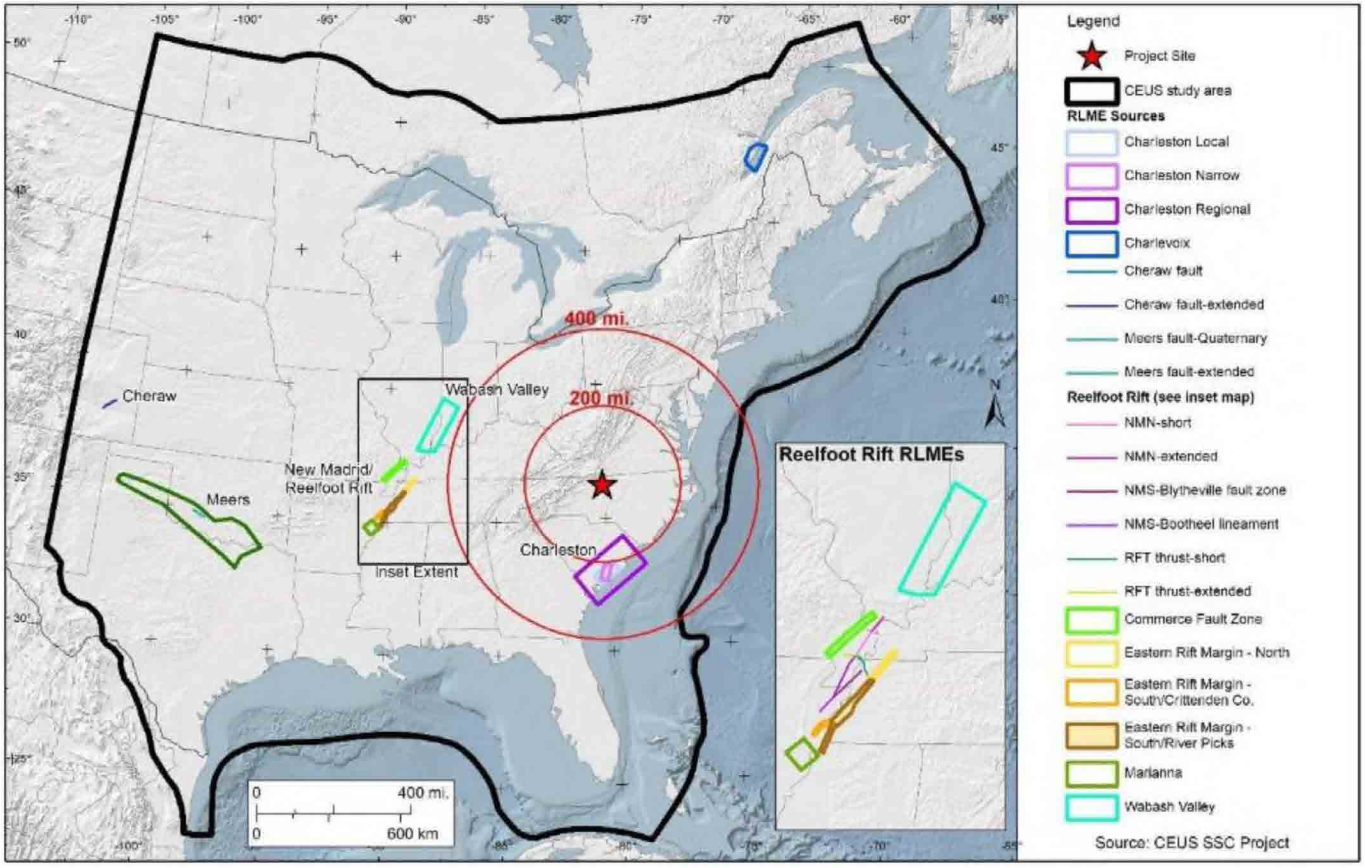
Source: Reference 2.5-60

Figure 2.5-42
Seismotectonic Zones Shown in the Case Where the Rough Creek Graben Is Part of the Reelfoot Rift and the Paleozoic Extended Zone is Wide



Source: Reference 2.5-60

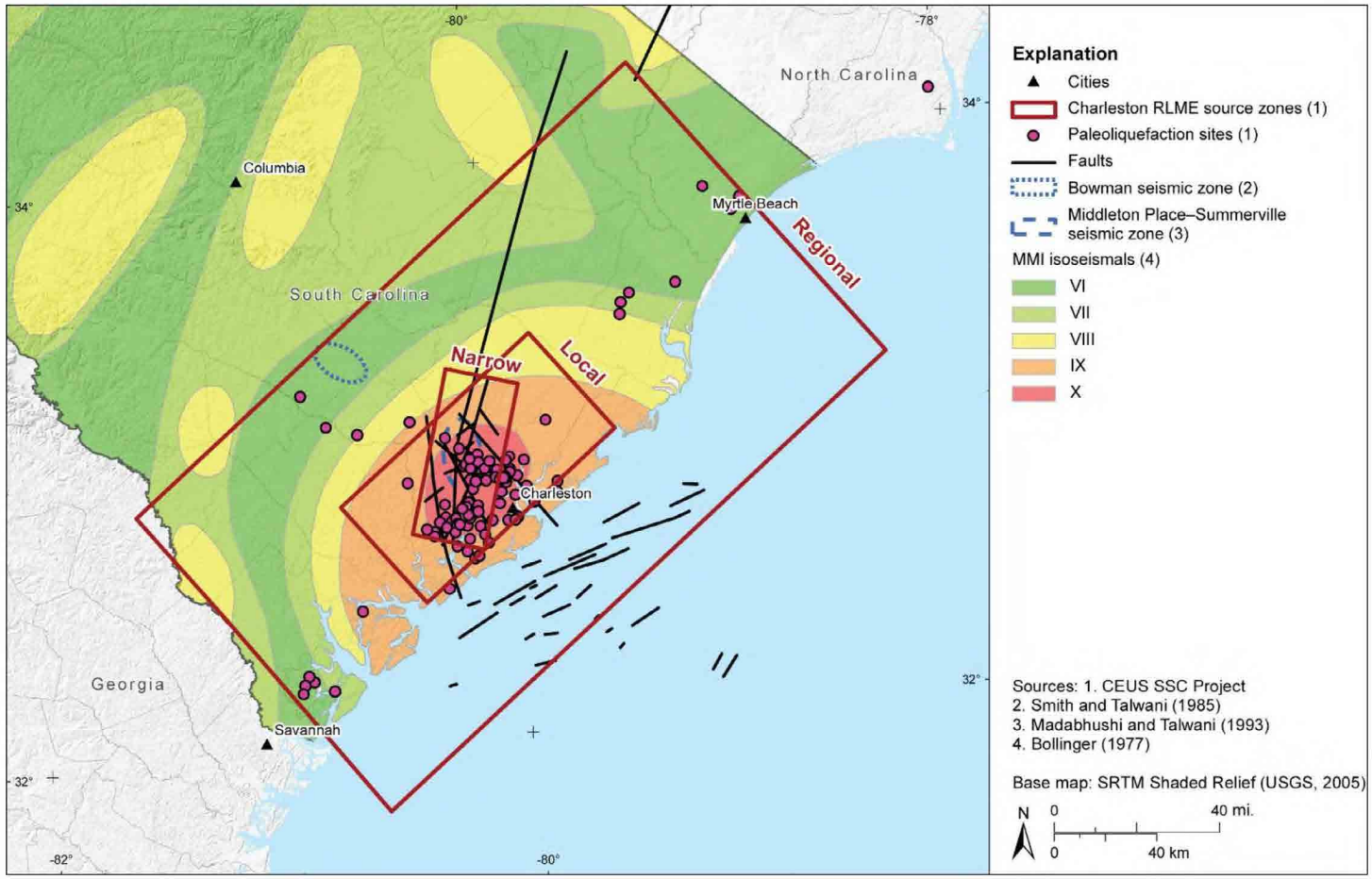
Figure 2.5-43
Map Showing RLME Sources



Source: Reference 2.5-60

Key: CEUS = Central and Eastern United States; mi. = miles; RLME = repeated large magnitude earthquake

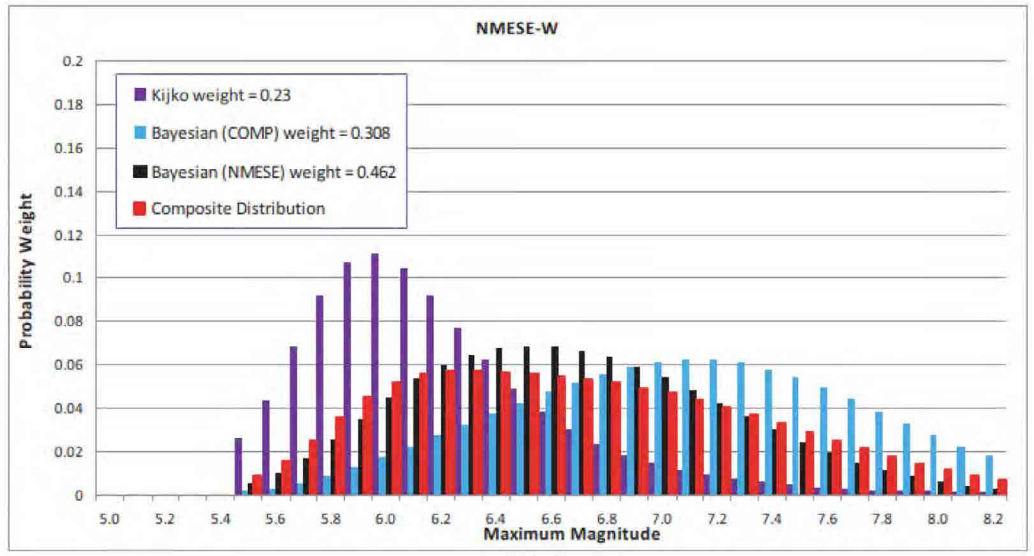
Figure 2.5-44
Charleston Configuration



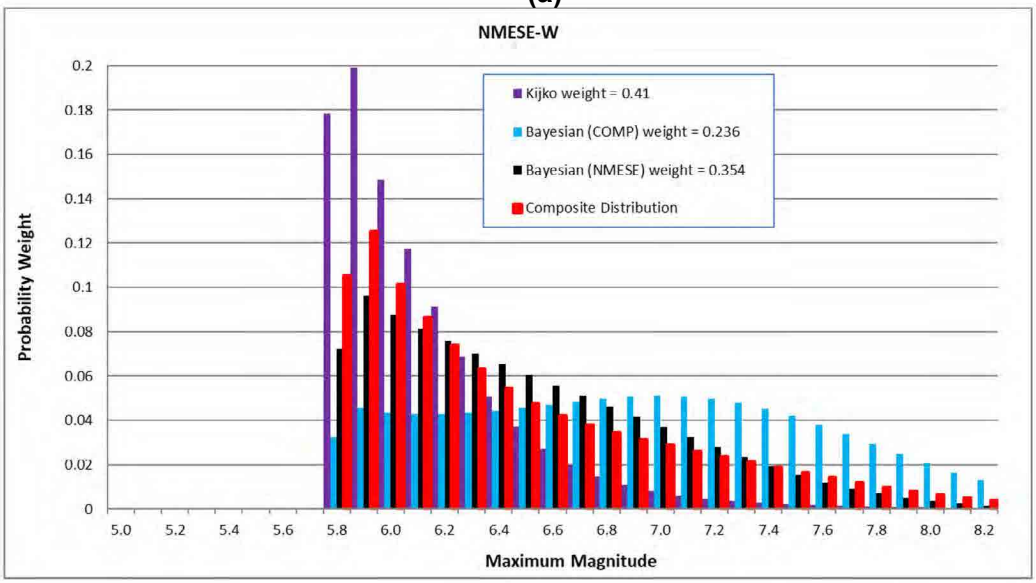
Source: Reference 2.5-60

Key: MMI = modified Mercalli intensity; RLME = repeated large-magnitude earthquake

Figure 2.5-45
Mmax Distribution for the NMESE-W Mmax Zone: (a) EPRI, DOE, and NRC (Reference 2.5-60, Figure 6.3.2-5); and (b) Update Distribution



(a)

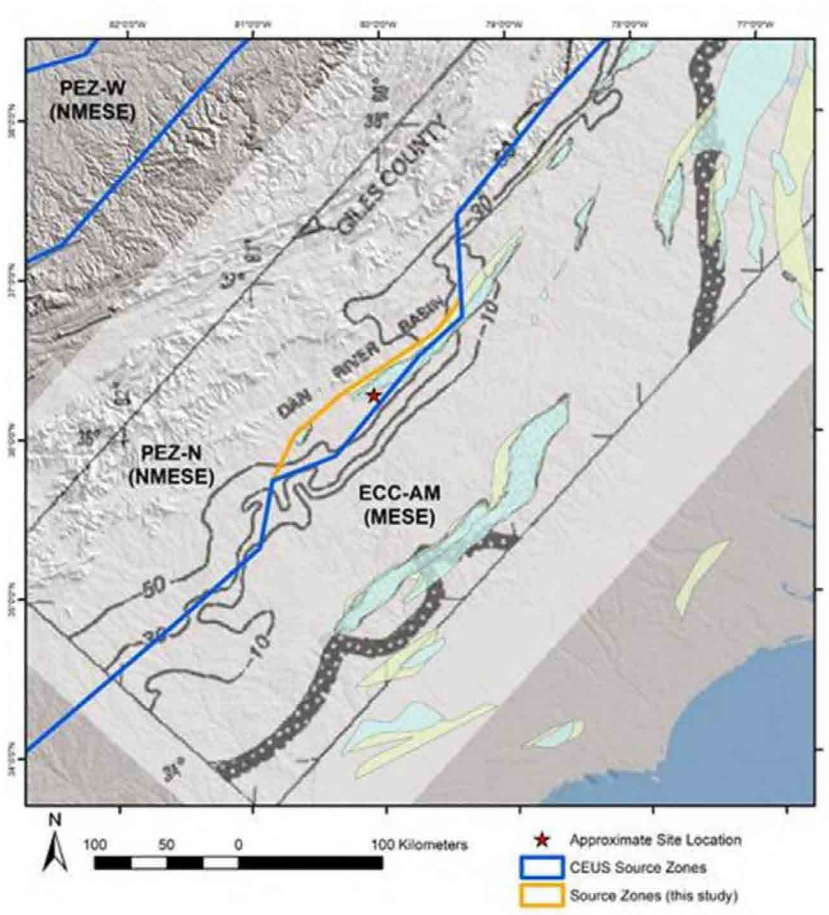


(b)

Source: Reference 2.5-60

Key: DOE = U.S. Department of Energy; EPRI = Electric Power Research Institute; Mmax = maximum magnitude; NMESE-W = Non-extended crust or crust where the most recent extension occurred before the Mesozoic-Wide; NRC = U.S. Nuclear Regulatory Commission

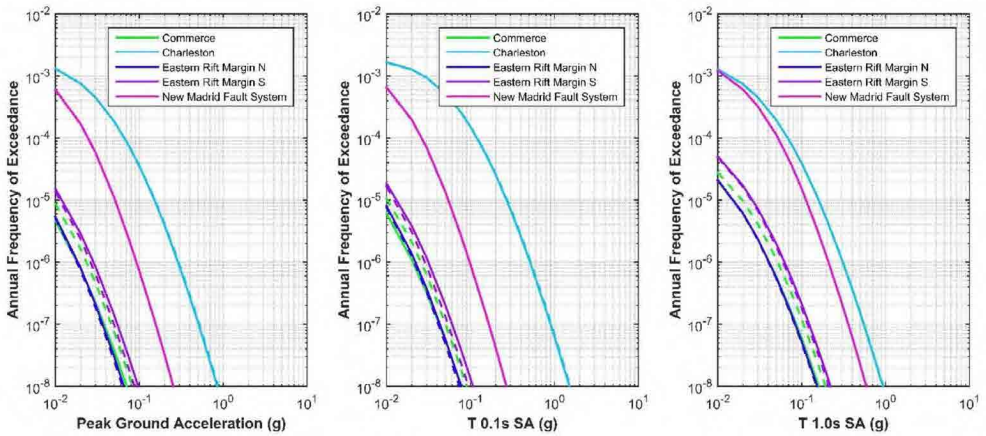
Figure 2.5-46
Map from Bollinger and Wheeler (Reference 2.5-79) Georeferenced Relative to the CEUS SSC Model (Blue) and the Alternative Source Zone Boundary from the SSHAC Level 2 (Orange)



Source: Reference 2.5-79

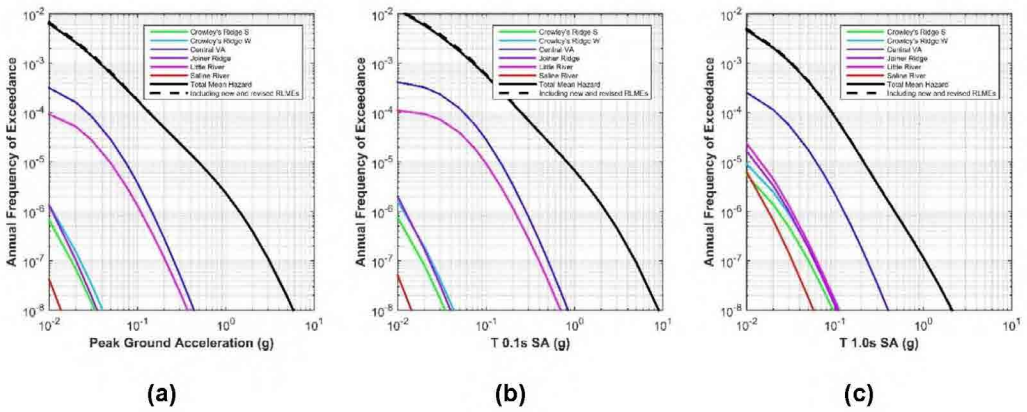
Key: CEUS SSC = Central and Eastern United States Seismic Source Characterization; MESE = Mesozoic and younger extended crust; NMESE = Non-extended crust or crust where the most recent extension occurred before the Mesozoic; PEZ-N = Paleozoic Extended Zone-Narrow; PEZ-W = Paleozoic Extended Zone-Wide; SSHAC = Senior Seismic Hazard Analysis Committee

Figure 2.5-47
Sensitivity Analysis Showing the Effect of Model Changes for Individual RLME Sources (Dashed Lines) Compared to the Model as Published in EPRI, DOE, and NRC (Reference 2.5-60) (Solid Lines): (a) PGA; (b) 0.1 Sec. (10 Hz) Spectral Acceleration; and (c) 1 Sec. (1 Hz) Spectral Acceleration



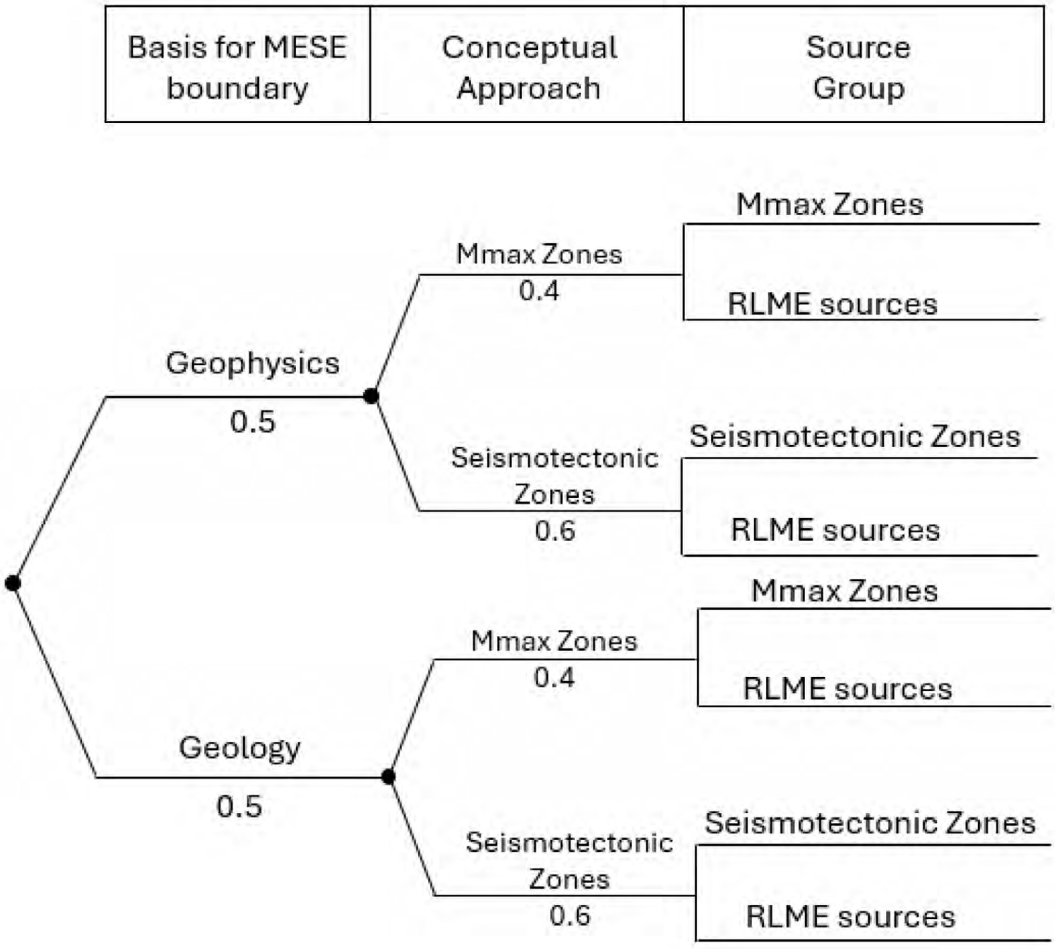
Key: DOE = U.S. Department of Energy; EPRI = Electric Power Research Institute; Hz = hertz; NRC = PGA = peak ground acceleration RLME = repeated large-magnitude earthquake; sec. = second; SA = spectral acceleration

Figure 2.5-48
Sensitivity Analysis Showing the Effect of Including Additional Fault Sources to the Seismic Hazard Model: (a) PGA; (b) 0.1 Sec. (10 Hz) Spectral Acceleration; and (c) 1 Sec. (1 Hz) Spectral Acceleration



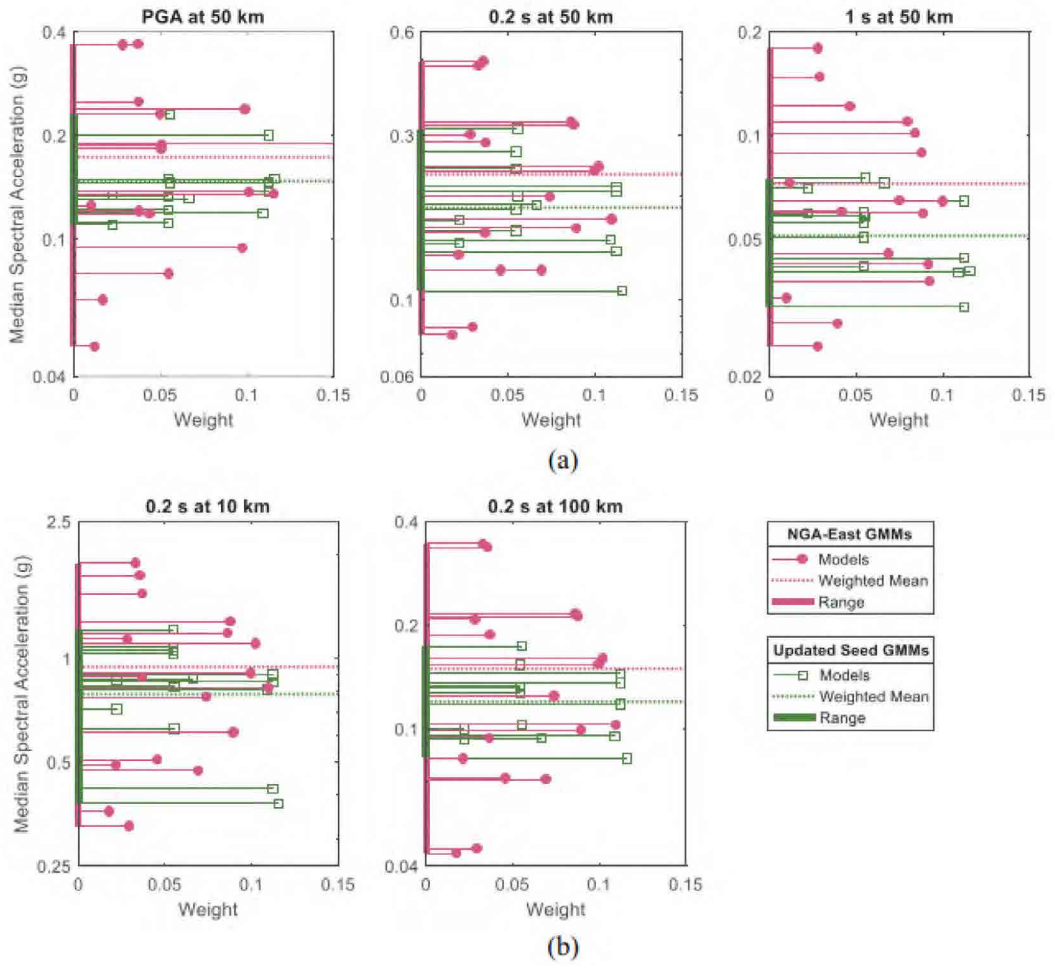
Key: Hz = hertz; PGA = peak ground acceleration; RLME = repeated large-magnitude earthquake; sec. = second; SA = spectral acceleration

Figure 2.5-49
SSHAC Level 2 Seismic Source Characterization Master Logic Tree



Key: MESE = Mesozoic and younger extended crust; Mmax = maximum magnitude; RLME = repeated large-magnitude earthquake; SSHAC = Senior Seismic Hazard Analysis Committee

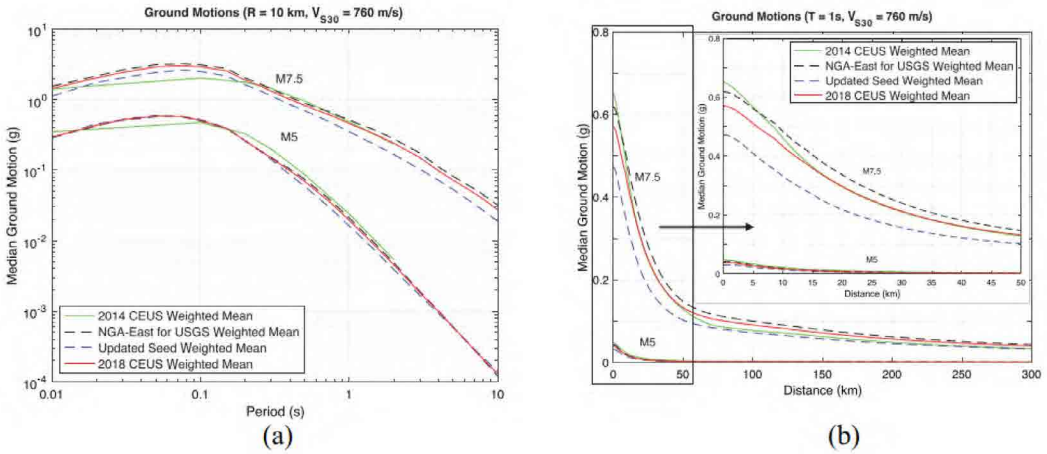
Figure 2.5-50
Epistemic Uncertainty of NGA-East GMMs and of the 14 Seed GMMs Used by USGS



Source: Reference 2.5-159

Key: GMM = ground motion model; km = kilometer; NGA = Next Generation Attenuation; s= second; USGS = U.S. Geological Survey

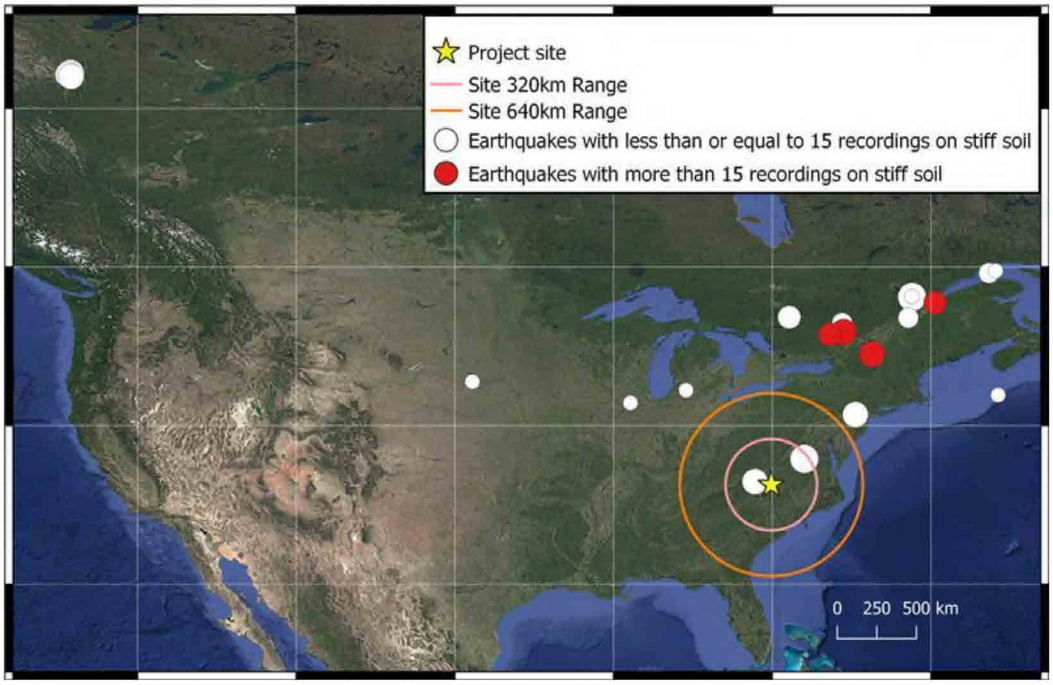
Figure 2.5-51
Comparison of Median Ground Motions from NGA-East GMMs, the Expanded Seed Approach, and the Combination of the Two Used by USGS in the 2018 NSHM: (a) Median Ground Motion Versus Period for M 5 and M 7.5, VS30 = 760 M/s, Distance 10 Km; (b) Ground Shaking as a Function of Site-To-Source Distance for M 5 and M 7.5 for Various Source-To-Site Distances



Source: Reference 2.5-160

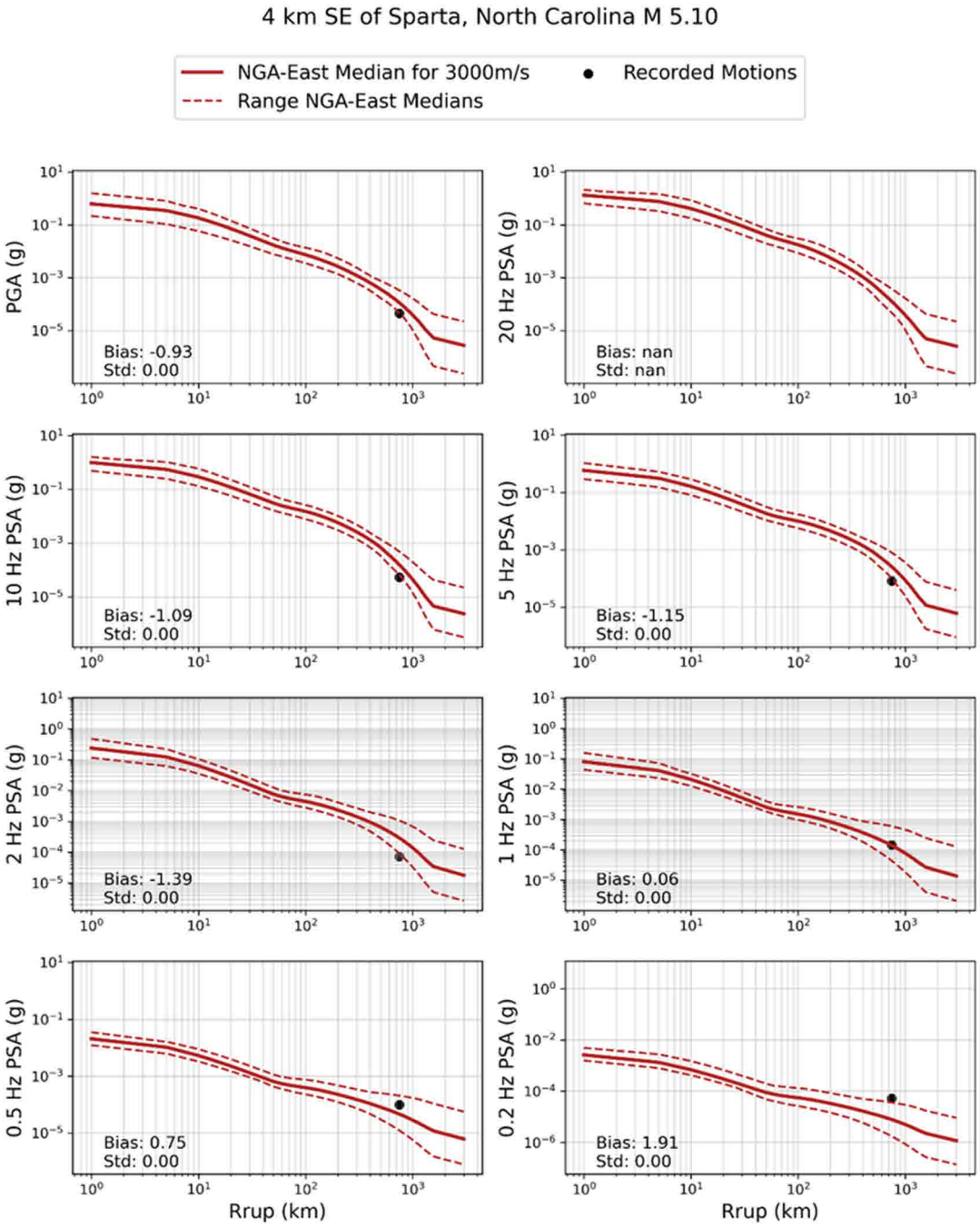
Key: CEUS = Central and Eastern United States; GMM = ground motion model; km = kilometer; **M** = magnitude; m/s = meter per second; NGA = Next Generation Attenuation; NSHM = National Seismic Hazard Map; USGS = U.S. Geological Survey; VS30 = time-average shear wave velocity in the upper 30 meters

Figure 2.5-52
Location of CENA Earthquakes with M ≥ 4 Recorded on Stiff Sites at Distances Less than 621 Mi. (1000 Km)



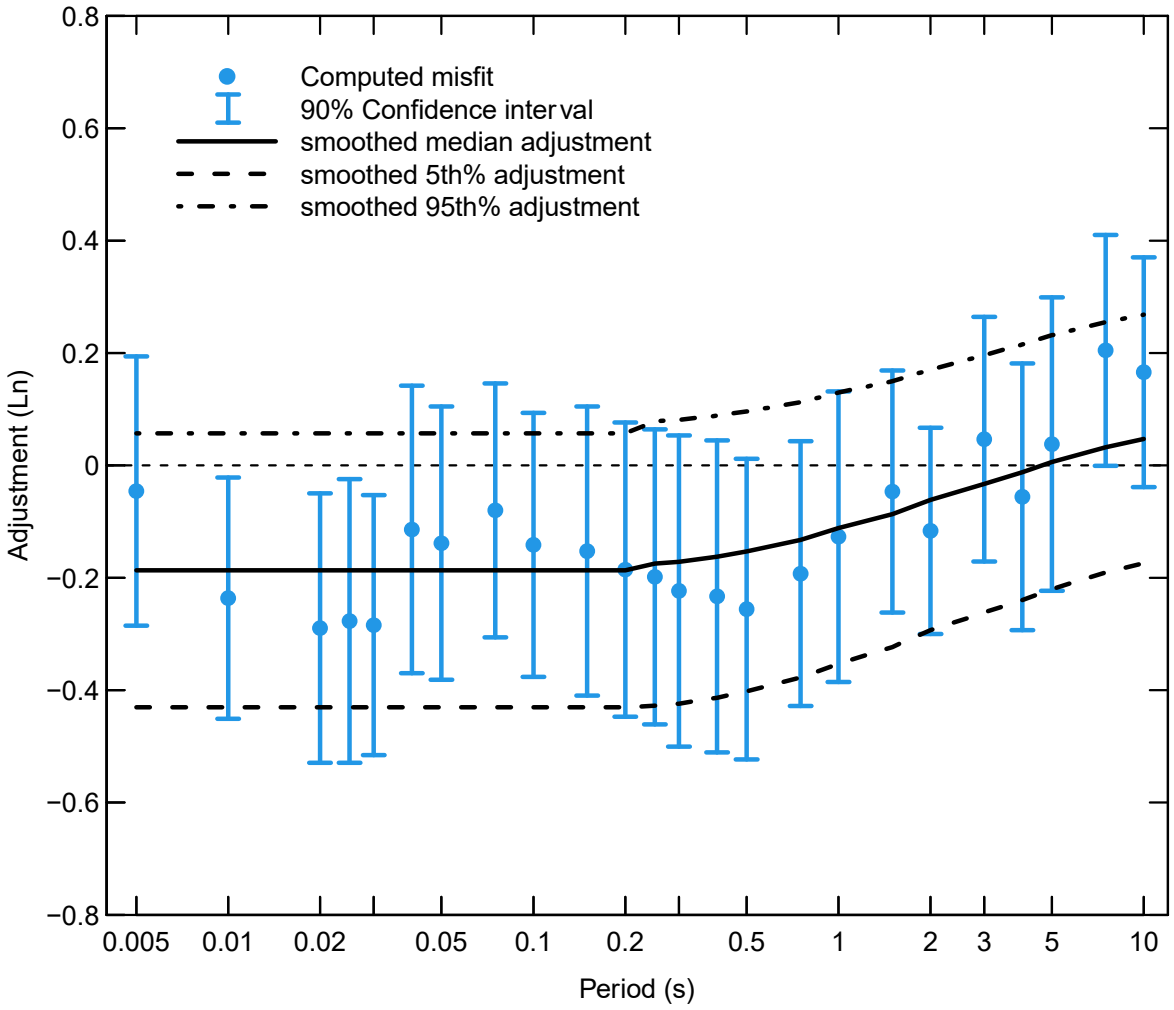
Key: CENA = Central and Eastern North America; km = kilometer; **M** = magnitude; mi. = miles

Figure 2.5-53
Comparison of Observed Ground Motion Corrected to Hard Rock Condition (V_S Approximately 9842 Ft/s [3000 M/s] to Ground Motion Predicted by Median NGA-East GMMs)



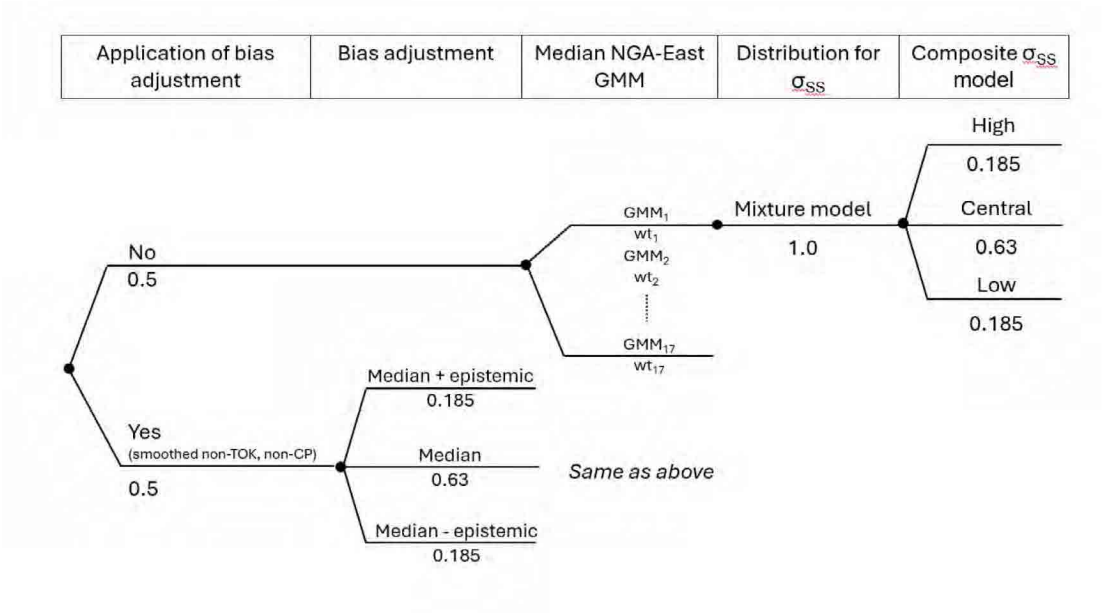
Key: ft/s = foot per second; g = acceleration; GMM = ground motion model; Hz = hertz; km = kilometer; **M** = magnitude; m/s = meter per second; PGA = peak ground acceleration; PSA = pseudo-spectral acceleration; Rrup = distance to earthquake rupture; SE = southeast; V_S = shear wave velocity

Figure 2.5-54
Median, 5th, 95th Percentiles Adjustments, and Average Misfits, 5th and 95th Percentiles Computed Using Ground Motion with M ≥ 4 and Rrup ≤ 373 Mi. (600 Km), Corrected to Hard Rock Condition (V_S Approximately 9842 Ft/s [3000 M/s]) Recorded by Stiff Sites, V_S30 ≥ 4921 Ft/s (1500 M/s)



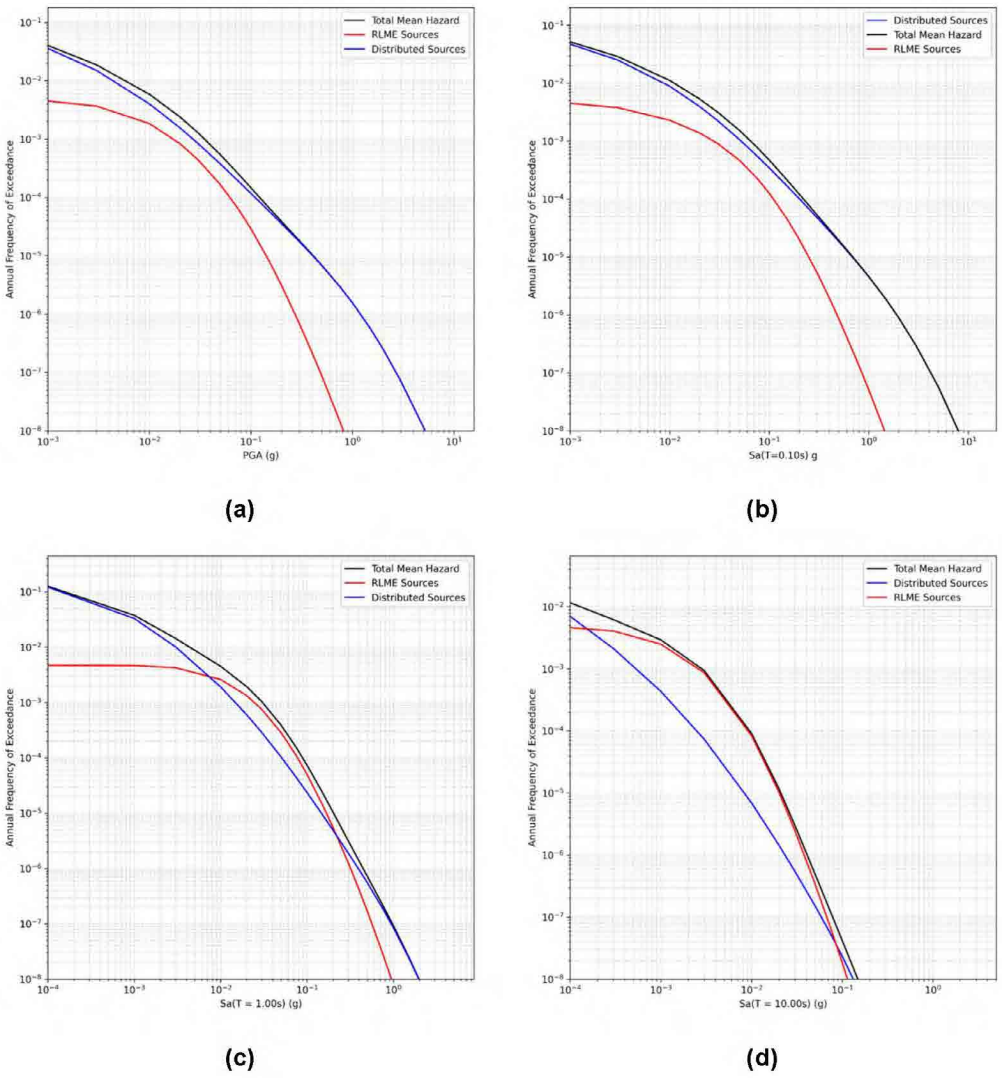
Key: ft/s = foot per second; km = kilometer; **M** = magnitude; mi. = miles; m/s = meter per second; Rrup = distance to earthquake rupture; s = second; V_{S30} = time-average shear wave velocity in the upper 30 meters

Figure 2.5-55
SSHAC Level 2 Ground Motion Characterization Master Logic Tree



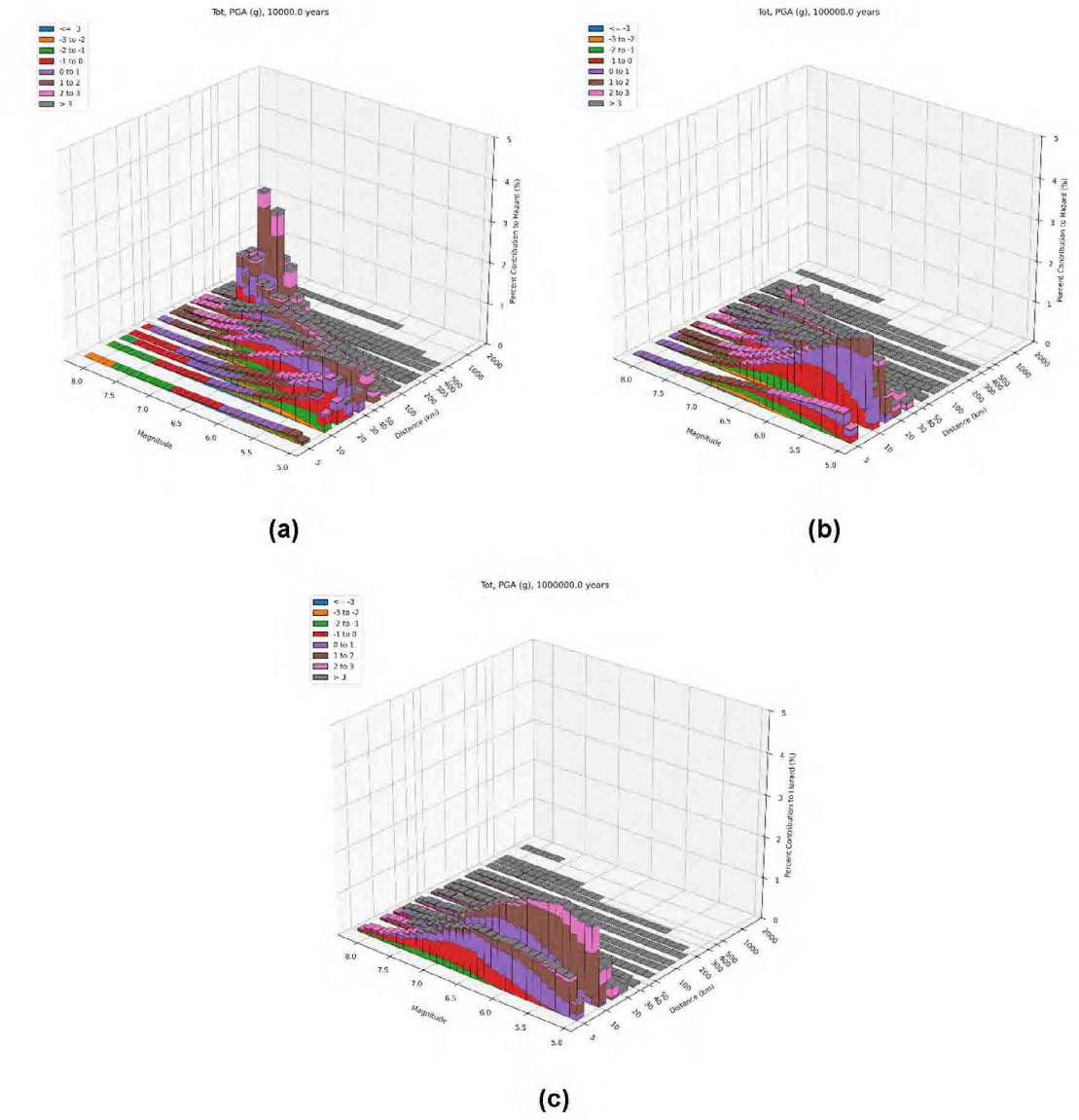
Key: CP = Coastal Plain; GMM = ground motion model; NGA = Next Generation Attenuation; SSHAC = Senior Seismic Hazard Analysis Committee; TOK = Texas-Oklahoma-Arkansas region

Figure 2.5-56
Total Mean Reference Rock Hazard and Contributions From Distributed Seismicity Sources and RLME Sources for: (a) PGA; (b) 10 Hz (0.1 Sec.) Spectral Acceleration; (c) 1 Hz (1 Sec.) Spectral Acceleration; (d) 0.1 Hz (10 Sec.) Spectral Acceleration



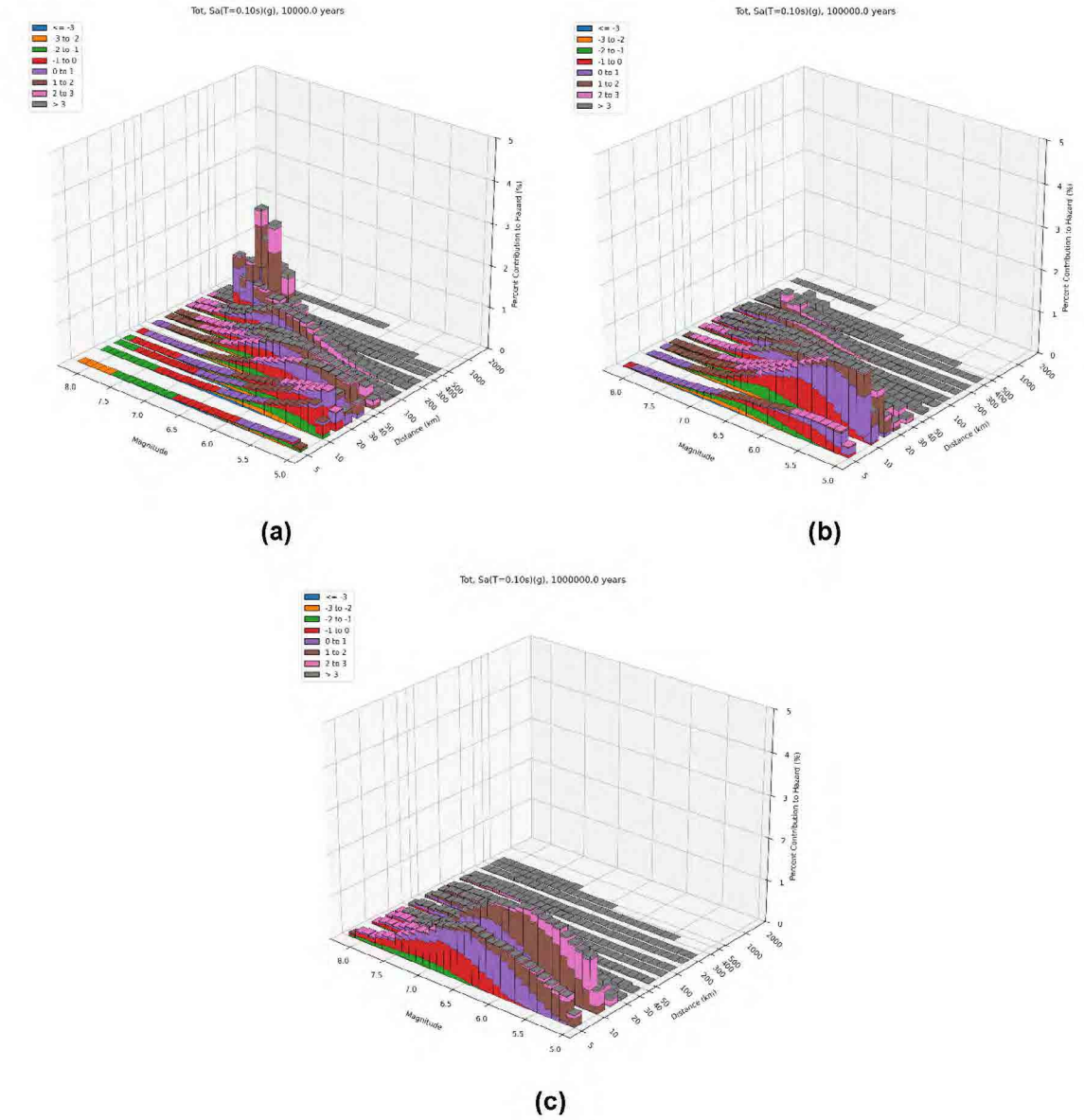
Key: g = acceleration of gravity; Hz = hertz; PGA = peak ground acceleration; RLME = repeated large-magnitude earthquake; sec. = second; Sa = spectral acceleration

Figure 2.5-57
Magnitude-Distance-Epsilon Deaggregation of the Total Mean Reference Rock Hazard for PGA: (a) AFE 1E-4 (10,000 Years Return Period); (b) AFE 1E-5 (100,000 Years Return Period); (c) AFE 1E-6 (1 Million Years Return Period)



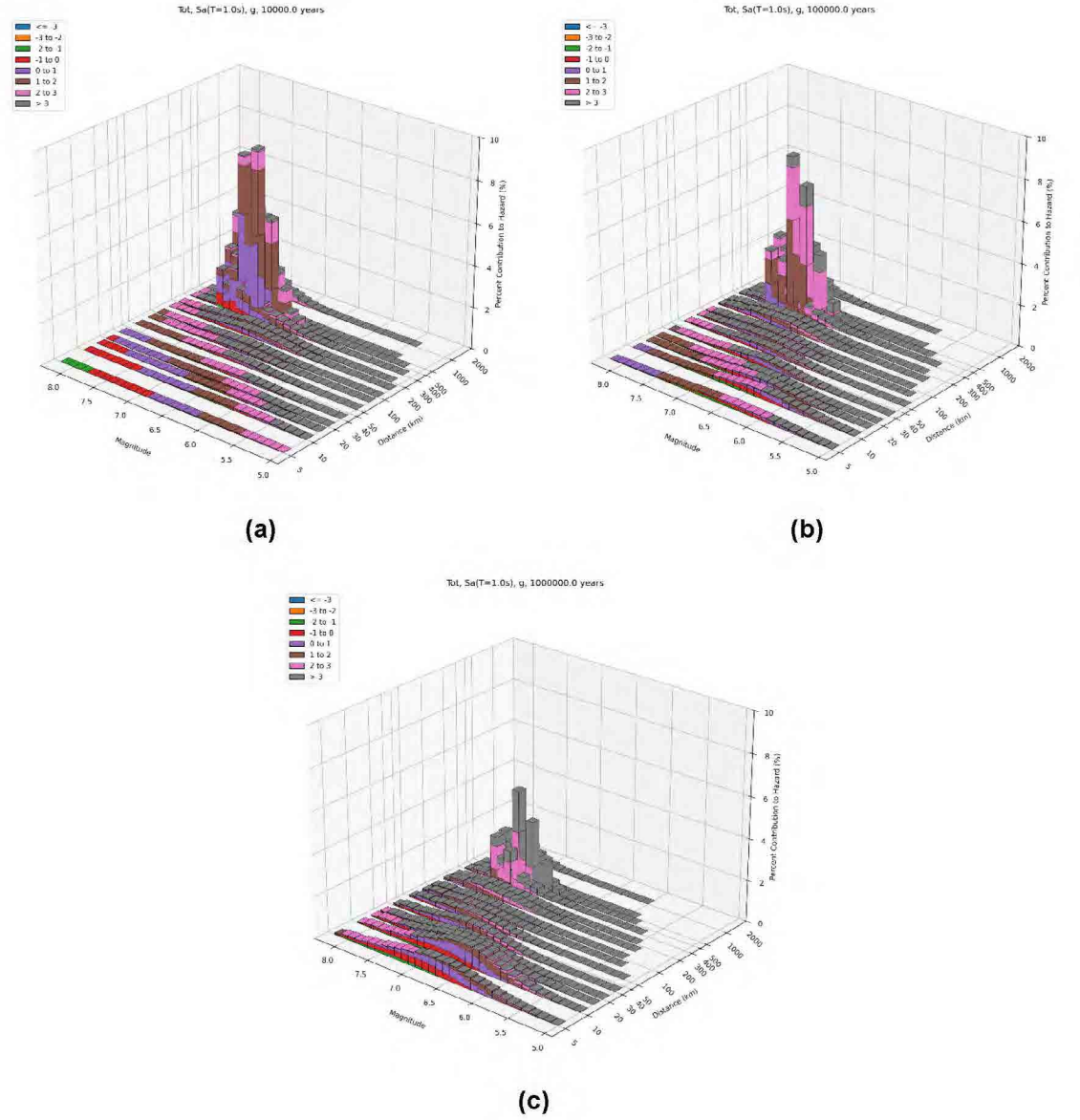
Key: AFE = annual frequency of exceedance; PGA = peak ground acceleration; g = acceleration of gravity; Tot = total mean hazard

Figure 2.5-58
Magnitude-Distance-Epsilon Deaggregation of the Total Mean Reference Rock Hazard for 10 Hz (0.1 Second) Spectral Acceleration: (a) AFE 1E-4 (10,000 Years Return Period); (b) AFE 1E-5 (100,000 Years Return Period); (c) AFE 1E-6 (1 Million Years Return Period)



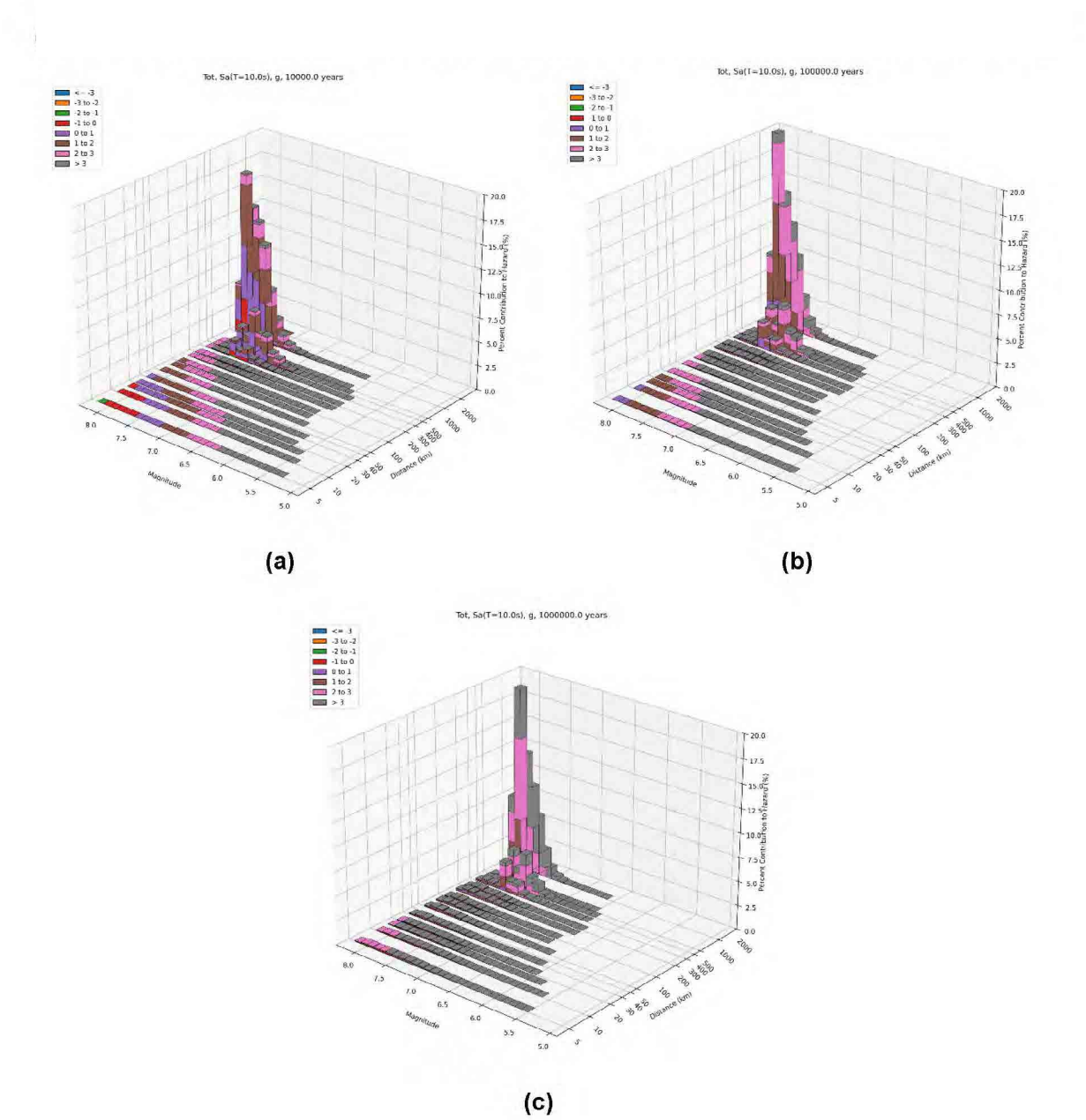
Key: AFE = annual frequency of exceedance; g = acceleration of gravity; Hz = hertz; s = second; Sa = spectral acceleration; Tot = total mean hazard

Figure 2.5-59
Magnitude-Distance-Epsilon Deaggregation of the Total Mean Reference Rock Hazard for 1 Hz (1 Second) Spectral Acceleration: (a) AFE 1E-4 (10,000 Years Return Period); (b) AFE 1E-5 (100,000 Years Return Period); (c) AFE 1E-6 (1 Million Years Return Period)



Key: AFE = annual frequency of exceedance; g = acceleration of gravity; s = second; Sa = spectral acceleration; Tot = total mean hazard

Figure 2.5-60
Magnitude-Distance-Epsilon Deaggregation of the Total Mean Reference Rock Hazard for 0.1 Hz (10 Second) Spectral Acceleration: (a) AFE 1E-4 (10,000 Years Return Period); (b) AFE 1E-5 (100,000 Years Return Period); (c) AFE 1E-6 (1 Million Years Return Period)

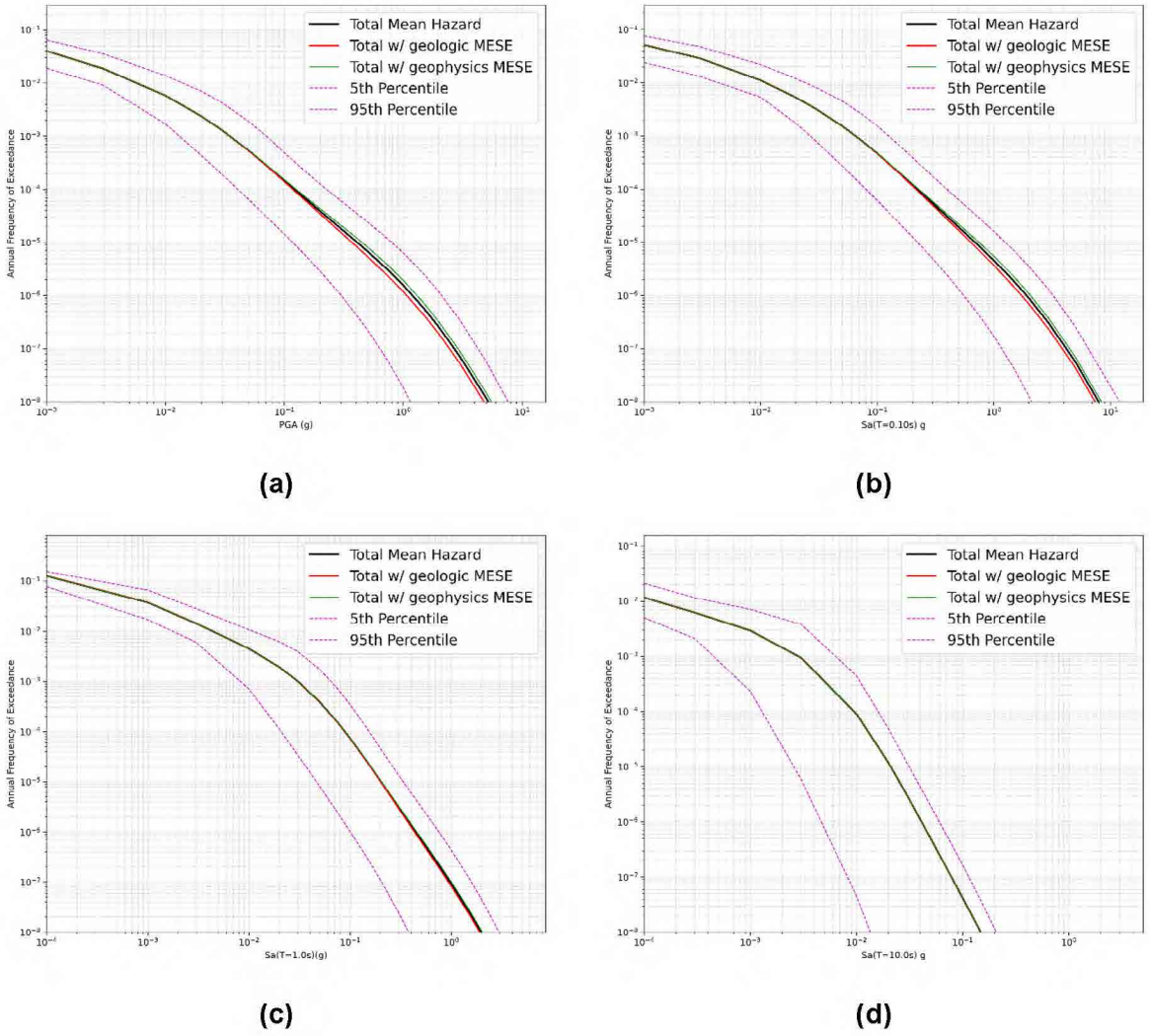


(a) (b)

(c)

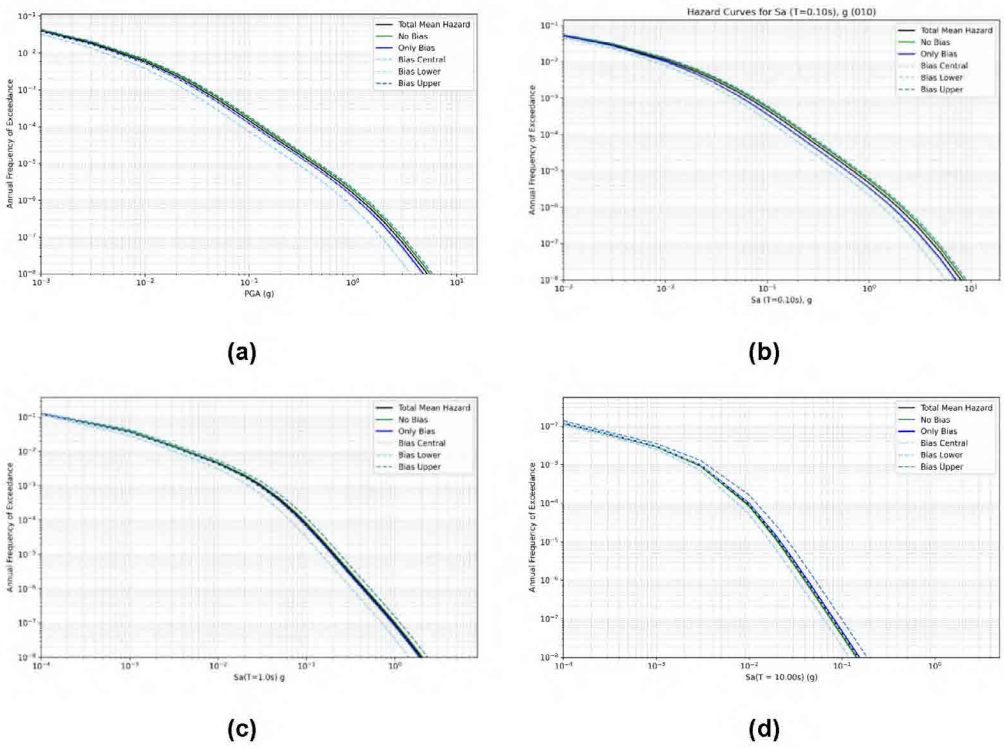
Key: AFE = annual frequency of exceedance; g = acceleration of gravity; Hz = hertz; s = second; Sa = spectral acceleration; Tot = total mean hazard

Figure 2.5-61
Sensitivity Analysis Illustrating the Effect of Using Alternative Geometries of the MESE Boundary: (a) PGA; (b) 10 Hz (0.1 Sec.) Spectral Acceleration; (c) 1 Hz (1 Sec.) Spectral Acceleration; (d) 0.1 Hz (10 Sec.) Spectral Acceleration



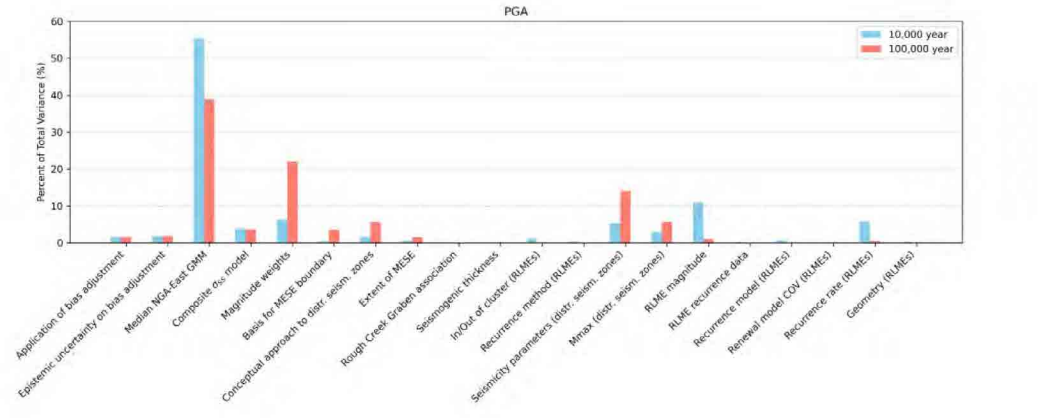
Key: AFE = annual frequency of exceedance; g = acceleration of gravity; Hz = hertz; MESE = Mesozoic and younger extended crust; PGA = peak ground acceleration; sec. = second; Sa = spectral acceleration

Figure 2.5-62
Sensitivity Analysis Illustrating the Effect of Adjusting the NGA-East Median Ground Motion Models for Data Misfit (Bias): (a) PGA; (b) 10 Hz (0.1 Sec.) Spectral Acceleration; (c) 1 Hz (1 Sec.) Spectral Acceleration; (d) 0.1 Hz (10 Sec.) Spectral Acceleration

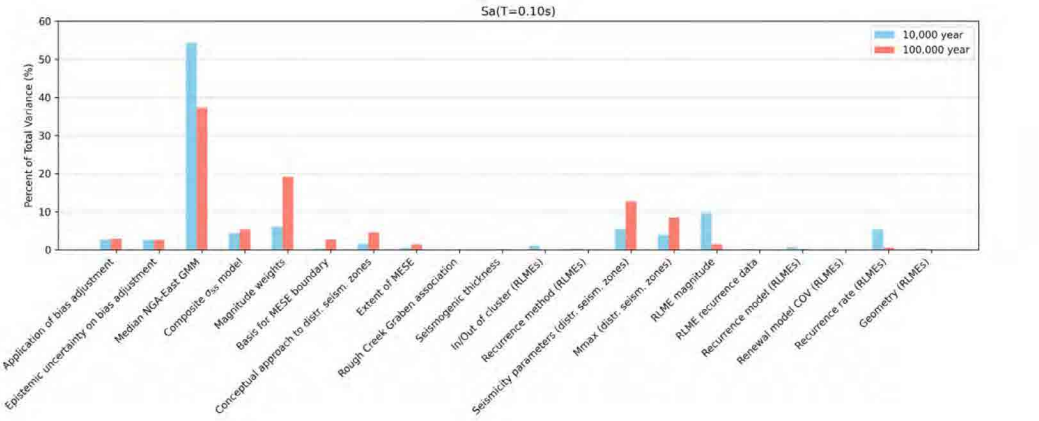


Key: AFE = annual frequency of exceedance; g = acceleration of gravity; Hz = hertz; NGA = Next Generation Attenuation; PGA = peak ground acceleration; sec. = second; Sa = spectral acceleration

Figure 2.5-63
Variance Histogram for AFE 1E-4 (10,000 Years Return Period) and AFE 1E-5 (100,000 Years Return Period) for: (a) PGA; (b) 10 Hz (0.1 Second) Spectral Acceleration



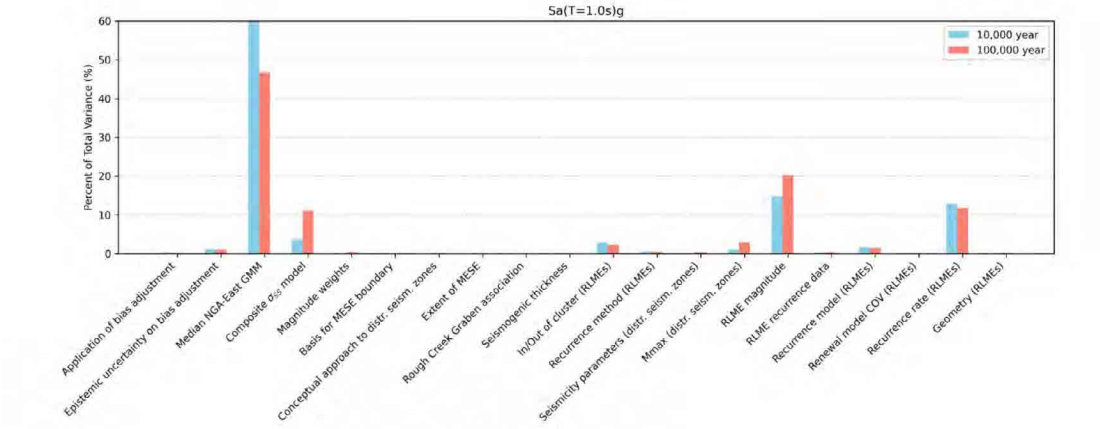
(a)



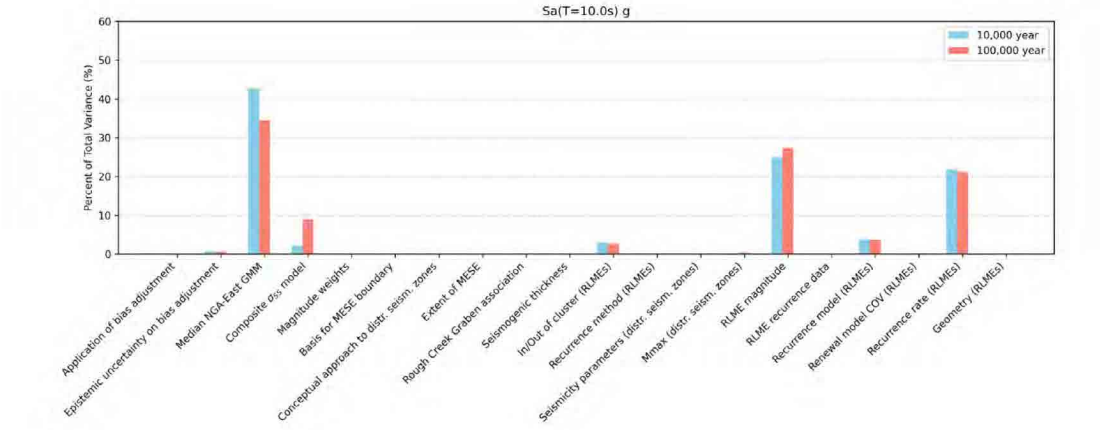
(b)

Key: AFE = annual frequency of exceedance; g = acceleration of gravity; GMM = ground motion model; Hz = hertz; MESE = Mesozoic and younger extended crust; NGA = Next Generation Attenuation; s = second; RLME = repeated large-magnitude earthquake; Sa = spectral acceleration; T= spectral period

Figure 2.5-64
Variance Histogram for AFE 1E-4 (10,000 Years Return Period) and AFE 1E-5 (100,000 Years Return Period) for: (a) 1 Hz (1 Sec.) Spectral Acceleration; (b) 0.1 Hz (10 Sec.) Spectral Acceleration



(a)



(b)

Key: AFE = annual frequency of exceedance; g = acceleration of gravity; GMM = ground motion model; Hz = hertz; MESE = Mesozoic and younger extended crust; NGA = Next Generation Attenuation; sec. = second; RLME = repeated large-magnitude earthquake; Sa = spectral acceleration; T= spectral period

Figure 2.5-65
Stratigraphic Cross Section of All Plant Complexes with Final Grade Pad Elevation and Reactor Base Elevations

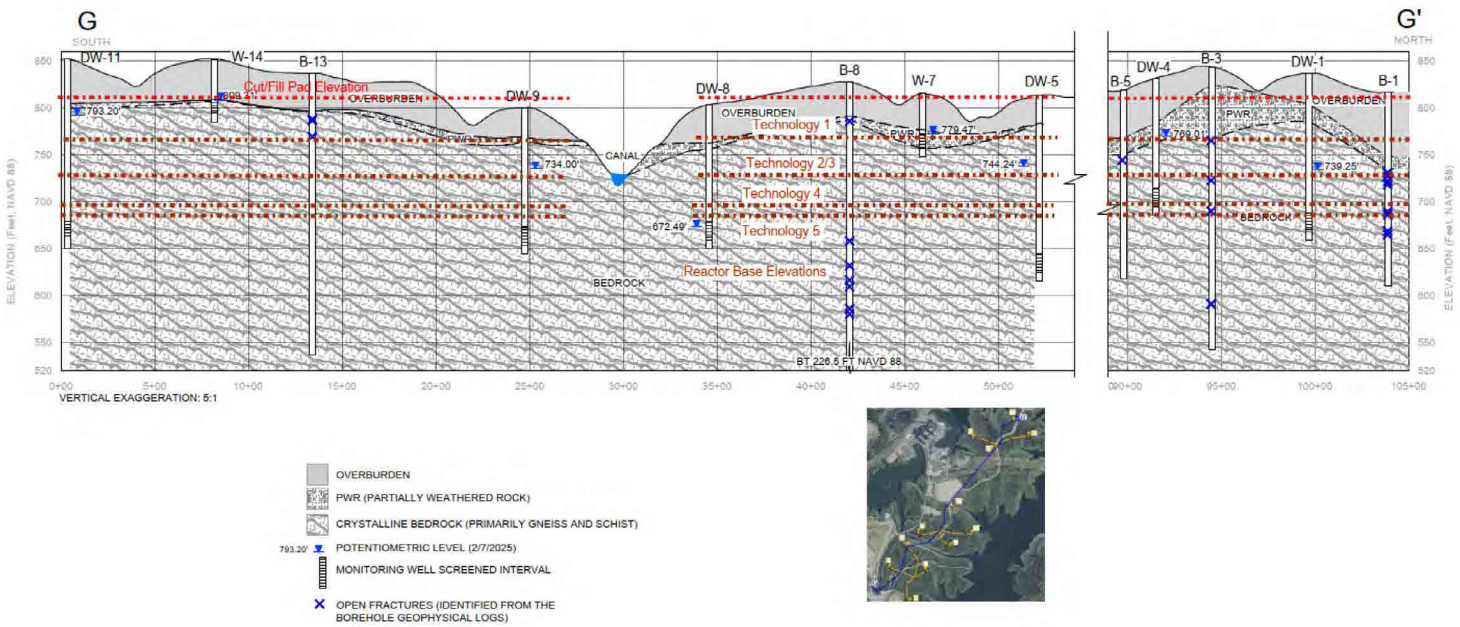
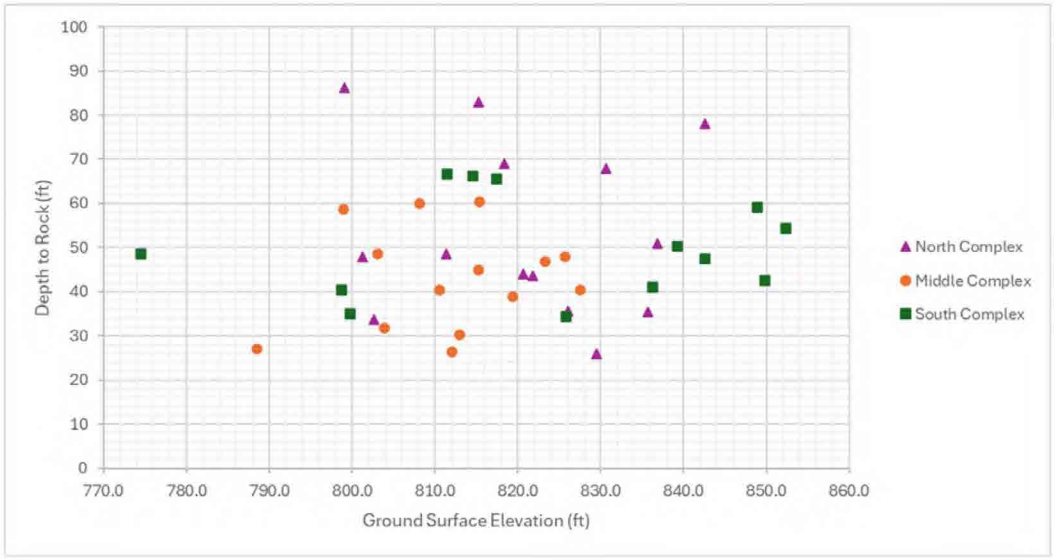
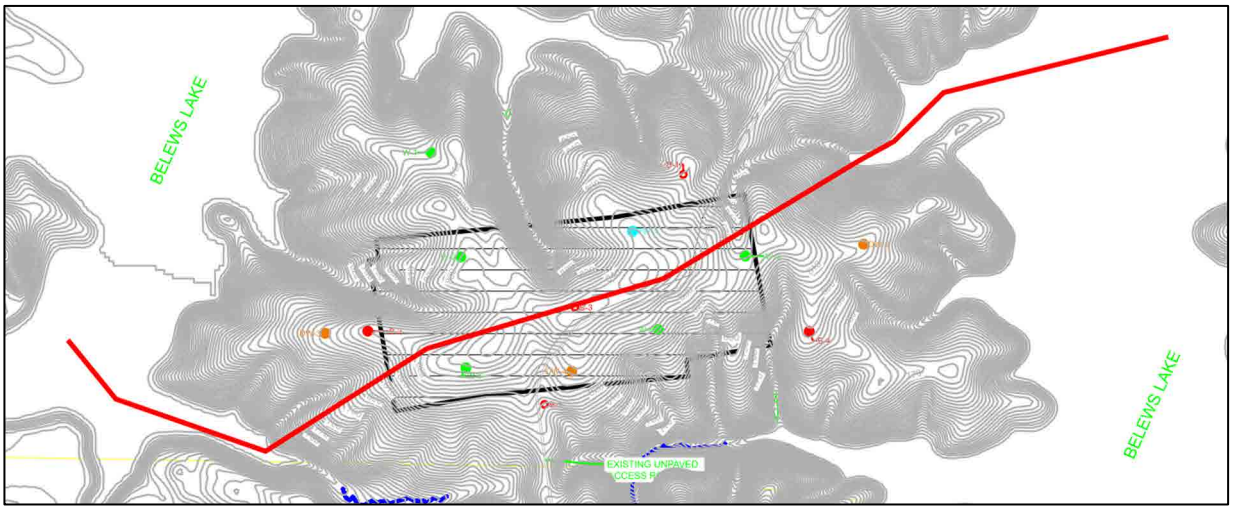


Figure 2.5-66
Depth to Bedrock Versus Ground Surface Elevation Across the Project Site

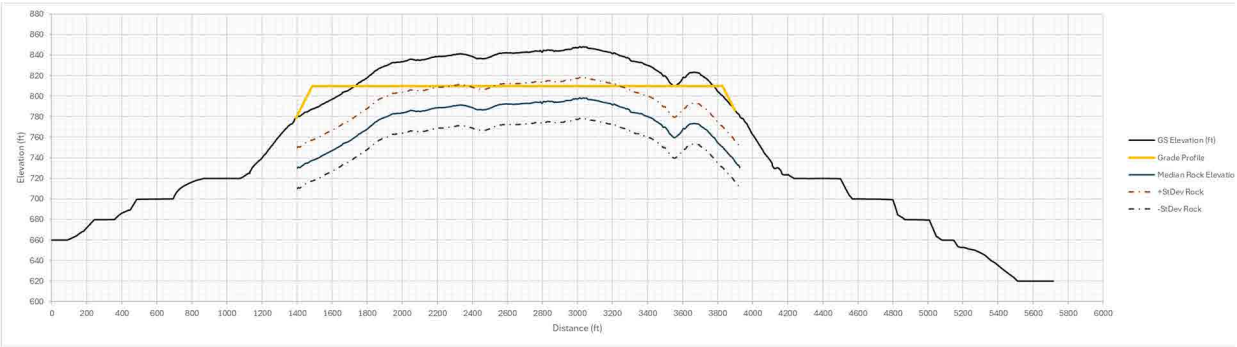


Key: ft. = feet

Figure 2.5-67
Topographic Profile Indicating the Planned Finished Grade Elevation (Yellow) and the Variation of Top of Bedrock Elevation in the North Plant Complex; (a) Location of Profile; (b) Topographic Profile



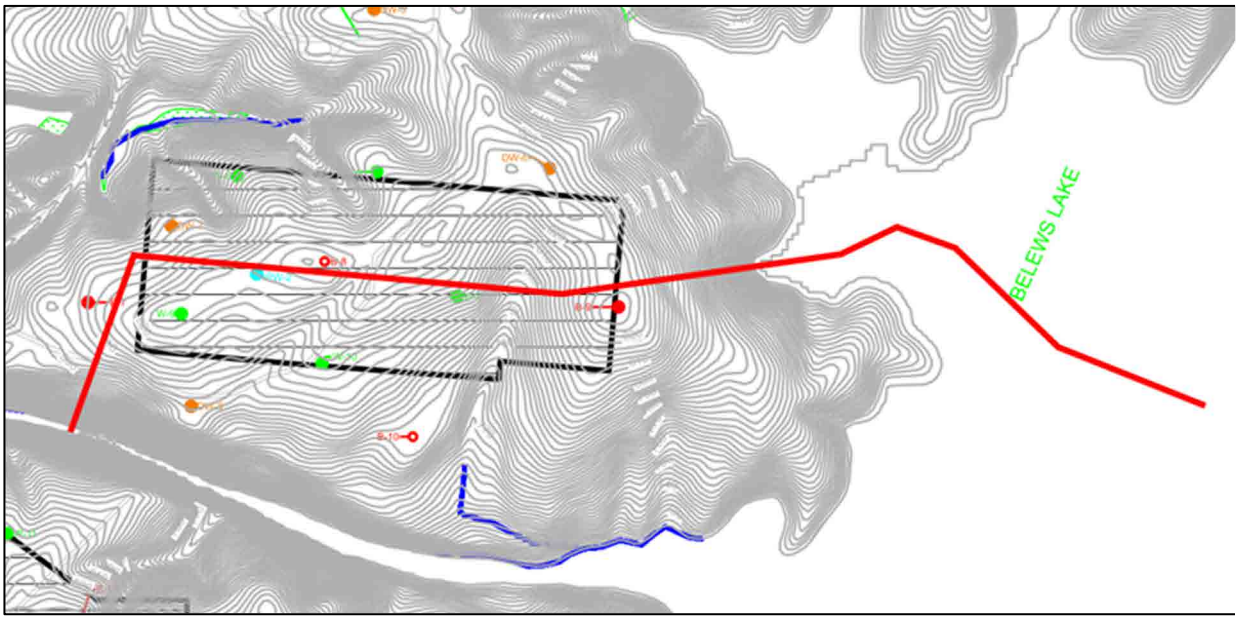
(a)



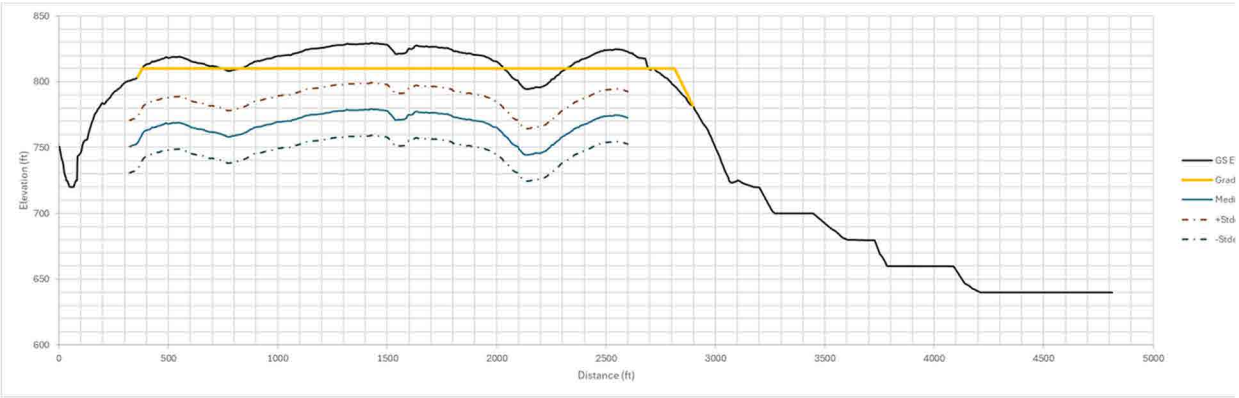
(b)

Key: ft. = feet

Figure 2.5-68
Topographic Profile Indicating the Planned Finished Grade Elevation (Yellow) and the Variation of Top of Bedrock Elevation in the Middle Plant Complex: (a) Location of Profile; (b) Topographic Profile



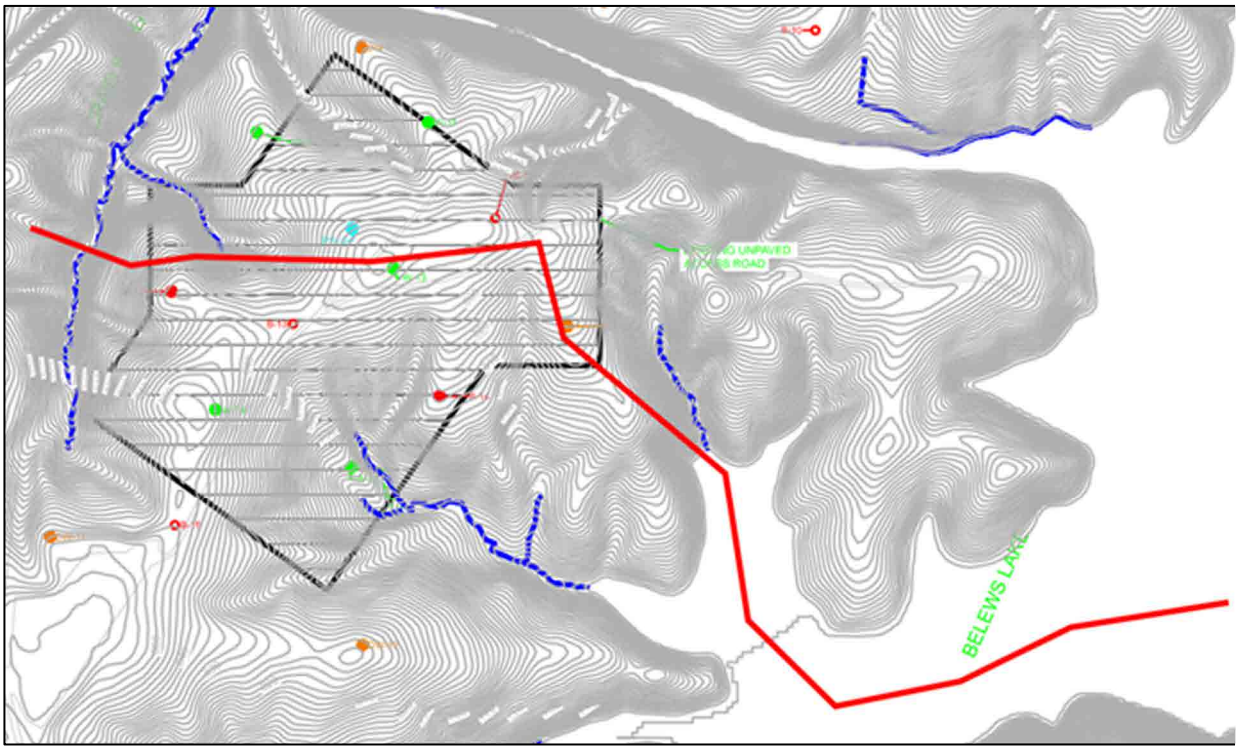
(a)



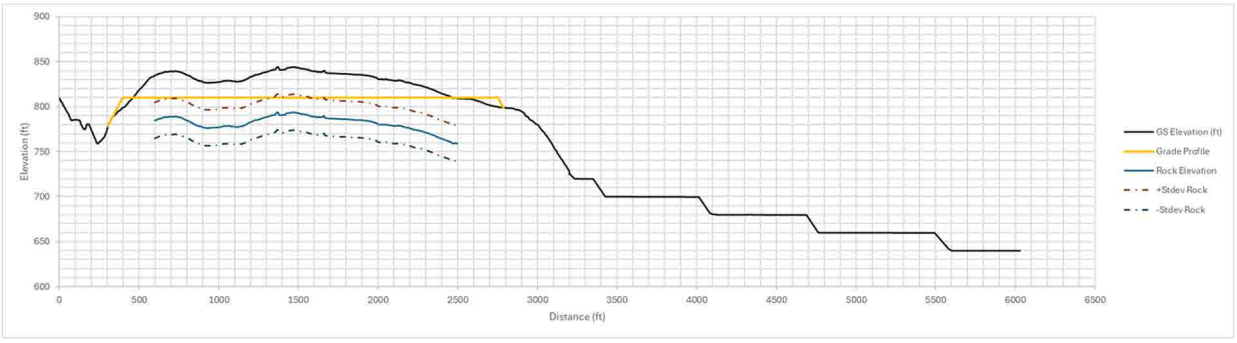
(b)

Key: ft. = feet

Figure 2.5-69
Topographic Profile Indicating the Planned Finished Grade Elevation (Yellow) and the Variation of Top of Bedrock Elevation in the South Plant Complex: (a) Location of Profile; (b) Topographic Profile



(a)



(b)

Key: ft. = feet

Figure 2.5-70
Topographic Map Showing the Safety-Related Area (Black) within the North Plant Complex and the Three Areas Selected for Site Response Analyses (Red)

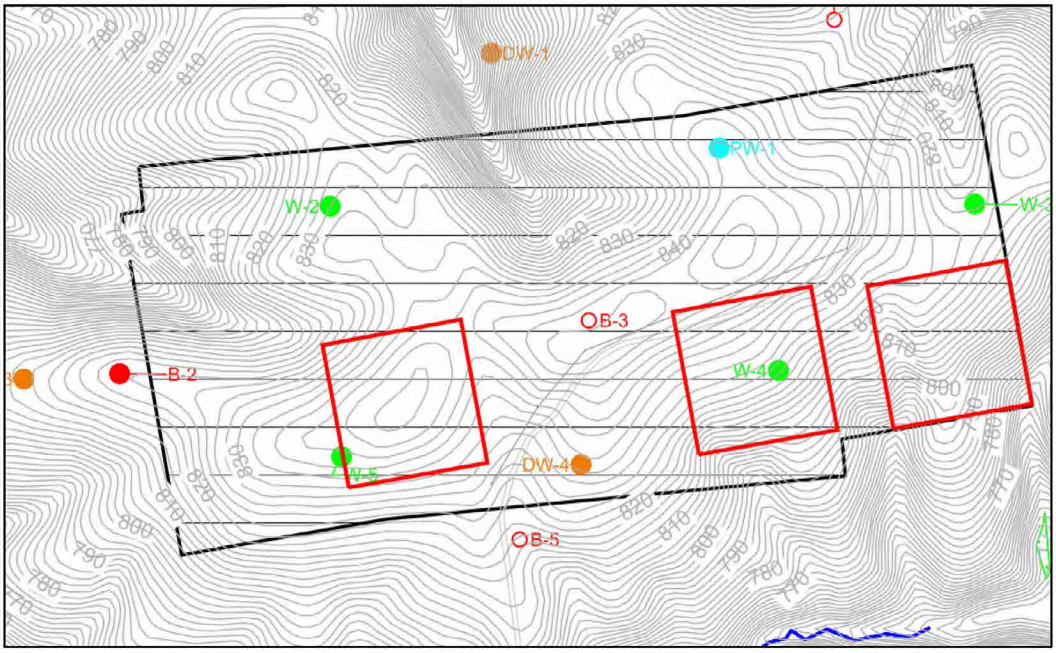
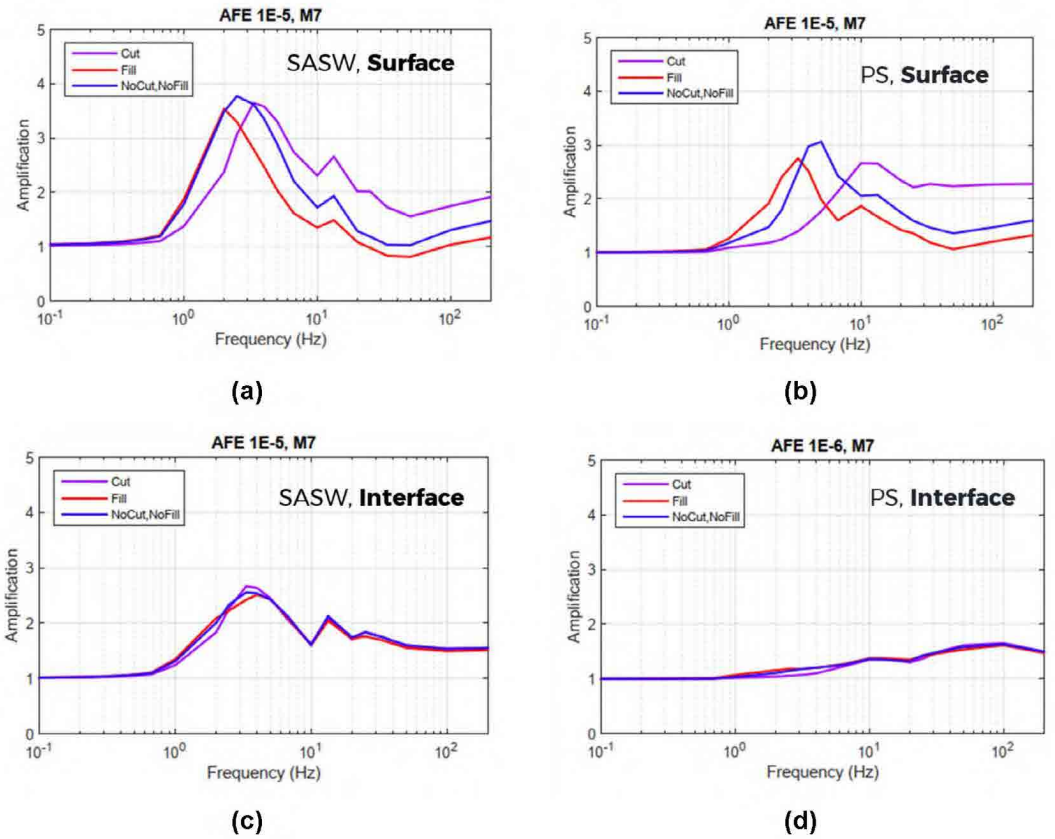


Figure 2.5-71
Comparison of Site Amplification Functions to Evaluate Differences Between Different Site Grading Cases



Key: AFE = annual frequency of exceedance; Hz = hertz; **M** = magnitude; SASW = Spectral Analysis of Surface Waves

Figure 2.5-72
Topographic Map Showing the Safety-Related Area (Black) within the Middle Plant Complex and the Three Areas Selected for Site Response Analyses (Red)

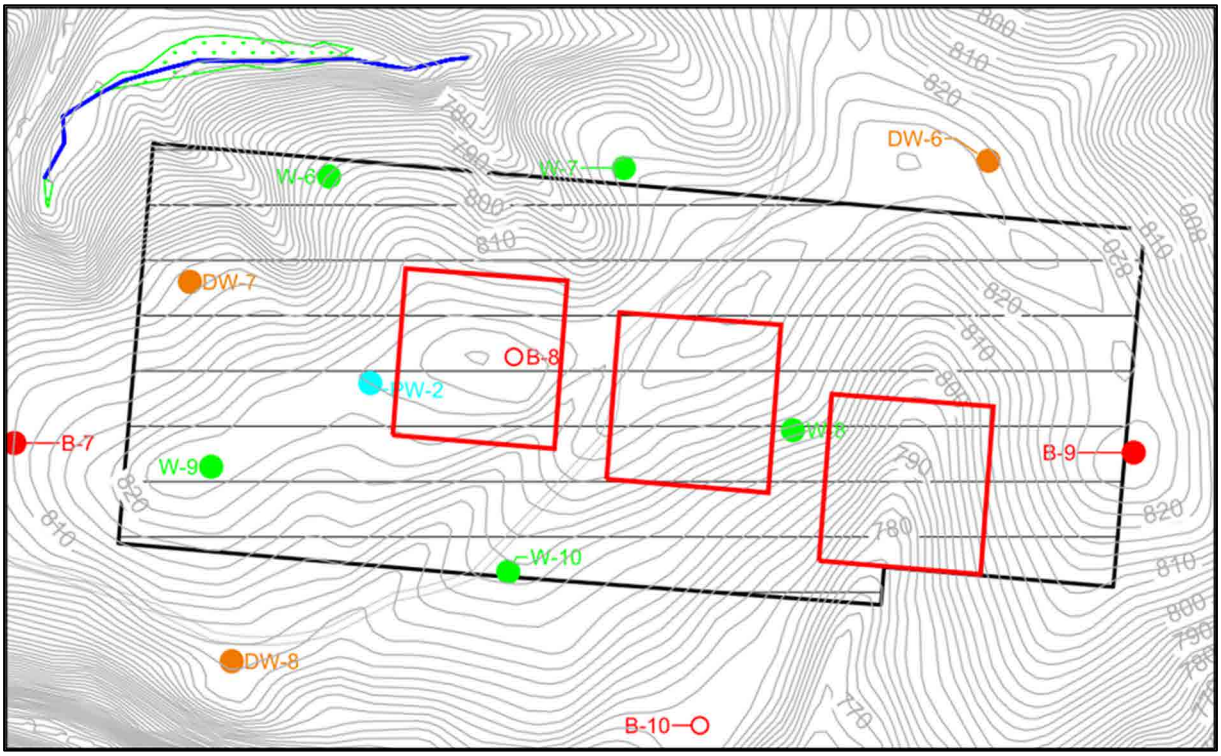


Figure 2.5-73
Topographic Map Showing the Safety-Related Area (Black) within the South Plant Complex and the Five Areas Selected for Site Response Analyses (Red)

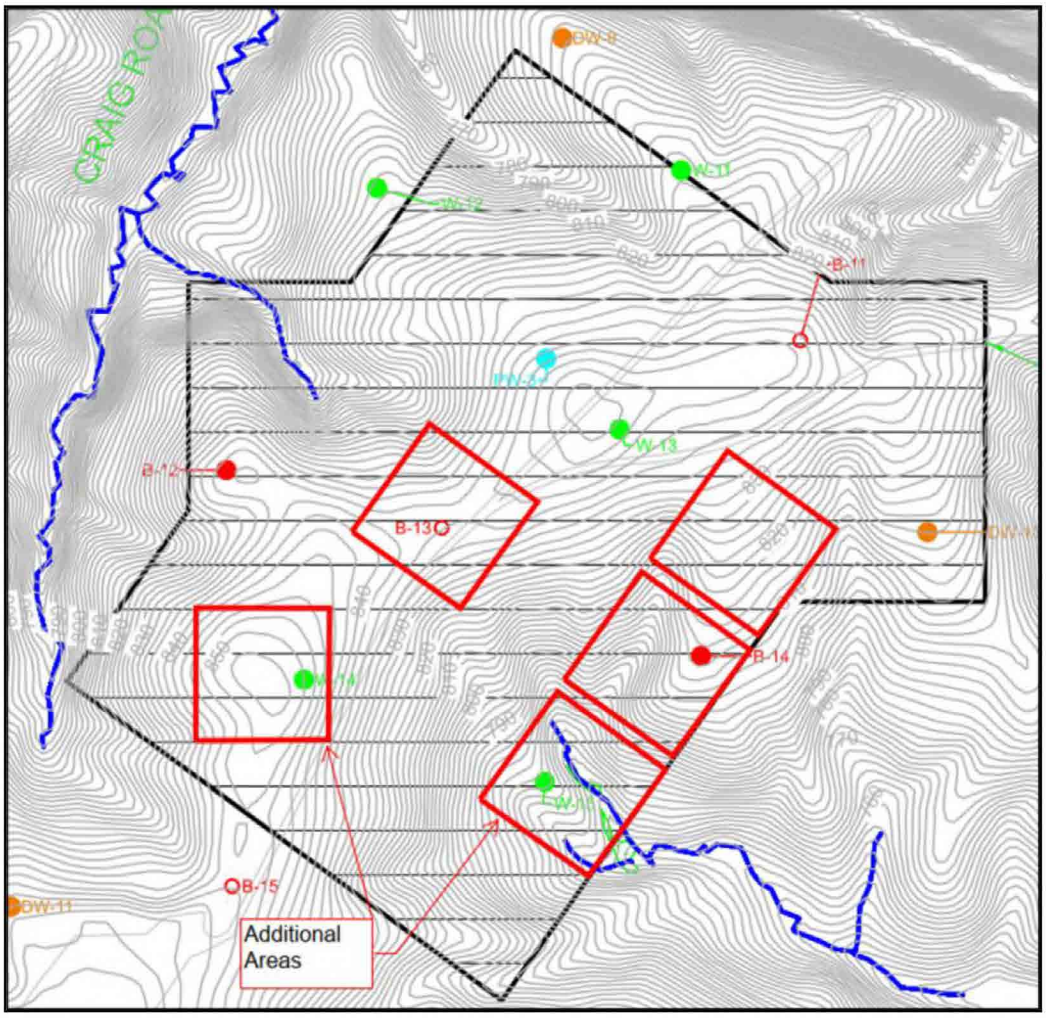
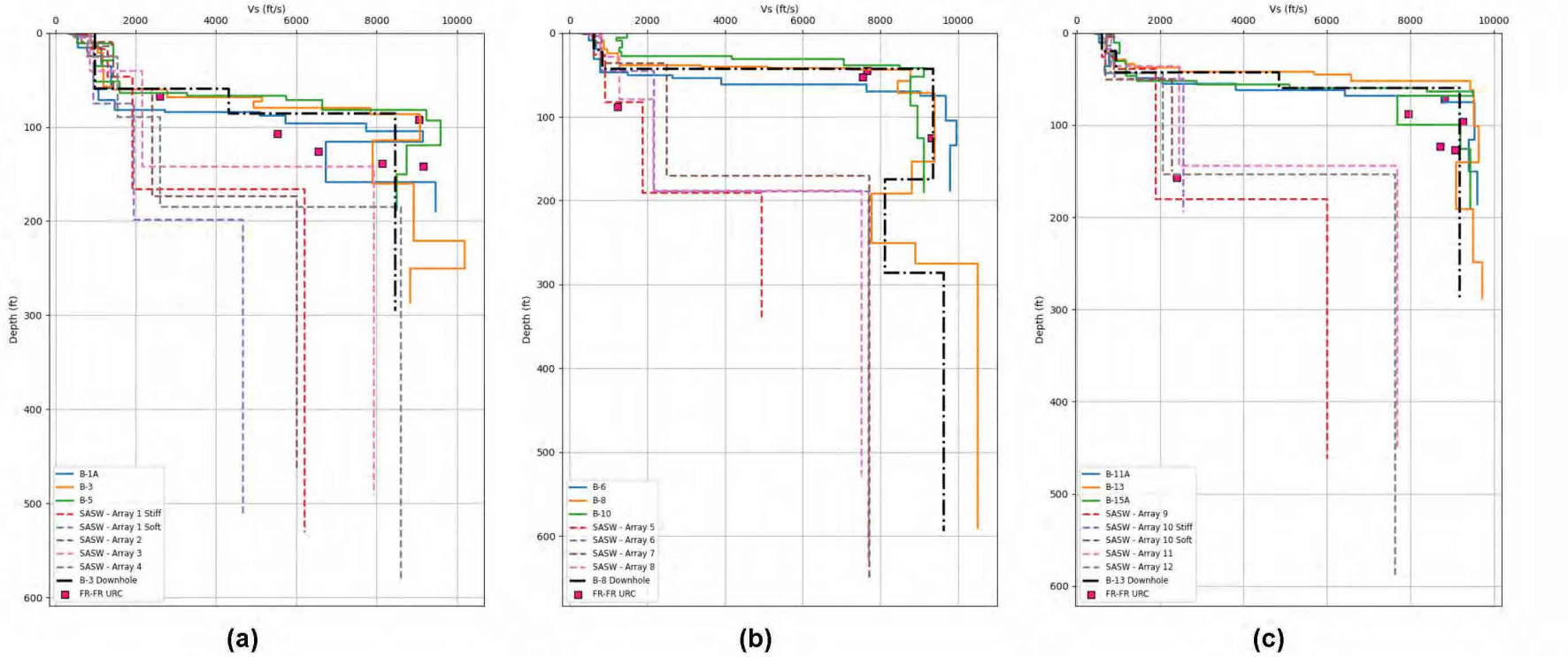
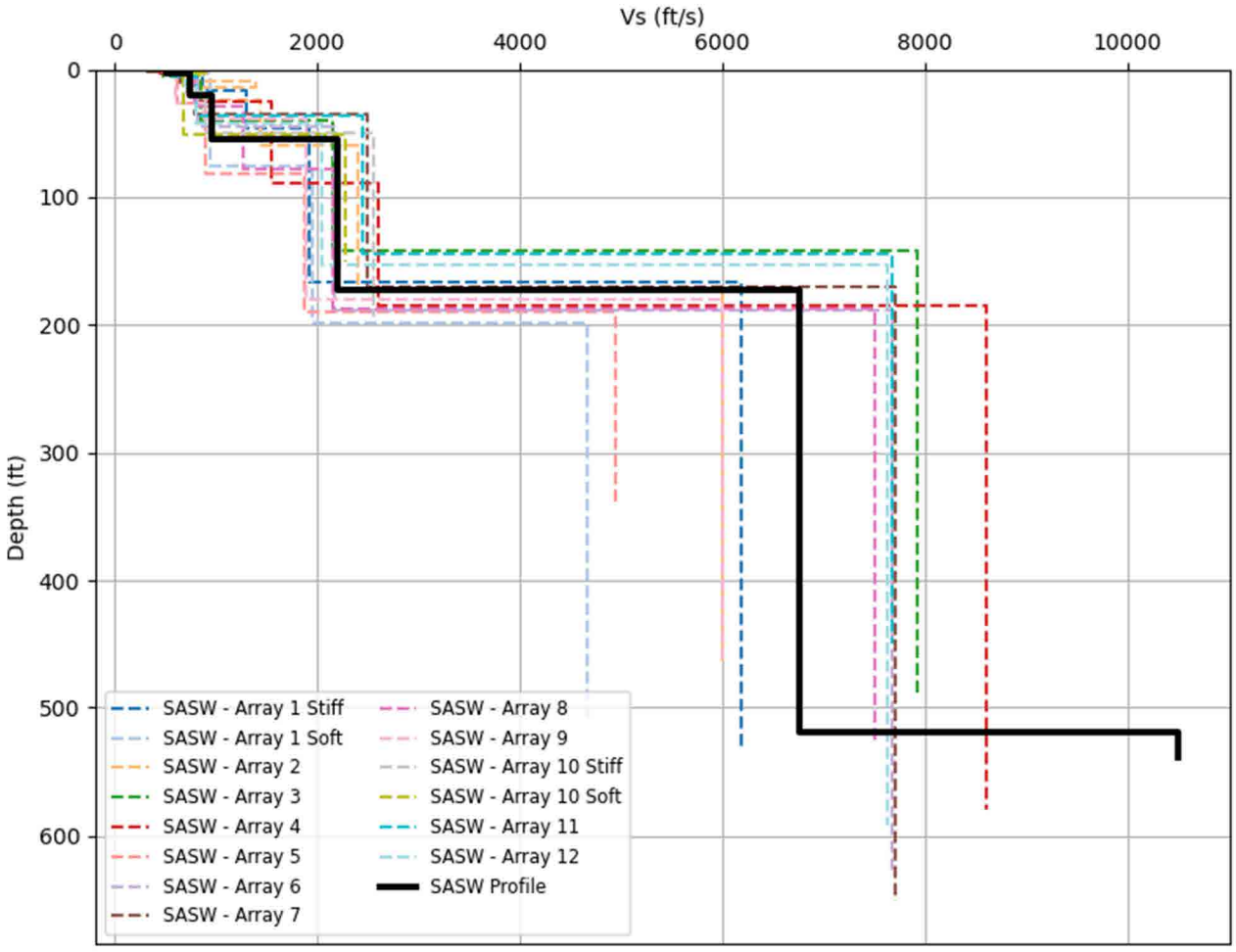


Figure 2.5-74
Shear Wave Velocity Profiles from Different Data Sets: (a) North Plant Complex; (b) Middle Plant Complex; (c) South Plant Complex



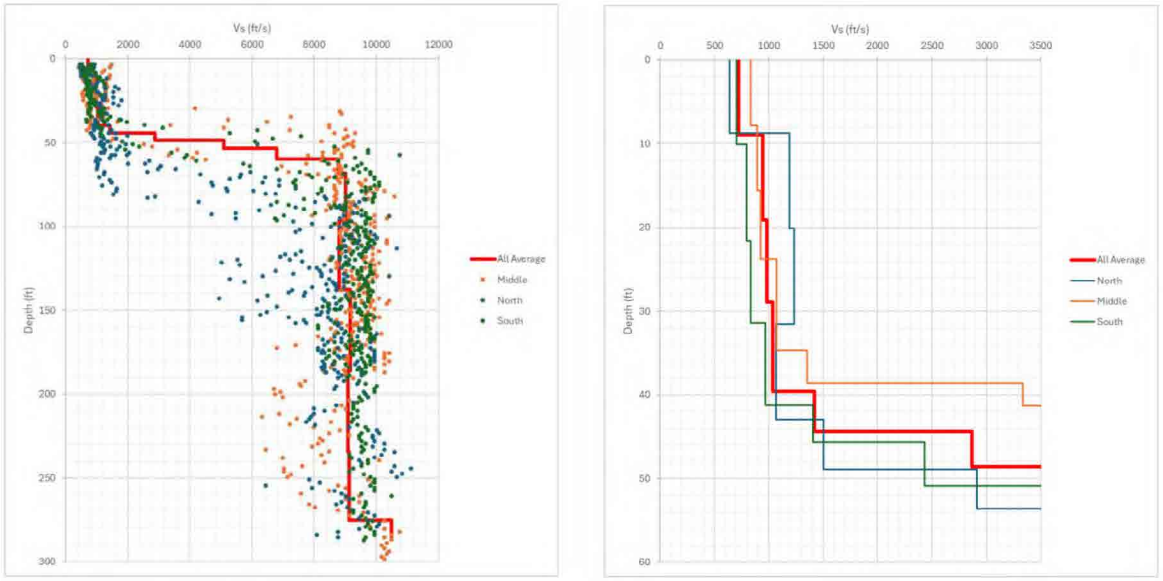
Key: FR-FR = free-free; ft. = feet; ft/s = feet per second; SASW = Spectral Analysis of Surface Waves; V_S = shear wave velocity

Figure 2.5-75
SASW Velocity Profiles



Key: ft = feet; ft/s = feet per second; SASW = Spectral Analysis of Surface Waves; V_S = shear wave velocity

Figure 2.5-76
Suspension Log Velocity Profiles



(a) **(b)**

Key: ft. = feet; ft/s = feet per second; V_S = shear wave velocity

Figure 2.5-77
Evaluation of Differences in Site Amplification Between the Middle and the North Complex

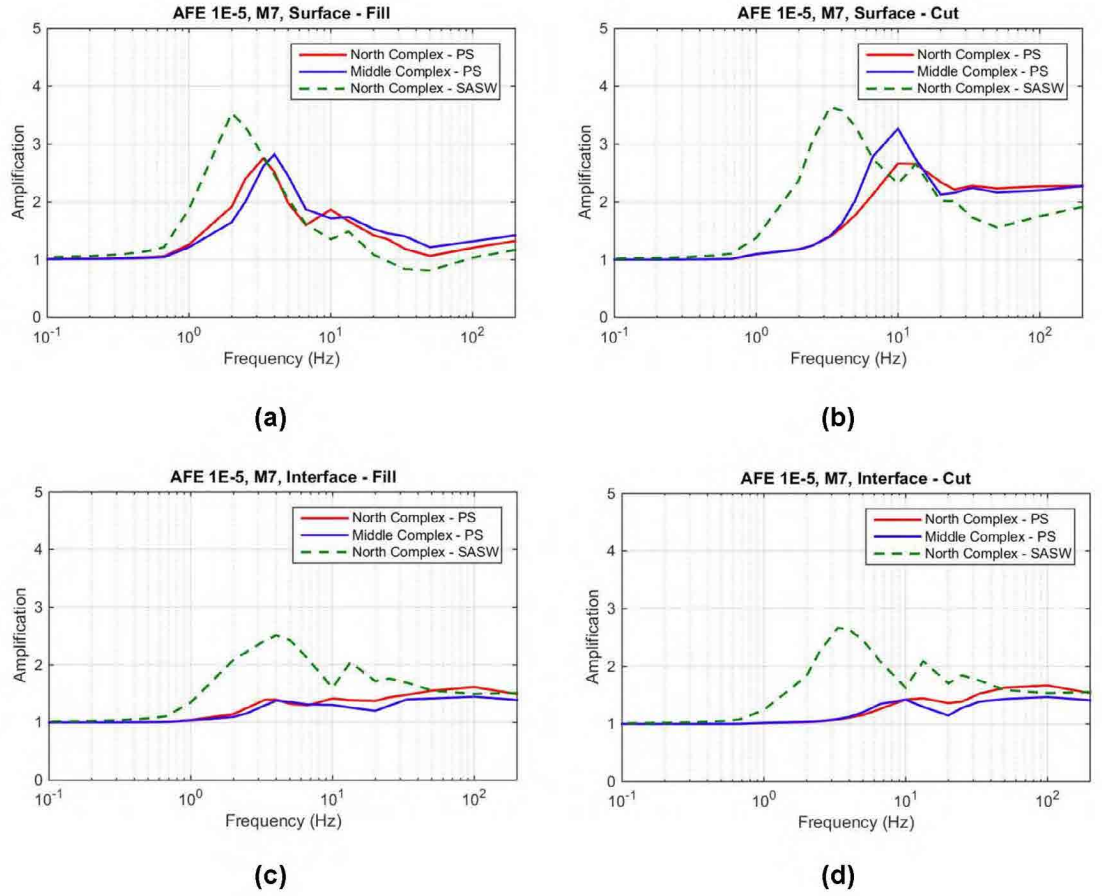
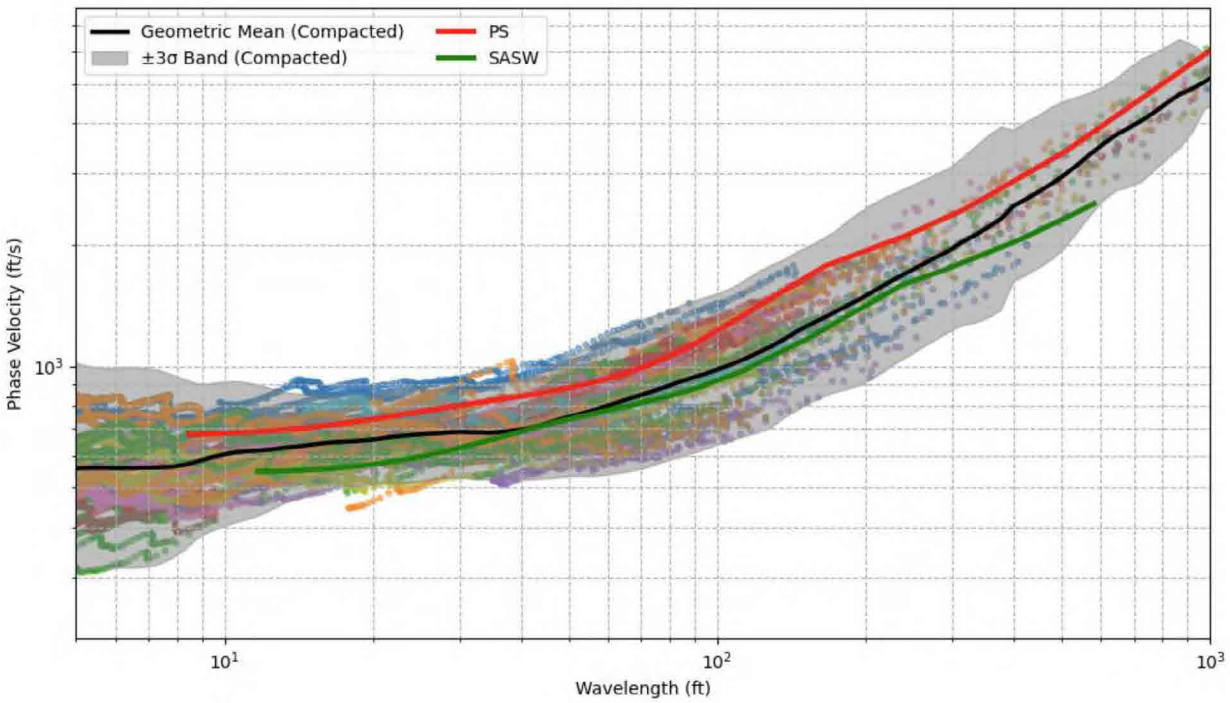
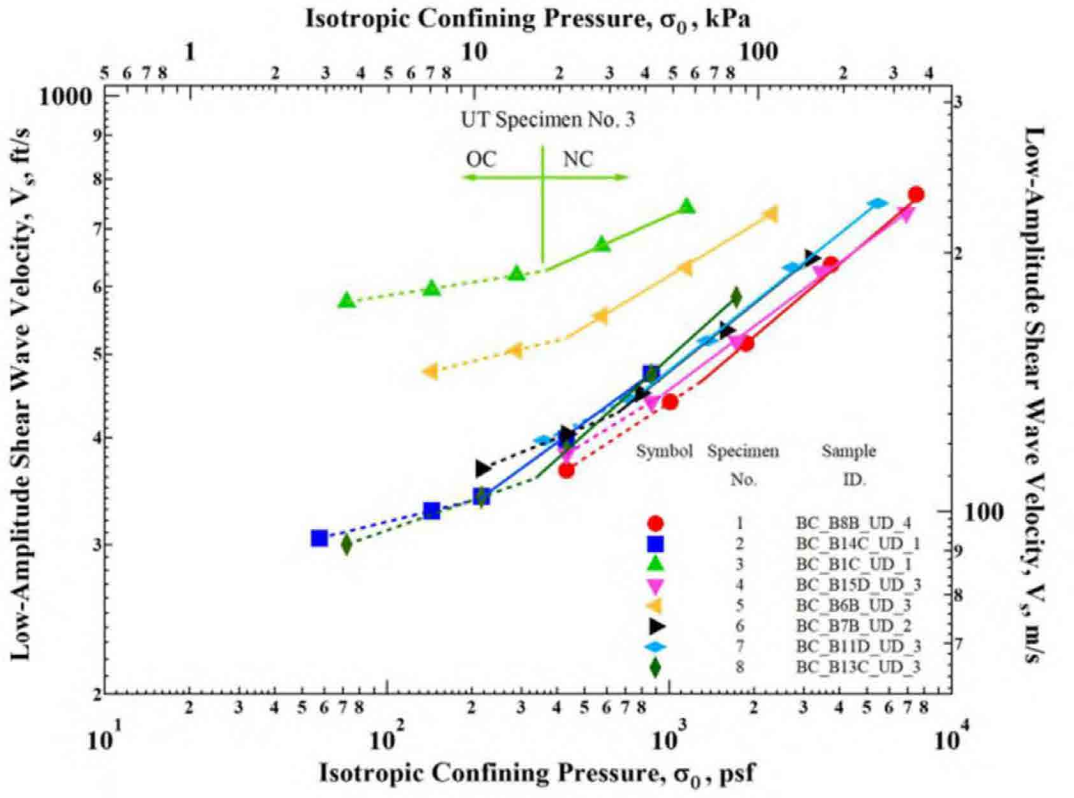


Figure 2.5-78
Comparison of Experimental Dispersion Curves (Points), Three Sigma Bounds of Dispersion Curve Data, and the Dispersion Curves of the Suspension Log (Red Line) and SASW Profiles (Green Line)



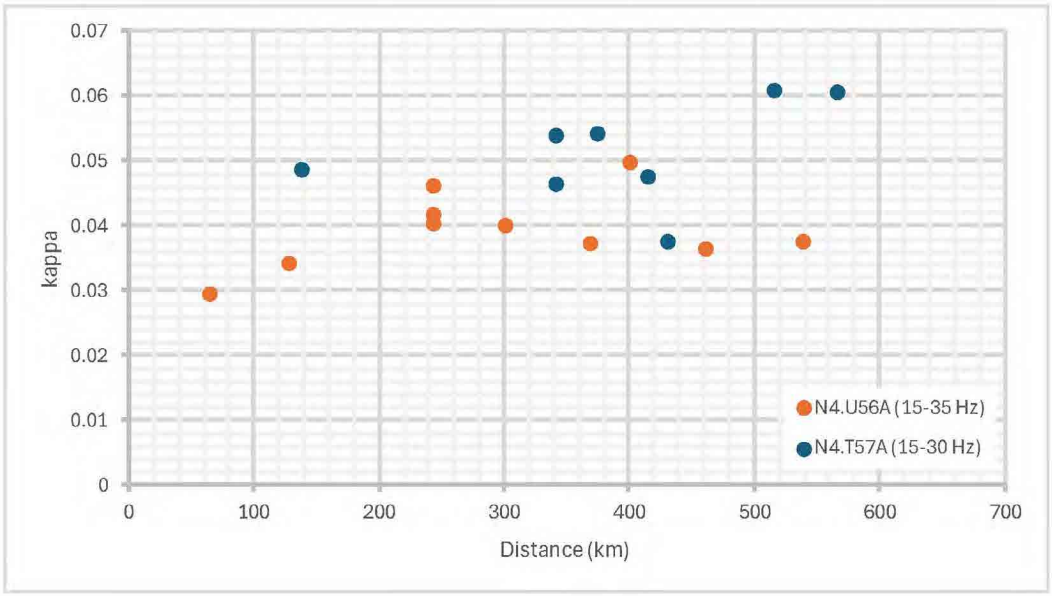
Key: ft. = feet; ft/s = feet per second; SASW = spectral analysis of surface waves

Figure 2.5-79
Variation in Small-Strain Shear Modulus with Total Isotropic Confining Pressure of the Eight Soil Specimens as Determined from Resonant Column Testing



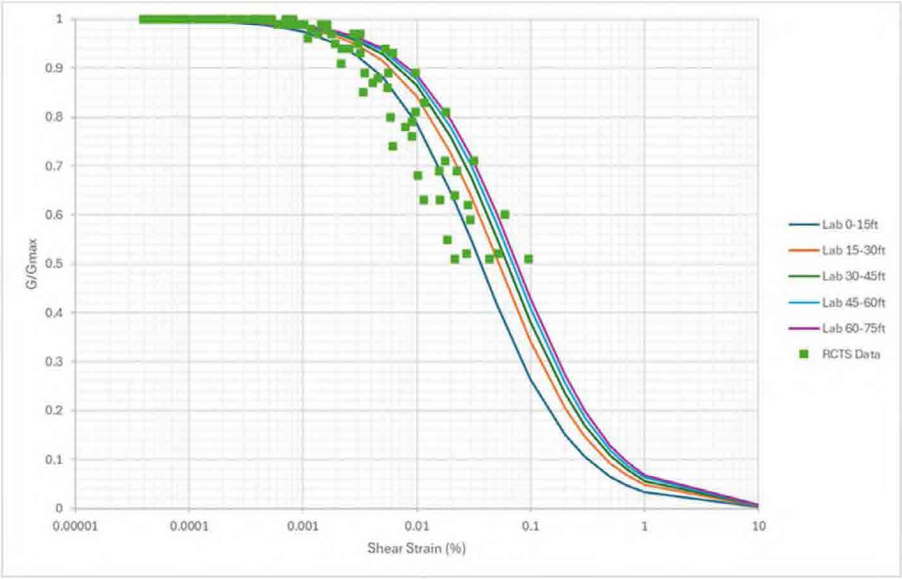
Key: ft/s = feet per second; kPa = kilopascals; m/s = meters per second; psf = pounds per square foot

Figure 2.5-80
Calculated Kappa Values (Average of Two Horizontal Components) for Stations N4.U56A and N4.T57A

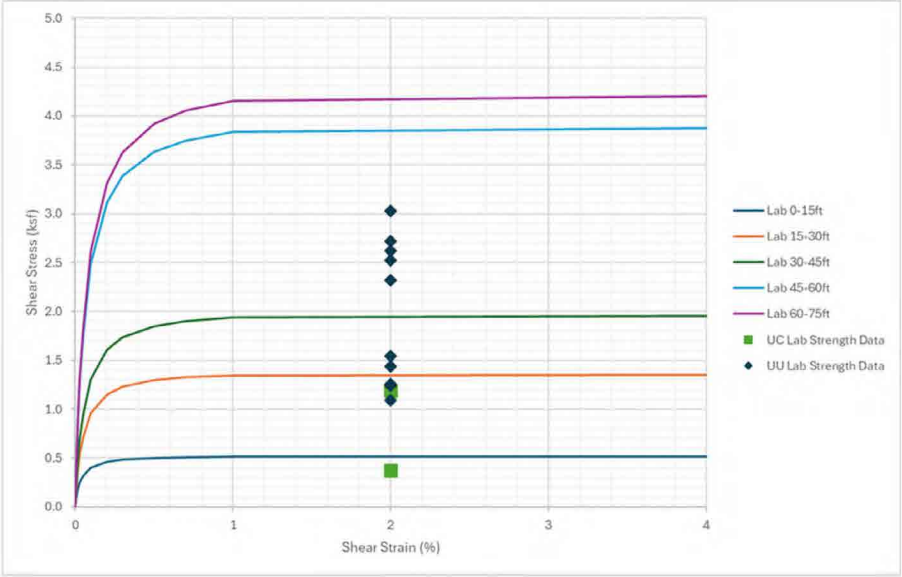


Key: Hz = hertz; km = kilometer

Figure 2.5-81
Lab-Derived Modulus Reduction Curves for
Residual Soils (a) and Comparison of Shear Strain and Shear Stress Curves (b)



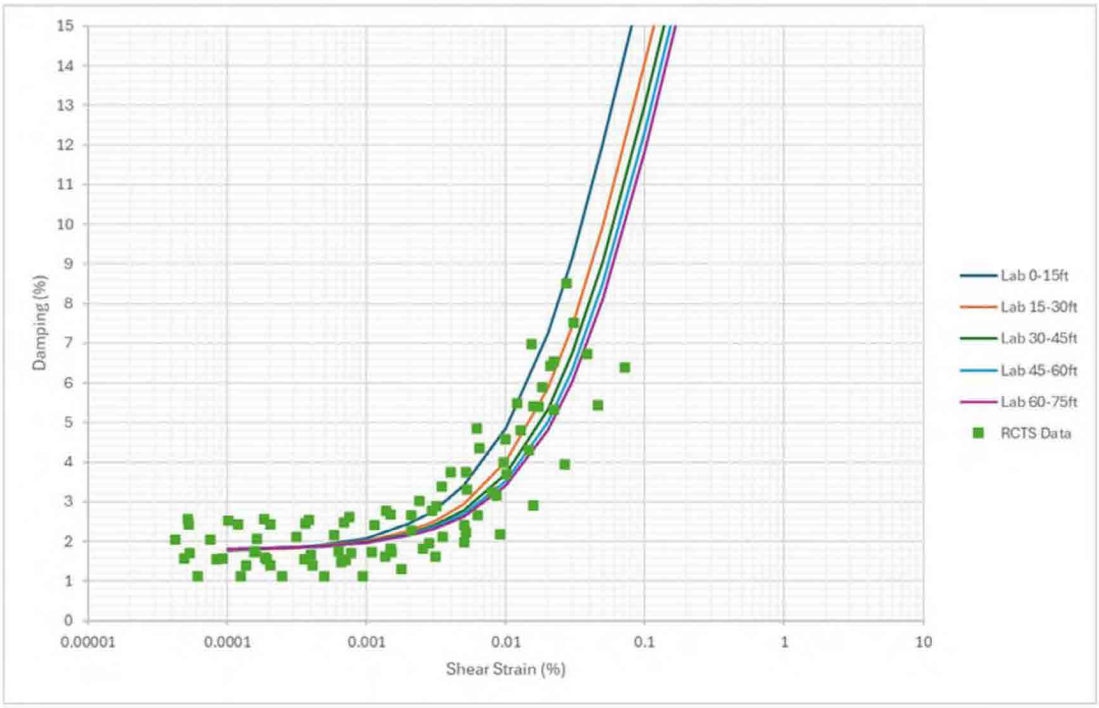
(a)



(b)

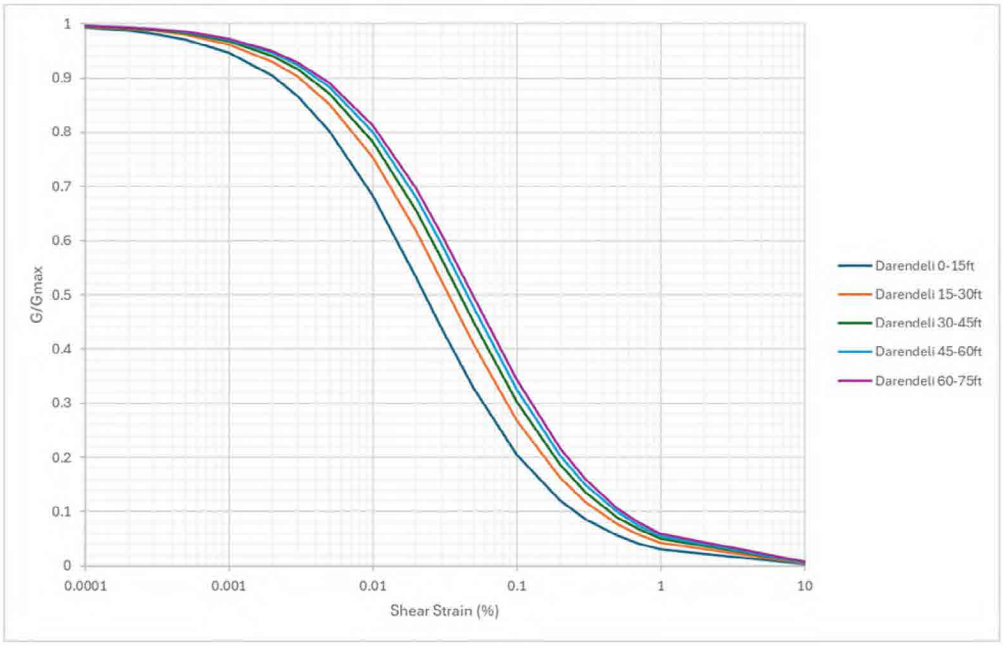
Key: ft. = feet; RCTS = resonant column torsional shear

Figure 2.5-82
Lab-Derived Damping Curves for Residual Soils

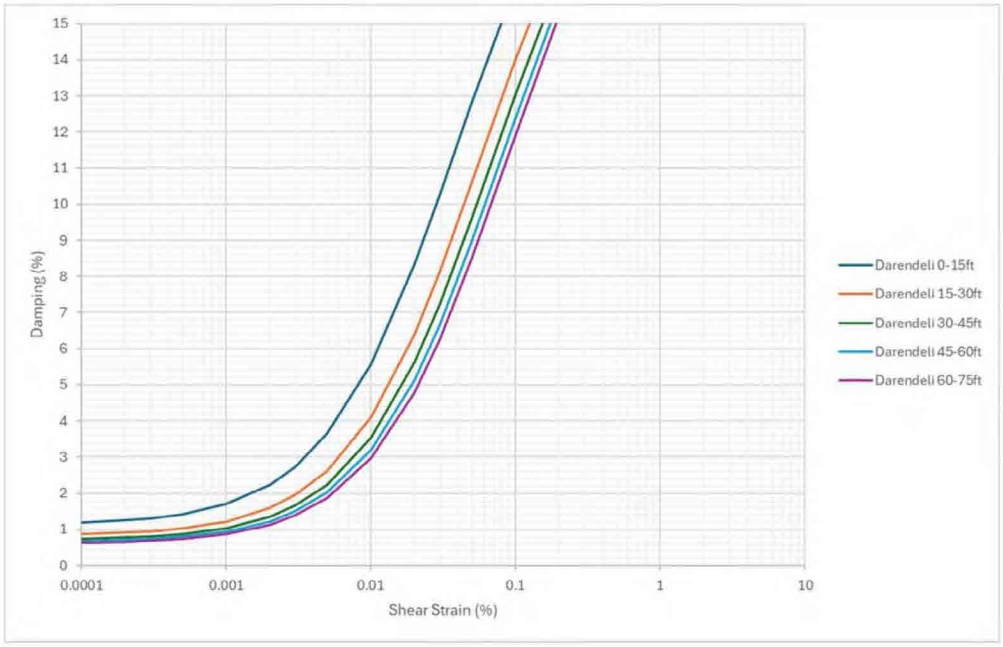


Key: ft. = feet; RCTS = resonant column torsional shear

Figure 2.5-83
Darendeli (2001) Based Modulus Reduction Curves for Residual Soils (a) and Damping Curves (b)



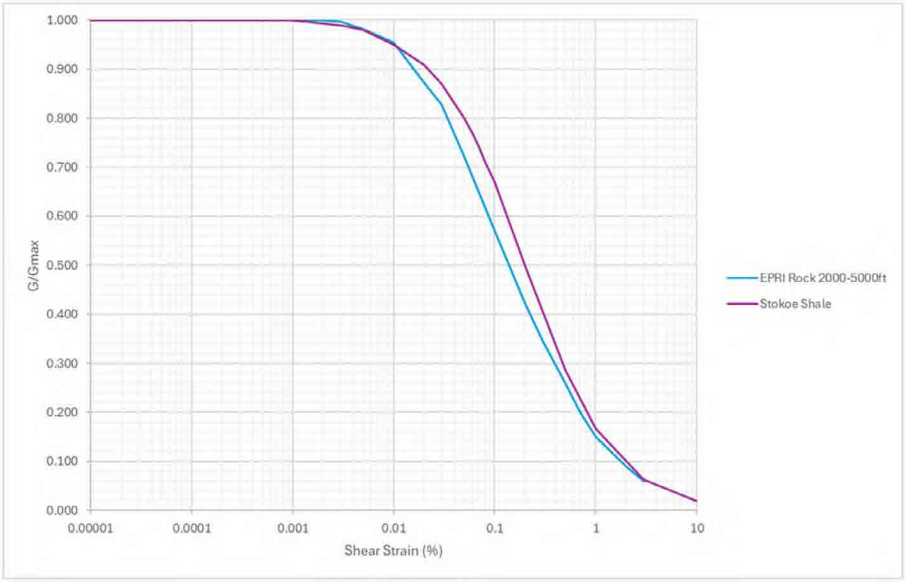
(a)



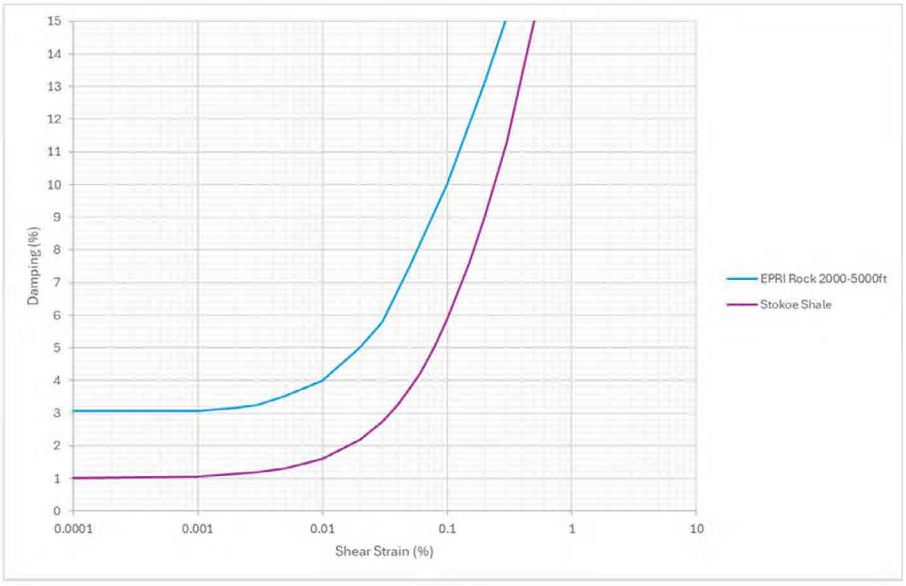
(b)

Key: ft. = feet; G/Gmax = modulus reduction

Figure 2.5-84
Modulus Reduction Curves for Partially Weathered Rock and Rock (a) and Damping Curves (b)



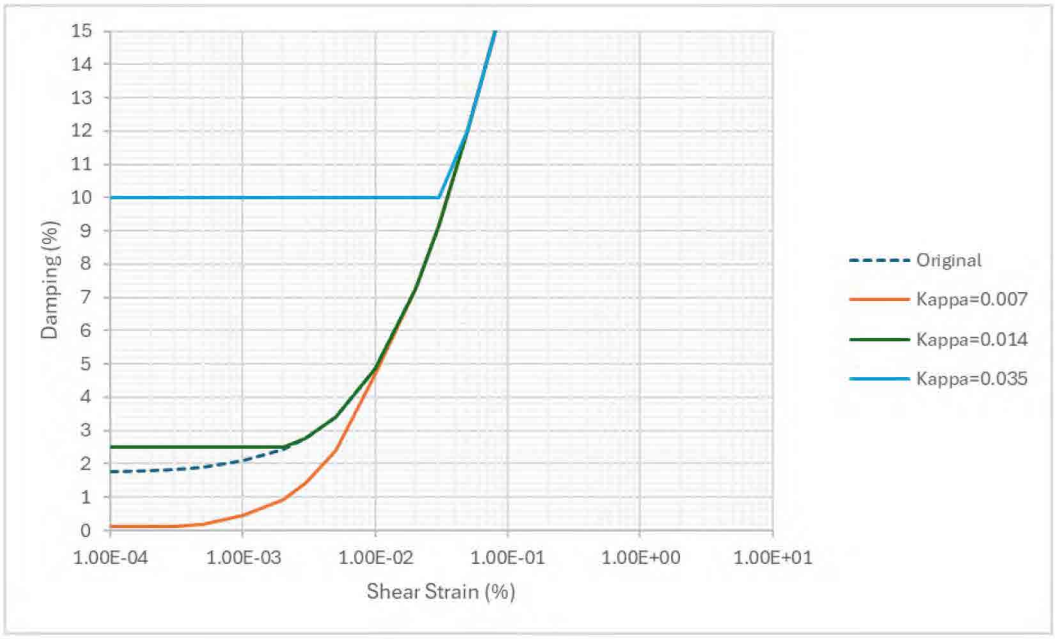
(a)



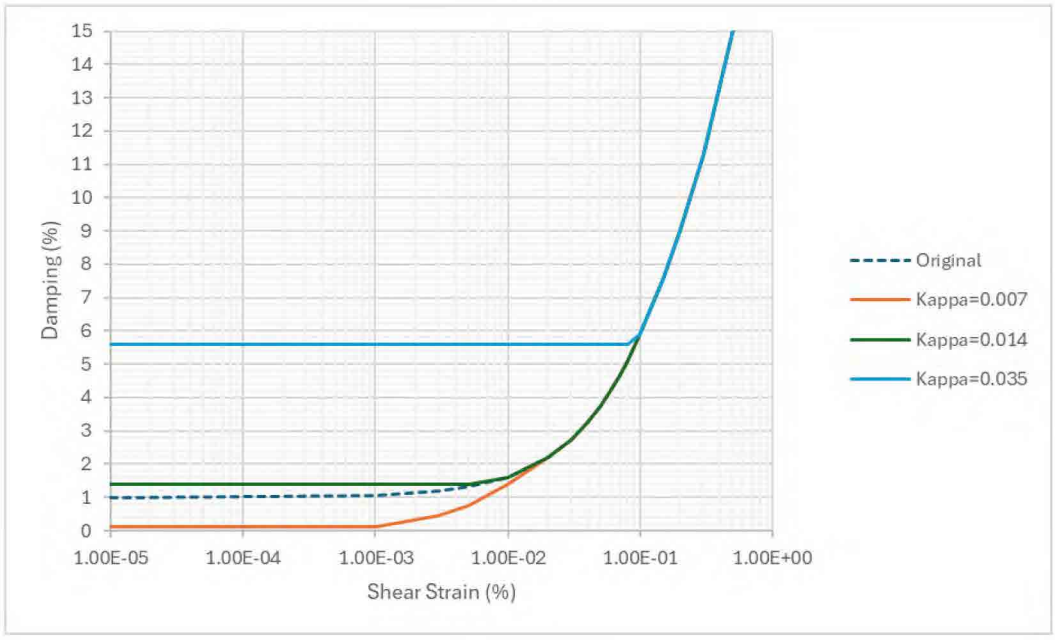
(b)

Key: EPRI = Electric Power Research Institute; G/Gmax = modulus reduction

Figure 2.5-85
Examples of Kappa-Adjusted Damping Curves for: (a) Residual Soil; (b) Partially Weathered Rock

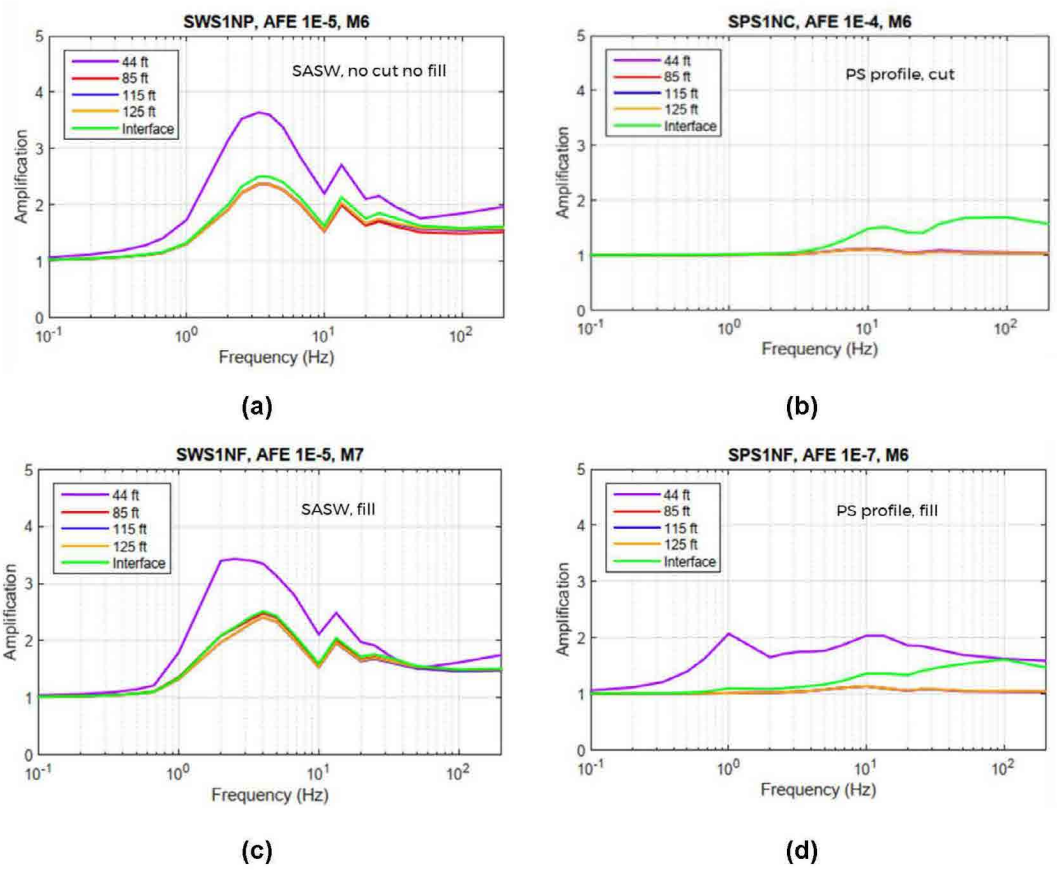


(a)



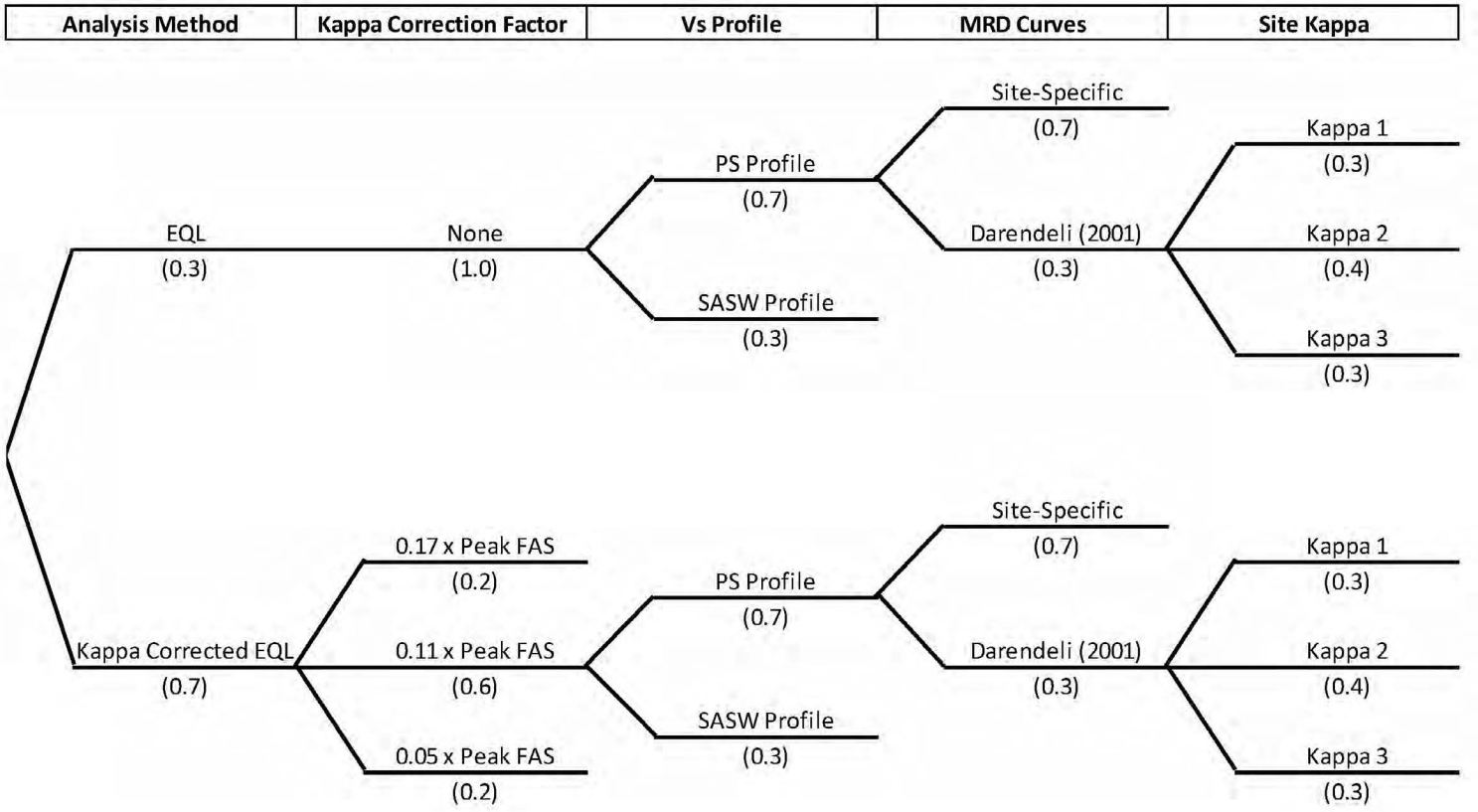
(b)

Figure 2.5-86
Example of Differences in Site Amplification for Alternative Control Point Depths: (a) SASW Profile (No Cut/No Fill); (b) Suspension Log Profile, Cut; (c) SASW Profile, Fill; (d) Suspension Log Profile, Fill



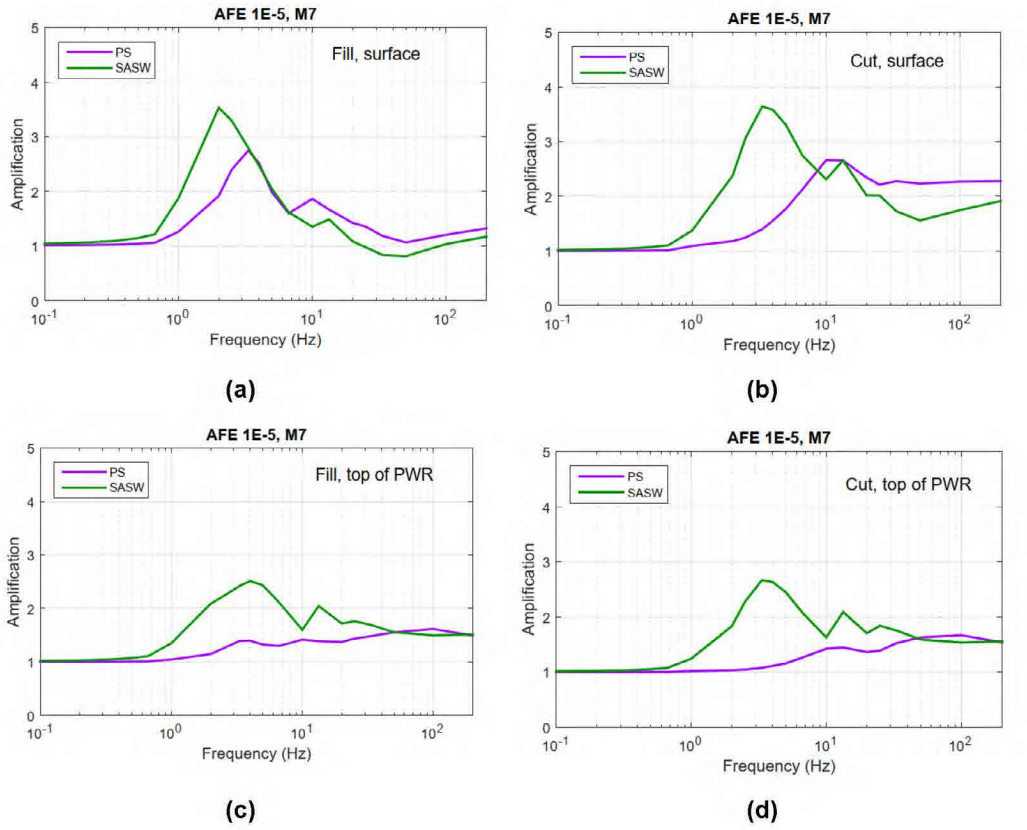
Key: AFE = annual frequency of exceedance; ft = feet; Hz = hertz; **M** = magnitude; SASW = spectral analysis of surface waves

Figure 2.5-87
Logic Tree for Site Response Analysis



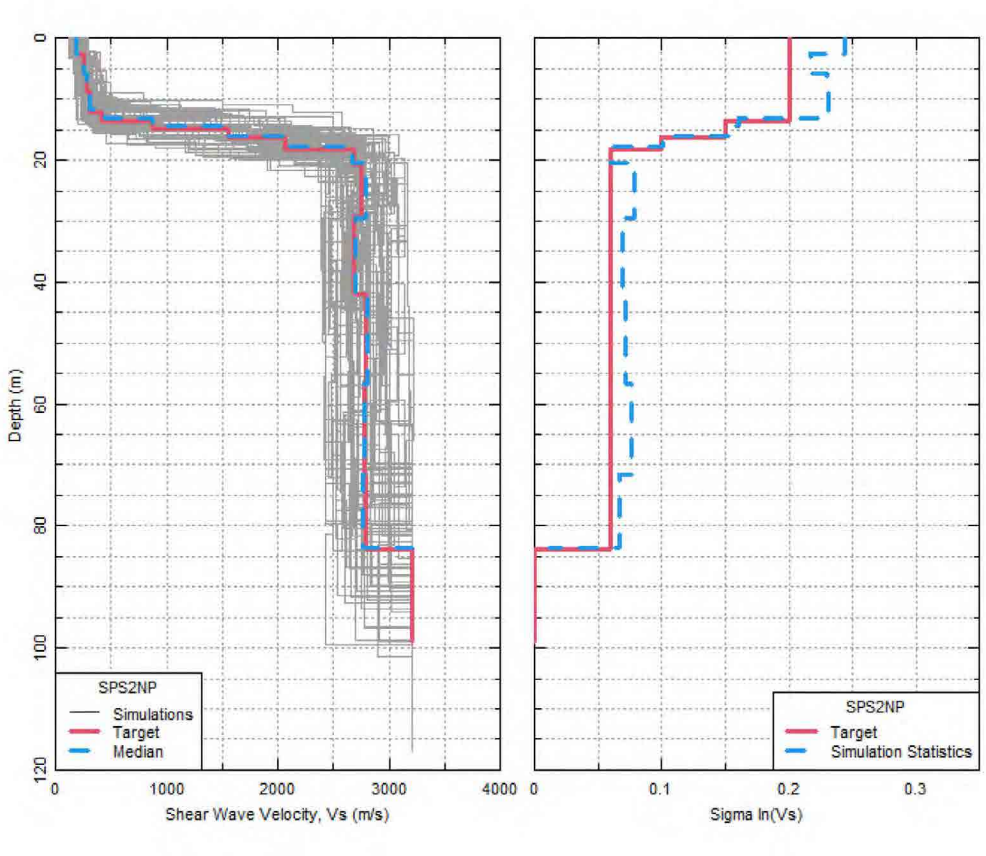
Key: EQL = equivalent linear; FAS = Fourier amplitude spectra; MRD = modulus reduction and damping; SASW = spectral analysis of surface waves; V_S = shear wave velocity

Figure 2.5-88
Sensitivity Analysis to Demonstrate the Effect of Alternative Velocity Profiles on Site Amplification at the Project Site



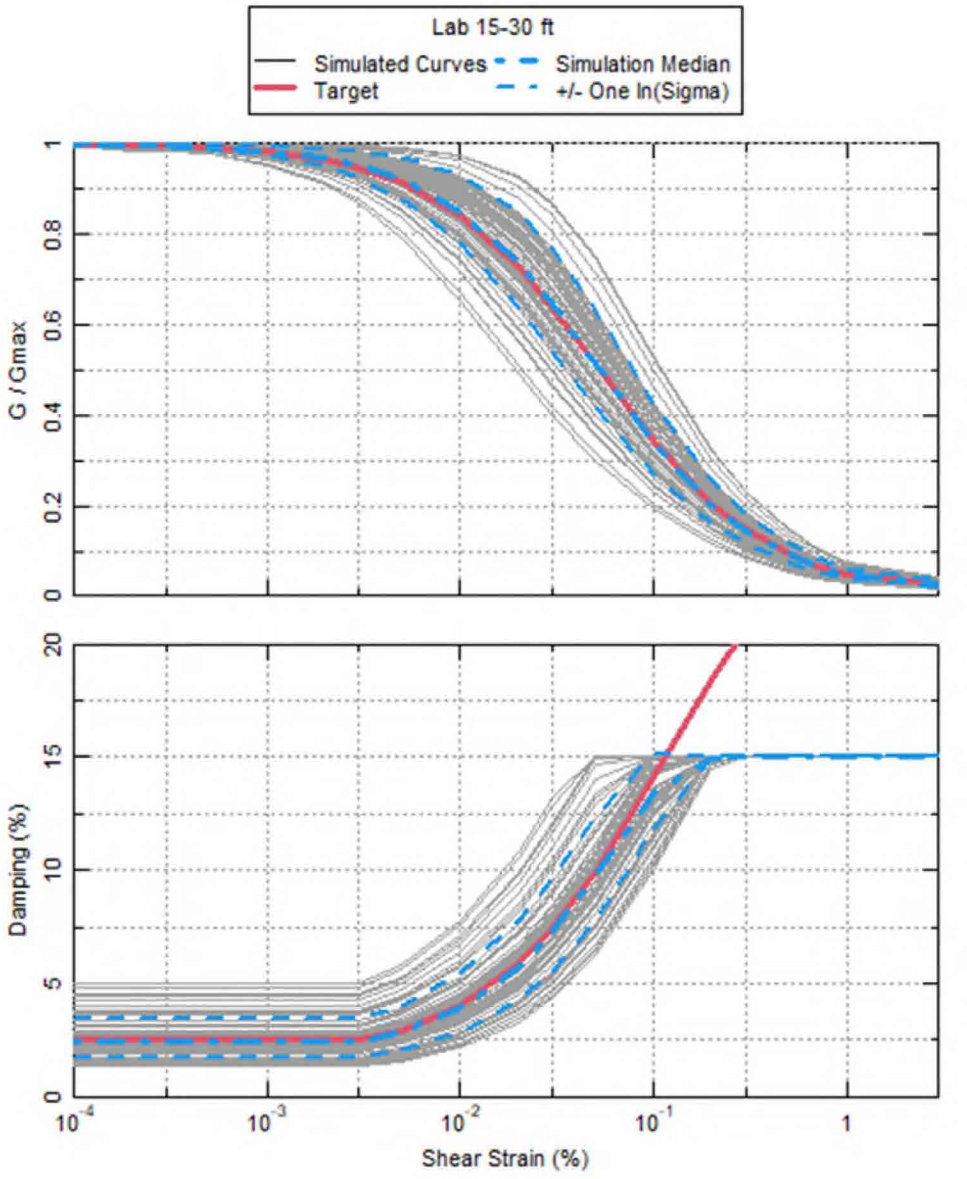
Key: AFE = annual frequency of exceedance; Hz = hertz; **M** = magnitude; PWR = partially weathered rock; SASW = spectral analysis of surface waves

Figure 2.5-89
Randomized V_s Profiles and Standard Deviation of ln(V_s) and Target Values for the Suspension Log Profile, Site-Specific Material Curves, Kappa2 Approach, Before Cut



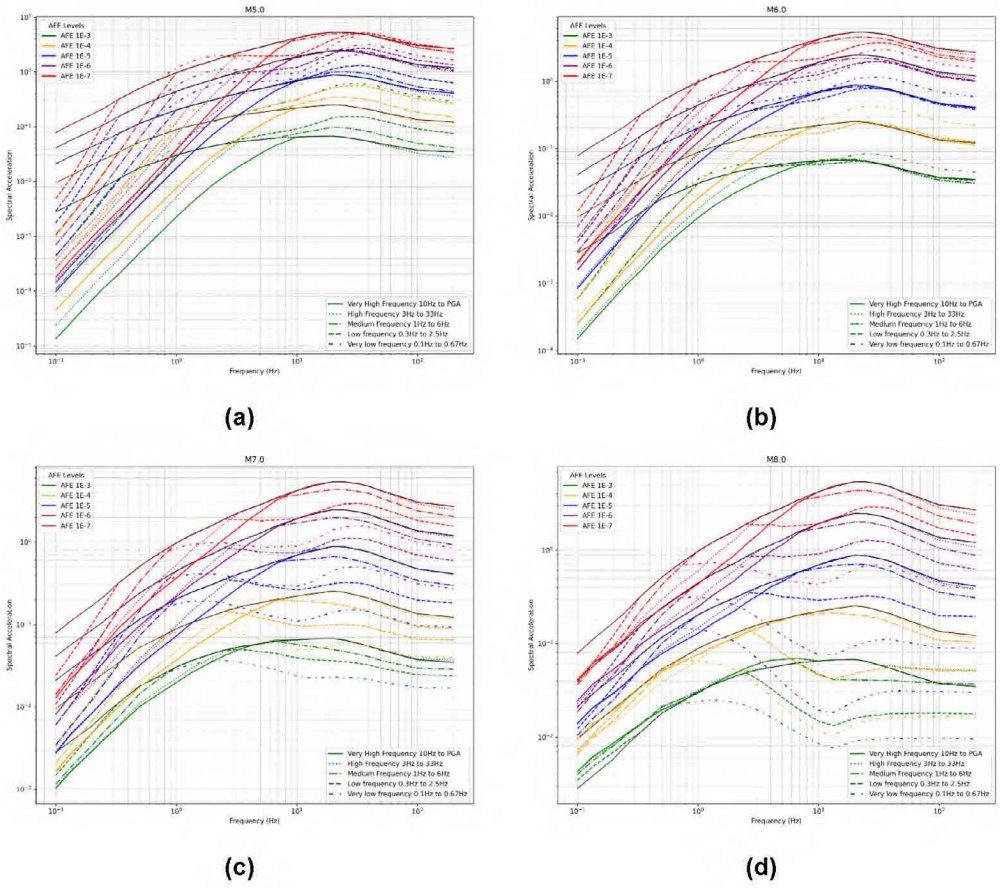
Key: m = meter; m/s = meters per second; V_S = shear wave velocity

Figure 2.5-90
Randomized Modulus Reduction and Damping Curves for Residual Soil (Depth Ranges of about 15 to 30 Ft.), Target Values, for the Suspension Log Profile, Site-Specific Material Curves, Kappa 2 Approach, 24 Ft. of Cut Case



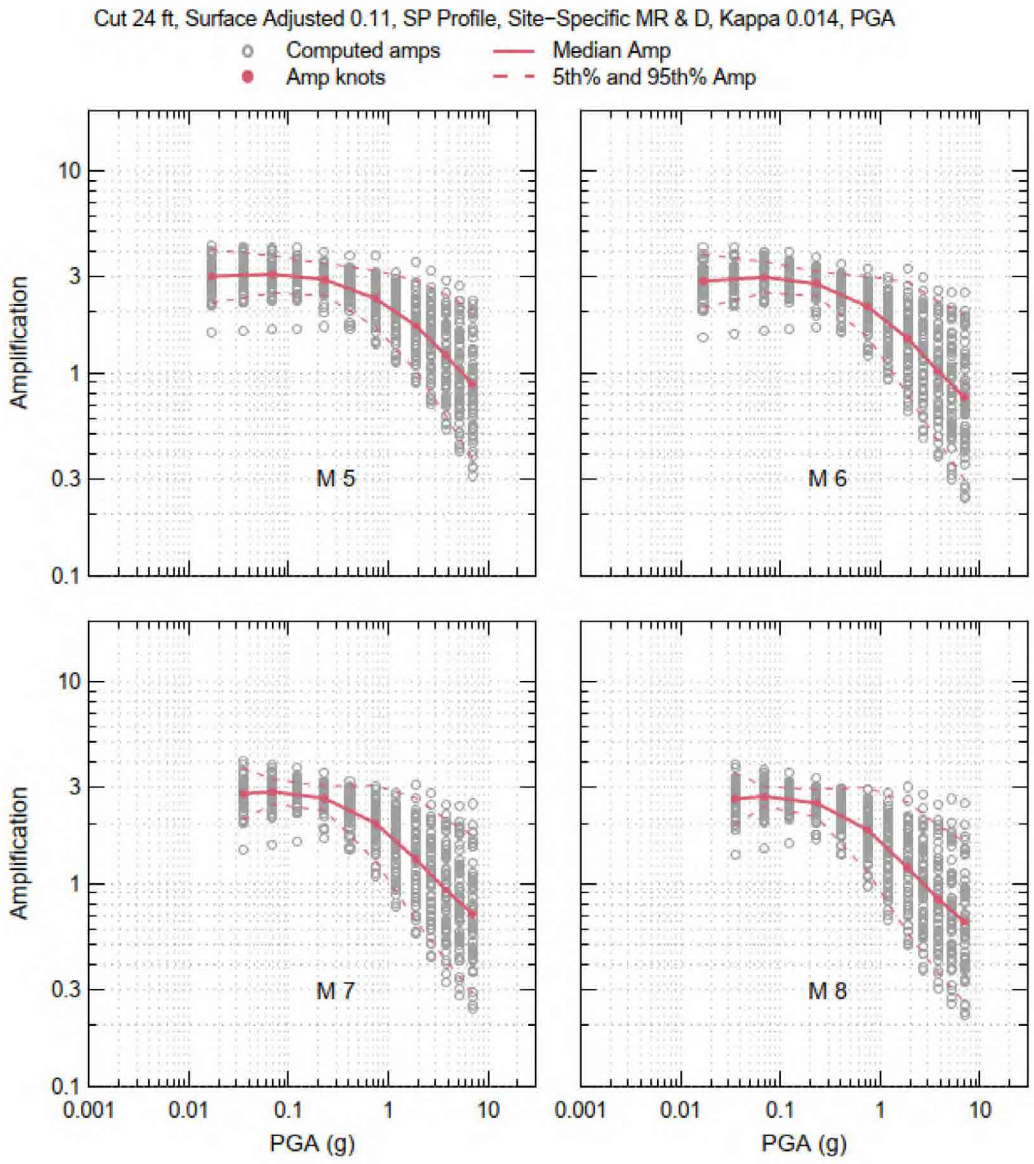
Key: ft. = feet

Figure 2.5-91
Conditional Mean Spectra for: (a) M 5; (b) M 6; (c) M 7; (d) M 8



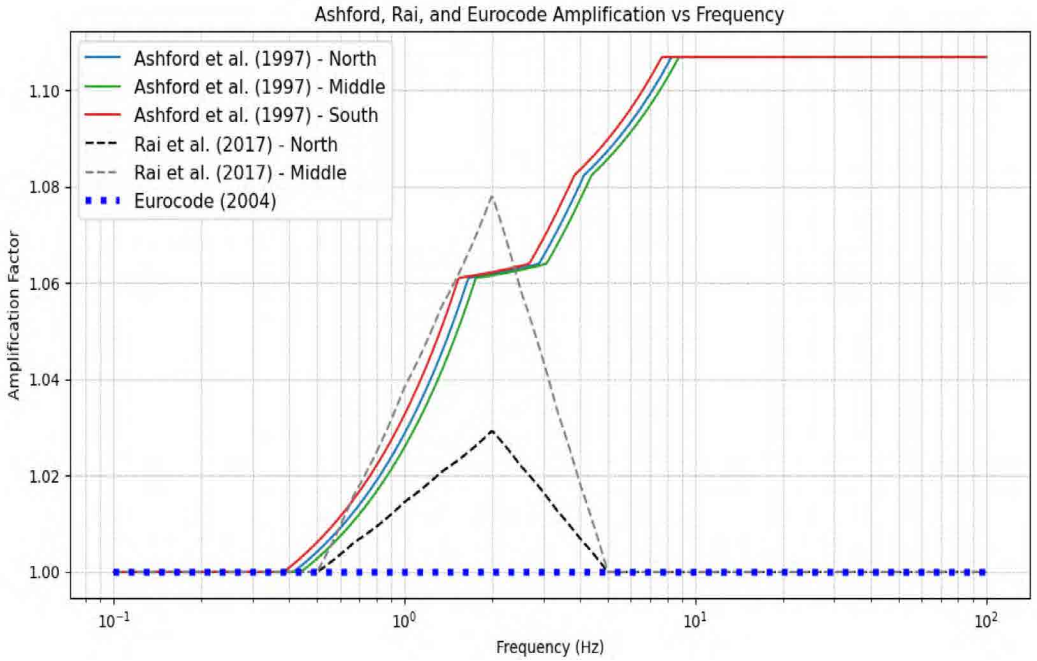
Key: AFE = annual frequency of exceedance; Hz = hertz; **M** = magnitude; PGA = peak ground acceleration

Figure 2.5-92
Example of Amplification Fitting Using a Piecewise-Linear Function



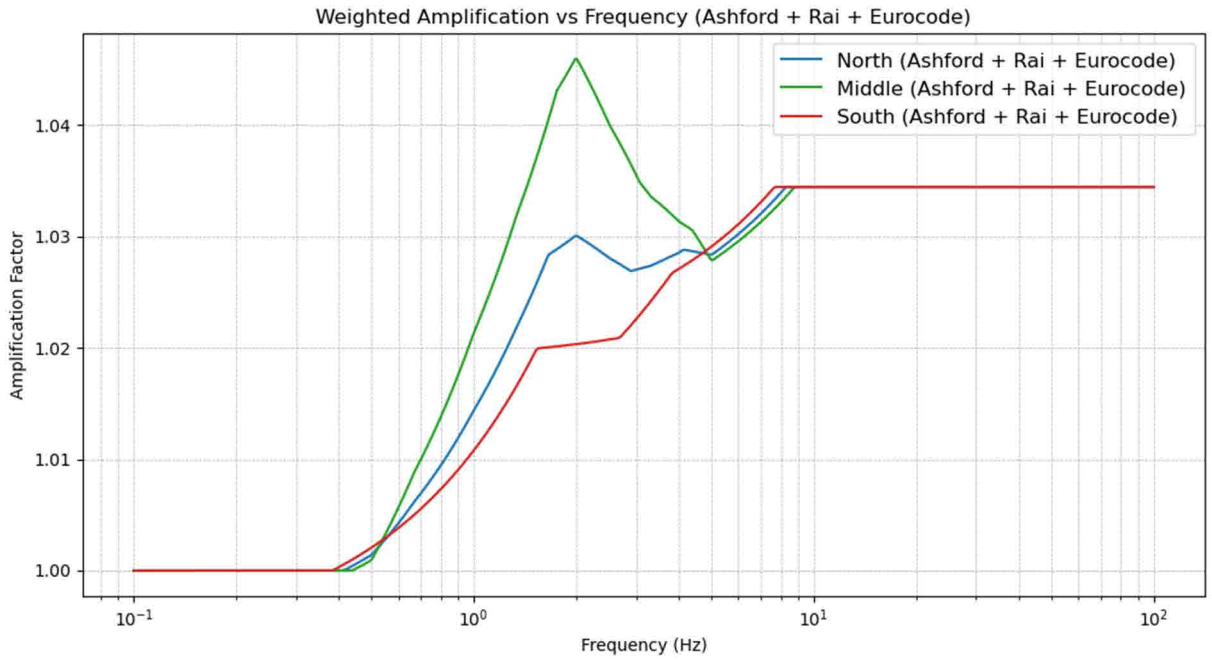
Key: Amp. = amplification; ft. = feet; PGA = peak ground acceleration

Figure 2.5-93
Topographic Amplification Functions Obtained with Different Empirical Models for Areas Near the Edge of the Crest at Each Plant Complex



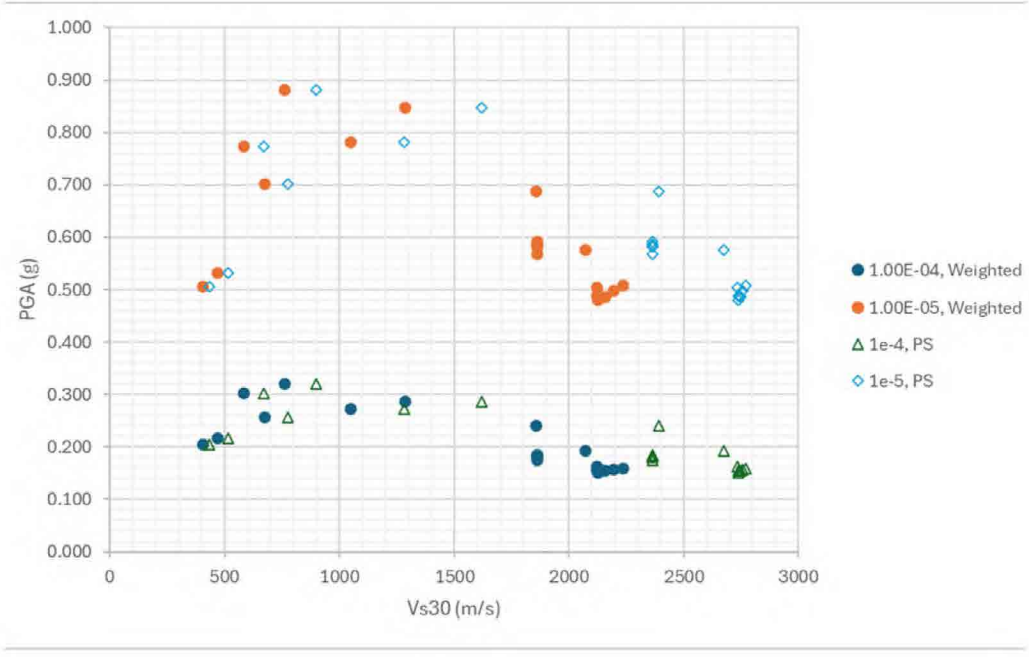
Key: Hz = hertz

Figure 2.5-94
Topographic Amplification Functions for Areas Near the Edge of the Crest at Each Plant Complex



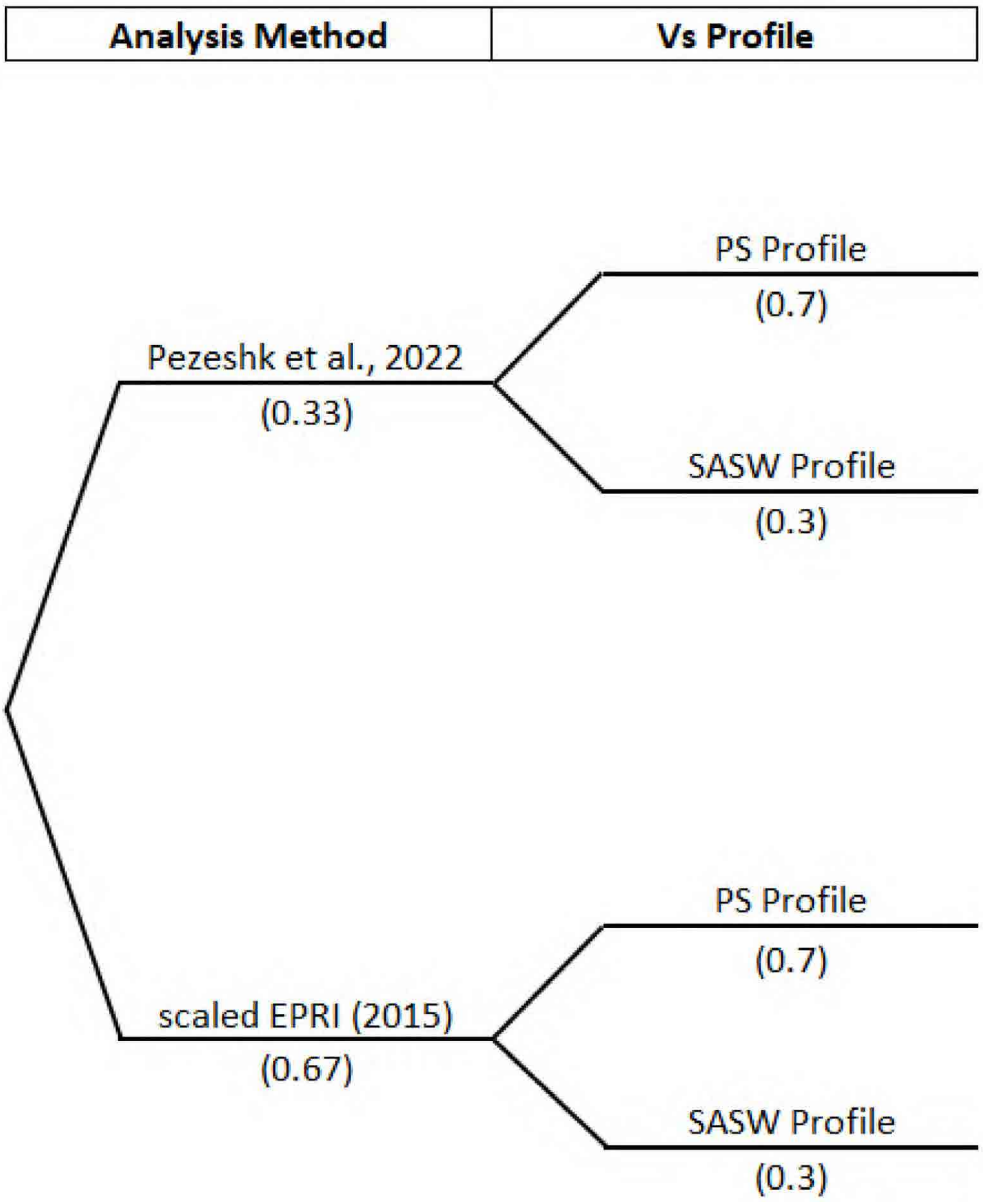
Key: Hz = hertz

Figure 2.5-95
Variations in Peak Ground Acceleration (PGA) for Annual Frequency of Exceedance (AFE) 1E-4 and 1E-5 as a Function of V_{S30} for 21 Combinations of Site Grading and Control Point Depths



Key: m/s = meters per second; V_{S30} = time-averaged shear-wave velocity to a depth of 30 meters

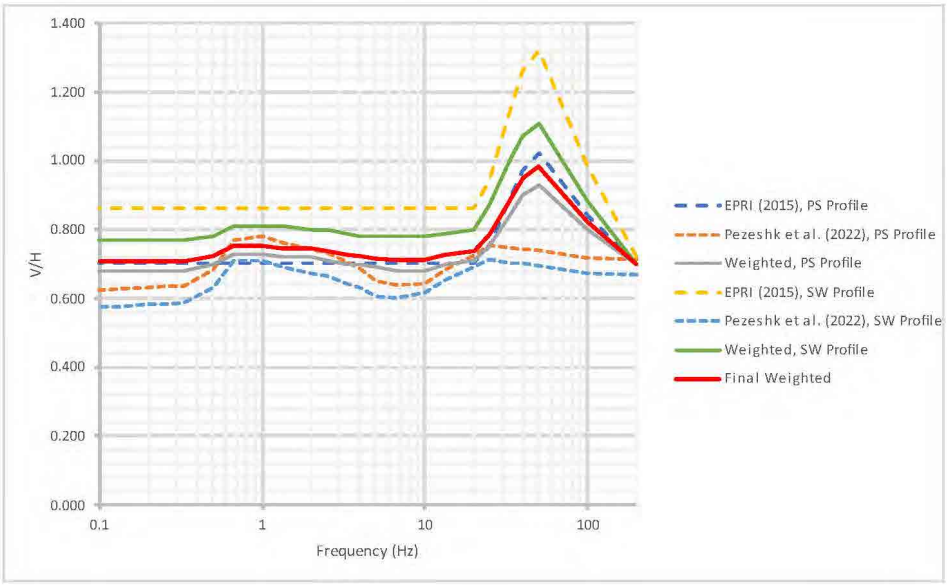
Figure 2.5-96
Logic Tree for Vertical-to-Horizontal Spectral Ratios



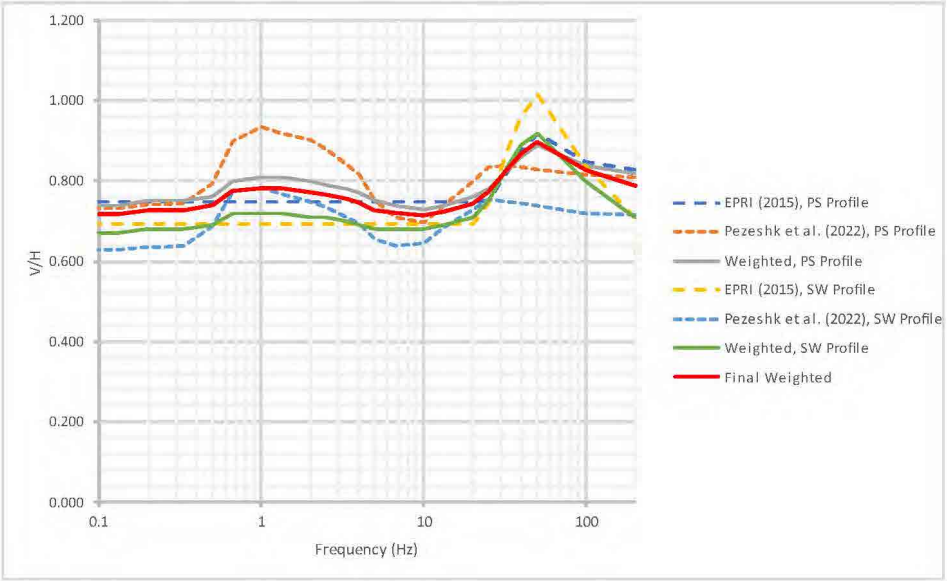
Note: EPRI (2015) in the figure refers to Reference 2.5-203 in this document.

Key: EPRI = Electric Power Research Institute; SASW = spectral analysis of surface waves; V_S = shear wave velocity

Figure 2.5-97
Vertical-to-Horizontal (V/H) Obtained with Pezeshk et al. (Reference 2.5-202) and EPRI (Reference 2.5-201), Weighted V/H Ratios for Velocity Profiles, and Final Weighted V/H, 10 Ft. (3 M) of Cut, for AFE of 1E-4s: (a) Ground Surface; (b) Top of PWR



(a)

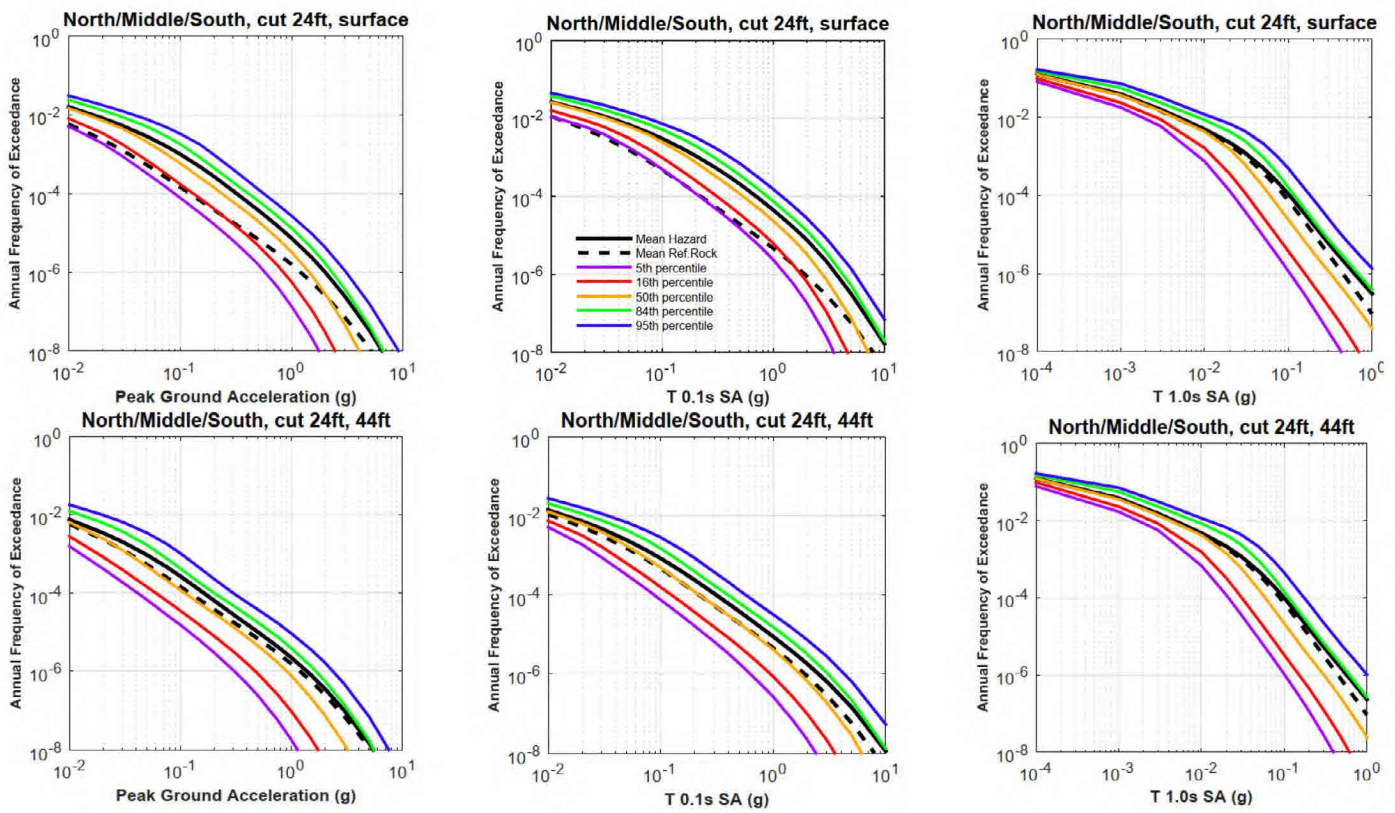


(b)

Note: EPRI (2015) in the figures refers to Reference 2.5-203 in this document.

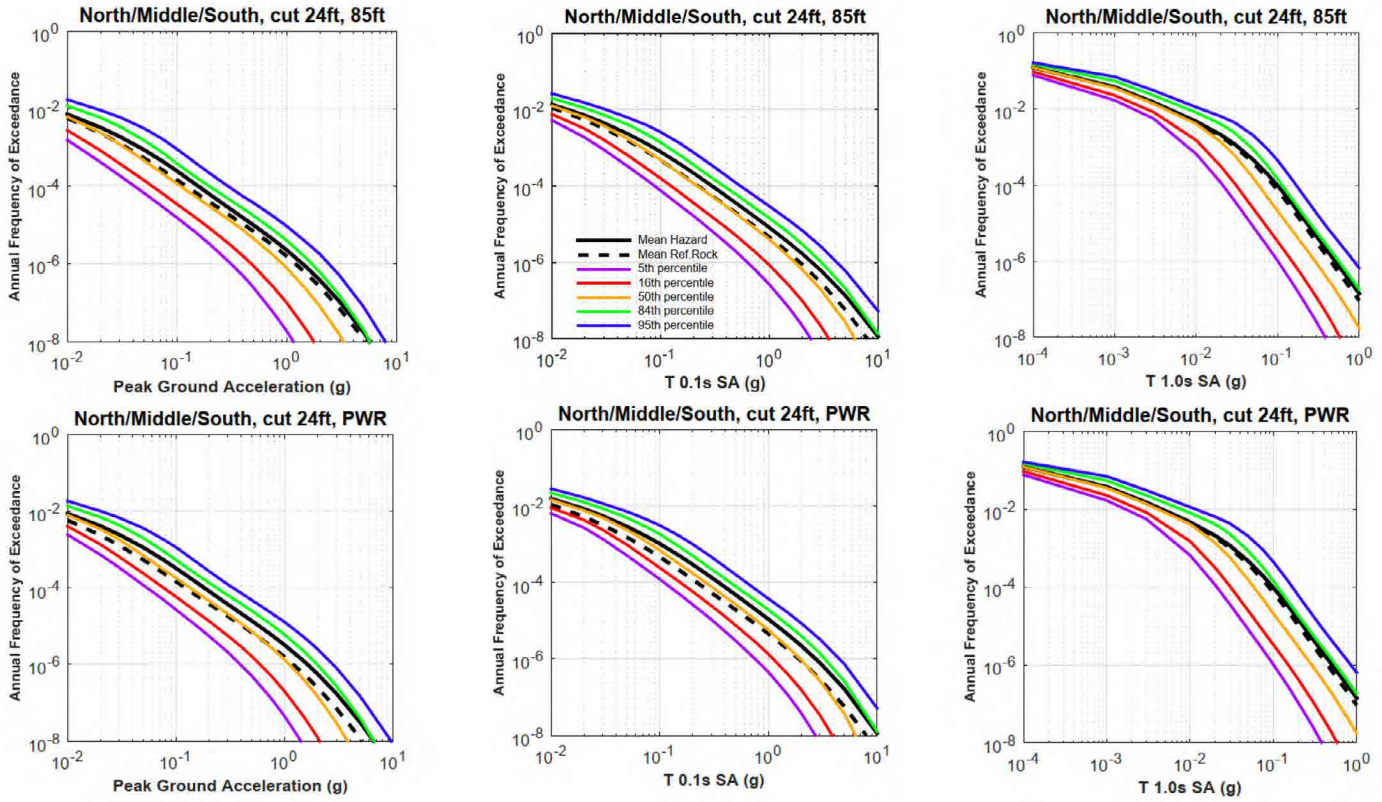
Key: AFE = annual frequency of exceedance; EPRI = Electric Power Research Institute; ft. = feet; Hz = hertz; m = meter; PWR = partially weathered rock

Figure 2.5-98
Comparison of Seismic Hazard Curves for the North and Middle Plant Complexes at Different Control Points
(Sheet 1 of 2)



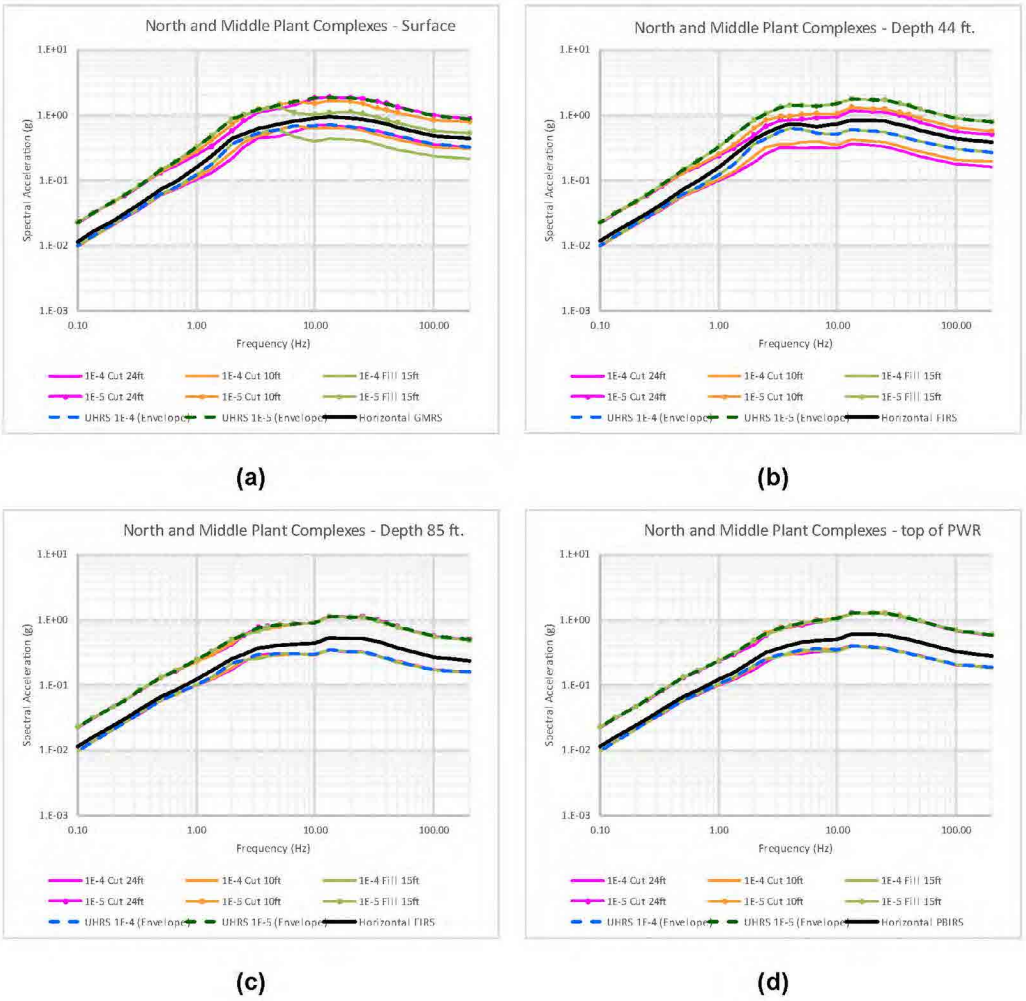
Key: ft = feet; PWR = partially weathered rock; Ref.Rock = reference rock; s = second; SA = spectral acceleration; T = spectral period

Figure 2.5-98
Comparison of Seismic Hazard Curves for the North and Middle Plant Complexes at Different Control Points
(Sheet 2 of 2)



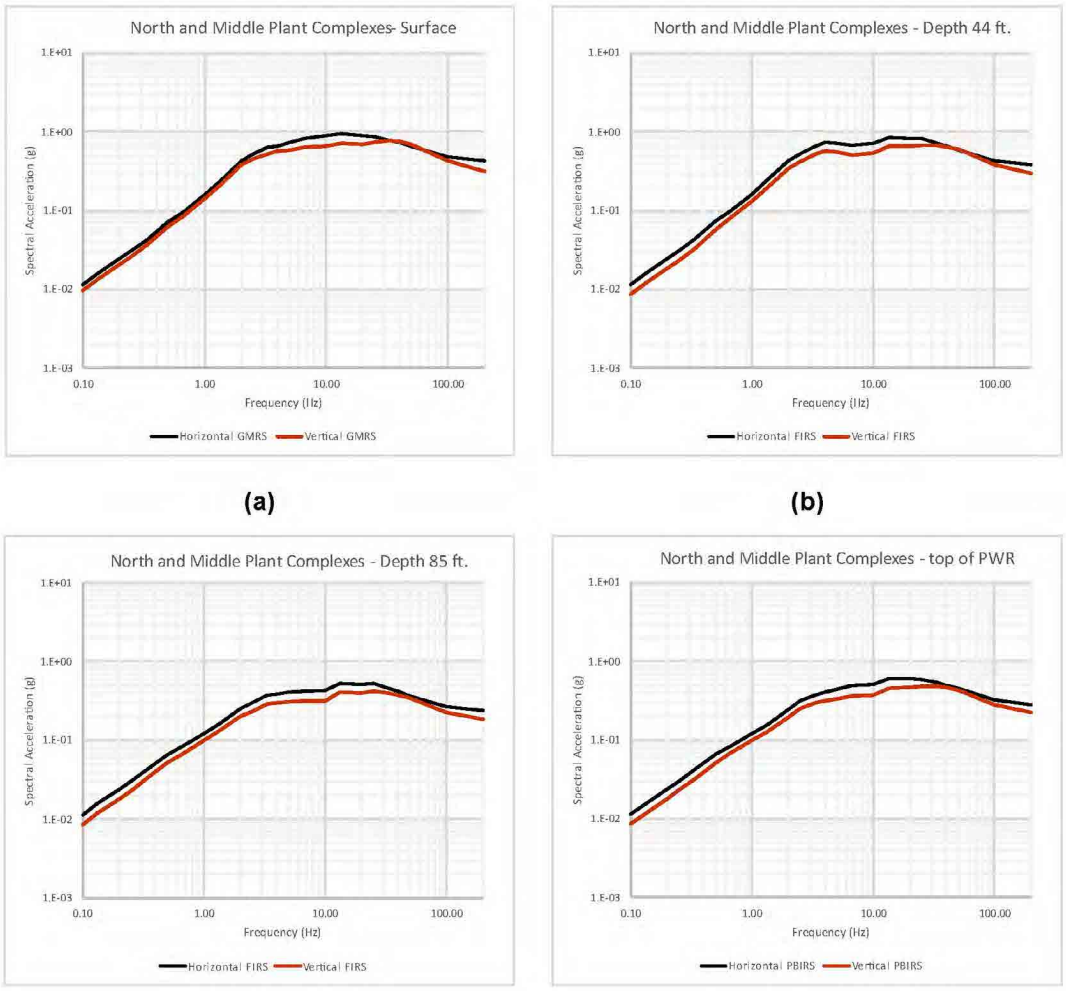
Key: ft = feet; PWR = partially weathered rock; Ref.Rock = reference rock; s = second; SA = spectral acceleration; T = spectral period

Figure 2.5-99
Site-Specific Horizontal Uniform Hazard Response Spectra (UHRS) and Design Response Spectra (DRS) for the North and Middle Plant Complexes



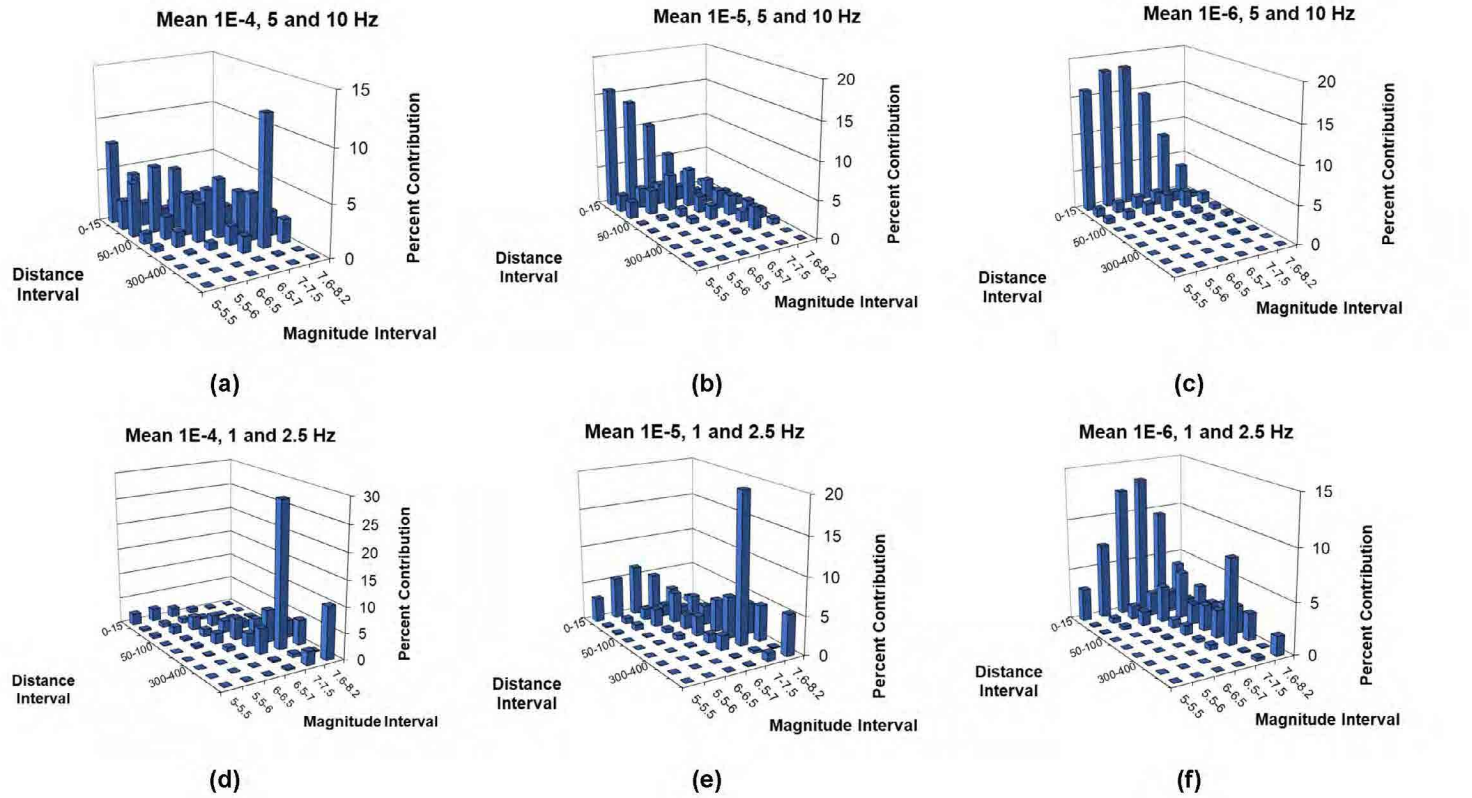
Key: FIRS = Foundation Input Response Spectrum; ft. = feet; GMRS = Ground Motion Response Spectrum; Hz = hertz; PBIRS = Performance-Based Interface Response Spectrum; PWR = partially weathered rock

Figure 2.5-100
Horizontal and Vertical Performance-Based Design Response Spectra (DRS) for the North and Middle Plant Complexes



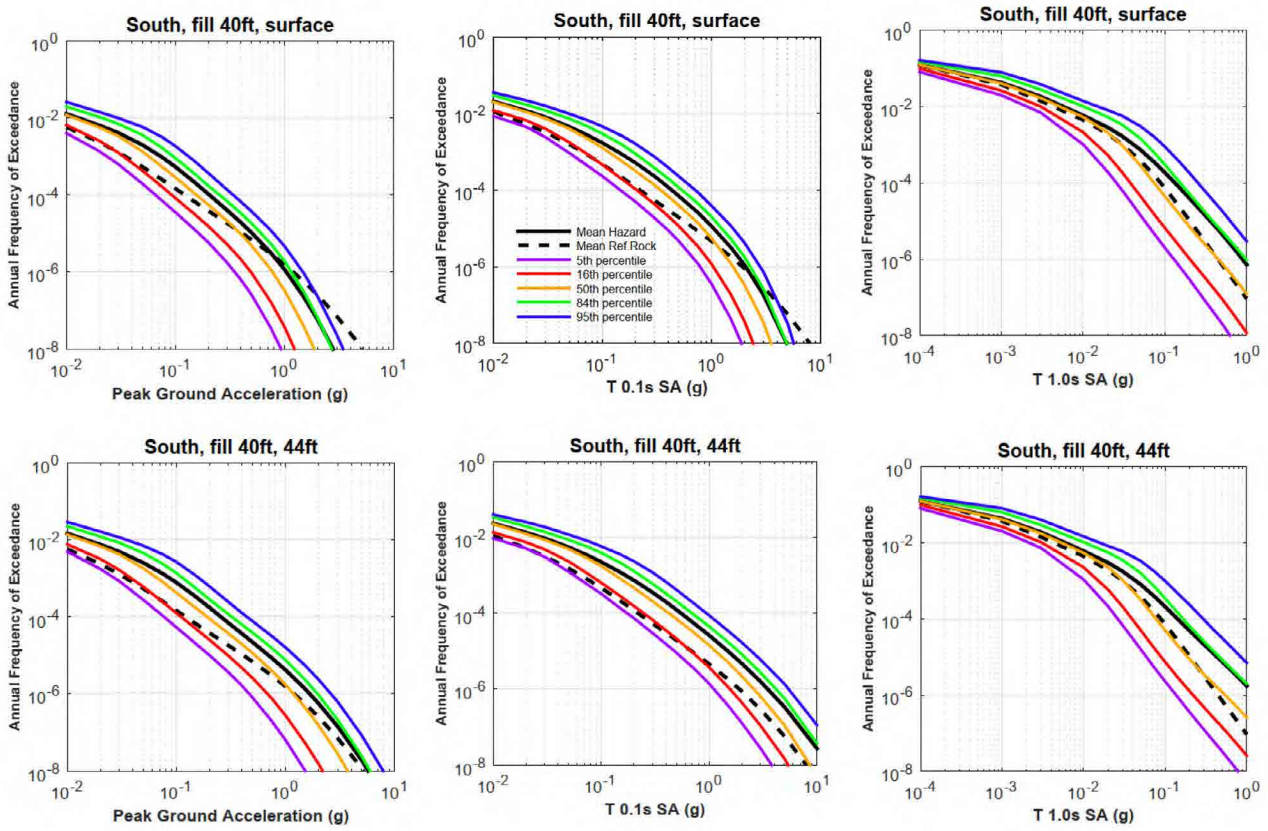
Key: ft. = feet; FIRS = Foundation Input Response Spectrum; GMRS = Ground Motion Response Spectrum; Hz = hertz; PBIRS = Performance-Based Interface Response Spectrum; PWR = partially weathered rock

Figure 2.5-101
Magnitude-Distance Deaggregation of the Site-Specific Hazard for the Cut 24 Ft. and Ground Surface Case: (a) Mean of 5 and 10 Hz, AFE 1E-4; (b) Mean of 5 and 10 Hz, AFE 1E-5; (c) Mean of 5 and 10 Hz, AFE 1E-6; (d) Mean of 1 and 2.5 Hz, AFE 1E-4; (e) Mean of 1 and 2.5 Hz, AFE 1E-5; (f) Mean of 1 and 2.5 Hz, AFE 1E-6



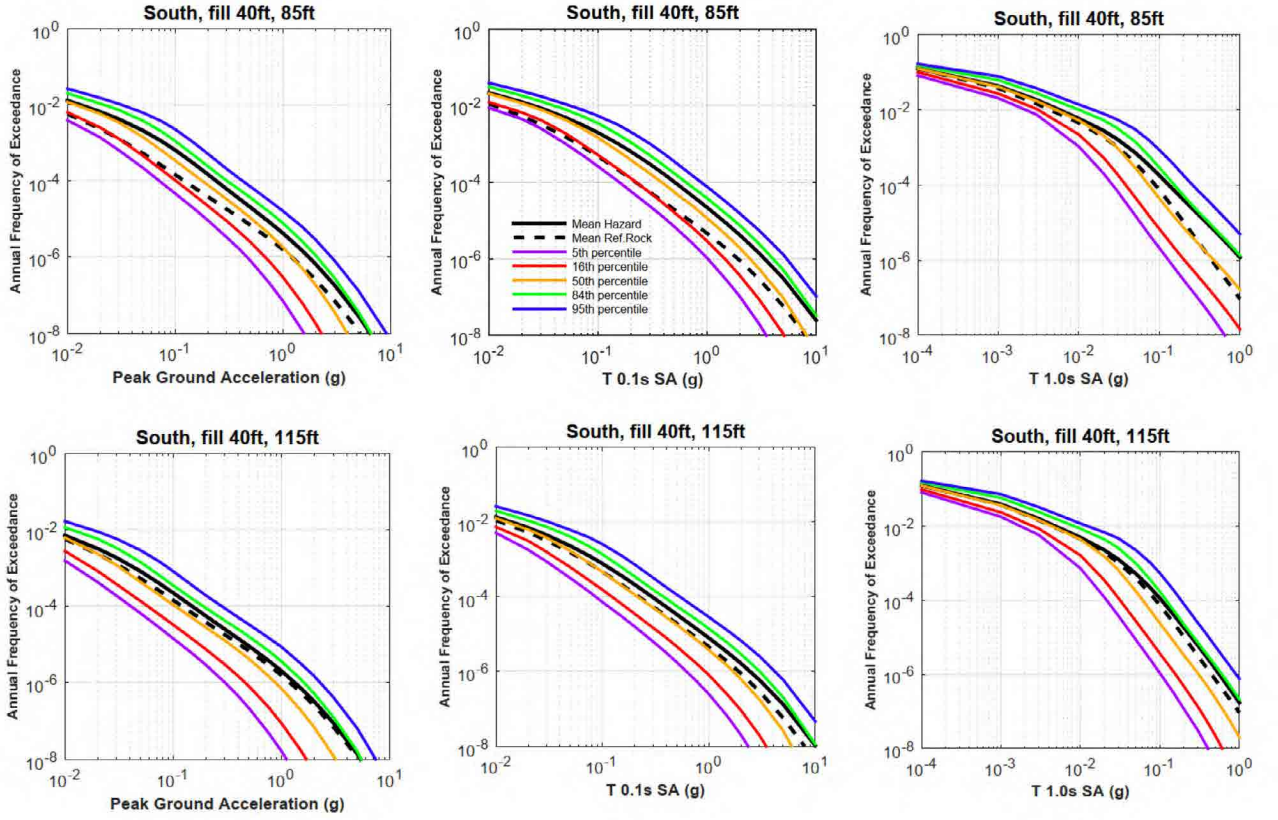
Key: AFE = annual frequency of exceedance; ft. = feet; Hz = hertz

Figure 2.5-102
Comparison of Seismic Hazard Curves for the South Plant Complex at Different Control Points
(Sheet 1 of 3)



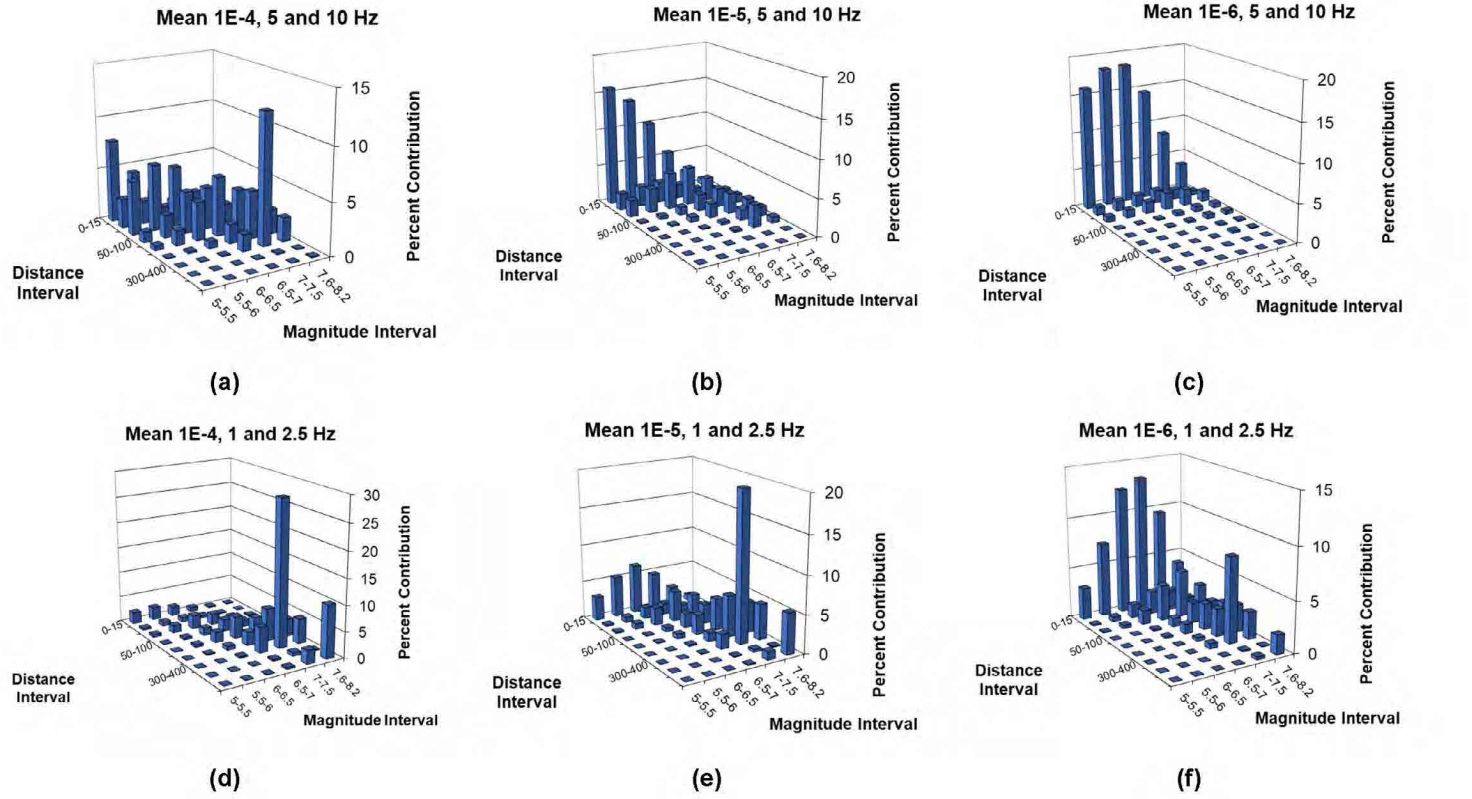
Key: ft = feet; PWR = partially weathered rock; Ref.Rock = reference rock; s = second; SA = spectral acceleration; T = spectral period

Figure 2.5-102
Comparison of Seismic Hazard Curves for the South Plant Complex at Different Control Points
(Sheet 2 of 3)



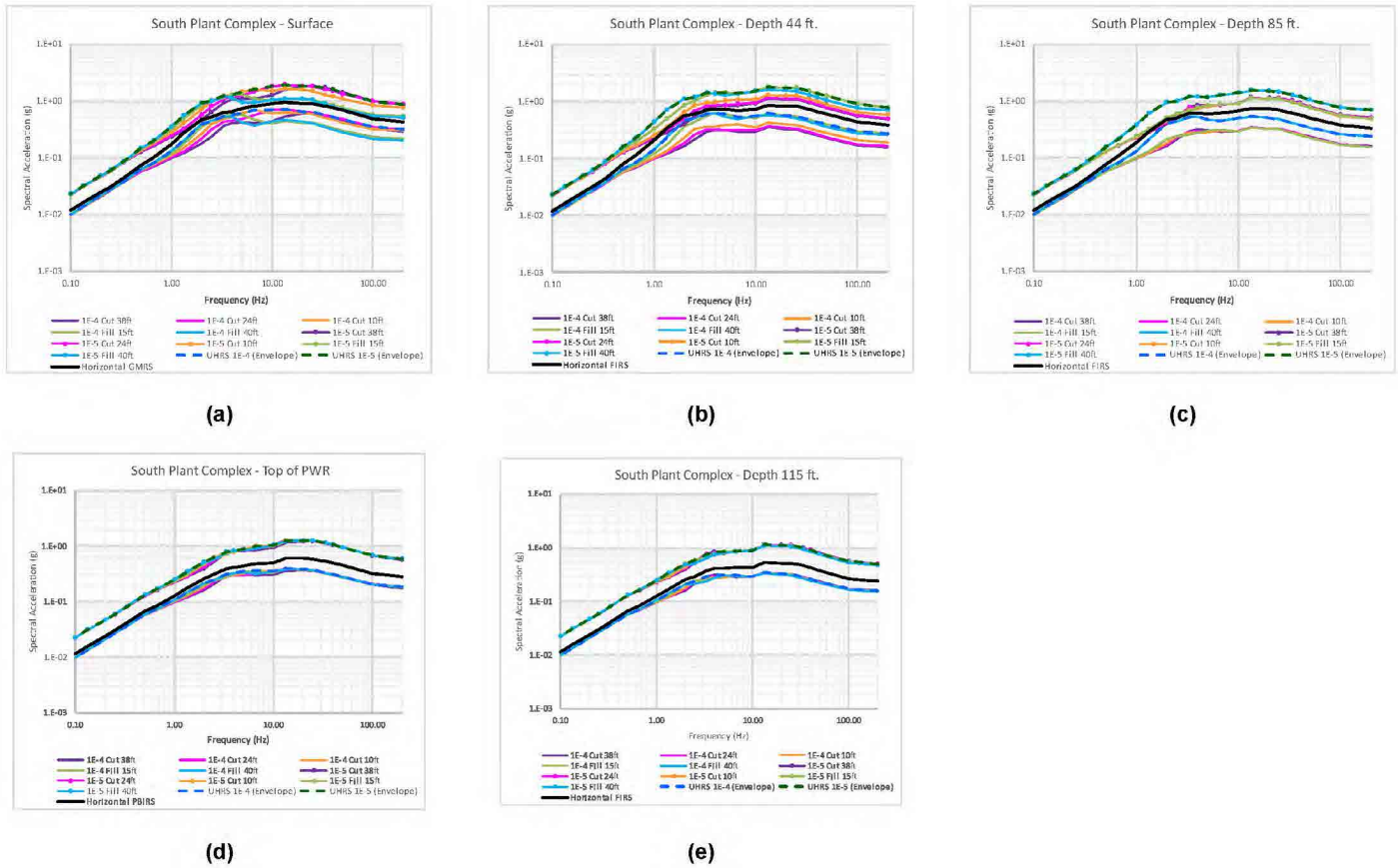
Key: ft = feet; PWR = partially weathered rock; Ref.Rock = reference rock; s = second; SA = spectral acceleration; T = spectral period

Figure 2.5-102
Comparison of Seismic Hazard Curves for the South Plant Complex at Different Control Points
(Sheet 3 of 3)



Key: ft = feet; PWR = partially weathered rock; Ref.Rock = reference rock; s = second; SA = spectral acceleration; T = spectral period

Figure 2.5-103
Site-Specific Horizontal Uniform Hazard Response Spectra (UHRS) and Design Response Spectra (DRS) for the South Plant Complex

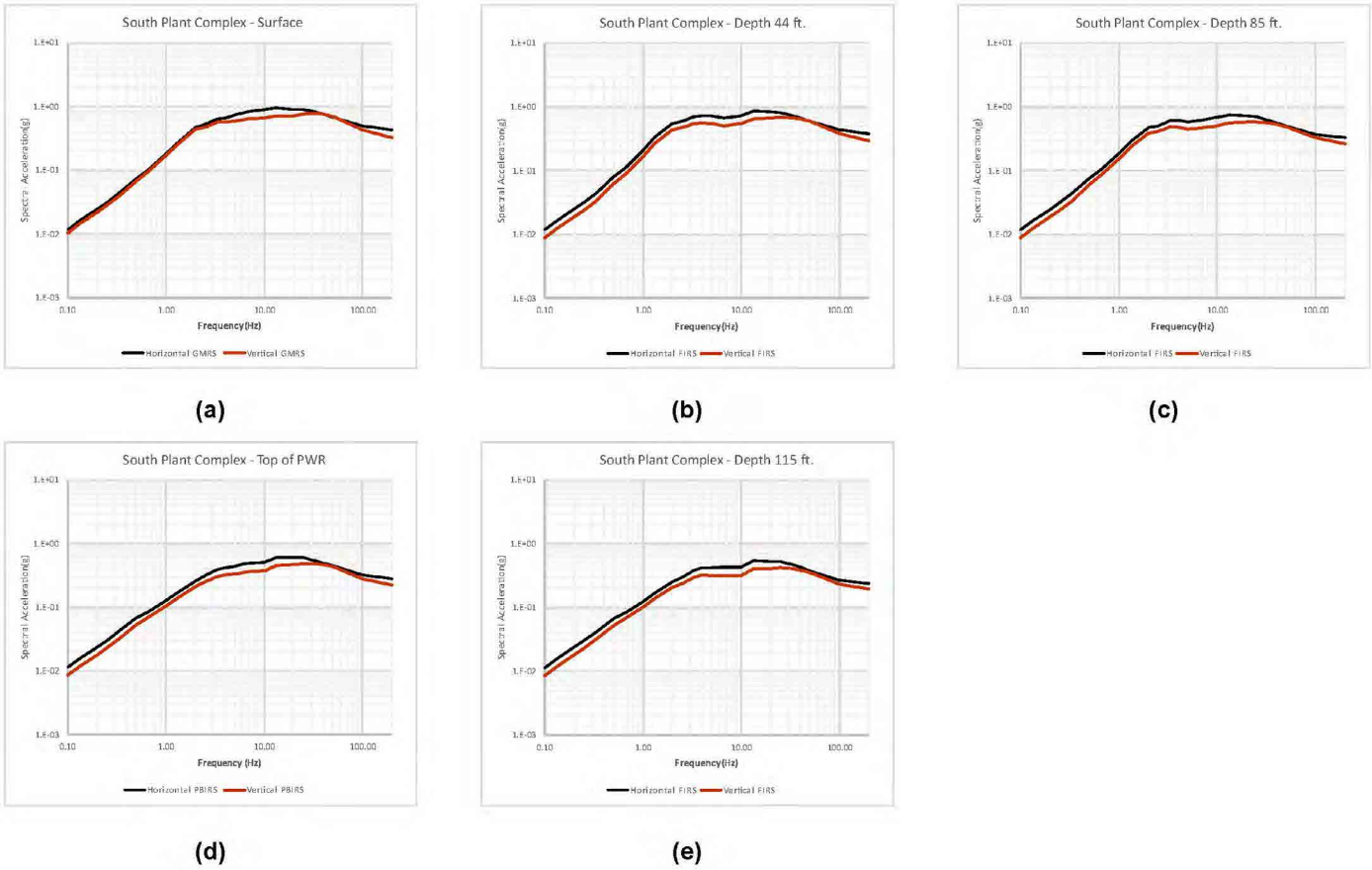


(a) (b) (c)

(d) (e)

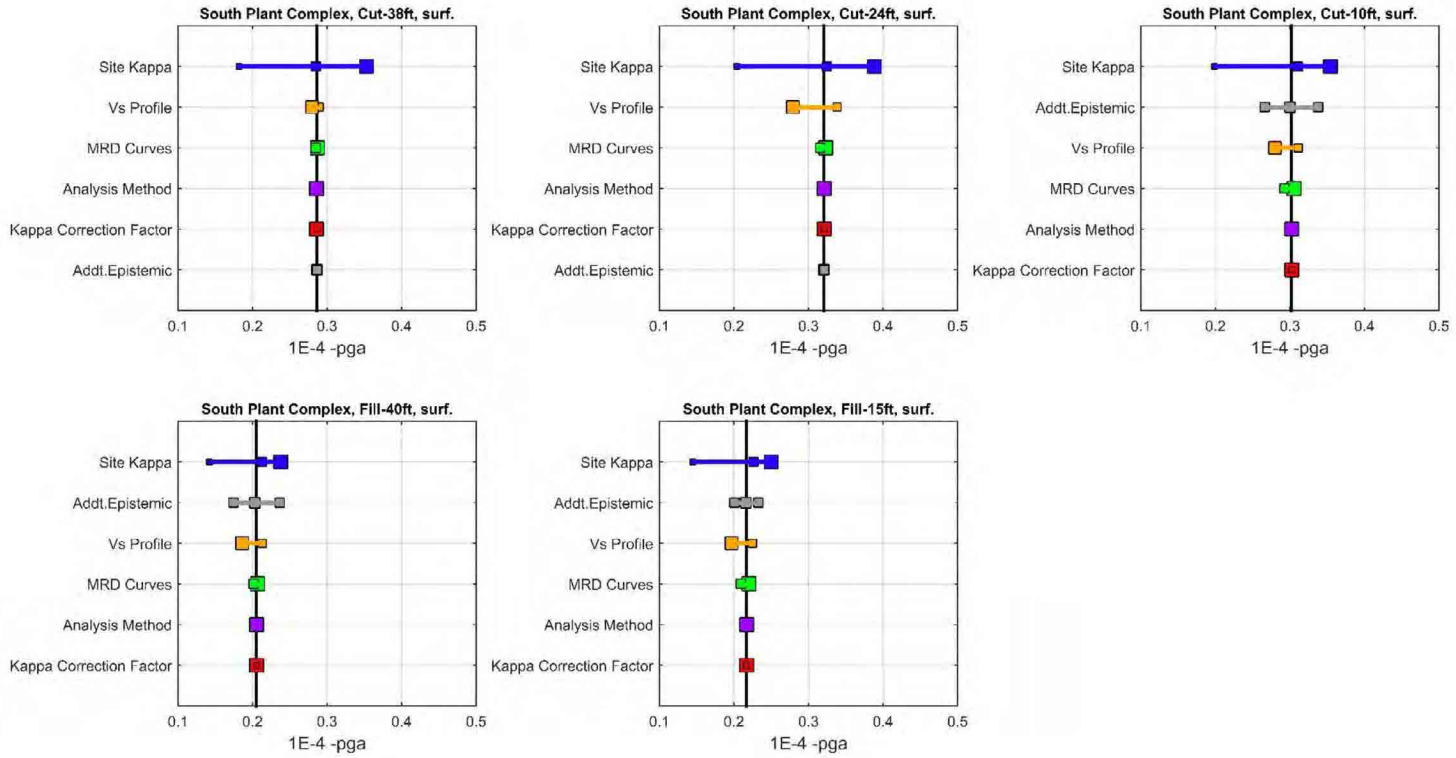
Key: FIRS = Foundation Input Response Spectra; ft. = feet; Hz = hertz; PBIRS = Performance-Based Interface Response Spectrum; PWR = partially weathered rock

Figure 2.5-104
Horizontal and Vertical Performance-Based Design Response Spectra (DRS) for the South Plant Complex



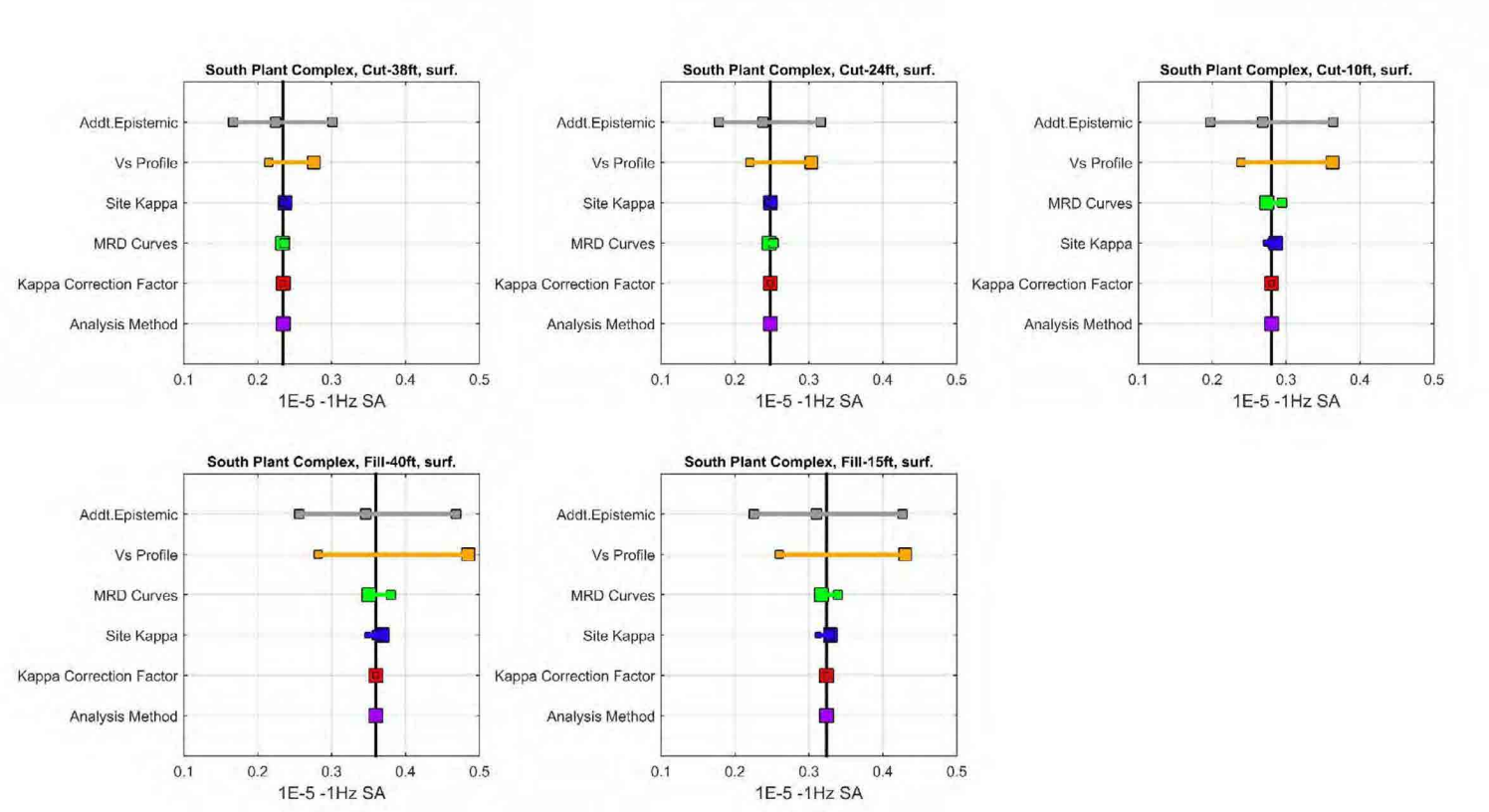
Key: FIRS = Foundation Input Response Spectra; ft. = feet; Hz = hertz; PBIRS = Performance-Based Interface Response Spectrum; PWR = partially weathered rock

Figure 2.5-105
Tornado Plots for the Ground Surface Elevation of the South Plant Complex, Showing the Influence of Elements of the Site Characterization Logic Tree on Peak Ground Acceleration (PGA) at AFE 1E-4



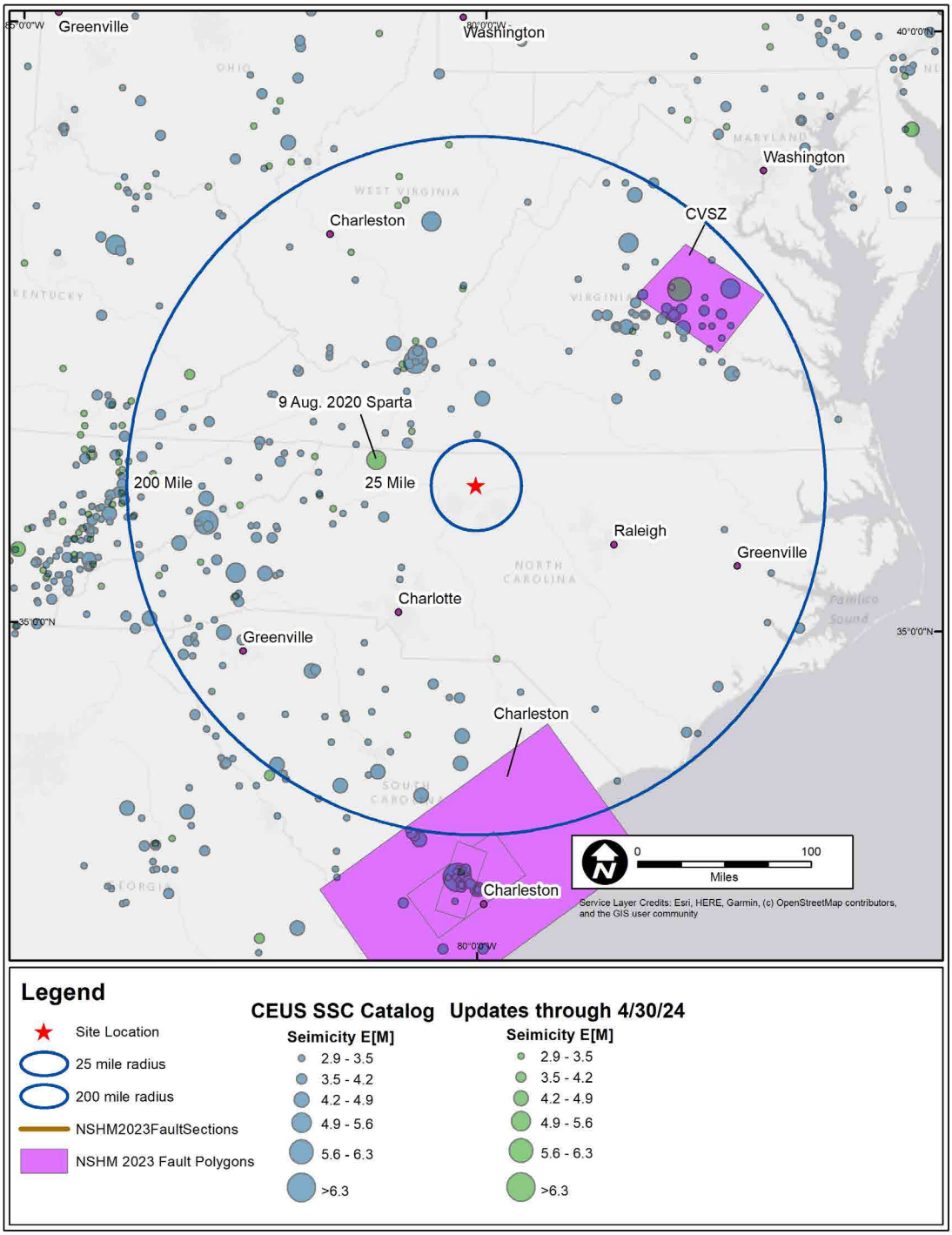
Key: AFE = annual frequency of exceedance; ft. = feet; MRD = modulus reduction and damping; surf. = surface; V_S = shear wave velocity

Figure 2.5-106
Tornado Plots for the Ground Surface Elevation of the South Plant Complex, Showing the Influence of Elements of the Site Characterization Logic Tree on the Spectral Acceleration at 1 Hz at AFE 1E-5



Key: AFE = annual frequency of exceedance; ft. = feet; MRD = modulus reduction and damping; surf. = surface; V_S = shear wave velocity

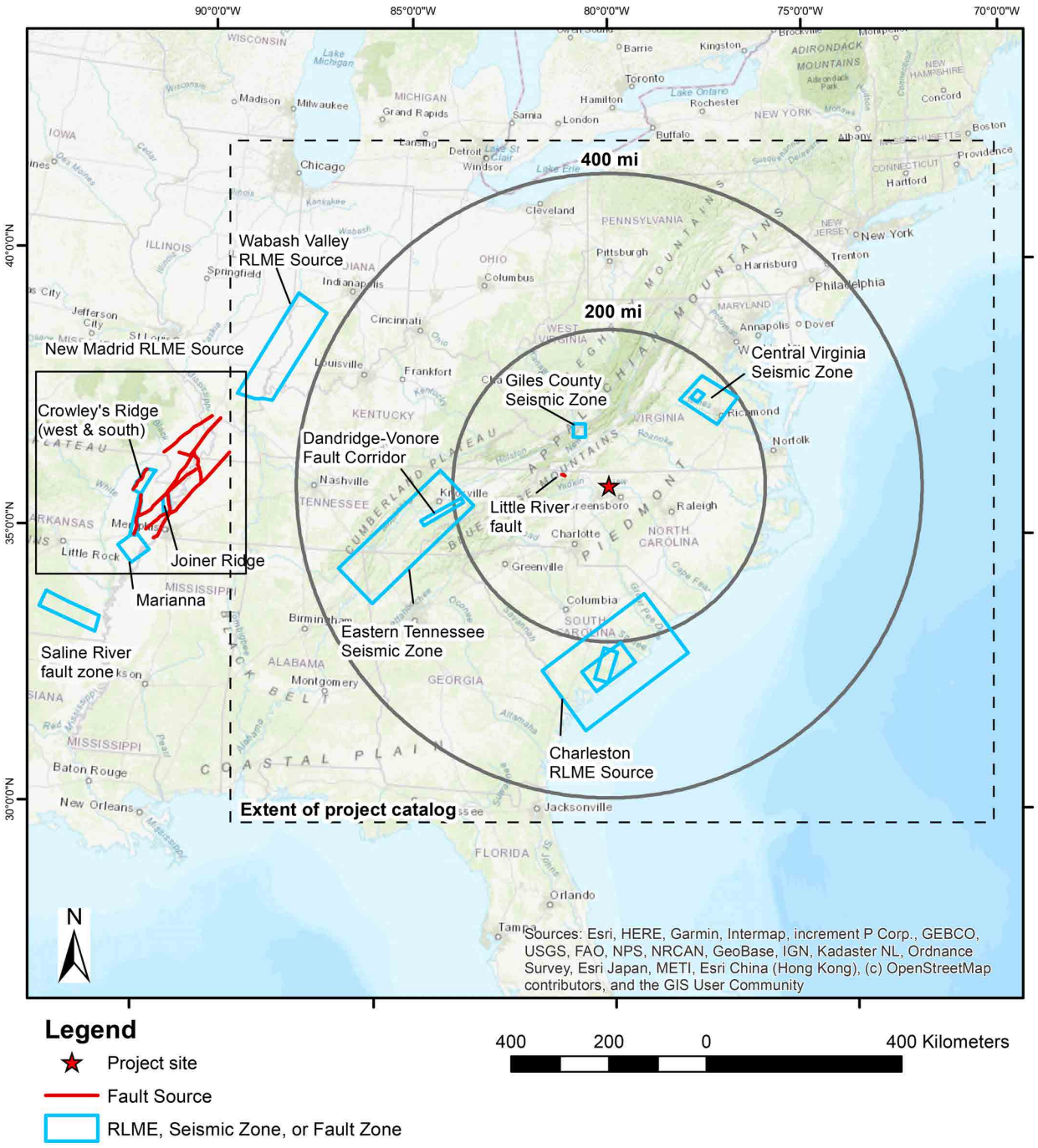
Figure 2.5-107
Seismicity from the Belews Creek Project Catalog and Fault Sources from the National Seismic Hazard Map



Source: Fault Polygons from Reference 2.5-59

Key: CEUS SSC = Central Eastern United States seismic source characterization; CVSZ = Central Virginia Seismic Zone; E[M] = expected moment magnitude; NSHM = National Seismic Hazard Map

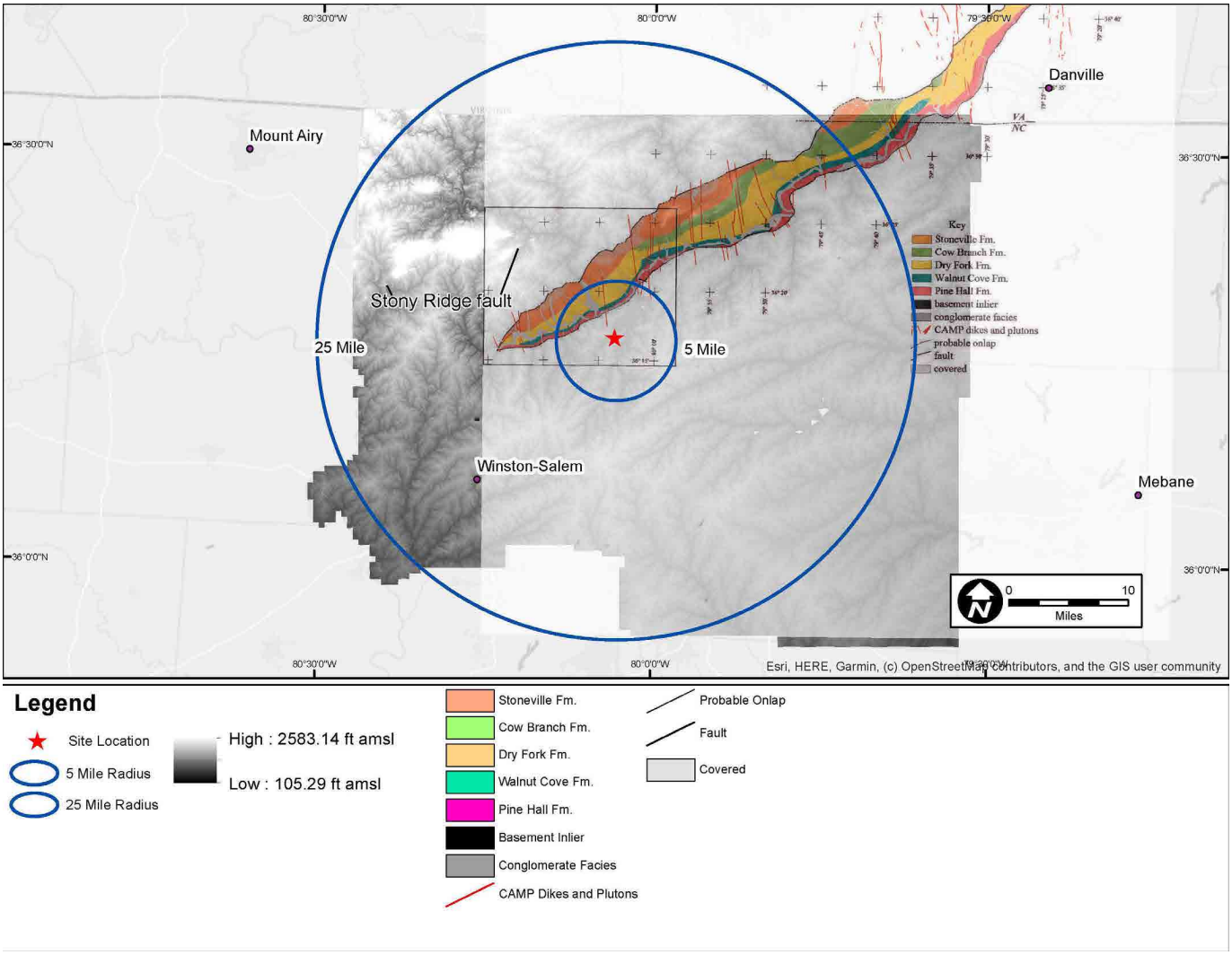
Figure 2.5-108
Fault Sources from the USGS NSHM (Reference 2.5-59) and Other Seismic Zones



Source: Reference 2.5-59

Key: NSHM = National Seismic Hazard Map; RLME = repeated large-magnitude earthquake; USGS = U.S. Geological Survey

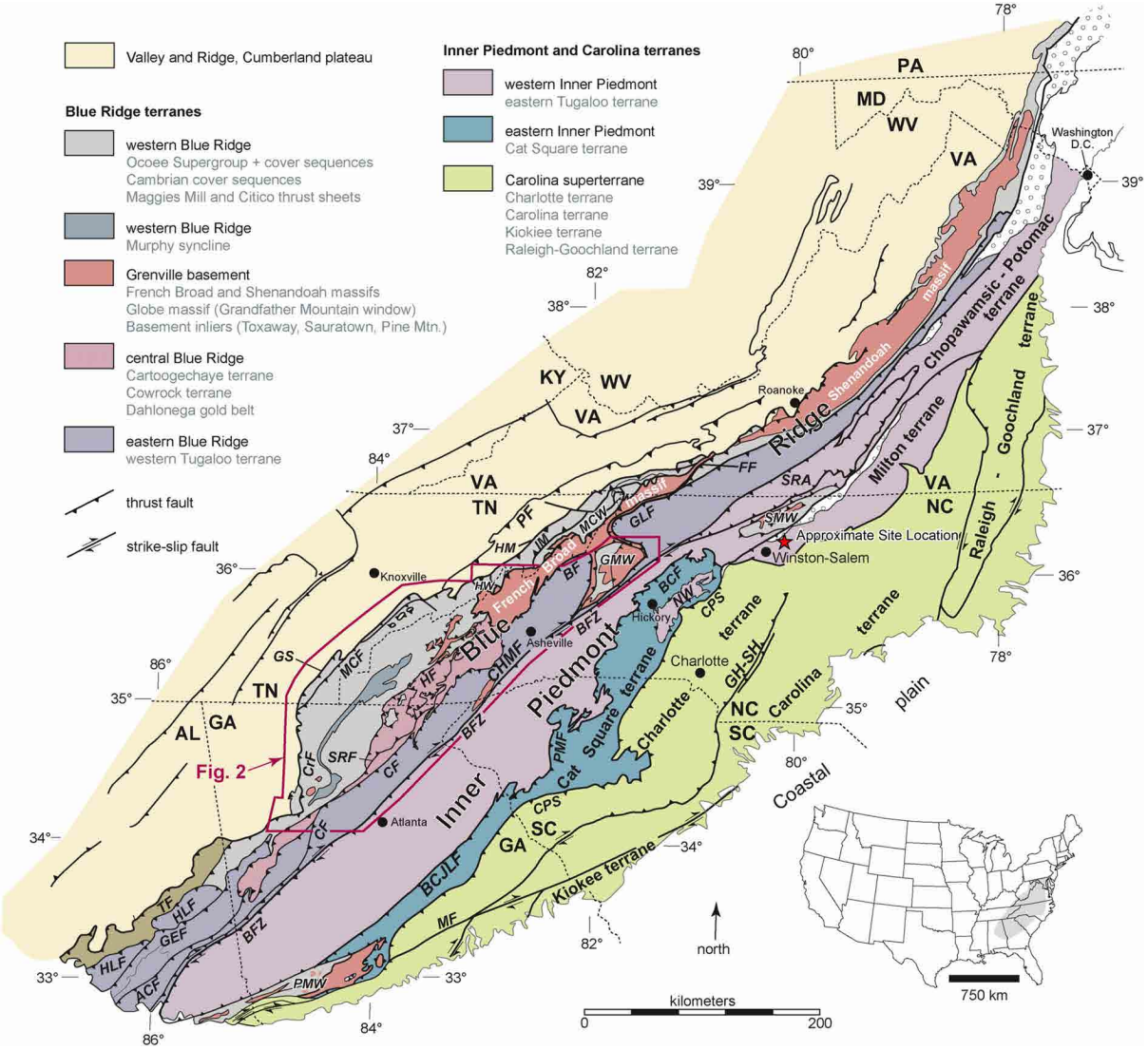
Figure 2.5-109
The Dan River Basin and LiDAR Data



Source: Modified from Reference 2.5-123; Reference 2.5-208

Key: amsl = above mean sea level; LiDAR = Light Detection and Ranging

Figure 2.5-110
Tectonic Map of the Southern and Central Appalachians



Source: Modified from Reference 2.5-214

Key: ACF = Alexander City fault, BCF = Brindle Creek fault, BCJLF = Brindle Creek-Jackson Lake fault, BF = Burnsville fault, BFZ = Brevard fault zone, CF = Chattahoochee fault, CHMF = Chattahoochee-Holland Mountain fault, CPS = Central Piedmont suture, CrF = Cartersville fault, FF = Fries fault, GEF = Goodwater-Enitachopco fault, GH-SH = Gold Hill-Silver Hill shear zone, GLF = Gossan Lead fault, GMW = Grandfather Mountain window, GS = Great Smoky thrust, HF = Hayesville fault, HLF = Hollins Line fault, HM = Holston Mountain fault, HW = Hot Springs window, IM = Iron Mountain fault, MCF = Miller Cove fault, MCW = Mountain City window, MF = Modoc fault zone, Newton window, PF = Pulaski fault, PMF = Paris Mountain fault, PMW = Pine Mountain window, SMW = Sauratown Mountains window, SRA = Smith River allochthon, SRF = Soque River fault, TF = Talladega fault

State abbreviations: AL = Alabama, GA = Georgia, KY = Kentucky, MD = Maryland, NC = North Carolina, SC = South Carolina, TN = Tennessee, VA = Virginia, WV = West Virginia

Figure 2.5-111
Geology of the Project Site (a) Geologic Map; (b) Cross-section Running Northwest to Southeast Approximately 4.5 Mi. (7.2 Km) Southwest of the Site
(Sheet 1 of 2)

(a)

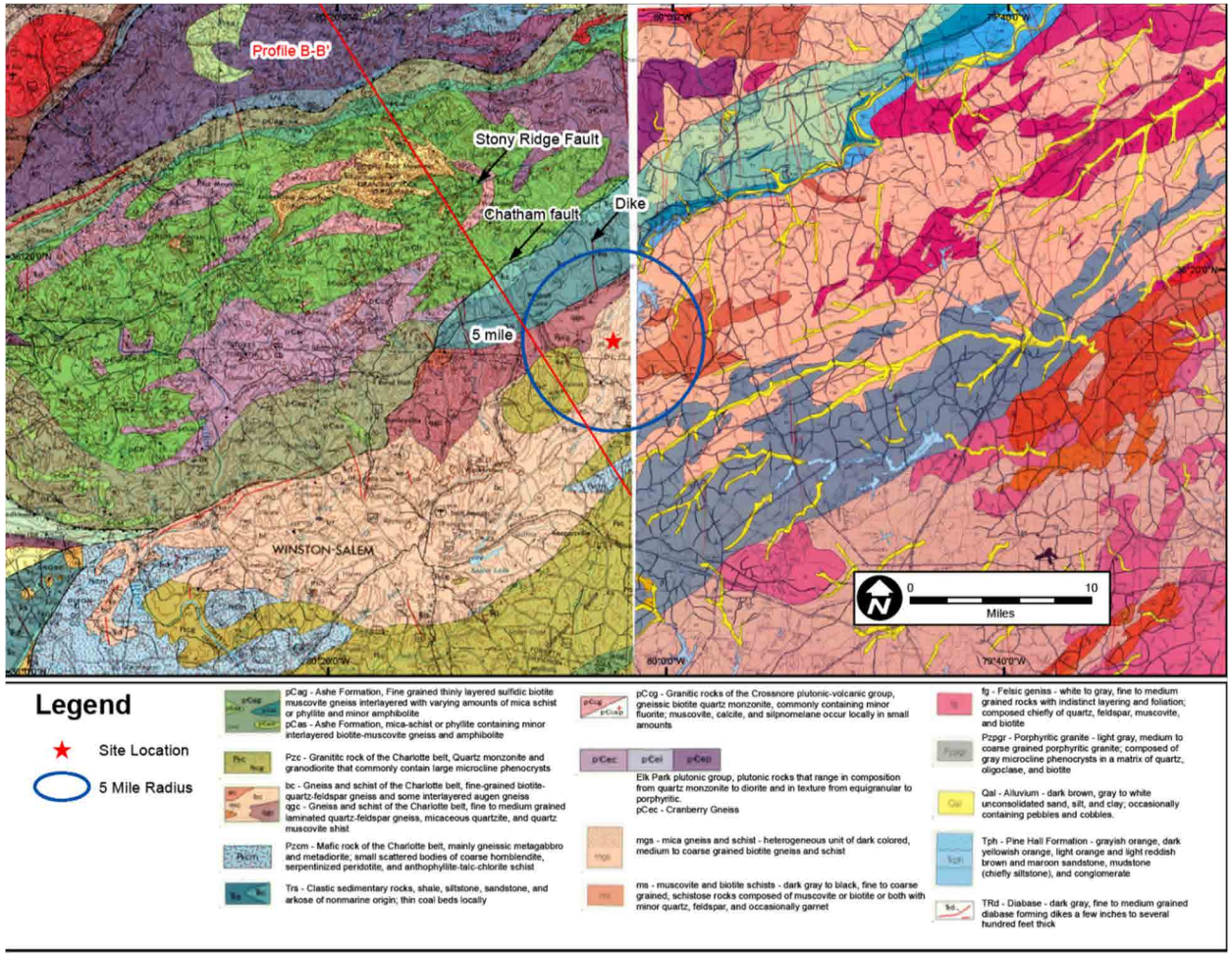
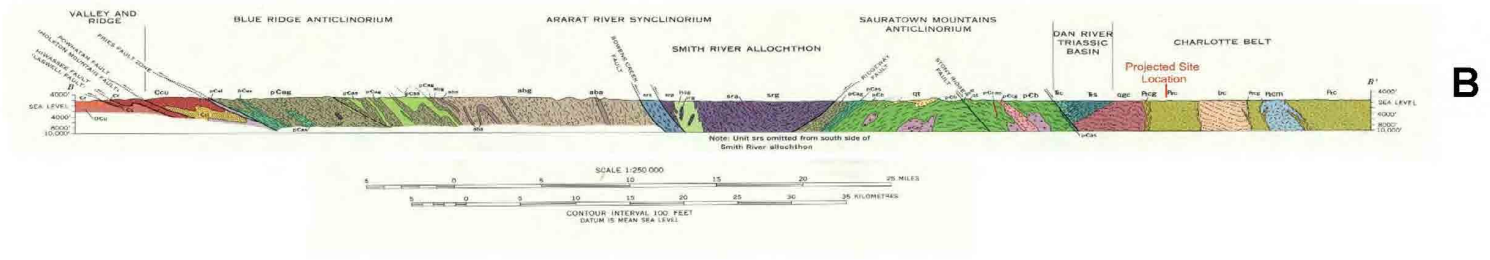


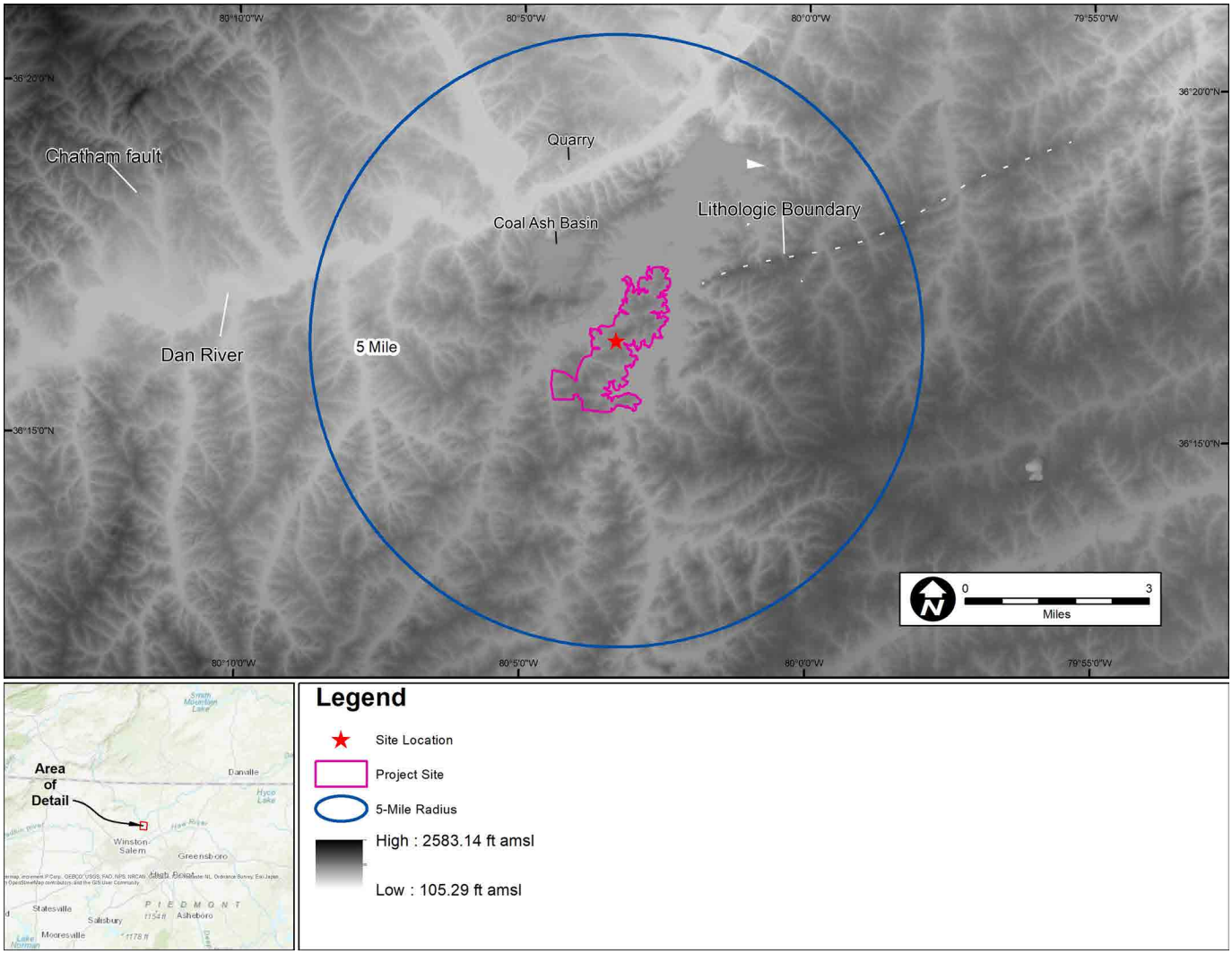
Figure 2.5-111
Geology of the Project Site (a) Geologic Map; (b) Cross-section Running Northwest to Southeast Approximately 4.5 Mi. (7.2 Km) Southwest of the Site
(Sheet 2 of 2)

(b)



Source: Reference 2.5-133; Reference 2.5-51

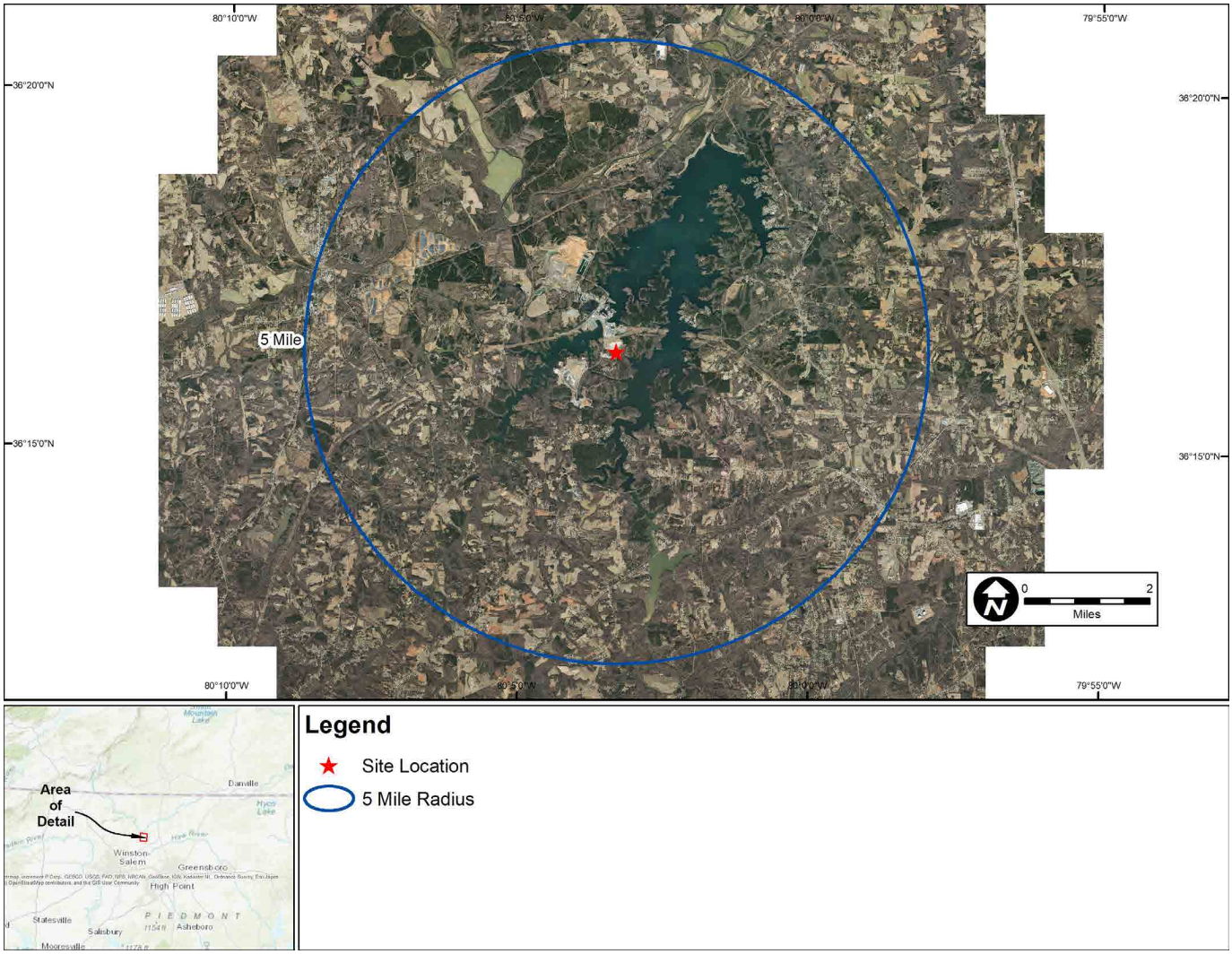
Figure 2.5-112
LiDAR DEM of the Project Site Area (5 Mi. [8 Km])



Source: Reference 2.5-208

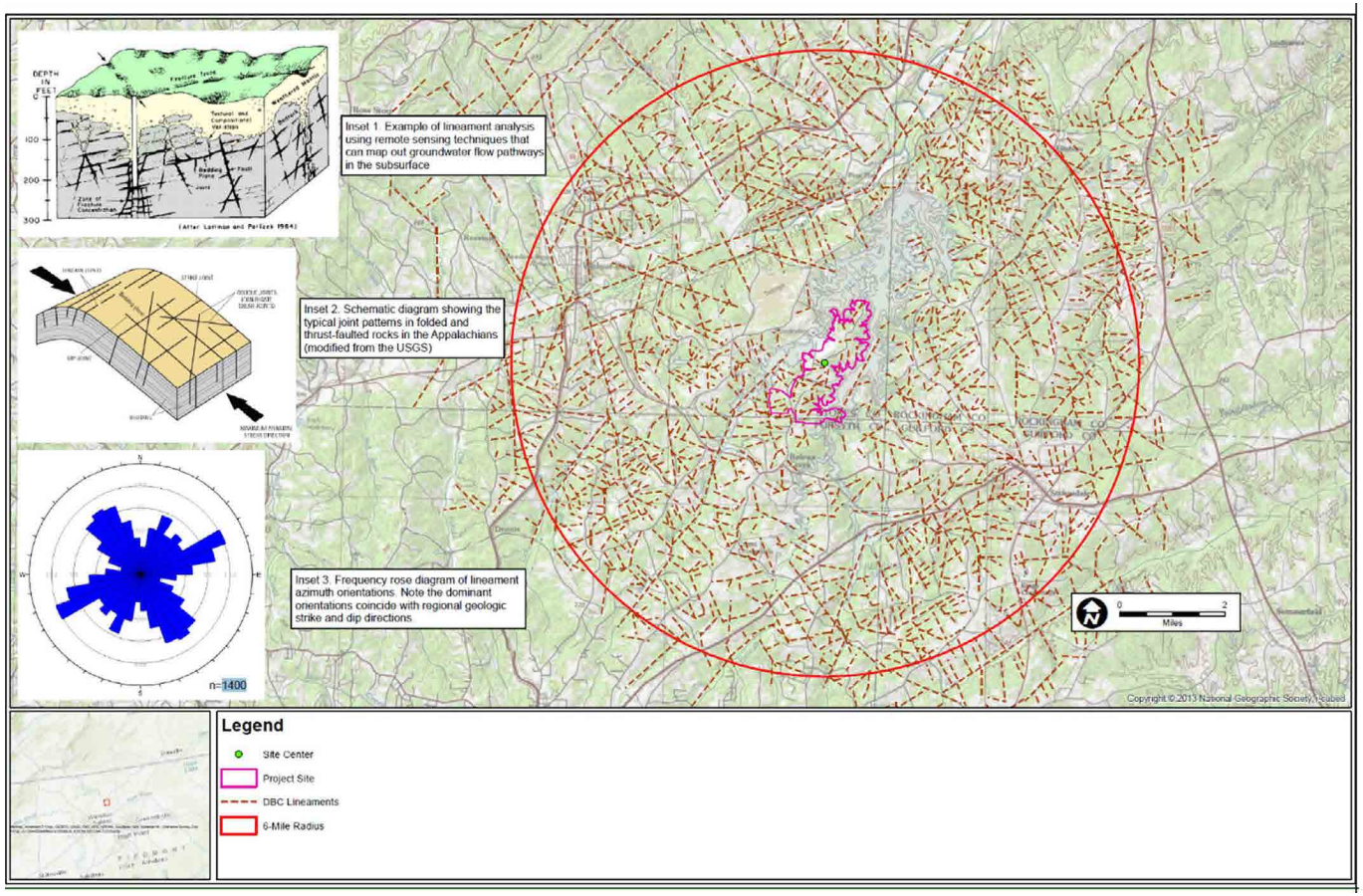
Key: amsl = above mean sea level; DEM = Digital Elevation Model; LiDAR = Light Detection and Ranging

Figure 2.5-113
Aerial Photographs of the Project Site Area (5 Mi. [8 Km])



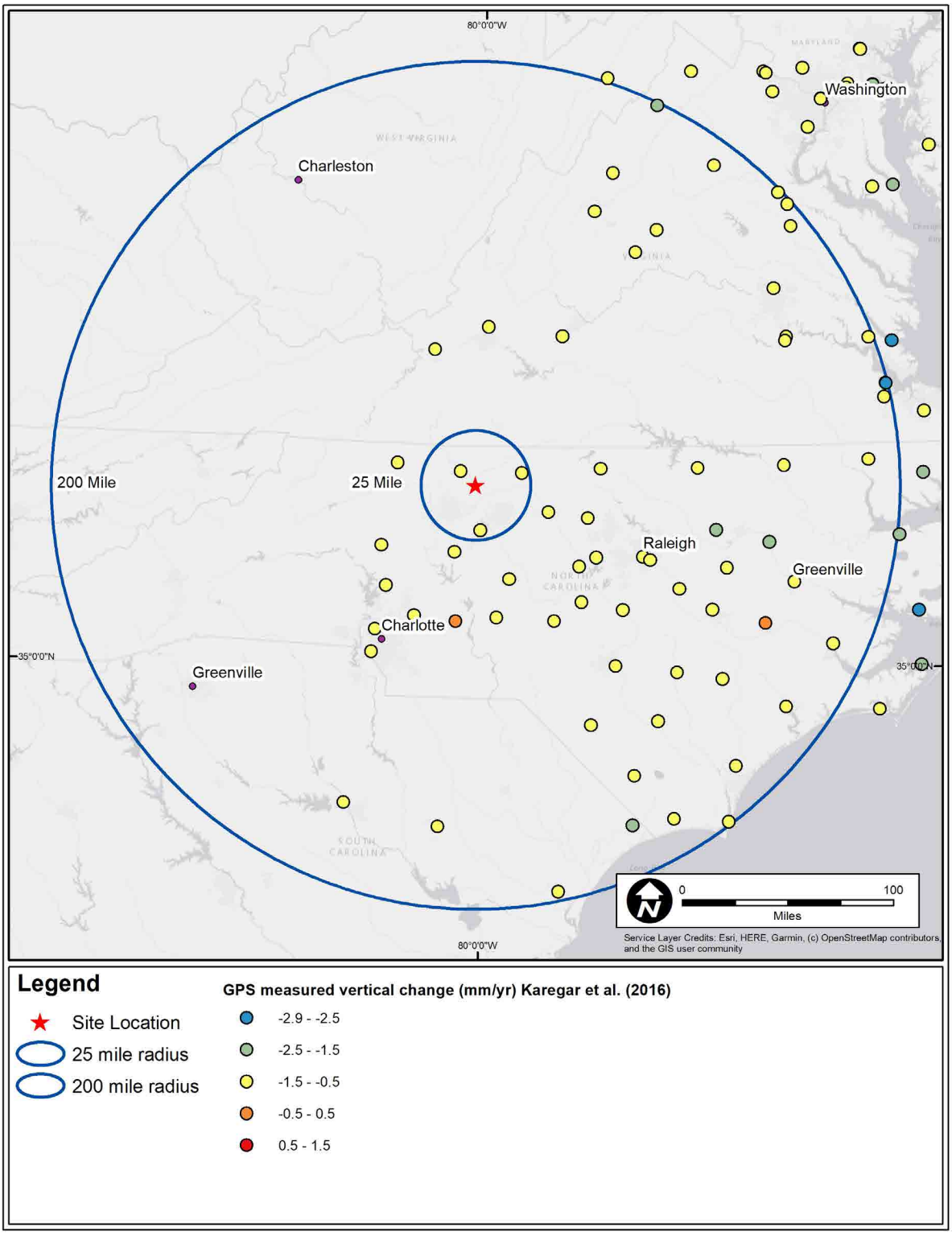
Source: Reference 2.5-216

Figure 2.5-114
Remote-Sensing Lineament Map



Note: Further description related to this figure is provided in Section 2.4.12.

Figure 2.5-115
Land-Level Changes in the Mid-Atlantic Region as Interpreted from GPS Data



Source: Reference 2.5-217

Key: GPS = Global Positioning System; mm/yr = millimeters per year

Figure 2.5-116
Map of Field Data Collection Locations and Cross Section G to G'

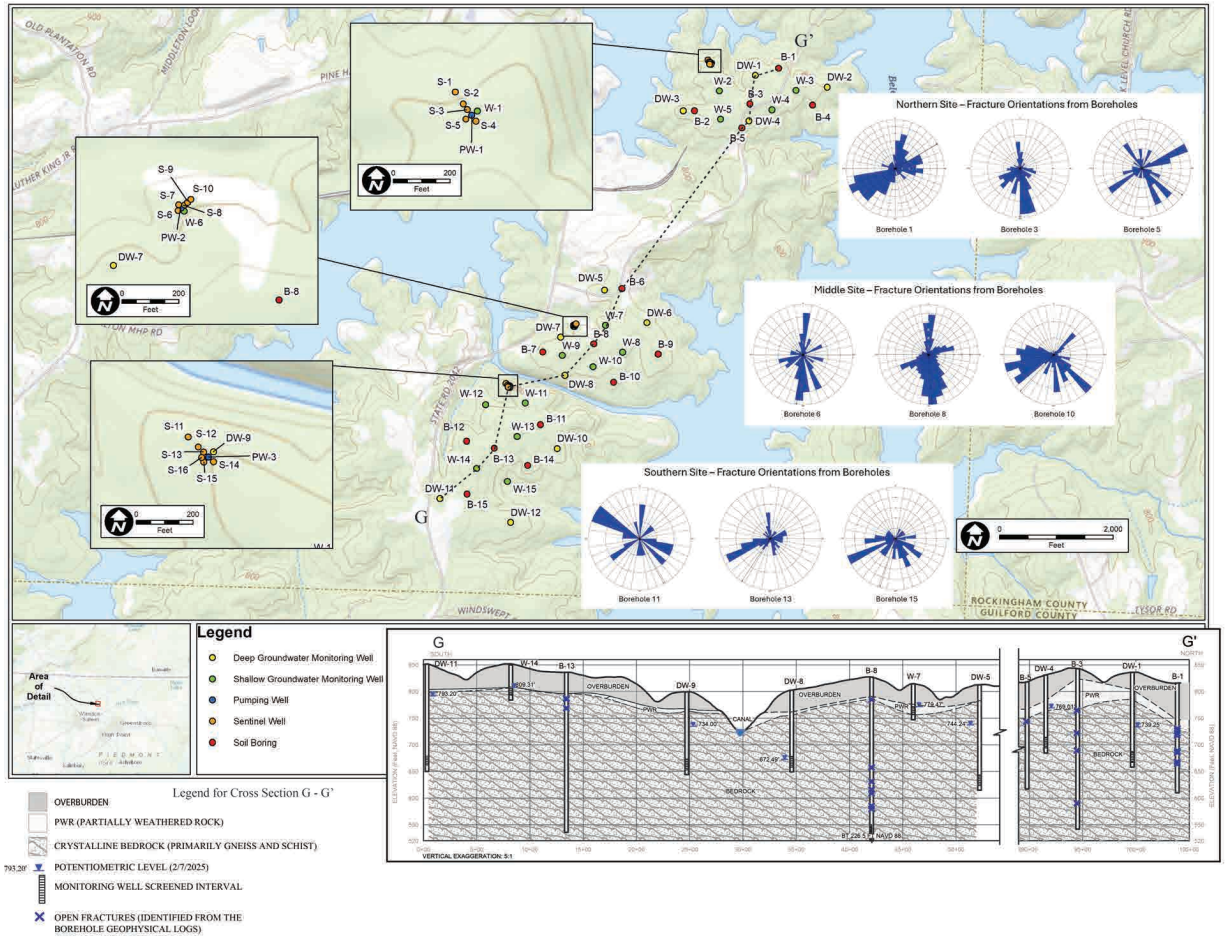
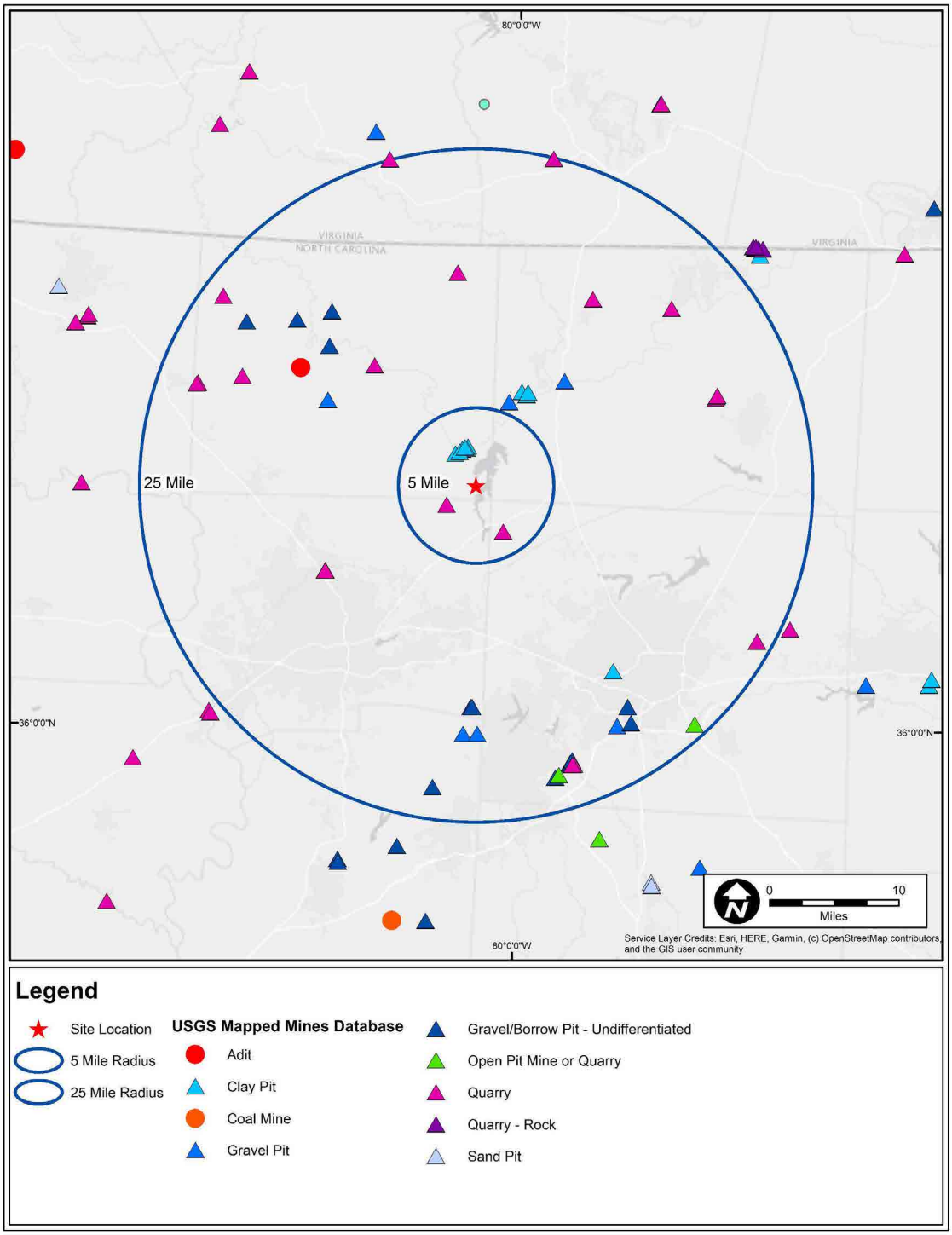


Figure 2.5-117
Mines Mapped by the USGS in the Project Site Vicinity (25 Mi. [40 Km])

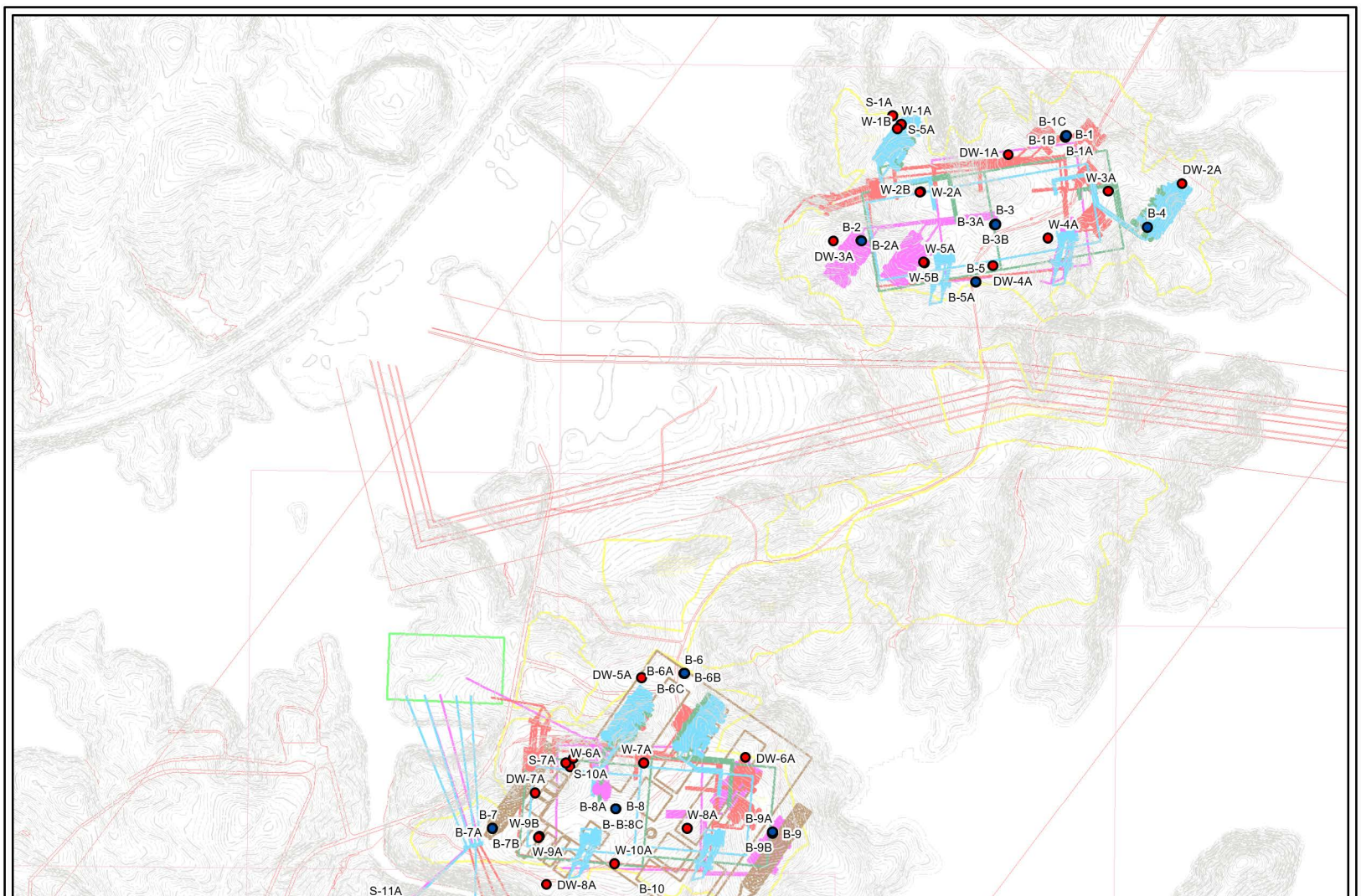


Source: Reference 2.5-218

Note: Site Vicinity contains no mapped underground mine features per Section 2.5.3.7.1.

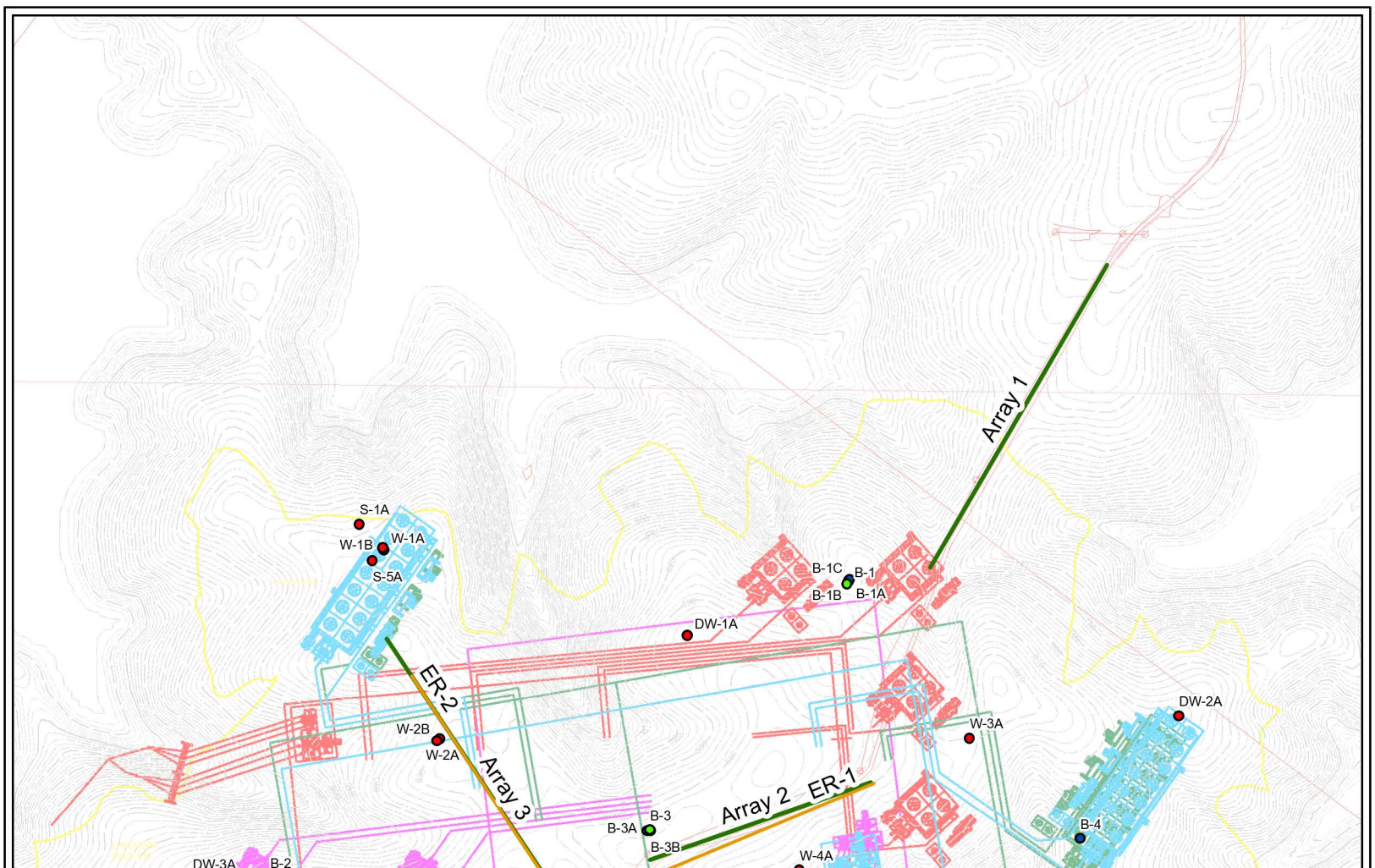
Key: USGS = U.S. Geological Survey

Figure 2.5-118
Geotechnical Test Location Plan – All Three Plant Complexes



Note: The plant layout used as a base layer in this map is a composite of the proposed reactor technologies.

Figure 2.5-119
Geophysical and Geotechnical Test Location Plan – North Plant Complex



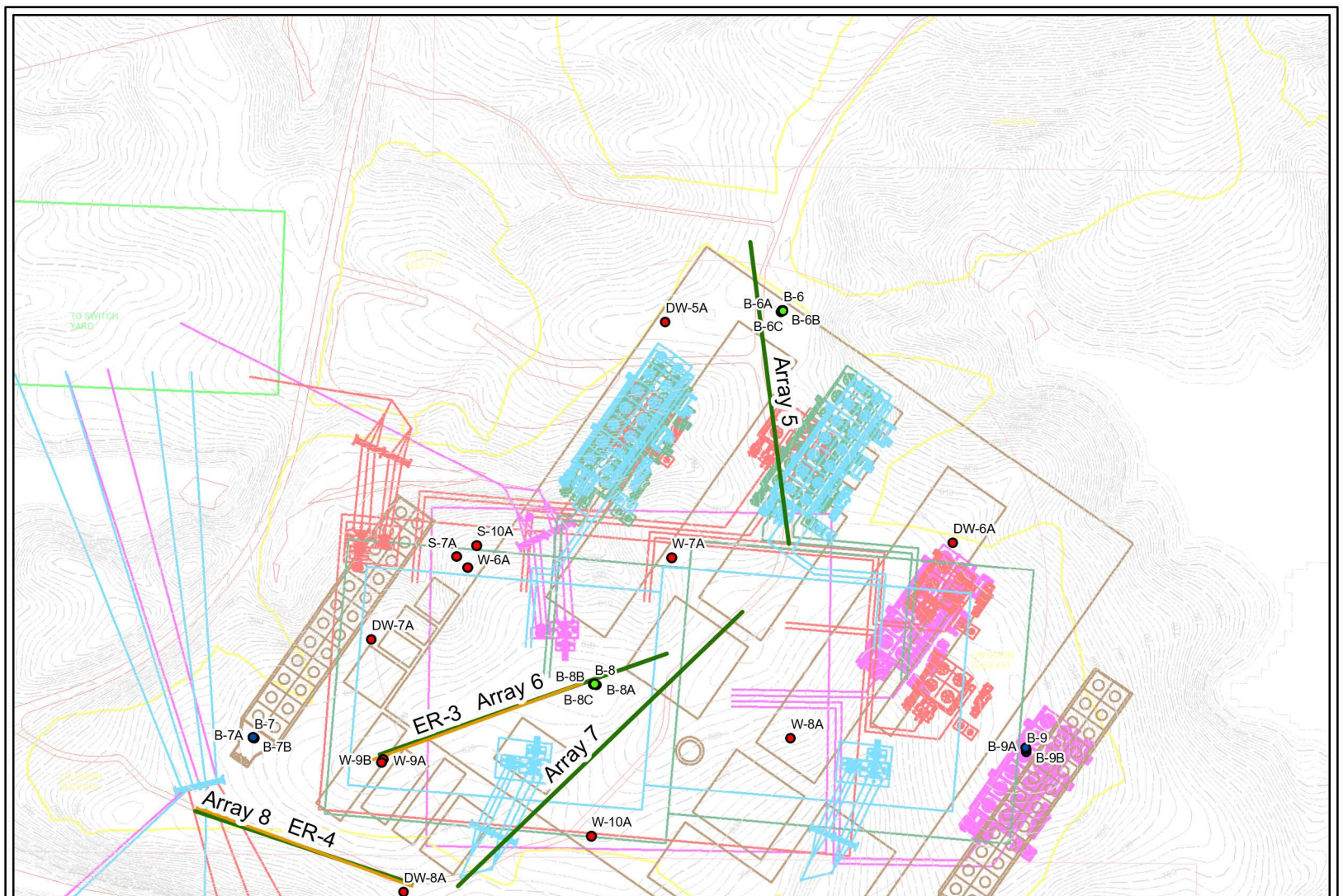
Legend

- Well / Lithologic Boring
- Geotechnical Boring
- Geophysical Boring
- Electrical Resistivity Array
- SASW Array

Note: The plant layout used as a base layer in this map is a composite of the proposed reactor technologies.

Key: SASW = Spectral Analysis of Surface Waves

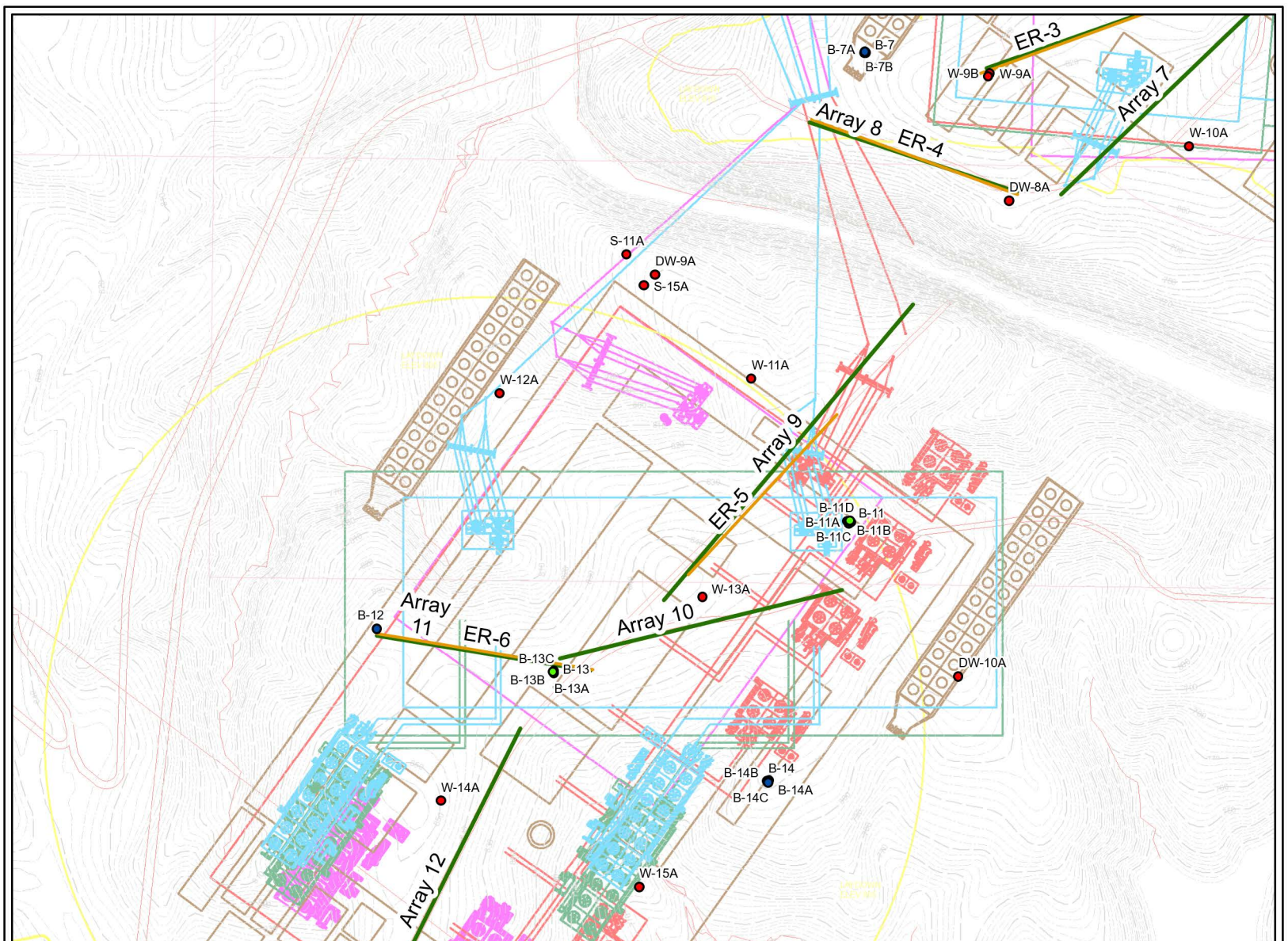
Figure 2.5-120
Geophysical and Geotechnical Test Location Plan – Middle Plant Complex



Note: The plant layout used as a base layer in this map is a composite of the proposed reactor technologies.

Key: SASW = Spectral Analysis of Surface Waves

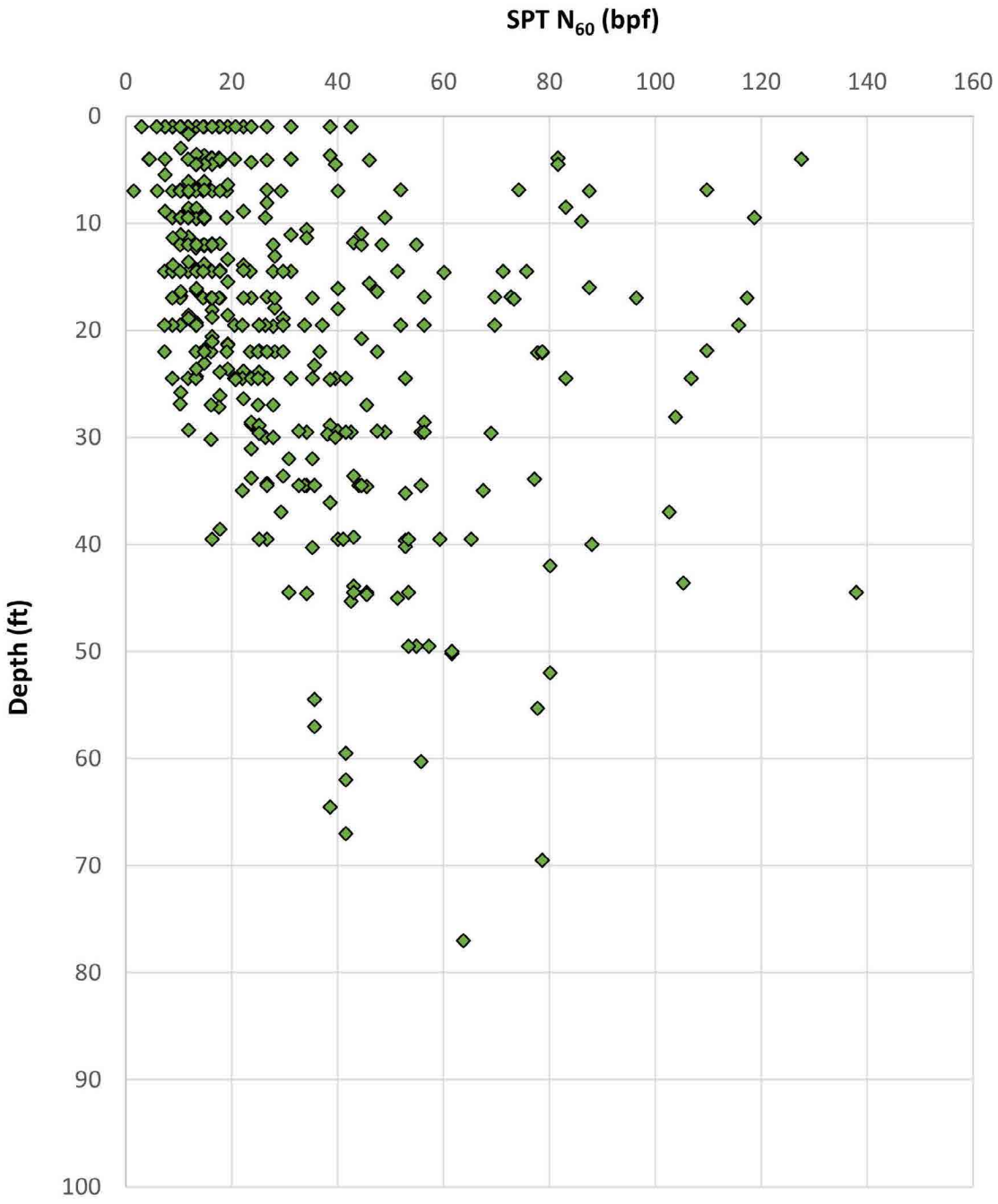
Figure 2.5-121
Geophysical and Geotechnical Test Location Plan – South Plant Complex



Note: The plant layout used as a base layer in this map is a composite of the proposed reactor technologies.

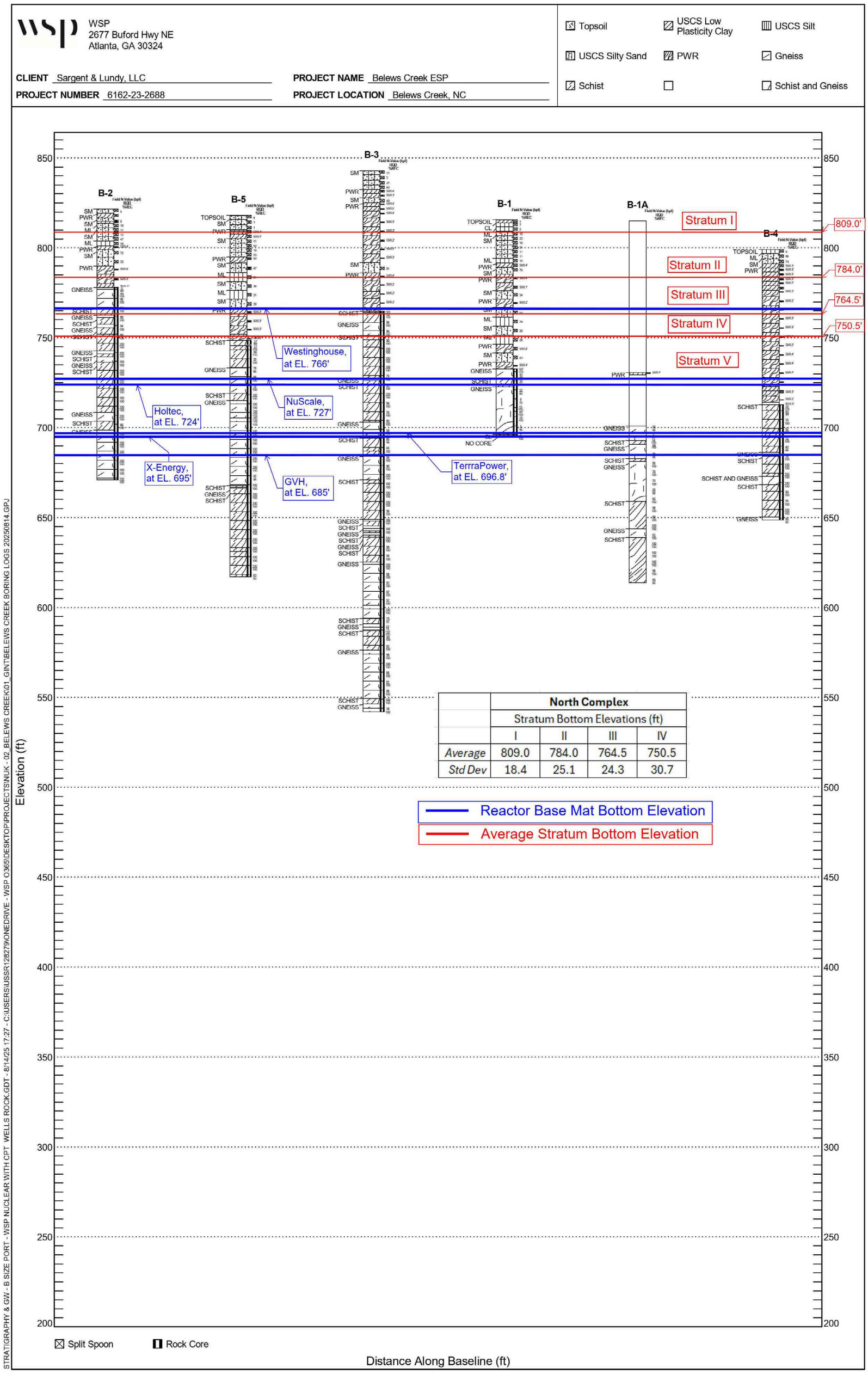
Key: SASW = Spectral Analysis of Surface Waves

Figure 2.5-122
Summary of Standard Penetration Test (SPT) N_{60} Values (All Three Plant Complexes)



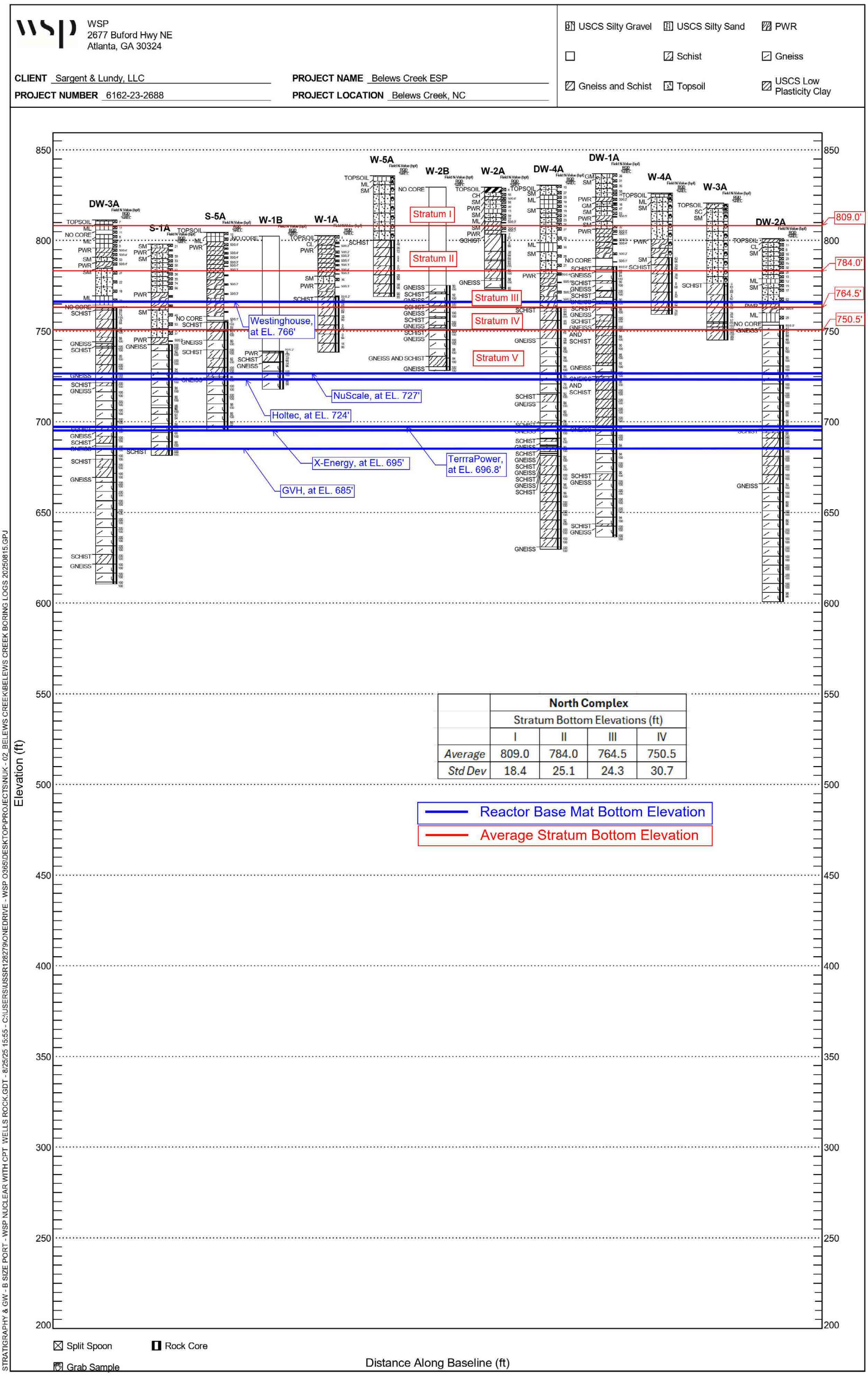
Key: bpf = blows per foot; ft. = feet; N_{60} = hammer energy-corrected SPT N-values

Figure 2.5-123
Subsurface Diagrams – North Plant Complex (B-Series Borings)



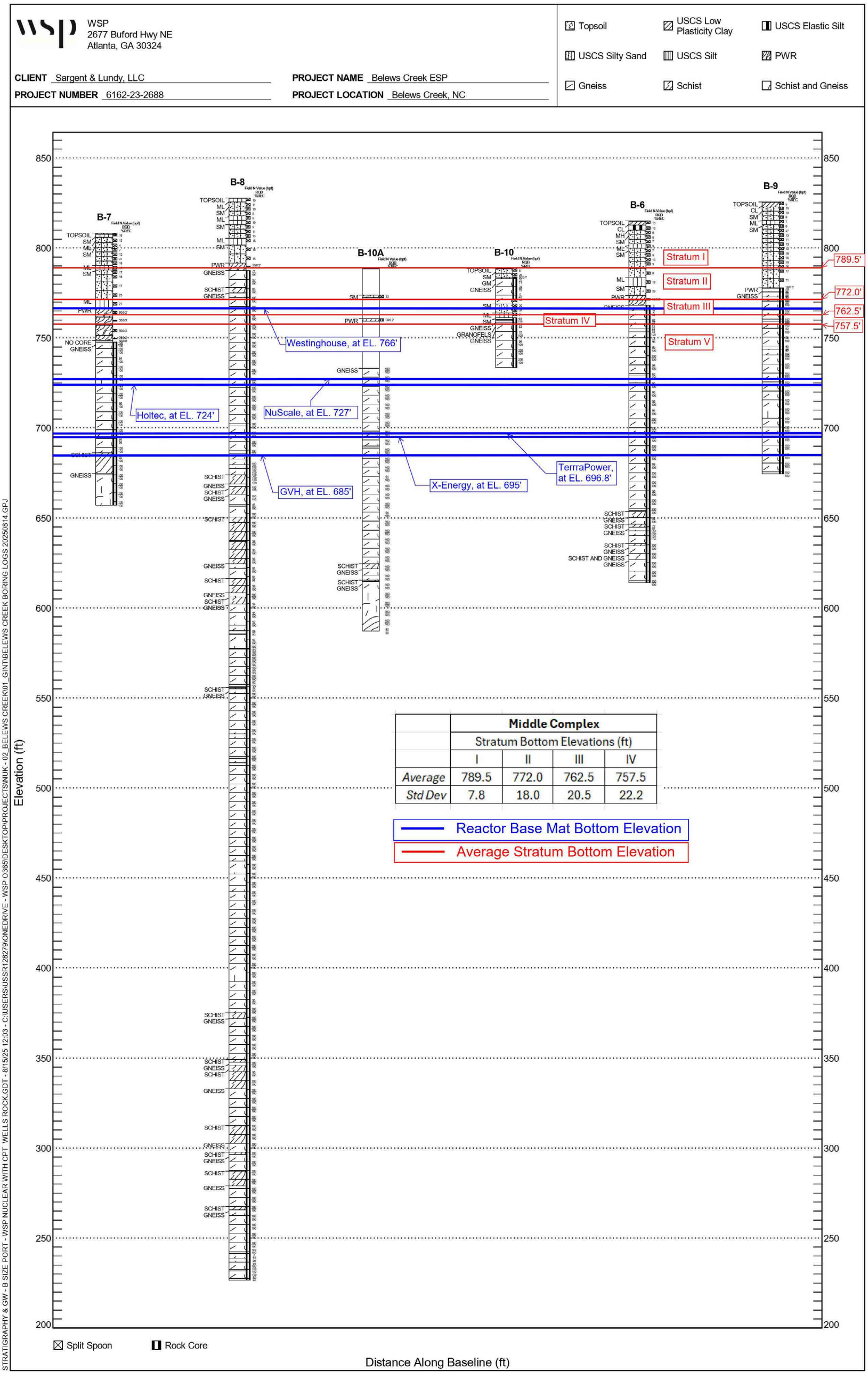
Key: EL. = elevation; ft = feet; PWR = partially weathered rock; std dev = standard deviation; USCS = Unified Soil Classification System

Figure 2.5-124
Subsurface Diagrams – North Plant Complex (S-, W- and DW-Series Borings)



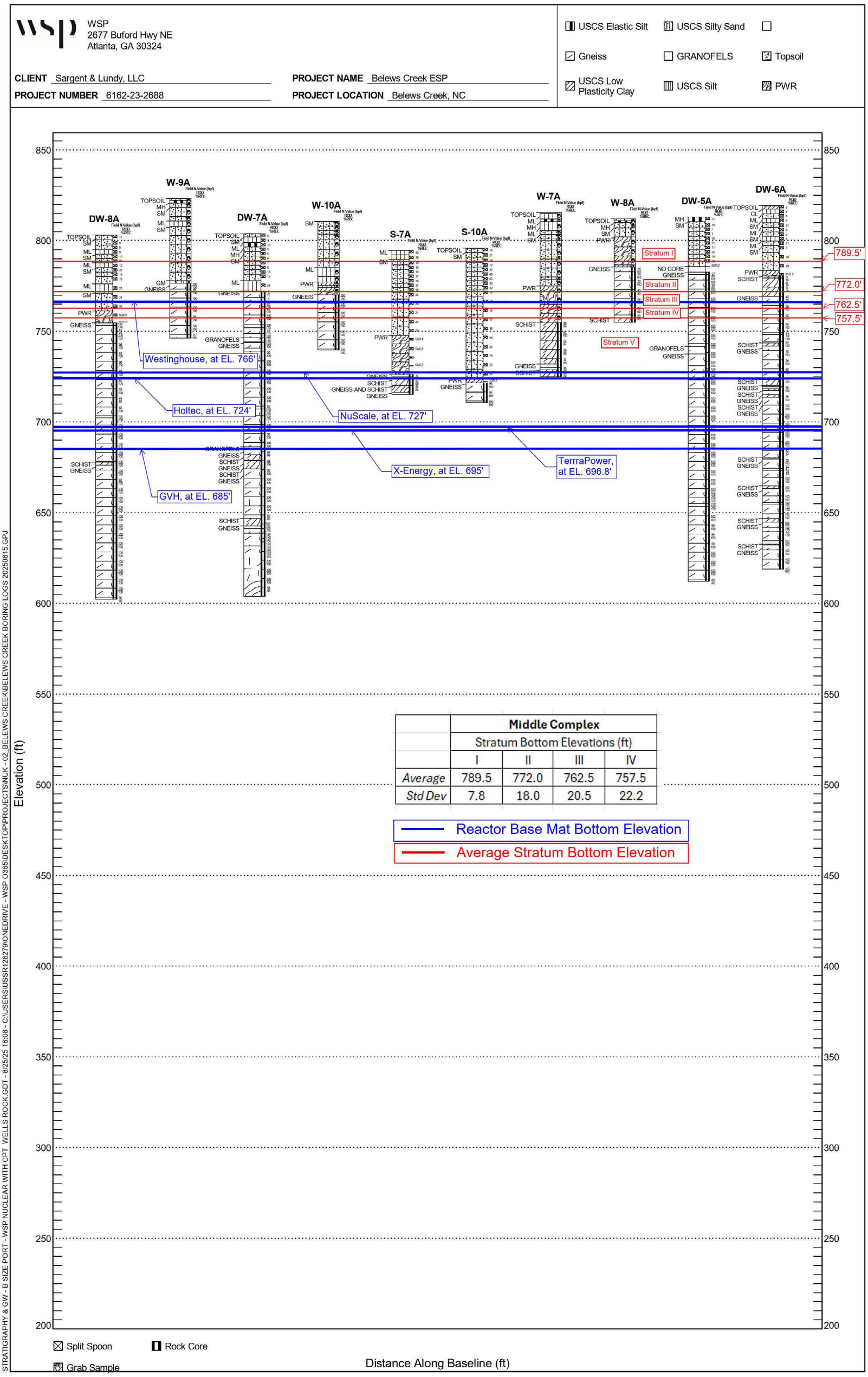
Key: EL. = elevation; ft = feet; PWR = partially weathered rock; std dev = standard deviation; USCS = Unified Soil Classification System

Figure 2.5-125
Subsurface Diagrams – Middle Plant Complex (B-Series Borings)



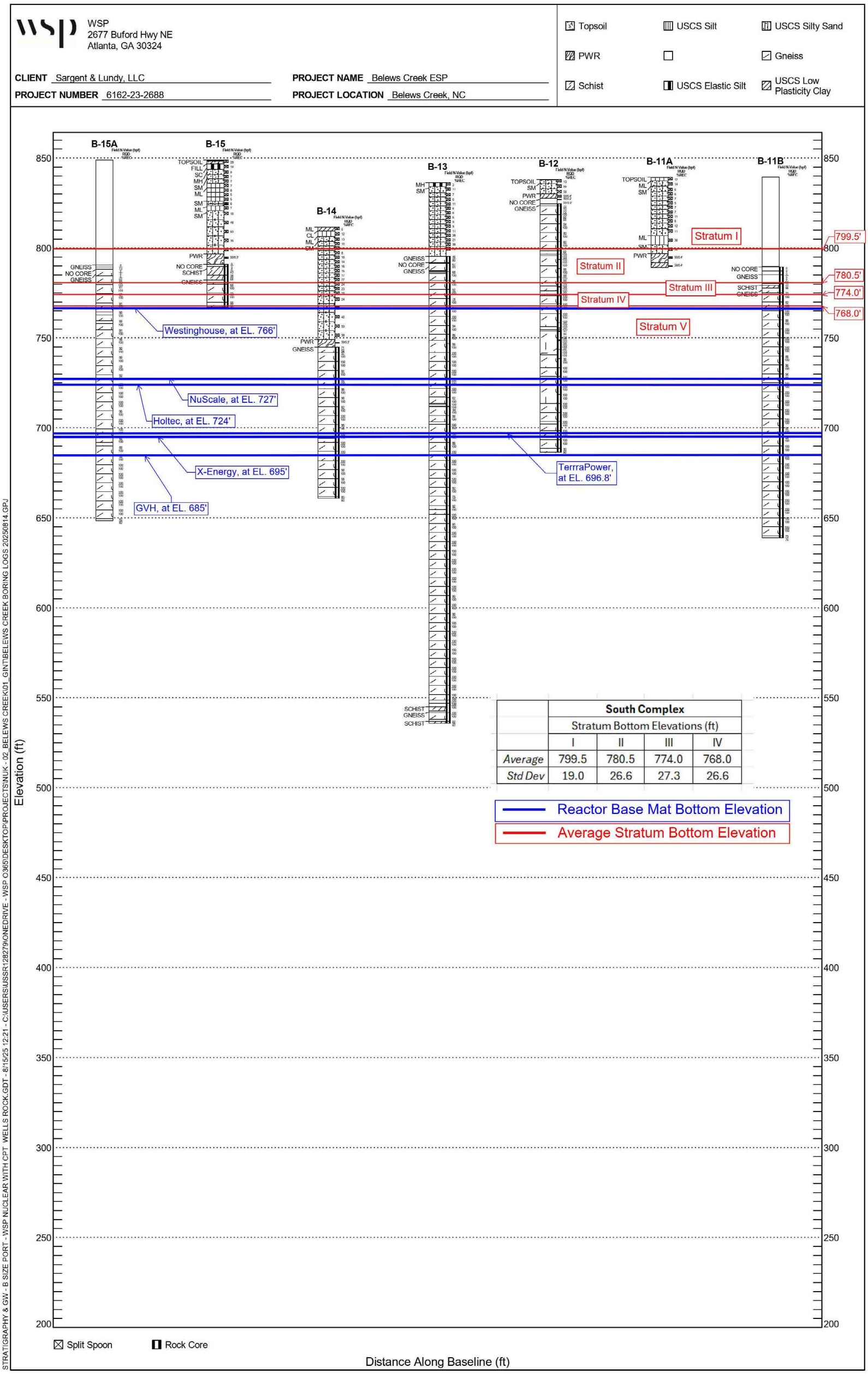
Key: EL. = elevation; ft = feet; PWR = partially weathered rock; std dev = standard deviation; USCS = Unified Soil Classification System

Figure 2.5-126
Subsurface Diagrams – Middle Plant Complex (S-, W- and DW-Series Borings)



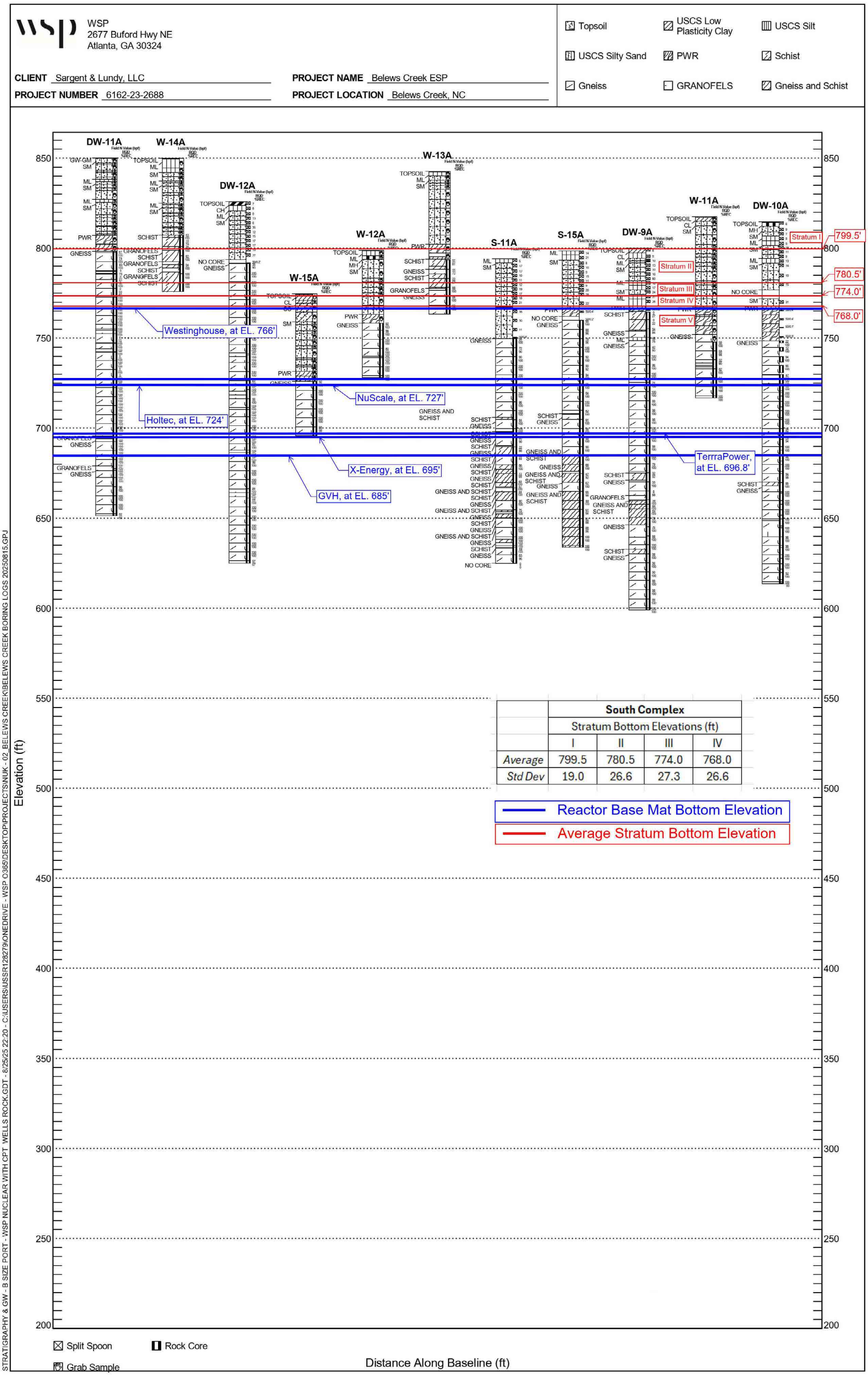
Key: EL. = elevation; ft = feet; PWR = partially weathered rock; std dev = standard deviation; USCS = Unified Soil Classification System

Figure 2.5-127
Subsurface Diagrams – South Plant Complex (B-Series Borings)



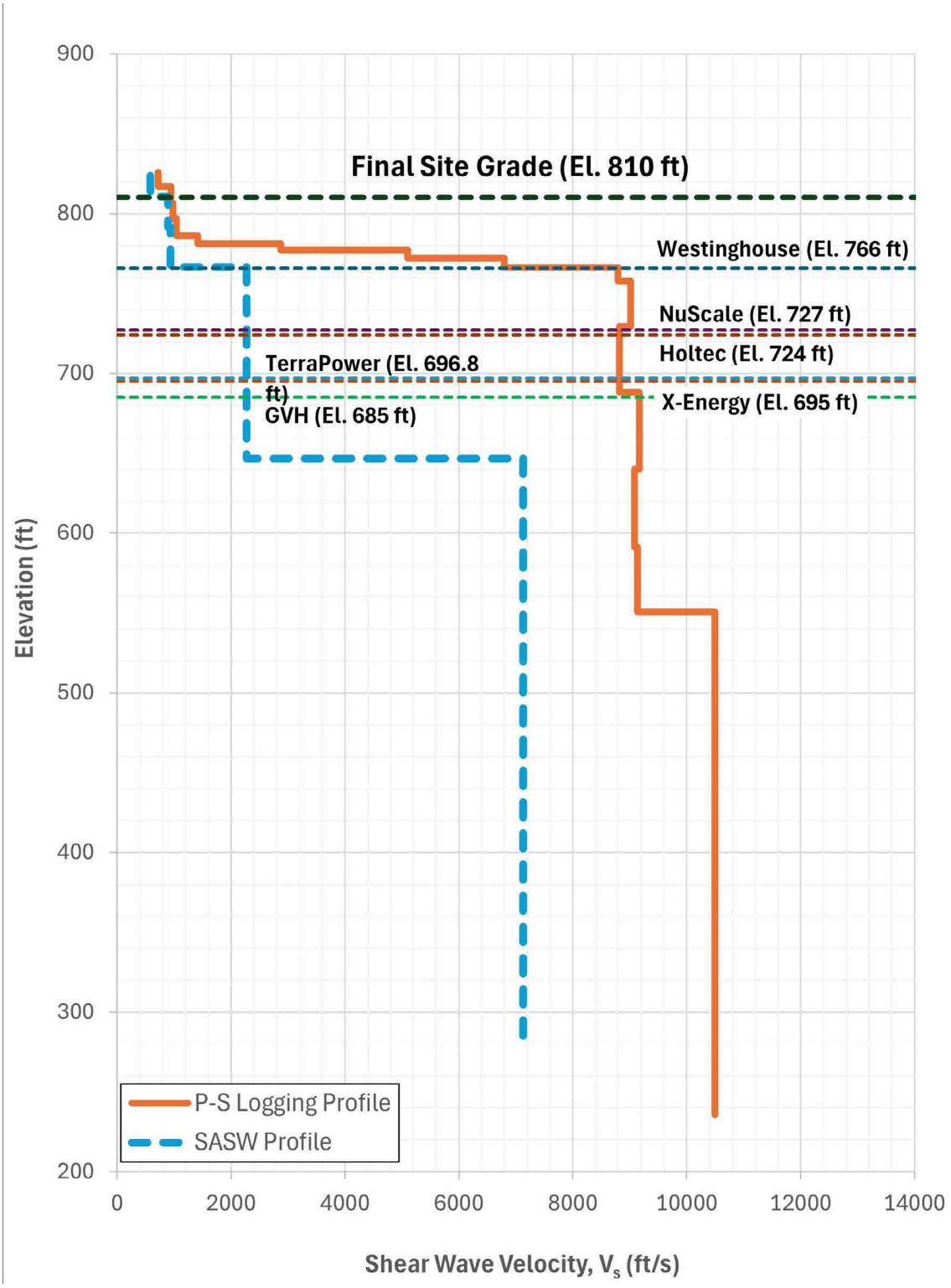
Key: EL. = elevation; ft = feet; PWR = partially weathered rock; std dev = standard deviation; USCS = Unified Soil Classification System

Figure 2.5-128
Subsurface Diagrams – South Plant Complex (S-, W- and DW-Series Borings)



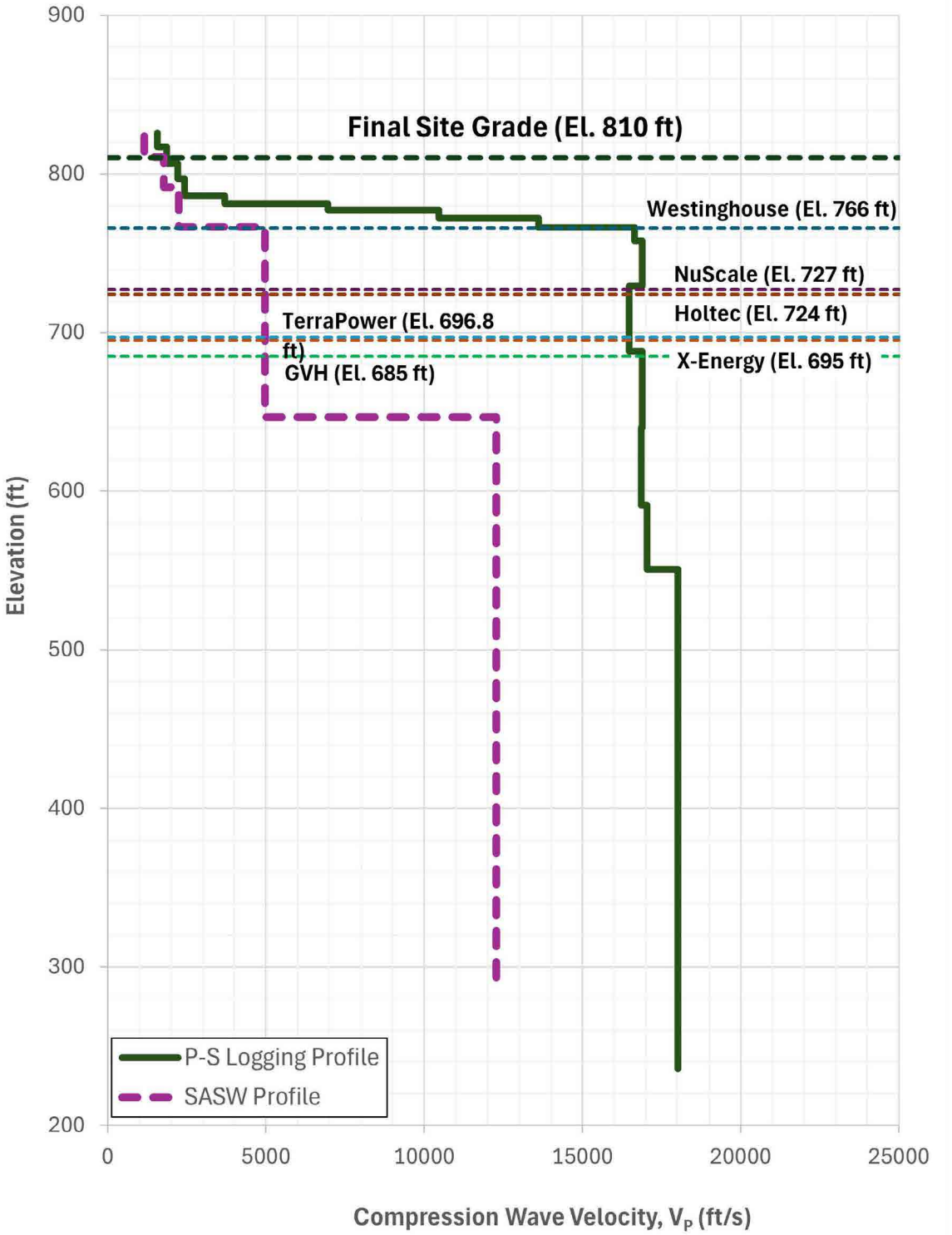
Key: EL. = elevation; ft = feet; PWR = partially weathered rock; std dev = standard deviation; USCS = Unified Soil Classification System

Figure 2.5-129
Best Estimate Shear Wave Velocity Profiles for Belews Creek Site



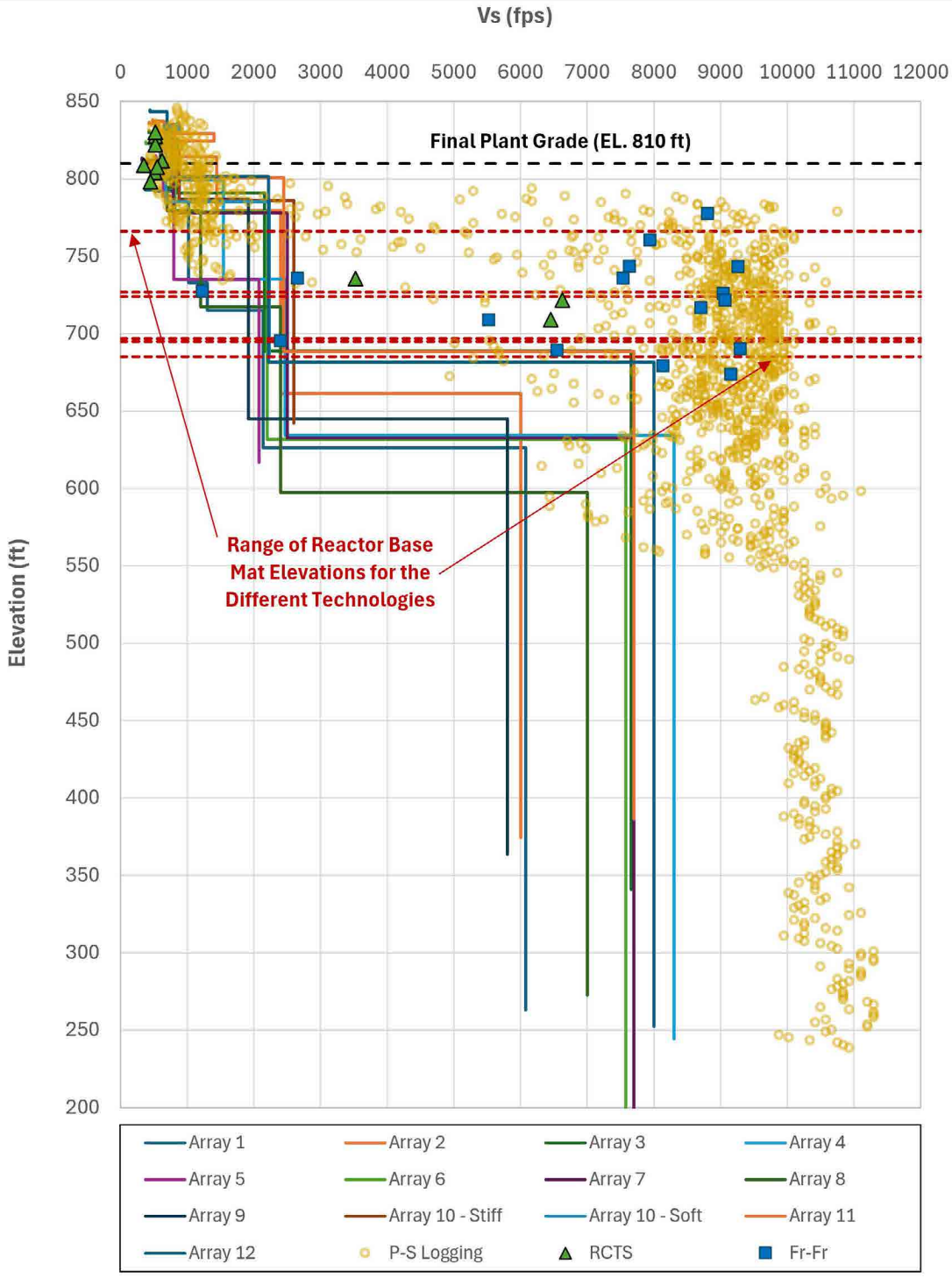
Key: EL. = elevation; ft. = feet; ft/s = feet per second; P-S = P-wave (compression) and S-wave (shear); SASW = Spectral Analysis of Surface Waves

Figure 2.5-130
Best Estimate Compression Wave Velocity Profiles for Belews Creek Site



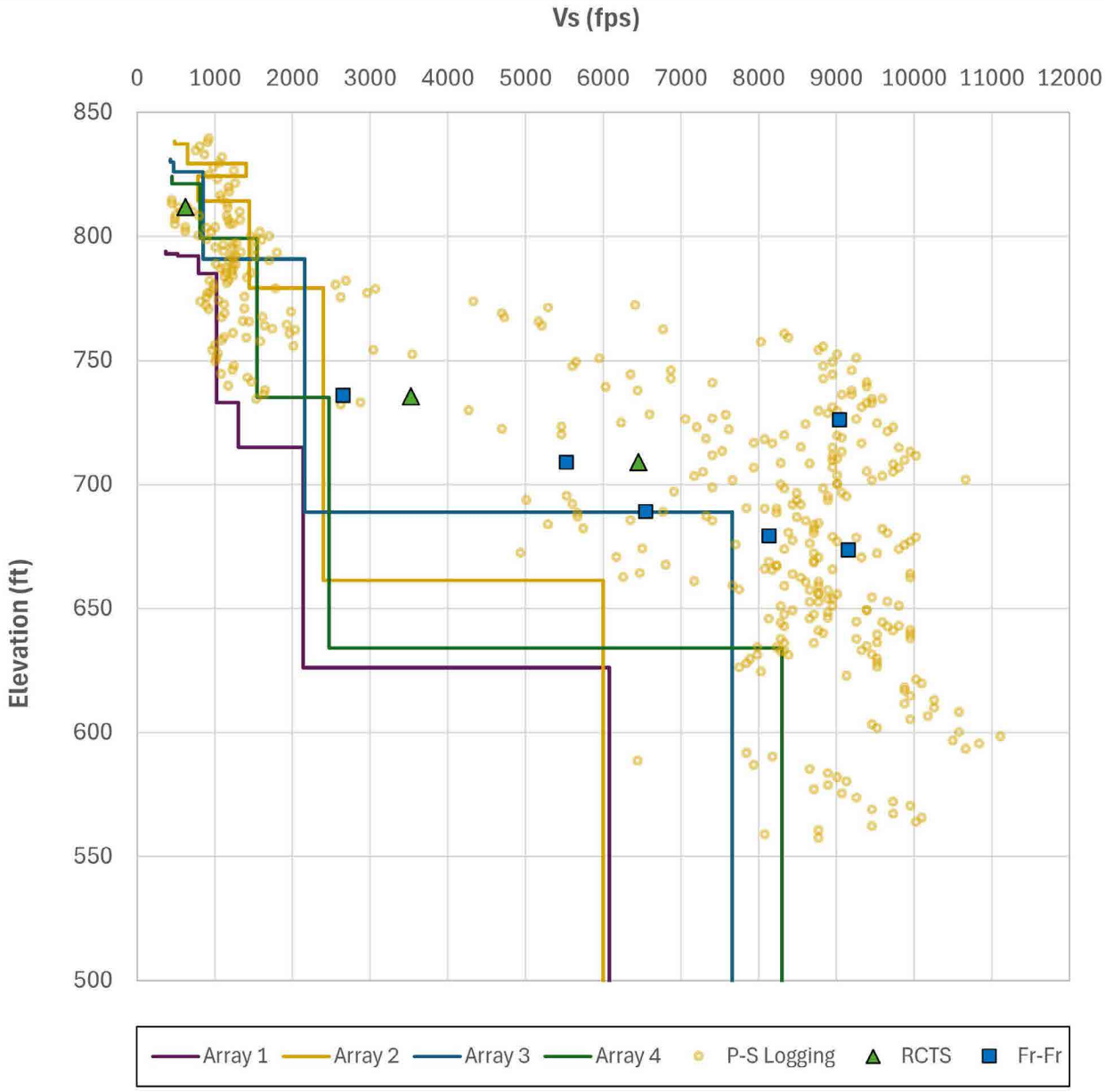
Key: EL. = elevation; ft. = feet; ft/s = feet per second; P-S = P-wave (compression) and S-wave (shear); SASW = Spectral Analysis of Surface Waves

Figure 2.5-131
Summary of Shear Wave Velocities (by Elevation) – All Three Plant Complexes



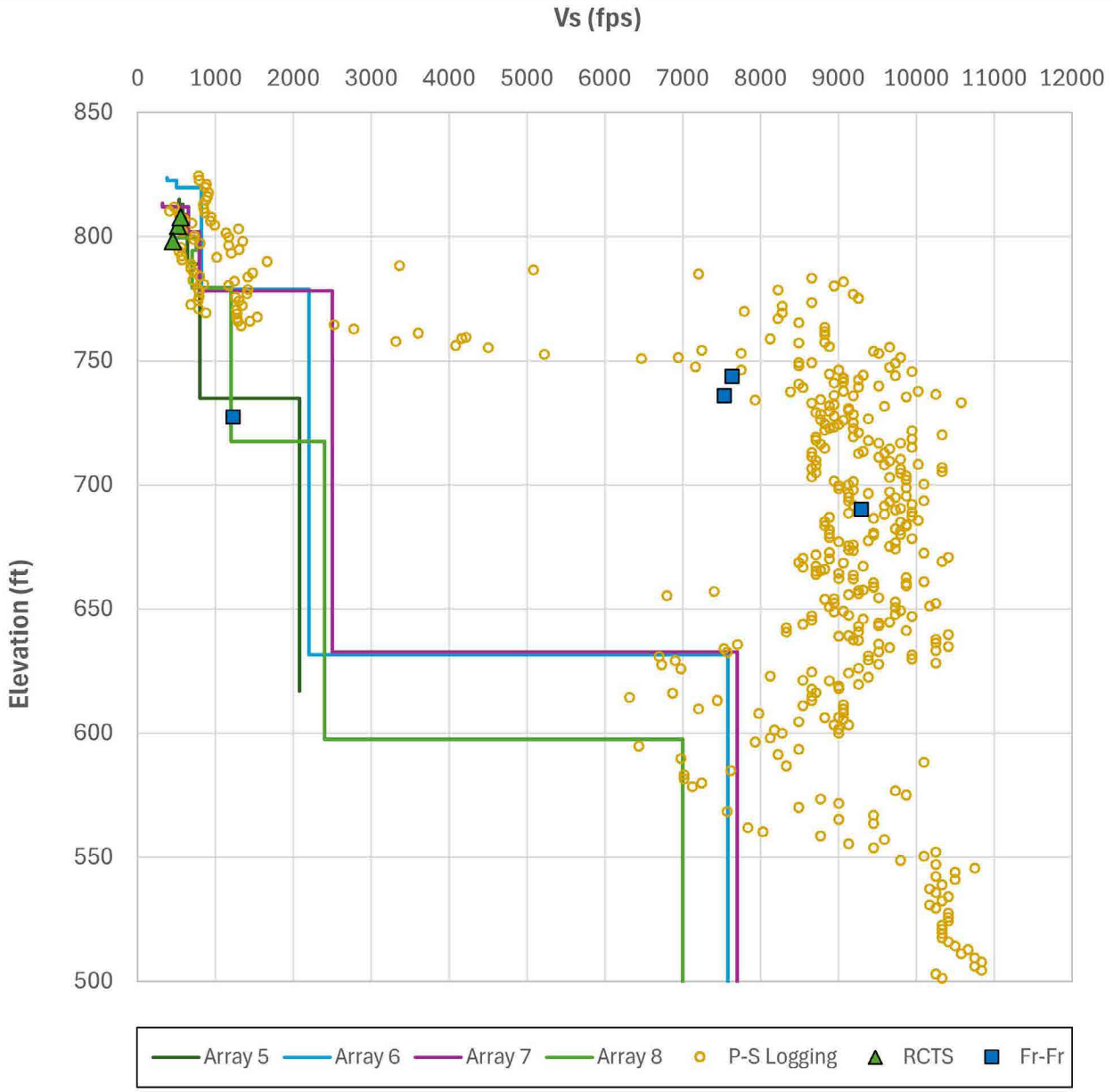
Key: EL. = elevation; fps = feet per second; Fr-Fr = Free-Free; ft. = feet; P-S = P-wave (compression) and S-wave (shear); RCTS = Resonant Column Torsional Shear

Figure 2.5-132
Summary of Shear Wave Velocities (by Elevation) – North Plant Complex



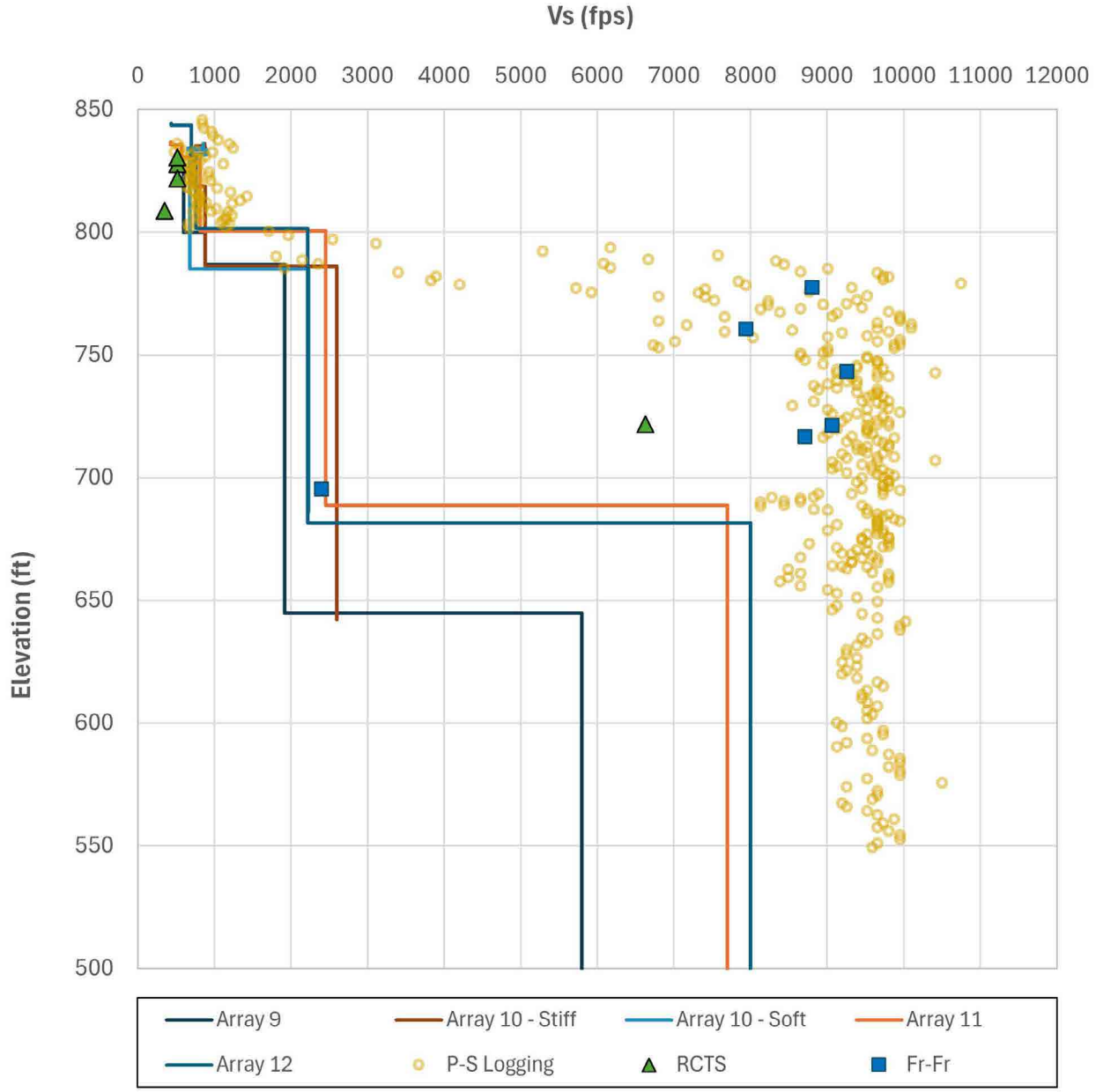
Key: EL. = elevation; fps = feet per second; Fr-Fr = Free-Free Unconfined Resonant Column; ft. = feet; P-S = P-wave (compression) and S-wave (shear); RCTS = Resonant Column Torsional Shear

Figure 2.5-133
Summary of Shear Wave Velocities (by Elevation) – Middle Plant Complex



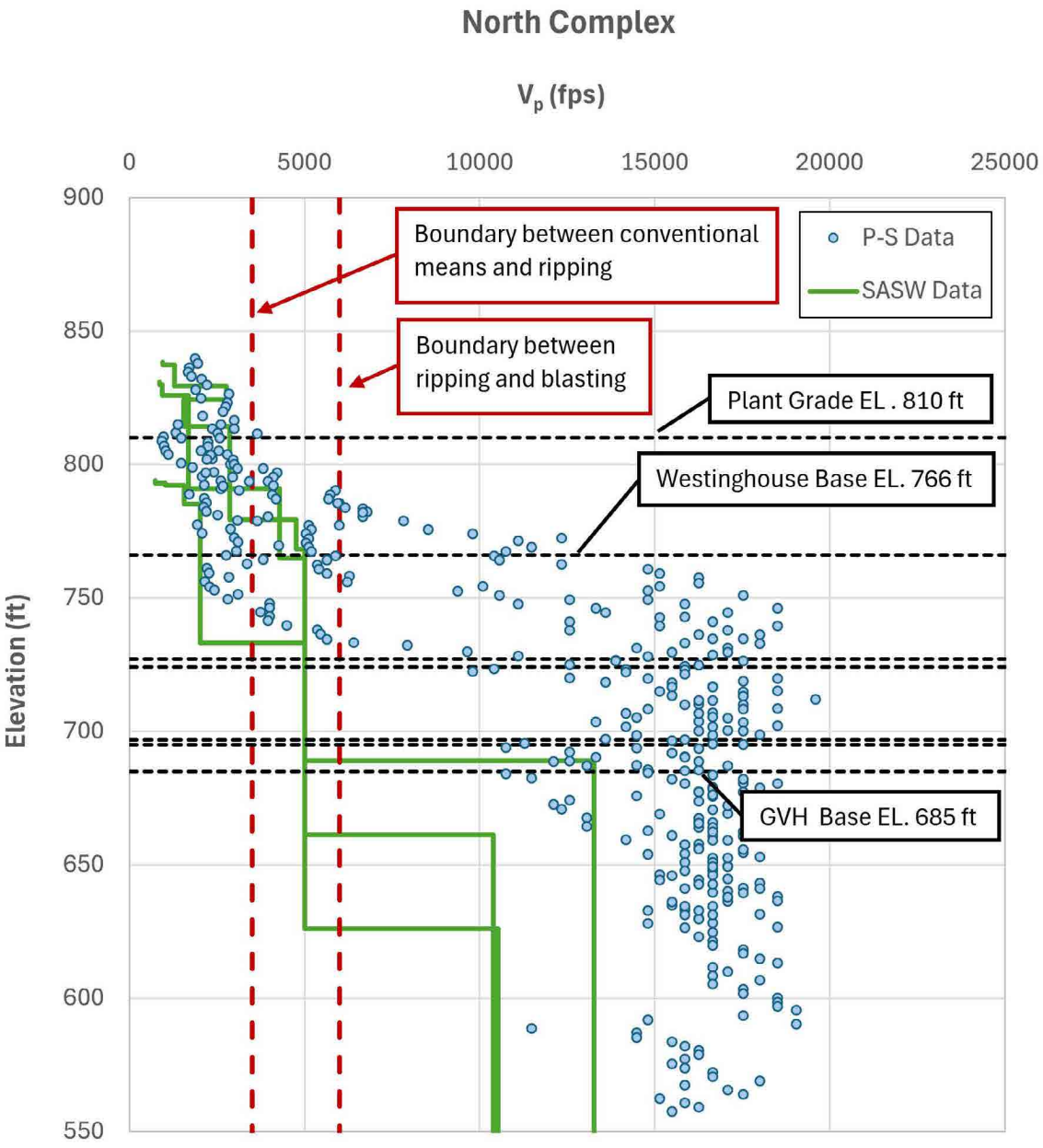
Key: EL. = elevation; fps = feet per second; Fr-Fr = Free-Free Unconfined Resonant Column; ft. = feet; P-S = P-wave (compression) and S-wave (shear); RCTS = Resonant Column Torsional Shear

Figure 2.5-134
Summary of Shear Wave Velocities (by Elevation) – South Plant Complex



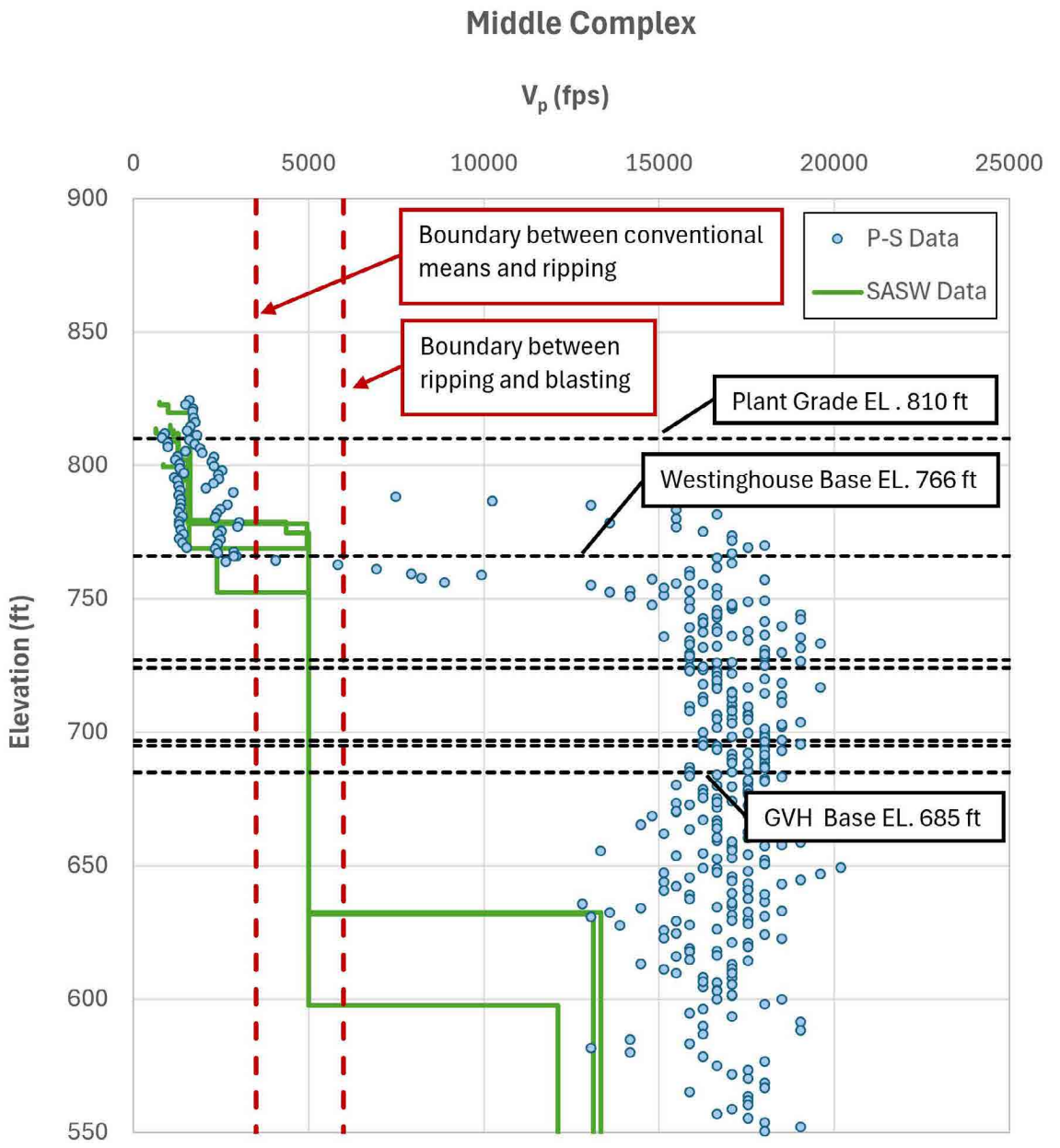
Key: EL. = elevation; fps = feet per second; Fr-Fr = Free-Free Unconfined Resonant Column; ft. = feet; P-S = P-wave (compression) and S-wave (shear); RCTS = Resonant Column Torsional Shear

Figure 2.5-135
Summary of Compression Wave Velocities – North Plant Complex



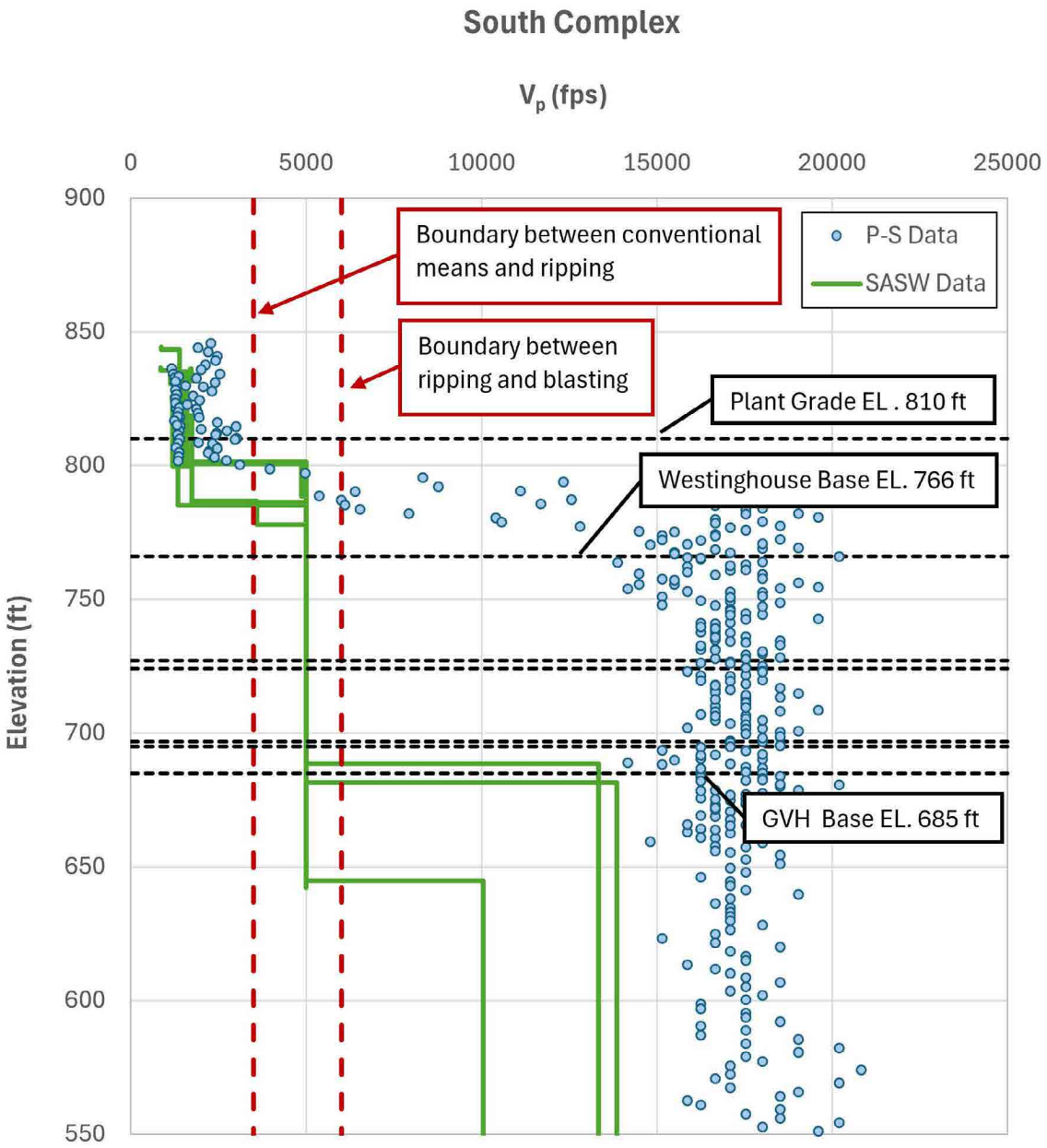
ar;
SASW = Spectral Analysis of Surface Waves

Figure 2.5-136
Summary of Compression Wave Velocities – Middle Plant Complex



Key: EL. = elevation; fps = feet per second; ft. = feet; P-S = P-wave (compression) and S-wave (shear); SASW = Spectral Analysis of Surface Waves

Figure 2.5-137
Summary of Compression Wave Velocities – South Plant Complex



Key: EL. = elevation; fps = feet per second; ft. = feet; P-S = P-wave (compression) and S-wave (shear); SASW = Spectral Analysis of Surface Waves

Figure 2.5-138
Shear Wave Velocity Profiles from Different Data Sets (by Depth): (a) North Plant Complex; (b) Middle Plant Complex; (c) South Plant Complex
(Sheet 1 of 3)

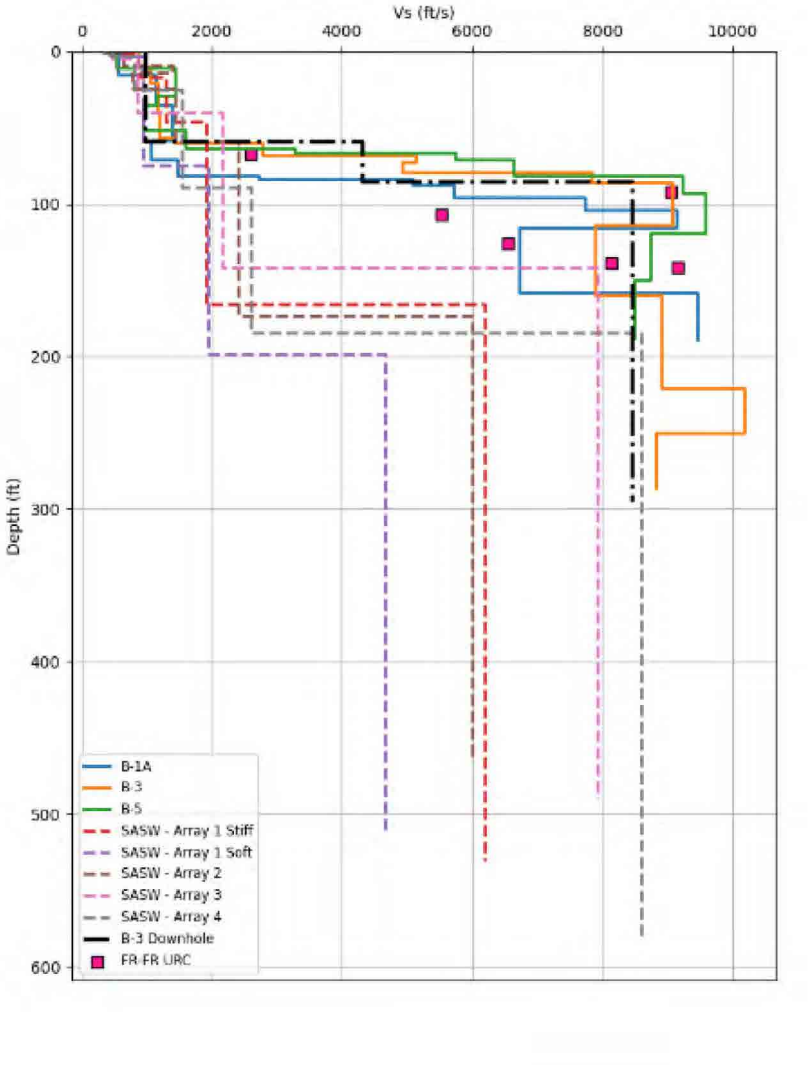


Figure 2.5-138
Shear Wave Velocity Profiles from Different Data Sets (by Depth): (a) North Plant Complex; (b) Middle Plant Complex; (c) South Plant Complex
(Sheet 2 of 3)

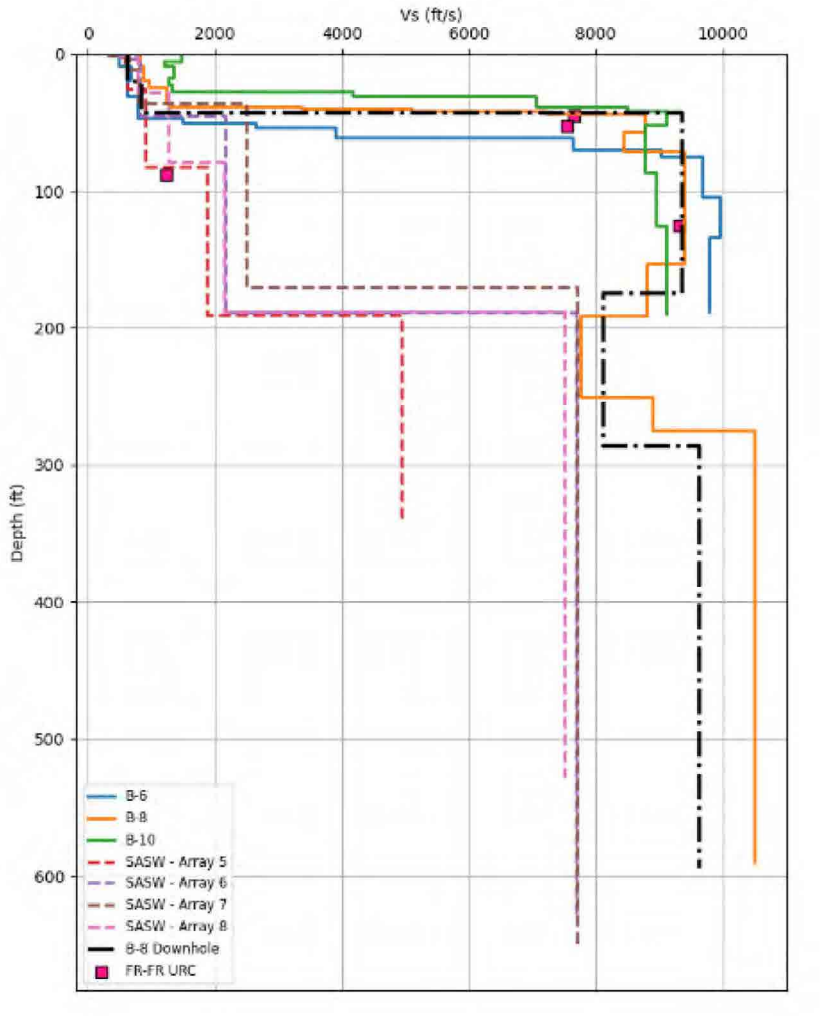
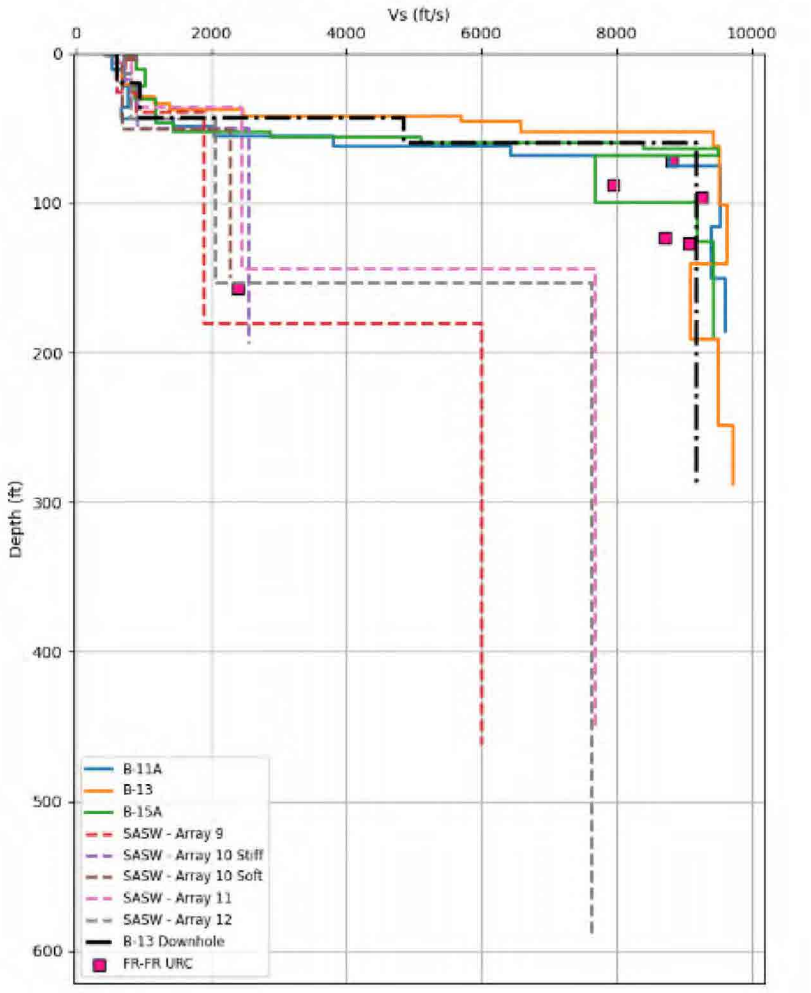
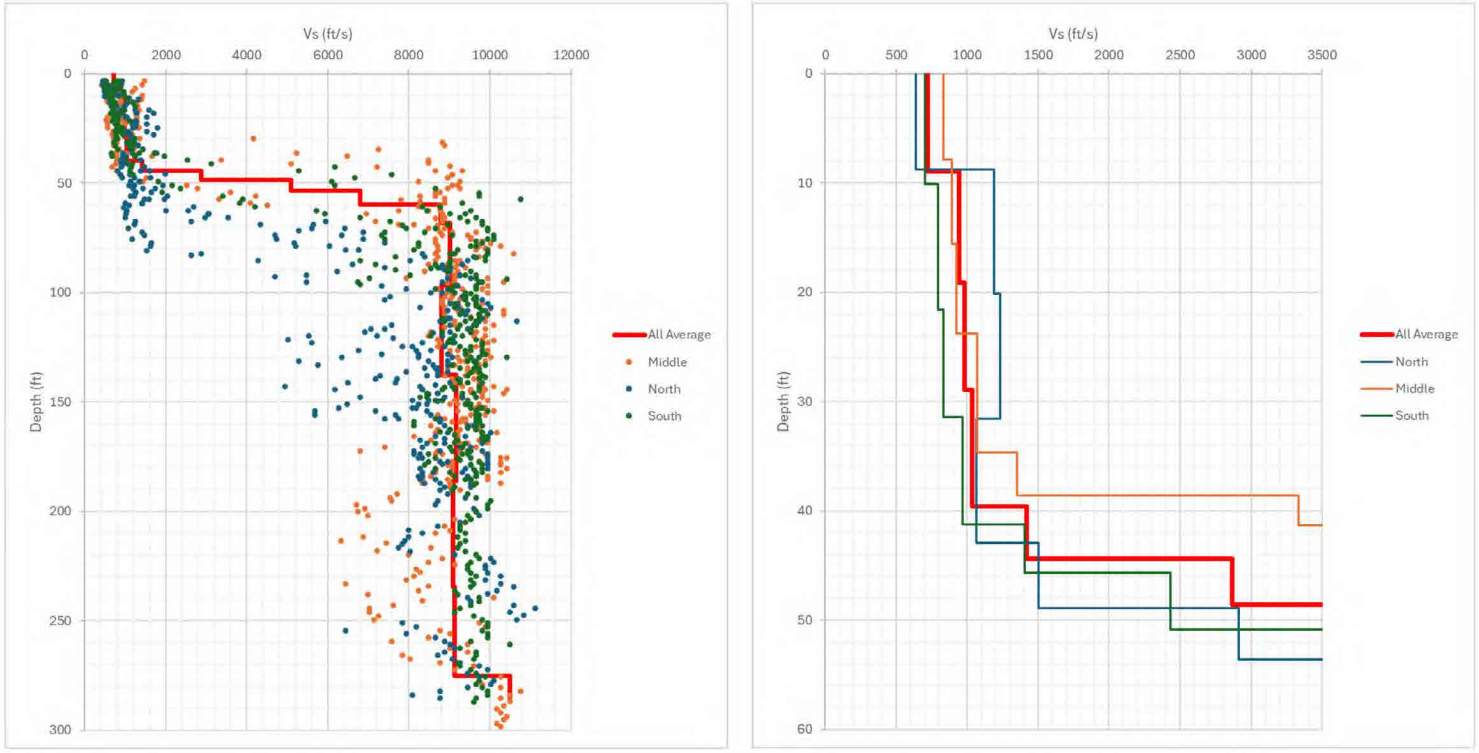


Figure 2.5-138
Shear Wave Velocity Profiles from Different Data Sets (by Depth): (a) North Plant Complex; (b) Middle Plant Complex; (c) South Plant Complex
(Sheet 3 of 3)



Key: Fr-Fr = Free-Free; ft = feet; ft/s = feet per second; SASW = Spectral Analysis of Surface Waves; URC = unconfined resonant column; VS = shear wave velocity

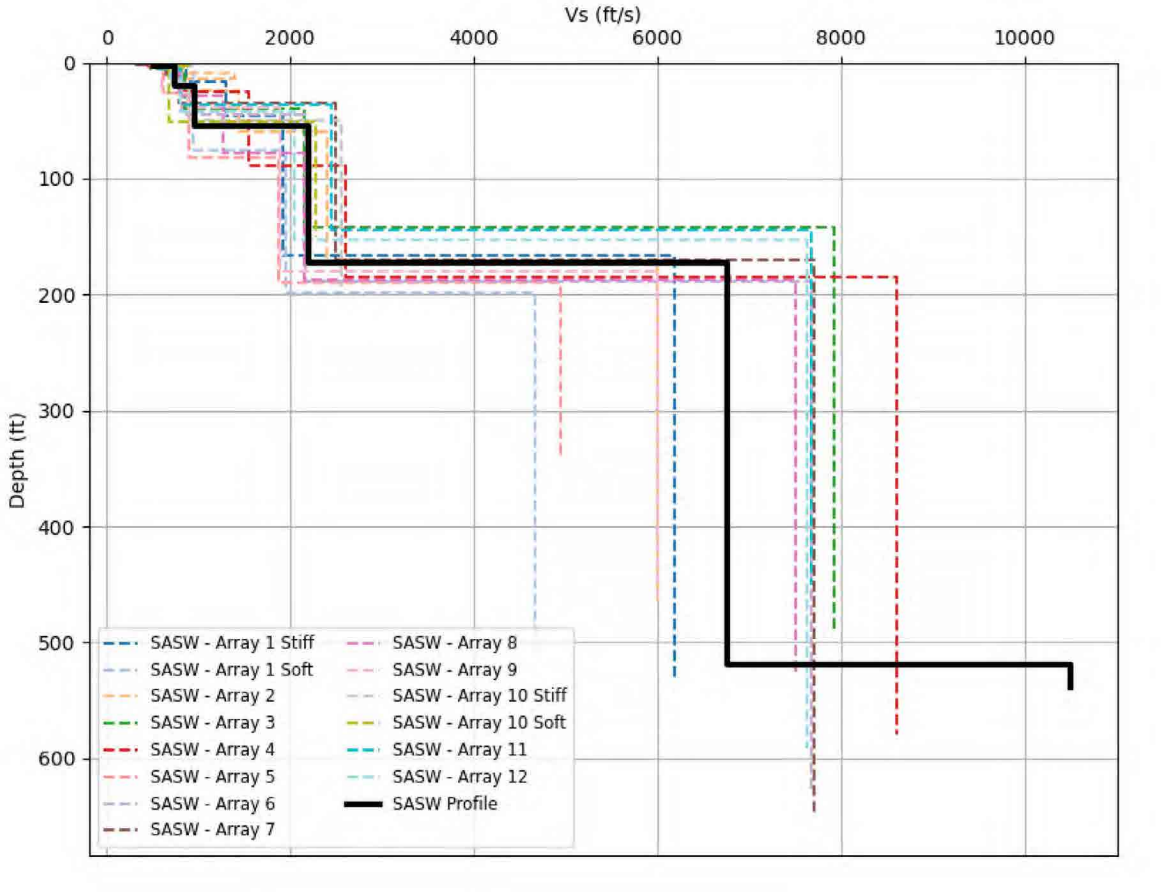
Figure 2.5-139
Suspension P-S Logging Shear Wave Velocity Profiles (All Complexes)



(a) (b)

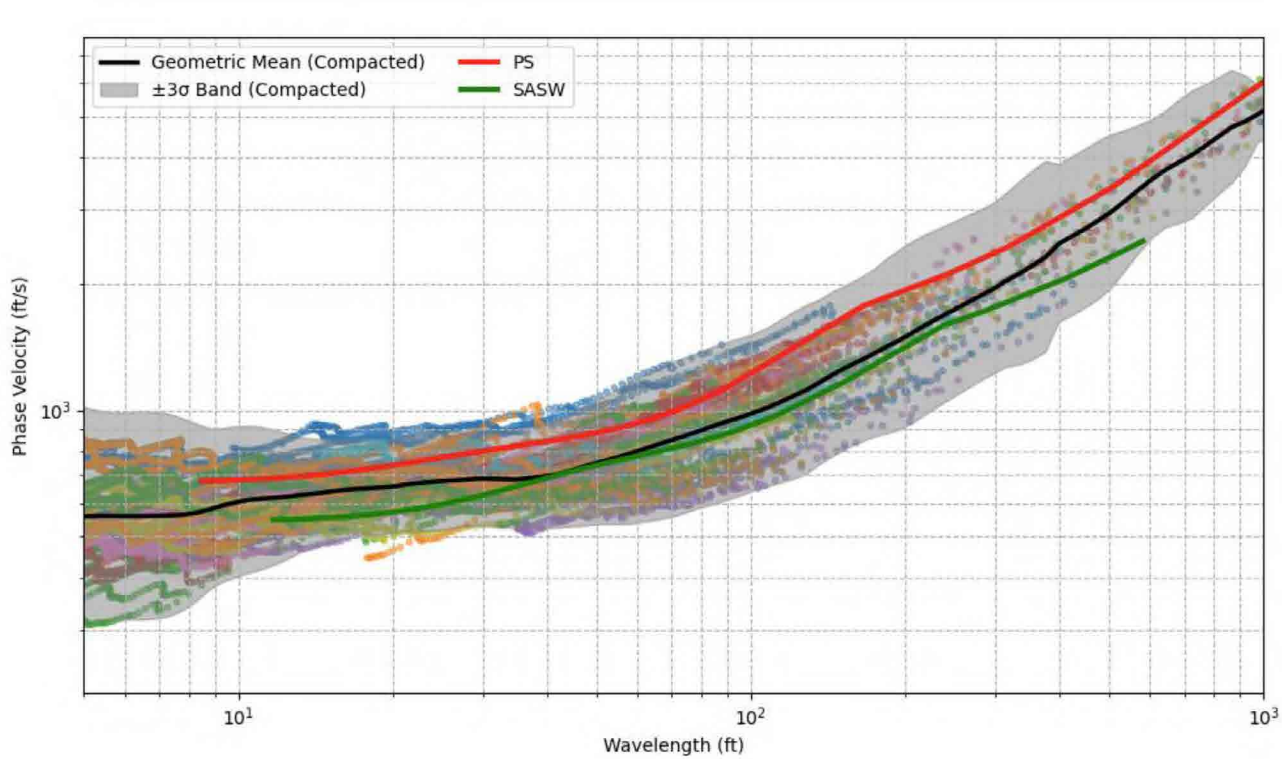
Key: ft = feet; ft/s = feet per second; P-S = P-wave (compression and S-wave (shear; V_S = shear wave velocity

Figure 2.5-140
SASW Shear Wave Velocity Profiles (All Complexes)



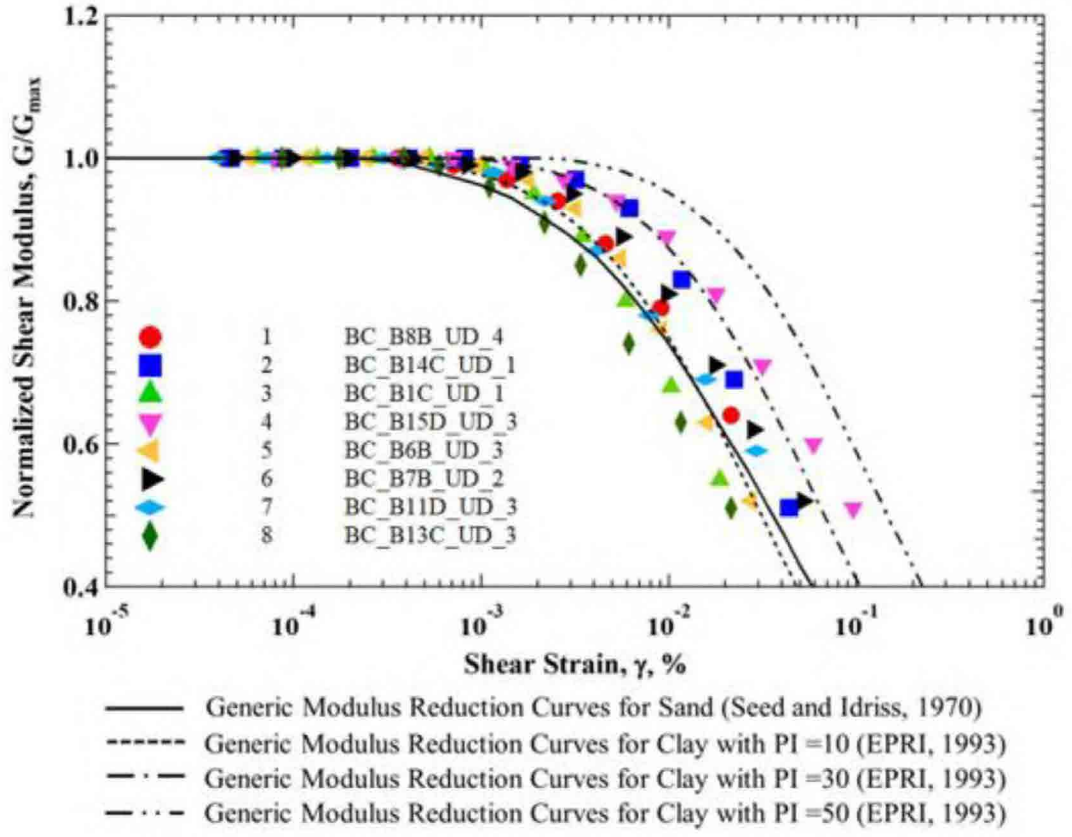
Key: ft = feet; ft/s = feet per second; SASW = Spectral Analysis of Surface Waves; V_S = shear wave velocity

Figure 2.5-141
Comparison of Experimental Dispersion Curves (Points), Three Sigma Bounds of Dispersion Curve Data, and the Dispersion Curves of the Suspension Log (Red Line) and SASW Profiles (Green Line)



Key: ft = feet; ft/s = feet per second; PS = P-wave (compression) and S-wave (shear); SASW = Spectral Analysis of Surface Waves

Figure 2.5-142
Shear Modulus Reduction Data and Empirical Curves



Key: EPRI = Electric Power Research Institute; G = shear modulus; Gmax = maximum shear modulus; PI = plasticity index

Figure 2.5-143
Material Damping Ratio Data

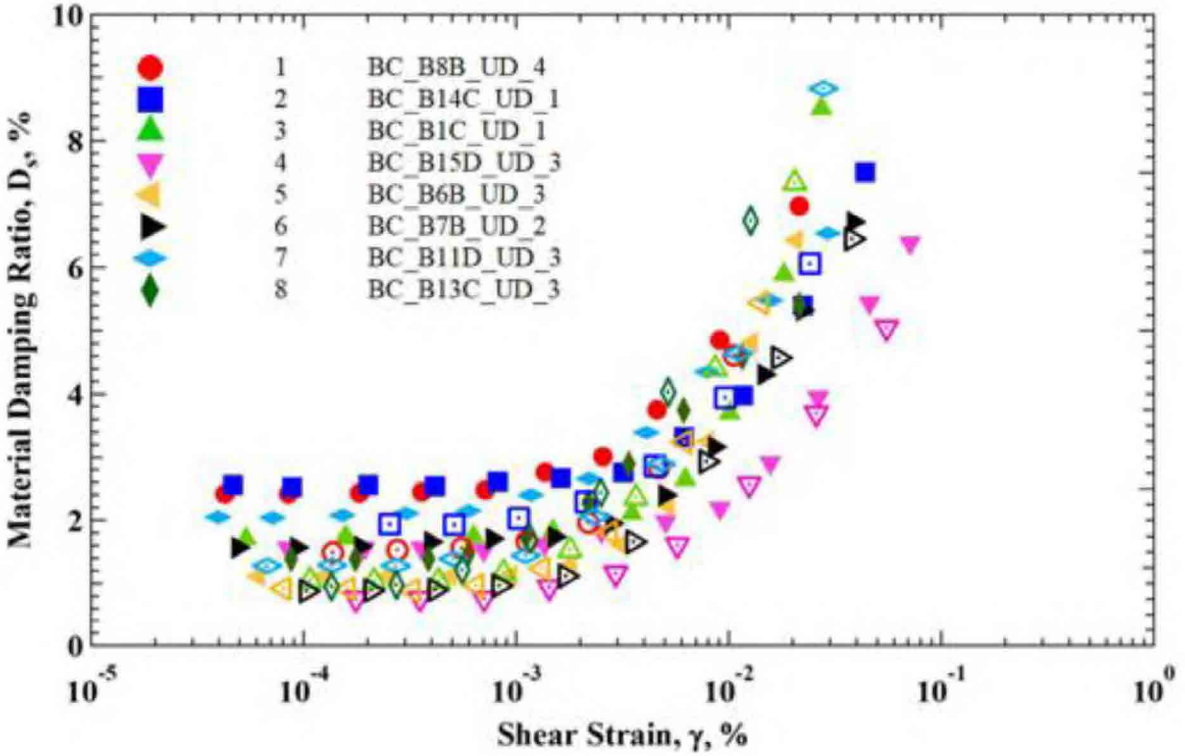
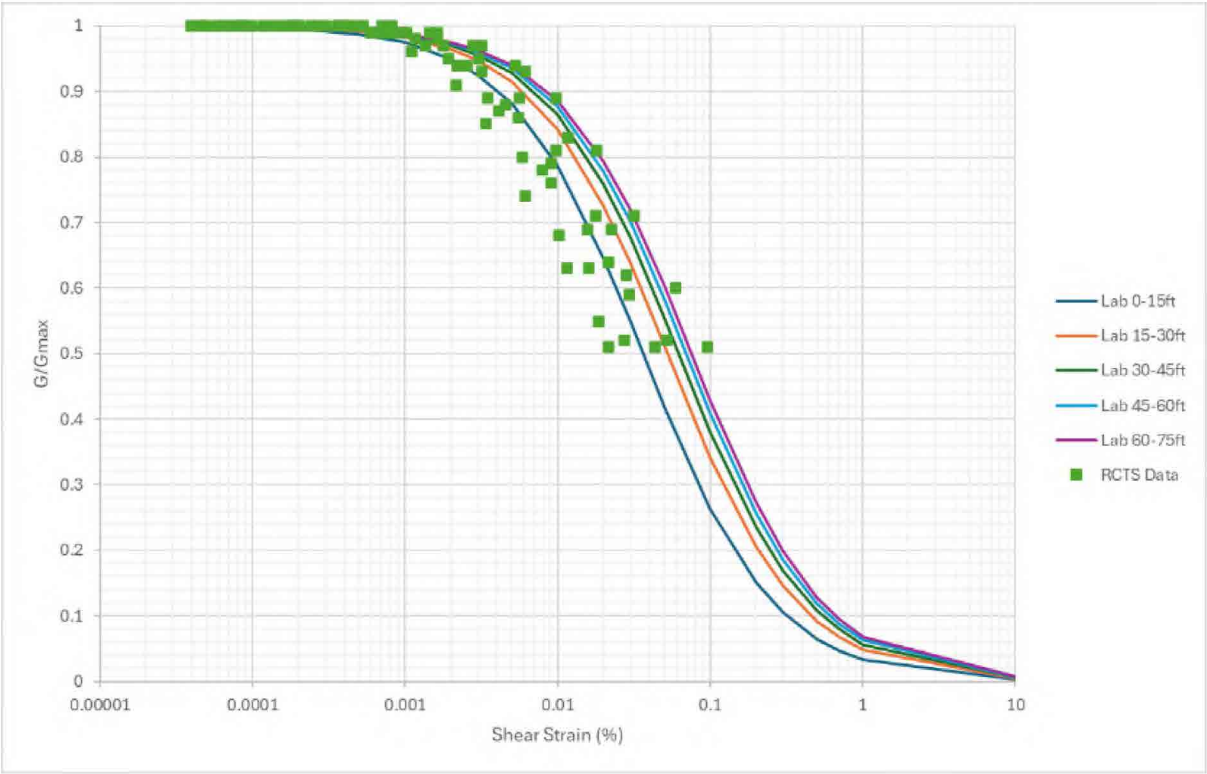
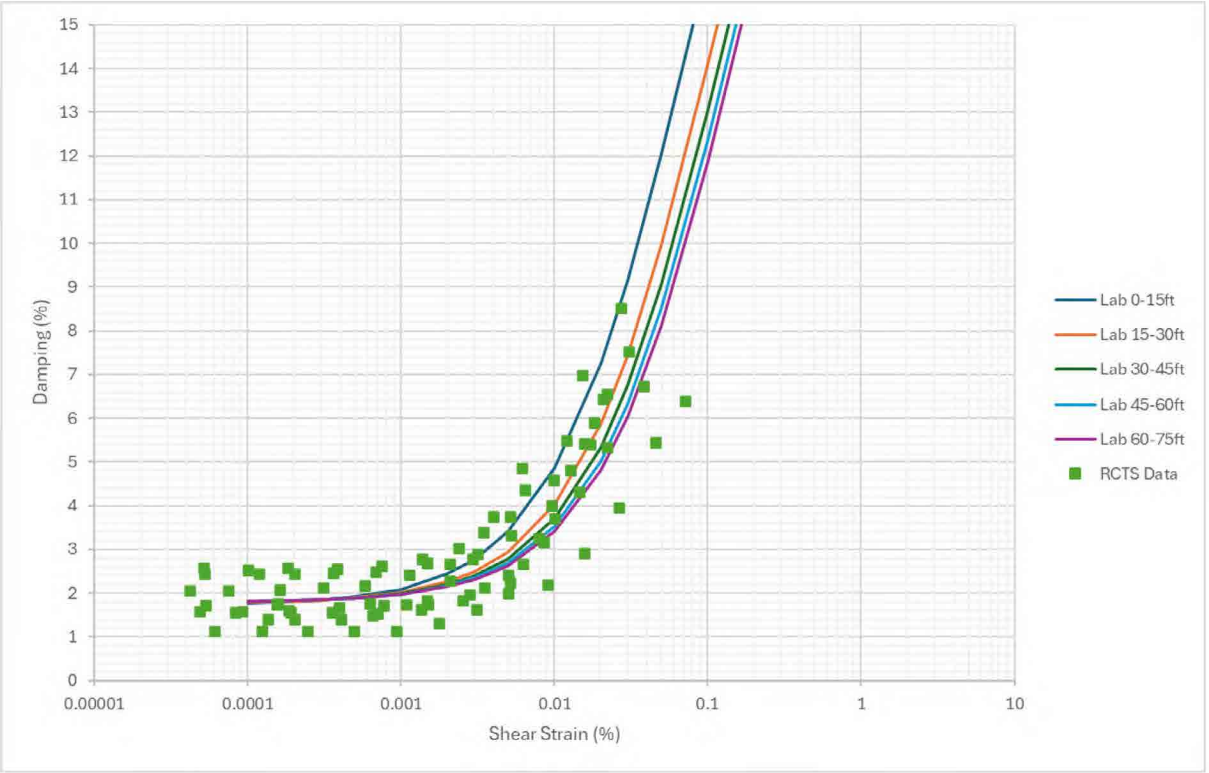


Figure 2.5-144
Site-Specific (Lab-Derived) Modulus Reduction Curves for Residual Soils with Resonant Column Torsional Shear (RCTS) Test Results



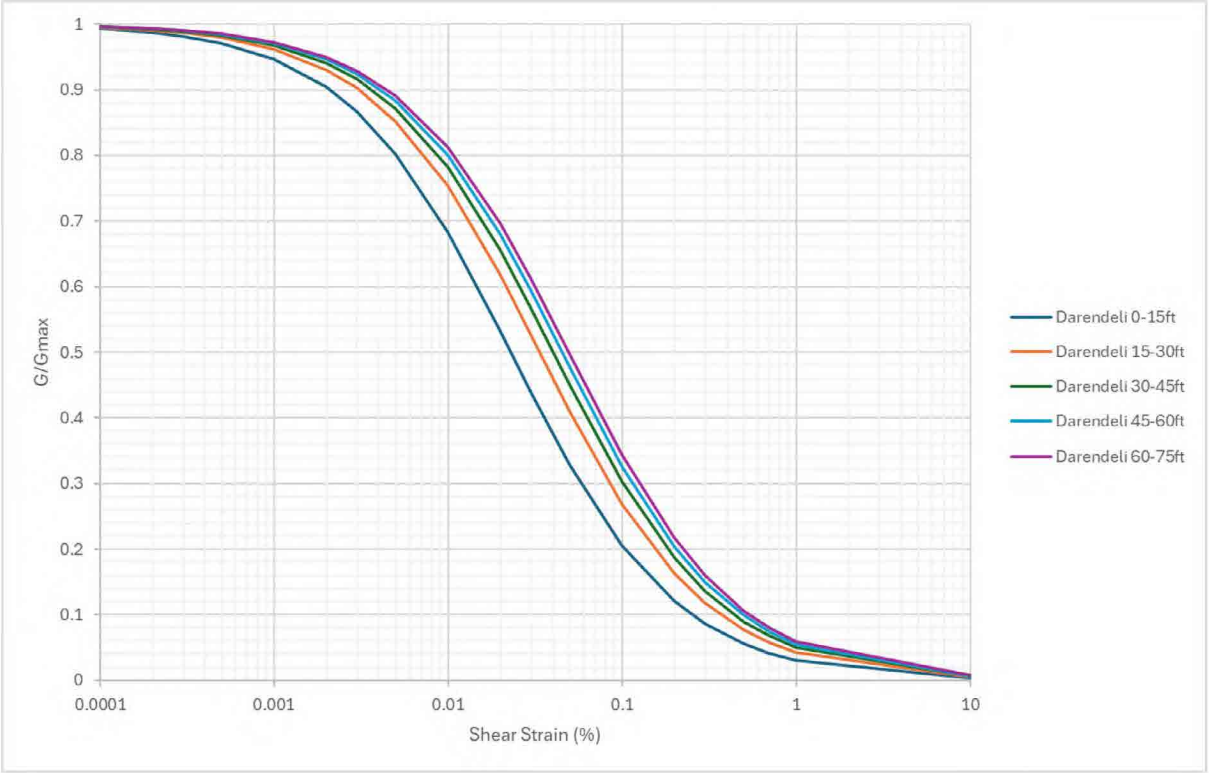
Key: ft = feet; G = shear modulus; Gmax = maximum shear modulus

Figure 2.5-145
Site-Specific (Lab-Derived) Damping Curves for Residual Soils with Resonant Column Torsional Shear (RCTS) Test Results



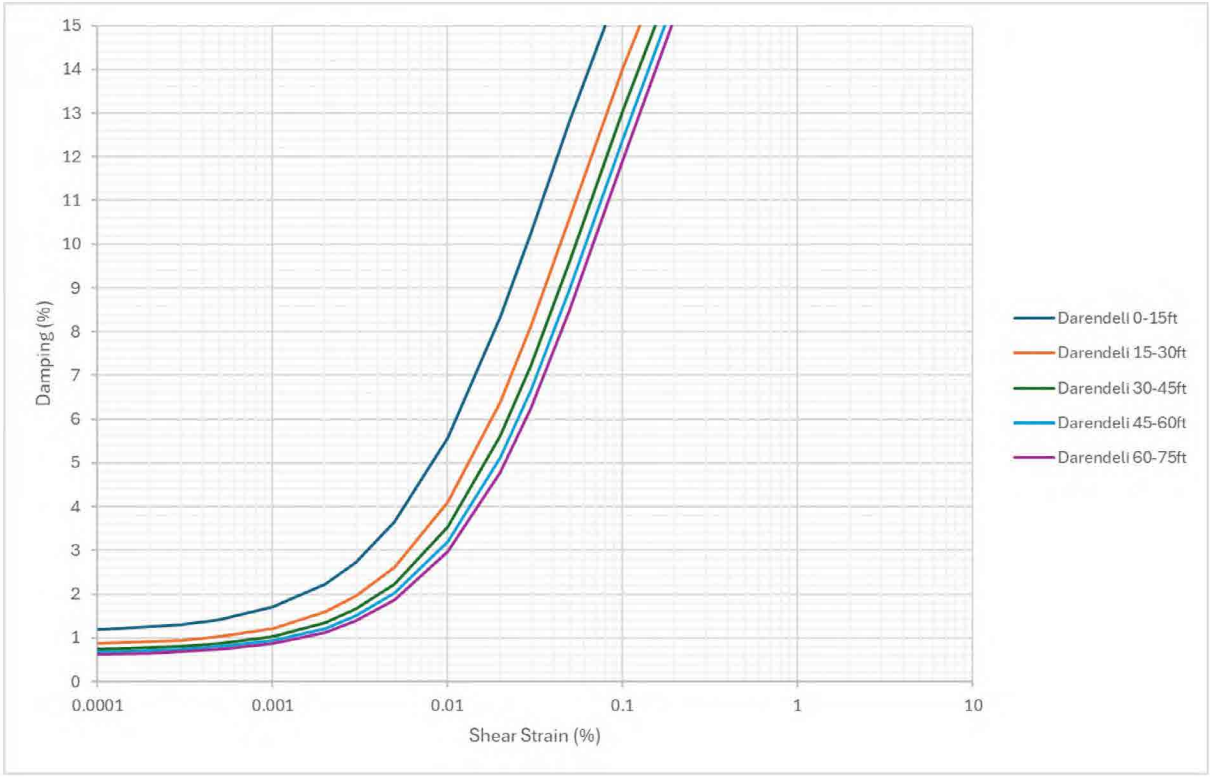
Key: ft = feet

Figure 2.5-146
Darendeli (Reference 2.5-170)-Based Modulus Reduction Curves for Residual Soils



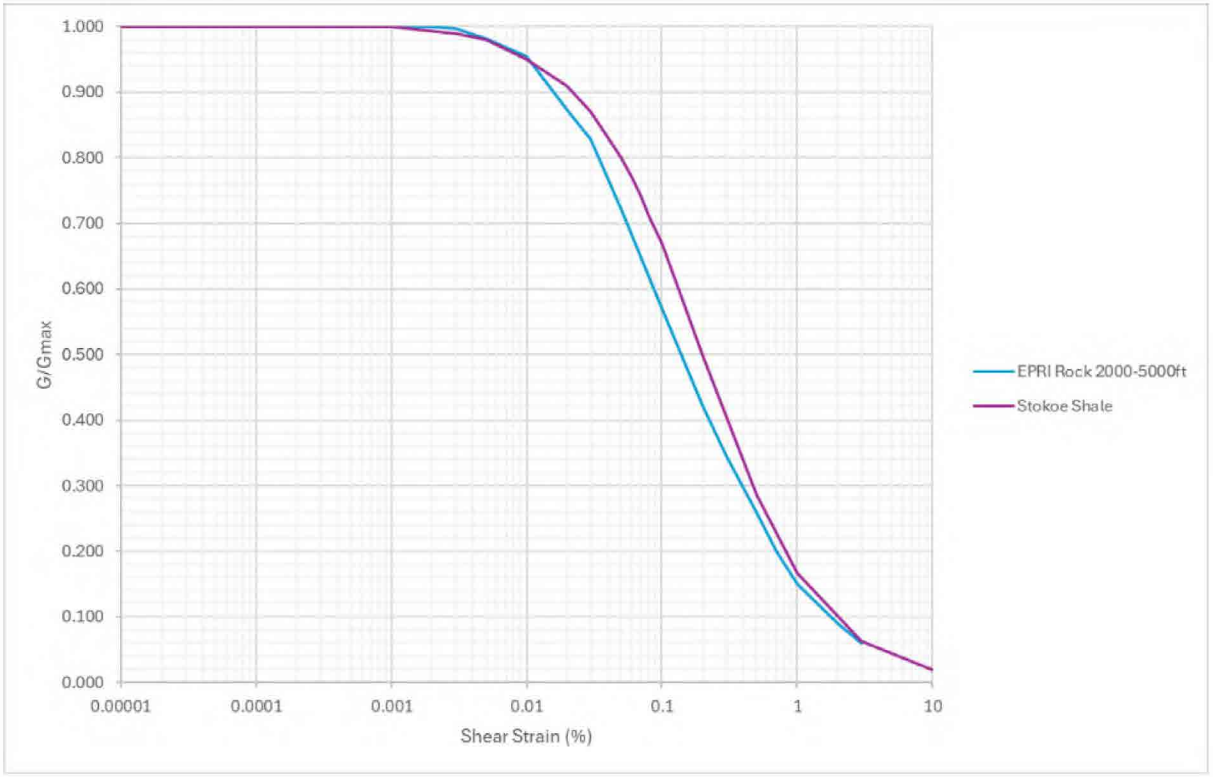
Key: ft = feet; G = shear modulus; G_{max} = maximum shear modulus

Figure 2.5-147
Darendeli (Reference 2.5-170)-Based Damping Curves for Residual Soils



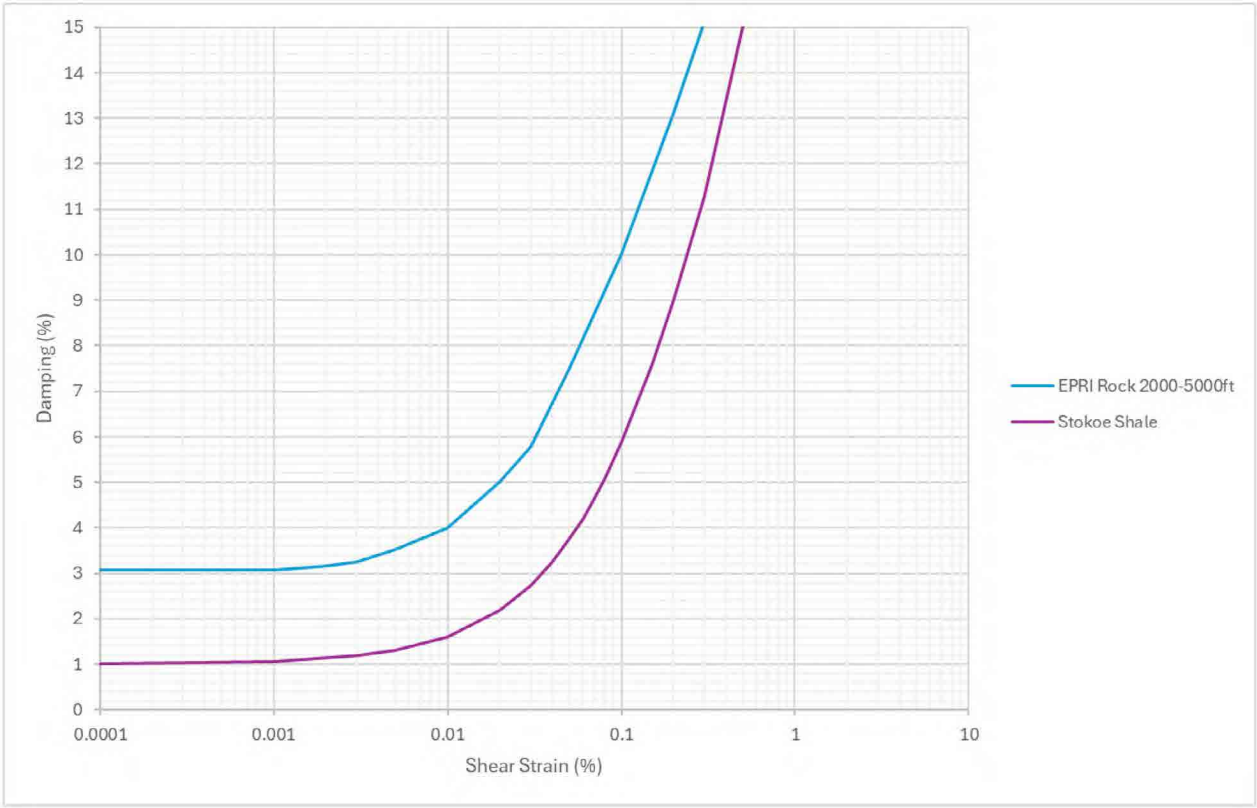
Key: ft = feet

Figure 2.5-148
Modulus Reduction Curves for Partially Weathered Rock (PWR) and Crystalline Rock (Fractured Rock and Sound Rock)



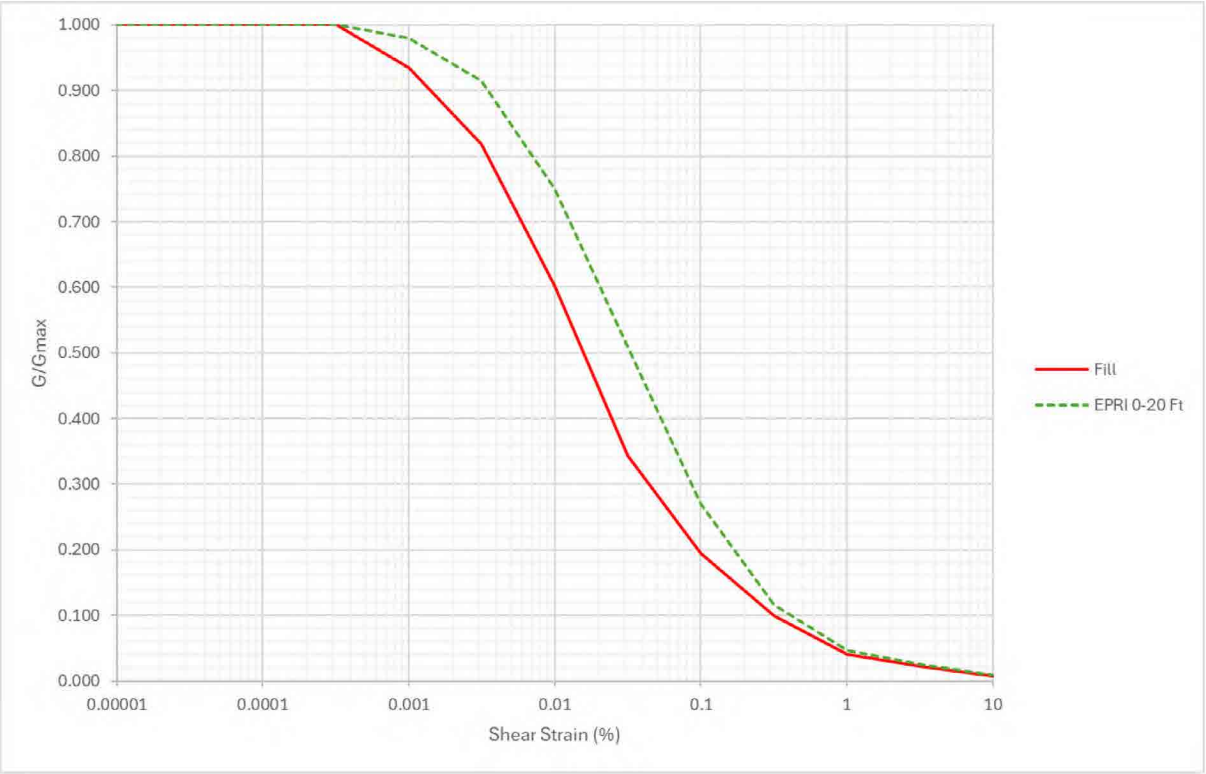
Key: EPRI = Electric Power Research Institute; ft = feet; G = shear modulus; G_{max} = maximum shear modulus

Figure 2.5-149
Damping Curves for Partially Weathered Rock (PWR) and Crystalline Rock (Fractured Rock and Sound Rock)



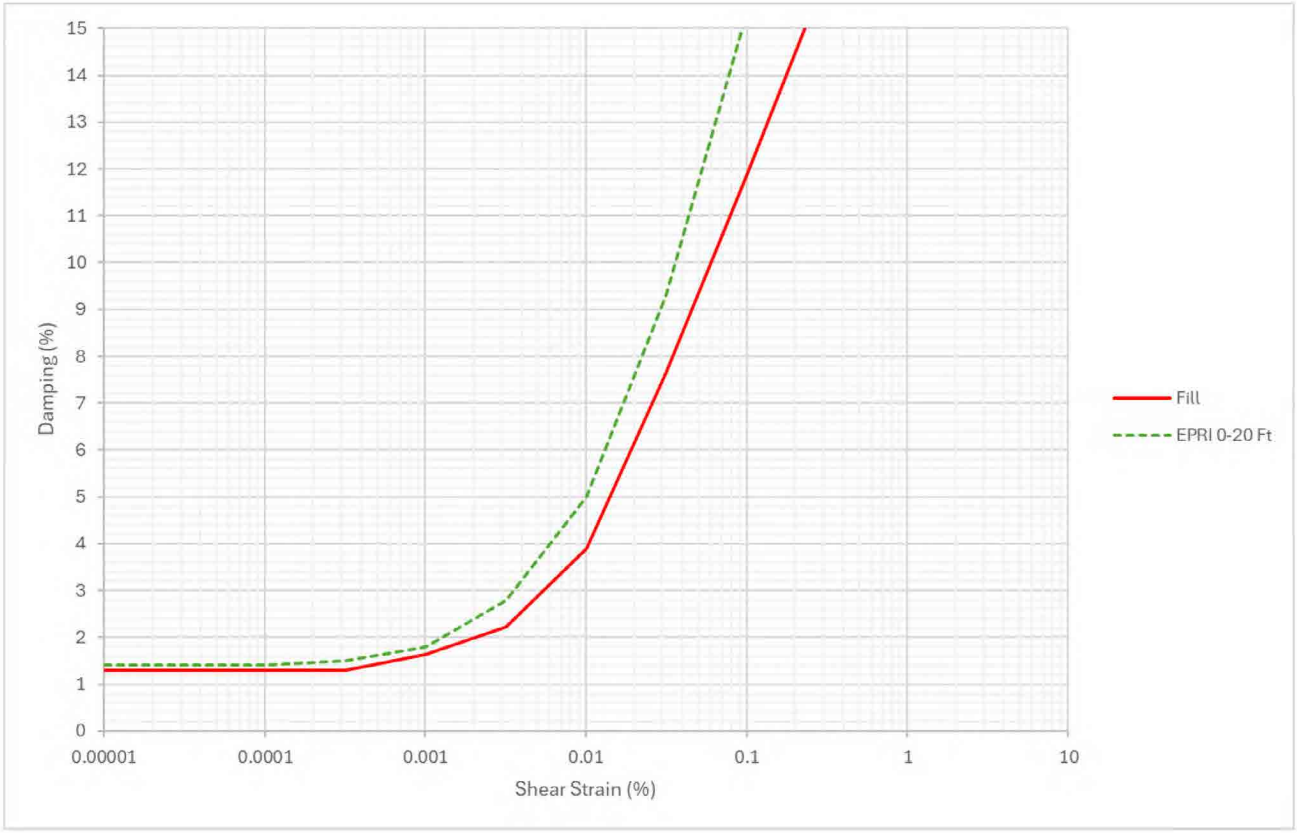
Key: EPRI = Electric Power Research Institute; ft = feet

Figure 2.5-150
Modulus Reduction Curve for Fill, with Comparison to EPRI (1993) (Reference 2.5-299) Curve for 0 to 20 Ft. in Depth



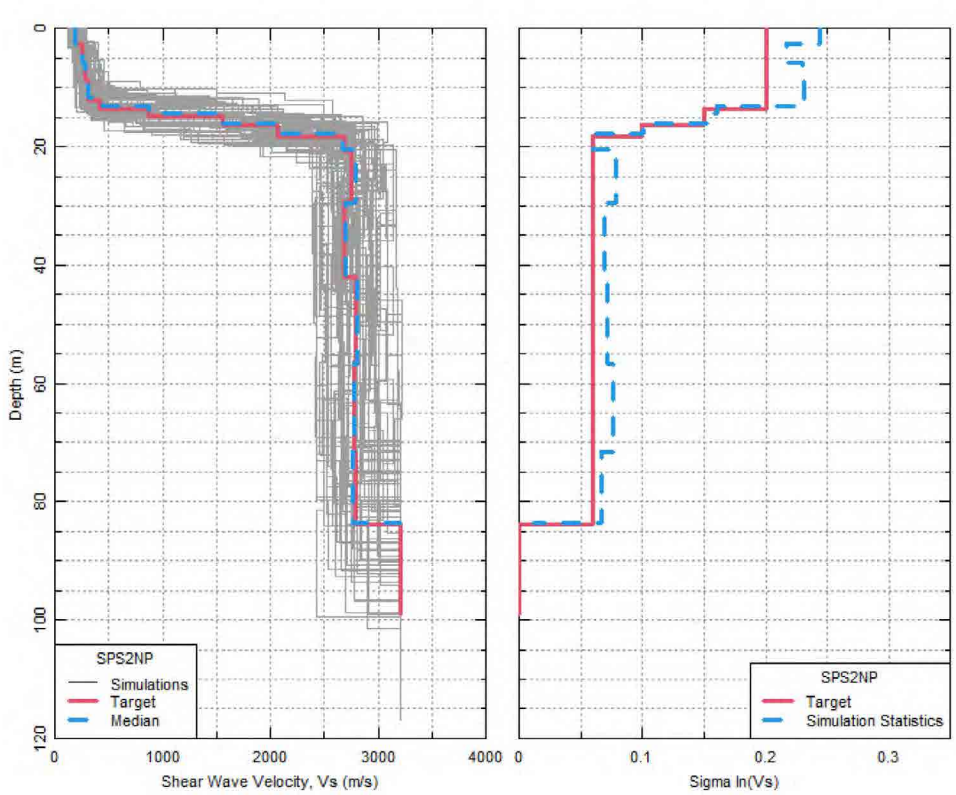
Key: EPRI = Electric Power Research Institute; ft = feet; G = shear modulus; G_{max} = maximum shear modulus

Figure 2.5-151
Damping Curve for Fill, with Comparison to EPRI (1993) (Reference 2.5-299) Curve for 0 to 20 Ft. in Depth



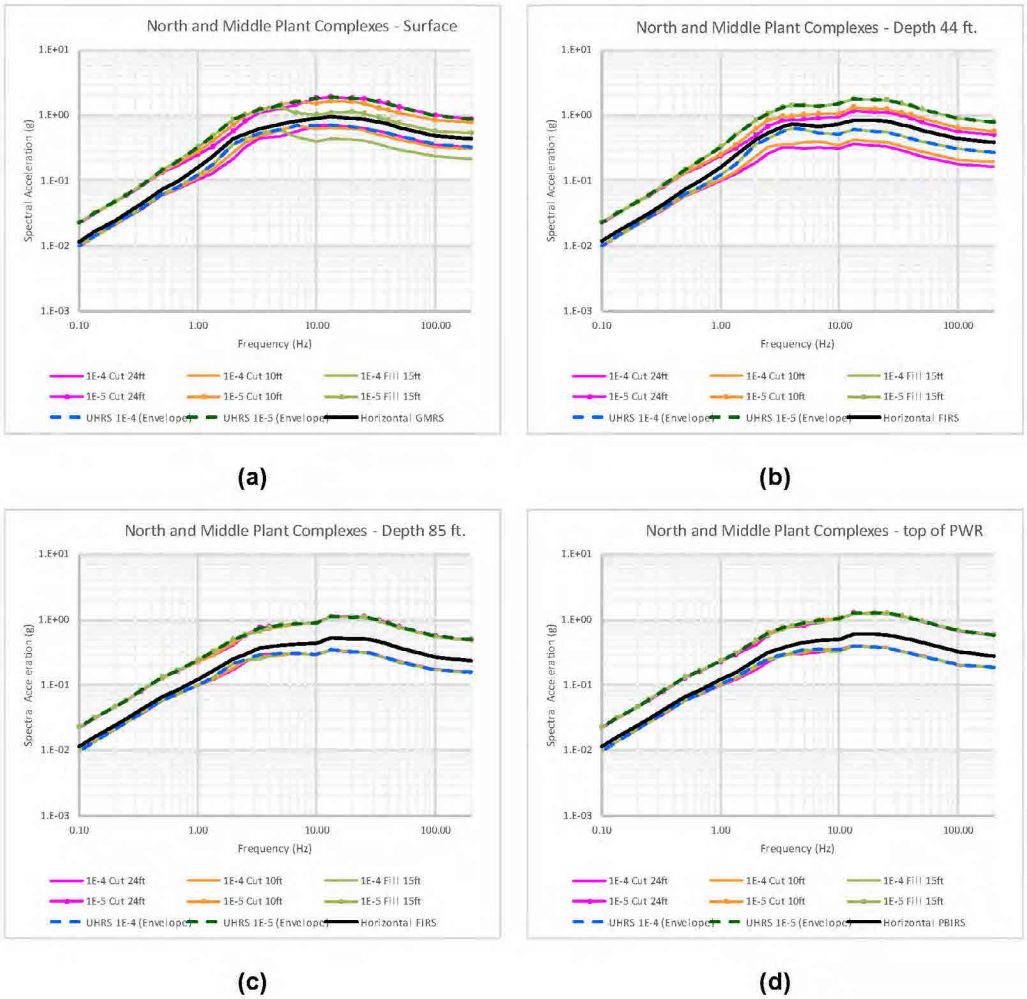
Key: EPRI = Electric Power Research Institute; ft. = feet

Figure 2.5-152
Randomized VS Profiles and Standard Deviation of ln(V_S) and Target Values for the Suspension Log Profile, Site-Specific Material Curves, Kappa2 Approach, Before Cut



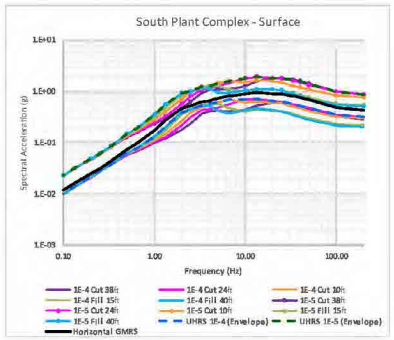
Key: m/s = meter per second; V_S = shear wave velocity

Figure 2.5-153
Site-Specific Horizontal Uniform Hazard Response Spectra (UHRS) and Design Response Spectra (DRS) for the North and Middle Plant Complexes

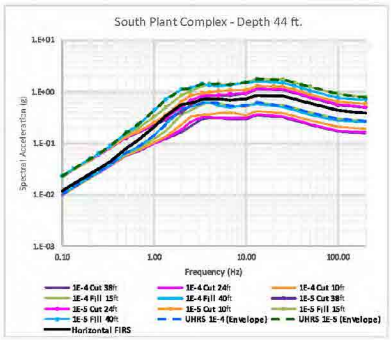


Key: ft. = feet; FIRS = foundation input response spectrum; GMRS = ground motion response spectrum; Hz = hertz; PBIRS = performance-based interface response spectrum; PWR = partially weathered rock

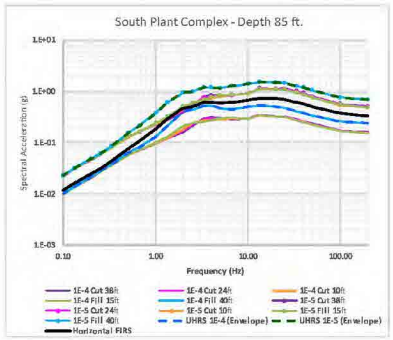
Figure 2.5-154
Site-Specific Horizontal Uniform Hazard Response Spectra (UHRS) and Design Response Spectra (DRS) for the South Plant Complex



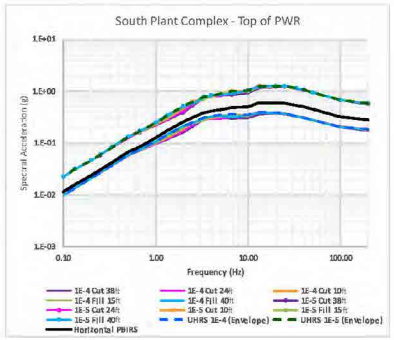
(a)



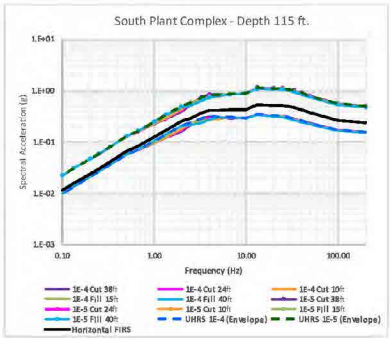
(b)



(c)



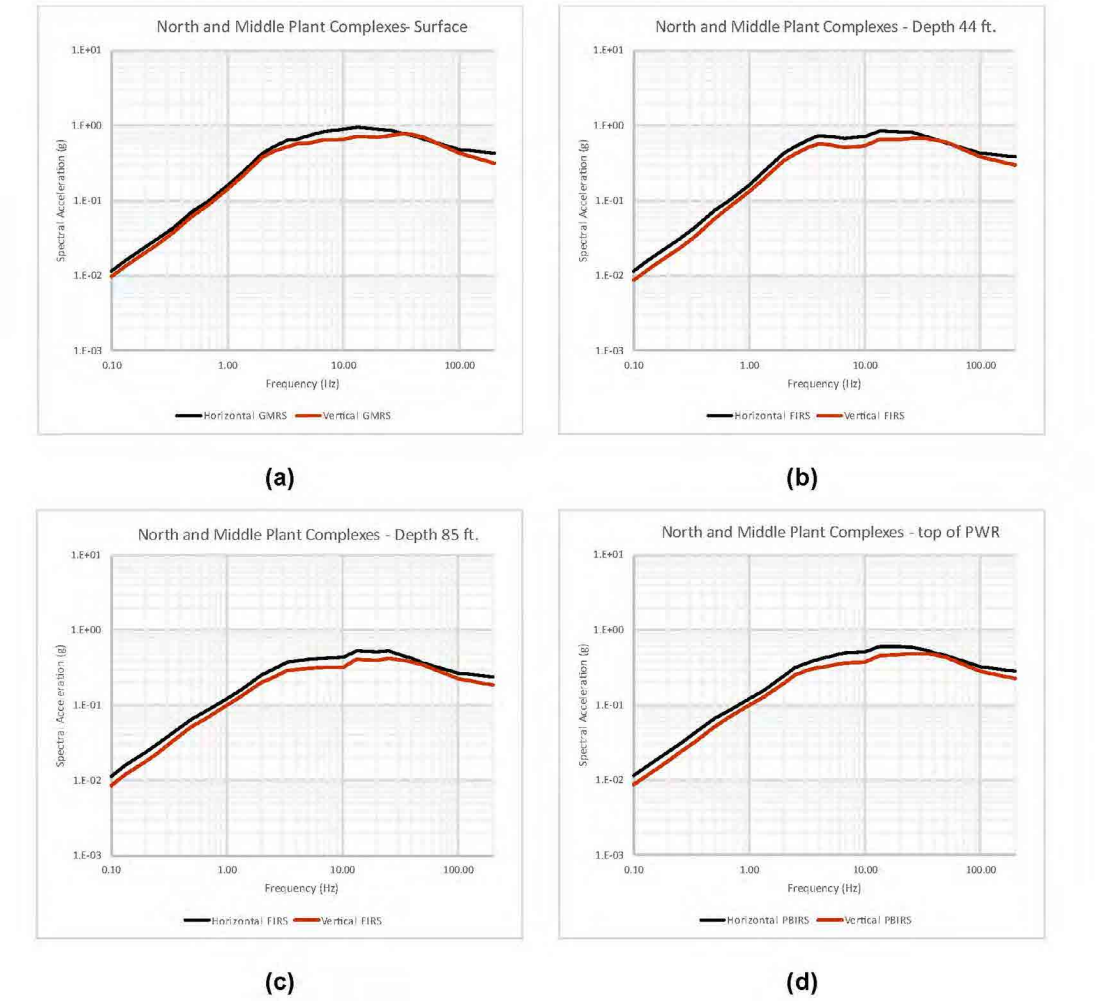
(d)



(e)

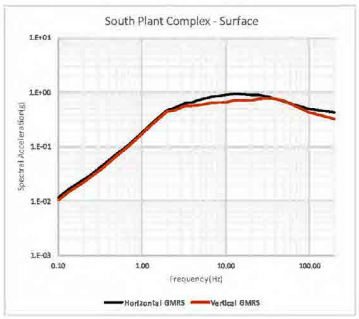
Key: FIRS = foundation input response spectrum; ft. = feet; Hz = hertz; PBIRS = performance-based interface response spectrum; PWR = partially weathered rock

Figure 2.5-155
Horizontal and Vertical Performance-Based Design Response Spectra (DRS) for the North and Middle Plant Complexes

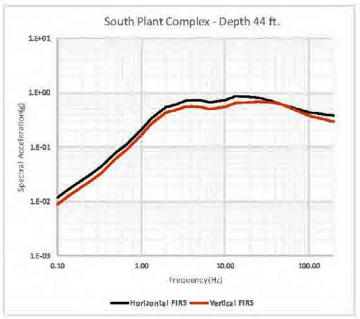


Key: FIRS = foundation input response spectrum; ft. = feet; GMRS = ground motion response spectrum; Hz = hertz; PBIRS = performance-based interface response spectrum; PWR = partially weathered rock

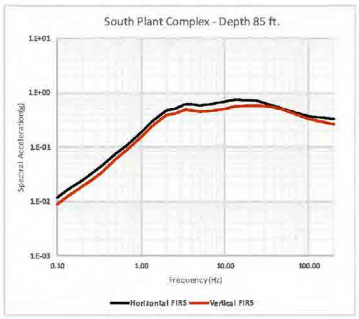
Figure 2.5-156
Horizontal and Vertical Performance-Based Design Response Spectra (DRS) for the South Plant Complex



(a)



(b)



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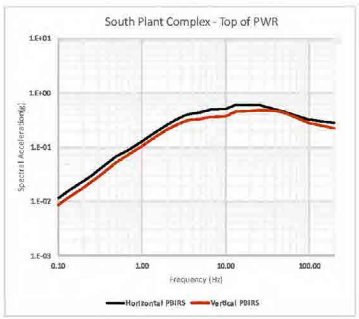

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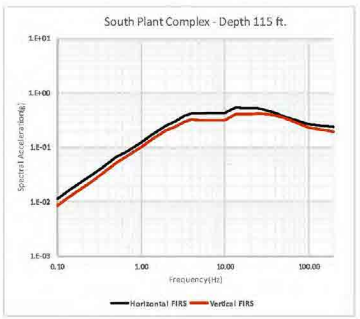
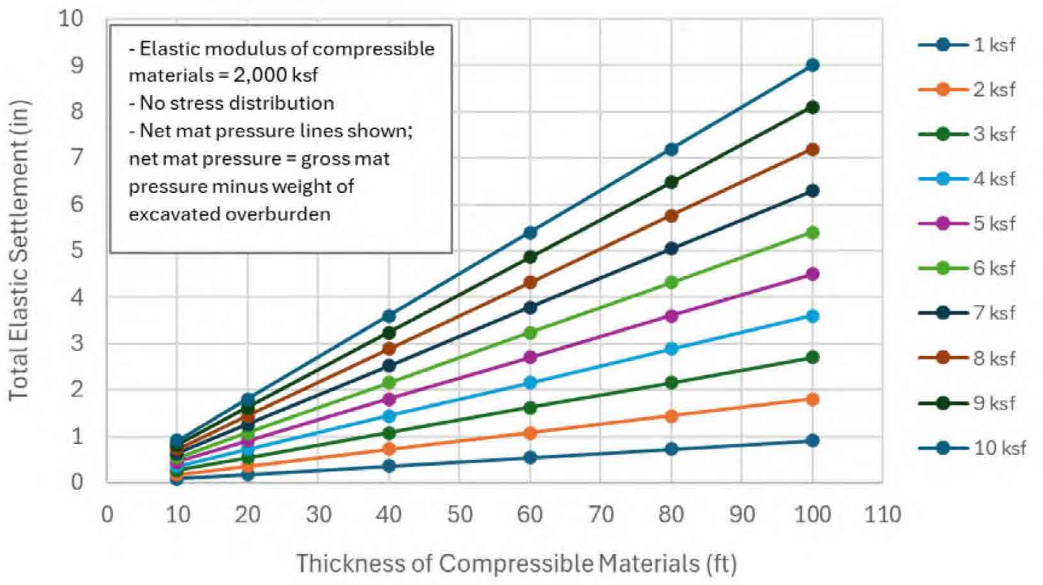


(e)

Key: FIRS = foundation input response spectrum; ft. = feet; GMRS = ground motion response spectrum; Hz = hertz; PBIRS = performance-based interface response spectrum; PWR = partially weathered rock

Figure 2.5-157
Estimated Total Elastic Settlement for Reactor Base Mats for Various Net Mat Pressures



Key: ft = feet; in = inch; ksf = kips per square foot

Figure 2.5-158
Proposed Overall Site Grading Plan

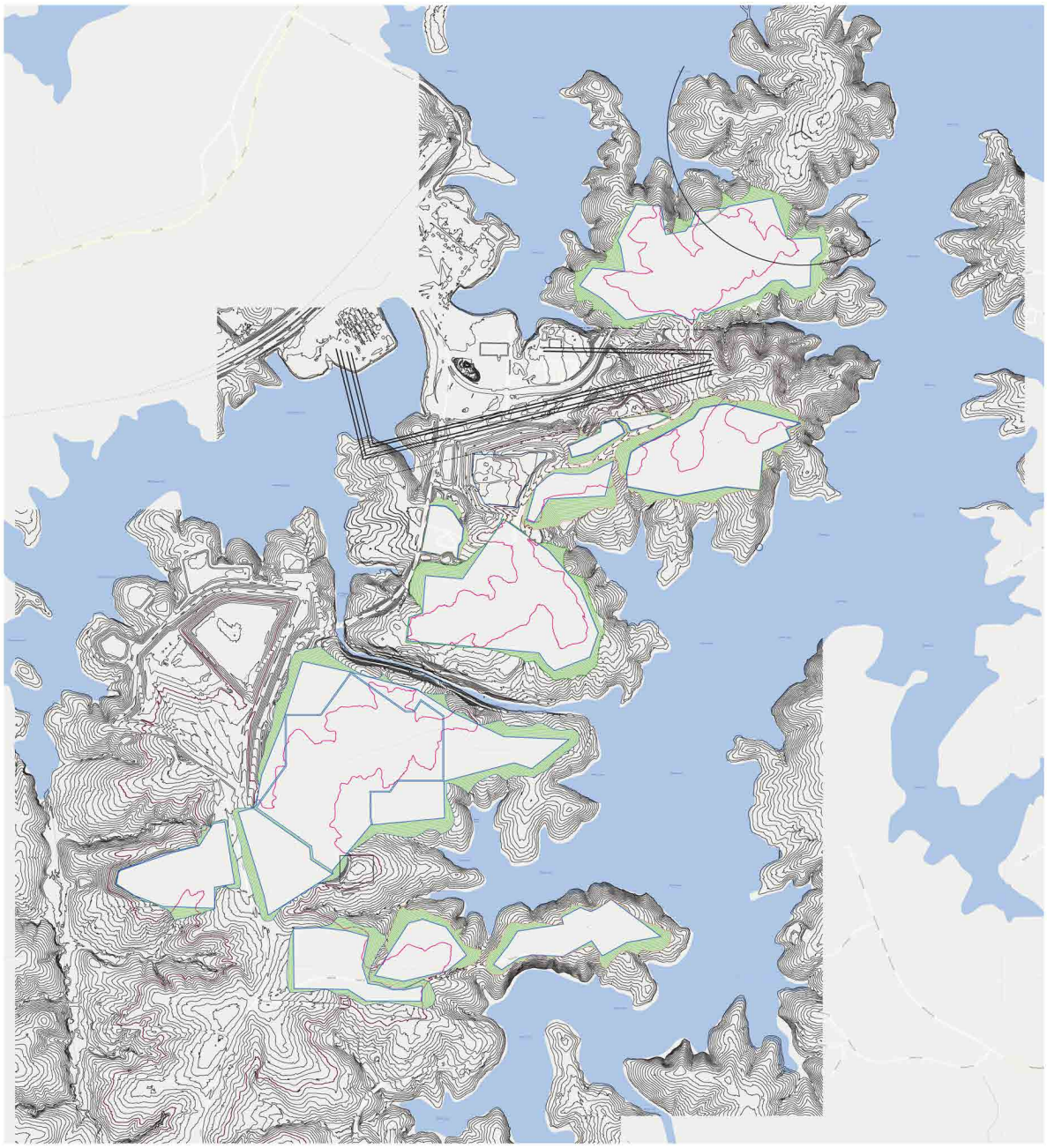


Figure 2.5-159
Proposed Grading Plan for North Complex

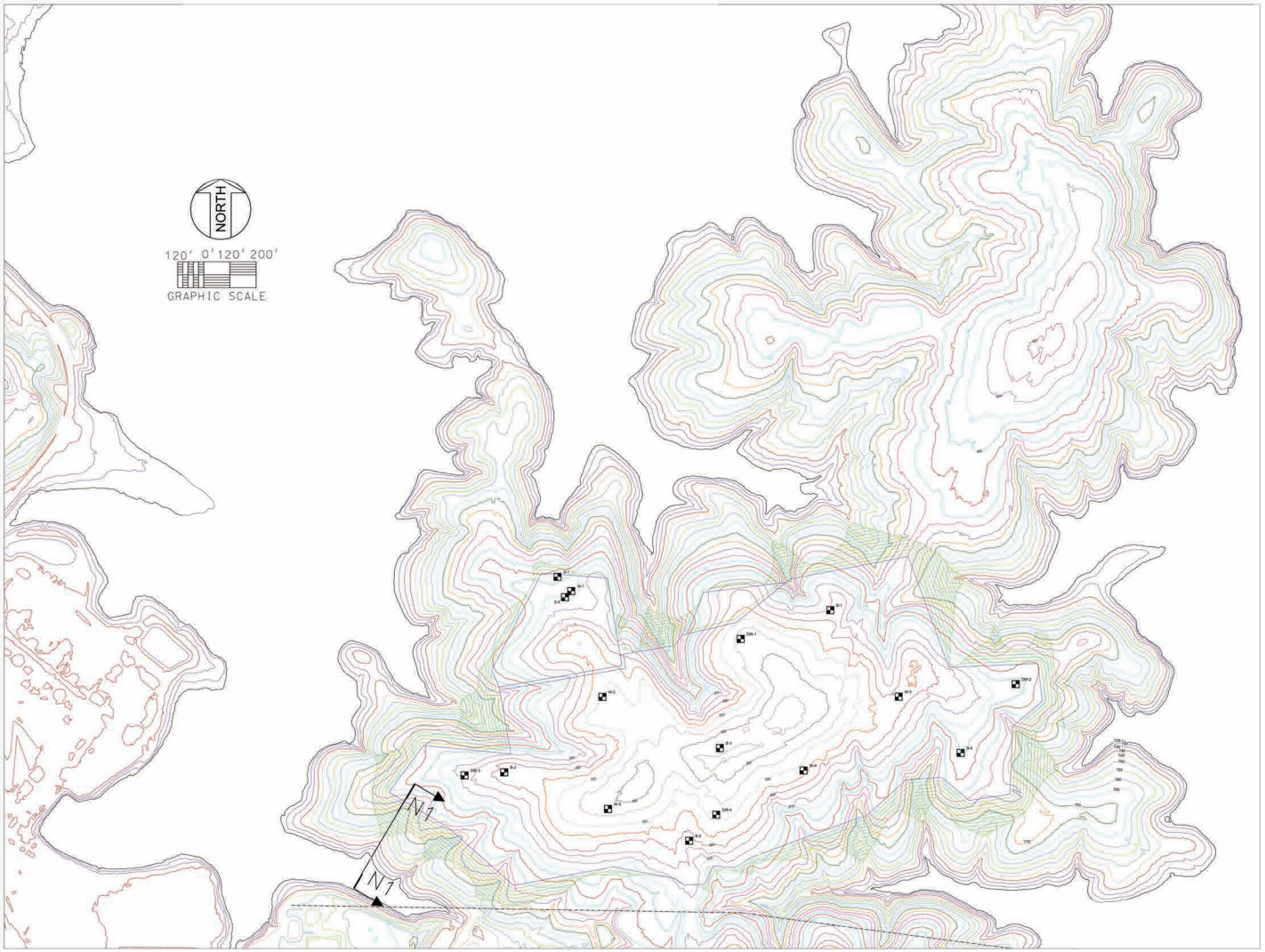


Figure 2.5-160
Proposed Grading Plan for North Complex

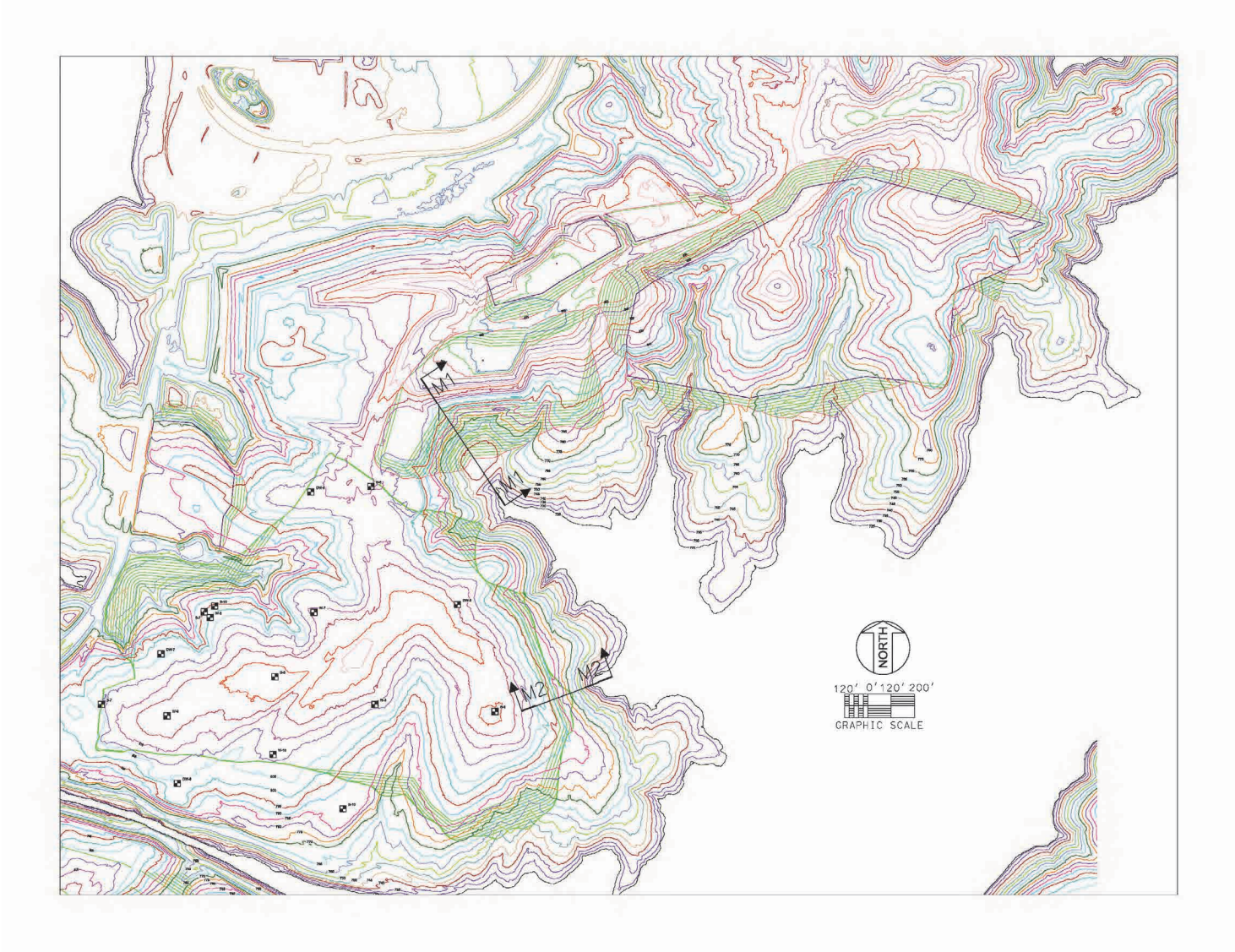


Figure 2.5-161
Proposed Grading Plan for South Complex

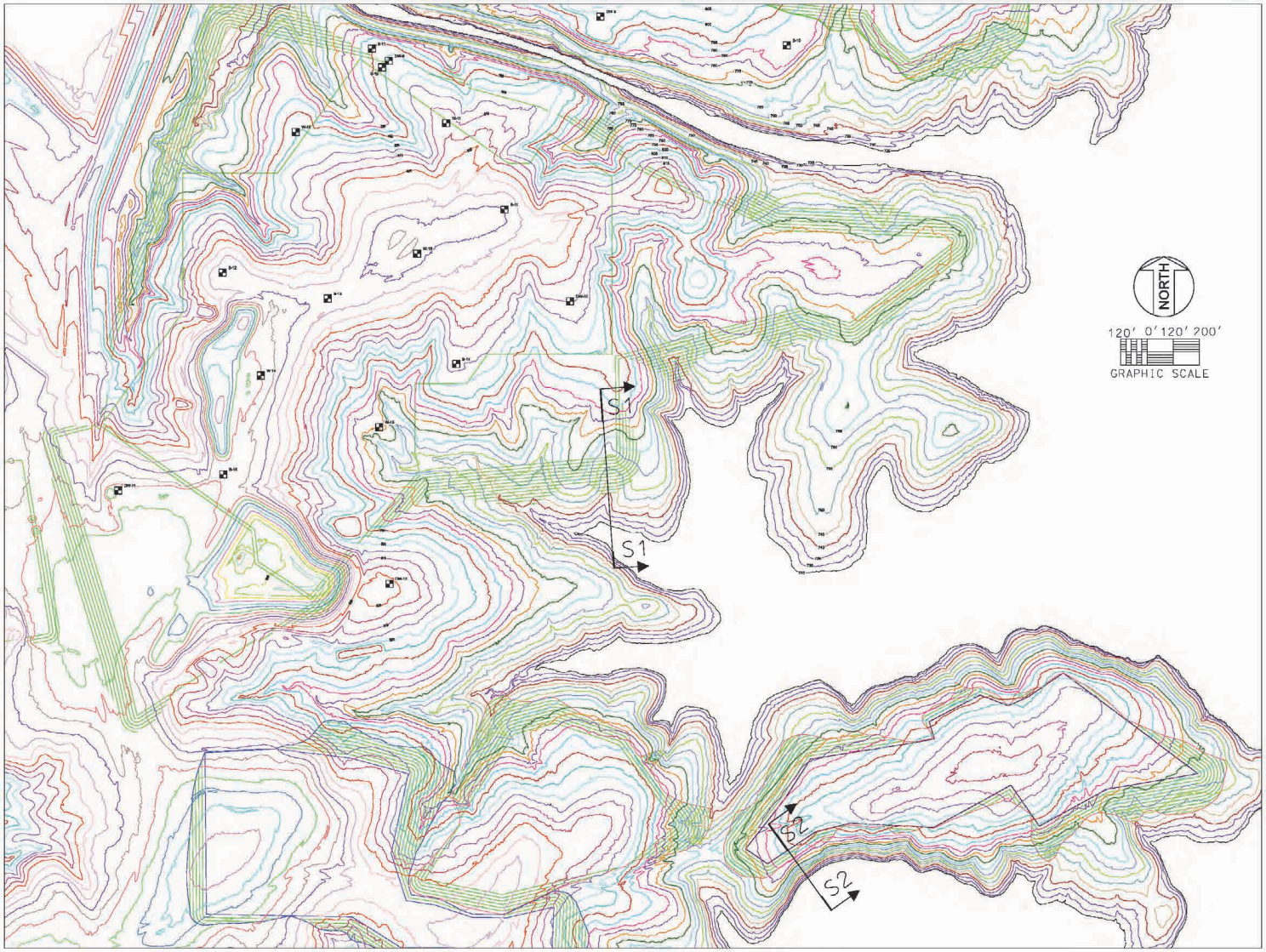


Figure 2.5-162
Slope Stability Section N1 Steady-State

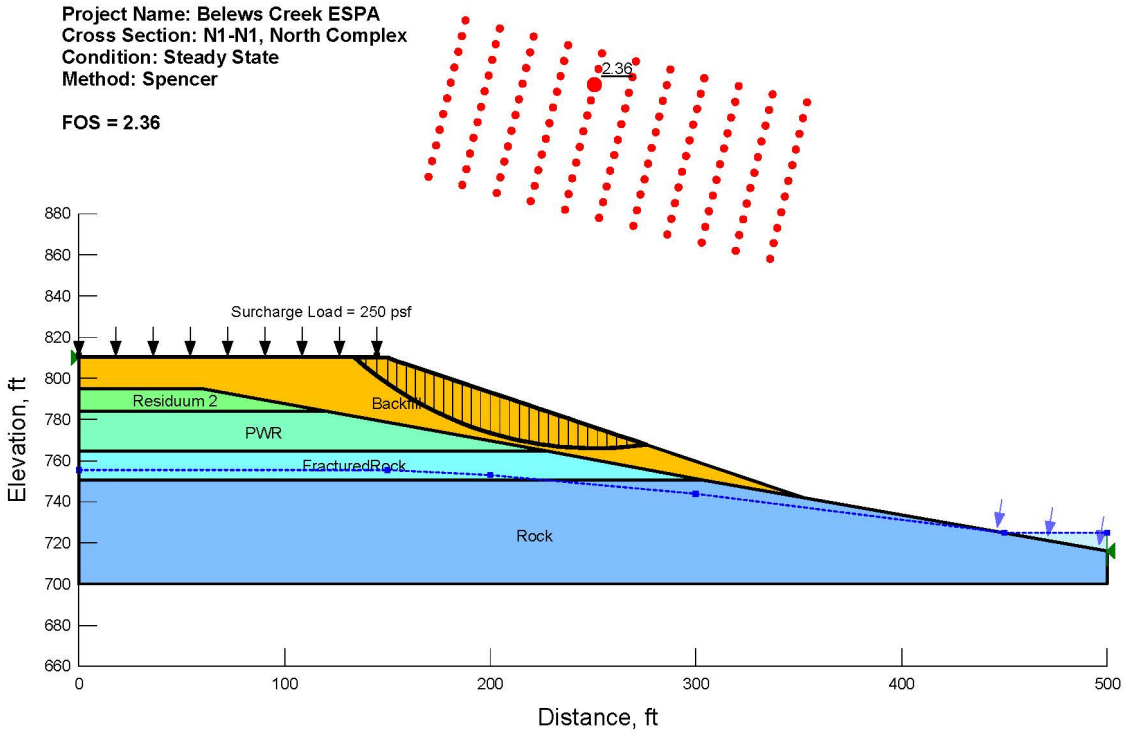


Figure 2.5-163
Slope Stability Section N1 Pseudo-Static

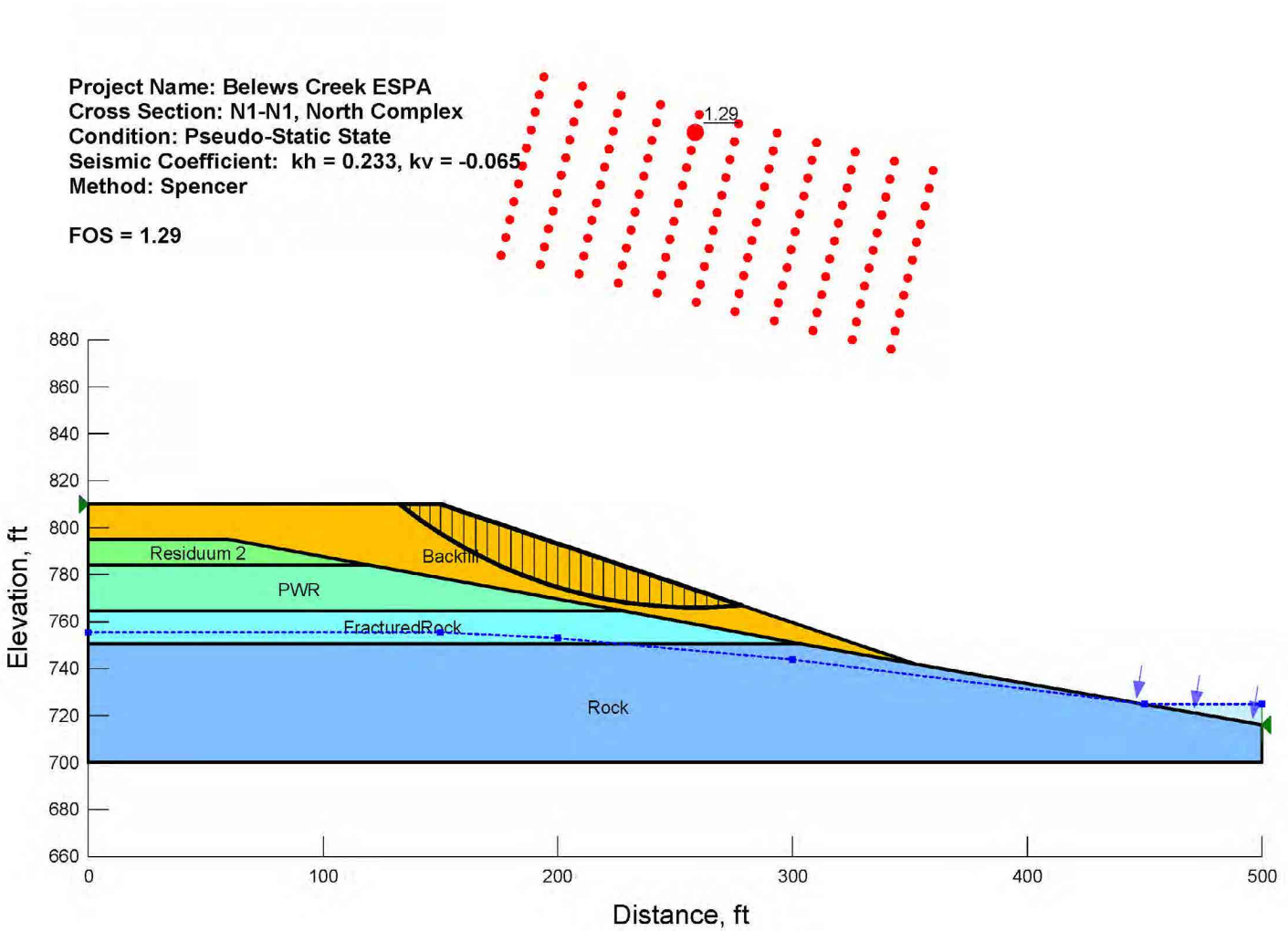


Figure 2.5-164
Slope Stability Section M1 Steady-State

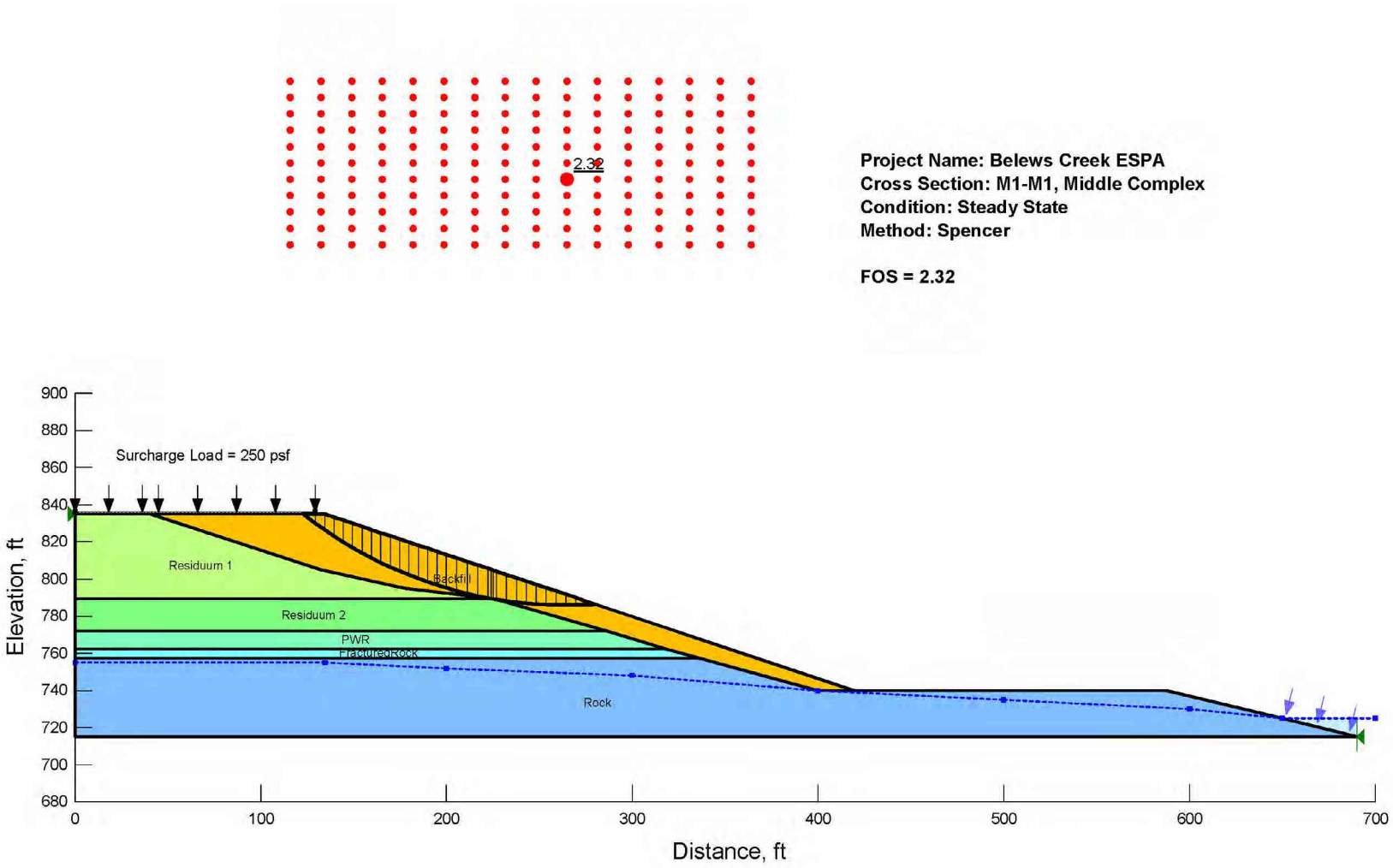
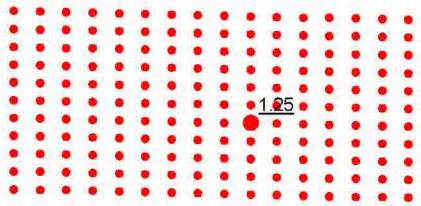


Figure 2.5-165
Slope Stability Section M1 Pseudo-Static



Project Name: Belews Creek ESPA
Cross Section: M1-M1, Middle Complex
Condition: Pseudo-Static State
Seismic Coefficient: kh = 0.233, kv = -0.065
Method: Spencer

FOS = 1.25

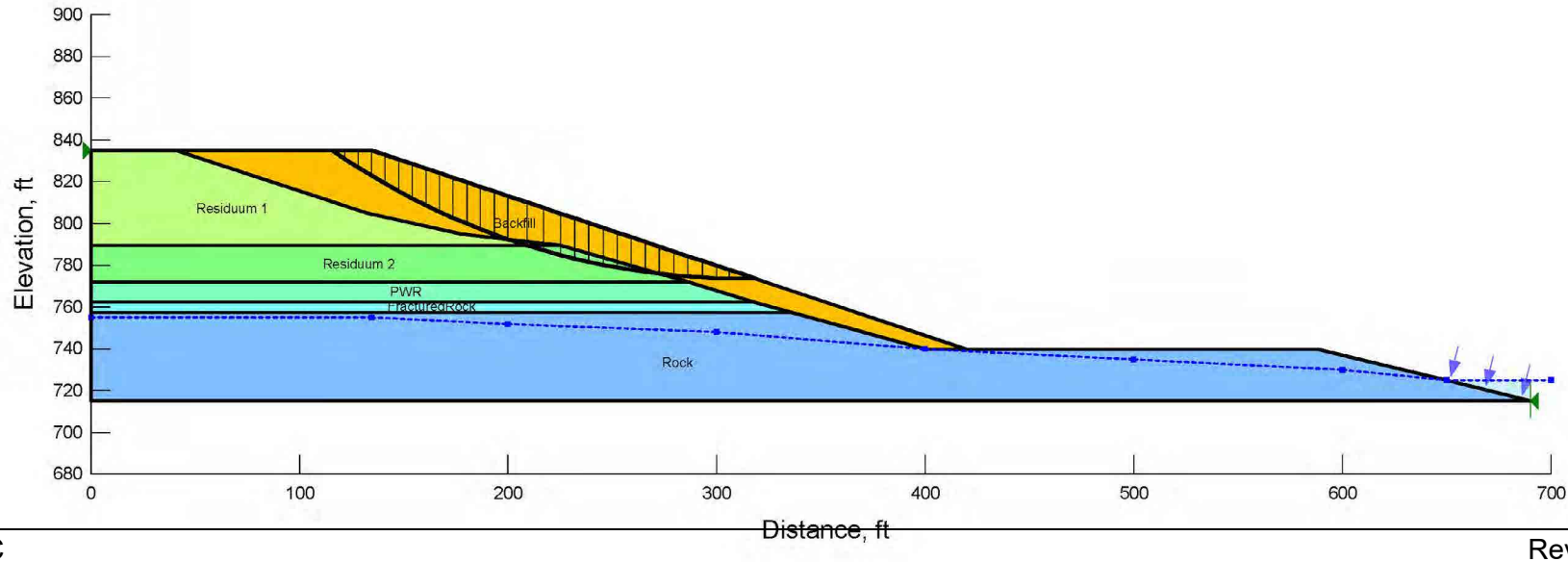


Figure 2.5-166
Slope Stability Section M2 Steady-State

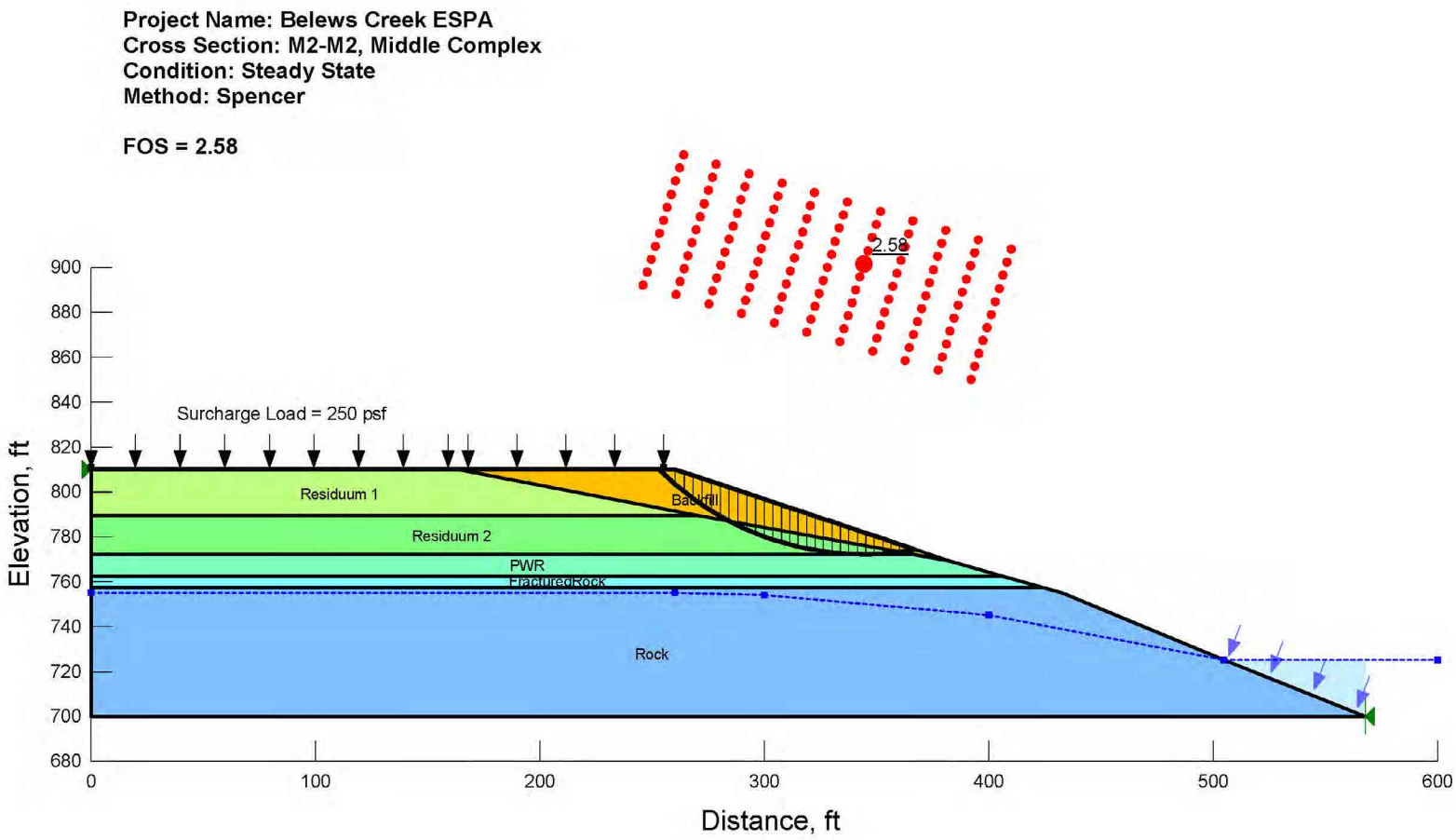


Figure 2.5-167
Slope Stability Section M2 Pseudo-Static

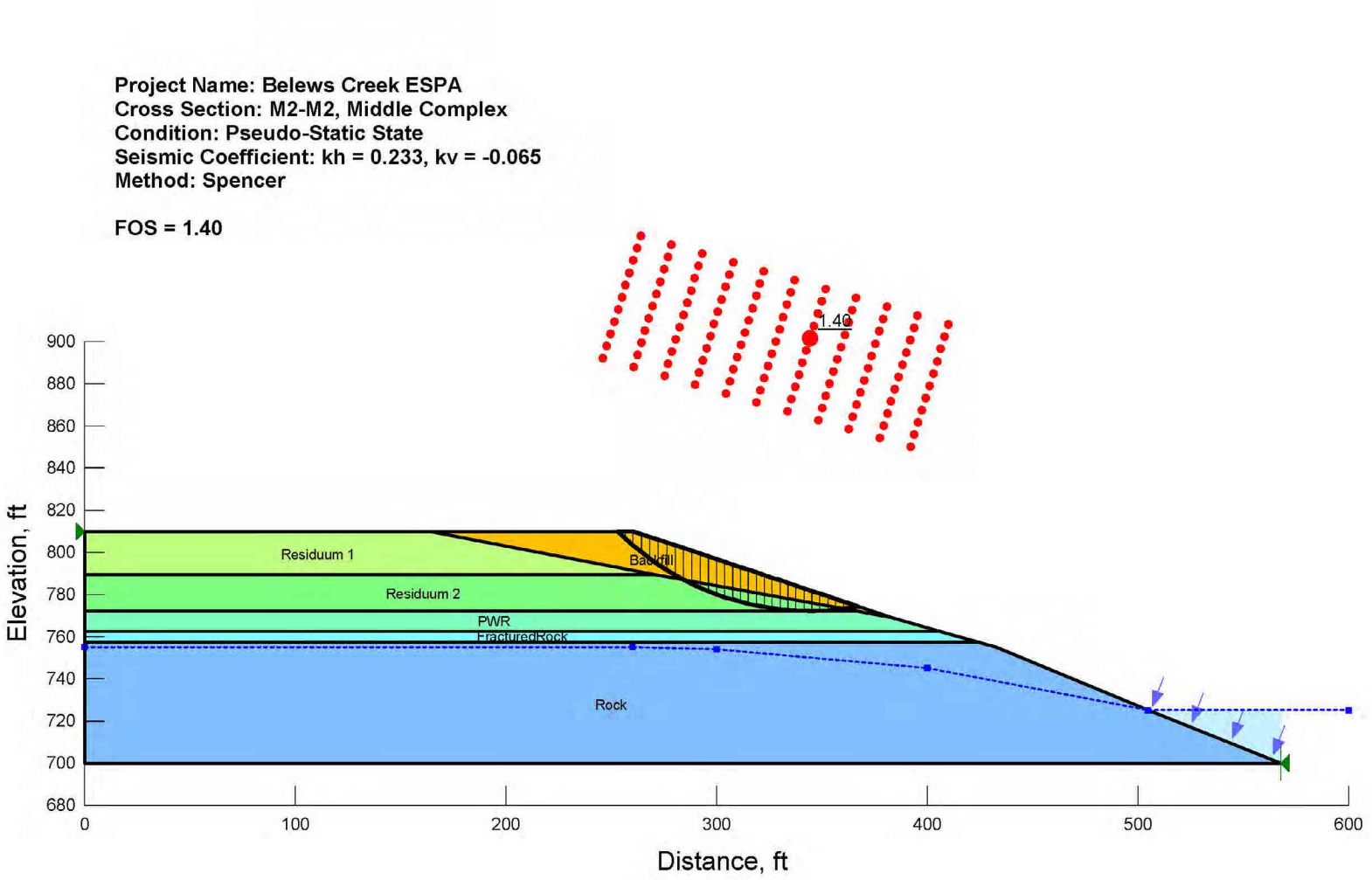


Figure 2.5-168
Slope Stability Section S1 Steady-State

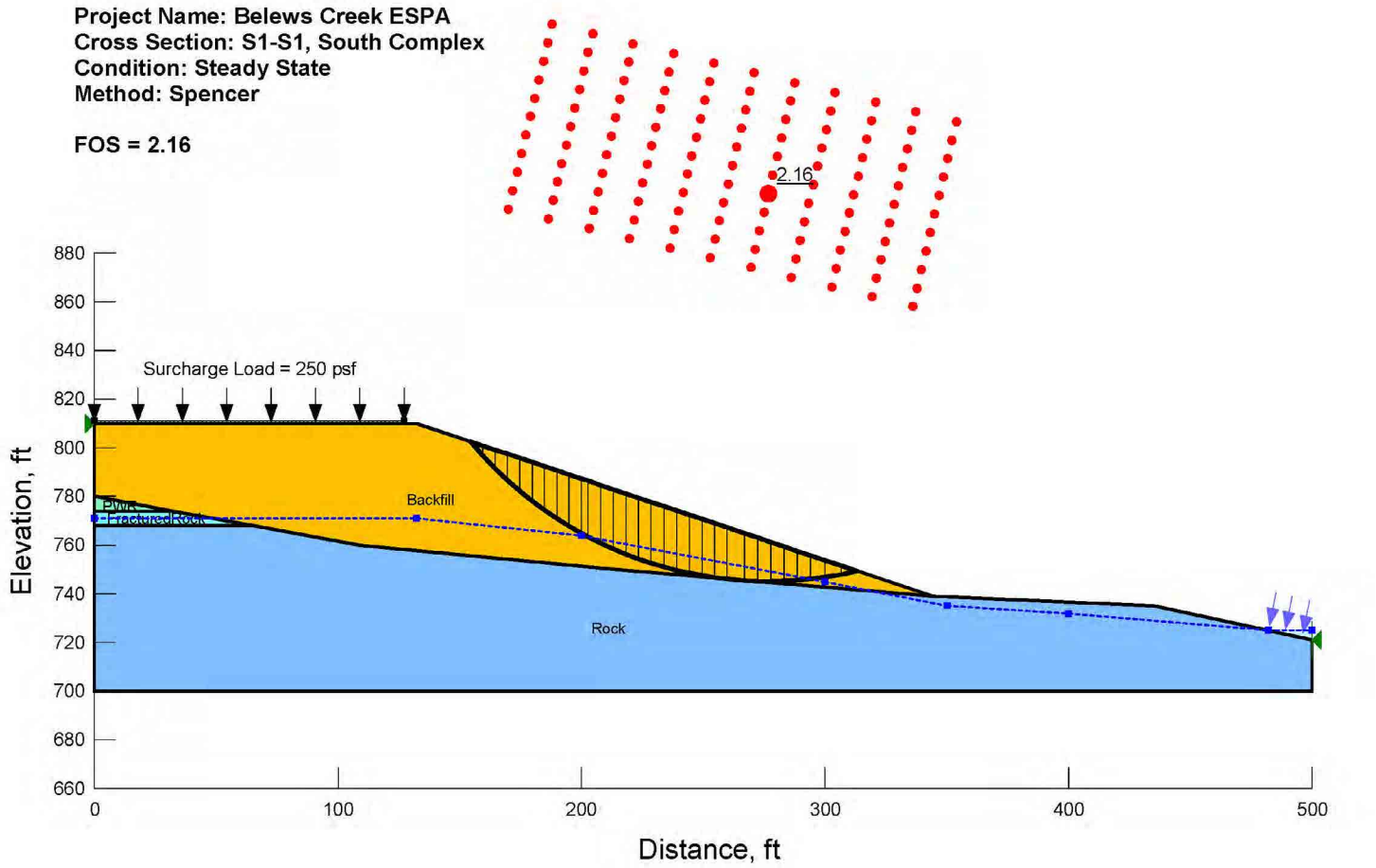


Figure 2.5-169
Slope Stability Section S1 Pseudo-Static

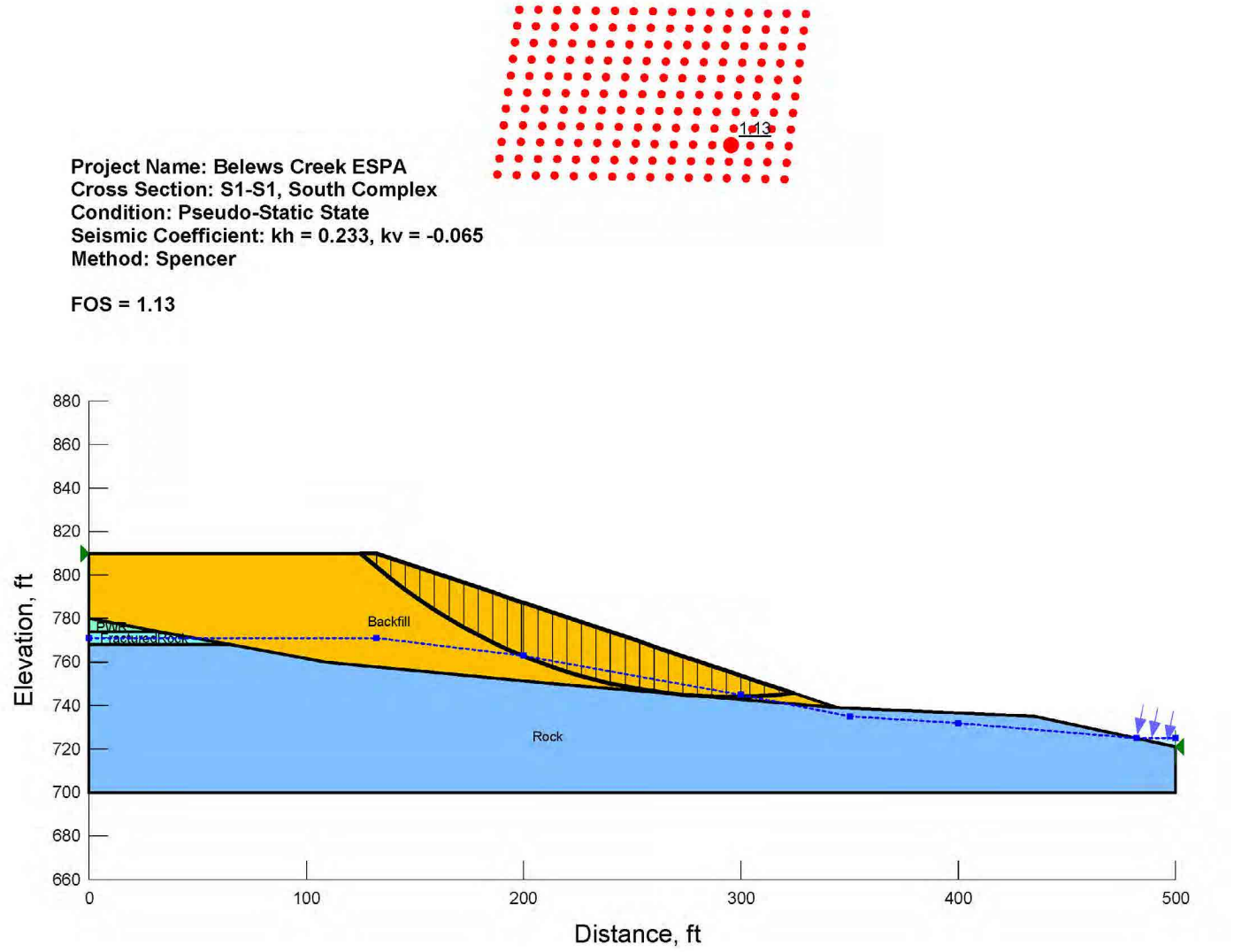


Figure 2.5-170
Slope Stability Section S2 Steady-State

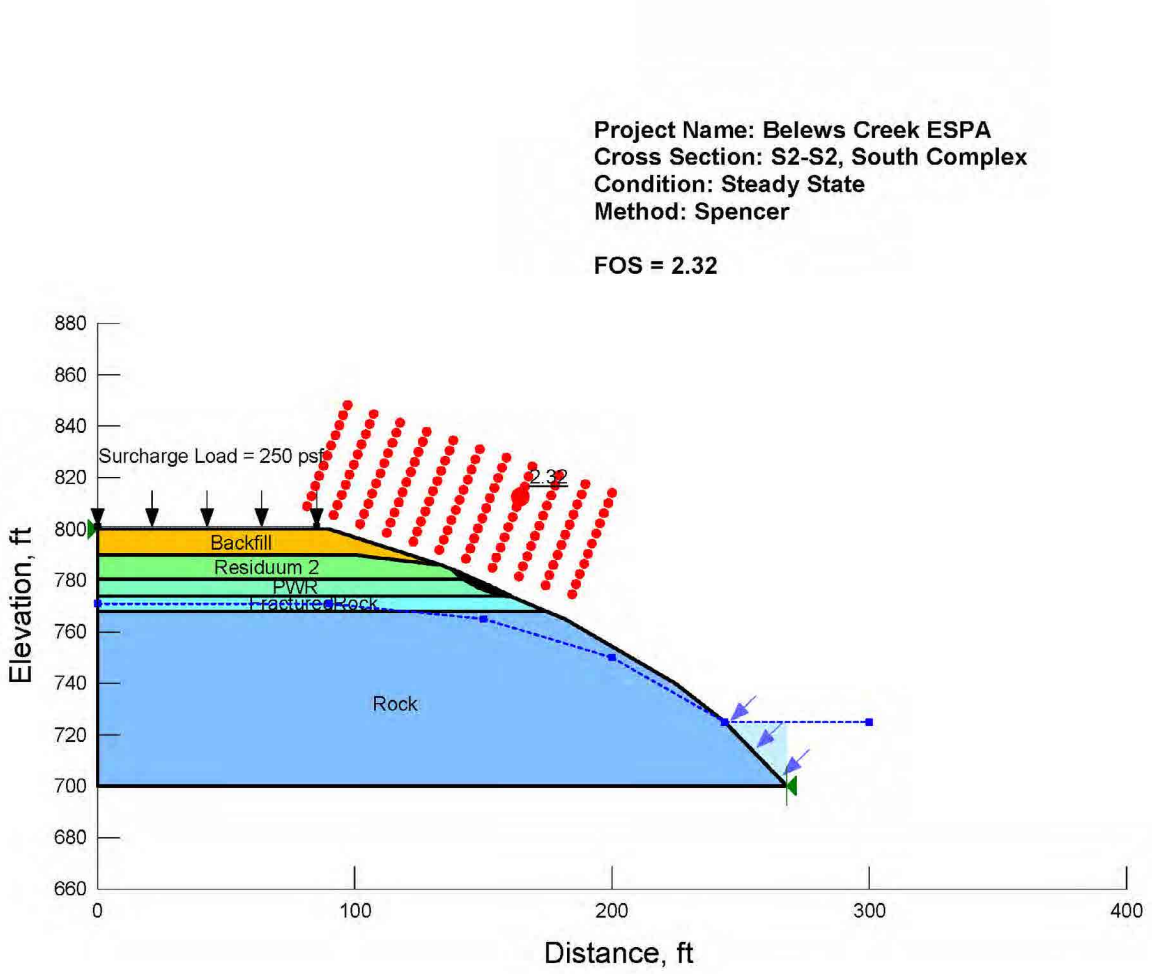
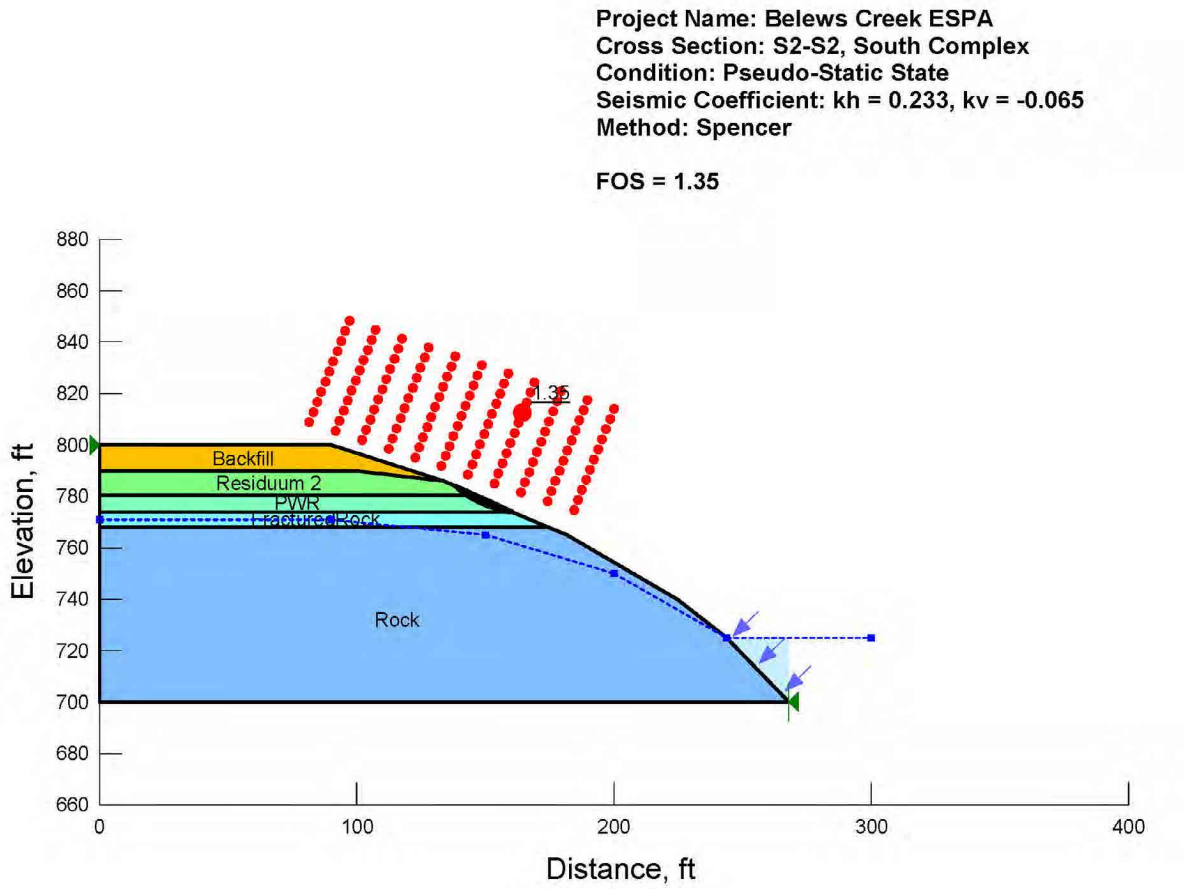


Figure 2.5-171
Slope Stability Section S2 Pseudo-Static



CHAPTER 3
DESIGN OF STRUCTURES, SYSTEMS, COMPONENTS, AND EQUIPMENT

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None.

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None.

GLOSSARY

Term	Definition
AL	approach and landing
CFR	Code of Federal Regulations
ft.	feet
km	kilometer
LWR	light-water reactor
m	meter
mi.	mile
NC	North Carolina
NUREG	NRC Technical Report designation
Project site	Belews Creek, NC site
rev.	revision
sq.	square
yr.	year

Chapter 3 Design of Structures, Systems, Components, and Equipment

3.5 MISSILE PROTECTION

3.5.1 Missile Selection and Description

3.5.1.6 Aircraft Hazards

NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Light Water Reactor (LWR) Edition*, establishes an acceptable method for applicants to demonstrate that the risks from aircraft hazards are sufficiently low. The NUREG establishes proximity-based screening criteria that allow an applicant to assess risk consequences by inspection. However, as noted below, the Belews Creek, North Carolina (NC) site (Project site) does not meet these criteria. In such cases, the NUREG requires a more detailed review of aircraft hazards. Specifically, NUREG-0800, Section 3.5.1.6, Rev. 4, “Aircraft Hazards,” provides that aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of Title 10 of the Code of Federal Regulations (CFR) Part 100, with a probability of occurrence greater than an order of magnitude of 10^{-7} per year (yr.), should be considered in the design of the plant. The NUREG establishes the expected rate of exposure identified in 10 CFR 50.34(a)(1) dose guidelines as it relates to the requirements identified in 10 CFR 100.20(b) should be about an order of magnitude of 10^{-6} per yr. If it can be shown with rigorous analysis, using realistic assumptions and reasonable arguments, that the estimated probability could be lower, then, in accordance with NUREG-0800, Section 2.2.3, Rev. 3, “Evaluation of Potential Accidents,” the risk level is considered acceptable.

The aircraft facilities and airways are described in Section 2.2.2.7. A screening evaluation was first performed to determine if the probability is considered to be less than an order of magnitude of 10^{-7} per yr. by inspection in accordance with the proximity criteria set in NUREG-0800. The evaluation determined there are two airports within five statute miles (mi.) (eight kilometers [km]) of the Project site – Meadow Brook Field (N63) and DS Butler Farm and Airfield (N83). Additionally, there is one airport with projected operations in 2050 that are greater than that allowed by the screening criteria – Piedmont Triad International (GSO). The evaluation further determined there are multiple federal airways (V-20/T-224, V-45, and V-103) whose edges are closer than two statute mi. (3.2 km) to the Project site. The Project site is approximately 1.9 statute mi. (3.0 km) from the centerline of airway V-20/T-224, 3.1 statute mi. (5.0 km) from the centerline of airway V-45, and 3.5 statute mi. (5.6 km) from the centerline of airway V-103. Additionally, approach pattern, approach and landing (AL)178 to Runway 14 of the Piedmont Triad International (GSO) airport does not meet the two statute mi. (3.2 km) criteria. Therefore, due to the airports, airways, and an approach pattern that fail the screening criteria in NUREG-0800, a detailed review of aircraft hazards was performed to determine whether the accident frequency is less than an order of magnitude of 10^{-7} per yr.

Details of the aircraft hazards analysis are provided in Section 2.2.2.7 and follow the methodology in DOE-STD-3014-2006 (Reference 3.5-1). To demonstrate acceptability, further evaluation is required to show the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the guidelines identified in 10 CFR 50.34(a)(1), as it relates to the requirements identified in 10 CFR 100.20(b), is on the order of magnitude of 10^{-6} per yr. and the realistic probability is lower, based on qualitative arguments. The accident frequency evaluation in Section 2.2.2.7 utilizes a set of bounding building dimensions (i.e., with a safety-related footprint diagonal, R, less than or equal to 216 feet [ft.] [65.8 meters {m}], height less than or equal to 176 ft. [53.6 m], and footprint area less than or equal to 20,700 square [sq.] ft.

[1920 sq. m]). These dimensions, as well as the aircraft's wingspan, skid distance, and impact angle define the effective area used in the accident frequency calculation as explained in DOE-STD-3014-2006 (Reference 3.5-1). The bounding building dimensions associated with the selected reactor technology will be confirmed at the time of the construction permit or license application.

When the technology vendor is selected, further assessments will be performed to confirm that the risk of a radiological release due to an aircraft accident satisfies NUREG-0800, Section 3.5.1.6 acceptance criteria. The results of these assessments will be documented in the construction permit or license application.

3.6 REFERENCES

3.5-1 United States Department of Energy, *Accident Analysis for Aircraft Crash into Hazardous Facilities*, DOE-STD-3014-2006, October 1996, Reaffirmed May 2006.

CHAPTER 11
RADIOACTIVE WASTE MANAGEMENT

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Table 11.3.3-6	Belews Creek, NC Site GASPAR II Gaseous Pathway Doses for Maximally Exposed Individuals

Number	Title
Table 11.3.3-7	Comparison of Belews Creek, NC Site Gaseous Annual Doses to 10 CFR Part 50 Appendix I Dose Limits
Table 11.3.3-8	Comparison of Belews Creek, NC Site Annual Dose Estimates to 40 CFR Part 190 and 10 CFR 20.1301(e) Dose Limits
Table 11.3.3-9	Belews Creek, NC Site Collective Population Dose from Gaseous Pathways

LIST OF FIGURES

Number	Title

None.

GLOSSARY

Term	Definition
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci/yr	curies per year
CR	Contractor Report
D/Q	ground deposition
ECL	effluent concentration limit
GI-LLI	gastrointestinal tract - lower large intestine
hr/yr	hours/year
kg/yr	kilogram/year
km	kilometer
LWR	light-water reactor
L/yr	liters per year
m^3/s	cubic meters per second
MEI	maximally exposed individual
mi.	mile
mrem	millirem
mrem/yr	millirem per year
NC	North Carolina

Term	Definition
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC Technical Report designation
Project site	Belews Creek, NC site
rev.	revision
RG	Regulatory Guide
U.S.	United States
USEPA	U.S. Environmental Protection Agency
µCi/ml	microcuries per milliliter
χ/Q	atmospheric dispersion factor

Chapter 11 Radioactive Waste Management

11.2 LIQUID WASTE MANAGEMENT SYSTEM

11.2.3 Liquid Radioactive Releases

This section describes the liquid radiological impacts of normal plant operation from the Belews Creek, North Carolina (NC) site (Project site) to members of the public. Section 11.2.3.1 describes the exposure pathways by which radiation from radiological liquid effluents could be transmitted from the Project site to members of the public. Section 11.2.3.2 estimates individual and collective doses to members of the public from radiological liquid effluents and evaluates the impact of these doses by comparing them to regulatory limits.

11.2.3.1 Exposure Pathways

During normal operation of the Project site, radiological liquid effluents are expected to be discharged to the environment. The Project site will release small quantities of treated and diluted radioactive liquid effluent into the Dan River. The liquid effluent pathways associated with the Dan River are analyzed to estimate the potential doses from liquid releases during normal operation. The major pathways of concern are those that could yield the highest radiological doses for a given receptor. The pathways are determined from the type and amount of radioactivity transported, the transport mechanism, and the consumption or usage factors of the receptor.

The exposure pathways considered for the Project site are analyzed and estimated for the maximally exposed individual (MEI) and the general population surrounding the Project site. The MEI is the member of the public who is positioned to receive the maximum possible calculated dose. The doses estimated for the Project site are based on United States (U.S.) Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.109, Rev. 1, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*. These estimated doses are used to confirm that anticipated releases, associated with normal operation of the plants (being considered for the Project site) will result in doses that are within the dose limits to the public described in Title 10 of the Code of Federal Regulations (CFR), Part 50, (10 CFR 50), Appendix I; 10 CFR Part 20, and 40 CFR Part 190, the U.S. Environmental Protection Agency (USEPA) limits on dose to the public.

The LADTAP II module of the NRCDose computer code implements the methodology discussed in RG 1.109, Rev. 1 to estimate doses from liquid effluents from the Project site (Reference 11.2-1). The code estimates the dose to the MEI and to the average individual through the following pathways:

- Internal exposure from ingestion of aquatic foods.
- Internal exposure from ingestion of drinking water.
- Internal exposure from ingestion of milk and meat from livestock consuming pasture feed from farms irrigated by contaminated water.
- Internal exposure from ingestion of vegetables and fruits from farms irrigated by contaminated water.

- External exposure to shoreline sediments.
- External exposure from boating and swimming.

The reactor effluent discharge flow rate of 7.35 cubic feet per second (cfs) (0.208 cubic meters per second [m^3/s]) and a mean flow rate for the Dan River of 498.4 cfs (14.11 m^3/s) is utilized for the analysis. Additionally, transit time from liquid discharge to the Dan River is assumed to be zero. This is conservative since the Dan River is greater than 2.24 miles (mi.) (3.6 kilometers [km]) from the Project site, and thus some decay will occur before it is discharged into the river.

The shoreline, swimming, and boating usage is determined by multiplying the 50 mi. (80 km) radius population for the year 2079 (Table 11.2.3-3) by the average shoreline usage rate. The fish consumption is similarly determined by multiplying the 50 mi. (80 km) radius population for the year 2079 (Table 11.2.3-3) by the average adult fish consumption; however, the only identified location of commercial fish supply within 50 mi. (80 km) of the Project site produces 250,000 pounds of tilapia per year. Therefore, the average adult fish consumption is reduced by 50 percent to account for the fraction of consumption attributed to the Dan River.

The drinking water usage rate is determined using the survey conducted in 2024, which shows that the Dan River is used as drinking water for two locations (i.e., city of Eden and town of Madison in NC). The 2025 population for both locations (i.e., 17,581) was used and scaled appropriately to 2079, using the same scale factors (i.e., 1.39) used for the projected 2079 50 mi. (80 km) radius population.

The milk production, meat production, and produce production that utilized irrigation from the Dan River, downstream of the radioactive liquid effluent discharge location, is determined using the survey conducted in 2024 and consumption rates from the GASPAR II Technical Manual. Using the survey, the sum of the fractions of irrigated cropland is determined to be 0.0153. Additionally, the ratio of total cropland from counties using irrigation to the total cropland within 50 mi. (80 km) is identified to be 0.585. For the analysis, the national irrigation usage rate in 2024 of 38.1 liters/m^2/month is utilized. Using this information and the consumption rates in Table 11.3.3-3, the production rates for milk, meat and produce that use Dan River water for irrigation, are determined.

Table 11.2.3-1 contains an overview of the liquid pathway parameters used by LADTAP II. Table 11.2.3-2 contains the fish and invertebrate consumption rates and aquatic recreation usage rates used for the MEI and average individual. The consumption factors (infant, child, teen, or adult) from RG 1.109, Rev. 1 are used to determine the doses to the average individual and MEI. Additionally, these consumption factors are multiplied by the projected population (Table 11.2.3-3) within 50 mi. (80 km) of the Project site.

Additionally, since Duke Energy has not yet selected a technology for the Project site, the activity assumed to be released for the site is based on an enveloping approach to bound the technologies considered in this application. The bounding liquid release activity utilized for the Project site is provided in Table 11.2.3-4.

A pump station located roughly three miles downstream from the discharge location can pump river water into Belews Lake in accordance with permitted limitations related to river flow and season. However, any dose contributions from the pathways associated with the Belews Lake would be negligible due to the distance from the discharge location, additional dilution from the Dan River and Belews Lake, and the assumption that liquid radioactive effluent is released in

intermittent batch releases and could be discharged when the pump is not operating.

Population doses for the Project site are calculated for the year 2079, which is projected to be approximately 40 years from starting normal operation. The projected population within 50 mi. (80 km) of the Project site for the year 2079 is provided in Table 11.2.3-3.

11.2.3.2 Liquid Pathway Doses

Table 11.2.3-5 converts the liquid bounding release activity to concentrations to compare against the effluent concentration limits (ECLs) of 10 CFR Part 20, Appendix B, Table 2, Column 2. The bounding release activity is converted to concentrations by dividing by the reactor effluent discharge flow rate and the dilution factor. As shown in Table 11.2.3-5, the bounding release activity concentrations are within the liquid ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 2.

Table 11.2.3-6 provides the resultant doses for the Project site from LADTAP II to the MEI at each pathway location determined. These results are based on the inputs in Tables 11.2.3-1, 11.2.3-2, and 11.2.3-4. Table 11.2.3-7 compares 10 CFR Part 50, Appendix I, dose limits for liquid effluents to the MEI doses for a single unit. The MEI doses calculated from liquid effluents for the Project site are compared to 40 CFR Part 190 and 10 CFR 20.1301(e) dose limits, as shown in Table 11.3.3-8. Table 11.2.3-8 provides the collective population doses from liquid effluents to individuals living within a 50 mi. (80 km) radius of the Project site.

As can be seen from Tables 11.2.3-7 and 11.3.3-8, the estimated liquid effluent doses to the MEI for a single unit are within design objectives of 10 CFR Part 50, Appendix I; and the estimated gaseous and liquid effluent doses to the MEI are within 40 CFR Part 190 and 10 CFR 20.1301(e) dose limits; respectively.

Table 11.2.3-1
Liquid Pathway Parameters

Parameter	Value
Water Type	Fresh Water
Discharge Rate	7.35 cfs
Dilution Factor	68
Transit Time to Receptor	0 hour
Impoundment Reconcentration Model	None
Shore-Width Factor	0.2
Population within 50 miles	3,057,906
50-mi Shoreline Usage (person -hr/yr)	39,141,197
50-mi Swimming Usage (person -hr/yr)	39,141,197
50-mi Boating Usage (person -hr/yr)	39,141,197
50-mi Sport Fishing Harvest (kg/yr)	10,549,775.7
50-mi Commercial Fishing Harvest	0
50-mi Sport Invertebrate Harvest	0
50-mi Commercial Invertebrate Harvest	0
Drinking Water Population	24,500
Milk Production using Dan River as Irrigation (L/yr)	10,947,915.1
Meat Production using Dan River as Irrigation (kg/yr)	3,010,676.6
Produce Production using Dan River as Irrigation (kg/yr)	18,994,632.6

Key: cfs = cubic feet per second; hr/yr = hours per year; kg/yr = kilograms per year; L/yr = liters per year; mi. = mile

Table 11.2.3-2
Fish and Invertebrate Consumption Rates and Aquatic Recreation Usage Rates

Consumption Factor	MEI Annual Rate				Average Annual Rate				Average Rate
	Adult	Teen	Child	Infant	Adult	Teen	Child	Infant	
Fish Consumption (kg/yr)	21	16	6.9	0	6.9	5.2	2.2	0	5.9
Invertebrate Consumption (kg/yr)	0	0	0	0	1.0	0.75	0.33	0	0.85
Shoreline Usage (hr/yr)	12	67	14	0	8.3	47	9.5	-	12.8
Swimming (hr/yr)	12	67	14	0	8.3	47	9.5	-	12.8
Boating (hr/yr)	12	67	14	0	8.3	47	9.5	-	12.8
Drinking Water Consumption (L/yr)	730	510	510	330	370	260	260	-	-

Key: hr/yr = hours per year; kg/yr = kilograms per year; L/yr = liters per year; MEI = maximally exposed individual

Table 11.2.3-3
Total Population (50 Mi. Radius) 2079

Compass Direction Sector	Distance (mi.)									
	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 10	10 - 20	20 - 30	30 - 40	40 - 50
N	84	66	160	330	201	1537	2749	5070	9016	16,879
NNE	33	66	120	193	525	5706	5908	15,305	14,166	9186
NE	42	102	200	204	276	2684	8814	18,825	10,907	19,729
ENE	363	104	255	341	360	2053	8484	18,452	15,056	27,983
E	57	103	265	415	533	2918	11,057	14,851	9346	10,303
ESE	54	210	362	889	971	10,152	78,898	51,019	205,187	97,668
SE	162	354	522	743	1266	12,246	328,571	126,504	25,122	37,549
SSE	115	260	510	763	1404	12,377	139,009	62,072	52,117	47,590
S	193	221	357	744	788	25,967	106,623	119,719	28,425	15,598
SSW	172	317	280	382	1042	19,912	99,007	56,550	76,034	91,252
SW	64	159	223	319	889	12,249	272,070	117,988	37,164	38,984
WSW	33	91	236	288	384	4422	95,606	26,794	20,368	26,171
W	33	367	78	298	474	2902	27,320	9007	13,725	26,001
WNW	33	56	80	249	882	2264	6628	13,176	34,111	10,794
NW	33	73	192	290	311	2150	4033	3891	4888	8063
NNW	33	66	141	147	167	1197	2848	4206	2384	9182

Note: Total population within 50 miles - 3,057,906.

Key: E = east; mi. = mile; N = north; S = south; W = west

Table 11.2.3-4
Bounding Normal Liquid Radioactive Release Rates
(Sheet 1 of 2)

Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)	Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)
Ag-110m	1.50E-04	9.00E-04	I-129	6.26E-11	1.25E-10
Am-241	1.00E-05	6.00E-05	I-130	8.80E-10	1.76E-09
Ba-139	2.20E-04	1.32E-03	I-131	1.10E-03	6.60E-03
Ba-140	4.90E-03	2.94E-02	I-132	1.50E-04	9.00E-04
Br-82	7.86E-08	1.57E-07	I-133	1.90E-03	1.14E-02
Br-83	6.70E-04	4.02E-03	I-134	1.00E-05	6.00E-05
Br-84	1.00E-05	6.00E-05	I-135	8.60E-04	5.16E-03
Br-85	2.35E-06	1.41E-05	La-140	2.00E-04	1.20E-03
C-14	1.00E-05	6.00E-05	La-141	6.29E-22	1.26E-21
Ce-141	3.30E-04	1.98E-03	La-142	1.80E-04	1.08E-03
Ce-143	1.60E-04	9.60E-04	Mn-54	6.50E-03	3.90E-02
Ce-144	4.70E-04	2.82E-03	Mn-56	2.00E-04	1.20E-03
Cm-242	1.00E-05	6.00E-05	Mo-99	2.80E-03	1.68E-02
Cm-244	1.00E-05	6.00E-05	Na-24	1.90E-03	1.14E-02
Co-57	1.00E-05	6.00E-05	Nb-95	1.20E-03	7.20E-03
Co-58	3.40E-03	2.04E-02	Nd-147	4.00E-05	2.40E-04
Co-60	6.60E-03	3.96E-02	Ni-63	3.10E-03	1.86E-02
Cr-51	1.20E-02	7.20E-02	Ni-65	4.00E-05	2.40E-04
Cs-134	2.30E-03	1.38E-02	Np-239	2.10E-03	1.26E-02
Cs-136	1.30E-03	7.80E-03	P-32	4.70E-04	2.82E-03
Cs-137	3.50E-03	2.10E-02	Pr-143	5.90E-04	3.54E-03
Cs-138	2.96E-04	1.78E-03	Pr-144	4.70E-04	2.82E-03
Cu-64	7.40E-03	4.44E-02	Pu-238	1.00E-05	6.00E-05
Fe-55	1.40E-02	8.40E-02	Pu-239	1.00E-05	6.00E-05
Fe-59	3.50E-03	2.10E-02	Pu-240	1.00E-05	6.00E-05

Table 11.2.3-4
Bounding Normal Liquid Radioactive Release Rates
(Sheet 2 of 2)

Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)	Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)
H-3	2.70E+02	1.62E+03	Pu-241	1.00E-05	6.00E-05
Rb-86	2.88E-04	5.76E-04	Te-127m	1.69E-06	3.38E-06
Rb-88	1.00E-05	6.00E-05	Te-129	3.00E-05	1.80E-04
Rb-89	4.07E-05	2.44E-04	Te-129m	5.00E-04	3.00E-03
Rh-105	3.15E-09	6.30E-09	Te-131	2.10E-04	1.26E-03
Ru-103	7.70E-04	4.62E-03	Te-131m	2.00E-05	1.20E-04
Ru-105	7.90E-04	4.74E-03	Te-132	7.00E-05	4.20E-04
Ru-106	4.80E-04	2.88E-03	Te-133m	2.50E-05	1.50E-04
Sb-124	1.00E-05	6.00E-05	Te-134	3.45E-05	2.07E-04
Sb-125	1.00E-05	6.00E-05	W-187	7.40E-04	4.44E-03
Sb-127	2.92E-09	5.84E-09	Y-90	1.50E-07	3.00E-07
Sr-89	5.00E-05	3.00E-04	Y-91	6.70E-04	4.02E-03
Sr-90	1.00E-05	6.00E-05	Y-91m	1.00E-05	6.00E-05
Sr-91	2.00E-03	1.20E-02	Y-92	1.50E-03	9.00E-03
Sr-92	4.80E-04	2.88E-03	Y-93	1.60E-04	9.60E-04
Tc-99	5.80E-09	1.16E-08	Zn-65	2.70E-03	1.62E-02
Tc-99m	2.80E-03	1.68E-02	Zr-95	1.10E-03	6.60E-03
Te-125m	4.19E-07	8.38E-07	Zr-97	2.00E-05	1.20E-04
Te-127	1.65E-06	3.30E-06	Total	2.70E+02	1.62E+03

Key: Ci/yr = curies per year

Table 11.2.3-5
Site Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 2 Liquid Effluent Concentration Limits
(Sheet 1 of 4)

Radionuclide	Site Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
Ag-110m	1.37E-10	6.00E-06	2.28E-05
Am-241	9.14E-12	2.00E-08	4.57E-04
Ba-139	2.01E-10	2.00E-04	1.01E-06
Ba-140	4.48E-09	8.00E-06	5.60E-04
Br-82	2.39E-14	4.00E-05	5.98E-10
Br-83	6.12E-10	9.00E-04	6.80E-07
Br-84	9.14E-12	4.00E-04	2.28E-08
Br-85	2.15E-12	NA	NA
C-14	9.14E-12	3.00E-05	3.05E-07
Ce-141	3.02E-10	3.00E-05	1.01E-05
Ce-143	1.46E-10	2.00E-05	7.31E-06
Ce-144	4.30E-10	3.00E-06	1.43E-04
Cm-242	9.14E-12	7.00E-07	1.31E-05
Cm-244	9.14E-12	3.00E-08	3.05E-04
Co-57	9.14E-12	6.00E-05	1.52E-07
Co-58	3.11E-09	2.00E-05	1.55E-04
Co-60	6.03E-09	3.00E-06	2.01E-03
Cr-51	1.10E-08	5.00E-04	2.19E-05
Cs-134	2.10E-09	9.00E-07	2.34E-03
Cs-136	1.19E-09	6.00E-06	1.98E-04
Cs-137	3.20E-09	1.00E-06	3.20E-03
Cs-138	2.71E-10	4.00E-04	6.78E-07
Cu-64	6.76E-09	2.00E-04	3.38E-05
Fe-55	1.28E-08	1.00E-04	1.28E-04

Table 11.2.3-5
Site Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 2 Liquid Effluent Concentration Limits
(Sheet 2 of 4)

Radionuclide	Site Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
Fe-59	3.20E-09	1.00E-05	3.20E-04
H-3	2.47E-04	1.00E-03	2.47E-01
I-129	1.90E-17	2.00E-07	9.52E-11
I-130	2.68E-16	2.00E-05	1.34E-11
I-131	1.01E-09	1.00E-06	1.01E-03
I-132	1.37E-10	1.00E-04	1.37E-06
I-133	1.74E-09	7.00E-06	2.48E-04
I-134	9.14E-12	4.00E-04	2.28E-08
I-135	7.86E-10	3.00E-05	2.62E-05
La-140	1.83E-10	9.00E-06	2.03E-05
La-141	1.92E-28	5.00E-05	3.84E-24
La-142	1.65E-10	1.00E-04	1.65E-06
Mn-54	5.94E-09	3.00E-05	1.98E-04
Mn-56	1.83E-10	7.00E-05	2.61E-06
Mo-99	2.56E-09	2.00E-05	1.28E-04
Na-24	1.74E-09	5.00E-05	3.47E-05
Nb-95	1.10E-09	3.00E-05	3.66E-05
Nd-147	3.66E-11	2.00E-05	1.83E-06
Ni-63	2.83E-09	1.00E-04	2.83E-05
Ni-65	3.66E-11	1.00E-04	3.66E-07
Np-239	1.92E-09	2.00E-05	9.60E-05
P-32	4.30E-10	9.00E-06	4.77E-05
Pr-143	5.39E-10	7.00E-05	7.70E-06
Pr-144	4.30E-10	2.00E-05	2.15E-05

Table 11.2.3-5
Site Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 2 Liquid Effluent Concentration Limits
(Sheet 3 of 4)

Radionuclide	Site Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
Pu-238	9.14E-12	2.00E-08	4.57E-04
Pu-239	9.14E-12	2.00E-08	4.57E-04
Pu-240	9.14E-12	2.00E-08	4.57E-04
Pu-241	9.14E-12	1.00E-06	9.14E-06
Rb-86	8.77E-11	7.00E-06	1.25E-05
Rb-88	9.14E-12	4.00E-04	2.28E-08
Rb-89	3.72E-11	9.00E-04	4.13E-08
Rh-105	9.60E-16	5.00E-05	1.92E-11
Ru-103	7.04E-10	3.00E-05	2.35E-05
Ru-105	7.22E-10	7.00E-05	1.03E-05
Ru-106	4.39E-10	3.00E-06	1.46E-04
Sb-124	9.14E-12	7.00E-06	1.31E-06
Sb-125	9.14E-12	3.00E-05	3.05E-07
Sb-127	8.90E-16	1.00E-05	8.90E-11
Sr-89	4.57E-11	8.00E-06	5.71E-06
Sr-90	9.14E-12	5.00E-07	1.83E-05
Sr-91	1.83E-09	2.00E-05	9.14E-05
Sr-92	4.39E-10	4.00E-05	1.10E-05
Tc-99	1.77E-15	6.00E-05	2.94E-11
Tc-99m	2.56E-09	1.00E-03	2.56E-06
Te-125m	1.28E-13	2.00E-05	6.38E-09
Te-127	5.03E-13	1.00E-04	5.03E-09
Te-127m	5.15E-13	9.00E-06	5.72E-08
Te-129	2.74E-11	4.00E-04	6.85E-08

Table 11.2.3-5
Site Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 2 Liquid Effluent Concentration Limits
(Sheet 4 of 4)

Radionuclide	Site Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
Te-129m	4.57E-10	7.00E-06	6.53E-05
Te-131	1.92E-10	8.00E-05	2.40E-06
Te-131m	1.83E-11	8.00E-06	2.28E-06
Te-132	6.40E-11	9.00E-06	7.11E-06
Te-133m	2.28E-11	9.00E-05	2.54E-07
Te-134	3.15E-11	3.00E-04	1.05E-07
W-187	6.76E-10	3.00E-05	2.25E-05
Y-90	4.57E-14	7.00E-06	6.53E-09
Y-91	6.12E-10	8.00E-06	7.65E-05
Y-91m	9.14E-12	2.00E-03	4.57E-09
Y-92	1.37E-09	4.00E-05	3.43E-05
Y-93	1.46E-10	2.00E-05	7.31E-06
Zn-65	2.47E-09	5.00E-06	4.94E-04
Zr-95	1.01E-09	2.00E-05	5.03E-05
Zr-97	1.83E-11	9.00E-06	2.03E-06
Total	2.47E-04	NA	2.61E-01

Key: µCi/ml = microcuries per milliliter; CFR = Code of Federal Regulations; ECL = effluent concentration limit

Table 11.2.3-6
Belews Creek, NC Site LADTAP II Liquid Pathway Doses for Maximally Exposed Individuals
(Sheet 1 of 2)

Pathway	Skin (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Total Body (mrem/yr)	Thyroid (mrem/yr)	Kidney (mrem/yr)	Lung (mrem/yr)	GI-LLI (mrem/yr)
				Fish[a]				
Adult	0.00E+00	2.68E+00	6.08E-01	4.20E-01	1.39E-02	1.68E-01	5.08E-02	5.36E-01
Teen	0.00E+00	2.91E+00	6.31E-01	2.98E-01	1.25E-02	1.69E-01	5.84E-02	4.09E-01
Child	0.00E+00	3.74E+00	5.65E-01	2.22E-01	1.25E-02	1.41E-01	4.62E-02	1.63E-01
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
				Drinking[a]				
Adult	0.00E+00	1.21E-02	1.67E-01	1.64E-01	1.82E-01	1.61E-01	1.59E-01	1.71E-01
Teen	0.00E+00	1.15E-02	1.20E-01	1.15E-01	1.32E-01	1.14E-01	1.12E-01	1.20E-01
Child	0.00E+00	3.32E-02	2.31E-01	2.19E-01	2.66E-01	2.20E-01	2.15E-01	2.22E-01
Infant	0.00E+00	3.22E-02	2.31E-01	2.14E-01	2.93E-01	2.16E-01	2.12E-01	2.15E-01
				Shoreline[a]				
Adult	1.13E-03	9.60E-04	9.60E-04	9.60E-04	9.60E-04	9.60E-04	9.60E-04	9.60E-04
Teen	6.29E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03
Child	1.31E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
				Swimming[a]				
Adult	0.00E+00	1.90E-05	1.90E-05	1.90E-05	1.90E-05	1.90E-05	1.90E-05	1.90E-05
Teen	0.00E+00	1.06E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04
Child	0.00E+00	2.21E-05	2.21E-05	2.21E-05	2.21E-05	2.21E-05	2.21E-05	2.21E-05
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
				Boating[a]				
Adult	0.00E+00	9.49E-06	9.49E-06	9.49E-06	9.49E-06	9.49E-06	9.49E-06	9.49E-06
Teen	0.00E+00	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05
Child	0.00E+00	1.11E-05	1.11E-05	1.11E-05	1.11E-05	1.11E-05	1.11E-05	1.11E-05
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 11.2.3-6
Belews Creek, NC Site LADTAP II Liquid Pathway Doses for Maximally Exposed Individuals
(Sheet 2 of 2)

Pathway	Skin (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Total Body (mrem/yr)	Thyroid (mrem/yr)	Kidney (mrem/yr)	Lung (mrem/yr)	GI-LLI (mrem/yr)
Irrigated Vegetation[(a)]								
Adult	0.00E+00	2.55E-02	1.32E-01	1.26E-01	1.17E-01	1.19E-01	1.14E-01	1.31E-01
Teen	0.00E+00	4.16E-02	1.70E-01	1.51E-01	1.45E-01	1.48E-01	1.41E-01	1.59E-01
Child	0.00E+00	9.96E-02	2.72E-01	2.32E-01	2.32E-01	2.34E-01	2.23E-01	2.32E-01
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Irrigated Milk[(a)]								
Adult	0.00E+00	1.77E-02	8.61E-02	8.00E-02	7.73E-02	7.43E-02	6.86E-02	7.14E-02
Teen	0.00E+00	3.13E-02	1.20E-01	1.01E-01	1.03E-01	9.96E-02	9.06E-02	9.24E-02
Child	0.00E+00	7.53E-02	1.93E-01	1.53E-01	1.71E-01	1.58E-01	1.43E-01	1.42E-01
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Irrigated Meat[(a)]								
Adult	0.00E+00	4.96E-03	2.77E-02	2.61E-02	2.41E-02	2.61E-02	2.44E-02	5.47E-02
Teen	0.00E+00	4.03E-03	1.73E-02	1.56E-02	1.44E-02	1.61E-02	1.48E-02	3.28E-02
Child	0.00E+00	7.50E-03	2.12E-02	1.89E-02	1.76E-02	1.96E-02	1.79E-02	2.81E-02
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total[(a)]								
Adult	1.13E-03	2.74E+00	1.02E+00	8.17E-01	4.15E-01	5.49E-01	4.18E-01	9.65E-01
Teen	6.29E-03	3.00E+00	1.06E+00	6.86E-01	4.12E-01	5.52E-01	4.22E-01	8.19E-01
Child	1.31E-03	3.96E+00	1.28E+00	8.46E-01	7.00E-01	7.74E-01	6.46E-01	7.88E-01
Infant	0.00E+00	3.22E-02	2.31E-01	2.14E-01	2.93E-01	2.16E-01	2.12E-01	2.15E-01

Notes:

(a) The doses listed are for the entire Project site.

Key: GI-LLI = gastrointestinal tract - lower large intestine; mrem/yr = millirem per year

Table 11.2.3-7
Comparison of Belews Creek, NC Site Liquid Annual Doses to 10 CFR Part 50 Appendix I Dose Limits

Type of Dose	Location	Annual Dose per Reactor	
		Dose	Limit
Total Body (mrem/yr)	Dan River	1.41E-01	3
Maximum Organ (Bone) (mrem/yr)	Dan River	6.59E-01	10

Key: CFR = Code of Federal Regulations; mrem/yr = millirem per year; NC = North Carolina

Table 11.2.3-8
Belews Creek, NC Site Collective Population Dose from Liquid Pathways

Pathway	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI	Skin
	Site Dose (person-rem/yr)							
Fish Ingestion	1.31E+03	3.27E+02	2.00E+02	5.16E+00	9.36E+01	2.95E+01	2.19E+02	0.00E+00
Water Consumption	1.95E-01	2.16E+00	2.10E+00	2.35E+00	2.07E+00	2.04E+00	2.16E+00	0.00E+00
Shoreline	0.00E+00	0.00E+00	3.13E+00	3.13E+00	0.00E+00	0.00E+00	0.00E+00	3.67E+00
Swimming	0.00E+00	0.00E+00	6.19E-02	6.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boating	0.00E+00	0.00E+00	3.09E-02	3.09E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vegetation	1.38E+00	5.72E+00	5.24E+00	4.77E+00	5.07E+00	4.87E+00	5.27E+00	0.00E+00
Milk	1.09E+00	3.87E+00	3.34E+00	3.33E+00	3.25E+00	2.98E+00	3.03E+00	0.00E+00
Meat	1.74E-01	8.29E-01	7.72E-01	7.14E-01	7.77E-01	7.23E-01	1.55E+00	0.00E+00
Total	1.31E+03	3.40E+02	2.15E+02	1.95E+01	1.05E+02	4.01E+01	2.31E+02	3.67E+00

Key: GI-LLI = gastrointestinal tract - lower large intestine

11.3 GASEOUS WASTE MANAGEMENT SYSTEM

11.3.3 Gaseous Radioactive Releases

This section describes the gaseous radiological impacts of normal plant operation from the Project site to members of the public. Section 11.3.3.1 describes the exposure pathways by which radiation from radiological gaseous effluents could be transmitted from the Project site to members of the public. Section 11.3.3.2 estimates individual and collective doses to members of the public from radiological gaseous effluents and evaluates the impact of these doses by comparing them to regulatory limits.

11.3.3.1 Exposure Pathways

During normal operation of the plants considered for the Project site, radiological gaseous effluents are expected to be discharged to the environment. Exposure to the radiological effluents from normal operation is dependent on the radiological exposure pathways. A radiological exposure pathway is the vehicle by which a receptor may become exposed to radiological releases from nuclear facilities. The major pathways of concern are those that could yield the highest radiological doses for a given receptor. These pathways are determined from the type and amount of radioactivity transported, the transport mechanism, and the consumption or usage factors of the receptor. Environmental transport mechanisms for gaseous effluents consider the historical meteorological characteristics of the area that are defined by windspeed and wind direction. Additional factors such as location of homes, use of cattle for milk, and gardens for vegetable consumption are considered when evaluating exposure pathways.

The exposure pathways considered for the Project site are analyzed and estimated for the MEI and the general population surrounding the Project site. The MEI is the member of the public who is positioned to receive the maximum possible calculated dose. The doses estimated for the Project site are based on RG 1.109 and RG 1.111, Rev. 1, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors*. The estimated doses are used to confirm that anticipated releases associated with normal operation of the plants considered for the Project site are within the dose limits to the public described in 10 CFR Part 50, Appendix I; 10 CFR Part 20; and 40 CFR Part 190, the USEPA limits on dose to the public.

Section 2.3.5 contains discussion regarding the atmospheric dispersion (χ/Q) and ground deposition (D/Q) factors for the Project site. The χ/Q factors in Section 2.3.5 are determined using the XOQDOQ computer code, which implements RG 1.111 methodology (Reference 11.3-1). Table 11.3.3-1 contains the χ/Q and D/Q values for the maximally exposed location (MEL) and offsite receptors that are utilized for the evaluation.

The GASPAR II module of the NRCDose computer code implements the methodology discussed in RG 1.109, Rev. 1 to estimate doses from gaseous effluents from the Project site (Reference 11.3-2). The code calculates the radiation exposure to people through the following potential pathways:

- External exposure to airborne radioactivity
- External exposure to deposited activity on the ground

- Inhalation of airborne radioactivity
- Ingestion of contaminated agricultural products

Table 11.3.3-2 contains an overview of the gaseous pathway parameters used by GASPAR II. The fraction of the year that leafy vegetables are grown, and milk and meat animals are on pasture is based on site-specific conditions. NC experiences all four seasons; therefore, it is not expected that vegetables are grown all year, and milk and meat animals are on pasture all year.

Figure 2.2 in the GASPAR II technical manual (Reference 11.3-2) is used to determine the length of the growing season. In the case of the Project site, the growing/pasture season is 8 months. The GASPAR II Technical Manual states to add one month for goats for nine total months and to subtract three months for leafy greens for five months.

The fraction of the maximum individual's vegetable intake that is from their own garden is expected to be lower than the default GASPAR II value. The land survey conducted in December of 2024 identified the nearest vegetable garden as a soybean farm. Furthermore, the survey found that the crop production within 2 miles of the Project site is comprised of corn, sorghum, soybeans, tobacco, winter wheat, triticale, and hay. The crop production within 2 miles also appears to be operations that would require the crops to be processed and shipped outside of the project area. As such, it is not reasonable to assume that 76 percent (i.e., the value from Table E-15 of RG 1.109) of vegetables consumed are from an individual's garden. Therefore, it is reasonable, and still conservative to assume that an individual consumes roughly a third of their vegetable intake (i.e., 0.35) for 42 percent (i.e., 5 months) of the year from their own garden.

Table 11.3.3-3 contains food consumption rates for the average individual and the MEI within 50 mi. (80 km) of the Project site. The table is based on the most conservative consumption factor (infant, child, teen, or adult) from Reference 11.3-2 which is used to determine the dose to the average individual and the MEI. Additionally, these consumption factors are multiplied by the projected population (Table 11.2.3-3) within 50 mi. (80 km) of the Project site. Because milk and meat animals are not identified to be within 5 mi. (8 km) of the Project site, dose contributions from milk and meat animals do not contribute to the MEI dose.

Additionally, since Duke Energy has not yet selected a technology for the Project site, the activity assumed to be released from the site is based on an enveloping approach to bound the technologies considered in this application. The bounding gaseous release activity utilized for the Project site is provided in Table 11.3.3-4.

As noted in NUREG-2226 (Reference 11.3-3), direct radiation from sources within a light-water reactor (LWR) is primarily due to nitrogen-16. Because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of LWRs are generally undetectable and less than 1 mrem/yr at the unrestricted area boundary. Some plants (mostly boiling-water reactors) do not have completely shielded secondary systems and may contribute some measurable offsite doses. Additionally, since the dose rates discussed in NUREG-2226 and NUREG-1437 relate more to units that are larger than the advanced reactors considered in the analysis, the dose is expected to be less for the technologies considered for the Project site. Therefore, a dose rate for direct radiation of 1 mrem/yr at the unrestricted area boundary is utilized. However, since 40 CFR Part 190 applies to the MEI, which is located at the nearest resident, and since the nearest resident is located farther from the unrestricted area boundary, any contributions to the MEI from direct radiation are expected to be negligible.

Population doses for the Project site are calculated for the year 2079, which is projected to be approximately 40 years from starting normal operation. The projected population within 50 mi. (80 km) of the Project site for the year 2079 is provided in Table 11.2.3-3.

11.3.3.2 Gaseous Pathway Doses

Table 11.3.3-5 converts the gaseous bounding release activity to concentrations for the Project site to compare against the Gaseous ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 1. As can be seen from Table 11.3.3-5, the bounding release activity concentrations for the Project site are within the ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 1. To convert the bounding release activity to a concentration, each radionuclide is multiplied by the unrestricted area boundary MEL χ/Q factor for each plant. The activities utilized for each Plant Complex are determined by multiplying the per unit activities by the expected number of units at each Plant Complex, as discussed in Section 1.11. Since the bounding release activity is primarily based on technologies that would build two units at each Plant Complex, it is reasonable to multiply the per unit activities by two. The resulting concentrations for each Plant Complex are summed to obtain the bounding site gaseous release concentrations and are compared against the ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 1.

Table 11.3.3-6 provides the results for the Project site from GASPAR II to the MEI at each pathway location. These results are based on the inputs in Tables 11.3.3-2 and 11.3.3-3. Table 11.3.3-7 compares 10 CFR Part 50, Appendix I, dose limits for gaseous effluents to the MEI doses for a single unit. The MEI doses calculated from gaseous and liquid effluents for the Project site are compared to 40 CFR Part 190 and 10 CFR 20.1301 dose limits, as shown in Table 11.3.3-8. Table 11.3.3-9 provides the collective population doses from gaseous effluents to individuals living within a 50 mi. (80 km) radius of the Project site.

As can be seen from Tables 11.3.3-5, 11.3.3-7, and 11.3.3-8, the bounding site gaseous release concentrations are within the ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 1; the estimated gaseous effluent doses to the MEI for a single unit are within design objectives of 10 CFR Part 50, Appendix I; and the estimated gaseous and liquid effluent doses to the MEI are within 40 CFR Part 190 and 10 CFR 20.1301(e) dose limits, respectively.

Table 11.3.3-1
Atmospheric Dispersion and Ground Deposition Factors

MEI Location	Sector	Distance (mi.)	χ /Q (s/m³)			D/Q (1/m²)
			No Decay	2.26 day Decay	8 day Decay	
			Undepleted	Undepleted	Depleted	
North Plant Complex (Unrestricted Area Boundary MEL)	NE	0.15	2.60E-04	2.60E-04	2.50E-04	6.00E-07
Middle Plant Complex (Unrestricted Area Boundary)	ESE	0.16	1.40E-04	1.40E-04	1.40E-04	3.80E-07
Middle Plant Complex (Unrestricted Area Boundary MEL)	N	1.11	7.20E-06	7.10E-06	6.20E-06	1.80E-08
South Plant Complex (Unrestricted Area Boundary)	N	0.24	1.30E-04	1.30E-04	1.20E-04	2.40E-07
South Plant Complex (Unrestricted Area Boundary MEL)	N	1.53	3.40E-06	3.30E-06	2.90E-06	8.10E-09
Nearest Resident (North)	SSW	1.38	1.30E-06	1.30E-06	1.10E-06	3.10E-09
Nearest Resident (Middle)	SSW	0.78	5.60E-06	5.60E-06	5.00E-06	1.40E-08
Nearest Resident (South)	SSW	0.22	5.00E-05	5.00E-05	4.70E-05	1.00E-07
Nearest Vegetable Garden (North)	SSW	1.70	8.40E-07	8.20E-07	7.00E-07	1.90E-09
Nearest Vegetable Garden (Middle)	SSW	1.10	2.40E-06	2.30E-06	2.10E-06	5.60E-09
Nearest Vegetable Garden (South)	SSW	0.54	1.10E-05	1.10E-05	1.00E-05	2.60E-08

Key: D/Q = ground deposition; MEI = maximally exposed individual; MEL = maximally exposed location; mi. = mile

Table 11.3.3-2
GASPAR II Parameters

Value	Description
0.42	Fraction of the year that leafy vegetables are grown.
0.67	Fraction of the year that milk cows are on pasture.
0.35	Fraction of the maximum individual's vegetable intake that is from his own garden.
1.0	Fraction of milk-cow feed intake that is from pasture while on pasture.
8.0	Average absolute humidity over the growing season (g/m^3).
0.75	Fraction of the year that goats are on pasture.
1.0	Fraction of goat-feed intake that is from pasture while on pasture.
0.67	Fraction of the year that beef cattle are on pasture.
1.0	Fraction of beef-cattle feed intake that is from pasture while the cattle are on pasture.

Key: kg/m^3 per cubic meter

Table 11.3.3-3
Food Consumption Rates

Consumer	Vegetables	Leafy Vegetables	Milk	Meat
	kg/yr	kg/yr	L/yr	kg/yr
Average Adult	190	30	110	95
Average Teen	240	20	200	59
Average Child	200	10	170	37
Maximum Adult	520	**64**	310	**110**
Maximum Teen	**630**	42	**400**	65
Maximum Child	520	26	330	41
Maximum Infant	0	0	330	0

Note: Maximum values are bold.
Key: kg/yr = kilograms per year; L/yr = liters per year

Table 11.3.3-4
Bounding Normal Gaseous Radioactive Release Rates
(Sheet 1 of 2)

Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)	Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)
Ag-110m	1.00E-05	6.00E-05	I-130	1.69E-05	3.38E-05
Am-241	1.00E-05	6.00E-05	I-131	1.41E-02	8.48E-02
Ar-41	3.40E+01	2.04E+02	I-132	8.33E-02	5.00E-01
Ba-139	5.06E-08	1.01E-07	I-133	6.54E-02	3.92E-01
Ba-140	1.92E-04	1.15E-03	I-134	2.35E-01	1.41E+00
Br-82	2.08E-06	4.16E-06	I-135	1.25E-01	7.52E-01
Br-83	1.19E-05	2.38E-05	Kr-83m	8.11E+00	4.87E+01
Br-84	5.52E-06	1.10E-05	Kr-85	6.03E+01	3.62E+02
Br-85	6.58E-07	1.32E-06	Kr-85m	8.95E-01	5.37E+00
C-14	1.09E+01	6.51E+01	Kr-87	2.76E+00	1.65E+01
Ce-141	1.23E-05	7.35E-05	Kr-88	3.00E+00	1.80E+01
Ce-143	3.36E-08	6.72E-08	Kr-89	1.29E+01	7.71E+01
Ce-144	1.00E-05	6.00E-05	La-140	4.44E-05	2.66E-04
Co-57	8.20E-08	4.92E-07	La-141	1.56E-08	3.12E-08
Co-58	1.41E-04	8.46E-04	La-142	7.47E-09	1.49E-08
Co-60	2.95E-04	1.77E-03	Mn-54	3.14E-04	1.89E-03
Cr-51	5.31E-04	3.19E-03	Mn-56	1.22E-05	7.32E-05
Cs-134	1.79E-05	1.07E-04	Mo-99	7.03E-05	4.22E-04
Cs-136	9.92E-06	5.95E-05	Na-24	3.87E-05	2.32E-04
Cs-137	2.78E-05	1.67E-04	Nb-95	4.82E-05	2.89E-04
Cs-138	2.99E-06	1.79E-05	Ni-63	6.63E-07	3.98E-06
Cu-64	1.56E-04	9.37E-04	Np-239	4.76E-05	2.86E-04
Fe-55	6.59E-04	3.96E-03	P-32	1.86E-05	1.12E-04
Fe-59	1.56E-04	9.39E-04	Pr-143	4.36E-08	8.72E-08
I-129	1.00E-05	6.00E-05	Pr-144	2.27E-09	1.36E-08

Table 11.3.3-4
Bounding Normal Gaseous Radioactive Release Rates
(Sheet 2 of 2)

Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)	Radionuclide	Per Reactor Release (Ci/yr)	Site Release (Ci/yr)
Pu-238	1.00E-05	6.00E-05	Te-131	1.54E-06	3.08E-06
Pu-239	1.00E-05	6.00E-05	Te-131m	4.07E-06	2.44E-05
Rb-86	2.30E-06	4.60E-06	Te-132	1.00E-05	6.00E-05
Rb-88	2.50E-04	5.00E-04	Te-133m	1.91E-06	3.82E-06
Rb-89	1.19E-06	7.17E-06	Te-134	2.71E-06	5.42E-06
Rh-105	3.83E-08	7.66E-08	W-187	1.42E-05	8.53E-05
Ru-103	1.22E-05	7.31E-05	Xe-131m	9.00E+00	5.40E+01
Ru-105	1.76E-08	3.52E-08	Xe-133	4.28E+01	2.57E+02
Ru-106	1.00E-05	6.00E-05	Xe-133m	3.10E-02	1.86E-01
Sb-124	1.00E-05	6.00E-05	Xe-135	3.33E+01	2.00E+02
Sb-125	1.00E-05	6.00E-05	Xe-135m	1.63E+01	9.75E+01
Sb-127	3.35E-09	6.70E-09	Xe-137	3.13E+00	1.88E+01
Sr-89	9.40E-06	5.64E-05	Xe-138	3.18E+01	1.91E+02
Sr-90	3.70E-06	2.22E-05	Y-90	2.38E-08	1.43E-07
Sr-91	4.56E-05	2.73E-04	Y-91	2.41E-05	1.45E-04
Sr-92	2.77E-05	1.66E-04	Y-91m	5.20E-08	1.04E-07
Tc-99	1.24E-09	2.48E-09	Y-92	1.12E-05	6.70E-05
Tc-99m	6.07E-06	3.64E-05	Y-93	3.53E-06	2.12E-05
Te-125m	1.01E-07	2.02E-07	Zn-65	1.34E-04	8.01E-04
Te-127	1.35E-05	2.70E-05	Zr-95	5.09E-05	3.05E-04
Te-127m	3.85E-07	7.70E-07	Zr-97	3.15E-08	6.30E-08
Te-129	1.43E-06	2.86E-06	H-3	2.61E+01	1.57E+02
Te-129m	2.26E-05	1.36E-04	Total	7.08E+02	4.25E+03

Key: Ci/yr = curies per year

Table 11.3.3-5
Plant Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 1 Gaseous ECLs
(Sheet 1 of 4)

Radionuclide	North Plant Complex Concentration (µCi/ml)	Middle Plant Complex Concentration (µCi/ml)	South Plant Complex Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
Ag-110m	1.65E-16	4.57E-18	2.16E-18	1.00E-10	1.72E-06
Am-241	1.65E-16	4.57E-18	2.16E-18	2.00E-14	8.58E-03
Ar-41	5.61E-10	1.55E-11	7.33E-12	1.00E-08	5.83E-02
Ba-139	8.34E-19	2.31E-20	1.09E-20	4.00E-08	2.17E-11
Ba-140	3.17E-15	8.77E-17	4.14E-17	2.00E-09	1.65E-06
Br-82	3.43E-17	9.50E-19	4.49E-19	5.00E-09	7.14E-09
Br-83	1.96E-16	5.43E-18	2.57E-18	9.00E-08	2.27E-09
Br-84	9.10E-17	2.52E-18	1.19E-18	8.00E-08	1.18E-09
Br-85	1.08E-17	3.00E-19	1.42E-19	1.00E-09	1.13E-08
C-14	1.79E-10	4.96E-12	2.34E-12	3.00E-09	6.21E-02
Ce-141	2.02E-16	5.60E-18	2.64E-18	8.00E-10	2.63E-07
Ce-143	5.54E-19	1.53E-20	7.25E-21	2.00E-09	2.88E-10
Ce-144	1.65E-16	4.57E-18	2.16E-18	2.00E-11	8.58E-06
Co-57	1.35E-18	3.74E-20	1.77E-20	9.00E-10	1.56E-09
Co-58	2.33E-15	6.44E-17	3.04E-17	1.00E-09	2.42E-06
Co-60	4.87E-15	1.35E-16	6.37E-17	5.00E-11	1.01E-04
Cr-51	8.76E-15	2.43E-16	1.15E-16	3.00E-08	3.04E-07
Cs-134	2.95E-16	8.17E-18	3.86E-18	2.00E-10	1.53E-06
Cs-136	1.64E-16	4.53E-18	2.14E-18	9.00E-10	1.89E-07
Cs-137	4.58E-16	1.27E-17	5.99E-18	2.00E-10	2.39E-06
Cs-138	4.92E-17	1.36E-18	6.44E-19	8.00E-08	6.40E-10
Cu-64	2.58E-15	7.13E-17	3.37E-17	3.00E-08	8.93E-08
Fe-55	1.09E-14	3.01E-16	1.42E-16	3.00E-09	3.77E-06
Fe-59	2.58E-15	7.14E-17	3.37E-17	5.00E-10	5.37E-06

Table 11.3.3-5
Plant Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 1 Gaseous ECLs
(Sheet 2 of 4)

Radionuclide	North Plant Complex Concentration (µCi/ml)	Middle Plant Complex Concentration (µCi/ml)	South Plant Complex Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
I-129	1.65E-16	4.57E-18	2.16E-18	4.00E-11	4.29E-06
I-130	2.79E-16	7.72E-18	3.64E-18	3.00E-09	9.67E-08
I-131	2.33E-13	6.45E-15	3.05E-15	2.00E-10	1.21E-03
I-132	1.37E-12	3.80E-14	1.80E-14	2.00E-08	7.14E-05
I-133	1.08E-12	2.98E-14	1.41E-14	1.00E-09	1.12E-03
I-134	3.88E-12	1.07E-13	5.07E-14	6.00E-08	6.73E-05
I-135	2.07E-12	5.72E-14	2.70E-14	6.00E-09	3.58E-04
Kr-83m	1.34E-10	3.70E-12	1.75E-12	5.00E-05	2.78E-06
Kr-85	9.95E-10	2.76E-11	1.30E-11	7.00E-07	1.48E-03
Kr-85m	1.48E-11	4.09E-13	1.93E-13	1.00E-07	1.54E-04
Kr-87	4.54E-11	1.26E-12	5.94E-13	2.00E-08	2.36E-03
Kr-88	4.95E-11	1.37E-12	6.48E-13	9.00E-09	5.73E-03
Kr-89	2.12E-10	5.87E-12	2.77E-12	1.00E-09	2.21E-01
La-140	7.32E-16	2.03E-17	9.57E-18	2.00E-09	3.81E-07
La-141	2.57E-19	7.12E-21	3.36E-21	1.00E-08	2.68E-11
La-142	1.23E-19	3.41E-21	1.61E-21	3.00E-08	4.27E-12
Mn-54	5.18E-15	1.44E-16	6.78E-17	1.00E-09	5.40E-06
Mn-56	2.01E-16	5.57E-18	2.63E-18	2.00E-08	1.05E-08
Mo-99	1.16E-15	3.21E-17	1.52E-17	2.00E-09	6.04E-07
Na-24	6.38E-16	1.77E-17	8.34E-18	7.00E-09	9.48E-08
Nb-95	7.94E-16	2.20E-17	1.04E-17	2.00E-09	4.13E-07
Ni-63	1.09E-17	3.03E-19	1.43E-19	1.00E-09	1.14E-08
Np-239	7.85E-16	2.17E-17	1.03E-17	3.00E-09	2.72E-07
P-32	3.07E-16	8.50E-18	4.01E-18	5.00E-10	6.39E-07

Table 11.3.3-5
Plant Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 1 Gaseous ECLs
(Sheet 3 of 4)

Radionuclide	North Plant Complex Concentration (µCi/ml)	Middle Plant Complex Concentration (µCi/ml)	South Plant Complex Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
Pr-143	7.19E-19	1.99E-20	9.40E-21	8.00E-10	9.35E-10
Pr-144	3.74E-20	1.04E-21	4.90E-22	2.00E-07	1.95E-13
Pu-238	1.65E-16	4.57E-18	2.16E-18	2.00E-14	8.58E-03
Pu-239	1.65E-16	4.57E-18	2.16E-18	2.00E-14	8.58E-03
Rb-86	3.79E-17	1.05E-18	4.96E-19	1.00E-09	3.95E-08
Rb-88	4.12E-15	1.14E-16	5.39E-17	9.00E-08	4.77E-08
Rb-89	1.97E-17	5.45E-19	2.58E-19	2.00E-07	1.02E-10
Rh-105	6.32E-19	1.75E-20	8.26E-21	8.00E-09	8.22E-11
Ru-103	2.01E-16	5.57E-18	2.63E-18	9.00E-10	2.32E-07
Ru-105	2.90E-19	8.04E-21	3.80E-21	2.00E-08	1.51E-11
Ru-106	1.65E-16	4.57E-18	2.16E-18	2.00E-11	8.58E-06
Sb-124	1.65E-16	4.57E-18	2.16E-18	3.00E-10	5.72E-07
Sb-125	1.65E-16	4.57E-18	2.16E-18	7.00E-10	2.45E-07
Sb-127	5.52E-20	1.53E-21	7.22E-22	1.00E-09	5.75E-11
Sr-89	1.55E-16	4.29E-18	2.03E-18	2.00E-10	8.07E-07
Sr-90	6.10E-17	1.69E-18	7.98E-19	6.00E-12	1.06E-05
Sr-91	7.51E-16	2.08E-17	9.82E-18	5.00E-09	1.56E-07
Sr-92	4.56E-16	1.26E-17	5.97E-18	9.00E-09	5.28E-08
Tc-99	2.04E-20	5.66E-22	2.67E-22	9.00E-10	2.36E-11
Tc-99m	1.00E-16	2.77E-18	1.31E-18	2.00E-07	5.21E-10
Te-125m	1.67E-18	4.61E-20	2.18E-20	1.00E-09	1.73E-09
Te-127	2.23E-16	6.16E-18	2.91E-18	2.00E-08	1.16E-08
Te-127m	6.35E-18	1.76E-19	8.30E-20	4.00E-10	1.65E-08
Te-129	2.36E-17	6.53E-19	3.08E-19	9.00E-08	2.73E-10

Table 11.3.3-5
Plant Concentration Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 1 Gaseous ECLs
(Sheet 4 of 4)

Radionuclide	North Plant Complex Concentration (µCi/ml)	Middle Plant Complex Concentration (µCi/ml)	South Plant Complex Concentration (µCi/ml)	ECL (µCi/ml)	ECL Fraction
Te-129m	3.73E-16	1.03E-17	4.88E-18	3.00E-10	1.29E-06
Te-131	2.54E-17	7.03E-19	3.32E-19	2.00E-08	1.32E-09
Te-131m	6.71E-17	1.86E-18	8.77E-19	1.00E-09	6.98E-08
Te-132	1.65E-16	4.57E-18	2.16E-18	9.00E-10	1.91E-07
Te-133m	3.15E-17	8.72E-19	4.12E-19	2.00E-08	1.64E-09
Te-134	4.47E-17	1.24E-18	5.84E-19	7.00E-08	6.64E-10
W-187	2.34E-16	6.49E-18	3.06E-18	1.00E-08	2.44E-08
Xe-131m	1.48E-10	4.11E-12	1.94E-12	2.00E-06	7.72E-05
Xe-133	7.06E-10	1.96E-11	9.23E-12	5.00E-07	1.47E-03
Xe-133m	5.11E-13	1.41E-14	6.68E-15	6.00E-07	8.86E-07
Xe-135	5.49E-10	1.52E-11	7.18E-12	7.00E-08	8.16E-03
Xe-135m	2.68E-10	7.42E-12	3.50E-12	4.00E-08	6.97E-03
Xe-137	5.16E-11	1.43E-12	6.75E-13	1.00E-09	5.37E-02
Xe-138	5.24E-10	1.45E-11	6.86E-12	2.00E-08	2.73E-02
Y-90	3.92E-19	1.09E-20	5.13E-21	9.00E-10	4.54E-10
Y-91	3.98E-16	1.10E-17	5.20E-18	2.00E-10	2.07E-06
Y-91m	8.57E-19	2.37E-20	1.12E-20	2.00E-07	4.46E-12
Y-92	1.84E-16	5.10E-18	2.41E-18	1.00E-08	1.92E-08
Y-93	5.82E-17	1.61E-18	7.61E-19	3.00E-09	2.02E-08
Zn-65	2.20E-15	6.10E-17	2.88E-17	4.00E-10	5.73E-06
Zr-95	8.39E-16	2.32E-17	1.10E-17	4.00E-10	2.18E-06
Zr-97	5.19E-19	1.44E-20	6.79E-21	2.00E-09	2.70E-10
H-3	4.30E-10	1.19E-11	5.63E-12	1.00E-07	4.48E-03
Total	4.88E-09	1.35E-10	6.38E-11	NA	4.82E-01

Key: CFR = Code of Federal Regulations; ECL = effluent concentration limit; µCi/ml = microcuries per milliliter;

Table 11.3.3-6
Belews Creek, NC Site GASPAR II Gaseous Pathway Doses for Maximally Exposed Individuals
(Sheet 1 of 2)

Pathway	Total Body (mrem/yr)	GI Tract (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Kidney (mrem/yr)	Thyroid (mrem/yr)	Lung (mrem/yr)	Skin (mrem/yr)
Unrestricted Area Boundary Location With Maximum Doses (For Site)								
Plume	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.16E+01	2.34E+01
Ground Shine	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.98E-01
Inhalation Dose[a,c]								
Teen	6.46E-01	3.60E-01	6.61E+00	4.80E+00	2.00E+00	8.66E+00	1.34E+00	3.25E-01
Vegetable Dose for Biota[c]								
Child	6.12E+01	6.11E+01	3.03E+02	6.13E+01	6.13E+01	9.45E+01	6.10E+01	6.10E+01
Nearest Residence Dose Used for MEI[c]								
Plume	2.49E+00	2.49E+00	2.49E+00	2.49E+00	2.49E+00	2.49E+00	2.51E+00	5.06E+00
Ground Shine	6.33E-02	6.33E-02	6.33E-02	6.33E-02	6.33E-02	6.33E-02	6.33E-02	7.45E-02
Plume Plus Ground Shine (For Site)				Plume Plus Ground Shine (Per Reactor)				
Total Body External		2.55E+00	mrem/yr	Total Body External			4.26E-01	mrem/yr
Total Skin External		5.14E+00	mrem/yr	Total Skin External			8.57E-01	mrem/yr
Inhalation[b,c]								
Adult	1.29E-01	7.36E-02	1.29E+00	9.33E-01	3.90E-01	1.39E+00	1.91E-01	6.76E-02
Teen	1.34E-01	7.55E-02	1.35E+00	9.86E-01	4.12E-01	1.80E+00	2.77E-01	6.83E-02
Child	1.13E-01	6.58E-02	1.05E+00	7.12E-01	2.93E-01	2.18E+00	2.47E-01	6.03E-02
Infant	5.76E-02	3.78E-02	4.23E-01	3.02E-01	1.32E-01	1.96E+00	1.46E-01	3.47E-02
Nearest Vegetable Garden Dose Used for MEI[c]								
Adult	8.26E-01	8.28E-01	4.06E+00	8.28E-01	8.28E-01	1.59E+00	8.25E-01	8.25E-01
Teen	1.34E+00	1.34E+00	6.61E+00	1.34E+00	1.35E+00	2.29E+00	1.34E+00	1.34E+00
Child	3.22E+00	3.21E+00	1.59E+01	3.22E+00	3.22E+00	5.00E+00	3.21E+00	3.21E+00

Table 11.3.3-6
Belews Creek, NC Site GASPAR II Gaseous Pathway Doses for Maximally Exposed Individuals
(Sheet 2 of 2)

Total MEI Organ Dose (Nearest Resident Plume, Ground Shine, Inhalation Plus Nearest Vegetable Garden Dose)[c]							
Total	**T. Body**	**GI Tract**	**Bone**	**Liver**	**Kidney**	**Thyroid**	**Lung**
Adult	3.51E+00	3.46E+00	7.90E+00	4.31E+00	3.77E+00	5.54E+00	3.59E+00
Teen	4.02E+00	3.97E+00	1.05E+01	4.88E+00	4.31E+00	6.65E+00	4.19E+00
Child	5.89E+00	5.83E+00	1.95E+01	6.49E+00	6.07E+00	9.73E+00	6.03E+00
Infant	2.61E+00	2.59E+00	2.98E+00	2.86E+00	2.68E+00	4.52E+00	2.72E+00

Notes:

(a) The location of the inhalation doses is at the unrestricted area boundary maximally exposed location.

(b) The location of the inhalation doses is at the nearest residence.

(c) The doses listed are doses for the entire Project site.

Key: GI = gastrointestinal; MEI = maximally exposed individual; mrem/yr = millirem per year

Table 11.3.3-7
Comparison of Belews Creek, NC Site Gaseous Annual Doses to 10 CFR Part 50 Appendix I Dose Limits

Type of Dose	Annual Dose per Reactor	
	Dose	Limit
Gamma Air (mrad/yr)	8.54E+00	10
Beta Air (mrad/yr)	6.16E+00	20
Total Body (mrem/yr)	1.12E+00	5
Skin (mrem/yr)	2.26E+00	15
Maximum Organ (Bone) (mrem/yr)	7.74E+00	15

Key: CFR = Code of Federal Regulations; mrad/yr = millirads per year; mrem/yr = millirem per year; NC = North Carolina

Table 11.3.3-8
Comparison of Belews Creek, NC Site Annual Dose Estimates to 40 CFR Part 190 and 10 CFR 20.1301(e) Dose Limits

Type of Dose	Site Dose (mrem/yr)			Limit
	Gaseous Dose	Liquid Dose	Total Dose	
Total Body	5.89E+00	8.46E-01	6.73E+00	25
Thyroid	9.73E+00	7.00E-01	1.04E+01	75
Other Organ (Bone)	1.95E+01	3.96E+00	2.35E+01	25

Key: CFR = Code of Federal Regulations; mrem/yr = millirem per year; NC = North Carolina

Table 11.3.3-9
Belews Creek, NC Site Collective Population Dose from Gaseous Pathways

Pathway	Total Body	GI Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
	Site Dose (person-rem/yr)							
Plume	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.24E+00	4.05E+00
Ground	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.71E-01
Inhalation	4.67E-01	2.96E-01	3.93E+00	2.88E+00	1.23E+00	4.75E+00	7.33E-01	2.81E-01
Vegetables	1.95E+01	1.95E+01	9.64E+01	1.95E+01	1.95E+01	1.98E+01	1.95E+01	1.95E+01
Milk	8.60E+00	8.60E+00	4.26E+01	8.61E+00	8.63E+00	1.58E+01	8.60E+00	8.60E+00
Meat	9.68E+00	9.71E+00	4.80E+01	9.69E+00	9.69E+00	1.01E+01	9.68E+00	9.68E+00
Total	3.95E+01	3.94E+01	1.92E+02	4.20E+01	4.05E+01	5.17E+01	3.98E+01	4.24E+01

Key: GI = gastrointestinal

11.4 REFERENCES

11.2-1 U.S. Nuclear Regulatory Commission (NRC), *LADTAP II – Technical Reference and User Guide*, NUREG/CR-4013, 1986.

11.3-1 U.S. Nuclear Regulatory Commission (NRC), *XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations*, NUREG/CR-2919, 1982.

11.3-2 U.S. Nuclear Regulatory Commission (NRC), *GASPAR II – Technical Reference and User Guide*, NUREG/CR-4653, 1987.

11.3-3 U.S. Nuclear Regulatory Commission (NRC), *Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site*, NUREG-2226, 2019.

CHAPTER 13
CONDUCT OF OPERATIONS

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None.

LIST OF FIGURES

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None.

GLOSSARY

Term	Definition
ac.	acre
CFR	Code of Federal Regulations
EAB	exclusion area boundary
EAL	Emergency Action Levels
EPZ	emergency planning zone
ESPA	Early Site Permit Application
ETE	Evacuation Time Estimate
GVH	GE Vernova Hitachi Nuclear Energy
km	kilometer
mi.	mile
mSv	millisievert
NC	North Carolina
non-LWR	non-light-water reactor
NRC	U.S. Nuclear Regulatory Commission
NuScale	NuScale Power, LLC
Project site	Belews Creek, NC site
rem	roentgen equivalent man
rev.	revision

Term	Definition
RG	Regulatory Guide
SMR	small modular reactor
SSAR	Site Safety Analysis Report
TEDE	total effective dose equivalent
TerraPower	TerraPower, LLC
U.S.	United States
USCB	U.S. Census Bureau
WEC	Westinghouse Electric Company, LLC
X-energy	X-energy, LLC

Chapter 13 Conduct of Operations

13.3 EMERGENCY PREPAREDNESS

This section, along with the Part 5, Emergency Plan, of the early site permit application (ESPA), describes emergency preparedness to support the addition of new nuclear power Plant Complexes at the Belews Creek, North Carolina (NC) site (Project site). In accordance with Title 10 of the Code of Federal Regulations (CFR) Part 52, Section 52.17(b)(2)(i), this plan describes major features of a performance-based emergency preparedness program and addresses pertinent requirements contained in 10 CFR 50.160, *Emergency Preparedness for Small Modular Reactors, Non-Light Water Reactors, and Non-Power Production or Utilization Facilities* and associated guidance contained in Regulatory Guide (RG) 1.242, Rev. 0, *Performance-Based Emergency Preparedness For Small Modular Reactors, Non Light-Water Reactors, and Non-Power Production or Utilization Facilities*. The Emergency Plan meets the applicable requirements of 10 CFR 50.47(a)(1) as delineated by 10 CFR 50.160.

To maintain consistency throughout the Duke Energy fleet, the Project site Emergency Plan references applicable emergency preparedness processes that are described in the existing Duke Energy Common Emergency Plan. The Duke Energy Common Emergency Plan has been approved by the U.S. Nuclear Regulatory Commission (NRC) to support all of the Duke Energy operating nuclear facilities in Safety Evaluation Report dated August 26, 2021 (Reference 13.3-1).

Duke Energy has not selected a reactor technology to be built at the Project site. However, six advanced reactor technologies are being considered. These include four small modular reactors (SMRs) (BWRX-300, VOYGR, SMR-300, and AP300) and two non-light water reactors (non-LWR) (Natrium and Xe-100):

- GVH BWRX-300
- NuScale VOYGR
- Holtec SMR-300
- WEC AP300
- TerraPower Natrium
- X-energy Xe-100

The reactor technology options currently under consideration incorporate design features that provide inherent improvements in safety and security, relying more upon passive processes.

As described in Section 13.3.3.1, the Duke Energy ESPA is establishing the aggregate of the three-Plant Complex exclusion area boundaries (EABs) as the plume exposure pathway emergency planning zone (EPZ). Once a reactor technology has been selected, Duke Energy will be required to provide a confirmatory analysis of the EPZ at the construction permit or license application phase.

Establishment of the plume exposure pathway EPZ at the EABs will not require off-site planning activities including,

- Contacts and arrangements with federal, state, and local government agencies.
- Development of off-site state/county emergency plans.
- Initial/follow-up notifications to state/county organizations (unless required).
- Annual dissemination of public information materials.
- An off-site facility to coordinate on-site/off-site emergency response.
- Off-site dose projections (unless required) and protective actions recommendations.
- Preparatory activities such as evacuation time estimates and contacts and arrangements (agreements with federal, state, local, and tribal governmental agencies).

Duke Energy has established a performance monitoring program at the Project site to demonstrate the effectiveness of the Emergency Plan to carry out effective response to emergency and accident conditions. The framework of the performance monitoring program is based on the current Duke Energy Drill and Exercise Program which describes all objectives and evaluation criteria that may be used for a drill or exercise. Specific performance metrics and objectives for each of the emergency response functions have been developed and are used for evaluation to demonstrate capabilities of the emergency response organization to maintain and perform the emergency response functions described in 10 CFR 50.160 and RG 1.242. Specific details pertaining to performance monitoring and maintenance are contained in Part 5, Section III of the ESPA.

As discussed previously, when Duke Energy chooses a design technology and moves forward in the construction permit or license application phase, the Emergency Plan will be revised to address additional site-specific emergency preparedness requirements. These include determination of Emergency Action Levels (EALs) used to establish emergency classifications, on-site staffing and augmentation time requirements, and locations of emergency response facilities. Additionally, emergency preparedness-specific inspections, tests, analysis, and acceptance criteria will be developed during the construction permit or license application phase. Duke Energy will adopt an EAL scheme similar to NEI 99-01, Rev. 7, *Development of Emergency Action Levels for Non-Passive Reactors*, which has been approved by the NRC. Staffing and augmentation time requirements will be based on a staffing analysis performed in accordance with NEI 10-05, Rev. 0, *Assessment of On-Shift Emergency Response Organization Staffing and Capabilities*, or a similar staffing assessment.

13.3.1 PHYSICAL CHARACTERISTICS

13.3.1.1 Site Description

The proposed Project site is located primarily in Sauratown Township, in the southeastern corner of Stokes County, NC, with a small portion in Belews Creek Township, Forsyth County, NC. All proposed nuclear units will be in Stokes County, while support facilities, such as laydown areas, will be in Forsyth County. The Project site, adjacent to Belews Lake, is approximately 14 miles (mi.) (22.5 kilometers [km]) northeast of Winston-Salem, NC, and approximately 19 mi. (30.6 km) northwest of Greensboro, NC. The total site is approximately 1187 acres (ac). Access to the Project site is available by road using the Duke Power Steam Plant Rd, via Pine Hall Rd, or using Craig Rd, via State Highway 65.

Chapter 2 provides information regarding the physical characteristics of the proposed site, including the preliminary site layout, population distribution, and potential hazards in the site vicinity.

Figure I-1 in Part 5 of the ESPA provides a Project site layout map depicting the proposed reactor design technologies under consideration and site access.

13.3.1.2 Area Population

The resident population has been estimated based on the year 2020 U.S. Census Bureau (USCB) decennial census data (Reference 13.3-2). The resident population distribution within 50 mi. (80.5 km) of the Project site was computed using ArcGIS Pro by overlaying the 2020 USCB block group data on the grid of segments and summing the population of the block group(s) within, or partially intersecting, each segment. The ArcGIS Pro geoprocessing tool was used to calculate overlapping areas (Reference 13.3-3). The tabulate intersection tool was used to calculate the overlapping area of each block group-segment intersection. The block group populations in the segment were grouped and summed to calculate a total segment population. In 2020, the residential population within 5 mi. (8.0 km), 10 mi. (16.1 km), and 20 mi. (32.2 km) of the Project site was 16,951, 74,442, and 675,829, respectively.

The transient population within a 20-mi. (32.2-km) region surrounding the Project site was estimated via a variety of public sources associated with major employers, schools, medical facilities, lodging facilities, and recreational areas and venues. The public sources included government and corporate websites, federal databases, tourism sites, and aggregators of service provider records for the region. Raw transient population estimates were weighted according to the length of time each population group was expected to be in the 20-mi. (32.2-km) area. Weighted transient population estimates were rounded to the nearest whole number to avoid estimating a fraction of a person. Projected transient populations were computed with the same methodology used to develop the resident population projections. The transient population estimates were assumed to be reflective of 2020. The transient population within the 20-mi. (32.2-km) area both unweighted and weighted is estimated to be 230,756 and 116,790, respectively.

13.3.2 EMERGENCY PLAN

Part 5 of the ESPA contains the Project site Emergency Plan with all available information at the time of submittal.

13.3.3 EMERGENCY PLANNING ZONES

Duke Energy is developing a performance-based emergency preparedness program using 10 CFR 50.160 and applying for an Early Site Permit under 10 CFR Part 52. Discussion on the plume exposure pathway EPZ and ingestion response planning is provided below.

13.3.3.1 Plume Exposure Pathway Emergency Planning Zone

In accordance with the 10 CFR 50.160, performance-based approach, the plume exposure pathway EPZ is the area within which public dose is projected to exceed 1 roentgen equivalent man (rem) total effective dose equivalent (TEDE) over the first 96 hours from the release of radioactive materials from the facility as specified in 10 CFR 50.33(g)(2)(i). The criterion considers accident likelihood and source term, timing of the accident sequence, and meteorology. In addition, the plume exposure pathway EPZ is the area in which predetermined, prompt protective measures are necessary. This is consistent with the guidance in EPA-400/R-17/001, January 2017, *PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents*. Due to the state of the reactor designs of the technologies being

considered in this ESPA, the analysis used to determine whether the criteria in 10 CFR 50.33(g)(2)(i)(A) and (B) are met, and if they are met, the size of the plume exposure pathway EPZ, is not available from the reactor technology vendors. When Duke Energy makes its technology selection for the Project site, the selected reactor technology vendor will be required to provide a confirmatory acceptance analysis at the construction permit or license application phase. This analysis will confirm that the public dose, as defined in 10 CFR 20.1003, does not exceed the limit of 10 millisievert (mSv) (1 rem) TEDE over 96 hours from the release of radioactive materials from the facility considering accident likelihood and source term, timing of the accident sequence, and meteorology per 10 CFR 50.33(g)(2). This will result in the plume exposure pathway EPZ being within the aggregate of the three-Plant Complex EABs defined in Section 2.1.2 and Figure 2.1-5. The analysis will be performed in accordance with the methodology described in RG 1.242, Appendices A and B. With the plume exposure pathway EPZ located within the EABs, evacuation of the public during the first 96 hours of the accident is not required. As such, the Emergency Plan focuses primarily on on-site planning activities.

13.3.3.2 Ingestion Response Planning

Although the Project site plume exposure pathway EPZ is bounded by the EABs, ingestion response planning is required to protect the food ingestion pathway in the event of a radiological release at the site. The probability of such a release is considered very low due to the design of advanced reactors, which include SMRs and non-LWRs, currently under consideration, and strict operational guidelines enforced by the NRC. In the event of a radiological release, the principal exposure sources are contaminated water or food, such as milk or fresh vegetables.

Ingestion response is not required in the early phase of an emergency, because the ingestion of contaminated foods and water is a longer-term concern. Local, state, and federal resources are available for the intermediate and late phases of emergency response and can support intermediate and long-term monitoring, analysis, interdiction, or embargo, when warranted, for products identified as part of the site's food and water ingestion pathway. Additional details can be found in ESPA, Part 5, Section I.F.

13.3.4 EVACUATION TIME ASSESSMENTS

As discussed earlier, Duke Energy is establishing the EABs as the plume exposure pathway EPZ at this time. Therefore, in accordance with 10 CFR 50.160 and the guidance in RG 1.242, an Evacuation Time Estimate (ETE) study is not required, and the Emergency Plan is focused on on-site planning activities.

13.3.5 CONTACTS AND AGREEMENTS

The proposed plume exposure pathway EPZ is aligned with the EABs. As such, the need for off-site contracts, agreements, and certifications is not required in accordance with 10 CFR 50.160 and the guidance in RG 1.242.

13.6 PHYSICAL SECURITY

The Project site is located in the southeastern corner of Stokes County, NC, just north of Belews Creek Township, NC, extending slightly into the northeastern corner of Forsyth County, NC. The Project site is owned by Duke Energy. Duke Energy proposes to construct up to three nuclear power Plant Complexes on the Project site; each complex may contain multiple advanced reactors. The specific reactor technology has not been selected.

The Project site is located on a peninsula surrounded by Belews Lake to the north, east, and much of the western sides. Belews Lake is also owned by Duke Energy and was constructed in the early 1970's as a cooling reservoir for the adjacent Belews Creek Steam Station. The site may be accessed from either Pine Hall Road from the west or Craig Road from the south. For a detailed description of the Project site, refer to Section 2.1.

As required by 10 CFR 100.21(f), the characteristics of the Project site are such that adequate security plans and measures can be developed and implemented. The following highlights key site characteristics of the proposed site.

The configuration of the Project site is suitable for implementing the requirements of 10 CFR 73.55, ensuring adequate separation between structures and security boundaries, as well as deterring both land-based and waterborne threats. The natural topography presents no unusual features that would impede implementation of necessary physical barriers and other protection measures. Site layouts are arranged to maintain sufficient spatial separation to facilitate effective security measures. The reactor technologies under consideration incorporate defense-in-depth measures to mitigate the risk of radiological sabotage, including controls for exclusion, protected, and vital areas. The proposed site layout is provided in Figure 1.2-3. A topological map of the site is presented in Figure 2.1-1.

In accordance with 10 CFR 100.21(f), Duke Energy will ensure that site characteristics are such that adequate security plans and measures can be developed and implemented. During the construction permit or license application phase, the specific design features will be reviewed to ensure site physical protection measures comply with 10 CFR 73.55 requirements. A detailed security assessment will be provided during the construction permit or license application phase, which will address site-specific design features of the selected reactor technology that support site security and will describe the key features of the physical protection plan. These features include descriptions of the security monitoring systems, threat detection and deterrence measures, physical barriers to be provided for protected and vital areas and vehicle control measures, personnel screening requirements, security equipment testing and maintenance, and communication requirements.

Vehicle access is limited to the west and south sides of the property because the Project site is bordered by Belews Lake. A railroad spur connects the Project site to the Norfolk Southern Railway. No major highways, railroads, or waterways traverse the proposed exclusion, owner-controlled, or protected areas. Further, an EAB will be established to mitigate security threats from both land and water. Exclusion area authority and control is discussed in more detail in Section 2.1.2. Therefore, accidental explosion from the nearby transportation routes is not expected to be a credible scenario.

While the Project site is in a relatively rural location, the region surrounding the site contains a significant population associated with the Piedmont metropolitan area. Major metropolitan areas include Winston-Salem, NC (14 mi.) and Greensboro, NC (19 mi.). The moderately close

proximity of the site location to the metro areas ensures the availability of material, equipment, or services needed to maintain and support the security systems and operations. Refer to Section 2.1 for additional details on the demography surrounding the Project site.

The effects of acute and prolonged exposure to severe weather and resulting environmental conditions such as flood and drought will not challenge the engineered and administrative controls for security operations. Engineered and administrative controls will not be challenged in the event of flooding or low water conditions at the Project site. Minimum standoff distances will not be impacted by flooding or low water conditions. Additional details regarding site hydrological features are provided in Section 2.4.

The geological and seismology characteristics for the Project site have been determined to be suitable for nuclear plant construction. The identified regional seismic characteristics do not challenge or pose an impediment to the engineered and administrative controls required for a physical protection system. Security plans and measures will be developed and implemented to comply with applicable codes and standards for the reactor technology selected. The specific reactor technologies under consideration have robust seismic design specifications which provide reasonable assurance that nuclear safety-related systems, structures, and components as well as the security features will remain available under design-basis seismic conditions. Additional details regarding the site seismic and geological features are provided in Section 2.5.

Review of nearby facilities, including nearby chemical/industrial facilities, pipelines, transportation routes (railroads, waterways, airways), and military facilities (military bases, training bases, munitions storage) reveals no potential hazards associated with off-site explosions, flammable vapor clouds, and fires in the vicinity of the Project site that pose a security concern. Additionally, toxic vapor clouds do not pose a security concern for the Middle or South Plant Complex power blocks. However, that same risk may pose a design-basis hazard to the North Plant Complex power block and additional refinement, or mitigating features may need to be employed once a final reactor technology is selected. Additional assessments on nearby site hazards are provided in Section 2.2.

Because the detailed site layout design has not been finalized at this ESPA stage, Duke Energy has not identified possible planned culverts or unattended openings that could extend from the outside to the inside of the designated Protected Area to render a potential security breach. The site-specific security assessment conducted for the construction permit or license application phase will identify and describe the specific security features implemented to address planned culverts or unattended openings. The resulting security plan will describe the measures taken to ensure assessment, observation, detection, and surveillance requirements are met, and appropriate barriers, as necessary, are installed to prevent potential exploitation of any planned culverts or unattended openings.

13.7 REFERENCES

13.3-1 U.S. Nuclear Regulatory Commission, *Catawba Nuclear Station, Units 1 and 2; McGuire Nuclear Station, Units 1 and 2; Oconee Nuclear Station, Units 1, 2, and 3; Brunswick Steam Electric Plant, Units 1 and 2; Shearon Harris Nuclear Power Plant, Unit 1; and H.B. Robinson Steam Electric Plant, Unit No. 2 – Issuance of Amendments for Common Emergency Plan Consistent with NUREG-0654, Revision 2*, Accession Number ML21155A213, August 26, 2021.

13.3-2 2020 Decennial Census Redistricting Data, Total Population (Table P1), https://data.census.gov/, accessed December 27, 2023.

13.3-3 ArcGIS Pro Version 2.4.19948, Redlands, California: Environmental Systems Research Institute.

CHAPTER 15
ACCIDENT ANALYSIS

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Table 15.3-1	Belews Creek Bounding Accident Doses

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None.

GLOSSARY

Term	Definition
BWR	boiling-water reactor
CFR	Code of Federal Regulations
COL	Combined License
DBA	design-basis accident
EAB	exclusion area boundary
ESP	Early Site Permit
ESPA	Early Site Permit Application
FSAR	Final Safety Analysis Report
GVH	GE Vernova Hitachi Nuclear Energy
Holtec	Holtec International
ILBA	Instrument Line Break Accident
LPZ	low population zone
LWR	light-water reactor
MWt	megawatts thermal
NC	North Carolina
NEI	Nuclear Energy Institute
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC Technical Report designation

Term	Definition
NuScale	NuScale Power, LLC
PPE	plant parameter envelope
Project site	Belews Creek, NC site
PWR	pressurized-water reactor
rev.	revision
RG	Regulatory Guide
SMR	small modular reactor
TEDE	Total Effective Dose Equivalent
TerraPower	TerraPower, LLC
TRISO	TRi-structural ISOtropic
TVA	Tennessee Valley Authority
WEC	Westinghouse Electric Company, LLC
X-energy	X-energy, LLC
χ /Q	atmospheric dispersion factor

Chapter 15 Accident Analysis

15.1 ACCIDENT SELECTION

As discussed in Section 1.11, Duke Energy is considering several nuclear technologies for potential construction and operation on the Belews Creek, North Carolina (NC) site (Project site). A specific technology has not yet been selected. Accordingly, Duke Energy is employing a Plant Parameter Envelope (PPE) approach in the Duke Energy Belews Creek Early Site Permit Application (ESPA). As discussed in Section 1.11, the advanced reactor technologies considered in development of the PPE for this ESPA include enhanced design and passive safety features expected to improve overall reactor safety compared to current operating reactors. These technologies include:

GVH BWRX-300	An advanced boiling-water reactor (BWR) design with passive safety features that uses standard light-water reactor (LWR) fuel and generates 870 megawatts thermal (MWt).
NuScale VOYGR	An advanced, integral pressurized-water reactor (PWR) design with passive design features that uses standard LWR fuel with a shorter fuel assembly length, with up to 12 reactors generating 250 MWt each, with the containment of each reactor submerged in the Reactor Building pool.
Holtec SMR-300	An advanced PWR design that includes passive safety features, uses standard LWR fuel, and generates approximately 1000 MWt.
WEC AP300	An advanced PWR design that includes passive safety features, uses standard LWR fuel, and generates 990 MWt.
TerraPower Natrium	An advanced, metal fueled, pool-type sodium fast reactor with passive design features that generates 840 MWt and uses sodium-bonded metallic fuel with high chromium martensitic steel cladding, that operates at near atmospheric pressures and includes a molten salt energy storage system.
X-energy Xe-100	An advanced high-temperature gas-cooled reactor that includes passive safety features. Each reactor generates 200 MWt. The X-energy Xe-100 uses TRi-structural ISOtropic (TRISO) particle fuel. The reactor and steam generator are located inside the containment structure.

As discussed in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.206, Rev. 1, *Applications for Nuclear Power Plants*, Section C.1.2, “Safety Analysis Report, for an ESPA, “Chapter 15 is analogous to a COL FSAR for the potential reactor designs but is limited to Section 15.0.3 addressing the evaluation of the radiological consequences of design basis.” [accidents].” Accordingly, this chapter is limited to evaluation of the radiation doses at the exclusion area boundary (EAB) and low population zone (LPZ) for the technologies considered in the development of the PPE. For the Project site, the EAB and LPZ are established at the same boundary.

NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition*, (SRP) 15.0.3, “Design Basis Accident Radiological Consequence

Analyses for Advanced Light Water Reactors," March 2007, states the following in Section I.3, for an ESPA employing a PPE approach:

> *A PPE is a set of plant design parameters that are expected to bound the characteristics of a reactor or reactors that may be constructed at a site, and it serves as a surrogate for actual reactor design information. The PPE values are selected by the applicant to bound a range of possible current and future reactor designs. The PPE values and associated information in the ESP application must contain sufficient information for the staff to make a determination regarding the acceptability of the proposed site using the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1).*

Nuclear Energy Institute (NEI) document NEI 10-01, Rev. 1 (Reference 15.1-1), Section 4, "Development of Normal and Accident Source Terms for a PPE-Based ESP," recognizes that radiation dose calculations for accidents require input from multiple release pathways, radionuclide removal mechanisms, and dispersion factors, which differ among various nuclear technologies. NEI 10-01, Rev. 1, recognizes further that based on the maturity of the technology design, all factors potentially affecting off-site doses for all postulated events may not yet have been sufficiently developed to support definitive projections of the dose consequences for every postulated event. Specifically, NEI 10-01 states:

> *Accident analyses model the time-dependent transport of radionuclides out of the reactor core through several pathways, each with different time-dependent removal mechanisms for radionuclides. Each reactor design has different release pathways, and each pathway has different release rates and different radionuclide removal mechanisms. Given the differences in the reactor designs, it is not possible to develop a bounding analysis for use in PPE based ESP.*
>
> *In addition, the applicant using a PPE may not know the site layout and building configuration making it impossible to model near field atmospheric dispersion around buildings in order to determine doses in the main control room and other areas where habitability is required post accident. Detailed accident analyses are more appropriately performed in the COLA, when a technology is selected and the orientation of the plant onsite is known.*

In the most recently approved Early Site Permit (ESP), ESP No. ESP-006, issued to Tennessee Valley Authority (TVA) for the Clinch River Nuclear site, the NRC accepted the above approach. In Section 15.0.3 of the Final Safety Evaluation Report for the ESPA for the Clinch River Nuclear site (Reference 15.1-2), the NRC noted:

> *SSAR Chapter 15 describes the applicant's assessment of the offsite radiological consequences of DBAs for a surrogate plant, as bounded by the PPE (TVA 2017-TN5387). The U.S. Nuclear Energy Institute 10-01, "Industry Guidance for Developing a Plant Parameter Envelope in Support of an Early Site Permit," notes that accident analyses model the time-dependent transport of radionuclides out of the reactor core through several pathways, each with different time-dependent removal mechanisms for radionuclides (NEI 2010-TN5866). As the applicant notes in SSAR Section 15.1, "Accident Selection," different reactor designs have different release pathways, and each pathway has different release rates and different radionuclide removal mechanisms (TVA 2017-TN5387). Given these differences, the applicant chose to use the DBA*

> *radiological consequence analyses from the design that resulted in the highest post-accident offsite doses in its assessment of the radiological consequences of DBAs at the CRN Site.*

Consistent with the above approach, Duke Energy has selected a source term (radioactivity released to the environment) expected to yield the highest post-accident doses at the EAB/LPZ as the surrogate for the purpose of evaluating the Project site against the site radiological consequence evaluation factors set forth in Title 10 of the Code of Federal Regulations (CFR) Part 52, Section 10 CFR 52.17(a)(1)(ix) and 10 CFR 50.34(a)(1)(ii)(D). The surrogate accident source term selected for analysis represents an instrument line break accident (ILBA) associated with one of the LWRs (GVH BWRX-300) considered in this application. The ILBA assumes a non-isolable circumferential break of a primary cooling system instrument line located outside of primary containment, discussed in further detail in Section 15.2 below.

Using the surrogate source term, doses have been calculated for a two-hour period following initiation of the accident for the EAB, and for the 30-day period following initiation of the accident for the LPZ. The doses calculated using the surrogate accident source term are expected to bound the accident doses of the technologies under consideration in this ESPA at the site EAB/LPZ over any two-hour period and the 30-day period following initiation of the accident.

15.2 SOURCE TERM

The surrogate accident source term (radioactivity released to the environment) used in evaluating the Project site EAB/LPZ doses is provided in Section 2.0, Table 2.0-3. Based on the information currently available, and as discussed above, a primary cooling system ILBA postulated by one of the LWRs was selected as the surrogate accident for the Project site.

The surrogate design-basis accident (DBA) source term was developed by first evaluating information provided by reactor technologies whose designs were sufficiently mature to enable adjusting doses provided to the site conditions. Those technologies included NuScale, X-energy, and TerraPower. To obtain doses for the three Project site Plant Complexes described in Section 2.1.2, doses of these three technologies were scaled using the methodology applied in the Clinch River Nuclear site ESPA. Specifically, the technology vendor doses were divided by the short-term atmospheric dispersion factors (χ/Qs) assumed by the technology vendors and multiplied by the Project site short-term χ/Qs to obtain the site-specific doses for these technologies for the three Plant Complexes. The resultant doses for those technologies were well within the 10 CFR 52.17(a)(1)(ix) and 10 CFR 50.34(a)(1)(ii)(D) dose limits.

Note 1 of 10 CFR 52.17 states:

> *The fission product release assumed for this evaluation should be based upon a major accident, hypothesized for purposes of site analysis or postulated from considerations of possible accidental events. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release into the containment of appreciable quantities of fission products.*

X-energy did not assume a fission product release for the hypothesized major accident due to substantial meltdown of the core because for the Xe-100, core meltdown is not credible at the temperatures experienced in its non-metallic core. NuScale assumed a beyond design basis event core damage accident, and TerraPower postulated a fuel fault DBA resulting in fuel assembly failure.

Of the three remaining technologies, all of which are LWRs, only one vendor (GVH) had advanced their accident analyses sufficiently to provide source terms for their postulated spectrum of accidents. Of the two remaining technologies, one was able to provide an estimated dose which is bounded by the surrogate accident dose; the other has not yet provided either a dose estimate or source term.

GVH BWRX-300 provided source term information regarding multiple line break accidents (feedwater line break accident, main steam line break accident, isolation condenser system line break accident, and instrument line break accident).

Accordingly, site-specific dose assessments of the accidents postulated by GVH were performed, using conservative assumptions. Based on these dose assessments, the ILBA, which does not assume core damage, was determined to be the bounding accident for the technology. The doses for the ILBA were higher than the core damage accident postulated by NuScale and TerraPower.

In addition to the conservative assumptions used in developing the χ/Qs for the Project site discussed in Section 15.3 below, the dose assessment included the following conservative assumptions:

- The accident was modeled assuming a pre-incident iodine spike.
- Although creditable under NRC RG 1.183, the accident is postulated to result in release of primary coolant activity to the atmosphere with no credit for holdup, filtration, or plateout of the effluent in any plant building.
- It is assumed that relevant daughter products are included in the activities released to the environment.

Based on the conservative methodology discussed above, Duke Energy has concluded that the source term developed is a reasonable surrogate for analysis of DBAs for the Project site.

15.3 EVALUATION METHODOLOGY AND CONCLUSIONS

Doses for the bounding DBA at the limiting EAB/LPZ boundary are shown in Table 15.3-1. The limiting two-hour EAB short-term χ/Q is conservatively applied to the LPZ dose determination because the EAB and the LPZ boundary are the same, the release is an instantaneous release, and the 0-to-2-hour EAB short-term χ/Q is larger than the LPZ short-term χ/Qs.

Key inputs to determination of the doses in Table 15.3-1 include:

- As discussed in Section 2.3.4, the greater of the short-term χ/Q values calculated for the directionally dependent (0.5% maximum sector) or the directionally independent (5% overall site) for the Project site is used.

- Use of the surrogate accident source term to calculate doses at the EAB/LPZ.

As discussed in Section 2.3.4, the Project site short-term dispersion factors were calculated using conservative assumptions:

- No building wake effects were credited.

- Effluent release points are assumed to occur at the perimeter of each of the technology composite footprints depicted as power block areas in Figure 2.1-5. This adds additional conservatism as the actual releases in most cases occur at the perimeter of the reactor building, located well inside of the perimeter of each vendor's technology plot footprint.

- As discussed in Section 2.3.4, the short-term dispersion factors for the Project site have been calculated in accordance with the guidance contained in NRC RG 1.45, Rev. 1, using the PAVAN code. Use of the ARCON code in accordance with NRC RG 1.249, Rev. 0, would likely reduce the Project site dispersion factors, and thus reduce the calculated doses by up to an order of magnitude.

- It is assumed that the LPZ dose is equal to the 0-2 hour EAB dose for the instantaneous release since the EAB and the LPZ are the same boundary. This is conservative as the 0-8 hour LPZ χ/Q is smaller than the 0-2 hour EAB χ/Q factor, which would result in a smaller dose at the LPZ. Since an instantaneous release is assumed, it is acceptable to utilize the 0-2 hour EAB χ/Q as the 0-8 hour LPZ χ/Q.

Based on the conservatisms applied in development of both the surrogate source term and the short term χ/Qs for the project site, Duke Energy is reasonably confident that the doses calculated for the surrogate accident will bound the two remaining technologies that have not yet provided sufficient information to validate this conclusion. However, for any technology selected, descriptions of each of the postulated DBAs and their associated dose consequences will be provided in the construction permit or license application.

The resulting accident doses are expressed as total effective dose equivalent (TEDE), consistent with 10 CFR 52.17(a)(1)(ix) and 10 CFR 50.34(a)(1)(ii)(D). As shown in Table 15.3-1, the accident doses of the technologies considered in the development of the PPE are below the 25 rem TEDE limits specified in 10 CFR 52.17(a)(1)(ix) and 10 CFR 50.34(a)(1)(ii)(D) at the EAB/LPZ for the Project site.

Table 15.3-1
Belews Creek Bounding Accident Doses

Location	Time (hr)	Dose (rem TEDE) [(a)(b)]
EAB	0 - 2	18.3
LPZ	0 - 720	18.3(c)

Notes:

(a) As compared to the 25 rem Total Effective Dose Equivalent (TEDE) limit specified in 10 CFR 50.34(a)(1)(ii)(D).

(b) Doses for the 0-2 hour time are for the worst two hours and not necessarily the first two hours.

(c) The two-hour EAB short-term atmospheric dispersion factor is conservatively applied to the LPZ dose determination because the EAB and the LPZ boundary are the same, the release is an instantaneous release, and the 0-to-2-hour EAB short-term atmospheric dispersion factor is larger than the zero to eight-hour LPZ short-term atmospheric dispersion factor.

Key: EAB = exclusion area boundary; hr = hour; LPZ = low population zone; rem = roentgen equivalent man; TEDE = Total Effective Dose Equivalent

15.4 REFERENCES

15.1-1 NEI 10-01, *Industry Guideline for Developing a Plant Parameter Envelope in Support of an Early Site Permit*, Revision 1, May 2012.

15.1-2 *Final Safety Evaluation Report for the Early Site Permit Application for the Clinch River Nuclear Site*, U. S. Nuclear Regulatory Commission, Office of New Reactors, Washington, DC 20555-0001, June 2019, (Accession Number ML19162A157).

CHAPTER 17

QUALITY ASSURANCE PROGRAM DESCRIPTION

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None.

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None.

GLOSSARY

Term	Definition
ANSI	American National Standards Institute
ASME	ASME
CFR	Code of Federal Regulations
CNO	Chief Nuclear Officer
ESPA	Early Site Permit Application
GL	NRC Generic Letters
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC Technical Report designation
Project site	Belews Creek, NC site
QA	quality assurance
QAPD	Quality Assurance Program Description
rev.	revision
RG	Regulatory Guide
SRP	Standard Review Plan
SSCs	structures, systems, and components

Chapter 17 Quality Assurance Program Description

17.5 QUALITY ASSURANCE PROGRAM DESCRIPTION – DESIGN CERTIFICATION, EARLY SITE PERMIT, AND NEW LICENSE APPLICANTS

17.5.1 INTRODUCTION

The Quality Assurance Program implemented during the development of this Early Site Permit Application (ESPA) for safety-related activities is described in the Duke Energy Topical Report, *Quality Assurance Program Description Operating Fleet*, DUKE-QAPD-001 (hereby referred to as QAPD). The QAPD and associated procedures provide for control of Duke Energy's activities that have the potential to affect the quality of safety-related structures, systems, and components (SSCs) of the proposed advanced reactors at the Belews Creek, North Carolina (NC) site (Project site).

17.5.2 SUMMARY

The QAPD is the top-level quality assurance (QA) document that applies to Duke Energy's fleet and that defines the quality policy and assigns major functional responsibilities. The QAPD applies to Duke Energy's personnel, organizations, and contractors performing activities within the scope of the QAPD that could affect the quality of safety-related SSCs at Duke Energy's nuclear plants. The QAPD applies to design, construction, testing, operation, maintenance, repair, replacement, and modification of Duke Energy's nuclear facilities. The QAPD also addresses the site-related activities associated with the preparation of the ESPA.

The QAPD applies to site suitability quality assurance activities associated with the ESPA, including designing, procuring, handling, testing, siting, inspecting, storing, training, and shipping. The QAPD is based on American National Standards Institute (ANSI) N18.7 and the ANSI N45.2 series standards in lieu of ANSI / American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1. The following addresses specific areas of NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition*, specifically Sections A through V under Section 17.5, "Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants."

17.5.3 EVALUATION

Title 10 of the Code of Federal Regulations (CFR) 52.17(a)(1)(xii) requires an evaluation of the site against applicable sections of the NUREG-0800 revision in effect six months before the docket date of the application. NUREG-0800, Chapter 17, Section 17.5, Rev. 1, "Quality Assurance," is based on 10 CFR Part 50, Appendix B, and reflects alignment with Duke Energy's QAPD, which the NRC staff found acceptable for meeting the requirement of Appendix B. The Duke Energy QAPD reflects alignment with an earlier set of standards, ANSI N18.7 and ANSI N45.2, considered by the NRC to be acceptable methods for complying with the provisions of 10 CFR 50, Appendix B. The QAPD is approved by the NRC to govern QA activities at multiple operating nuclear plants.

The QAPD has been evaluated in relationship to NUREG-0800, Section 17.5 and found to be in compliance with the Standard Review Plan (SRP) with following two exceptions:

- Section S, Items 2 and 3 – Per the QAPD, the Chief Nuclear Officer (CNO) is responsible for quality assurance and is the highest level of management responsible for establishing Duke Energy Corporation's nuclear policies, goals, and objectives. The qualifications of the CNO meet the intent of Section S, Item 2 qualifications for management of the implementation of the QA plan. Section S, Item 3 individuals responsible for planning, implementing, and maintaining the QA plan are qualified in accordance with the QAPD and are the same personnel for the operating plants. These qualifications meet the intent of Section S, Item 3 of the SRP.

- Section V, Item 1e – The QAPD does not commit to NRC Generic Letter (GL) 91-05, *Licensee Commercial-Grade Dedication Programs*. The QAPD commits to other dedication guidelines, such as GL 89-02, *Actions to Improve the Detection of Counterfeit and Fraudulently Marked Products*, and Regulatory Guide (RG) 1.164, *Dedication of Commercial-Grade Items for Use in Nuclear Power Plants*. The current QAPD meets the intent of Section V, Item 1e of the SRP.

17.6 REFERENCES

None.

Duke Energy Carolinas, LLC
Belews Creek, North Carolina Site
Early Site Permit Application

Part 3

Environmental Report

Revision 0

CHAPTER 1
INTRODUCTION

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GLOSSARY

Term	Definition
BCSS	Belews Creek Steam Station
CAA	Clean Air Act
CFR	Code of Federal Regulations
CRP	Carolinas Resource Plan
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DEMLR	NCDEQ Division of Energy, Minerals and Land Resources
DWM	NCDEQ Division of Waste Management
DWR	NCDEQ Division of Water Resources
ER	Environmental Report
ESP	Early Site Permit
ESPA	Early Site Permit Application
GS	General Statute
GVH	GE Vernova Hitachi Nuclear Energy
Holtec	Holtec International
HB951	North Carolina House Bill 951
km	kilometer

Term	Definition
kV	kilovolt
mi.	mile
MWe	megawatts electric
MWt	megawatts thermal
NC	North Carolina
NCAC	North Carolina Administrative Code
NCDEQ	North Carolina Department of Environmental Quality
NCDNCR	North Carolina Department of Natural and Cultural Resources
NCFS	North Carolina Forest Service
NCGA	General Assembly of North Carolina
NCSHPO	North Carolina State Historic Preservation Office
NCUC	North Carolina Utilities Commission
NCWRC	North Carolina Wildlife Resources Commission
NHP	NCDNCR Natural Heritage Program
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NuScale	NuScale Power, LLC
NUREG	NRC Technical Report designation

Term	Definition
PPE	plant parameter envelope
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc.
Project site	Belews Creek, NC site
rev.	revision
ROI	region of interest
SC	South Carolina
SMR	small modular reactor
TerraPower	TerraPower, LLC
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WEC	Westinghouse Electric Company, LLC
X-energy	X-energy, LLC

Chapter 1 Introduction

This Environmental Report (ER) is prepared and submitted as part of the Duke Energy Carolinas, LLC (DEC), referred to herein as "Duke Energy," a wholly owned subsidiary of Duke Energy Corporation, application for an Early Site Permit (ESP) to the U.S. Nuclear Regulatory Commission (NRC) in accordance with Title 10 of the Code of Federal Regulations (CFR) Part 52 (10 CFR 52), for the Belews Creek, North Carolina (NC) site (Project site). This is separate from the filing of an application for a construction permit or combined license for the facility.

This ESP application (ESPA) is for a new nuclear power generating plant located adjacent to the existing Belews Creek Steam Station (BCSS). The general Project site location is shown in Figure 1.1-1. A detailed site plan is provided on Figure 3.1-1, which illustrates the site boundary, permanently disturbed laydown areas, and the general arrangement of structures including the three proposed nuclear power Plant Complexes (referred to as Plant Complexes). Existing and shared structures and supporting infrastructure are shown on Figure 3.1-2 and Figure 3.1-3, respectively.

In accordance with NRC regulations, this ER evaluates the environmental impacts of constructing, operating, and decommissioning multiple advanced reactors at the Project site as part of the ESPA. Advanced reactors include both light water small modular reactors (SMRs) and non-light water reactors, such as those using gas, liquid metal, or molten salt coolants (NRC, 2023; NRC, 2025). The NRC uses this ER to develop an Environmental Impact Statement or Environmental Assessment, in compliance with the National Environmental Policy Act, to assess the environmental impacts of issuing an ESP.

1.1 APPLICANT AND REACTOR TYPE

1.1.1 APPLICANT

The Applicant is Duke Energy Carolinas, LLC (DEC), referred to herein as "Duke Energy," a wholly owned subsidiary of Duke Energy Corporation.

1.1.2 SITE LOCATION

The Project site is located along Belews Creek and Belews Lake in an unincorporated community of Sauratown Township, Stokes County, and partially in Belews Creek Township, Forsyth County, NC. The proposed nuclear reactors are located in Sauratown Township, Stokes County. The southern portion of the site, which includes additional permanently disturbed land, such as laydown areas, is located in Forsyth County, NC.

The Project site is adjacent to the existing Duke Energy-owned BCSS. It is approximately 14 miles (mi.) (23 kilometers [km]) northeast of Winston-Salem, NC and approximately 19 mi. (31 km) northwest of Greensboro, NC. Figure 1.1-1 shows the general location of the Project site.

Additional information regarding the Project site can be found in Section 2.1, Land Use.

1.1.3 REACTOR TYPE

A specific reactor design has not been selected, but advanced reactors under consideration are noted in Section 1.2.1. The Project site is planned to accommodate up to three nuclear Plant

Complexes, with the specific number of reactors dependent on the technology selected. To assist the NRC in determining the suitability of the site for new nuclear units, Duke Energy utilized a set of bounding plant parameters, referred to as the plant parameter envelope (PPE) described in Section 3.1.2. Technical information from various reactor designs was used to develop a set of bounding parameters that envelop the proposed facility characterization. This approach enables the NRC to assess the suitability of the Project site and allows Duke Energy to select the best technology.

Additional information regarding the reactor technologies considered in the PPE can be found in Section 3.2.1, Reactor Power Conversion System.

1.1.4 COOLING SYSTEM INFORMATION

The cooling water system being considered for the Project site is a closed-cycle recirculating water system with mechanical draft cooling towers. The number of cooling towers is dependent upon the selected reactor technology. A new common intake structure is planned on Belews Lake to service each Plant Complex. The common facility houses pump/motor sets of adequate number and size to supply the selected reactor technology and to overcome pipe routing head losses to each Plant Complex. The system design assumes makeup water for the cooling water system is obtained from the common intake structure on Belews Lake, pumped to the cooling towers, and circulated into and out of the main condenser. Discharge locations are described in Section 3.2.2.4.3, Blowdown Discharge.

Additional information regarding the cooling system and associated structures is provided in Section 3.2.2, Cooling System.

1.1.5 TRANSMISSION SYSTEM INFORMATION

The proposed project involves using the existing BCSS transmission system owned by Duke Energy. Necessary modifications or improvements to the transmission system to support the reactors are limited to the Project site and the existing BCSS 230-kilovolt (kV) switchyard.

Additional information regarding the power transmission system is provided in Section 3.2.4, Power Transmission System.

1.2 DESCRIPTION OF THE PROPOSED ACTION AND PURPOSE AND NEED

1.2.1 PROPOSED ACTION

The proposed action is the issuance of an ESP by the NRC under the provisions of 10 CFR Part 52 for the Duke Energy Project site. This ESP would establish that the proposed site is a suitable location for the potential construction and operation of multiple advanced reactors. This determination would encompass a range of reactor technologies, including SMRs and non-light-water reactor (non-LWR) designs, independent of any future application for a construction permit or combined license for the facility. Issuance of the ESP confirms the site's readiness for nuclear reactor deployment, independent of a specific reactor design or technology. Duke Energy requests the NRC issue an ESP for the proposed site for a period of 20 years from the date of issuance.

The site is being evaluated for its suitability to support the construction and operation of advanced reactors. At this stage, the ESPA does not commit to a specific reactor technology. Instead, it considers a range of potential advanced reactor designs that could be deployed at the site. These technologies include:

- GVH BWRX-300
- NuScale VOYGR
- Holtec SMR-300
- WEC AP300
- TerraPower Natrium
- X-energy Xe-100

As noted in Section 1.1.3, the application employs a PPE approach that integrates characteristics of the technologies under consideration, including reactor safety features, efficiency, and environmental impacts. Given that a specific reactor technology has not been selected at the time of this application, the environmental impacts analyses within this ER consider bounding conditions based on information provided by each vendor. This approach ensures that potential environmental impacts are assessed, irrespective of the final technology selection.

The Project site has a bounding gross electrical output of 2250 megawatts electric (MWe) with a total bounding thermal output of 6250 megawatts thermal (MWt) limited by certain land use, water constraints, and regulatory requirements. These values represent the upper limits for the potential deployment of the technologies being considered. Environmental analyses are performed for up to six units for GVH, Holtec, and WEC reactors; a single 12-unit configuration for NuScale; up to 14 units for X-energy; and up to two units for TerraPower.

This ER analyzes the environmental impacts associated with site preparation, construction, operation, and eventual decommissioning of advanced reactors at the Project site, based on the parameters defined in the PPE. The issuance of the ESP will not authorize construction or operation of any facility but will establish the site's suitability for future licensing decisions, contingent on the selection of the specific advanced reactors.

1.2.2 PURPOSE AND NEED

The purpose of the proposed action, the issuance of an ESP by the NRC, is to resolve identified site safety and environmental issues early in the licensing process. This proactive approach provides stability and clarity for the subsequent development and licensing phases of the project, enabling the deployment of advanced reactors at the Project site.

Duke Energy proposes deploying advanced reactors on a site located adjacent to the existing BCSS, which is scheduled for retirement in the mid-2030s. The site has been selected due to its existing infrastructure, including grid connections; its access to cooling resources; and its proximity to energy demand centers. These factors make the site well-suited for transitioning to advanced nuclear energy generation while minimizing environmental impacts.

The proposed project aims to replace the existing coal and natural gas generation capacity with multiple advanced reactors, which will be integrated into the existing power grid. The total maximum output capacity for the site will not exceed 6250 MWt (2250 gross MWe), consistent with land use, water constraints, and regulatory requirements. This transition to carbon-free energy will help meet growing demand for reliable, baseload power in the region of interest (ROI), while also addressing the critical need for reduced carbon emissions.

Duke Energy Corporation, a regulated rate-based utility, provides electricity to approximately 4.6 million retail customers across 52,000 square miles in NC and South Carolina (SC). As part of its commitment to a sustainable future, Duke Energy is responding to the requirements of NC House Bill 951 (HB951), which mandates net-zero emissions by 2050 (NCGA, 2021). The transition to dispatchable, carbon-free nuclear energy is essential for meeting these state-mandated emission reduction goals, particularly as regulatory pressure on fossil fuel generation increases.

In support of this transition, Duke Energy submitted a Carbon Plan to the North Carolina Utilities Commission (NCUC), which outlines portfolios to achieve the carbon emissions reduction targets set forth in HB951. The NCUC adopted an initial Carbon Plan, providing direction for future planning and authorizing Duke Energy to initiate development activities related to new nuclear facilities. These activities include organizing staff for nuclear development, conducting siting studies, evaluating new nuclear technologies, and preparing an ESPA for the proposed project (NCUC, 2022).

Duke Energy Corporation plans to achieve net-zero carbon emissions by 2050, and as part of this goal, aims to retire over 8400 MW of dispatchable coal-fired generation in the coming decades. This includes the BCSS, a 2220 MWe dual-fuel power generation facility capable of operating on both coal and natural gas. The new nuclear facility at the Project site will provide up to 2250 gross MWe of net generation capacity, replacing the BCSS and ensuring a stable supply of baseload, carbon-free power for the Carolinas service territory. Duke Energy will utilize the existing transmission infrastructure, minimizing additional environmental impacts associated with new transmission line construction. Additional details regarding the transmission lines are described in Section 3.2.4.

Duke Energy strategies and goals for this transition are outlined in its Carolinas Resource Plan (CRP). The CRP is the framework for replacing aging coal plants in a manner that ensures economic benefits for the Carolinas, while meeting growing demand for clean energy. Over the next 15 years, Duke Energy projects a 35,000-gigawatthour increase in electricity demand

within NC and SC, further underscoring the need for reliable, carbon-free power (Duke Energy, 2023).

Duke Energy proposes to deploy multiple advanced reactors with a maximum capacity of 6250 MWt (2250 gross MWe) to replace an existing coal and natural gas plant scheduled for retirement and to meet the demand for clean, reliable, carbon-free power generation in the Carolinas. The Project supports state and regional goals for emission reduction and energy resiliency, and it plays a crucial role in the clean energy transition by enabling continued reliable power generation while meeting the growing energy demand in the ROI.

1.3 PLANNED ACTIVITIES AND SCHEDULES

1.3.1 PREAPPLICATION PUBLIC INVOLVEMENT

Since BCSS began operating in 1974 (Duke Energy, 2025a), Duke Energy has actively participated in the local community and remains a valued member of the community, providing jobs, tax base, community involvement, and volunteer support. Duke Energy has dedicated Local Government and Community Relations staff in the ROI, ensuring a strong connection to the community and its leaders (Duke Energy, 2025b).

The proposed use of nuclear power generation at the Project site has been publicized through various media outlets. The NRC and Duke Energy have engaged in preapplication activities, and public preapplication meetings have been held.

Additionally, Duke Energy has actively engaged with community stakeholders regarding the Project through various efforts including:

- Providing presentations to government, civic, and community leaders.
- Providing tours of the Project site and an operating nuclear power plant.
- Attending community events and distributing information.
- Maintaining communication efforts through traditional media outlets.

As the Project progresses, Duke Energy remains committed to community engagement.

1.3.2 SCHEDULE OF MAJOR ACTIVITIES FOR THE PROPOSED ACTION

Duke Energy has not established a date for preconstruction activities and acknowledges that the ESP does not constitute a decision or approval to build new reactors. A limited work authorization application outlined in 10 CFR 50.10 is not included with this ESPA.

Currently, Duke Energy has not established a date for preconstruction activities. Site preparation activities (preconstruction) are expected to take between six and 18 months. Assuming all necessary licenses are obtained, and based on reactor vendor estimates, the actual construction of each Plant Complex is projected to take between three and five years. Additional information is provided in Section 3.3.

1.4 STATUS OF COMPLIANCE

Federal, state, regional, local, and affected Native American tribal agencies require various environmental protection licenses, permits, reviews, approvals, and consultations (collectively referred to as “authorizations”) to support the preconstruction, construction, and operation phases of the project.

Consultations with federal, state, tribal, and local agencies have been initiated and status noted in Table 1.4-1. Engagement letters sent to government agencies are included as Appendix 1A. However, construction and operation authorizations from these authorities are not yet required, as an ESP solely establishes the Project site’s suitability for future development. Duke Energy will secure any necessary authorizations before starting preconstruction, construction, and operational activities that require approval.

While many agencies are involved, the NRC is ultimately responsible for approving the ESP in accordance with the requirements and procedures outlined in 10 CFR Part 52, Subpart A. Table 1.4-2 lists the permits and other approvals required for construction and operation of the facility.

1.4.1 EARLY SITE PERMIT ISSUANCE

The following statutes summarize the principal agency consultations necessary for the ESP.

The Clean Air Act (CAA) establishes regulatory requirements on federally licensed projects that may affect state and regional air quality during construction and operation. The U.S. Environmental Protection Agency (USEPA) has authorized the North Carolina Department of Environmental Quality (NCDEQ), Division of Air Quality, to implement the provisions of the CAA in NC.

The Clean Water Act (CWA) requires that federal agencies consider the potential impacts to jurisdictional “waters of the United States.” Section 401 of the CWA regulates the issuance of Water Quality Certifications for activities that may result in discharges to these waters. A Section 401 certification is not currently required for the Project site because the ESP, if granted, does not authorize any activities that would result in discharges to jurisdictional waters. This certification is required at a future application phase authorizing construction or operation, when activities with the potential to discharge to such waters are proposed. Section 402 regulates point source and non-point source discharges under the National Pollutant Discharge Elimination System (NPDES). The NCDEQ, Division of Water Resources is the agency responsible for the oversight of CWA Sections 401 and 402. Section 404 of the CWA regulates the placement of fill material in waters of the United States. The U.S. Army Corps of Engineers (USACE) regulates dredge and fill activities in navigable waters pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the CWA.

The Coastal Zone Management Act (CZMA) imposes regulatory requirements on applicants seeking a federal license to conduct an activity that could affect a coastal zone. The CZMA requires the applicant to certify to the licensing agency that the proposed activity is consistent with the state’s federally approved coastal zone management program. Because the Project site is not located within a coastal zone, it is not subject to the CZMA.

The Endangered Species Act requires federal agencies to ensure that agency action is not likely to jeopardize any species that is listed or proposed for listing as endangered or threatened. The Endangered Species Act requires consultation with the U.S. Fish and Wildlife Service (USFWS).

The National Historic Preservation Act requires federal agencies having the authority to license any major federal action, prior to issuing the license, to consider the effect of the undertaking on historic properties and to afford the Advisory Committee on Historic Preservation an opportunity to comment on the undertaking. Committee regulations provide for establishing an agreement with any State Historic Preservation Officer to substitute state review for Committee review (36 CFR 800.2(c)(4)).

1.4.2 PRECONSTRUCTION, CONSTRUCTION, AND OPERATION ACTIVITIES

Permits and authorizations for future construction and operation of multiple advanced reactors are to be obtained in accordance with applicable statutes and regulations. Applications for these authorizations are to be developed after the reactor technology has been selected and detailed design is initiated. Table 1.4-2 lists authorizations that are anticipated for preconstruction, construction, and operation of advanced reactors. Each authorization includes the jurisdictional agency, the statute, law, or regulation providing authority, the applicant requirement, and the activity that is approved upon issuance of the authorization.

Table 1.4-1
Consultations Required for Early Site Permit
(Sheet 1 of 2)

Agency	Authority	Requirement	Activity	Status
Catawba Indian Nation, Tribal Historic Preservation Office	National Historic Preservation Act, Section 106, 16 United States Code (USC) 470	Consultation.	Consultation regarding presence of historic or prehistoric sites of cultural significance.	• Duke Energy sent a formal notification letter on August 20, 2024. • Formal response from Catawba Indian Nation dated September 24, 2024.
Monacan Indian Nation, Tribal Office	National Historic Preservation Act, Section 106, 16 United States Code (USC) 470	Consultation.	Consultation regarding presence of historic or prehistoric sites of cultural significance.	• Duke Energy sent a formal notification letter on November 7, 2024.
NC Department of Environmental Quality	NC Administrative Code (NCAC) Title 15A Environmental Quality	Consultation.	Concurrence with no potential adverse effects or consultation on appropriate mitigation measures.	• Initial meeting with NCDEQ on June 11, 2024. • Duke Energy sent a formal notification letter to NCDEQ on June 19, 2024. • Virtual meeting with NCDEQ staff on July 19, 2024. • Formal response from NCDEQ dated September 17, 2024.
NC Department of Natural and Cultural Resources (NCDNCR) Natural Heritage Program (NHP)	NC General Statute (GS) Chapter 143B, Article 2	Consultation.	Consultation regarding presence of natural heritage resources.	• Duke Energy sent a formal notification letter on August 20, 2024. • Formal response from NCDNCR NHP dated September 30, 2024.
NCDNCR State Historic Preservation Office (NCSHPO)	NCGS 121-12(a)	Consultation.	Consultation regarding presence of historic or prehistoric sites of cultural significance.	• Duke Energy sent a formal notification letter on July 18, 2024. • Formal response from NCDNCR NCSHPO dated August 14, 2024. • Phase I Archeological Survey sent to NCSHPO dated November 4, 2024. • Formal response from NCSHPO dated January 17, 2025. • Phase II Archeological Survey sent to NCSHPO October 6, 2025.

Table 1.4-1
Consultations Required for Early Site Permit
(Sheet 2 of 2)

Agency	Authority	Requirement	Activity	Status
NC Wildlife Resources Commission (NCWRC)	NC GS Chapter 143B, Article 24	Consultation.	Concurrence with no adverse effect or consultation on appropriate mitigation measures.	• On-site meeting with NCWRC staff on May 21, 2024. • Duke Energy sent a formal notification letter to NCWRC on June 14, 2024. • Formal response from the NCWRC dated July 26, 2024. • Virtual project update meeting was held on May 29, 2025. Representatives from NCWRC, USFWS, and Duke Energy were present.
U.S. Army Corps of Engineers (USACE)	Clean Water Act, 33 CFR Part 330 Rivers and Harbors Act, 33 USC 403	Consultation regarding potential to adverse effects on waters of the U.S.	Concurrence with no adverse effect or consultation on appropriate mitigation measures.	• Duke Energy sent a formal notification letter to USACE on July 18, 2024. • Virtual meeting with USACE staff on October 8, 2024. • Delineation Concurrence submittal sent to USACE dated October 22, 2024. • Formal response from USACE dated January 16, 2025.
U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act, 16 USC 1536	Consultation.	Concurrence with no adverse effect or consultation on appropriate mitigation measures.	• On-site meeting with USFWS staff on May 23, 2024. • Formal notification letter sent to USFWS on June 19, 2024. • Formal response from USFWS dated July 16, 2024. • Virtual project update meeting was held on May 29, 2025. Representatives from USFWS, NCWRC, and Duke Energy were present.
	Bald and Golden Eagle Protection Act, 16 USC 668-668c	Consultation regarding potential to adversely affect bald eagles.	Concurrence with no adverse effect or consultation on appropriate mitigation measures.	

Table 1.4-2
Authorizations Anticipated for Preconstruction, Construction, and Operation Activities
(Sheet 1 of 4)

Agency	Authority (Law/Rule)	Requirement	Activity
Federal Authorizations			
USACE	CWA Section 404; 33 USC Chapter 26, Section 1344; 33 CFR 320.1(b)	Section 404 Permit.	Dredge and fill activities of wetlands/water of the U.S.
U.S. Department of Transportation	49 USC 5108	Annual Certificate of Registration.	Transportation of hazardous materials.
U.S. Federal Aviation Administration	14 CFR 77.13 et seq	Notice of Proposed Construction or Alteration.	Construction or alteration of structures more than 200 feet in height above the ground level.
NRC	10 CFR 50.10(b) and 10 CFR 52.71; 10 CFR 52.103; 10 CFR 51.20; 10 CFR 70.3; 10 CFR 30.3; 10 CFR 52.103; 10 CFR Part 52	ESP; Construction Permit and or Combined License; and applicable By-Product License, Source Material License, and Special Nuclear Material License.	Site Licensing, including safety-related construction activities and operation of a nuclear power reactor. Possession of fuel.
USEPA	40 CFR Part 112	Oil Terminal Facility Spill Planning Requirements.	Requires Spill Prevention, Control, and Countermeasures Plan outlining containment and countermeasures for oil storage. May require Facility Response Plan. (Operation Phase).
USFWS	Endangered Species Act Section 7 (16 USC 1536)	Consultation.	Requires consultation regarding rare, threatened, and endangered terrestrial and aquatic species.(Preconstruction Phase).
	16 USC 703; 50 CFR Part 13 and 50 CFR Part 21.	Permit; Depredation.	Removal and relocation of migratory bird nests. (Construction Phase).

Table 1.4-2
Authorizations Anticipated for Preconstruction, Construction, and Operation Activities
(Sheet 2 of 4)

Agency	Authority (Law/Rule)	Requirement	Activity
State Authorizations			
NC Department of Administration	NCGS 146-12	Easement.	Authorization for structures placed in State navigable waters.
NC Department of Commerce, Public Utilities Commission	NCGS 62-110.1; 04 NCAC 11 R08-61	Certificate of Public Convenience and Necessity.	Certificate that public convenience and necessity requires, or will require construction of any steam, water, or other facility for the generation of electricity.
	NCGS 62-101; 04 NCAC 11 R08-62	Certificate of Environmental Compatibility and Public Convenience and Necessity.	Transmission line construction.
NCDNCR NCSHPO	National Historic Preservation Act Section 106 (16 USC 470); NCGS 121-12(a)	Permit.	Requires consultation with the NCSHPO regarding presence of historic or prehistoric sites of cultural significance. (Preconstruction Phase).
NCDEQ, Division of Air Quality	15A NCAC Title 02Q.0101 et seq.	Title V or synthetic minor Operating Permit.	Operation of facility generating air emissions.
NCDEQ, Division of Energy, Minerals and Land Resources (DEMLR), Dam Safety Section	NCGS 143-215.23 to 143-215.37; 15A NCAC 02K	Permit.	Modifications to jurisdictional dams (if needed).
NCDEQ, DEMLR, Land Quality Section	15A NCAC Title 4 B; NCGS 113A-54.1	Erosion and Sedimentation Control Plan.	Land disturbing activity greater than or equal to one acre.
NCDEQ, DEMLR, Stormwater Permitting	15A NCAC 02H.0127(a)(11)	NPDES Construction Permit.	Permit for stormwater generated during construction.
	NCGS 143-215.1; 15A NCAC 02H.0101 through .0121	NPDES Industrial Permits.	Permit for operational storm water discharges.

Table 1.4-2
Authorizations Anticipated for Preconstruction, Construction, and Operation Activities
(Sheet 3 of 4)

Agency	Authority (Law/Rule)	Requirement	Activity
State Authorizations			
NCDEQ, Division of Waste Management (DWM)	NCGS 143-215.96	Certificate of Registration of Oil Terminal Facility.	Requires registration of an Oil Terminal Facility with 500 barrels or more of storage (21,000 gallons or more).
	40 CFR 262.12	Notification of regulated waste activity USEPA Form 8700-12.	Standards applicable to generators of regulated waste.
	Resource Conservation and Recovery Act (RCRA-EPA 530-K-05-017)	Development, Operating, and Supplemental Permits.	Storage and transportation of hazardous materials.
NCDEQ DWM	NCGS 130-294; 15A NCAC 13B	Landfill permit.	No person shall treat, process, store, or dispose of solid waste or arrange for the treatment, processing, storage, or disposal of solid waste except at a solid waste management facility permitted by the Division.
NCDEQ, Division of Water Resources (DWR)	15A NCAC 02H.0500	401 Water Quality Certification.	Certification that the federal action will not contravene state water quality standards in project affected waters.
	15A NCAC Title 2E.0401; NCGS 143-215.22H	Water Withdrawal Registration.	Withdrawal of water for plant operation.
	NCAC 15A Subchapter 13B.0827	Sanitary Wastewater Hauling Permit.	Hauling wastewater for disposal.
	NCAC 15A Subchapter 13B.0820 and 13B.0825	Temporary Sewage Operating Permit for Construction Phase.	Detention of sewage and operation of a treatment facility.
	15 NCAC 02C.0113	Consultation with NCDEQ.	Well abandonment procedures.
	NCGS 143-215.1; 15A NCAC 02H.0101 through .0121	NPDES Permit (Operation).	Permit for operational wastewater and stormwater discharges.

Table 1.4-2
Authorizations Anticipated for Preconstruction, Construction, and Operation Activities
(Sheet 4 of 4)

Agency	Authority (Law/Rule)	Requirement	Activity
State Authorizations			
NC Department of Transportation	19A NCAC 02B.0502	Utility encroachment agreement.	State Highway System rights-of-way.
	19A NCAC 02B.0600	Access permit.	Permits for new access of any NC Department of Transportation maintained road.
NC Forest Service	15A NCAC 02D.1900	Open burning permit.	Open burning of land-clearing debris.
NCWRC	NC Statutory Authority 113-274 (c)(1a); NCAC Title 15A Subchapter 10B.0105	Special migratory bird permit and consultation.	Removal and relocation of migratory bird nests (Construction Phase).
Local Authorizations			
Duke Energy Lake Services Department	Permits for shoreline activities.	Permit for work at shoreline.	Intake and discharge infrastructure construction and operation.
Forsyth County	Winston-Salem/Forsyth County Unified Development Ordinances	Planning board review.	Board review and approval of land use activity.
Norfolk Southern Railway Company	Utility Accommodation Policy	Railroad crossing authorization (if needed).	Railroad crossing for infrastructure.
Stokes County	Stokes County Environmental Health	Permit to install or abandon.	Install well.
		Permit to install or repair.	Install septic system.
	Stokes County Fire Marshall NC Building Code 105.6.15, Explosives	Blasting/explosive materials permit application.	Use of explosives (Construction Phase).
	Stokes County Zoning Ordinance, Article VIII, Use Requirements by District, 80.2, Conditional Zoning Site Development	Special Use Permit.	Land-clearing and inert debris landfills, and construction and demolition landfills, are permitted as special uses in any zoning district.
	Stokes County Zoning Ordinance 91.2	Conditional zoning approval.	Approval for new electric generation facility.

1.5 METHODOLOGY

In accordance with NRC regulation 10 CFR 52.17, which specifies the required contents of applications for an ESP, this ER has been prepared to meet applicable regulatory requirements.

In preparing this ER, Duke Energy followed the content structure and organizational principles outlined in the NRC's Regulatory Guide (RG) 4.2, Rev. 3, *Preparation of Environmental Reports for Nuclear Power Stations*. The ER was developed using NRC guidance documents such as NUREG-1555, Initial, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants* and NUREG-2249, Initial, *Generic Environmental Impact Statement for Licensing of New Nuclear Reactors—Draft Report for Comment*, which provided further guidance. To facilitate NRC review, Table 1.5-1 lists the applicable regulatory requirements, alongside the corresponding sections of the ER where each requirement is addressed.

Table 1.5-1
Environmental Report Responses to Early Site Permit Regulatory Requirements

No.	Regulatory Requirement (10 CFR)[a]	Responsive Environmental Report Section
1	51.45(a), Signed original	Transmittal letter
2	51.45(b), Description of proposed action	Chapter 3, Site Layout and Project Description
3	51.45(b), Statement of purpose of proposed action	Section 1.2, Description of the Proposed Action and Purpose and Need
4	51.45(b), Description of environment affected by proposed action	Chapter 2, The Proposed Site and the Affected Environment
5	51.45(b)(1) and 51.50(b), Environmental impact of proposed action	Chapter 4, Environmental Impacts from Construction of the Proposed Project; Chapter 5, Environmental Impacts from Operation of the Proposed Project; Section 5.11, Environmental Impacts of Postulated Accidents; and Chapter 10, Conclusions
6	51.45(b)(2), Unavoidable adverse impacts	Section 10.2, Unavoidable Adverse Impacts
7	51.45(b)(3), Alternatives to proposed action	Chapter 9, Environmental Impacts of Alternatives and Section 10.5, Alternatives to the Proposed Action
8	51.45(b)(4), Relationship between short- term use and long-term productivity	Section 10.3, Relationship of Short-Term Use of the Environment and Long-Term Productivity
9	51.45(b)(5), Irreversible and irretrievable commitments of resources	Section 10.4, Irreversible and Irretrievable Commitments of Resources
10	51.45(c) and 51.50(b), Comparison of environmental effects of proposed action and alternatives	Chapter 4, Environmental Impacts from Construction of the Proposed Project; Chapter 5, Environmental Impacts from Operation of the Proposed Project; Section 5.11, Environmental Impacts of Postulated Accidents; Chapter 9, Environmental Impacts of Alternatives; and Chapter 10, Conclusions
11	51.45(c), Description of impacts of the preconstruction activities	Chapter 4, Environmental Impacts from Construction of the Proposed Project
12	51.45(c), Alternatives for reducing or avoiding adverse environmental impacts	Section 4.11, Measures and Controls to Limit Adverse Impacts During Construction; and Section 5.12, Measures and Controls to Limit Adverse Impacts During Operation
13	51.45(c), Economic, technical, and other benefits and costs of proposed action alternatives	Section 10.6, Benefits and Costs
14	51.45(d), Status of compliance with Federal permits, licenses, approvals, and other entitlements, including applicable environmental quality standards	Section 1.4, Status of Compliance
15	51.45(d) and 51.50(b), Compliance for alternatives	Section 9.3, Alternative Sites
16	51.45(e), Adverse information	Section 10.2, Unavoidable Adverse Impacts
17	51.50(a), 51.50(b) and 51.51(a), Uranium fuel cycle	Section 6.1, Fuel-Cycle Impacts and Waste Management
18	51.50(a) and 51.52, Fuel and waste transportation	Section 6.2, Transportation of Fuel and Wastes
19	51.50(a) and 51.50(b), Reporting and record keeping procedures	Details are in the corresponding resources sections.
20	51.50(a) and 51.50(b), Conditions and monitoring	Details are in the corresponding resources sections.

Note:

(a) 10 CFR 51.45, 10 CFR 51.50, 10 CFR 51.51, and 10 CFR 51.52.

1.6 REFERENCES

1 **Duke Energy, 2023.** *2023 Carolinas Resource Plan*, https://www.duke-energy.com/our-company/about-us/irp-carolinas, Date accessed: March 01, 2025.

2 **Duke Energy, 2025a.** *Our Company, Belews Creek Steam Station*, Duke Energy, https://www.duke-energy.com/our-company/about-us/power-plants/belews-creek-steam-station, Date accessed: March 7, 2025.

3 **Duke Energy, 2025b.** *City, County & Local Government*, Duke Energy, https://www.duke-energy.com/partner-with-us/city-county-local-government, Date accessed: March 18, 2025.

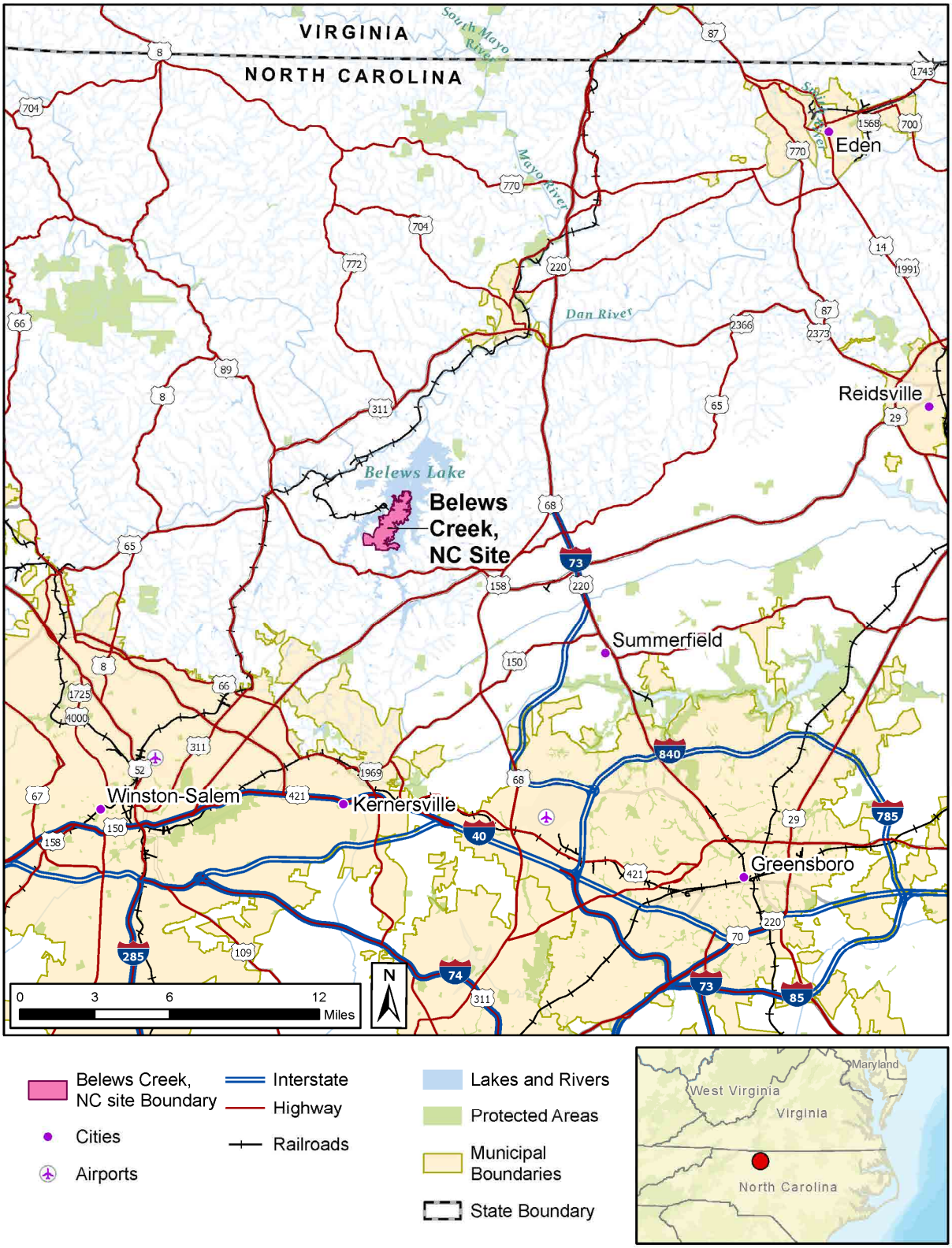
4 **NCGA, 2021.** *General Assembly of North Carolina Session 2021 House Bill 951 Ratified Bill, *H951-V-5*, An Act to Authorize the Utilities Commission to (I) Take all Reasonable Steps to Achieve a Seventy Percent Reduction in Emissions of Carbon Dioxide from Electric Public Utilities from 2005 Levels by the Year 2030 and Carbon Neutrality by the Year 2050, (II) Authorize Performance-Based Regulation of Electric Public Utilities, (III) proceed with Rulemaking on Securitization of Certain Costs and Other Matters, and (IV) Allow Potential Modification of Certain Existing Power Purchase Agreements with Eligible Small Power Producers*.

5 **NCUC, 2022.** *In the Matter of Duke Energy Progress, LLC, and Duke Energy Carolinas, LLC, 2022 Biennial Integrated Resource Plans and Carbon Plan. Order Adopting Initial Carbon Plan and Providing Direction for Future Planning.*

6 **NRC, 2023.** *Advanced Reactors, Glossary, Basic References*, NRC Library, U.S. Nuclear Regulatory Commission, Updated February 15, 2023, Website: https://www.nrc.gov/reading-rm/basic-ref/glossary/advanced-reactors.html, Accessed Date: May 14, 2025.

7 **NRC, 2025.** *Advanced Reactors, New Reactors, Nuclear Reactors*, U.S. Nuclear Regulatory Commission, Updated, March 4, 2025, Website: https://www.nrc.gov/reactors/new-reactors/advanced.html, Accessed Date: May 14, 2025.

Figure 1.1-1
Belews Creek, NC Site Location Map



CHAPTER 2
THE PROPOSED SITE AND THE AFFECTED ENVIRONMENT

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GLOSSARY

Term	Definition
7Q10	the lowest 7-day average flow that occurs on average once every 10 years
°C	degrees Celsius
°F	degrees Fahrenheit
AADT	average annual daily traffic
ac.	acre
ac-ft	acre-foot
ACRES	Assessment, Cleanup and Redevelopment Exchange System
ACS	American Community Survey
AGL	above ground level
AMS	ambient monitoring system
AMSL	above mean sea level
ANSI	American National Standards Institute
APE	area of potential effect
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
B.C.E.	Before the Common Era
BCSS	Belews Creek Steam Station

Term	Definition
bgs	below ground surface
BLS	Bureau of Labor Statistics
BLSW	Belews Lake surface water
Blue Ridge	Blue Ridge Physiographic Province
BOD	biological oxygen demand
bya	billion years ago
C-14	carbon-14
C.E.	Common Era
CAA	Clean Air Act
$CaCO_3$	calcium carbonate
CAP	corrective action plan as part of BCSS ash basin closure activities
CBC	Christmas Bird Count
CBG	Census Block Group
CCW	condenser cooling water
CDC	U.S. Center for Disease Control and Prevention
CDP	census-designated place
CFOI	census of fatal occupational injuries
CFR	Code of Federal Regulations

Term	Definition
cfs	cubic feet per second
cm	centimeter
cm/yr	centimeters per year
CO_2	carbon dioxide
CO_2-eq	carbon dioxide equivalent
Coastal Plain	Coastal Plain physiographic province
Corp.	corporation
COVID-19	Coronavirus disease 2019
CPUE	catch-per-unit-effort
CWA	Clean Water Act
dB	decibel
dBA	A-weighted sound level
DBA	design-basis accident
DBT	dry bulb temperature
DPT	dew point temperature
D/Q	Deposition Factor
DRSW	Dan River surface water
E	east

Term	Definition
EAB	exclusion area boundary
EF Scale	Enhanced Fujita Scale
EHS	environmental health and safety
EMF	electromagnetic field
ENE	east-northeast
ESE	east-southeast
FBI	Federal Bureau of Investigation
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FGD	flue gas desulfurization
FHWA	Federal Highway Administration
FRS	Facility Registry Services
ft.	feet
ft^2	square feet
ft/day	feet per day
ft/s	feet per second
$ft.^3/s$	cubic feet per second
FY	fiscal year

Term	Definition
g/cm3	grams per cubic centimeter
gal.	gallon
GHG	greenhouse gases
GIS	geographic information system
GMA	growth management area
gpm	gallons per minute
Gt	gigaton
ha	hectare
HAAs	Haloacetic acids
HCM	Highway Capacity Manual
hr.	hour
HUC	Hydrologic Unit Code
Hz	hertz
I	interstate
ICIS	Integrated Compliance Information System
ih	horizontal hydraulic gradient
in.	inches
in/yr	Inches per year

Term	Definition
Inc.	incorporated
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
JFD	joint frequency distribution
K	hydraulic conductivity
K-40	potassium-40
KGSO	Piedmont Triad International Airport
KINT	Smith Reynolds Airport
km	kilometers
km^2	square kilometers
kph	kilometers per hour
KRDU	Raleigh/Durham International Airport
kV	kilovolt
kV/m	kilovolts per meter
L	liter
L_{dn}	day-night or community noise level
L_{eq}	equivalent sound level
$L_{eq(1hr)}$	Hourly equivalent noise level

Term	Definition
lb	pound
LCD	local climatological data
LLC	limited liability corporation
LMDCT	linear mechanical draft cooling towers
LOS	level of service
lpm	liters per minute
LPZ	Low Population Zone
LSASD	Laboratory Services and Applied Science Division
LWSP	local water supply plan
m	meter
m^3	cubic meter
m^3/d	cubic meters per day
m^3/s	cubic meters per second
m/s	meters per second
Max	maximum
MCAWW	Methods for Chemical Analysis of Water and Wastes
MDL	method detection limit
MEL	Maximally Exposed Location

Term	Definition
MET tower	Belews Creek, NC site meteorological tower
mg/L	milligrams per liter
mg/m3	milligrams per cubic meter
mgd	million gallons per day
mi.	mile
mi^2	square mile
Min.	minimum
mL	milliliter
mld	million liters per day
mm	millimeter
mph	miles per hour
mpn	most probable number
mpn/100mL	most probable number per 100 milliliters
mrem/yr	millirems per year
MRI	mean recurrence interval
MRLC	Multi-Resolution Land Characteristics
ms/cm	millisiemens per centimeter
mSv/yr	millisieverts per year

Term	Definition
MT	million metric tons
mV	millivolt
MWIS	Makeup Water Intake Structure
mya	million years ago
n	effective porosity
N	north
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NAVD 88	North American Vertical Datum of 1988
NC	North Carolina
NCOSA	North Carolina Office of State Archaeology
NCOSBM	North Carolina Office of State Budget and Management
NCSHPO	North Carolina State Historic Preservation Office
NCWAM	North Carolina Wetland Assessment Method
NCA	National Climate Assessment
NCAC	North Carolina Administrative Code
NCCSR	North Carolina Climate Science Report
NCDEQ	North Carolina Department of Environmental Quality

Term	Definition
NCDOC	North Carolina Department of Commerce
NCDOR	North Carolina Department of Revenue
NCDOT	North Carolina Department of Transportation
NCDWR	North Carolina Division of Water Resources
NCEI	National Centers for Environmental Information
NCEM	North Carolina Emergency Management
NCES	National Center for Education Statistics
NCGA	North Carolina General Assembly
NCHHS	North Carolina Department of Health and Human Services
NC-IPC	North Carolina Invasive Plant Council
NCNHP	North Carolina Natural Heritage Program
NCWRC	North Carolina Wildlife Resources Commission
n.d.	not dated
NE	northeast
NE	no regulatory standard established for this constituent
NFPA	National Fire Protection Association
NHPA	National Historic Preservation Act
ng/L	nanograms per liter

Term	Definition
NLCD	National Land Cover Database
NM	noise monitoring
NNE	north-northeast
NNW	north-northwest
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NS	Norfolk Southern
NTU	nephelometric turbidity units
NUREG	NRC Technical Report designation
NW	northwest
NWI	National Wetland Inventory
NWQMC	National Water Quality Monitoring Council
NWS	National Weather Service
OB	overburden

Term	Definition
OHWM	ordinary high-water mark
ORW	outstanding resource waters
OSHA	U.S. Occupational Safety and Health Administration
pci/L	picocuries per liter
PEM	palustrine emergent
PFAS	perfluoroalkyl and polyfluoroalkyl substances
PFO	palustrine forested
PHFS	Primary Highway Freight System
Piedmont	Piedmont Physiographic Province
$PM_{2.5}$	particulate matter with a diameter of 2.5 microns or less
PM_{10}	particulate matter with a diameter of less than 10 microns
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc
Project Region	The area encompassed within a 50-mi. radius of the Belews Creek, NC site bounding limit unless otherwise specified for a particular resource.
Project site	Belews Creek, NC site
Project Vicinity	The area encompassed within a 6-mi. radius of the Project site center point unless otherwise specified for a particular resource.
PSM	process safety management

Term	Definition
PWR	partially weathered rock
PWS	public water supply
QC	quality control
RCP4.5	Representative Concentration Pathway 4.5
RCP8.5	Representative Concentration Pathway 8.5
RCRA	Resource Conservation and Recovery Act
REMP	radiological environmental monitoring program
RH	relative humidity
ROI	region of influence
ROW	right-of-way
RV	recreational vehicle
s	second
S	south
SE	southeast
SEMS	Superfund Enterprise Management System
SM	standard method
SOII	Survey of Occupational Injuries and Illnesses
SPC	Storm Prediction Center

Term	Definition
SR	State Route
SSAR	Site Safety Analysis Report
SSE	south-southeast
SSW	south-southwest
STP	shovel test pit
SW	southwest
TFCSW	Town Fork Creek surface water
TKN	Total Kjeldahl nitrogen
TMDL	total maximum daily load
TRI	Toxics Release Inventory
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service

Term	Definition
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
V	velocity
VDH	Virginia Department of Health
W	west
WBT	wet bulb temperature
WER	water effect ratio
WNW	west-northwest
WOTUS	Waters of the U.S.
WS	water supply
WSP	WSP USA
WSW	west-southwest
WWTP	wastewater treatment plant
yr.	year
ΔT	temperature difference
µg/g	micrograms per gram
µg/L	micrograms per liter
µs/cm	microsiemens per centimeter

Term	Definition
μT	microtesla
χ/Q	atmospheric-dispersion factor

Chapter 2 The Proposed Site and the Affected Environment

2.1 LAND USE

This section describes land use on the Belews Creek, North Carolina (NC) site (Project site), the Project Vicinity (6-mile [mi.] [10-kilometer {km}] radius) and the Project Region (50-mi. [80-km] radius). The Project site is located along Belews Creek and Belews Lake in an unincorporated community of Sauratown Township, Stokes County, and partially in Belews Creek Township, Forsyth County, NC. The site is approximately 14 mi. (23 km) northeast of Winston-Salem, NC, and approximately 19 mi. (31 km) northwest of Greensboro, NC (Section 1.1.2). Land use within the Project site, Project Vicinity, and Project Region are analyzed using the Multi-Resolution Land Characteristics (MRLC) Consortium National Land Cover Database (NLCD) (MRLC Consortium, 2021). The Project site is depicted on Figure 2.1-1. Figure 2.1-2 presents a high oblique aerial photograph of the Project site. Figure 2.1-3 depicts the Project Vicinity and the Project Region.

2.1.1 THE REGION, VICINITY, AND SITE

2.1.1.1 The Region

There are 26 counties within the Project Region which extends to a 50-mi. (80-km) radius of the Project site center point. Eighteen of these counties are in NC and eight are in Virginia (Table 2.1-1, Figure 2.1-3). Additionally, two independent cities (Danville, Virginia, and Martinsville, Virginia) are located within the Project Region. In Virginia, cities are considered an equal level of government as counties. For some counties, the Bureau of Economic Analysis, for statistical purposes, combines any independent cities with the county of which it was once part (Virginia Association of Counties, 2024). Therefore, Danville is included in the statistical data reported within Pittsylvania County, and Martinsville is included in the statistical data reported within Henry County. As stated in Section 2.4.1.2, the largest city in the Project Region is Greensboro, NC. As of the 2020 census, the population of Greensboro was 299,035 persons. The next largest city located within the Project Region is Winston-Salem, NC, with a population of 249,545 (see Section 2.4 for more information on regional demographics).

Major highways, roads, railroads, and airports are shown in Figure 2.1-4. Four interstate highways traverse the Project Region: Interstate (I) 40, I-74, I-77, and I-85. Major rail lines or rail systems include those owned by Norfolk and Western Railroad, Norfolk Southern (NS) Railroad, and Winston-Salem Southbound Railway. There are two major public airports, Piedmont Triad International Airport (KGSO) and Smith Reynolds Airport (KINT). Section 2.4 provides a description of the transportation network in the vicinity of the Project site.

Land cover within the Project Region is predominantly undeveloped forested land and hay/pasture. Large tracts of forested land are located within the northern portion of the Project Region. Developed land within the Project Region is concentrated within major cities located within the south-central portion of the Project Region. Land use and land cover in the Project Region are categorized in Table 2.1-2 and Figure 2.1-5.

The breakdown of agricultural commodity type, acreages, and yield for the counties in the Project Region is included in Table 2.1-3 and Table 2.1-4. The U.S. Department of Agriculture (USDA) 2022 Census of Agriculture indicates that the principal agricultural commodities in the Project Region are corn for grain, corn for silage, forage (hay/haylage), wheat for grain, soybeans, and tobacco (USDA, 2022b and 2022c). The breakdown of forestry commodity by

product for the counties in the Project Region is included in Table 2.1-5 and Table 2.1-6. According to the USDA Forest Service, Halifax County, Virginia, and Chatham County, NC, are among the top producers of wood products, including wood for biofuel, composite panel, poles, posts and pilings, pulpwood, saw logs, veneer logs, and other miscellaneous products.

Major public and trust land areas in the Project Region (areas that are 500 acres [ac.] [202 hectares {ha}]) or larger] are illustrated on Figure 2.1-6. These include the Uwharrie National Forest, Blue Ridge Parkway, North Carolina Zoological Park, several wildlife management areas, nature preserves, game lands, and state parks. Most of these public lands offer camping, fishing, swimming, hiking, and other recreational activities for visitors.

2.1.1.2 The Vicinity

Figure 2.1-3 illustrates the Project Vicinity, defined as a 6-mi. (10-km) radius from the Project site center point. The Project Vicinity spans the southeastern portion of Stokes County, northeastern portion of Forsyth County, southwestern portion of Rockingham County, and the northwestern portion of Guilford County. Figure 2.1-7 illustrates the topography within the Project Vicinity.

Land cover in the Project Vicinity is shown in Table 2.1-2 and Figure 2.1-8. The predominate land cover types include undeveloped forested land, followed by hay/pasture. Evergreen forest is primarily located around Belews Lake with undisturbed pockets of mixed forest, deciduous forest, and hay/pasture dispersed throughout the Project Vicinity. Developed land classified as low intensity or open space is located sparsely throughout the Project Vicinity, whereas most of the high intensity and medium intensity developed lands are found within the Belews Creek Steam Station (BCSS), Walnut Cove, and Stokesdale areas. Belews Lake represents most of the open water within the Project Vicinity.

Prime farmland is defined by the USDA as farmland exhibiting the best combination of physical and chemical soil properties for agricultural production (USDA, 2022d). As shown in Table 2.1-7, approximately 67 percent of soils in the Project Vicinity are identified by the USDA as prime farmland soils. Prime farmland and farmland of statewide importance are found in areas associated with hay/pasture and cultivated cropland adjacent to rivers and streams in the Project Vicinity (see Figure 2.1-8). As illustrated in Figure 2.1-9, prime farmland soils are widespread throughout the Project Vicinity.

Special land uses, 500 ac. (202 ha) or larger, within the Project Vicinity are included on Figure 2.1-6. The Piedmont Land Conservancy consists of three preserves that collectively span 1,716 ac. (694 ha) throughout the Project Region. One of those preserves, the Knight Brown Nature Preserve, is located approximately 3.7 mi. (6 km) northeast of the Project site center point within the Project Vicinity. The Knight Brown Nature Preserve consists of approximately 147 ac. (60 ha) with almost 5 mi. of walking trails, a wooded valley, and two streams (Piedmont Land Conservancy, 2024). Additionally, several recreational areas, parks, marinas, and boat ramps are located adjacent to the Belews Lake. Recreational land use is discussed in detail in Section 2.4.2.6.

Transportation facilities within the Project Vicinity are shown on Figure 2.1-4. Two U.S. highways (U.S Highway 311 and U.S. Highway 158) and one state highway (NC Highway 65) are located within Project Vicinity. A NS railroad line runs to the north of the Project site. The railroad throughline is 2.2 mi. (3.5 km) to the north of the Project site, and a spur line runs to the Project site.

Chapter 160D of the North Carolina General Statutes, Local Planning, and Development Regulations require local governments to adopt and reasonably maintain a comprehensive plan or land use plan (NCGA, 2024). Accordingly, all of the counties within the Project Vicinity (Stokes, Forsyth, Guilford, and Rockingham counties) have adopted countywide comprehensive plans. All four of the county comprehensive plans identify goals for increasing economic growth and attracting businesses, development of a variety of housing options, protection and preservation of natural resources, and improvements to transportation and utilities (Guilford County, 2024a, Rockingham County, 2021, Stokes County, 2015, City-County Planning Board, 2013).

Most of the Project site falls within Stokes County, and according to the Stokes County Comprehensive Plan, Land Use Framework Maps, the Project site and most of Stokes County is designated as "(O-2) Open Space: Rural Community." These designations reflect areas where land uses are designated for very low-density development typically lacking centralized water or sewer infrastructure. The plan notes some of these areas could ultimately transition to O-1 Open Space: Preserved Lands, which are intended for preservation, conservation, or very limited development areas (Stokes County, 2015). A small portion of the Project site falls within Forsyth County. According to the Forsyth County Proposed Land Use Map, the Project site is designated as Growth Management Area (GMA) 5 / Rural Area. This designation identifies land uses in these areas as those intended for preserved agricultural uses, tourism, and recreation opportunities. It also reflects a policy of limited road building, limited expansion of sewer infrastructure, and an intention to avoid rezoning to more intensive land use districts.

2.1.1.3 The Site

As shown on Figure 2.1-1, the Project site is located adjacent to the BCSS on a peninsula surrounded by Belews Lake to the north, east, and much of the western sides. The Project site is accessed from either Pine Hall Road (State Route [SR] 1908) from the west or Craig Road (SR 2042) from the south. Duke Energy Carolinas, LLC (Duke Energy) owns the approximately 1187-ac. (480 ha) Project site and no off-site land acquisition is needed to support project activities.

NC did not adopt the Public Land Survey System; therefore, the Project site is not assigned a section, township, or range (Digital Data Services, Inc., 2016). The Project site is located within the U.S. Geological Survey (USGS) Belews Lake Quadrangle.

Because the layout of the Project site is not finalized, the exact location of the Project site center point is yet to be determined. As a conservative approach, site bounding limit encompass any and all areas in which nuclear facilities could be located. The coordinates of the Project site center point is shown in Table 2.1-8. The Project site center point incorporates a bounding radius around the Project site center point coordinate such that the radius encompasses all safety-related features of the Project. The Project site center point represents the center of the property which is designated for future development of three Plant Complexes. The site center point will remain the same regardless of final site layouts in the final project design. Unless otherwise specified, distance measurements to features within the Project Vicinity and Project Region are measured from the Project site center point.

A topographic map of the Project site is presented on Figure 2.1-10. As shown on the figure, the Project site consists of rolling hills and steep slopes with surface elevations ranging from approximately 725 feet (ft.) (219.5 meters [m]) North American Vertical Datum of 1988 (NAVD 88) near the shoreline of Belews Lake to approximately 890 ft. (271 m) NAVD 88 along the

ridgetops. As described in Section 2.10, the Project site lies within the NC western Piedmont physiographic province (Piedmont), which is characterized by gently rolling, well-rounded hills and long, low ridges ranging in a few hundred feet of elevation difference between the hills and valleys.

Land cover within the Project site is identified in Figure 2.1-8 and summarized in Table 2.1-2. Land cover categories shown are consistent with the land use classification codes listed in MRLC Consortium NLCD. The Project site is primarily undeveloped forested land (deciduous, evergreen, or mixed forest), which accounts for approximately 79 percent of the land cover. Approximately 7 percent of the land cover within the Project site is classified as developed land (high, medium, or low intensity, or open space). These areas represent various land uses to support operation of the BCSS. There are no special land uses within the Project site (Figure 2.1-6).

As shown on Figure 2.1-9 and summarized in Table 2.1-7, approximately 46 percent of soils within the Project site are considered prime farmland and farmland of statewide importance.

Most of the Project site is located in Stokes County, with a small portion located in Forsyth County (Figure 2.1-1). The portion in Stokes County is zoned as “M-1.” Per the Stokes County Zoning Ordinance, M-1 is a light manufacturing district. This zoning district is assigned to areas where the principal use of the land is for light manufacturing and warehousing, uses that normally seek locations on large tracts of land where operations do not detract from the development potential of nearby undeveloped properties. The southern portion of the Project site, located in Forsyth County, is zoned “AG-Agricultural.” The AG-Agricultural District designation was established to maintain agricultural nature uses and scattered non-farm residences on large tracts of land.

There are no known mineral resources within or adjacent to the Project site that are currently being extracted or utilized (USGS NMIC, 2003).

There is an existing natural gas pipeline traversing the Project site that provides natural gas to the existing BCSS. Three double-circuit 230-kilovolt (kV) transmission lines also cross the Project site (Figure 2.1-1). Duke Energy owns and operates the lines.

The Project site is not located within a Coastal Zone and therefore is not subject to requirements in the Coastal Zone Management Act.

Section 2.3.1 provides a further discussion of natural and human-made habitat types within the Project site. Descriptions of floodplains and wetlands within the Project site are discussed in Section 2.2.

2.1.2 TRANSMISSION CORRIDORS AND OTHER OFF-SITE AREAS

The existing BCSS is served by an existing switchyard and established transmission corridors that will serve the needs of the Project site. Therefore, no additional off-site transmission lines or corridors are needed to support the Project. However, the need for a new large 230-kV switchyard or multiple new smaller 230-kV switchyards (in addition to the existing switchyard), has been identified. The new switchyard(s) are located within the existing site boundary. The new transmission lines and any relocation of existing transmission lines are located within the existing Project site, no off-site land acquisition is needed. As such, discussion of land use, special land uses, prime farmland, and natural areas within the Project site, which contains any

new transmission lines, are described above in Section 2.1.1.3. Transmission information is discussed in more detail in Section 3.2.

Portions of the existing wastewater pipeline corridor extends outside the Project site. The existing wastewater pipeline, depicted on Figure 2.1-1, is an associated off-site feature, which is approximately 40 ac. (16 ha), and is currently used by the BCSS to transfer wastewater to its National Permit Discharge Elimination System (NPDES) permitted discharge point to the Dan River. Table 2.1-2 and Figure 2.1-8 identify and categorize the land cover in the existing wastewater pipeline corridor. As shown in Table 2.1-7, approximately 48 percent of soils in the existing wastewater pipeline corridor are identified by the USDA as prime farmland and farmland of statewide or local importance. The existing wastewater pipeline is located within the 6 mi. (10 km) Project Vicinity. Additionally, details of land use, special land uses, and land use plans within the Project Vicinity are described above in Section 2.1.1.2.

Table 2.1-1
Counties within the 50-Mile Project Region

State	County
North Carolina	Alamance
North Carolina	Alleghany
North Carolina	Caswell
North Carolina	Chatham
North Carolina	Davidson
North Carolina	Davie
North Carolina	Forsyth
North Carolina	Guilford
North Carolina	Iredell
North Carolina	Orange
North Carolina	Person
North Carolina	Randolph
North Carolina	Rockingham
North Carolina	Rowan
North Carolina	Stokes
North Carolina	Surry
North Carolina	Wilkes
North Carolina	Yadkin
Virginia	Carroll
Virginia	Danville (Independent City)
Virginia	Floyd
Virginia	Franklin
Virginia	Grayson
Virginia	Halifax
Virginia	Henry
Virginia	Martinsville (Independent City)
Virginia	Patrick
Virginia	Pittsylvania

Source: USCB, 2023

Table 2.1-2
Land Cover in the Project Site, Vicinity, and Region

USGS Description	Project Site		Existing Wastewater Pipeline		Project Vicinity		Project Region	
	Acre	Percent of Land Cover	Acre	Percent of Land Cover	Acre	Percent of Land Cover	Acre	Precent of Land Cover
Barren Land	14.0	1.2	1.4	3.5	372.8	0.4	4964.3	0.1
Cultivated Crops	-	-	-	-	3097.7	3.1	185,611.6	3.5
Deciduous Forest	367.2	30.9	4.8	12.0	36,003.3	36.5	1,925,488.0	36.8
Developed, Low Intensity	11.1	0.9	4.3	10.6	3339.4	3.4	232,367.9	4.4
Developed, Medium Intensity	19.8	1.7	7.7	19.2	743.2	0.8	94,809.2	1.8
Developed, High Intensity	11.4	1.0	3.5	8.6	304.6	0.3	39,597.5	0.8
Developed, Open Space	40.7	3.4	6.2	15.4	7747.0	7.9	462,880.2	8.9
Emergent Herbaceous Wetlands	4.0	0.3	-	-	146.1	0.1	3229.4	0.1
Evergreen Forest	430.6	36.3	6.0	15.0	9578.0	9.7	342,275.5	6.5
Hay/Pasture	19.5	1.6	0.2	0.5	17088.2	17.3	1,007,100.8	19.3
Herbaceous	41.4	3.5	2.7	6.6	2916.8	3.0	109,993.5	2.1
Mixed Forest	134.3	11.3	2.2	5.3	8497.1	8.6	602,734.6	11.5
Open Water	29.6	2.5	0.2	0.5	4115.8	4.2	57,434.1	1.1
Shrub/Scrub	63.2	5.3	1.1	2.8	2386.8	2.4	132,472.7	2.5
Woody Wetlands	-	-	-	-	2178.5	2.2	28,332.8	0.5
Total	**1186.7**	**100**	**40.1**	**100**	**98,515.1**	**100.0**	**5,229,292.0**	**100.0**

Source: MRLC Consortium, 2021
Note: Column totals may not equal sum of individual values due to rounding.

Table 2.1-3
Principal Agricultural Crops as of 2022 in the Project Region North Carolina
(Sheet 1 of 2)

Crops	Alamance County	Alleghany County	Casewell County	Chatham County	Davidson County	Davie County	Forsyth County	Guilford County	Iredell County
Corn for grain									
Area (ac.)	1856	205	505	3228	3912	9461	1677	3712	8221
Yield (bushels)	158,216	(D)	32,943	229,162	409,050	1,252,701	165,581	338,339	1,179,275
Corn for silage or greenchop									
Area (ac.)	-	1284	-	-	-	-	-	1000	8345
Yield (tons)	-	32,844	-	-	-	-	-	10,510	162,521
Wheat for grain, all									
Area (ac.)	1692	-	1496	1188	1970	2018	1376	4657	8514
Yield (bushels)	87,404	-	81,545	76,539	125,594	125,813	110,498	225,886	522,505
Soybeans for beans									
Area (ac.)	4308	(D)	4122	4127	9096	13,568	5010	8446	15,250
Yield (bushels)	124,424	(D)	121,714	124,609	294,470	713,693	215,052	262,421	800,592
Tobacco									
Area (ac.)	511	-	2039	792	321	-	298	1181	-
Yield (bushels)	949,026	-	4,025,405	2,017,292	250,962	-	603,550	1,925,103	-
Forage (hay/haylage), all									
Area (ac.)	12,181	11,110	7220	18,288	13,182	9,883	4631	12,603	20,620
Yield (tons)	23,507	23,679	7749	33,461	19,651	18,526	6428	21,899	44,877
Total area (ac.)	**20,548**	**12,599**	**15,382**	**27,623**	**28,481**	**34,930**	**12,992**	**31,599**	**60,950**

Table 2.1-3
Principal Agricultural Crops as of 2022 in the Project Region North Carolina
(Sheet 2 of 2)

Crops	Orange County	Person County	Randolph County	Rockingham County	Rowan County	Stokes County	Surry County	Wilkes County	Yadkin County
Corn for grain									
Area (ac.)	2752	4947	7865	2594	10,010	1104	9546	4736	12,049
Yield (bushels)	398,229	493,365	794,202	210,211	1,087,569	124,635	1,449,433	685,660	1,867,014
Corn for silage or greenchop									
Area (ac.)	135	204	5497	956	831	-	65	3565	904
Yield (tons)	2179	5136	93,349	15,044	17,036	-	2472	52,158	18,852
Wheat for grain, all									
Area (ac.)	560	7583	4769	3499	8128	108	2901	85	4567
Yield (bushels)	31,542	382,521	319,955	183,408	586,176	5183	172,967	(D)	339,494
Soybeans for beans									
Area (ac.)	3266	14,663	10,156	7521	21,330	2663	13,420	1161	27,024
Yield (bushels)	110,975	394,726	380,240	253,667	937,407	113,078	738,750	58,238	1,247,331
Tobacco									
Area (ac.)	184	4844	275	1701	-	806	2166	1032	2611
Yield (pounds)	299,810	11,072,143	570,332	2,766,071	-	1,601,566	4,052,737	(D)	4,555,360
Forage (hay/haylage), all									
Area (ac.)	8330	10,816	21,630	15,310	17,292	16,472	17,101	21,235	13,421
Yield (tons)	13,737	21,150	46,406	27,370	34,127	26,835	39,160	58,800	27,679
Total area (ac.)	**15,227**	**43,057**	**50,192**	**31,581**	**57,591**	**21,153**	**45,199**	**31,814**	**60,576**

Source: USDA, 2022b
Note: (D) = Withheld to avoid disclosing data for individual farms.

Table 2.1-4
Principal Agricultural Crops as of 2022 in the Project Region Virginia

Crops	Carroll County	Floyd County	Franklin County	Grayson County	Halifax County	Henry County	Patrick County	Pittsylvania County
Corn for grain								
Area (ac.)	(D)	103	6179	2860	3820	40	445	3709
Yield (tons)	(D)	18,210	707,412	232,094	481,461	3600	48,295	443,001
Corn for silage or greenchop								
Area (ac.)	199	855	5937	1087	-	(D)	(D)	2570
Yield (tons)	2783	13,270	85,903	23,613	-	(D)	(D)	35,184
Wheat for grain, all								
Area (ac.)	-	(D)	3316	-	4596	133	437	6224
Yield (bushels)	-	(D)	219,182	-	249,188	6946	19,368	316,635
Soybeans for beans								
Area (ac.)	-	(D)	7508	(D)	11,476	-	173	9197
Yield (bushels)	-	(D)	322,296	(D)	470,690	-	8820	356,846
Tobacco								
Area (ac.)	-	-	705	(D)	1028	194	(D)	3219
Yield (pounds)	-	-	1,419,237	(D)	2,184,683	250,578	(D)	7,056,720
Forage (hay/haylage), all								
Area (ac.)	23,298	21,292	31,846	20,379	19,725	8623	12,624	45,865
Yield (pounds)	46,427	45,421	63,892	42,744	28,137	16,743	24,534	97,526
Total area (ac.)	**23,497**	**22,250**	**55,491**	**24,326**	**40,645**	**8990**	**13,679**	**70,784**

Source: USDA, 2022c
Note: (D) = Withheld to avoid disclosing data for individual farms.

Table 2.1-5
Forest Inventory for North Carolina, Volume by County, Product, Species (Green Tons)

County	Grand total	Bioenergy/Fuelwood (softwood and hardwood)	Composite panel (softwood and hardwood)	Miscellaneous (softwood and hardwood)	Poles, Posts, Pilings (softwood and hardwood)	Pulpwood (softwood and hardwood)	Saw logs (softwood and hardwood)	Veneer logs (softwood and hardwood)
Alamance	2,524,913	9410	102,231	161,268	-	182,910	1,983,233	85,862
Alleghany	1,481,133	-	9563	61,002	8750	230,898	1,162,521	8400
Caswell	4,339,492	408,290	688,491	934,340	-	685,352	1,566,110	56,909
Chatham	7,211,234	127,585	450,118	754,389	33,790	710,353	4,654,436	480,563
Davidson	3,815,459	60,920	148,647	208,503	860	245,578	3,134,673	16,278
Davie	1,190,051	20,375	66,642	149,178	840	122,442	820,004	10,571
Forsyth	1,358,461	4633	79,246	200,349	1995	175,917	887,560	8761
Guilford	2,292,249	48,570	99,950	57,571	-	225,408	1,857,859	2891
Iredell	3,188,119	14,082	137,697	353,555	1470	743,389	1,928,641	9285
Orange	1,833,975	4848	365,341	209,192	-	129,922	1,044,681	79,992
Person	4,524,969	551,756	810,809	1,280,765	6125	480,946	1,342,149	52,419
Randolph	5,051,239	163,101	133,890	219,222	860	429,200	3,944,251	160,716
Rockingham	4,737,950	177,480	458,713	190,170	-	1,471,949	2,411,840	27,797
Rowan	3,620,188	11,809	148,757	228,348	3800	865,663	2,355,890	5921
Stokes	2,750,056	30,378	322,820	295,639	12,145	303,179	1,778,484	7411
Surry	2,997,092	24,658	256,780	425,444	24,045	342,092	1,902,591	21,482
Wilkes	5,761,124	39,209	146,563	144,699	8505	1,389,100	4,001,308	31,741
Yadkin	2,138,302	23,446	93,565	243,137	6440	210,770	1,560,857	88
Total	**60,816,007**	**1,720,550**	**4,519,821**	**6,116,770**	**109,625**	**8,945,067**	**38,337,088**	**1,067,086**

Source: USDA Forest Service, 2024

Table 2.1-6
Forest Inventory for Virginia, Volume by County, Product, Species (Green Tons)

County	Grand total	Bioenergy/Fuelwood (softwood and hardwood)	Composite panel (softwood and hardwood)	Miscellaneous (softwood and hardwood)	Poles, Posts, Pilings (softwood and hardwood)	Pulpwood (softwood and hardwood)	Saw logs (softwood and hardwood)	Veneer logs (softwood and hardwood)
Carroll	3,726,629	34,268	123,345	144,014	630	220,222	3,165,396	38,754
Floyd	1,784,270	-	25,510	93,130	-	162,204	1,501,041	2386
Franklin	5,241,909	301,099	243,900	452,008	-	1,275,897	2,962,050	6955
Grayson	2,117,529	5070	55,791	108,478	630	121,411	1,773,675	52,474
Halifax	12,482,446	1,448,853	1,393,562	3,005,013	2449	1,826,486	4,696,176	108,994
Henry	3,564,206	53,125	274,361	219,346	-	1,192,685	1,819,088	5601
Patrick	3,857,743	287,448	254,363	281,646	630	735,674	2,293,248	4734
Pittsylvania	10,794,731	1,054,241	1,305,489	1,562,027	1841	3,045,744	3,778,657	46,731
Total	**43,569,463**	**3,184,105**	**3,676,321**	**5,865,663**	**6,180**	**8,580,322**	**21,989,331**	**266,628**

Source: USDA Forest Service, 2024

Table 2.1-7
Prime Farmland in the Project Site and Project Vicinity

Prime Farmland	Existing Wastewater Pipeline (acre)	Existing Wastewater Pipeline (percent)	Project Site (acre)	Project Site (percent)	Project Vicinity (acre)	Project Vicinity (percent)
Not Prime Farmland	20.9	52.1	640.1	53.9	32,199.8	32.7
Prime Farmland Classifications						
All Areas are Prime Farmland	7.0	17.4	88.7	7.5	30,154.2	30.6
Farmland of Statewide Importance	12.2	30.5	457.9	38.6	32,616.5	33.1
Farmland of Local Importance	--	--	--	--	27.1	>0.1
Prime Farmland if Drained	--	--	>0.1	>0.1	628.5	0.6
Prime Farmland if drained and either protected from flooding or not frequently flooded during growing season	--	--	--	--	2,240.3	2.3
Prime Farmland if protected from flooding or not frequently flooded during growing season	--	--	--	--	648.8	0.7
Total Prime Farmland (all Classifications)	19.2	48.0	546.6	46.1	66,315.3	67.3
Total	**40.1**	**100**	**1186.7**	**100**	**98,515.1**	**100**

Source: USDA NRCS, 2022

Table 2.1-8
Approximate Coordinates of the Project Site Center Point

North Carolina State Plane Coordinate System	
Zone	North Carolina State Plane (NC-3200)
North y-coordinate	919,919.19 U.S. survey feet (ft)
East x-coordinate	1,688,757.54 U.S. survey ft
Universal Transverse Mercator/U.S. National Grid Coordinates	
Zone	17
Northing	4,014,636.73 meter (m)
Easting	584,805.45 m
National Geodetic Survey Coordinates	
Latitude	N 36° 16′ 22.62″ (36.27295 N)
Longitude	W 80° 3’ 20.88″ (80.0558 W)

2.2 WATER RESOURCES

This section describes the hydrological processes governing the movement and distribution of water in the existing environment at and around the Project site. Sections 2.2.1, 2.2.2, and 2.2.3 describe surface water and groundwater hydrology, water uses, and water quality, respectively. Section 2.2.4 describes water monitoring that characterizes the Project site hydrology.

Sections 4.2 and 5.2 describe the potential impacts to surface water and groundwater resources during plant construction and operation. Water level measurements presented in this section are converted to the NAVD 88, unless otherwise specified.

2.2.1 HYDROLOGY

This section describes the hydrologic characteristics of surface water and groundwater resources that could be affected by building activities or operation of the Project. Site-specific and regional data for the physical and hydrologic characteristics of surface water and groundwater are summarized below.

2.2.1.1 Surface Water

2.2.1.1.1 Regional Surface Water Resources

Figure 2.2-1 presents surface water resources in the 50-mi. (mi.) (80-km [km]) Project Region surrounding the Project site. The Project Region encompasses the Piedmont Ecoregion of NC and Virginia, which is characterized by gently rolling hills with many stream-cut valleys and only a few level floodplains (see Section 2.3.1.1.1). Major surface water features in the Project Region include streams, rivers, and reservoirs that were constructed for flood control, water supply, and power generation. There are no natural lakes in the Piedmont region. Major watersheds in the Project Region are associated with river systems that include the Upper Dan, Lower Dan, Haw, Deep, Lower Yadkin, and Upper Yadkin. Watersheds that are less well represented within the region include those of the South Yadkin, Upper New, Upper Roanoke, Banister, Upper Neuse, and Upper Pee Dee Rivers. Major surface waters in the Project Region include the Dan River, Haw River, Yadkin River, High Rock Lake, and Belews Lake (Figure 2.2-1). Table 2.2-1 summarizes drainage areas and the related flow characteristics of notable streams in the Project Region.

Figure 2.2-2 presents the surface water resources in the 6-mi. (10-km) Project Vicinity. Watersheds in the Project Vicinity include the Upper Dan (Hydrologic Unit Code [HUC] 03010103) and Haw (HUC 03030002); however, the Project has the potential to affect only those surface waters within the Upper Dan River watershed (Figure 2.2-2).

Surface waters in the Project Vicinity include Belews Lake, Belews Creek, East Belews Creek, West Belews Creek, Dan River, Lick Creek, Town Fork Creek, Watershed Lake Two (on Town Fork Creek), Boy Scout Pond, Eurins Creek, and Hogans Creek (Figure 2.2-2).

The Project site drains to Belews Lake via the main Belews Creek arm and the West Belews Creek arm. Water flows from Belews Lake north to the Dan River via a spillway located at the dam (Figure 2.2-3) and short segment of Belews Creek channel. The Project may affect Belews Lake, the Dan River, Belews Creek downstream of the Belews Lake spillway, and smaller tributary streams on the Project site. These surface water resources are discussed in more detail below.

2.2.1.1.2 Dan River

The Dan River is located generally north of the Project site and flows southeasterly from uplands within the Piedmont Ecoregion (see Section 2.3.1.1.1 for a description of the Piedmont Ecoregion), then progresses in a northeasterly direction (Figure 2.2-2). The Dan River receives water from the Belews Lake spillway (Figure 2.2-3). As described in Section 2.2.1.1.2.3, the Dan River also provides source water for the Belews Lake storage augmentation system via a pumping station (i.e., the makeup water intake structure [MWIS]) located near the confluence with Belews Creek (Figure 2.2-3).

2.2.1.1.2.1 Normal Hydrologic Conditions

The Dan River is a free-flowing, unchanneled river system with no associated levees or major flow modifications (Figure 2.2-2). No upstream hydroelectric projects are on the Dan River, and therefore there are no dam-related fluctuations in flow. Potential flow diversions are associated with the MWIS located on the Dan River at the confluence with Belews Creek that provides makeup water to Belews Lake (see Section 2.2.1.1.2.3). No other known flow modifications are located near the Project site.

A USGS streamflow gaging station on the Dan River at Pine Hall (USGS Station No. 02069000) is located approximately 1.2 mi. (1.9 km) upstream of the confluence with Belews Creek (Figure 2.2-3). The Dan River drainage area at the Pine Hall station is 501 square mi. (mi.^{2}) (1297.6 square kilometers [km^2]). Information on representative drainage areas of the Dan River and Belews Lake watersheds are summarized in Table 2.2-2.

Streamflow measurements at the Pine Hall station are periodic; however, official USGS records are available from October 1923 to April 1926, from April 1986 through December 1990, , and from December 2008 through current time. Approved USGS streamflow values from 1986 through early 2024 represents 21 years of approved average annual flow values, 22.1 years of average monthly flows, and 23.4 years of mean daily flow available to characterize the Dan River at Pine Hall. Data from the 1920s were not included due to potential impacts of watershed development and representative data that better capture current watershed conditions.

Table 2.2-3 presents the mean and median daily flow characteristics of the Dan River at Pine Hall stream station for available data. The mean daily flow in this section of the Dan River from 1987 to 2024 is 677 cubic feet per second (cfs) (19.2 cubic meters per second [m^3/s]) and the median flow is 474 cfs (13.4 m^3/s). Table 2.2-4 summarizes mean monthly discharges from available data spanning 1986 through 2024. The highest average flows normally occur in February (959 cfs [27.1 m^3/s]), and the lowest average flows occur in August (421 cfs [11.9 m^3/s]), which corresponds to a typical late summer to fall low-flow period.

Figure 2.2-4 presents annual peak flow exceedance probabilities for the Dan River at Pine Hall. A peak flow of 14,780 cfs has an annual probability of exceedance of 50 percent (i.e., 2-year return period); the 1 percent annual probability (100-year return period) peak discharge is 29,864 cfs; and the 0.2 percent annual probability (500-year return period) peak discharge is 32,245 cfs). Flood stage (i.e., threshold for minor flooding) of the Dan River at the Pine Hall station is 586.3 feet (ft.) (178.7 meters [m]) or 23.0 ft. (7.0 m) gage height (NOAA, n.d.). The peak instantaneous flow was 27,800 cfs (787.2 m^3/s) recorded on January 25, 2010, and corresponded to a maximum river stage of 25.8 ft. (7.9 m).

2.2.1.1.2.2 Drought Conditions

Table 2.2-5 presents annual average low-flow data for durations from one to 60 days for the Dan River at Pine Hall from 1986 through 2024. In July of 1986, USGS estimated and approved a low-flow value of 65 cfs (1.8 m^3/s). The lowest 60-day average flow was 141 cfs (4.0 m^3/s) in 1986. The Dan River has an estimated summer 7-day duration, 10-year return period average low flow (7Q10) of 80 cfs (2.3 m^3/s), and a winter 7Q10 of 160 cfs (4.5 m^3/s) (NCDEQ, 2025a).

2.2.1.1.2.3 Supplemental Pumping to Belews Lake

The Dan River has occasionally provided the source water for a Belews Lake storage augmentation via two separate pumping systems. Prior to 2010, diversions from the Dan River to Belews Lake occurred via a temporary pumping system authorized by the North Carolina Division of Water Quality (predecessor to the North Carolina Department of Environmental Quality [NCDEQ] Division of Water Resources [NCDWR]). This temporary system consisted of 12 8.0-cfs (0.23 m^3/s) pumps (i.e., 96 cfs [2.63 m^3/s] total pumping capacity) supplying six force mains to Belews Lake. Water was pumped from the Dan River into Belews Lake via the temporary system over three periods: December 23, 2002 to February 28, 2003; January 22 to March 31, 2008; and January 12 to March 23, 2009. In 2010, a permanent pumping system (the MWIS) subject to conditions outlined in the BCSS NPDES permit was constructed near the Belews Creek confluence with the Dan River (Figure 2.2-3). Section 2.2.2.1.3 further describes the MWIS.

Duke Energy's BCSS operations plan for Belews Lake determined the need for supplemental pumping from the Dan River. This spillway operational plan established target water level control points of 724.50 ft. (220.8 m) during summer, 724.45 ft. (220.80 m) during fall, and 724.70 ft. (220.88 m) during winter and spring (Table 2.2-7).The MWIS operation plan includes initiating pumping when the lake level falls below 722.5 ft. The current NPDES permit prohibits pumping when the lake level is above 724.5 ft.

2.2.1.1.2.4 Physical Characteristics

Stream channel and flow characteristics of the Dan River and Belews Creek were collected on October 25, 2024. Representative cross sections were characterized at established water quality sampling sites as described in Section 2.2.3. Figures 2.2-5 to 2.2-8 present cross sections at each of the three sampling locations on the Dan River and one location on Belews Creek.

Measurements of the local channel width and mid-channel depths were obtained from the water quality sampling sites, which are further described in Section 2.2.4.1, on October 25, 2024. The local measurements indicated the channel width of the Dan River is less than approximately 100 ft. (30.5 m) with mid-channel depths that range from less than 1 ft. (0.3 m) to approximately 3 ft. (0.9 m) (Figures 2.2-5 to 2.2-7). Near the confluence with the Dan River, Belews Creek has a width of approximately 55 ft. (16.8 m) and depth of approximately 2 ft. (0.6 m) (Figure 2.2-8). Velocity values along cross sections in the Dan River ranged from 0.0 feet per second (ft/s) (0.0 meters per second [m/s]) within slack-water habitats (i.e., slow-moving water) to 2.7 ft/s (0.8 m/s) in faster flowing chute habitats. Flows at the Belews Creek sampling location were less than 0.03 ft/s (0.01 m/s)—essentially slack-water.

Additionally, Dan River channel information available from the USGS Dan River at Pine Hall streamflow station provides a robust characterization of the channel dimensions as well as the

hydraulic characteristics over a range of flow conditions. To supplement the field measurements, a review of the existing field conditions at the USGS station are provided for comparison. The following Dan River channel characteristics were determined based on the available Pine Hall streamflow station field measurement data:

- The gage height varies from 0.41 ft. (0.12 m) at a measured low-flow rate of 83.9 cfs (2.38 m^3/s) to 3.04 ft. (0.93 m) at a measured median flow of 584 cfs (16.54 m^3/s);
- The channel width varies from 97 ft. (29.57 m) at a measured low-flow rate of 83.9 cfs (2.38 m^3/s) to 137 ft. (41.76 m) at a measured median flow of 584 cfs (16.54 m^3/s);
- Bank heights are typically in the range of 13 to 19 ft. (3.96 to 5.79 m);
- The average channel velocity varies from 0.49 ft/s (0.15 m/s) to a median velocity of 1.83 ft/s (0.56 m/s).

Other physical characteristics estimated for the Dan River near the Project site include stream gradient, sediment type, and sediment transport. Near the Project site, the Dan River has a gradient of approximately 3.1 ft/mi (0.6 m/km) and stream slope of 0.06 percent. Stream sediments observed in the Dan River were primarily sand and gravel with mud shorelines. Some areas of bedrock and woody debris were also present. Sediment transport was not directly measured; however, Simmons (1993) summarized regional sediment transport in NC streams including in the Dan River. Simmons (1993) estimated the annual suspended sediment loads in the Dan River near Franscisco, NC (upstream of the Project site), and near Wentworth, NC (downstream of the Project site), as 35,000 tons (270 tons/mi^2) and 460,000 tons (440 tons/mi^2), respectively. Median suspended sediment concentrations were 33 milligrams per liter (mg/L) and 98 mg/L, respectively. Maximum suspended sediment concentration measured 1520 mg/L in the study.

2.2.1.1.3 Belews Lake

2.2.1.1.3.1 Hydrology

2.2.1.1.3.1.1 Hydrologic Overview

Belews Lake is a man-made reservoir formed in 1970 following construction of an earthen embankment dam across Belews Creek. The lake was constructed to serve as a condenser cooling water (CCW) source for the BCSS. Three named streams flow into Belews Lake: Belews Creek, West Belews Creek, and East Belews Creek (Figure 2.2-3).

Belews Lake is oriented in a generally north-northeasterly direction with two primary arms of the reservoir formed by Belews Creek and West Belews Creek (Figure 2.2-3). Figure 2.2-3 shows inflows and flow directions throughout Belews Lake. The BCSS CCW flow influences lake circulation patterns. East Belews Creek flows into the southern end of Belews Lake near the main Belews Creek channel. The West Belews Creek arm is separated into two hydraulically distinct waterbodies by an earthen plug that Duke Energy installed when the BCSS CCW system was constructed. The BCSS CCW canal was then excavated through the ridge that separated West Belews Creek from Belews Creek (Figure 2.2-3). This modification altered the natural flow of West Belews Creek, allowing water from the CCW discharge to flow through the CCW canal and into the lake, upstream of its natural confluence with the main Belews Creek arm.

The normal full pond elevation of Belews Lake is 725 ft. (221.0 m). The average depth of the lake is approximately 49 ft. (14.9 m), and the maximum depth is approximately 144 ft. (43.9 m) (HDR, 2023). The lake occupies approximately 3862 ac. (1562.9 hectares [ha]) and has approximately 88 mi. (141.6 km) of shoreline (Duke Energy, 2020). Belews Lake drains to the Dan River downstream of the dam spillway (Figure 2.2-3).

The upland drainage area into Belews Lake consists of several drainage basins, including East Belews Creek (8.0 $mi.^2$ [20.7 km^2]), West Belews Creek (9.0 $mi.^2$ [23.3 km^2]), Belews Creek (20.8 $mi.^2$ [53.9 km^2]), and drainage areas from smaller tributaries (Table 2.2-2). The dam impounds a total drainage area of approximately 69.4 $mi.^2$ (179.7 km^2). The CCW canal drains an area of approximately 13.2 $mi.^2$ (34.2 km^2), while the lower West Belews Creek drainage area, downstream of the earthen plug, is approximately 2.4 $mi.^2$ (6.2 km^2) (Table 2.2-2).

As Section 2.2.3.1.4 describes, the BCSS uses water from Belews Lake for CCW. The once-through CCW system has a total maximum flow rate of approximately 2340 cfs (66.2 m^3/s) and returns virtually all CCW intake to the lake. However, the elevated discharge temperature generates increased evaporation, known as forced evaporation, that exceeds natural lake evaporation.

2.2.1.1.3.1.2 Watershed Runoff and Belews Lake Water Balance

A comprehensive hydrologic model evaluates relevant inputs and outputs (i.e., direct precipitation, stream inflow, consumptive losses from water use, natural evaporation, forced evaporation, seepage losses, and supplemental pumping from the Dan River) using average monthly data to evaluate long-term hydrologic characteristics of Belews Lake and the Dan River and to inform potential effects of the proposed action on future hydrological conditions (see Section 5.2.1).

Hydrologic characteristics of Belews Lake were estimated for a 27-year historical period from 1997 to 2024 based on historical operations of BCSS (i.e., BCSS historical condition) to capture a range of meteorological (e.g., extended droughts) and operational conditions. This modeling period encompasses available BCSS operations data and Flue gas desulfurization (FGD) operation and includes a variation in BCSS operations and change in consumptive water use as a result of the FGD systems and a reduction in average power generation and plant capacity factor during the years since 2015. The reduction in power generation reduced the heat load to the lake, and thus the forced evaporation, as well as the FGD system demand. Water inflows and outflows were modeled using available lake elevation data, plant operations data, local precipitation data, and other Belews Lake water budget components. Average monthly watershed runoff data were estimated by the model using regional USGS flow records to inform selection of parameters for water balance components.

Belews Lake receives inflows from the watershed, direct precipitation on the lake surface, and via pumping from the Dan River. Most of the inflows to Belews Lake are from the watershed. As described above, major tributaries to Belews Lake include Belews Creek, East Belews Creek, West Belews Creek, and an unnamed tributary to the northeast of Belews Lake (Figure 2.2-3).

Total inflows to Belews Lake based on the modeling are estimated to be approximately 89.5 cfs (2.53 m^3/s). This flow rate is equivalent to an average annual watershed runoff of approximately 14.6 inches (in.) (36.8 centimeters [cm]). Based on the water budget analysis, Belews Lake received an estimated 76.5 percent of inflows from the contributing watershed. Direct precipitation accounted for an estimated 21.8 percent of inflows, while the remaining 1.7 percent

were from pumping (i.e., supplemental diversions) from the Dan River (Table 2.2-6).

Estimated outflows from Belews Lake over the modeling period include consumptive losses from forced evaporation (18.8 percent) and from the operation of BCSS (11.4 percent). Natural evaporation from the entire surface area of the lake accounts for approximately 18.9 percent of the total losses. Other outflows include releases from the spillway (32.3 percent) and estimated seepage through the dam, spillway gates, or into groundwater (18.6 percent) (Table 2.2-6). The average net seepage loss to groundwater is estimated at 20 inches per year (in/year) (6437 ac-ft/year) averaged over the lake surface area.

Figure 2.2-9 provides a characterization of the varying Belews Lake water levels over the historical modeling period. The end-of-month water levels plotted are measured water levels. This figure also depicts the primary inflow component (i.e., watershed runoff) and outflow component (i.e., spillway releases). Based upon this analysis, water levels demonstrated a regular annual variability of approximately 1.5 ft. (0.46 m) from the lake control elevation (724.5 ft. [220.8 m]) to approximately 723 ft. (220.4 m). The normal water level fluctuation range decreased during the time period from approximately 2015 to 2024 due mostly to the reduced BCSS generation as indicated by the annual capacity factor also indicated on Figure 2.2-9. Several periods of increased water level drawdown are also notable, including the drawdown in 2001 to 2003 during a drought which reduced lake elevation to approximately 717.2 ft. (218.6 m) on October 11, 2002. Pumping water from the Dan River using the temporary pumping system and increased precipitation in late 2002 alleviated the drought and lake-level recession. Other moderate droughts occurred from late 2007 through 2009, during which water levels declined to approximately 720.65 ft. (219.65 m), about 3.85 ft. (1.17 m) below the lake control elevation. Pumping from the Dan River via the temporary pumping system in late 2007 through early 2008 alleviated the drought and lake-level recession.

As described above and in Table 2.2-7, the Belews Lake water balance is also influenced by losses associated with forced evaporation and consumptive use (predominantly associated with FGD operations). As illustrated in Figure 2.2-9, decreases in forced evaporation reflect a reduced level of BCSS power generation and its associated thermal discharges to Belews Lake in the years since 2015. Similarly, the pattern of losses associated with consumptive use reflects a higher amount of variability and a general downward trend over the same period. Together, these trends reflect a reduced capacity factor for the BCSS and contribute to a less variable water surface elevation of Belews Lake in recent years.

2.2.1.1.3.1.3 Belews Lake Residence Time

The hydraulic retention, or residence, time of Belews Lake has been estimated to be 1500 days (4.13 years) (HDR, 2023). The estimate was based on a total full-lake storage of 184,843 ac-ft (2.280×10^8 m^3).

2.2.1.1.3.1.4 The Current Water Level Control (Includes BCSS Belews Lake Operational Considerations)

The Belews Lake spillway and water level control structure is located at the northernmost end of Belews Lake and is operated to achieve target seasonal water levels. The structure includes six flow control gates, including two moveable floodgates, known as Taintor gates (Gate 1 and Gate 2). Each Taintor gate is 20-ft. (6.10-m) wide with a sill elevation of 710.0 ft. (216.41 m). The Taintor gates discharge water during unusually high lake levels. The pier separating the Taintor gates contains four other gates: two 5-ft. by 5-ft. (1.5-m by 1.5-m) sluice gates (Gate 3 and Gate

4), an overflow gate (Gate 5), and a stop-log gate (Gate 6). Gate 5 provides normal lake-level control and releases water from the lake. Specifically, water releases from the surface of the mixing chamber within the center pier of the spillway. Gates 3, 4, and 6 (namely 3 and 4) are opened at subsurface elevations as needed to fill the mixing chamber. Contents of the mixing chamber are then released via overtopping Gate 5 (which opens downward).

The spillway operational plan established target water level control points of 724.50 ft. (220.8 m) during summer, 724.45 ft. (220.80 m) during fall, and 724.70 ft. (220.88 m) during winter and spring (Table 2.2-7). Target lake levels identified in Table 2.2-7 were developed by Duke Energy based on a high BCSS capacity factor and with FGD operation (i.e., high forced evaporation and consumptive use). As described in Section 2.2.1.1.3.1.2, water losses from Belews Lake associated with forced evaporation and consumptive use from BCSS have declined in recent years (notably since 2015) due to reduced capacity factor. Table 2.2-7 summarizes the monthly daily elevation durations of Belews Lake water levels relative to the established target levels.

Historically, Belews Lake water levels have periodically fallen below BCSS operational target elevations. The most extreme instance occurred during the May 2001 to May 2003 drought, when the Belews Lake water level dropped to approximately 717.2 ft. (218.60 m), near the critical elevation for BCSS CCW intake operation, in October 2002.

As described in Section 2.2.1.1.2, the Dan River provides source water for the Belews Lake storage augmentation system via the MWIS located near the confluence with Belews Creek. The MWIS was constructed in 2010. In 2011 and 2012, the pumps diverted approximately 2074 ac-ft (2,558,241 m^3) of water to Belews Lake from December 2011 through March 2012; and about 3388 ac-ft (4,179,036 m^3) from August through December 2012. Prior to 2010, diversions from the Dan River to Belews Lake occurred three times via a temporary pumping system (see Section 2.2.1.1.2.3).

2.2.1.1.3.2 Physical Characteristics

2.2.1.1.3.2.1 Belews Lake Depth, Elevation, and Storage Volume Relationships

Belews Lake elevation, surface area, and storage volume relationship data are summarized in Table 2.2-8 and shown on Figure 2.2-10. Both the table and the figure show the relationship between these three parameters based on the original lake design (i.e., “1970”). Bathymetry of Belews Lake was developed based on pre-impoundment topographic mapping (Figure 2.2-11). Similarly, pre-impoundment topographic mapping within the Belews Creek arm is provided in Figure 2.2-12. These data are based on the original lake design and do not reflect sedimentation or erosion that may have occurred since lake construction in 1970 (see Section 2.2.1.1.3.2.3).

Focused hydrographic surveys were conducted by Duke Energy in 2024 and 2025 to verify depths in the vicinity of proposed intake and discharge locations and are provided in Figures 2.2-13 and 2.2-14, respectively. In the area near the proposed water intake and discharges within the Belews Creek arm, depths range from 80 ft. (24.4 m) to 110 ft. (33.5 m) below the normal surface level of the lake, which corresponds to lakebed elevations of approximately 645 ft. (196.6 m) and 615 ft. (187.5 m). These surveys compared to pre-impoundment mapping indicate some sedimentation has occurred along the Belews Creek valley throughout the lake (see Section 2.2.1.1.3.2.3).

2.2.1.1.3.2.2 Belews Lake Circulation

In general, circulation within Belews Lake is driven by inflow from the watershed that is conveyed through each arm of Belews Lake to the spillway where it is released to the Dan River (Figure 2.2-3). As part of the BCSS construction, a segment of the natural West Belews Creek valley was filled, obstructing flow, and the BCSS CCW discharge canal was excavated (Figure 2.2-3). This results in both natural West Belews Creek flow and BCSS CCW discharge flow to be conveyed to the main Belews Creek arm of the lake through the discharge canal south-southeast (SSE) of the BCSS. During periods of low and normal watershed runoff to Belews Lake, the BCSS CCW system creates a counterclockwise flow circulation pattern with recirculated CCW flowing southwest through the lower West Belews Creek embayment to the BCSS intake (Figure 2.2-3). The BCSS CCW flow rate is normally significantly larger than the Belews Creek watershed inflow which influences whole lake circulation patterns. The CCW flow generally occurs as a surface current because it is warm water with lower density.

2.2.1.1.3.2.3 Belews Lake Sedimentation

2.2.1.1.3.2.3.1 Historical and Current Sedimentation

The Belews Lake elevation, area, and storage volume relationship data from original dam design documents based on pre-dam topography (i.e., “1970”) were used for the water balance model for the historical period (Figure 2.2-10). A detailed assessment of lake sedimentation has not been conducted; however, recent bathymetric data for Belews Lake are available to assess sedimentation at selected locations.

Focused bathymetric data from 2024 and 2025, including detailed survey of selected areas of the lake, indicate some sedimentation has occurred since construction in each area surveyed, including tributary inflow areas and in the downstream, deeper part of the lake (Figures 2.2-13 and 2.2-14). The focused survey data indicates approximately 10 to 15 ft. (3.1 to 4.6 m) of potential sedimentation at these locations when compared to the pre-dam topography.

Belews Lake bed profiles further indicate sedimentation since impoundment. Belews Creek and East Belews Creek bed profiles were developed using recent hydrographic surveys and USGS LiDAR data. These profiles were then compared to pre-lake topographic maps and indicate variable sedimentation throughout the lake. Some areas of the lake show minimal sedimentation where others indicate pronounced sedimentation (i.e., approximately 10 ft. [3.0 m] to 20 ft. [6.1 m]).

Belews Lake has approximately 88 mi. (141.6 km) of shoreline (Duke Energy, 2020). Shoreline erosion conditions are typical of larger lakes in NC and no severe erosion segments exist.

2.2.1.1.3.2.3.2 Future Sedimentation

No sedimentation survey or sediment yield data were developed for Belews Lake; however, to estimate future sedimentation within the lake, whole lake sedimentation from within the watershed was estimated using published rates for other NC reservoirs. Annual sedimentation rates are available for 28 reservoirs in NC (Petryniak and Loveless, 2013). Of the reservoirs investigated, W. Kerr Scott Reservoir had the highest sedimentation rate of 0.52 ac-ft per year per square mi. drainage area (ac-ft/yr/mi^2) (640.0 m^3/yr/km^2) (Petryniak and Loveless, 2013). The median rate for the investigated reservoirs is 0.23 ac-ft/yr/mi^2 (283.7 m^3/yr/km^2) (Petryniak and Loveless, 2013).

The W. Kerr Scott Reservoir sedimentation rate is used as a conservative, representative estimate for the total Belews Lake sedimentation rate and applied over the 53-year period since Belews Lake was constructed. This analysis considered an upland drainage area of 63.8 mi.^{2} (165.2 km^2), exclusive of the Belews Lake surface area. A total sedimentation volume of 1758 ac-ft (2,168,458 m^3) was estimated within Belews Lake using this approach. This is equivalent to a 0.95 percent loss of reservoir volume over the 53-year life, which is a relatively small rate of reservoir storage loss to sedimentation.

Should sediment trapping efficiency not change significantly over the next approximately 50-year period, a similar amount of deposition may be estimated for the future condition, resulting in a total of approximately 3500 ac-ft of storage loss by 2075.

2.2.1.1.3.2.4 Temperature Characteristics of Belews Lake

Water temperatures have been measured and modeled at numerous locations within Belews Lake. Surface water temperatures within Belews Lake are influenced by BCSS operation and the use of Lake water for the once-through cooling system. Figure 2.2-15 shows water temperature profiles at different locations throughout Belews Lake for a modeled period assuming full BCSS generation. The BCSS has demonstrated through 316(a) studies that increased temperatures in the lake have not impacted the ability of the lake to support a balanced and indigenous population. The BCSS maintains an active 316(a) thermal variance for operation (NCDEQ, 2025b). As described in Section 2.2.1.1.3.1.1, the CCW discharge of BCSS is located on the upper West Belews Creek arm and water from the discharge passes through the CCW canal into the central portion of the Belews Creek arm.

Figure 2.2-16 and Figure 2.2-17 illustrate the Belews Lake water surface temperatures from observations in July 2002 and January 2018, respectively. During summer operations, water temperatures are more elevated in the West Belews Creek arm. The CCW canal flow influences surface water temperature within the Belews Creek arm. Temperatures are progressively cooler both downstream and upstream of the CCW canal outlet. By comparison, surface water temperatures in the winter demonstrate a similar distributional trend in temperature, whereby temperatures are more elevated in the upper West Belews Creek arm and progressively cooler both downstream and upstream of the CCW canal outlet. Warmer CCW intrudes upstream (south) along the Belews Creek arm as a result of buoyant spreading of the thermal plume on the surface; however, temperatures in the winter are lower than summer values. The lower, deeper lake water, or hypolimnion, has relatively stable water temperatures with only small seasonal variation (Duke Energy, 2021).

Figure 2.2-18 and Figure 2.2-19 show Belews Lake water temperature profiles within the main lake from August 2002 and January 2018, respectively. August 2002 shows severe drought conditions, evident by the surface elevation of approximately 718 ft. [218.85 m]) and represents a worst-case scenario for lake temperatures. The depth profiles illustrate the vertical temperatures extending from near the dam (Station 416) up the Belews Creek arm to Station 405 and up the West Belews Creek arm to Station 418 near the CCW intake. Belews Lake is thermally stratified most of the time as observed from vertical temperature profiles at various locations (Duke Energy, 2021).

Belews Lake thermal stratification characteristics vary seasonally and with location. Stratification patterns are consistent with other relatively deep reservoirs in the southeastern United States (U.S.), with seasonal stratification setting up in warmer months and mixing occurring during cooler months. The temperature profiles identified in Figure 2.2-18 and Figure 2.2-19 indicate

that the Belews Lake surface layer (i.e., epilimnion) is typically 30 to 60 ft. (10 to 20 m) deep at locations and times of the year when it is well-defined. The thermocline, when clearly defined, is typically 15-ft. (5-m) thick. Meaning, the deeper layer (i.e., hypolimnion) generally extends from approximately 50 to 75 ft. (15 to 25 m) down to the lake bottom (Duke Energy, 2021).

The Belews Lake epilimnion thickness and heat storage is a balance between natural heat sources, including solar radiation, the BCSS CCW heat load, and heat losses, including natural and forced evaporative cooling. The epilimnion thickness is generally variable over the course of the year based on seasonal conditions.

2.2.1.1.3.2.5 Belews Lake Currents

In general, currents within Belews Lake are low, and gradients from inflowing streams, outflows via the spillway, and CCW-induced circulation create them. The long residence time in Belews Lake, as described in Section 2.2.1.1.3.1.3, and the long periods of no spillway discharge indicate extremely low velocities. Water movement generally progresses from the upper arms of Belews Lake toward the dam. However, as described in Section 2.2.1.1.3.1, CCW use modifies water circulation within Belews Lake. In the CCW system, water is drawn from the lower (north) West Belews Creek arm into BCSS for cooling and then discharged to the upper (south) West Belews Creek arm. Then, the water flows via the CCW canal to the Belews Creek arm of the lake. Currents are substantially greater as water is conveyed through the CCW canal to the Belews Creek arm, where currents are reduced.

Density and buoyancy differences may also influence localized currents within Belews Lake. For example, water flowing from a stream into a lake tends to float or sink, depending on the density and buoyancy difference. Density differences may be the result of temperature, dissolved solids, or suspended sediments. Ford and Johnson (1983) provide a summary of density currents associated with stream inflows to reservoirs. Depending on the relative densities and hydrodynamic (flow of water) factors, inflowing streamflow may plunge to the reservoir bottom, float over the reservoir surface, or find a neutral buoyancy level in the reservoir known as *interflow* or *intrusion*. Temperature difference is the primary cause for density differences in most stream and reservoir systems. Inflowing water from tributaries, with seasonally lower temperatures and potentially higher suspended sediment concentrations, is denser and will likely sink and flow along the lake bottom. This flow pattern is referred to as a “density current” and may be expected to occur in conjunction with runoff into Belews Lake.

2.2.1.1.4 Project Site Streams

2.2.1.1.4.1 Identified Project Site Streams

Other surface waters located within the Project site are subject to jurisdiction under Section 401 and Section 404 of the Clean Water Act (CWA) (33 U.S. Code [USC] 1251). The U.S. Army Corps of Engineers (USACE) regulates the discharge of dredged or fill material into Waters of the U.S. (WOTUS) under the CWA Section 404 permit program (33 USC 1344). Under Section 401 of the CWA, a Section 401 Water Quality Certification is required for any project requiring a federal construction permit or license for activities that may result in any discharge into navigable waters. In NC, NCDWR is responsible for issuing Section 401 water quality certifications through the USACE and NCDEQ Joint Pre-Construction Notification application.

Screening of the Project site for the potential occurrence of WOTUS initially involved a review of the USGS topographic map, U.S. Fish and Wildlife Service (USFWS) National Wetlands

Inventory (NWI) data, Natural Resources Conservation Service soil survey data, Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps, and current and historical aerial photography. The lake features include portions of Belews Lake contained within the Project site and the canal that extends through the middle portion of the Project site.

Field delineation surveys to identify WOTUS were performed April 16 to 19, April 24 to 26, and May 10, 2024, within the Project site. A defined delineation survey area, subject to potential impacts from the Project, includes 1041 ac. (421 ha) adjacent to the BCSS and an existing approximately 3.7-mi. (5.95-km) associated off-site wastewater pipeline corridor (Figure 2.2-20). Following the field survey, Duke Energy submitted a WOTUS report and request for a Jurisdictional Delineation Concurrence to the USACE. The USACE performed a site visit on December 10, 2024, to field verify the WOTUS delineation. On January 16, 2025, the USACE issued a Jurisdictional Delineation Concurrence letter confirming the delineation (as depicted on Figure 2.2-20) is a sufficiently accurate representation of the geographic boundaries of the aquatic resources located on the site within the delineation survey area. No surveys for WOTUS were conducted outside of the defined delineation survey area, as impacts are not anticipated beyond this boundary. Duke Energy will coordinate with the USACE to expand the Jurisdictional Delineation Concurrence request to include any areas outside of the defined delineation survey area, if necessary.

As Table 2.2-9 indicates, 23 jurisdictional streams were delineated within the delineation survey area. Of these 23 streams, six are intermittent, seven are perennial, and ten begin as intermittent and transition to perennial along their reaches. 22 of these streams drain into Belews Lake. The final jurisdictional stream is the Dan River. Stream resources on-site and within the associated off-site areas total 21,671 linear ft. (6,605 linear m). All delineated features are connected with Belews Lake, the Dan River, or downstream surface waters. The USACE verified all of the 23 delineated streams.

2.2.1.1.4.2 Physical Characteristics of Project Site Drainages

Numerous drainage areas are within the Project site. Drainage areas, profile lengths, and slopes vary. Drainage lengths range from 80 ft. (24.4 m) to more than 3440 ft. (1048.5 m) in length (Table 2.2-9). Slopes of drainages are typically steep, ranging from 2.3 to 4.8 percent for selected Project site drainages that Table 2.2-10 and Figure 2.2-21 show. Stream characteristics are somewhat variable but are generally narrow and have evidence of an ordinary high-water mark (OHWM), clear natural shelving, sediment sorting, changes in the character of the soil, a natural bank line, and moderately continuous bed and bank. Figure 2.2-21 illustrates representative valley cross sections for select stream segments.

2.2.1.1.5 Floodplains

Floodplains are relatively level land areas along streams or rivers that are subject to periodic flooding. FEMA maintains and updates floodplain data through regulatory flood maps. FEMA defines any land area subject to inundation by at least a 1 percent annual-chance flood event as a “special flood hazard area.” These recurring events are also known as base floods or 100-year floods. FEMA flood maps include different flood zones defined by type, depth, and frequency of flooding. For example, flood zones A/AE are areas subject to inundation by the 1 percent annual-chance flood event. Other flood zones labeled as B or X are areas between the limits of the base flood and the 0.2 percent-annual-chance (or 500-year) flood event. FEMA also defines a “Regulatory Floodway” as the channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without cumulatively

increasing the water surface elevation more than a designated height.

Floodplains and floodways in the Project Vicinity are presented in Figure 2.2-22. In total, there are 11,038 ac. (4467 ha) of regulatory floodplains and 284 ac. (115 ha) of floodway in the Project Vicinity. Only FEMA flood zones A/AE are in the Project Vicinity—no other flood zone types are present. Floodways are present at the headwaters of Belews Creek and two other drainages along the outskirts of the Project Vicinity (Figure 2.2-22).

According to FEMA data, floodplains at the Project site are mostly concentrated along the shorelines and tributaries to Belews Lake and along the Dan River (Figure 2.2-22). However, because of the presence of the Belews Lake Dam, the floodplains of Belews Lake and the Dan River are separate and disjunct such that flooding on the Dan River does not have an effect on Belews Lake. The Dan River contains significant floodplains, specifically floodplain forest. Floodplain forests are found beside most rivers and streams in the Piedmont (NCWRC, 2025). Piedmont floodplain forests are typically smaller, with varying widths depending on the topography of land adjacent to the river, and the transition between floodplain and upland forest is often gradual. Human-influences have altered much of the Piedmont riverine and floodplain habitats. For example, many historical riparian areas were lost to create reservoirs like Belews Lake. The Dan River, conversely, remains as one of the larger tracts of intact forested floodplain left at the Project site and in the wider Piedmont Ecoregion.

2.2.1.1.6 Wetlands

Wetlands in the Project Vicinity and at the Project site are presented in Section 2.3.1.2.

2.2.1.2 Groundwater

Building activities and operation of the Project could affect the regional and local groundwater resources described in this section.

2.2.1.2.1 Hydrologic Setting

As described in Section 2.10, the Project site is situated in the Piedmont, which extends approximately 1000 mi. (1600 km) from Alabama to southern New York and mainly consists of northeast-southwest trending metamorphic and igneous rocks. Gently rolling, well-rounded hills and long, low ridges characterize the Piedmont. The elevation within the eastern Piedmont ranges from 300 to 600 ft. (91 to 183 m) above sea level. To the west, elevations gradually rise to about 1500 ft. (457 m) above sea level.

2.2.1.2.2 Regional Groundwater Hydrology

As described in Section 2.10, the Project Region encompasses two physiographic provinces, the Piedmont and the Blue Ridge.

The principal aquifers identified within the Project Region are crystalline-rock aquifers and aquifers in Early Mesozoic basins (Figure 2.2-23). The crystalline-rock aquifers primarily consist of igneous and metamorphic crystalline rock that trends northeast-southwest within the Piedmont and Blue Ridge. The aquifers in Early Mesozoic basins consist of sedimentary rocks, mainly sandstone and siltstone, and are located west of the Project site (USGS, 1997). Groundwater in the aquifers of the Piedmont and Blue Ridge generally are unconfined and lack a competent confining unit (USGS, 1990).

The Blue Ridge-Piedmont groundwater system consists of four components. These components are the unsaturated zone in the regolith, the saturated zone in the regolith, the lower saturated regolith (which contains the transition zone between the saprolite and bedrock) and the fractured crystalline bedrock system. The regolith is the surficial or uppermost layer and is composed of saprolite, alluvium, and soil. The thickness of the regolith greatly varies throughout the Piedmont and Blue Ridge. The regolith consists of an unconsolidated or semi-consolidated mixture of clay and fragmental material ranging in grain size from silt to boulders (USGS, 2002).

Porosity and groundwater storage are the major differences in the water-bearing characteristics of the regolith and bedrock. The regolith can store water in pore spaces between particles, while the crystalline bedrock does not have any significant intergranular porosity; thus, water is stored in narrow planar openings formed along fractures, known as secondary porosity. Regolith porosities typically range from 35 to 55 percent. The regolith provides the bulk of the water storage within the Piedmont and Blue Ridge groundwater system. Porosity within the regolith decreases with depth in the transition zone as the degree of weathering decreases. Primary porosity within the fractured bedrock ranges from 1 to 10 percent but is more typically between 1 and 3 percent. The abundance of fractures and size of fracture openings in the crystalline bedrock decreases with depth. At depths below 750 ft. (229 m), the pressure of the overlying rock holds fractures closed and the total porosity can be less than 1 percent. Due to its higher porosity, the regolith functions as a reservoir that slowly transports water downward into fractures in the bedrock. These fractures form an intricate interconnected network of conveyances that transmit water to springs, wetlands, streams, and wells (USGS, 2002).

The Project Region receives groundwater recharge through infiltration of precipitation. Recharge and discharge are through porous granular material (clayey soil-saprolite or floodplain deposits), but much of the intermediate flow between recharge and discharge areas is through bedrock openings. Areas of recharge occur at upland areas and slopes, while discharge is concentrated in lowland areas bordering surface water bodies, marshes, and floodplains (LeGrand, 2004).

2.2.1.2.3 Groundwater Hydrology of the Vicinity

As described in Section 2.2.1.1, Belews Lake, Belews Creek, East Belews Creek, West Belews Creek, Dan River, Lick Creek, Town Fork Creek, Watershed Lake Two (on Town Fork Creek), Boy Scout Pond, Eurins Creek, and Hogans Creek are the major surface water bodies in the 6-mi. (10-km) Project Vicinity that may exert an effect on groundwater flow. Local groundwater is also influenced by many perennial and ephemeral streams within the Project Vicinity.

The principal aquifers identified within the Project Vicinity are the same aquifers identified within the Project Region: crystalline-rock aquifers and aquifers in Early Mesozoic basins (Figure 2.2-23). Groundwater systems within most of the Project Vicinity are characterized by the crystalline-rock aquifers.

2.2.1.2.3.1 Groundwater Hydrology Immediately Adjacent to the Project Site

The Craig Road Landfill, which Duke Energy owns and operates, borders the Project site to the southwest and is associated with BCSS, as Figure 2.2-24 shows (Synterra, 2024a). Subsurface data generated for this landfill provides an understanding of the hydrogeology immediately adjacent to the Project site.

During previous geologic investigations for the construction of Craig Road Landfill, soil testing and observation wells identified six hydrostratigraphic units within the subsurface: fill, residuum,

saprolite, weathered rock, partially weathered rock (PWR), and competent rock. Hydraulic conductivities and corresponding horizontal flow velocities were calculated using slug testing data (obtained by others), and Table 2.2-11 summarizes these conductivities and velocities (S&ME, 2011). Calculated velocities range from 54.3 ft/yr (16.6 m/yr) in competent rock to 495.9 ft/yr (151 m/yr) within the partially weathered/fractured rock.

As Figure 2.2-25 shows, groundwater beneath the Craig Road Landfill footprint flows northwest, north, and northeast toward Belews Lake (Synterra, 2024a).

2.2.1.2.4 Groundwater Hydrology at the Project Site

Groundwater at the Project site was characterized through subsurface investigations and aquifer testing techniques as described below.

2.2.1.2.4.1 Groundwater Hydrology of the Project Site

The hydrogeologic setting of the Project site includes crystalline bedrock composed primarily of gneiss with lesser amounts of schist overlain by PWR and overburden (OB). The OB includes silty to clayey sand, weathered in place from the underlying bedrock. Groundwater recharge occurs as direct infiltration of rainfall at land surface that percolates through the unconsolidated OB into fractured bedrock. The Project site bedrock generally has little primary porosity and permeability. Since groundwater is stored and transmitted along secondary fracture openings, the fracture density, orientation, openness, and interconnectivity dictate groundwater flow.

Field activities performed for the Site Safety Analysis Report (SSAR) identified fracture density at the Project site is high with an average of 65 fractures per every 100 vertical ft. (30.4 m) of bedrock. However, most (over 97 percent) of these fractures are tight, closed, or filled and likely produce little water. Many of the identified factures may also represent mineralogical or lithologic discontinuities and are not fractures. Less than 3 percent of the fractures identified were described as open or had a recorded open aperture width. Aperture widths range from 0.2 to 6.8 in. (5 to 172 millimeters [mm]) and average 1.3 in. (32 mm) with a median value of 0.9 in. (23 mm). Fractures with open apertures were only recorded in the upper 250 ft. (76.2 m) below ground surface (bgs).

Groundwater is present in the OB and PWR sediments under unconfined conditions and travel short distances, discharging to nearby tributary streams, springs, or surface water bodies such as Belews Lake.

2.2.1.2.4.2 Monitoring Well Network

To characterize the existing groundwater, multiple groundwater wells were installed at the north, middle, and south portions of the Project site. A total of 27 groundwater monitoring wells were installed at the three proposed Plant Complex locations: north, middle, and south. Fifteen of the monitoring wells (W-1 through W-15) were installed for this environmental report (five wells at each Plant Complex area). These monitoring wells were installed to be screened across or near the water table. Monitoring wells were installed with screen lengths ranging from 10 to 20 ft. (3 to 6 m) in length. Because the aquifer is unconfined and the water table occurs at various stratigraphic depths across the site, monitoring wells are screened in all units: OB, PWR, and bedrock. Eleven of the monitoring wells are installed in shallow bedrock, while wells W-6, W-7, W-11, and W-15 are installed in OB/PWR. Monitoring wells W-1 through W-15 have total depths ranging from 36 to 99 ft. (11.0 to 30.2 m) bgs. Well construction details are summarized in Table

2.2-12.

To complete the SSAR subsurface investigations, 12 additional deeper bedrock wells were also installed in the same three future Plant Complex locations. Aquifer pumping test wells were also installed at each North, Middle, and South Plant Complex sites. These monitoring and test wells are associated with the SSAR investigation and are described in SSAR Section 2.4.12.

The water table generally occurs within the PWR and upper 10 ft. (3 m) to 20 ft. (6 m) of the bedrock. In deeper wells, the potentiometric head rises substantially above the screen interval but generally remains within the fractured bedrock aquifer.

2.2.1.2.4.3 Groundwater Level Monitoring

Monthly groundwater level monitoring was performed for wells W-1 through W-15. Groundwater elevations were recorded monthly from July 2024 to June 2025. Groundwater elevations for wells W-1 through W-5 at the north site ranged from 746 to 780 ft. (226 to 238 m) above mean sea level (AMSL). Groundwater elevations for wells W-6 through W-10 at the center site ranged from 750 to 788ft. (229 to 240 m). Groundwater elevations for wells W-11 through W-15 at the south site ranged from 764 to 810 ft. (233 to 247 m). Groundwater level trends are steady and showed only slight fluctuations over the duration of the monitoring period, increasing slightly in the North Plant Complex and decreasing in the Middle and South Plant complexes. Groundwater elevations are tabulated and shown in Table 2.2-13.

2.2.1.2.4.4 Site-Specific Groundwater Recharge and Discharge

As discussed in Section 2.2.1.2.2 groundwater recharge takes place in areas of high elevation/upland and discharge takes place in areas of low elevation/lowlands. The Project site topography reflects higher elevation in the center with suspected areas of groundwater recharge. Recharge from infiltrating rainfall continually replenishes groundwater. The amount of water that recharges a groundwater system can be estimated by examining stream flow hydrographs and separating the contribution from groundwater, called baseflow. Over long periods of time, groundwater discharge in the form of stream baseflow equals groundwater recharge (Risser et al., 2005). Baseflow measurements and groundwater recharge estimates from various USGS streamflow-monitoring stations within the Dan River subbasin and in the Project Vicinity indicate an effective average groundwater recharge rate of 8.45 inches per year (in/yr) (21.4 centimeters per year [cm/yr]). Belews Lake is the main discharge point for groundwater at the Project site.

Site-specific groundwater recharge and discharge is further discussed in SSAR Chapter 2.4.12.

2.2.1.2.4.5 Groundwater Hydrology at the Flue Gas Desulfurization Landfill

Subsurface data generated for the FGD landfill provide an understanding of the hydrogeology proximate to the Project site. The FGD landfill, which Duke Energy owns and operates, is situated in the center of the Project site and is associated with the existing Duke BCSS, as Figure 2.2-24 shows (Synterra, 2024b). The FGD landfill is scheduled for closure by excavation by 2032. Figure 2.2-26 shows groundwater flow beneath the FGD landfill footprint flowing to the northwest toward Belews Lake (Synterra, 2024b).

2.2.1.2.4.6 Aquifer Characteristics

As part of the SSAR investigation, multiple aquifer tests were performed to characterize the aquifer at the Project site. Aquifer characteristic testing included slug testing, packer testing, and aquifer pumping tests. These test methods are described in detail in SSAR Section 2.4.12.

The following definitions are useful for a discussion of aquifer parameters measured from slug testing, packer testing, and aquifer pumping testing results:

- Hydraulic conductivity is the capacity of a unit cube of rock to transmit water.
- Transmissivity is the capacity of an aquifer to transmit water. It equals the hydraulic conductivity times the aquifer thickness.
- Storativity (storage coefficient) is the volume of water released from storage in a unit prism of an aquifer when the head is lowered a unit distance.

2.2.1.2.4.6.1 Project Site Groundwater Hydraulic Conductivity

Hydraulic conductivity can be estimated from the slug test method, which evaluates the aquifer response to an instantaneous change in water level in the test well. Slug testing was performed in each of the observation wells (W-1 through W-15) and is summarized in Table 2.2-14 below:

- North Plant Complex: The average hydraulic conductivity for the for wells W-1 through W-5 (within bedrock) is 3.31 feet per day (ft/day) (1.01 m/day).
- Middle Plant Complex: The average hydraulic conductivity for wells screened in OB/PWR (W-6 and W-7) is 9.07 ft/day (2.76 m/day). The average hydraulic conductivity for the bedrock wells W-8, W-9 and W-10) is 0.174 ft/day (5.30 x 10^{-2} m/day).
- South Plant Complex: The average K for the wells screened in OB/PWR (W-11 and W-15) is 3.67 ft/day (1.12 m/day). The average K for the bedrock wells (W-12, W-13 and W-14) is 0.270 ft/day (8.23 10 $^{-2}$ m/day).
- Hydraulic conductivity varies across the Project site but overall is moderately low in both OB/PWR and the crystalline bedrock. The moderately low hydraulic conductivity reflects the presence of silty sand OB/PWR and the low fracture permeability in the metamorphosed gneiss and shist bedrock.

2.2.1.2.4.6.2 Project Site Groundwater Hydraulic Gradient

Using groundwater elevation data, potentiometric surface maps were created for summer (July 2024), fall (October 2024), winter (January 2025), and spring (April 2025), as shown on Figures 2.2-27 through Figure 2.2-30, respectively. Groundwater flow direction among the potentiometric surfaces generally follows topography, with flow directions from areas of higher topographic elevations to lower elevations. At the South Plant Complex, groundwater flow is bilinear and radial toward the northwest, northeast, and southeast toward Belews Lake and the CCW discharge canal. At the Middle Plant Complex, groundwater flows toward the west and southwest because of the influence from the CCW discharge canal and, in part, to more limited water level data. At the North Plant Complex, flow is radial toward the northwest, north, and northeast because Belews Lake surrounds the area on these three sides. Overall, groundwater

elevations decrease from the south to the north as distance to the lake (discharge area) decreases, resulting in deeper groundwater at the northern portion of the Project site. Groundwater flow directions and patterns are generally consistent across the seasons.

The potentiometric surface maps were used to estimate horizontal hydraulic gradients at the Project site. For each map, horizontal hydraulic gradients were calculated by drawing a flow line on the potentiometric surface map and determining the head loss over the horizontal projection of the flow path length to determine the horizontal hydraulic gradient. Horizontal hydraulic gradients are presented on the respective potentiometric surface map for each event, Figure 2.2-27 through Figure 2.2-30.

The calculated horizontal hydraulic gradients for the ER wells range from 5.0 X 10^{-3} ft/ft (1.52 x 10^{-3} m/m) at the North Plant Complex to 9.2 x 10^{-2} ft/ft (2.80 x 10^{-2} m/m) at the South Plant Complex with an overall average value of 3.8 x 10^{-2} ft/ft. Horizontal hydraulic gradients from July 2024 to June 2025 are summarized in Table 2.2-15.

Vertical hydraulic gradients were calculated at the Project site from July 2024 to June 2025. Typically, the vertical hydraulic gradient is calculated by comparing differences in water level elevations and screened interval depths from nested monitoring wells. At the Project site, the shallow zone (OB/PWR) and deep zone (bedrock) monitoring wells are not co-located but are spread out among the three different areas of the Project site (North, Middle, and South). Vertical hydraulic gradients were, therefore, modeled using interpolated potentiometric surfaces from the shallow and deep zones and the mid-point of well screen elevation surfaces.

Aquifer systems typically have a downward vertical gradient in groundwater recharge areas that transition to upward vertical gradients in groundwater discharge areas. Vertical gradients measuring greater than zero have a downward flow potential; vertical gradients less than zero have an upward flow potential. Based on the monthly water level data from the Project site, the following vertical gradient trends were observed:

- All but two vertical hydraulic calculations demonstrated downward vertical hydraulic gradients (i.e., all vertical gradients had positive values).
- Modeled vertical hydraulic gradient values ranged from -4.1 x 10^{-2} ft/ft to 0.64 ft/ft (0.01 m/m to 0.2 m/m).
- The average modeled vertical hydraulic gradient value was 0.28 ft/ft (0.9 m/m).

Vertical hydraulic gradients are summarized per month in Table 2.2-16. Information regarding methods and models for vertical hydraulic gradient calculations are described in the SSAR Section 2.4.12.

2.2.1.2.4.6.3 Project Site Groundwater Velocity

Groundwater velocity (V) depends on the hydraulic conductivity (K), horizontal hydraulic gradient (ih), and effective porosity (n) of the water-bearing zone. The mathematical equation for calculating horizontal velocity is:

$$V = K*ih/n \qquad \text{(Equation 2.2-1)}$$

The groundwater velocity was determined by using the arithmetic average of the hydraulic

conductivities from the slug tests performed, the hydraulic gradients determined from site water levels data from monitoring wells, and the effective porosity, which was estimated using available published literature (Kresic, 2006). The published effective porosity values used for PWR and crystalline bedrock are 0.20 and 0.019, respectively. Horizontal travel times and velocities were calculated for the wells screened in OB/PWR and wells screened in the bedrock.

Results indicate an average groundwater velocity of 1.2 ft/day (0.37 m/day), and a maximum groundwater velocity of 2.9 ft/day (0.88 m/day) in the OB/PWR units, an average linear velocity of 3.3 ft/day (1.0 m/day) and a maximum linear velocity if 7.9 ft/day (2.4 m/day) in the shallow bedrock, and an average linear velocity of 0.35 ft/day (0.11 m/day) and a maximum velocity of 0.58 ft/day (0.18 m/day) in the deeper bedrock aquifer. Groundwater velocities are shown in Table 2.2-17.

2.2.1.2.4.6.4 Project Site Groundwater Transmissivity and Storativity

Aquifer pumping tests were performed in the OB/PWR, shallow and deep bedrock units to determine transmittivity and storage coefficient. Based on the results of the pumping tests, the OB/PWR unit has an average transmittivity of 132 square feet per day (ft^2/day) (12.3 square meters per day [m^2/day]) and an average storage coefficient of 1.99 x 10-2. The pumping test results concluded that the shallow and deep bedrock units have an average transmittivity of 8.89 ft^2/day (0.83 m^2/day) and 1.40 ft^2/day (0.13 m^2/day), respectively and an average storage coefficient of 1.06 x 10^{-2}, 1.5 x 10^{-3}, respectively. Aquifer pumping test results are shown in Table 2.2-18.

For the SSAR subsurface investigation, soil samples were collected for bulk density. Dry soil bulk densities ranged from 1.07 grams per cubic centimeter (g/cm^3) to 1.40 g/cm^3. Discussion of soil geotechnical testing is presented in SSAR Section 2.5.

2.2.2 WATER USE

This section describes water uses within the hydrological system of the Project site, Project Vicinity, and Project Region. The Project could impact water users that are located within the Upper Dan River subbasin and withdraw water upstream or downstream of Belews Lake, Belews Creek, and the Dan River. This section describes the types of consumptive and nonconsumptive water uses, identifies their locations, and quantifies water withdrawals, consumptions, and returns, as available. In addition, this section describes statutory and legal requirements on water use.

2.2.2.1 Surface Water

2.2.2.1.1 Surface Water Use Regulatory Setting

Surface water rights within NC are considered riparian rights, meaning they are tied to the ownership of land adjacent to a water resource. As a result, property owners next to water bodies can make reasonable use of the adjacent waters. Reasonable use of water generally includes recreational and navigational access and reasonable diversions of flow for industrial, domestic, and agricultural uses. Reasonable use does not include the right of local governments to withdraw water in amounts needed to supply a municipality for domestic purposes. However, public trust rights allow public use of state-owned waters for fishing and navigation (Poyner Spruill, 2009).

Public water systems are regulated by the NCDEQ under the authority of Title 15A, Subchapter 18C of the North Carolina Administrative Code. North Carolina General Statute Section 143-355(l) requires all units of local government that provide or plan to provide public water service to prepare a local water supply plan (LWSP). All community water systems that regularly serve 1000 or more service connections or serve more than 3000 people are also required to prepare a LWSP. An LWSP is an assessment of the current and future water needs of a water system and its ability to meet those needs to better manage water supplies and prepare for water supply system improvements (NCDEQ, 2024a).

In general, NC does not require permitting for surface water withdrawals; however, registration with the NCDEQ is required for nonagricultural water withdrawals or transfers of 100,000 gallons (gal.) (37,854 liters [L]) or more of water per day, in accordance with the North Carolina Water Withdrawal and Transfer Registration statute. Agricultural water users that withdraw 1,000,000 gal. (3,785,412 L) or more of water per day are also required to register. Registrations must be updated at least every 5 years, and local governments that submit an LWSP are exempt from registration requirements. The existing BCSS has a registered water withdrawal from both the Belews Lake and Dan River supplemental intake (Facility ID 0057-0013).

2.2.2.1.2 Regional Surface Water Use

Figure 2.2-1 identifies major surface water features in the Project Region. The analysis of water use in this section involves the hydrologic system in which the Project is proposed. Regionally, the Project has the potential to affect water use within the hydrologic system of the Dan River, which includes the Upper Dan River Subbasin (HUC 03010103) and the downstream Lower Dan River Subbasin (HUC 03010104). Within the Project Region, the Upper and Lower Dan River Subbasins cover many counties within NC and southern Virginia, including Caswell, Forsyth, Guilford, Rockingham, Stokes, and Surry counties in NC, and Franklin, Henry (including Martinsville City), Patrick, and Pittsylvania (including Danville City) counties in Virginia.

Self-supplied surface water use quantity data from the National Water Information System, provided by the USGS, were obtained and organized by water use category for the counties located within the Project Region and the Upper and Lower Dan River Subbasins. Table 2.2-19 presents these quantities for the most recently reported year of 2015 (USGS, 2018a). Users directly withdraw self-supplied water from a surface water source rather than a public water supply (USGS, 2018b). Uses of self-supplied surface water within the Project Region include public water supply, industrial, thermoelectric power, mining, livestock, aquaculture, and irrigation (Table 2.2-19). Among the reported uses, thermoelectric power generation and irrigation include consumptive uses of water, while all other reported uses are considered entirely nonconsumptive (USGS, 2018a). Section 2.2.2.1.2.1 provides additional information on regional consumptive water use. The National Water Information System did not report self-supplied surface water use data for domestic and commercial uses; however, public water supply sources can also provide water for domestic, commercial, and industrial uses (USGS, 2018a, 2018b).

2.2.2.1.2.1 Regional Public Water Supply

Table 2.2-20 and Figure 2.2-31 identify public water supply sources within the counties of the Project Region that withdraw water from the upper or lower Dan River subbasins. Point data for the public water supply intake locations were available for NC, however, intake location data for

Virginia were only available based on the number of public water supply intakes per service area, as shown using hatching in Figure 2.2-31. Five public water treatment facilities within the Project Region obtain water from tributaries of the Dan River: Mayo River, Smith River, Beaver Creek Reservoir, Farmers Lake, and South Mayo River (NCDEQ, 2024a; City of Martinsville, 2022; Henry County Public Service Authority, 2023; Town of Stuart, 2023). Additionally, three public water treatment facilities within the Project Region withdraw water directly from the Dan River, accounting for a total annual average withdrawal of approximately 3602 million gal. (13,635 million L) in 2023 (NCDEQ, 2024a; Danville and Pittsylvania County Economic Development, 2024; VDH, 2024a). These public water treatment facilities supply water to the Town of Madison, the City of Eden, and Danville. These three water users are downstream of BCSS, with the Town of Madison being the closest downstream user.

Section 2.4.2.8.1 includes more information on public water supply populations, available supply, and service area demand.

2.2.2.1.2.2 Regional Consumptive Use

Data on regional consumptive water use is limited. However, consumptive water use in the Project Region consists of that used in thermoelectric power generation and irrigation (Table 2.2-19) (USGS 2018a). In the Project Region, 1.3 percent of the total water used for thermoelectric power generation is consumptive, whereas all 21.34 million gallons per day (mgd) (97,696 cubic meters per day [m^3/d]) of water used for irrigation is consumptive.

2.2.2.1.2.3 Regional Recreational Water Use

In addition to the uses identified in Table 2.2-19, recreation is prevalent throughout the Project Region and within the Upper and Lower Dan River Subbasins. Approximately 46,000 ac. (18,616 ha) of federal and state land within the Dan River Basin provide opportunities for hunting, fishing, and paddling (Dan River Basin Association, 2023). The Dan River provides opportunities for paddling, canoeing, tubing, and kayaking (Town of Madison, 2013). Section 2.4.2.6.2 provides more information regarding recreational opportunities within the Project Region.

2.2.2.1.3 Surface Water Use in the Project Vicinity

Figure 2.2-2 depicts notable surface water bodies located within the Project Vicinity. These water bodies include the Dan River, Belews Creek, Belews Lake, and Town Fork Creek. There are no public water supply facilities that withdraw water from surface water resources within the Project Vicinity (NCDEQ, 2023a). Walnut Cove and Stokesdale obtain either a portion of or all of their public water supplies from surface water sources, with surface water supplies originating from Salem Lake (Salem Creek) and the W. Kerr Scott Reservoir located within the Yadkin River watershed. Both sources are located outside of the Project Vicinity and in the Upper Yadkin hydrologic system (HUC 03040101) (NCDEQ, 2024a).

There are only two self-supplied surface water withdrawal locations in the Project Vicinity reported under the Water Withdrawal and Transfer Registration Statute (G.S. 143-215.22H) and they are associated with the BCSS, including the MWIS and the CCW intake structure (Figure 2.2-2) (NCDEQ, 2022a). Section 2.2.2.1.4 provides more information on water use by the BCSS in association with the Project site.

2.2.2.1.3.1 Vicinity Recreational Water Use

The Dan River State Trail, a paddle trail that covers the entire 90 mi. (145 km) length of the Dan River within NC, runs through the Project Vicinity (North Carolina Trails, n.d.[a]). The Dan River State Trail is a unit of the state parks system that the Dan River Basin Association sponsors and manages (North Carolina Trails, n.d.[b]). Within the Project Vicinity, boaters occasionally use an unofficial access to the Dan River State Trail under the Pine Hall Road bridge (Figure 2.2-3). This access point is within the North Carolina Department of Transportation (NCDOT) corridor, but is not maintained (Dan River Basin Association, n.d.).

Belews Lake offers many recreational uses, including swimming, tubing, fishing, paddling, boating, and jet skiing (Rockingham County, 2024b). Because Duke Energy owns the riparian area around Belews Lake, the right to permit access to the lake is controlled by Duke Energy (Duke Energy, 2020). There are two public boat accesses located on Belews Lake: one near Pine Hall Road on the northwest side of the lake and one near Belews Creek Road on the southwest side of the lake (Figure 2.2-2 and 2.2-3). The North Carolina Wildlife Resources Commission (NCWRC) maintains both boat accesses (NCWRC, n.d.). Section 2.4.2.6.2 notes that 63 permitted private docks and two commercial docks are on Belews Lake (Duke Energy, 2020). Section 2.4.2.6.2 provides more information on recreational uses of Belews Lake.

2.2.2.1.3.2 Vicinity Consumptive Use

Available consumptive water use data for the Project Vicinity are included as part of the regional consumptive water use, as Section 2.2.2.1.2.2 discusses and Table 2.2-19 shows. In addition, no municipal or non-Duke Energy water withdrawals are allowed from Belews Lake; therefore, Belews Lake is not used for consumptive water uses such as irrigation or thermoelectric power generation associated with entities outside of Duke Energy (Duke Energy, 2020). Section 2.2.2.1.4.1 discusses consumptive water uses associated with current power generation at BCSS.

2.2.2.1.4 Surface Water Use within and Adjacent to the Project Site

BCSS draws water from Belews Lake, located adjacent to the Project site, which was created in the 1970s after damming Belews Creek (HDR, 2023). BCSS withdraws CCW from an intake structure located in a natural cove on the western arm of Belews Lake (Figure 2.2-2) (HDR, 2022). It has a combined pump capacity of approximately 1511 mgd (5,719,680 m^3/d) (Duke Energy, 2021). Heated effluent discharges into West Belews Creek arm (Figure 2.2-2) (HDR, 2023; NCDEQ, 2025b). As Section 2.2.1.1.3 describes, a man-made canal crosses the site peninsula to convey cooling water from the discharge area to the eastern portion of Belews Lake. The canal facilitates the reuse of water for the condenser cooling system, creating a closed-cycle recirculating system. Ultimately, using Belews Lake for cooling reduces cooling water withdrawals relative to a once-through system that does not reuse cooling water (HDR, 2022). The station also minimizes cooling water use by operating fewer pumps during cooler months and during periods of reduced electric demand.

Several factors influence the water surface elevation of Belews Lake, including natural processes (e.g., precipitation, watershed runoff, and meteorological conditions that affect evaporation rates) and operational processes associated with BCSS (e.g., spillway releases, diversions from the Dan River, and fluctuations in power generation capacity of BCSS that are associated with consumptive withdrawal rate). In most years, the runoff from the surrounding Belews Creek watershed sufficiently offsets the losses from Belews Lake due to consumptive

use, evaporation, and releases from the main dam. However, the BCSS can withdraw makeup water from an MWIS located at the confluence of the Dan River and Belews Creek (HDR, 2023).

There are two intake structures equipped with velocity caps at the MWIS location; one that draws water from the Dan River, and one that draws water from Belews Creek (HDR, 2022).

The MWIS is designed to support four pumps, each capable of pumping a nominal 9000 gpm (34,068 lpm) or approximately 20.1 cfs (0.57 m^3/s) (HDR, 2023). Duke Energy's NPDES permit for the MWIS allows for a maximum pumping capacity of up to 100 cfs (2.83 m^3/s) from the Dan River to Belews Lake (NCDEQ, 2025b). Cooling water is not used for process units or for contact-cooling purposes; therefore, all flows withdrawn by the MWIS are used in the closed-cycle recirculating system (HDR, 2022).

Makeup pump operation at BCSS has not been necessary since December 2012. Figure 2.2-9 shows that after 2014, Belews Lake water level elevations became more consistent than prior years despite increases in spillway release volumes and reductions in Dan River diversions. This consistency is due to increases in watershed runoff and precipitation as well as reductions in forced evaporation and consumptive use by BCSS resulting from reductions in BCSS power generation.

The NPDES permit (No. NC0024406) prohibits the operation of the MWIS from April 1 through June 30 to avoid peak spawning for many aquatic species. Additional permit conditions related to Dan River withdrawals that resource agencies requested and to which Duke Energy agreed include the following: at least 80 percent of the flow in the Dan River must be maintained during makeup pumping activities, pumping may occur to a maximum level in Belews Lake of 724.5 ft (220.8 m), and the Dan River flow must not fall below 110 cfs (3 m^3/s) as a result of pumping (NCDEQ, 2025b).

2.2.2.1.4.1 Project Site Consumptive Use

The water balance model, which uses historical BCSS power generation data to calculate consumptive use estimations, estimates average forced evaporation and average consumptive withdrawal for the BCSS historical condition to be approximately 16.8 cfs or 10.9 mgd (41,102 m^3/d) and approximately 10.2 cfs or 6.59 mgd (24,955 m^3/d) respectively as shown in Table 2.2-6. The maximum monthly rate of forced evaporation at BCSS is estimated to be approximately 25.3 cfs or 16.4 mgd (61,898 m^3/d) and the maximum monthly consumptive withdrawal at BCSS is 18.3 cfs or 11.8 mgd (44,772 m^3/d).

2.2.2.2 Groundwater

This section describes the current and anticipated future groundwater use within the Project Region, Project Vicinity, and Project site that the operation or building, including transmission corridors and off-site facilities, could affect.

2.2.2.2.1 Regional Groundwater Use

Section 2.2.1.2 describes the principal aquifers in the Project Region as crystalline-rock aquifers and aquifers within Early Mesozoic basins (USGS, 1997). Well yields for crystalline-rock aquifers are generally low, typically yielding 5 to 35 gallons per minute (gpm) (18.9 to 132.5 liters per minute [lpm]) within the fractured bedrock. Above the fractured bedrock, within the

surficial aquifer, well yields can increase up to approximately 200 gpm (757 lpm) (NCDWR, 2024). Well yield for Early Mesozoic basins is typically low with an average 11 to 12 gpm (41.6 to 45.4 lpm) (Huffman, 1996).

Groundwater use by category data are from the NCDEQ Water Withdrawal and Transfer Registration Annual Data website for the 18 NC counties within the 50-mi. (80-km) Project Region. These categories are industrial, mining, public water supply, recreation, and energy. For 13 of the 18 counties, most of the groundwater withdrawals from 1999 to 2022 were for public water supply. The remaining five counties' groundwater primary withdrawal uses were Alamance (recreation), Davidson (mining), Person (energy), Stokes (energy), and Wilkes (industrial). Annual groundwater withdrawal information was only reported for the year 2004 for Davidson County (NCDEQ, 2024b).

Further groundwater use by category data are from the Virginia Department of Environmental Quality Office of Water Withdrawal Permitting for the eight counties within the Project Region. Public water supply is currently and has historically been the primary groundwater withdrawal use for six of the eight Virginia counties. Manufacturing is currently and has historically been the primary groundwater withdrawal use for the two remaining counties, Patrick and Pittsylvania (VDEQ, 2024).

2.2.2.2.2 Sole-Source Aquifers

The U.S. Environmental Protection Agency (USEPA) has not declared any sole-source aquifers within Project Region, Project Vicinity, or Project site (USEPA, 2024a).

2.2.2.2.3 Vicinity Groundwater Use

The NCDWR Local Water Supply Planning Database was accessed for local water supplies within the Project Vicinity. The database identifies three municipalities (Madison, Stokesdale, and Walnut Cove) that have an LWSP for the year 2023. These LWSPs are designed to outline the current and projected water supply use and demand up to the year 2070 for surface water and groundwater. According to the LWSP, groundwater demand is projected to increase from 0.31 mgd (1.2 million liters per day [mld]) in 2023 to 0.32 mgd (1.2 mld) in 2070. This increase in demand correlates to an increase in overall projected population increases from 1757 in 2023 to 2000 in 2070 (NCDEQ, 2024c). The Madison and Stokesdale LWSPs do not identify groundwater withdrawals for current water use and do not identify groundwater withdrawal use in their projections. Table 2.2-21 summarizes the projected groundwater demands for Walnut Cove.

NC OneMap, a collaborative geographic information system (GIS) website that presents data from local, state, and federal government agencies, identifies public water supplies within the 6-mi. (10-km) Project Vicinity. NC OneMap classifies public water systems into three categories (USEPA, 2023a):

- Community water system: a public water system that supplies water to the same population year-round.
- Non-transient non-community water system: a public water system that regularly supplies water to at least 25 of the same people at least six months per year (e.g., schools, factories, and hospitals).

- Transient non-community water system: a public water system that provides water in a place such as a gas station or compound where people do not remain for long periods of time.

The NC OneMap query identified 47 community, 19 transient non-community, and seven non-transient non-community public water supply systems within the Project Vicinity. Table 2.2-22 tabulates the public water supply wells, and Figure 2.2-32 shows their locations. There are a total of 73 public water supply wells with 59 wells installed within the crystalline-rock aquifer and 19 installed within the Early Mesozoic basin aquifer. Well depths within the Project Vicinity range from 103 to 1504 ft. bgs (31.4 to 458 m bgs) within the crystalline-rock aquifer and range from 175 to 1230 ft. bgs (53 to 375 m bgs) within the Early Mesozoic basin aquifer. Well yields range from 5 to 132 gpm (19 to 500 lpm) within the crystalline-rock aquifer and range from 2 to 200 gpm (7.6 to 757 lpm) within the Early Mesozoic basin aquifer (NCGICC, 2023).

The latest groundwater use by category data (2022) for the four counties within the Project Vicinity (Forsyth, Guilford, Rockingham, and Stokes) from NCDEQ (2024a) is shown in Table 2.2-23 and summarized as follows:

- Forsyth County and Rockingham County reported public water supply as their primary groundwater withdrawal, with total groundwater withdrawals of 0.22 mgd (0.83 mld) and 0.10 mgd (0.38 mld), respectively.

- Stokes County reported 0.10 mgd (0.38 mld) for energy and 0.01 mgd (0.04 mld) for public water supply with a total of 0.11 mgd (0.42 mld).

- Guilford County reported 0.04 mgd (0.15 mld) for industrial, 0.86 mgd (3.3 mld) for public water supply, and 0.05 mgd (0.19 mld) for recreation, for a total of 0.95 mgd (3.6 mld).

Public water supply within Forsyth, Guilford, and Rockingham counties leads the groundwater withdrawal use category data from 2019 to 2022. Historically, Stokes County had public water supply as its primary groundwater withdrawal use; however, starting in 2021, groundwater withdrawals for energy surpassed public water supply as the primary groundwater withdrawal use.

The main groundwater withdrawal use is public water supply use. Therefore, most of the Project Vicinity groundwater use is nonconsumptive. Generally, water supplies are 30 percent consumptive due to outdoor use and water supply leaks. The remaining 70 percent is considered nonconsumptive as the water is returned to the watershed via septic system or wastewater treatment plant (WWTP) (USEPA, 2024b).

Based on the identified well yields within the Project Vicinity and the distance of these wells from the Project site, surrounding commercial groundwater withdrawals do not have an influence at the Project site. The closest existing water supply wells are approximately 0.25 mi. (0.40 km) away from the Project site owned by Humphrey's Ridge, LLC, and are located east of Belews Lake. The natural constant head boundary and groundwater divide represented by Belews Lake prevents groundwater drawdown from existing adjacent water supply wells (Freeze and Cherry, 1979).

A private well search was completed through the respective environmental health departments of the four counties. Private well information was successfully obtained from Guilford and

Rockingham counties; however, private well information was not readily available from Forsyth and Stokes counties.

The Guilford County GIS website identified [[ ]]WI private water supply wells within the portion of the Project Vicinity in Guilford County (Guilford County, 2024b). The Rockingham County search identified [[ ]]WI private water supply wells within the portion of the Project Vicinity in Rockingham County (Rockingham County, 2024c). Most of the well data from Rockingham County did not provide well yields or depths because these data are not readily available. From the private water supply well information provided, the well depths ranged from [[ ]]WI in the crystalline-rock aquifer and [[ ]]WI in the Early Mesozoic basin aquifer. Well yields ranged from [[ ]]WI within the crystalline-rock aquifer and from [[ ]]WI within the Early Mesozoic basin aquifer.

The USEPA 2020 U.S. Private Domestic Well database estimates the total private water supply wells for domestic use in Forsyth and Stokes counties. This database uses land use data combined with housing units within the area to provide a well count estimate. The query results estimate a private water supply well count of 3646 wells in Forsyth County and 3535 wells in Stokes County within the Project Vicinity (USEPA, 2024c). Most wells identified within the Project Vicinity are established within the crystalline-rock aquifer system. Others are established within aquifers of the Early Mesozoic basin. Wells developed within the Early Mesozoic basin exist approximately 3.2 mi. (5.1 km.) northwest of the Project site near Walnut Cove and approximately 1.6 mi. (2.6 km.) north of the Project site in the unincorporated community of Pine Hall and are not in hydraulic connection to the Project site. Table 2.2-24 shows the total private well counts for Guilford and Rockingham counties and estimated private well counts for Forsyth and Stokes counties.

2.2.2.2.4 Duke Energy–Owned Extraction Wells

Other than water withdrawals associated with the Duke Energy groundwater corrective action plan (CAP) remediation system, no groundwater withdrawals currently exist at the operating BCSS. The CAP remediation system was installed as part of BCSS ash basin closure activities. The full-scale CAP system is located approximately 2.2 mi. (3.5 km) northwest of the Project site and consists of 72 extraction wells and 64 clean water infiltration wells. Figure 2.2-32 depicts the location of the groundwater withdrawals used by the CAP remediation system wells owned by Duke Energy. The following outlines the total combined water withdrawal amounts for the 72 extraction wells operating as part of the full-scale CAP system:

- Minimum system flow rate: 72 gpm (273 lpm)
- Maximum system flow rate: 98 gpm (371 lpm)
- Average system flow rate: 81 gpm (307 lpm)

Ranges in individual extraction well flow rates include the following:

- Minimum extraction well flow rate: 0.3 gpm (1.1 lpm)
- Maximum extraction well flow rate: 12.6 gpm (47.7 lpm)
- Average extraction well flow rate: 1.3 gpm (4.9 lpm)

The total combined water infiltration amounts for the 64 clean water infiltration wells as part of the full-scale CAP system:

- Minimum system infiltration rate: 63 gpm (238 lpm)
- Maximum system infiltration rate: 89 gpm (337 lpm)
- Average system infiltration rate: 75 gpm (284 lpm)

Individual infiltration well infiltration rates:

- Minimum infiltration well infiltration rate: 0.02 gpm (0.08 lpm)
- Maximum infiltration well infiltration rate 5.8 gpm (22 lpm)
- Average infiltration well infiltration rate: 1.3 gpm (4.9 lpm)

On average, the monthly CAP system withdrawal rate is 3,541,790 gal. (13,407,815 L) and the average monthly infiltration system rate is 3,258,497 gal. (12,334,753 L). Extraction and infiltration wells are all within the saprolite-bedrock matrix of the crystalline-rock aquifer.

2.2.2.2.5 Site Groundwater Use

There are no current groundwater withdrawals at the Project site other than what Section 2.2.2.2.4 describes.

2.2.2.2.6 Groundwater Use Regulations

The NCDWR regulates groundwater use and withdrawals. The NCDWR Public Water Supply branch oversees the permitting of community and non-community public water supply well systems and large capacity water supply wells that are designed for over 100,000 gpd (378,541 lpd). Public water supply systems are regulated through the Safe Drinking Water Act of 1974 (Public Law No: 93-523) and the North Carolina Drinking Water Act (USEPA, 2024d). The rules and regulations regarding public water supply well systems are specified in North Carolina Administrative Code (NCAC) Title 15A Subchapter 18C, which summarizes the permitting, construction, and requirements for the usage of a public water supply well system.

The North Carolina Division of Health and Human Services, Division of Public Health, Environmental Health Section governs private water supply well laws and regulations and permits water supply wells through the local county health departments. NCAC Title 15A 02C covers the general rules regarding the permitting of private drinking-water wells. NCAC Title 15A 02C offers guidelines for private drinking-water well permitting, construction, abandonment, and distances from potential contamination and private wastewater systems. These rules and regulations protect the health of the local water supply.

NCDEQ requires LWSPs for large public water supply systems that provide water service to the community. At a minimum, LWSPs must include:

- Present and projected population, industrial development, and water use within the service area.
- Present and future water supplies.

- An estimate of the present and future water supplies.
- An estimate of the technical assistance that may be needed at the local level to address projected water needs.
- Current and future water conservation and water reuse programs, including a plan for the reduction of long-term per capita demand for potable water.
- A description of how the local government or large community water system responds to drought and other water shortage emergencies and continues to meet essential public water supply needs during the emergency.

A unit of local government or large community water system must submit a revised plan that specifies how the water system intends to address foreseeable future water needs when 80 percent of the water system's available water supply based on calendar year average daily demand has been allocated to current or prospective water users or the seasonal demand exceeds 90 percent.

2.2.3 WATER QUALITY

This section describes the surface water quality within the Project Vicinity for Belews Lake, the Dan River, and Town Fork Creek. The sections also describe groundwater resources and quality in the Project Region, Project Vicinity, and Project site.

2.2.3.1 Surface Water

The following sections discuss the existing water quality of Belews Lake, the Dan River, and Town Fork Creek within the 6-mi. Project Vicinity.

2.2.3.1.1 Project Site Streams

2.2.3.1.1.1 Preapplication Monitoring Program Results

Section 2.2.4.1 describes the surface water sampling locations, methods, parameters, and analyses included in Duke Energy's preapplication monitoring program.

Section 2.2.1.1.4 describes Project site streams characterized by narrow channels with moderate gradients. Streams on the Project site are largely intermittent, with periods of the year in which they have no flow. Table 2.2-25 compares seasonal water quality parameter values from first order streams on the Project site discharging into Belews Lake with USEPA national recommended water quality criteria (NRWQC) for human health and aquatic life and NC water quality criteria for domestic water and surface water, fish, and aquatic life. It includes the most restrictive water quality criteria values for the applicable designated uses and compares the average, range, and maximum measured values of reported water quality parameters against water quality criteria. Most of the Project site stream water quality constituents did not exceed the aforementioned standards; however, the following constituents are outside the standard range:

- Alkalinity exceedances of the USEPA NRWQC occurred in the on-site streams during the winter sampling at sample location BCSW2. USEPA NRWQC exceedances do not constitute a regulatory exceedance, nor do they indicate that a waterway is impaired.

- Arsenic exceedances of the USEPA NRWQC occurred in the on-site streams during the summer sampling at sample location BCSW3. The USEPA NRWQC exceedance from sample BCSW3 during the summer sampling appears to be an isolated result and does not necessarily indicate a regulatory exceedance. The remaining samples did not have detections of arsenic above their respective laboratory method detection limits (MDLs).

- Dissolved oxygen concentrations were below the NCDEQ NC 2B Standard within the on-site streams during the summer and fall sampling event at sample location BCSW2.

- At least one sample from each location during each sampling event exceeded the NCDEQ water quality standard for fecal coliforms/*E. coli* of >400, the most probable number (mpn)/100 milliliter (mL). However, the standard is not applicable to these sampling events. The *E. coli* standard states that the concentration should not exceed the water quality standard in more than 20 percent of the samples examined during a 30-day period. These samples were taken quarterly and only one sample per location. NCDEQ standards are not applicable for singular, point-in-time, sampling events. These concentrations of *E. coli* are not considered an exceedance.

- Fluoride exceedance of the NCDEQ 2B Standards occurred within the on-site streams at sample location BCSW2 during the summer sampling event.

- Lead sample results for the spring sampling event at locations BCSW1 and BCSW6 were above the chronic NCDEQ 2B Standard for Aquatic Life Freshwater. These samples did not exceed the acute NCDEQ 2B Standard and elevated values were not shown during subsequent sampling events. Therefore, sample results are not considered exceedances.

- Manganese exceedances of the USEPA NRWQC occurred in each of the four sampling quarters at multiple locations. Although manganese concentrations were identified above the USEPA NRWQCs, NCDEQ removed its surface water standards regarding manganese based on higher natural background concentrations (NCDENR, 2015c).

- Values of pH were out of the NC 2B Standard range within on-site streams during the spring sampling event at sample locations BCSW1, BCSW3, BCSW4, BCSW5, and BCSW6, and out-of-range values occurred during the winter sampling event at sample location BCSW1 and BCSW2.

- Turbidity exceedances of the NCDEQ NC 2B Standards within the on-site streams occurred during the summer sampling event at sample location BCSW4.

Temperatures in the on-site streams ranged seasonally from 41.7 to 73.0 degrees Fahrenheit (°F) (5.4 to 22.7 degrees Celsius [°C]). Temperature for NCDEQ is a narrative standard, per 15A NCAC 02B.0211 (18), which states, “Temperature: not to exceed 2.8°C (5.04°F) above the natural water temperature and in no case to exceed 32°C (89.6°F) for lower piedmont and coastal plain waters” (NCDEQ, 2022b). Per 15A NCAC 02B.0101 (b), a revision of this water quality standard is allowed, consistent with the provisions of Section 316(a) of the CWA (NCDEQ, 2022b).

2.2.3.1.2 Belews Lake

Belews Lake consists of distinct regions, which in part relate to its principal tributaries: the West Belews Creek arm; the Belews Creek arm; and the main body of the reservoir. Belews Lake

consists of seven water segments within the Project Vicinity as Table 2.2-26 summarizes and Figure 2.2-33 shows (NCDEQ, n.d. [a]).

2.2.3.1.2.1 Temperature

The upper portion of the West Belews Creek arm currently receives heated effluent from the BCSS once-through CCW system. This area is physically separated from the remainder of Belews Lake, except for a 0.93-mi. (1.5-km), man-made canal that facilitates the return of heated CCW effluent to the Belews Creek arm.

Duke Energy implemented a temperature sampling program in 2017 in which continuous in situ temperature profile loggers recorded hourly temperature data and were deployed from the surface down to 65.7 ft. (20 m) or lake bottom (whichever was less) at 6.6-ft. (2-m) intervals, except for Station 416.0 near the dam. The results of this program provided evidence that Belews Lake, and a major portion of the discharge arm near BCSS, maintains temperatures adequate to support biological communities under adverse lake level and weather conditions (Duke Energy, 2021). As a result of the thermal demonstration, NCDEQ, in agreement with these conclusions, approved the 316(a) thermal variance for operation of the BCSS.

Section 2.2.1.1.3 describes Belews Lake and analyzes its temperature.

2.2.3.1.2.2 Other Water Quality Data

In accordance with the NPDES permit and NCDEQ regulations, Duke Energy prepared an initial 316(a) demonstration in 2020 (Duke Energy, 2021). Duke Energy collected water chemistry samples for laboratory analysis semiannually and field measurements were collected quarterly at 13 stations depicted in Figure 2.2-34 as part of Duke Energy's 316(a) thermal variance study plan.

The 316(a) report for the BCSS compared these 2020 data to both NCDEQ water quality criteria and historical water quality and analytical data from 2001 to 2019. Table 2.2-27 summarizes the 2020 water quality maximum values for the 13 stations that measure water quality data for Belews Lake as part of the 316(a) sampling program. Notable findings from the water quality results are as follows (with the clarification that the "uplake" area is defined as the area starting at the confluence of Belews Creek and West Belews Creek with Belews Lake and "downlake" near the sample location marked "SPILLWAY" in Figure 2.2-34):

- Dissolved oxygen demonstrated seasonal variation and distribution within the reservoir.
- Spatially, total phosphorous exhibited a decreasing trend from uplake to downlake.
- Orthophosphate was low throughout Belews Lake during both the study period and historically.
- Phosphorous concentrations in Belews Lake were sufficient to sustain primary productivity. A ratio of nitrogen to phosphorous supports that the lake was phosphorous-limited.
- Nitrogen concentrations (i.e., ammonia, nitrate - nitrite, and Total Kjeldahl Nitrogen [TKN]) were low in all zones of Belews Lake, with TKN values higher uplake than downlake in 2020.

- The hardness concentrations observed in 2020 characterized the water in Belews Lake as soft, falling below the NC water quality criteria of 100 mg/L.
- Turbidity values generally decreased from uplake to downlake locations, both historically and in 2020. Mean turbidity values were below the NC water quality criteria of 25 nephelometric turbidity units (NTU) for lakes with the exception of two uplake sample station locations, 405.0 and 419.2, closest to the headwaters of the lake and are found on Figure 2.2-34.
- Trace metals concentrations collected during 2020 were below the NC water quality standards.
- Chlorophyll-α samples collected during 2020 had concentrations below the NC water quality criteria of 40 micrograms per liter (µg/L). Higher concentrations were measured uplake due to watershed inputs. Concentrations were generally highest in the winter. The data indicated that there was no trend in concentrations between thermally influenced areas and areas uplake and downlake.

In general, water quality sampling results from the thermal variance study indicate that the seasonal water quality and chemistry of Belews Lake provides a suitable physicochemical environment for sustaining a balanced and indigenous biological community.

2.2.3.1.3 Dan River

The Dan River water segment 22-(8) (listed within the 2024 Draft Integrated Report) is a 25.9-mi. (41.7-km) segment from Big Creek to a point 0.2 mi. (0.32 km) downstream of Town Fork Creek located within the Project Vicinity. The water segment meets quality standards and is not impaired. The uncharacterized section of the Dan River within the Project Vicinity, NC22-(25.5), travels from a point 0.2 mi. (0.32 km) downstream of Town Fork Creek to a point 0.3 mi. (0.48 km) upstream of Reed Creek. Table 2.2-26 and Figure 2.2-33 show the water classifications and locations for both segments (NCDEQ, n.d. [a]).

2.2.3.1.3.1 Preapplication Monitoring Program Results

Section 2.2.4.1 describes the surface water sampling locations, methods, parameters, and analyses included in Duke Energy's preapplication monitoring program.

Table 2.2-28 compares seasonal, quarterly water quality parameter values from the four sample locations within the Dan River with applicable federal NRWQC for human health and aquatic life and NC water quality criteria for domestic water and surface water, fish, and aquatic life. It includes the most restrictive water quality criteria values for the applicable designated uses, and compares the average, range, and maximum measured values of reported water quality parameters against water quality criteria.

Most Dan River water quality constituents did not exceed the aforementioned standards; however, the following constituents are outside the standard range:

- Alkalinity exceedances of the USEPA NRWQC occurred in the Dan River during the winter sampling at sample location DRSW1. USEPA NRWQC exceedances do not constitute a regulatory exceedance, nor do they indicate that a waterway is impaired.
- Samples exceeded the NCDEQ water quality standard for fecal coliforms/*E. coli* of >400 MPN/100 mL in at least one sample from each location during each sampling event.

However, the standard is not applicable to these sampling events. The *E. coli* standard states that the concentration should not exceed the water quality standard in more than 20 percent of the samples examined during a 30-day period. These samples were taken quarterly and only one sample per location. NCDEQ standards are not applicable for singular, point-in-time, sampling events. These concentrations of *E. coli* are not considered an exceedance.

- A lead exceedance of the chronic NCDEQ 2B Standard for Aquatic Life Freshwater was observed in the Dan River at sample location DRSW2 during the winter 2025 sampling. However, this sample did not exceed the acute NCDEQ 2B Standard; therefore, this sample is not considered an exceedance.

- Manganese exceedances of the USEPA NRWQC occurred in each of the four sampling quarters. Although manganese concentrations were identified above the USEPA NRWQCs, NCDEQ removed its surface water standards regarding manganese based on higher natural background concentrations (NCDENR, 2015c).

- pH values were out of the NC 2B Standard range occurred in the spring sampling event at Dan River sample location DRSW3.

Temperatures in the Dan River ranged seasonally from 34.5 to 78.4°F (1.4 to 25.8°C). Temperature for NCDEQ is a narrative standard, per 15A NCAC 02B.0211 (18), which states, “Temperature: not to exceed 2.8°C (5.04°F) above the natural water temperature and in no case to exceed 32°C (89.6°F) for lower piedmont and coastal plain waters” (NCDEQ, 2022b). Per 15A NCAC 02B.0101 (b), a revision of this water quality standard is allowed, consistent with the provisions of Section 316(a) of the Federal Water Pollution Control Act (NCDEQ, 2022b). The measured temperatures did not exceed any NCDEQ water quality standards.

In addition to other upstream and downstream Dan River sampling locations, the preapplication monitoring program location DRSW2 provides water quality information for the Dan River immediately upstream of the existing BCSS Outfall 006 sampling location (Figure 2.2-35).

2.2.3.1.3.2 Existing BCSS NPDES Wastewater Outfall 006

Duke Energy operates the BCSS and maintains NPDES wastewater permit NC0024406, which has an existing outfall (Figure 2.2-34) that currently discharges to the Dan River, which is referred to as Outfall 006 (NCDEQ, 2023b). Duke Energy has performed historical sampling for this outfall per NPDES requirements and the 2023 NPDES permit application includes the results of the historical sampling (NCDEQ, 2023b). As part of the NPDES permit application, BCSS sampled for maximum daily discharge for the following constituents:

- Conventional and nonconventional pollutants (40 CFR 122. 21(g)(7)(iii))
- Toxic metals, cyanide, total phenols, and organic toxic pollutants (40 CFR 122. 21(g)(7)(v))
- Certain conventional and nonconventional pollutants (40 CFR 122. 21(g)(7)(v))

2.2.3.1.3.3 Other Water Quality Data

Quarterly samples from the Dan River are collected as part of the NPDES wastewater permit instream monitoring requirements. Four stations, in addition to Outfall 006, quarterly monitor the

Dan River water body as part of Duke Energy's internal river health monitoring program and are shown in Figure 2.2-34. Outfall 006 also measures NPDES wastewater discharge into the Dan River subject to the permit requirements listed within NPDES permit number NC0024406 (NCDEQ, 2023b). NPDES Outfall 006 discharges comply with NC regulatory requirements.

In 2003, Duke Energy produced a report evaluating the water quality impact of pumping Dan River water into Belews Lake to augment the water level. The report evaluated three sample locations within Belews Lake: Stations 410.0, 416.0, and 418.0 (Figure 2.2-34). The evaluation concluded that measurable water quality impacts in regard to suspended solids and water clarity were localized to the immediate pump outlets in the lake and are both transient and insignificant compared to other natural background effects, such as stormwater runoff (Finley, 2003).

2.2.3.1.3.4 North Carolina Natural Heritage Program Classification

As Section 2.3.2.4 details, the North Carolina Natural Heritage Program (NCNHP) classifies the section of the Dan River within the Project Vicinity as a natural area, with a representational rating of R1 (Exceptional) and collective rating of C1 (Exceptional). Per 15A NCAC 02B.0225, "surface waters of the State shall be classified as outstanding resource waters (ORW) upon finding, on a case-by-case basis, that such waters are of exceptional state or national recreational or ecological significance that require additional protection to maintain existing uses and that the waters meets certain conditions," (NCDEQ, 2022b). A water body is deemed to be of exceptional state, or national recreational or ecological significance, if it received a designation, such as an NCNHP classification, which does not provide any water quality protection. The ORW classification provides additional water quality standards for the designated waterbody.

Even though the segment of the Dan River within the Project Vicinity is classified under the NCNHP, the North Carolina Environmental Management Commission has not classified this segment as an ORW (NCDEQ, n.d. [a]). The segment of the Dan River within the Project Vicinity is classified only as a WS-IV waterbody. Therefore, no additional water quality restrictions are required.

2.2.3.1.4 Town Fork Creek

The 2024 North Carolina Draft Integrated Report included an assessment of the water quality within the immediate 12.1-mi.-long (19.5-km-long) upstream segment, NC22-25b2, from Neatman Creek to the Dan River (NCDEQ, 2024d) located within the Project Vicinity. The current water body condition is meeting quality standards and is not impaired. The water classifications and location for the segment is found in Table 2.2-29 and shown in Figure 2.2-33 respectively (NCDEQ, n.d. [b]).

2.2.3.1.4.1 Preapplication Monitoring Program

As part of the preapplication monitoring program described in Section 2.2.4.1, Duke Energy collected water quality samples at one location within Town Fork Creek, approximately 300 ft. (91.1 m) upstream from its confluence with the Dan River. As Figure 2.2-33 shows, sample location TFCSW1 represents water quality in Town Fork Creek upstream from Dan River. This sample location provides water quality data related to the potential influence of background environmental factors.

Table 2.2-29 compares seasonal, quarterly water quality parameter values from the Town Fork Creek sample location with applicable federal NRWQC for human health and aquatic life and NC water quality criteria for domestic water and surface water, fish, and aquatic life. It also includes the most restrictive water quality criteria values for the applicable designated uses, and compares the average, range, and maximum measured values of reported water quality parameters against water quality criteria.

The majority of Town Fork Creek water quality constituents did not exceed the aforementioned standards; however, the following constituents are outside the standard range:

- Manganese exceedances of the USEPA NRWQC occurred in each of the four sampling quarters. Although manganese concentrations were identified above the USEPA NRWQCs, NCDEQ removed its surface water standards regarding manganese based on higher natural background concentrations (NCDENR, 2015c).

- Samples exceeded the NCDEQ water quality standard for fecal coliforms/*E. coli* of >400 MPN/100 mL during each sampling event. However, the standard is not applicable to these sampling events. The E. coli standard states that the concentration should not exceed the water quality standard in more than 20 percent of the samples examined during a 30-day period. These samples were taken quarterly and only one sample per location, NCDEQ standards are not applicable for singular, point-in-time, sampling events. These concentrations of *E. coli* are not considered an exceedance.

Temperatures in Town Fork Creek ranged from 41.5 to 79.0°F (5.3 to 26.1°C). Temperature for NCDEQ is a narrative standard, per 15A NCAC 02B.0211 (18), which states, “Temperature: not to exceed 2.8 °C (5.04 °F) above the natural water temperature and in no case to exceed 32°C (89.6°F) for lower piedmont and coastal plain waters” (NCDEQ, 2022b). Per 15A NCAC 02B.0101 (b), a revision of this water quality standard is allowed, consistent with the provisions of Section 316(a) of the Federal Water Pollution Control Act (NCDEQ, 2022b). The measured temperatures did not exceed any NCDEQ water quality standards.

2.2.3.1.5 Impaired Waters

NCDEQ monitors water quality and produces water quality reports that satisfy the requirements of the CWA Sections 305(b) and 303(d) (NCDEQ, 2024e). Water bodies are assessed based on their designated best use, which is defined in the surface water classifications in Title 15A of the NCAC and summarized in Table 2.2-27 (NCDEQ, 2017a). Each monitored water body receives a biennial assessment, which is reflected in an Integrated Report to satisfy 305(b) reporting requirements. The biennial 303(d) list and Integrated Report identify impaired water bodies that do not meet water quality standards for one or more of the designated uses. The 303(d) list is made up of Category 5 assessments only; however, Category 4 assessments are still considered impaired.

All states are required to develop total maximum daily loads (TMDLs) for water bodies that are impaired and on the 303(d) list (NCDEQ, n.d. [b]). A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, which is then used to establish limits on sources of the pollutants (NCDEQ, n.d. [b]).

2.2.3.1.5.1 Belews Lake Temperature Impairment

In 2014, a section of Belews Creek (NC22-27-[7]), “including Belews Lake below elevation 725,”

located from Southern Railroad Bridge to a point 1.8 mi. (2.9 km) downstream of Forsyth-Stokes County Line was identified as a Class C water impaired for water temperature (NCDEQ, 2024d). No TMDL has been developed, nor has a probable source of impairment been identified by the USEPA or NCDEQ (NCDEQ, n.d. [c]).

Duke Energy prepared a 316(a) demonstration in 2020 for Belews Lake. NCDEQ released a draft delisting document on October 9, 2024, which includes changing the previously impaired section of Belews Creek (NC22-27-[7]) from a Category 5 assessed water body to a Category 4v water body, thereby removing it from the 303(d) impaired waters list. A Category 4v water body is defined as one that exceeds criteria, but the parameter is part of a permit variance. The impaired section is officially removed from the 303(d) list once the 2024 draft delisting document is finalized. Section 2.2.1.1.3.2.4 discusses temperature trends within Belews Lake in greater detail.

2.2.3.1.5.2 Historical Selenium Impairment and Sampling

Within Belews Lake, historical selenium loading, occurring in the mid-1970s and exacerbated by the long retention time, was inhibiting fish reproduction (Duke Energy, 2021). Environmental studies were restructured to monitor effects of selenium on Belews Lake biota and water quality from 1976 to 1985. These lake recovery sampling programs evolved over time, and new sampling programs were created when BCSS redirected its regulated ash basin discharge from Belews Lake in October 1985. Belews Lake biota began to recover from the inhibition of reproduction once this redirection occurred. Further discussion of the biota and sampling is found in Section 2.3.2.7. Duke Energy and NCDEQ have acknowledged that macroinvertebrate and fish populations have recovered substantially from the selenium contamination that occurred during early operations of BCSS.

Data from the 2020 monitoring period relevant to this impact and recovery include almost all concentrations from Belews Lake of arsenic, selenium, and zinc were below reporting limits and the mean concentrations of copper and low-level mercury were below NC water quality standards and within historical ranges for the system.

2.2.3.2 Groundwater

2.2.3.2.1 Regional Groundwater Quality

The quality of groundwater from the Piedmont and Blue Ridge aquifers is generally suitable for drinking (USGS, 1997). Bedrock composition and geochemical conditions in the aquifer directly affect the occurrence and distribution of potentially naturally occurring contaminants. It is common for naturally occurring contaminants such as arsenic, iron, manganese, and radionuclides to be present and exceed state and federal drinking-water standards in aquifers within the Piedmont and Blue Ridge (Chapman et al., 2013).

2.2.3.2.2 Vicinity Groundwater Quality

As Section 2.2.1.2 describes, Duke Energy owns and operates the Craig Road Landfill, which is associated with BCSS and borders the Project site to the southwest. Groundwater monitoring is conducted semiannually through sampling of 17 monitoring wells surrounding the landfill. Monitoring wells are screened in different units to assess groundwater quality within the unconsolidated regolith and bedrock units (Synterra, 2024a).

Data from the July 2024 sampling event identifies at least one concentration of cobalt, iron, and manganese above their respective NCDEQ Groundwater Standards, 15A NCAC 02L. 0202, effective April 1, 2022 (NCDEQ 2L Standard) from 7 of 17 groundwater samples collected from monitoring wells screened within the unconsolidated regolith and in the bedrock units. Chromium was identified above its respective NDCEQ 2L Standard from one monitoring well sample in the bedrock unit only. PH values were outside of the NCDEQ 2L Standard range for groundwater samples taken from 16 of 17 monitoring wells screened within the unconsolidated regolith and in the bedrock units. Groundwater at the landfill generally flows to the north, northwest, and northeast toward Belews Lake (Synterra, 2024a). Groundwater flow beneath the Craig Road Landfill is not in hydraulic contact or flowing toward groundwater at the three proposed Plant Complex construction locations and is not a concern regarding groundwater quality for the Project site. Groundwater associated with the Craig Road Landfill is being monitored in accordance with the Water Quality Monitoring Plan (WQMP) accepted by NCDEQ Department of Waste Management Solid Waste Section, January 24, 2024 (Synterra, 2024a).

2.2.3.2.3 Site Groundwater Quality

2.2.3.2.3.1 Flue Gas Desulfurization Residue Landfill

As Section 2.2.1.2 describes, Duke Energy owns and operates the FGD Residue Landfill, which is situated within the center of the Project site. Groundwater monitoring is conducted semiannually through sampling of 31 monitoring wells throughout the landfill. Monitoring wells are screened in units to assess groundwater quality within the unconsolidated regolith and bedrock units (Synterra, 2024b).

Data from the May 2024 groundwater sampling event identifies at least one concentration of beryllium, cadmium, chromium, and/or cobalt above their respective NCDEQ 2L Standards in samples from 7 of 23 monitoring wells screened in the unconsolidated regolith unit. Groundwater sample concentrations of iron, manganese, sulfate, and total dissolved solids were above their respective NCDEQ 2L Standards in 17 of 31 monitoring wells screened in the unconsolidated regolith and bedrock units. PH values were outside of the NCDEQ 2L Standard range for groundwater samples taken from 28 of 31 monitoring wells, in the unconsolidated regolith and bedrock units.

In general, groundwater flow at the FGD landfill is to the northwest towards Belews Lake. A groundwater divide is located along the landfill perimeter road on the southeast side of the FGD landfill. Groundwater on the west side of the divide flows to the northwest towards Belews Lake, while groundwater on the east side of the divide flows to the southeast towards an intermittent stream that discharges to Belews Lake (Synterra, 2024b). The groundwater flow beneath the FGD landfill is not in hydraulic contact with the groundwater at the Project site three Plant Complexes and is not a concern regarding groundwater quality for the Project site. Groundwater associated with the FGD landfill is being monitored in accordance with the WQMP accepted by NCDEQ Department of Waste Management Solid Waste Section, January 24, 2024 (Synterra, 2024b).

2.2.3.2.3.2 Belews Creek Observation Well Groundwater Quality

As Section 2.2.1.2 describes, observation wells were installed throughout the Project site to characterize the groundwater and provide a baseline at the three proposed Plant Complexes

before building or operation of the proposed Project. Groundwater samples were collected quarterly from the observation wells (W-1 through W-15) in June 2024, October 2024, January 2025, and April 2025. Groundwater samples were analyzed for analytes listed in NUREG-1555 along with other voluntary selected parameters. These analytes and their analytical methods are summarized in Table 2.2-30.

The majority of groundwater quality constituents reported in the preapplication monitoring program did not exceed NC 2L Standards or USEPA water quality standards. The exceptions were aluminum, arsenic, cobalt, iron, manganese, nickel, nitrate, nitrite, pH, and total coliforms, detected at concentrations greater than NC 2L Standards and USEPA water quality standards in samples collected from certain monitoring wells.

- Constituents such as aluminum, arsenic, iron, and manganese commonly have elevated naturally occurring groundwater concentrations within the Piedmont, and these should be considered background concentrations (Chapman et al., 2013) (NCDWR, 2025).

- pH was recorded less than the range for both the USEPA maximum contaminant limit (MCL) and NC 2L Standard for the majority of wells sampled for each sampling event. Piedmont groundwater is often slightly acidic, resulting in naturally occurring lower pH measurements (Wang, 2016).

- Cobalt was identified in wells W-2, W-3, W-4, W-5, W-8, and W-9 in at least one sampling event greater than the NC 2L Standard. A background well associated with the FGD landfill has historical concentrations of elevated cobalt. Cobalt concentrations identified within the Project site wells are considered background concentrations.

- Nickel was detected in one well (W-3) greater than the NC 2L in April 2025.

- Nitrate was detected in one well (W-7) greater than the USEPA MCL and NC 2L in samples from the June and October 2024 and the January 2025 sampling events.

- Nitrite was detected in wells W-12 and W-13 greater than the USEPA MCL and NC 2L during the October 2024 and January 2025 sampling events.

- Total coliforms were identified in most samples collected in each sampling event. Coliform bacteria are naturally occurring in the environment and are not an indication of poor groundwater quality. *E. coli* was identified once in well W-11 in October 2024 and was not identified in other samples during the preapplication groundwater sampling.

While a limited number of constituents were detected at concentrations greater than regulatory thresholds, the results reflect site-specific background conditions and are not indicative of anthropogenic impact based on the previous undeveloped land use. Table 2.2-31 summarizes the groundwater analytical results for June and October 2024, January 2025, and April 2025 by range and mean.

2.2.4 WATER MONITORING

This section describes the water monitoring program that is used to characterize the surface and groundwater resources. It also includes details of relevant historical monitoring programs.

2.2.4.1 Surface Water

2.2.4.1.1 Existing Monitoring Locations

As Figure 2.2-36 shows, the NCDEQ has historical monitoring stations located throughout the Project Vicinity as part of the Ambient Monitoring System (AMS). These stations obtained data for areas of Town Fork Creek, Dan River, and Belews Lake from approximately 1973 through 2020 (Table 2.2-32). AMS stations are generally located at fixed points above and below known point source dischargers to monitor their possible effects on surface water quality. With the institution of the NPDES permitting program in the late 1970s AMS stations became redundant and were made inactive (NCDEQ, 2017a). Historical data include biological counts, minor inorganic metals, major inorganic metals, minor inorganic non-metals, biological, microbiological, nutrient, physical characteristics, other organics, organic polychlorinated biphenyls, and stable isotopes. Data is available through the USEPA-managed National Water Quality Monitoring Council (NWQMC). Table 2.2-32 lists the station identifiers, sample periods, and sampled characteristic groups. Figure 2.2-36 shows the locations of the stations.

The USGS maintains an active monitoring station at Dan River Pine Hall shown in Figure 2.2-36. It records daily data for precipitation, gage height, and discharge with data available through the USGS water data for the national inventory (USGS, n.d. [a]). Table 2.2-33 lists the station identifier, sample period, and sample parameters.

Belews Lake water levels are dependent on natural and man-made inflows and outflows. Section 2.2.1.1 describes the monitoring and characterization of these water levels.

Duke Energy regularly samples both the Dan River and Belews Lake and maintains water quality monitoring data in accordance with NPDES regulatory and permitting requirements, 316(a) thermal variance monitoring, and NCDEQ 15A NCAC 02B.0500 water quality instream monitoring requirements (NCDEQ, 2022b). Figure 2.2-34 shows sample locations.

2.2.4.1.2 Preapplication Monitoring Program

Duke Energy sampled 11 surface water quality sampling locations throughout the Project site and Project Vicinity as part of a preapplication surface water quality monitoring program (Figure 2.2-35). Surface water quality sampling locations were chosen to supplement available historical water quality information from the Project site and to characterize seasonal variation in chemical conditions of surface waters. Surface water monitoring of potential source water bodies and receiving streams was conducted on a quarterly basis from April 2024, July 2024, October 2024, and January 2025. Surface water resources and sampling locations are depicted on Figure 2.2-35 and include:

- Six locations on the Project site on unnamed tributaries (i.e., on-site streams) that discharge to Belews Lake
- Four locations on the Dan River
- One location within Town Fork Creek

Each location was sampled once quarterly from April 2024 through January 2025. During the summer 2024 sampling period, one location had a dry riverbed resulting in a total of 43 samples. State-certified laboratories analyzed samples for standard water quality parameters

(temperature, pH, conventional pollutants), metals, and selected radionuclides. Samples were collected in compliance with analytical requirements and met NCDEQ and USEPA requirements.

Grab samples were collected in laboratory-supplied containers, individually wrapped in bubble wrap, placed in a cooler on ice, and delivered to the analytical laboratories for analysis. Surface water grab samples and field water quality parameters (pH, dissolved oxygen, temperature, specific conductance, and turbidity) were measured at each location. The full analytical list and their corresponding laboratory methods are shown in Table 2.2-30.

Duke Energy's preapplication monitoring program included the surface water quality sampling locations, methods, parameters, and analyses that Section 2.2.3.1 describes.

2.2.4.2 Groundwater

Duke Energy's preapplication monitoring program included groundwater quality sampling and analyses, which Section 2.2.4.2 describes. The preapplication monitoring program consisted of sampling 15 groundwater observation wells (Figure 2.2-37). Groundwater sample locations were selected to establish baseline groundwater conditions at each of the three Plant Complexes. These sample locations were each sampled once quarterly from June 2024 to April 2025. Samples were analyzed for standard water quality parameters (temperature, pH, conventional pollutants), metals, and selected radionuclides following the guidance of NUREG-1555 as Section 2.2.3.2 describes.

2.2.4.2.1 Groundwater Quality

Groundwater quality sample collection occurred during each of the four quarters using low-flow (low purge) sampling methodology in general accordance with the procedures described in USEPA Region 4 Laboratory Services and Applied Science Division (LSASD), *Groundwater Sampling*, dated April 22, 2023, and in accordance with the Project site standard operating procedures and quality assurance procedures. Groundwater sampling was completed at the 15 observation wells for the sampling events in June 2024, October 2024, January 2025, and April 2025 with exceptions for wells W-2, W-9, and W-13. Samples were not retrieved from wells W-2 and W-9 in June 2024 because the water level was too low at the time and the wells could not be sampled. W-13 was not sampled in April 2025 due to insufficient water volume.

Prior to collecting groundwater samples, groundwater was purged from the observation wells using a stainless-steel submersible bladder pump. During well purging, water quality field parameters pH, dissolved oxygen, oxidation reduction potential, temperature, and specific conductance were measured using a calibrated YSI Professional Pro Plus and turbidity was measured using a calibrated MicroTPW turbidity meter. Water quality field parameters were measured and recorded during purging and at the time of sampling. Well purging continued until water quality parameters stabilized based on the procedures described in USEPA LSASD, *Groundwater Sampling*, dated April 22, 2023.

After purging, groundwater samples were collected in laboratory-supplied containers, individually wrapped in bubble wrap, placed in coolers on ice, and delivered to Eurofins USA locations in Savannah, Georgia, and Orlando, Florida – and Pace Analytical in Greensboro, NC. Samples for all events were released and transported to the analytical laboratories in accordance with chain of custody procedures. Quality assurance and quality control samples

were collected for each quarterly sampling event that consisted of one duplicate, one matrix spike and one matrix spike duplicate sample.

Before and in between observation well sampling locations, the bladder pump and corresponding sample equipment were decontaminated with an Alconox® and deionized water rinse. The YSI and MicroTPW were calibrated before use each morning and performed a calibration check at the end of each day of sampling.

2.2.4.2.2 Other Groundwater Monitoring

In conjunction with the SSAR field activities, groundwater level readings were taken on a monthly basis. This information was collected under approved work instructions as part of the subsurface investigation scope of work in accordance with nuclear quality assurance (NQA-1) procedures as described in SSAR Section 2.4.12.

Table 2.2-1
Regional USGS Stream Runoff Rates

Station	Drainage Area (mi^2)	Average Flow (cfs)	Median Flow (cfs)	10 Percentile Flow (cfs)	Average Annual Runoff (in./yr)
USGS 02093877 Brush Creek at Muirfield Rd at Greensboro, NC	5.3	**7.5**	**3.2**	**1.3**	19.3
USGS 02094659 South Buffalo Creek Near Pomona, NC	7.3	**12.3**	**2.5**	**0.8**	22.8
USGS 02099000 East Fork Deep River Near High Point, NC	14.8	**22.0**	**8.2**	**3.2**	20.4
USGS 0209399200 Horsepen Creek at US 220 Near Greensboro, NC	14.9	**21.0**	**8.6**	**3.0**	18.9
USGS 02093800 Reedy Fork Near Oak Ridge, NC	20.6	**22.0**	**12.8**	**4.9**	14.6
USGS 02075160 Moon Creek Near Yanceyville, NC	32.8	–	–	–	–
USGS 02095500 North Buffalo Creek Near Greensboro, NC	37.1	**58.0**	**26.0**	**11.4**	21.3
USGS 02114450 Little Yadkin River at Dalton, NC	42.8	**43.0**	**24.0**	**9.3**	13.6
USGS 02077200 Hyco Creek Near Leasburg, NC	49.5	**46.0**	**14.0**	**0.7**	12.6
USGS 0209553650 Buffalo Creek at SR2819 Near McLeansville, NC	88.5	**166.0**	**79.0**	**50.0**	25.5
USGS 02068500 Dan River Near Francisco, NC	129.0	**200.0**	**153.0**	**80.0**	21.0
USGS 02094500 Reedy Fork Near Gibsonville, NC	131.0	**95.0**	**19.2**	**4.0**	9.9
USGS 02093500 Haw River Near Benaja, NC	168.0	**132.0**	**82.0**	**26.0**	10.7
USGS 02113850 Ararat River at Ararat, NC	231.0	**331.0**	**245.0**	**123.0**	19.5
USGS 02070500 Mayo River Near Price, NC	242.0	**335.0**	**242.0**	**125.0**	18.8
USGS 02069000 Dan River at Pine Hall, NC	501.0	**652.0**	**426.0**	**215.0**	17.7
USGS 02074000 Smith River at Eden, NC	538.0	**684.0**	**495.0**	**229.0**	17.3
USGS 02071000 Dan River Near Wentworth, NC	1053.0	**1174.0**	**791.0**	**368.0**	15.1
Average	–	**235.3**	**154.8**	**73.8**	17.6
Minimum	–	**7.5**	**2.5**	**0.7**	9.9
Median	–	**95.1**	**25.6**	**11.4**	18.8
Maximum	–	**1173.9**	**791.0**	**368.0**	25.5
Belews Lake Spillway	69.3	**23.0**	**0.0**	**0.0**	4.4

Sources: USGS, n.d. (c)
Key: cfs = cubic feet per second; in./yr = inches per year; mi^2 = square mile; NC = North Carolina; USGS = U.S. Geological Survey

Table 2.2-2
Representative Drainage Areas within the Project Vicinity

Location	Drainage Area (mi^2)
Representative Dan River Basin Drainage Areas	
Dan River above the Confluence with Belews Creek[(a)]	501
Drainage Areas within Belews Lake	
East Belews Creek at Inflow to Lake	8.0
West Belews Creek at Inflow to Lake	9.0
West Belews Creek at Entrance to CCW Canal	13.3
Belews Creek at Inflow to Lake	20.8
Belews Creek below CCW Canal Junction	55.3
West Belews Creek at CCW Canal Outlet	13.5
Unnamed Right Bank Tributary to Belews Creek above Dam	2.0
Belews Creek at Belews Lake Spillway	69.4

Source: USGS, n.d.(b)
Notes:
(a) Town Fork Creek is 135 $mi.^2$ (350 km^2) of this drainage area.
Key: CCW = Condenser Cooling Water; mi^2 = square mile

Table 2.2-3
Dan River at Pine Hall Annual Average and Median Flows from 1924 through 2024

Water Year[a]	Annual Average Flow[b] (cfs)	Annual Median Flow[b] (cfs)
1924	623	438
1925	469	390
1987	849	477
1988	378	336
1989	727	510
1990	1025	780
2010	729	417
2011	424	301
2012	501	365
2013	677	519
2014	590	434
2015	396	298
2016	853	621
2017	520	280
2018	580	373
2019	1044	770
2020	943	598
2021	983	739
2022	464	336
2023	554	457
2024	636	405
Average WY (1987 – 2024)[b,c]	677	474
Average POR[b,d]	665	469

Source: USGS, n.d. (a).
Notes:
(a) Water year is from October 1 – September 30.
(b) Data for water years with limited or no data is not included.
(c) Average of USGS annual average flows WY 1987 – WY 2024.
(d) Average of USGS annual average flows WY 1924 – WY 2024.
Key: cfs = cubic feet per second; POR = period of record; WY = water year

Table 2.2-4
Monthly Mean Discharges of the Dan River at Pine Hall from 1986 through 2024

Month	Mean Discharge[(a)] (cfs)
January	822
February	959
March	831
April	861
May	842
June	568
July	437
August	421
September	465
October	525
November	564
December	724

Source: USGS, n.d. (a).
Note:
(a) Based on data April 1986 – November 1990; December 2008 – September 2024.
Key: cfs = cubic feet per second

Table 2.2-5
Annual Average Low-Flow Data (1- through 60-Day Durations) for the Dan River at Pine Hall

Year[a,c]	1-day[b]	7-day[b]	15-day[b]	30-day[b]	60-day[b]
1986	65	91	106	117	141
1987	185	192	200	227	267
1988	117	135	157	197	212
1989	229	247	250	260	289
1990	219	222	236	260	301
2009	121	143	153	165	187
2010	117	122	141	185	291
2011	111	130	131	151	172
2012	194	197	209	215	224
2013	238	244	261	271	270
2014	186	214	215	228	251
2015	112	122	143	152	211
2016	182	188	196	209	227
2017	159	163	175	208	227
2018	177	206	230	246	247
2019	179	190	199	203	246
2020	344	390	431	451	577
2021	221	226	232	241	247
2022	234	234	241	241	247
2023	154	157	160	164	176
2024	123	128	156	193	250

Source: USGS, n.d. (a)

Notes:

(a) Represents a calendar year.
(b) Values in cubic feet per second (cfs).
(c) Streamflow data missing from 1992 to 2007 due to inactive stream gage.

Table 2.2-6
Water Budget Summary for Belews Lake from 1997 to 2024

Component	Volume (ac-ft)	Rate		Percent (%)
		ac-ft/year	(cfs)	
Watershed Runoff	1,354,862	49,581	68.5	76.5
Direct Precipitation	385,687	14,114	19.5	21.8
Dan River Diversion	29,566	1082	1.5	1.7
Total Inflows	**1,770,115**	**64,777**	**89.5**	**100.0**
Consumptive Withdrawal	201,449	7372	10.2	11.4
Natural Lake Evaporation	334,354	12,236	16.9	18.9
Forced Evaporation	332,794	12,178	16.8	18.8
Spillway Release	572,213	20,940	28.9	32.3
Leakage and Seepage	328,510	12,022	16.6	18.6
Change in Storage	821	30	0.0	0.0
Total Outflows	**1,770,141**	**64,778**	**89.4**	**100.0**

Key: ac-ft = acre feet; cfs = cubic feet per second

Table 2.2-7
Daily Elevation Duration – Belews Lake Levels Relative to Target Lake Levels

Month	Target Elevation[(a)] (foot)	Percentile	0.5 foot below Target Elevation	Percentile	Percent within 0.5 foot
January	724.70	91%	724.20	42%	49%
February	724.70	87%	724.20	31%	56%
March	724.70	88%	724.20	20%	69%
April	724.70	92%	724.20	10%	82%
May	724.70	91%	724.20	8%	83%
June	724.50	62%	724.00	14%	48%
July	724.50	85%	724.00	41%	44%
August	724.50	87%	724.00	53%	34%
September	724.45	90%	723.95	60%	31%
October	724.45	91%	723.95	62%	29%
November	724.45	80%	723.95	63%	17%
December	724.70	94%	724.20	61%	34%

Note:
(a) Target Elevation obtained from Belews Lake Spillway Operations plan as described in Section 2.2.1.1.2.3.

Table 2.2-8
Belews Lake Elevation – Area – Storage Data (Original Lake Design)

Water Surface Elevation (foot)	**Surface Area** (acre)	**Storage Volume** (acre feet)
580	0	0
590	13	65
600	73	497
610	215	1939
620	384	4934
630	575	9909
640	760	16,581
650	1000	25,383
660	1228	36,525
670	1500	50,167
680	1770	66,519
690	2125	85,996
700	2525	109,248
705	2679[(a)]	122,259
710	2834	136,039
715	3096	150,884
720	3408	167,124
725	3863	185,299
730	4156	205,344
735	4325[(a)]	226,544

Note:
(a) interpolated value.

Table 2.2-9
Streams Identified within the Delineation Survey Area
(Sheet 1 of 2)

Name	Channel Length (feet) within the Delineation Survey Area	Channel Length (feet) within the Project Site[a]	Designation	Preliminary Jurisdictional Determination[b]	NCSAM Rating	Latitude	Longitude
S49	255	255	Perennial	Jurisdictional	High	36.259405	-80.069759
S52	2017	2017	Perennial	Jurisdictional	High	36.26232	-80.069181
S53	716	716	Intermittent/Perennial	Jurisdictional	High	36.264559	-80.072425
S54 (canal)	3440	3440	Perennial	Jurisdictional	High	36.266455	-80.053058
S55	285	286	Intermittent/Perennial	Jurisdictional	High	36.273856	-80.060102
S56	641	641	Intermittent/Perennial	Jurisdictional	Medium	36.278812	-80.051614
S57	432	432	Intermittent	Jurisdictional	High	36.278938	-80.050286
S58	772	768	Perennial	Jurisdictional	High	36.27858	-80.047245
S58a	80	80	Intermittent	Jurisdictional	High	36.279353	-80.047248
S59	343	343	Intermittent/Perennial	Jurisdictional	Medium	36.278136	-80.04389
S60	1387	1387	Perennial	Jurisdictional	High	36.273156	-80.047588
S61	938	924	Intermittent/Perennial	Jurisdictional	High	36.273121	-80.050742
S62	1061	1062	Intermittent	Jurisdictional	High	36.266686	-80.054032
S63	569	558	Intermittent/Perennial	Jurisdictional	High	36.26457	-80.058308
S64	1358	1358	Perennial	Jurisdictional	High	36.261924	-80.060111
S65	286	286	Intermittent	Jurisdictional	Medium	36.262682	-80.059915
S66	225	225	Intermittent	Jurisdictional	NCDWR: High USACE: Medium	36.262616	-80.062341
S67	1627	1597	Intermittent/Perennial	Jurisdictional	High	36.259516	-80.06478
S68	706	706	Intermittent/Perennial	Jurisdictional	High	36.258136	-80.061778
S69	2992	2992	Intermittent/Perennial	Jurisdictional	High	36.263156	-80.066343
S70	633	633	Intermittent	Jurisdictional	Medium	36.265339	-80.064281

Table 2.2-9
Streams Identified within the Delineation Survey Area
(Sheet 2 of 2)

Name	Channel Length (feet) within the Delineation Survey Area	Channel Length (feet) within the Project Site[(a)]	Designation	Preliminary Jurisdictional Determination[(b)]	NCSAM Rating	Latitude	Longitude
S127	865	865	Intermittent/Perennial	Jurisdictional	High	36.271143	-80.057785
Dan River	105	100	Perennial	Jurisdictional	NA	36.309744	-80.077654

Notes:

(a) Because of variations in the Project site boundary as compared to the delineation survey area, the lengths of five stream features (S58, S61, S63, S67, and the Dan River) are reduced within the Project site. These values represent areas of the features within the Project Site only.

(b) Based on current interpretations of the WOTUS Rule.

Key: NA = not applicable; NCDWR = North Carolina Division of Water Resources; NCSAM = North Carolina Stream Assessment Method; S = Stream

Table 2.2-10
Summary of Gradients of Selected Project Site Streams

Project Site Stream	Profile Slope		
	Length (foot)	Fall (foot)	Slope (percent)
S52	2017	69	3.4
S56	641	30	4.7
S60	1387	67	4.8
S69	2992	67	2.3

Table 2.2-11
Craig Road Landfill Hydraulic Conductivities and Flow Velocities

Hydrostratigraphic Unit	Hydraulic Conductivity (Geometric Mean) (ft/day)/(m/day)	Horizontal Flow Velocity (Geometric Mean) (ft/year)/(m/year)
Saprolite	2.12 (0.65)	90.3 (27.5)
Weathered Rock	0.97 (0.30)	61.2 (18.7)
Partially Weathered/Fractured Rock	1.92 (0.59)	495.9 (151)
Competent Rock	0.12 (0.04)	54.3 (16.6)

Source: S&ME, 2011
Key: ft/day = feet per day; ft/year = feet per year; m/day = meters per day; ft/year = feet per year m/year = meters per year

Table 2.2-12
Belews Creek Monitoring Well Construction

Monitoring Well	Northing[(a)]	Easting[(a)]	Ground Surface Elevation[(a)] (ft.)	Top of Casing Elevation[(a)] (ft.)	Well Diameter (inches)	Well Depth (ft. bgs)	Top of Screen (ft. bgs)	Bottom of Screen (ft. bgs)	Top of Screen (ft. NAVD 88)	Bottom of Screen (ft. NAVD 88)	Top of PWR (ft. bgs)	Top of PWR (ft. NAVD 88)	Top of Rock (ft. bgs)	Top of Rock (ft. NAVD 88)
W-1	923696.4	1690333.1	803.4	805.92	2	82.3	60.0	80.0	743.4	723.4	2.3	801.1	33.8	769.6
W-2	923203.1	1690472.0	830.3	832.97	2	97.3	72.0	92.0	758.3	738.3	19.0	811.3	26.0	804.3
W-3	923213.0	1691824.9	820.7	823.14	2	74.3	52.0	72.0	768.7	748.7	NP	NP	44.0	776.7
W-4	922868.5	1691399.6	826.1	828.74	2	66.3	54.0	64.0	772.1	762.1	25.4	800.7	35.6	790.5
W-5	922702.3	1690494.9	836.4	839.19	2	88.3	66.0	86.0	770.4	750.4	NP	NP	35.5	800.9
W-6	919044.7	1687926.2	798.6	801.51	2	64.3	44.0	59.0	754.6	739.6	35.5	763.1	58.7	739.9
W-7	919062.9	1688467.8	816.5	819.04	2	65.3	45.0	60.0	771.5	756.5	40.5	776.0	60.5	756.0
W-8	918586.5	1688768.2	812.1	815.30	2	36.3	21.0	31.0	791.1	781.1	10.0	802.1	26.5	785.6
W-9	918526.4	1687708.0	823.7	826.37	2	99.3	77.0	97.0	746.7	726.7	NP	NP	46.8	776.9
W-10	918328.9	1688247.8	810.5	813.35	2	49.3	34.0	44.0	776.5	766.5	33.5	777.0	40.5	770.0
W-11	917690.1	1687055.8	817.4	820.21	2	70.8	55.5	65.5	761.9	751.9	50.3	767.1	65.5	751.9
W-12	917656.0	1686355.0	798.1	801.12	2	50.3	35.0	45.0	763.1	753.1	35.5	762.6	40.5	757.6
W-13	917097.0	1686912.4	842.9	846.15	2	59.3	44.0	54.0	798.9	788.9	40.5	802.4	49.2	793.7
W-14	916538.5	1686198.0	850.4	853.09	2	62.3	42.0	57.0	808.4	793.4	42.0	808.4	42.6	807.8
W-15	916307.9	1686738.4	774.9	778.02	2	41.3	29.0	39.0	745.9	735.9	43.0	731.9	48.5	726.4

Note:
(a) Coordinates are North American Datum (NAD) 83; Elevations are North American Vertical Datum (NAVD) 1988.
Key: bgs = Below ground surface; ft = feet; ID = identification; NP = Not present

Table 2.2-13
Belews Creek Observation Well Groundwater Elevations
(Sheet 1 of 5)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft NAVD88)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft NAVD88)
W-1 (North Plant Complex)	6/12/2024	7/15/2024	805.92	62.14	743.78
		8/19/2024		62.58	743.34
		9/22/2024		62.58	743.34
		10/11/2024		62.20	743.72
		11/10/2024		62.18	743.74
		12/7/2024		62.19	743.73
		1/8/2025		61.89	744.03
		2/7/2025		61.68	744.24
		3/7/2025		60.72	745.20
		4/14/2025		60.31	745.61
		5/15/2025		59.95	745.97
		6/24/2025		59.00	746.92
W-2 (North Plant Complex)	9/19/2024	7/15/2024	832.97	NM	NM
		8/19/2024		NM	NM
		9/22/2024		71.84	761.13
		10/11/2024		57.89	775.08
		11/10/2024		54.76	778.21
		12/7/2024		53.46	779.51
		1/8/2025		53.17	779.80
		1/28/2025		53.02	779.95
		2/7/2025		59.83	773.14
		3/7/2025		53.78	779.19
		4/14/2025		52.95	780.02
		5/15/2025		54.35	778.62
		6/24/2025		53.12	779.85
W-3 (North Plant Complex)	6/21/2024	7/15/2024	823.14	58.70	764.44
		8/19/2024		57.78	765.36
		9/22/2024		57.91	765.23
		10/11/2024		58.36	764.78
		11/10/2024		57.96	765.18
		12/7/2024		58.01	765.13
		1/8/2025		59.55	763.59
		1/29/2025		60.65	762.49
		2/7/2025		64.66	758.48
		3/7/2025		64.34	758.80
		4/15/2025		64.94	758.20
		5/15/2025		67.41	755.73
		6/24/2025		66.65	756.49

Table 2.2-13
Belews Creek Observation Well Groundwater Elevations
(Sheet 2 of 5)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft NAVD88)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft NAVD88)
W-4 (North Plant Complex)	6/24/2024	7/15/2024	828.74	60.15	768.59
		8/19/2024		60.12	768.62
		9/22/2024		60.16	768.58
		10/11/2024		60.17	768.57
		11/10/2024		60.07	768.67
		12/7/2024		59.86	768.88
		1/8/2025		59.62	769.12
		2/7/2025		59.51	769.23
		3/7/2025		59.41	769.33
		4/16/2025		59.27	769.47
		5/15/2025		59.08	769.66
		6/24/2025		58.81	769.93
W-5(North Plant Complex)	6/18/2024	7/15/2024	839.19	67.59	771.60
		8/19/2024		67.58	771.61
		9/22/2024		66.41	772.78
		10/11/2024		67.26	771.93
		11/10/2024		67.63	771.56
		12/7/2024		67.76	771.43
		1/8/2025		67.81	771.38
		2/7/2025		67.88	771.31
		3/7/2025		67.73	771.46
		4/16/2025		67.67	771.52
		5/15/2025		67.55	771.64
		6/24/2025		67.45	771.74
W-6 (Middle Plant Complex)	6/13/2024	7/15/2024	801.51	47.80	753.71
		8/19/2024		48.81	752.70
		9/22/2024		49.75	751.76
		10/11/2024		50.03	751.48
		11/10/2024		50.52	750.99
		12/7/2024		51.06	750.45
		1/8/2025		51.36	750.15
		2/7/2025		51.64	749.87
		3/7/2025		51.12	750.39
		4/16/2025		50.78	750.73
		5/15/2025		50.53	750.98
		6/24/2025		50.55	750.96

Table 2.2-13
Belews Creek Observation Well Groundwater Elevations
(Sheet 3 of 5)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft NAVD88)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft NAVD88)
W-7 (Middle Plant Complex)	6/14/2024	7/15/2024	819.04	37.18	781.86
		8/19/2024		37.78	781.26
		9/22/2024		38.33	780.71
		10/11/2024		37.53	781.51
		11/10/2024		38.70	780.34
		12/7/2024		39.06	779.98
		1/8/2025		39.30	779.74
		2/7/2025		39.57	779.47
		3/7/2025		38.90	780.14
		4/15/2025		38.82	780.22
		5/15/2025		38.71	780.33
		6/24/2025		38.63	780.41
W-8 (Middle Plant Complex)	6/26/2024	7/15/2024	815.30	28.60	786.70
		8/19/2024		28.95	786.35
		9/22/2024		29.45	785.85
		10/11/2024		29.46	785.84
		11/10/2024		29.79	785.51
		12/7/2024		30.08	785.22
		1/8/2025		30.25	785.05
		2/7/2025		30.36	784.94
		3/7/2025		29.71	785.59
		4/16/2025		29.45	785.85
		5/15/2025		29.51	785.79
		6/24/2025		29.47	785.83
W-9(Middle Plant Complex)	9/19/2024	7/15/2024	826.37	NM	NM
		8/19/2024		54.24	772.13
		9/22/2024		87.62	738.75
		10/11/2024		74.12	752.25
		11/10/2024		55.79	770.58
		12/7/2024		50.81	775.56
		1/8/2025		50.40	775.97
		1/28/2025		50.41	775.96
		2/7/2025		57.34	769.03
		3/7/2025		50.99	775.38
		4/15/2025		50.48	775.89
		5/15/2025		51.31	775.06
		6/24/2025		50.78	775.59

Table 2.2-13
Belews Creek Observation Well Groundwater Elevations
(Sheet 4 of 5)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft NAVD88)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft NAVD88)
W-10 (Middle Plant Complex)	6/15/2024	7/15/2024	813.35	36.70	776.65
		8/19/2024		36.85	776.50
		9/22/2024		37.33	776.02
		10/11/2024		37.63	775.72
		11/10/2024		38.16	775.19
		12/7/2024		38.62	774.73
		1/8/2025		39.05	774.30
		2/7/2025		39.45	773.90
		3/7/2025		38.65	774.70
		4/15/2025		38.19	775.16
		5/15/2025		37.93	775.42
		6/24/2025		37.03	776.32
W-11 (South Plant Complex)	6/8/2024	7/15/2024	820.21	38.56	781.65
		8/19/2024		38.95	781.26
		9/22/2024		39.31	780.90
		10/11/2024		39.56	780.65
		11/10/2024		39.83	780.38
		12/7/2024		39.95	780.26
		1/8/2025		40.11	780.10
		2/7/2025		40.32	779.89
		3/7/2025		40.36	779.85
		4/14/2025		40.26	779.95
		5/15/2025		40.00	780.21
		6/24/2025		38.86	781.35
W-12 (South Plant Complex)	6/13/2024	7/15/2024	801.12	37.40	763.72
		8/19/2024		37.05	764.07
		9/22/2024		37.07	764.05
		10/11/2024		37.26	763.86
		11/10/2024		37.50	763.62
		12/7/2024		37.66	763.46
		1/8/2025		37.94	763.18
		2/7/2025		38.27	762.85
		3/7/2025		38.42	762.70
		4/14/2025		38.59	762.53
		5/15/2025		38.58	762.54
		6/24/2025		38.55	762.57

Table 2.2-13
Belews Creek Observation Well Groundwater Elevations
(Sheet 5 of 5)

Monitoring Well Identification	Well Development Completion Date	Date Gauged	TOC Elevation (ft NAVD88)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft NAVD88)
W-13(South Plant Complex)	6/26/2024	7/15/2024	846.15	56.63	789.52
		8/19/2024		56.39	789.76
		9/22/2024		56.36	789.79
		10/11/2024		56.55	789.60
		11/10/2024		56.61	789.54
		12/7/2024		56.64	789.51
		1/8/2025		56.74	789.41
		2/7/2025		56.93	789.22
		3/7/2025		57.06	789.09
		4/14/2025		57.00	789.15
		5/15/2025		62.12	784.03
		6/24/2025		62.15	784.00
W-14 (South Plant Complex)	6/11/2024	7/15/2024	853.09	42.93	810.16
		8/19/2024		42.81	810.28
		9/22/2024		42.89	810.20
		10/11/2024		43.09	810.00
		11/10/2024		43.21	809.88
		12/7/2024		43.28	809.81
		1/8/2025		43.49	809.60
		2/7/2025		43.78	809.31
		3/7/2025		43.97	809.12
		4/15/2025		44.15	808.94
		5/15/2025		44.18	808.91
		6/24/2025		44.24	808.85
W-15 (South Plant Complex)	6/9/2024	7/15/2024	778.02	11.33	766.69
		8/19/2024		10.85	767.17
		9/22/2024		11.49	766.53
		10/11/2024		11.44	766.58
		11/10/2024		11.71	766.31
		12/7/2024		11.75	766.27
		1/8/2025		11.67	766.35
		2/7/2025		11.63	766.39
		3/7/2025		11.23	766.79
		4/15/2025		10.98	767.04
		5/15/2025		11.53	766.49
		6/24/2025		11.77	766.25

Note: Gray shading indicates pre-development water level, or post-development water level that had not returned to static; conditions: data not used in contouring.
Key: ft = feet; BTOC = below top of casing; ID = identification; NAVD88 = North American Vertical Datum 1988; NM = not measured (well had not been installed and/or developed at time of measuring event); TOC = top of casing

Table 2.2-14
Belews Creek Observation Well Slug Test Results
(Sheet 1 of 2)

Well ID	Aquifer Zone	Date	Test	Hydraulic Conductivity (feet/day)			Selected Method	Representative Hydraulic Conductivity (feet/day)
				Hvorslev	Bouwer- Rice	KGS		
W-1	BR	10/14/2024	Falling	14.1	10.1	17.4	Hvorslev (averaged)	14.9
			Rising	15.6	10.6	30.1		
W-2	BR	10/21/2024	Falling	-	-	-	Hvorslev (rising)	9.15E-04
			Rising	9.15E-04	6.14E-04	5.07E-04		
W-3	BR	10/14/2024	Falling	-	-	-	Bouwer- Rice (rising)	1.64
			Rising	2.51	1.64	7.65E-01		
W-4	BR	10/21/2024	Falling	-	-	-	Bouwer- Rice (rising)	1.38E-02
			Rising	1.68E-02	.1.38E-02	-		
W-5	BR	10/21/2024	Falling	6.91E-03	4.78E-03	1.00E-02	Hvorslev (averaged)	4.30E-03
			Rising	1.68E-03	1.54E-03	-		
W-6	OB/PWR	10/13/2024	Falling	-	-	-	Bouwer- Rice (rising)	16.7
			Rising	22.3	16.7	85.0		
W-7	OB/PWR	11/8/2024	Falling	1.26	1.06	1.28	Hvorslev (averaged)	1.44
			Rising	1.62	9.24E-01	1.29		
W-8	BR	10/28/2024	Falling	-	-	-	Bouwer- Rice (rising)	1.72E-02
		10/29/2024	Rising	2.77E-02	1.72E-02	-		
W-9	BR	-	Falling	-	-	-	Hvorslev (rising)	7.09E-04
		11/5/2024	Rising	7.09E-04	5.31E-04	7.48E-04		
W-10	BR	11/5/2024	Falling	-	-	-	Bouwer- Rice (rising)	5.04E-01
			Rising	7.49E-01	5.04E-01	3.93E-02		

Table 2.2-14
Belews Creek Observation Well Slug Test Results
(Sheet 2 of 2)

Well ID	Aquifer Zone	Date	Test	Hydraulic Conductivity (feet/day)			Selected Method	Representative Hydraulic Conductivity (feet/day)
				Hvorslev	Bouwer- Rice	KGS		
W-11	OB/PWR	11/8/2024	Falling	2.36	1.96	4.50E-01	Hvorslev (averaged)	2.38
			Rising	2.40	1.95	4.33E-01		
W-12	BR	10/16/2024	Falling	5.68E-01	3.93E-01	1.38E-02	Bouwer-Rice (averaged)	2.11E-01
			Rising	4.11E-02	2.95E-02	-		
W-13	BR	10/28/2024	Falling	-	-	-	Bouwer-Rice (rising)	3.48E-01
			Rising	4.69E-01	3.48E-01	2.38E-02		
W-14	BR	10/24/2024	Falling	5.29E-01	4.28E-01	5.77E-01	Bouwer-Rice (averaged)	2.47E-01
			Rising	8.51E-02	6.61E-02	4.72E-01		
W-15	OB/PWR	10/15/2024	Falling (pneumatic)	6.03	4.99	7.42	Hvorslev (averaged)	4.95

Note: Gray shading indicates representative hydraulic conductivity value; "-" Not analyzed because water levels were still recovering or method was inappropriate, i.e., falling head in unconfined well screen.
Key: BR = Bedrock; KGS = Kansas Geological Survey, does not include skin effects; ID = Identification; OB = Overburden; PWR = Partially weathered rock

Table 2.2-15
Belews Creek Horizontal Hydraulic Gradients
(Sheet 1 of 4)

Date	Plant Complex	Flow Direction	Gradient Calculations				
			Δh (ft)	**L (ft)**	**i_h (ft/ft)**	**Average i_h (ft/ft)**	**Maximum i_h (ft/ft)**
7/15/2024	North	SSE to NNW (western flow line)	25	760	3.3E-02	1.9E-02	3.3E-02
	North	WSW to ENE (eastern flow line)	5	870	5.7E-03		
	Middle	SE to NW (northern flow line)	25	590	4.2E-02	2.9E-02	4.2E-02
	Middle	E to W (middle flow line)	10	580	1.7E-02		
	Middle	NE to SW (southern flow line)	5	170	2.9E-02		
	South	SSE to NNW (northern flow line)	35	620	5.6E-02	5.0E-02	7.6E-02
	South	SW to NE (middle flow line)	25	1,290	1.9E-02		
	South	NW to SE (southern flow line)	35	460	7.6E-02		
8/19/2024	North	SSE to NNW (western flow line)	25	780	3.2E-02	1.9E-02	3.2E-02
	North	WSW to ENE (eastern flow line)	5	1,010	5.0E-03		
	Middle	SE to NW (northern flow line)	15	460	3.3E-02	2.8E-02	3.3E-02
	Middle	E to W (middle flow line)	10	440	2.3E-02		
	Middle	NE to SW (southern flow line)	5	180	2.8E-02		
	South	S to N (northern flow line)	35	730	4.8E-02	5.0E-02	8.5E-02
	South	SW to NE (middle flow line)	25	1,380	1.8E-02		
	South	NW to SE (southern flow line)	35	410	8.5E-02		
9/22/2024	North	SSE to NNW (western flow line)	25	790	3.2E-02	2.0E-02	3.2E-02
	North	WSW to ENE (eastern flow line)	5	690	7.2E-03		
	Middle	SE to NW (northern flow line)	25	610	4.1E-02	3.3E-02	4.1E-02
	Middle	E to W (middle flow line)	30	880	3.4E-02		
	Middle	NE to SW (southern flow line)	5	220	2.3E-02		
	South	S to N (northern flow line)	40	880	4.5E-02	5.2E-02	9.2E-02

Table 2.2-15
Belews Creek Horizontal Hydraulic Gradients
(Sheet 2 of 4)

Date	Plant Complex	Flow Direction	Gradient Calculations				
			Δh (ft)	**L (ft)**	**i_h (ft/ft)**	**Average i_h (ft/ft)**	**Maximum i_h (ft/ft)**
10/11/2024	North	SSE to NNW (western flow line)	25	340	7.4E-02	4.0E-02	7.4E-02
	North	W to E (eastern flow line)	5	790	6.3E-03		
	Middle	SE to NW (northern flow line)	20	670	3.0E-02		
	Middle	E to W (middle flow line)	30	830	3.6E-02	2.8E-02	3.6E-02
	Middle	NE to SW (southern flow line)	10	530	1.9E-02		
	South	S to N (northern flow line)	40	840	4.8E-02		
	South	SW to NE (middle flow line)	25	1,220	2.0E-02	5.3E-02	9.2E-02
	South	NW to SE (southern flow line)	35	380	9.2E-02		
11/10/2024	North	SSE to NNW (western flow line)	30	390	7.7E-02	4.3E-02	7.7E-02
	North	W to E (eastern flow line)	10	1,120	8.9E-03		
	Middle	SE to NW (northern flow line)	25	700	3.6E-02		
	Middle	E to W (middle flow line)	15	1,070	1.4E-02	2.5E-02	3.6E-02
	Middle	NE to SW (southern flow line)	10	420	2.4E-02		
	South	S to N (northern flow line)	40	890	4.5E-02		
	South	SW to NE (middle flow line)	25	1,270	2.0E-02	3.8E-02	4.9E-02
	South	NW to SE (southern flow line)	35	720	4.9E-02		
12/7/2024	North	SSE to NNW (western flow line)	30	360	8.3E-02	4.6E-02	8.3E-02
	North	W to E (eastern flow line)	10	1,080	9.3E-03		
	Middle	SE to NW (northern flow line)	25	660	3.8E-02		
	Middle	E to W (middle flow line)	10	1,090	9.2E-03	2.6E-02	3.8E-02
	Middle	NE to SW (southern flow line)	10	310	3.2E-02		
	South	S to N (northern flow line)	40	770	5.2E-02		
	South	SW to NE (middle flow line)	25	1,230	2.0E-02	5.3E-02	8.8E-02
	South	NW to SE (southern flow line)	35	400	8.8E-02		

Table 2.2-15
Belews Creek Horizontal Hydraulic Gradients
(Sheet 3 of 4)

Date	Plant Complex	Flow Direction	Gradient Calculations				
			Δh (ft)	L (ft)	i_h (ft/ft)	Average i_h (ft/ft)	Maximum i_h (ft/ft)
1/8/2025	North	SSE to NNW (western flow line)	30	430	7.0E-02	3.9E-02	7.0E-02
	North	WNW to ESE (eastern flow line)	10	1,120	8.9E-03		
	Middle	SE to NW (northern flow line)	15	600	2.5E-02	2.2E-02	3.1E-02
	Middle	E to W (middle flow line)	10	1,070	9.3E-03		
	Middle	NE to SW (southern flow line)	10	320	3.1E-02		
	South	S to N (northern flow line)	40	880	4.5E-02	5.2E-02	9.2E-02
	South	SW to NE (middle flow line)	25	1,320	1.9E-02		
	South	NW to SE (southern flow line)	35	380	9.2E-02		
2/7/2025	North	SSE to NNW (western flow line)	30	420	7.1E-02	4.0E-02	7.1E-02
	North	WSW to ENE (eastern flow line)	10	1,030	9.7E-03		
	Middle	SE to NW (northern flow line)	30	370	8.1E-02	4.1E-02	8.1E-02
	Middle	E to W (middle flow line)	5	770	6.5E-03		
	Middle	NE to SW (southern flow line)	5	140	3.6E-02		
	South	S to N (northern flow line)	40	640	6.3E-02	5.5E-02	8.1E-02
	South	SW to NE (middle flow line)	25	1,140	2.2E-02		
	South	NW to SE (southern flow line)	35	430	8.1E-02		
3/7/2025	North	SSE to NNW (western flow line)	30	400	7.5E-02	4.4E-02	7.5E-02
	North	WSW to ENE (eastern flow line)	10	760	1.3E-02		
	Middle	SE to NW (northern flow line)	30	340	8.8E-02	4.8E-02	8.8E-02
	Middle	E to W (middle flow line)	5	630	7.9E-03		
	South	S to N (northern flow line)	35	800	4.4E-02	4.7E-02	8.0E-02

Table 2.2-15
Belews Creek Horizontal Hydraulic Gradients
(Sheet 4 of 4)

Date	Plant Complex	Flow Direction	Gradient Calculations				
			∆h (ft)	L (ft)	i_h (ft/ft)	Average i_h (ft/ft)	Maximum i_h (ft/ft)
4/14/2025	North	SSE to NNW (western flow line)	25	370	6.8E-02	4.8E-02	6.8E-02
	North	WSW to ENE (eastern flow line)	20	730	2.7E-02		
	Middle	SE to NW (northern flow line)	30	770	3.9E-02	2.7E-02	3.9E-02
	Middle	E to W (middle flow line)	10	1,060	9.4E-03		
	Middle	NE to SW (southern flow line)	5	150	3.3E-02		
	South	S to N (northern flow line)	35	840	4.2E-02	4.5E-02	7.5E-02
	South	SW to NE (middle flow line)	25	1,410	1.8E-02		
	South	NW to SE (eastern flow line)	30	400	7.5E-02		
5/15/2025	North	SSE to NNW (western flow line)	25	430	5.8E-02	3.2E-02	5.8E-02
	North	WSW to ENE (eastern flow line)	5	870	5.7E-03		
	Middle	SE to NW (northern flow line)	20	710	2.8E-02	2.0E-02	2.8E-02
	Middle	E to W (middle flow line)	10	960	1.0E-02		
	Middle	NE to SW (southern flow line)	5	240	2.1E-02		
	South	S to N (northern flow line)	30	750	4.0E-02	4.6E-02	8.1E-02
	South	SW to NE (middle flow line)	20	1,250	1.6E-02		
	South	NW to SE (southern flow line)	30	370	8.1E-02		
6/24/2025	North	SSE to NNW (western flow line)	25	380	6.6E-02	3.7E-02	6.6E-02
	North	WSW to ENE (eastern flow line)	5	700	7.1E-03		
	Middle	SE to NW (northern flow line)	20	690	2.9E-02	2.1E-02	2.9E-02
	Middle	E to W (middle flow line)	10	1,010	1.0E-02		
	Middle	NE to SW (southern flow line)	5	210	2.4E-02		
	South	S to N (northern flow line)	35	880	4.0E-02	4.8E-02	8.5E-02

Notes:
ih = Horizontal hydraulic gradient; calculated by the formula ih = ∆h/L.
∆h = Difference in hydraulic head between contour lines used to calculate ih.
L = Horizontal distance between contour lines used to calculate ih; L measured in ArcMap and rounded to the nearest 10-foot increment.
∆h and L values were obtained from the potentiometric surface maps for the July 2024 through February 2025 events.
Key: NC = not calculated

Table 2.2-16
Vertical Hydraulic Gradients[(a)]

Date	Plant Complex	Screen Mid-Point Approach		
		Minimum i_v (ft/ft)	Maximum i_v (ft/ft)	Average i_v (ft/ft)
7/15/2024	North	NA	NA	NA
	Middle	0.018	0.36	0.24
	South	NA	NA	NA
8/19/2024	North	NA	NA	NA
	Middle	0.13	0.37	0.27
	South	NA	NA	NA
9/22/2024	North	0.054	0.33	0.21
	Middle	0.091	0.39	0.27
	South	NA	NA	NA
10/11/2024	North	-0.041	0.43	0.24
	Middle	0.093	0.39	0.28
	South	NA	NA	NA
11/10/2024	North	0.048	0.50	0.34
	Middle	0.082	0.39	0.29
	South	NA	NA	NA
12/7/2024	North	0.049	0.51	0.34
	Middle	0.12	0.43	0.32
	South	NA	NA	NA
1/8/2025	North	0.040	0.50	0.32
	Middle	0.084	0.43	0.31
	South	NA	NA	NA
2/7/2025	North	0.055	0.44	0.30
	Middle	0.059	0.41	0.29
	South	NA	NA	NA
3/7/2025	North	0.065	0.51	0.33
	Middle	0.046	0.39	0.29
	South	NA	NA	NA
4/14/2025	North	0.059	0.48	0.30
	Middle	0.048	0.42	0.29
	South	0.054	0.62	0.23
5/15/2025	North	0.066	0.48	0.30
	Middle	0.083	0.42	0.30
	South	0.065	0.59	0.24
6/24/2025	North	0.080	0.48	0.32
	Middle	0.076	0.48	0.31
	South	-0.029	0.64	0.19

Note:

(a) i_v - Vertical hydraulic gradient (ft/ft); positive value represents downward gradient, negative values (shaded in gray) represent upward gradient.

Key: ft/ft = feet per foot; NA = Not available, insufficient data

Table 2.2-17
Horizontal Groundwater Flow Velocities

Stratigraphic Unit	Hydraulic Conductivity (K)[a] (ft/day)	Average Horizontal Hydraulic Gradient[c] (i_h)(ft/ft)	Maximum Horizontal Hydraulic Gradient[c] (i_h)(ft/ft)	Specific Yield (Effective Porosity, n)	Average Horizontal Flow Velocity[d] (V_{avg}) (ft/day)	Maximum Horizontal Flow Velocity[d] (V_{max}) (ft/day)
Overburden/Partially Weathered Rock (OB/PWR)[b]	6.37	3.8E-02	9.2E-02	0.20	1.2	2.9
Shallow Bedrock [b]	1.63	3.8E-02	9.2E-02	0.019	3.3	7.9
Deep Bedrock [b]	2.49E-01	2.7E-02	4.4E-02	0.019	0.35	0.58

Notes:

(a) Average K values from slug tests for each stratigraphic unit.

(b) K values for shallow and deep bedrock from all three plant complexes; K values for OB/PWR from middle and south plant complex only.

(c) Represents average or maximum ih for each stratigraphic unit.

(d) Vavg and Vmax calculated using Darcy's Law: V = K*ih/n; Vavg uses average K and average ih and Vmax uses average K and maximum ih.

Key: ft/day = feet per day; ft/ft = feet per foot

Table 2.2-18
Pump Testing Transmissivity
(Sheet 1 of 4)

Well Identification	Distance from PW-1 (feet)	Maximum Drawdown (feet)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[(a)] (ft/day)	Storativity
PW-1[(b)] (0.06 gpm)	0.00	9.98	Shallow BR	Theis	-	-	-
				Theis (Recovery)	-	-	-
S-1[(b)]	80.2 NW	0.00	Shallow BR	Theis	No observable connection		
				Theis (Recovery)			
S-2[(b)]	39.9 NW	0.30	Shallow BR	Theis	7.23	3.62E-01	4.32E-03
				Theis (Recovery)	4.02	2.01E-01	5.19E-03
S-3[(b)]	20.1 NW	1.50	Shallow BR	Theis	2.04	1.02E-01	9.28E-04
				Theis (Recovery)	2.01	1.01E-01	9.56E-04
S-4[(b)]	20.4 SE	0.31	Shallow BR	Theis	6.94	3.47E-01	2.08E-02
				Theis (Recovery)	2.68	1.34E-01	2.39E-02
S-5[(b)]	19.8 SW	0.33	Shallow BR	Theis	9.10	4.55E-01	7.16E-03
				Theis (Recovery)	8.75	4.38E-01	7.16E-03
W-1[(b)]	19.9 NE	0.31	Shallow BR	Theis	2.91	1.46E-01	2.28E-02
				Theis (Recovery)	2.88	1.44-01	2.31E-02
Distance-Drawdown	NA	NA	Shallow BR	Theis	49.19	2.46	6.80E-07
Average					**8.89**	**4.45E-01**	**1.06E-02**

Table 2.2-18
Pump Testing Transmissivity
(Sheet 2 of 4)

Well Identification	Distance from PW-1 (feet)	Maximum Drawdown (feet)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[(a)] (ft/day)	Storativity
PW-2[(c)] (3.5 gpm)	0.00	8.42	OB/PWR	Theis	–	–	–
				Theis (Recovery)	113.3	3.78	–
S-6[(c)]	15 SW	2.75	OB/PWR	Theis	96.2	3.21	3.18E-02
				Theis (Recovery)	103.2	3.44	3.23E-02
S-7[(c)]	14.5 NW	2.88	OB/PWR	Theis	117.1	3.90	8.43E-03
				Theis (Recovery)	132.4	4.41	1.11E-02
S-8[(c)]	15.1 NE	6.25	OB/PWR	Theis	57.2	1.91	3.37E-03
				Theis (Recovery)	105.1	3.50	2.93E-03
S-9[(c)]	30.1 NE	2.25	OB/PWR	Theis	127.8	4.26	3.93E-03
				Theis (Recovery)	165.4	5.51	4.54E-03
S-10[(c)]	45 NE	0.92	OB/PWR	Theis	198.6	6.62	1.75E-02
				Theis (Recovery)	347.3	11.58	4.22E-02
W-6[(c)]	15.2 SE	2.85	OB/PWR	Theis	89.3	2.98	5.45E-02
				Theis (Recovery)	85.3	2.84	4.04E-02
Distance-Drawdown	NA	NA	OB/PWR	Theis	117.3	3.91	5.38E-03
Average					**132**	**4.42**	**1.99E-02**

Table 2.2-18
Pump Testing Transmissivity
(Sheet 3 of 4)

Well Identification	Distance from PW-1 (feet)	Maximum Drawdown (feet)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[(a)] (ft/day)	Storativity
PW-3[(d)] (0.8 gpm)	0.00	0.00	Deep BR	Theis	–	–	–
				Hantush	–	–	–
				Theis (Recovery)	1.20	6.00E-02	–
S-11[(d)]	80.2 NW	19.34	Deep BR	Theis	1.09	5.45E-02	6.36E-05
				Hantush	0.63	3.13E-02	6.47E-05
				Theis (Recovery)	1.34	6.70E-02	2.55E-05
S-12[(d)]	40.5 NW	25.83	Deep BR	Theis	0.58	2.90E-02	1.57E-04
				Hantush	0.57	2.83E-02	1.09E-04
				Theis (Recovery)	0.73	3.65E-02	3.40E-05
S-13[(d)]	19.7 NW	26.48	Deep BR	Theis	1.57	7.85E-02	2.23E-04
				Hantush	1.33	6.65E-02	2.39E-04
				Theis (Recovery)	1.78	8.90E-02	9.56E-05
S-14[(d)]	19.5 SE	28.66	Deep BR	Theis	0.78	3.92E-02	7.72E-04
				Hantush	0.48	2.42E-02	6.72E-04
				Theis (Recovery)	0.87	4.33E-02	3.32E-04
S-15[(d)]	20.0 SW	51.19	Deep BR	Theis	1.49	7.45E-02	1.40E-05
				Hantush	1.21	6.05E-02	2.39E-05
				Theis (Recovery)	1.16	5.80E-02	3.06E-06

Table 2.2-18
Pump Testing Transmissivity
(Sheet 4 of 4)

Well Identification	Distance from PW-1 (feet)	Maximum Drawdown (feet)	Aquifer Zone	Test Method	Transmissivity (ft^2/day)	Hydraulic Conductivity[(a)] (ft/day)	Storativity
S-16[(d)]	19.8 W	6.92	Deep BR	Theis	2.26	1.13E-01	9.27E-03
				Hantush	1.90	9.50E-02	9.74E-03
				Theis (Recovery)	2.87	1.44E-01	1.17E-02
DW-9 [(d)]	19.8 NE	30.96	Deep BR	Theis	1.43	7.15E-02	1.30E-04
				Hantush	1.23	6.15E-02	1.53E-04
				Theis (Recovery)	1.50	7.50E-02	4.50E-05
Distance-Drawdown	NA	NA		Hantush	4.29	2.15E-01	2.49E-06
Average					**1.40**	**7.02E-02**	**1.54E-03**

Notes:
(a) K=T/b; b=saturated aquifer thickness, assumed to be 20 ft. equal to screen length where K=hydraulic conductivity and T=Transmissivity.
(b) wells are within the North Plant Complex.
(c) wells are within the Middle Plant Complex.
(d) wells are within the South Plant Complex.

Key: BR = bedrock; OB = overburden; PWR = partially weathered rock; ft^2/day = feet squared per day; ft/day = feet/day; gpm = gallons per minute (pumping rate in pumping well); PW = pumping well; NA=Not Applicable

Table 2.2-19
Self-Supplied Surface Water Use by Water Use Category within the Project Region (2015)
(Sheet 1 of 3)

Surface Water Use Category	Water Use (Million Gallons per Day)										
	Stokes County	Caswell County	Forsyth County	Guilford County	Rockingham County	Surry County	Franklin County	Henry County (including Martinsville City)	Patrick County	Pittsylvania County (including Danville City)	Total Water Use by Category
Public Water Supply											
Total Self-Supplied Withdrawals	0	0.38	48.2	47.02	11.23	4.15	0.76	4.83	0.26	6.98	**123.8**
Domestic											
Total Self-Supplied Withdrawals	–	–	–	–	–	–	–	–	–	–	–
Total Consumptive Use	–	–	–	–	–	–	–	–	–	–	–
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Commercial											
Total Self-Supplied Withdrawals	–	–	–	–	–	–	–	–	–	–	–
Total Consumptive Use	–	–	–	–	–	–	–	–	–	–	–
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Industrial											
Total Self-Supplied Withdrawals	0	0	0	0	0	0.08	0	0	0.13	0	**0.21**
Total Consumptive Use	–	–	–	–	–	–	–	–	–	–	–
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Thermoelectric Power Generation											
Total Thermoelectric Power											
Total Self-Supplied Withdrawals	1266.8	0	0	0	3.55	0	0	0	0	0.5	**1271**
Total Consumptive Use	13.3	0	0	0	2.84	0	0	0	0	0.35	**16.49**

Table 2.2-19
Self-Supplied Surface Water Use by Water Use Category within the Project Region (2015)
(Sheet 2 of 3)

Surface Water Use Category	Water Use (Million Gallons per Day)										
	Stokes County	Caswell County	Forsyth County	Guilford County	Rockingham County	Surry County	Franklin County	Henry County (including Martinsville City)	Patrick County	Pittsylvania County (including Danville City)	Total Water Use by Category
Reclaimed Wastewater											
Once-Through Cooling Thermoelectric Power											
Total Self-Supplied Withdrawals	1266.8	0	0	0	0	0	0	0	0	0	**1267**
Total Consumptive Use	13.3	0	0	0	0	0	0	0	0	0	**13.3**
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Closed-Loop Cooling Thermoelectric Power											
Total Self-Supplied Withdrawals	0	0	0	0	3.55	0	0	0	0	0.5	**4.05**
Total Consumptive Use	0	0	0	0	2.84	0	0	0	0	0.35	**3.19**
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Mining											
Total Self-Supplied Withdrawals	0	0	0	0.19	0.42	0.27	0	0.31	0	0	**1.19**
Total Consumptive Use	–	–	–	–	–	–	–	–	–	–	–
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Livestock											
Total Self-Supplied Withdrawals	0.13	0.01	0.04	0.29	0.07	0.61	0.75	0.06	0.21	0.79	**2.96**
Total Consumptive Use	–	–	–	–	–	–	–	–	–	–	–

Table 2.2-19
Self-Supplied Surface Water Use by Water Use Category within the Project Region (2015)
(Sheet 3 of 3)

Surface Water Use Category	Water Use (Million Gallons per Day)										
	Stokes County	Caswell County	Forsyth County	Guilford County	Rockingham County	Surry County	Franklin County	Henry County (including Martinsville City)	Patrick County	Pittsylvania County (including Danville City)	Total Water Use by Category
Aquaculture											
Total Self-Supplied Withdrawals	–	–	–	–	–	–	0	0	0	0.01	**0.01**
Total Consumptive Use	–	–	–	–	–	–	–	–	–	–	–
Irrigation											
Total Self-Supplied Withdrawals[a]	1.07	0	3.82	7.09	2.74	4.6	0.5	0.15	0.1	1.27	**21.34**
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Crop											
Total Self-Supplied Withdrawals[a]	0.68	0	1.46	3.62	1.4	3.6	0.24	0.04	0.03	1.03	**12.1**
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Golf Course											
Total Self-Supplied Withdrawals[a]	0.39	0	2.36	3.47	1.34	1	0.26	0.11	0.07	0.24	**9.24**
Reclaimed Wastewater	–	–	–	–	–	–	–	–	–	–	–
Total County Water Use	**1268**	**0.39**	**52.06**	**54.59**	**18.01**	**9.71**	**2.01**	**5.35**	**0.7**	**9.54**	**1420[b]**

Source: USGS, 2018a
Notes:
(a) Irrigation Total Self-Supplied Withdrawals are considered entirely consumptive.
(b) Summation of Total Self-Supplied Withdrawals.
Key: "-" = no information available

Table 2.2-20
Average Annual Public Water Supply Withdrawals within the Project Region in 2023

Ownership Type	County	City	Facility Name	Source	Monthly Average Use (million gallons)												Annual Average Use (million gallons)
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
North Carolina																	
Municipality	Rockingham	Eden	Robert A. Harris Water Filtration Plant	Dan River	127.07	107.74	114.48	113.82	126.29	128.37	145.42	141.52	138.45	141.58	125.76	127.75	**1538.25**
Municipality	Rockingham	Madison	Madison Water Treatment Plant	Dan River	13.95	12.32	13.21	13.26	14.14	14.07	14.76	15.50	13.59	1.46	14.55	13.61	**154.40**
Municipality	Rockingham	Mayodan	Mayodan Water Treatment Plant	Mayo River	22.54	21.28	22.54	19.98	23.13	22.65	24.24	26.94	23.49	22.10	22.41	21.14	**272.44**
Municipality	Caswell	Yanceyville	Yanceyville Water Treatment Plant	Farmers Lake	15.81	14.06	15.38	11.25	10.85	10.20	15.38	17.17	14.13	13.55	13.44	15.31	**166.53**
Virginia																	
Municipality	Pittsylvania	Danville	Danville Water Treatment Plant	Dan River	159.94	135.52	148.73	145.52	152.37	156.11	180.1	179.07	166.35	169.88	160.03	155.3	**1908.92**
County	Henry	Basset	Upper Smith River Water Filtration Plant	Smith River	94.81	83.05	91.71	88.14	95.22	92.78	98.32	97.02	92.5	96.63	92.7	94.4	**1117.28**
Municipality	Henry	Martinsville	City of Martinsville WTP	Beaver Creek Reservoir	60.34	48.88	55.7	58.93	62.03	56.39	62.66	65.59	65.4	71.27	72.22	73.57	**752.98**
County	Patrick	Stuart	Stuart Water Treatment Plant	South Mayo River	9.23	7.85	8.94	8.55	9.83	11.05	10.38	9.87	9.19	9.00	8.7	8.79	**111.38**
				Total													**6022.18**

Source: City of Eden, 2023; City of Martinsville, 2022; Danville and Pittsylvania County Economic Development, 2024; Henry County Public Service Authority, 2023; NCDEQ, 2024a; Town of Madison, 2013; Town of Mayodan, n.d.; Town of Stuart, 2023; VDH, 2024a, 2024b; Yanceyville, 2024.

Table 2.2-21
Walnut Cove Municipality LWSP Water Projections

Year	2023	2030	2040	2050	2060	2070
Year-Round Population	1757	1800	1850	1900	1950	2000
Groundwater Uses (mgd)						
Surface Water Supply	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ground Water Supply	0.4100	0.3190	0.3190	0.3190	0.3190	0.3190
Purchases	0.0500	0.1080	0.1080	0.1080	0.1080	0.1080
Future Supplies		0.0000	0.0000	0.0000	0.0000	0.0000
Total Available Supply	0.4600	0.4270	0.4270	0.4270	0.4270	0.4270
Service Area Demand	0.3066	0.3031	0.3064	0.3126	0.3157	0.3235
Sales	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Future Sales		0.0000	0.0000	0.0000	0.0000	0.0000
Total Demand	0.3066	0.3031	0.3064	0.3126	0.3157	0.3235
Demand as Percent of Supply	**67%**	**71%**	**72%**	**73%**	**74%**	**76%**

Source: NCDEQ, 2024b
Key: LWSP = Local Water Supply Plan; mgd = million gallons per day

Table 2.2-22
Public Water Supply Wells Identified Within the Project Vicinity
(Sheet 1 of 5)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft. bgs)	System Name	System Address	System City
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234139	Community	FORSYTH	WELL #3	55	250	PINE KNOLLS WATER SUPPLY	–	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234192	Community	FORSYTH	WELL #2	11	300	DEERPATH S/D	PINEY GROVE RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234192	Community	FORSYTH	WELL #3	30	405	DEERPATH S/D	PINEY GROVE RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234193	Community	FORSYTH	WELL #1	73	300	MIKKOLA DOWNS S/D	–	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0234193	Community	FORSYTH	WELL #2	18	300	MIKKOLA DOWNS S/D	–	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241197	Community	GUILFORD	WELL #1	18	505	SMOKE RIDGE ESTATES	9100 SMOKE HOLLOW RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241197	Community	GUILFORD	WELL #2	18	525	SMOKE RIDGE ESTATES	9100 SMOKE HOLLOW RD	KERNERSVILLE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241200	Community	GUILFORD	WELL #1	45	320	DORSETT DOWNS S/D	5 DORSETT DOWNS DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241203	Community	GUILFORD	WELL #2	41	-	RIVER OAKS S/D	NC 68	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241203	Community	GUILFORD	WELL #3	65	345	RIVER OAKS S/D	NC 68	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241206	Community	GUILFORD	WELL #1	60	280	WEATHERSTONE S/D	8107 BARTONSHIRE DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241206	Community	GUILFORD	WELL #2	10	700	WEATHERSTONE S/D	8107 BARTONSHIRE DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241207	Community	GUILFORD	WELL #1	55	358	MEADOW RIDGE S/D	7626 ANTHONY RD	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241207	Community	GUILFORD	WELL #2	71	385	MEADOW RIDGE S/D	7626 ANTHONY RD	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241217	Community	GUILFORD	WELL #1	37	400	HUNTCLIFF S/D	KRISTEN DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0241217	Community	GUILFORD	WELL #2	37	400	HUNTCLIFF S/D	KRISTEN DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279118	Community	ROCKINGHAM	WELL #1	18	225	RICHWOOD ACRES	–	MADISON
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279118	Community	ROCKINGHAM	WELL #2	10	300	RICHWOOD ACRES	–	MADISON
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279151	Community	ROCKINGHAM	WELL #1	15	225	QUAIL OAKS	123 FORREST DR	MADISON
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279176	Community	ROCKINGHAM	WELL #1	93	315	CEDAR HOLLOW S/D	109 SHETLAND CT	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC0279176	Community	ROCKINGHAM	WELL #4	92	605	CEDAR HOLLOW S/D	109 SHETLAND CT	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3034012	Community	FORSYTH	WELL #1	31	500	BLUE WATER COVE S/D	EASTSHORE CIRCLE	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041009	Community	GUILFORD	WELL #1	73	245	PROVIDENCE NORTH S/D	PROVIDENCE NORTH DR	STOKESDALE

Table 2.2-22
Public Water Supply Wells Identified Within the Project Vicinity
(Sheet 2 of 5)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft. bgs)	System Name	System Address	System City
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041010	Community	GUILFORD	WELL #1	62	585	HUNTING RIDGE S/D	–	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041011	Community	GUILFORD	WELL #1	25	500	SPRINGDALE S/D	8100 SPRINGBIRCH DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041011	Community	GUILFORD	WELL #2	66	300	SPRINGDALE S/D	8100 SPRINGBIRCH DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041039	Community	GUILFORD	WELL #1	7.5	800	ARBOR RUN/CHARLES PLACE S/D	7599 TREBBIANO DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041039	Community	GUILFORD	WELL #2	132	355	ARBOR RUN/CHARLES PLACE S/D	7599 TREBBIANO DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041039	Community	GUILFORD	WELL #4	50	500	ARBOR RUN/CHARLES PLACE S/D	7599 TREBBIANO DR	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041043	Community	GUILFORD	WELL #1	56	425	LINVILLE OAKS S/D	8504 CRESTED OAK COURT	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3041058	Community	GUILFORD	WELL #1	40	500	PEARMAN ESTATES	7512 BROADUS COURT	OAK RIDGE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3079023	Community	ROCKINGHAM	WELL #2	60	320	BELEWS LANDING S/D	301 CROWS NEST DR	STOKESDALE
Crystalline-Rock	AQUA NORTH CAROLINA INC.	NC3079023	Community	ROCKINGHAM	WELL #3	60	300	BELEWS LANDING S/D	301 CROWS NEST DR	STOKESDALE
Early Mesozoic basin	BAILEYTOWN CHRISTIAN CHURCH	NC3085005	Non-Community Transient	STOKES	WELL #1	10	265	BAILEYTOWN CHRISTIAN CHURCH	1163 BAILEYTOWN CH RD	WALNUT COVE
Crystalline-Rock	BETHEL UMC_0241697	NC0241697	Non-Community Transient	GUILFORD	WELL #1	40	330	BETHEL UMC	8424 HAW RIVER RD	OAK RIDGE
Early Mesozoic basin	EDEN UNITED METHODIST CHURCH_279413	NC0279413	Non-Community Transient	ROCKINGHAM	WELL #1	2	500	EDEN UNITED METHODIST CH	844 EDEN CHURCH RD	MADISON
Crystalline-Rock	ELLISBORO BAPT CH_279468	NC0279468	Non-Community Transient	ROCKINGHAM	WELL #1	40	–	ELLISBORO BAPTIST CHURCH	1604 ELLISBORO ROAD	MADISON
Crystalline-Rock	FULP MORAVIAN CHURCH_285416	NC0285416	Non-Community Transient	STOKES	WELL #1	40	–	FULP MORAVIAN CHURCH	1556 U.S. HWY 311	WALNUT COVE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279168	Non-Community Transient	ROCKINGHAM	WELL #1	50	–	HUMPHREYS RIDGE CAMPGROUND NO 2	–	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279169	Non-Community Transient	ROCKINGHAM	WELL #2	20	300	HUMPHREYS RIDGE CAMPGROUND NO 3	435 HUMPHREYS RIDGE DR.	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279169	Non-Community Transient	ROCKINGHAM	WELL #3	50	–	HUMPHREYS RIDGE CAMPGROUND NO 3	435 HUMPHREYS RIDGE DR.	STOKESDALE

Table 2.2-22
Public Water Supply Wells Identified Within the Project Vicinity
(Sheet 3 of 5)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft. bgs)	System Name	System Address	System City
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279695	Non-Community Transient	ROCKINGHAM	WELL #1	50	–	HUMPHREY`S RIDGE CAMPGRD NO 1	435 HUMPREYS RIDGE DR	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279695	Non-Community Transient	ROCKINGHAM	WELL #2	50	–	HUMPHREY`S RIDGE CAMPGRD NO 1	435 HUMPREYS RIDGE DR	STOKESDALE
Crystalline-Rock	HUMPHREYS RIDGE LLC	NC0279750	Non-Community Transient	ROCKINGHAM	WELL #2	6	500	HUMPHREY`S GRILL	435 HUMPHREYS RIDGE RD	STOKESDALE
Crystalline-Rock	JARVIS, ROSANNE	NC0285515	Non-Community Transient	STOKES	WELL #1	13	103	HILLBILLY HIDE AWAY	4335 PINE HALL RD	WALNUT COVE
Crystalline-Rock	JOYNER, JERRY	NC0241553	Non-Community Transient	GUILFORD	WELL #1	40	–	PARKERS RESTAURANT	6903 HWY 158 EAST	STOKESDALE
Crystalline-Rock	MT ZION METHODIST CHURCH_279415	NC0279415	Non-Community Transient	ROCKINGHAM	WELL #1	40	–	MT ZION METHODIST CHURCH	3708 ELLISBORO RD	STOKESDALE
Crystalline-Rock	OAK LEVEL BAPTIST CHURCH-ROCKINGHAM CO	NC3079008	Non-Transient, Non-Community	ROCKINGHAM	WELL #1	5	1504	OAK LEVEL BAPTIST ACADEMY-ROCKINGHAM CO	1569 OAK LEVEL CHURCH RD	STOKESDALE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041060	Community	GUILFORD	WELL #1	24	420	RACHEL`S LANDING	8531 BELEWS CREEK RD	STOKESDALE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041101	Community	GUILFORD	WELL #3	60	600	KNIGHT`S LANDING S/D	8515 PARKCHESTER PLACE	OAK RIDGE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041101	Community	GUILFORD	WELL #2	25	700	KNIGHT`S LANDING S/D	8515 PARKCHESTER PLACE	OAK RIDGE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041104	Community	GUILFORD	WELL #9	33	660	SHILOH SUBDIVISION	7635 MONTY DRIVE	KERNERSVILLE
Crystalline-Rock	OLD NORTH STATE WATER CO LLC	NC3041104	Community	GUILFORD	WELL #10	80	600	SHILOH SUBDIVISION	7635 MONTY DRIVE	KERNERSVILLE
Crystalline-Rock	PARKSIDE INVESTMENTS LLC	NC0285483	Non-Community Transient	STOKES	WELL #1	50	-	PARKSIDE INVESTMENTS LLC	4547 PINE HALL RD	WALNUT COVE
Crystalline-Rock	PATTEN, JIM	NC0279406	Non-Community Transient	ROCKINGHAM	WELL #1	30	225	CAROLINA CAMPING & MARINA	–	STOKESDALE
Crystalline-Rock	PATTEN, JIM	NC0279406	Non-Community Transient	ROCKINGHAM	WELL #2	25	225	CAROLINA CAMPING & MARINA	–	STOKESDALE

Table 2.2-22
Public Water Supply Wells Identified Within the Project Vicinity
(Sheet 4 of 5)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft. bgs)	System Name	System Address	System City
Crystalline-Rock	PATTEN, JIM	NC0279406	Non-Community Transient	ROCKINGHAM	WELL #3	35	300	CAROLINA CAMPING & MARINA	–	STOKESDALE
Crystalline-Rock	SIMAAN QUAIL ACRES, LLC	NC0279157	Community	ROCKINGHAM	WELL #3	29	505	QUAIL ACRES MHP	152 TURFWOOD CIRCLE	STOKESDALE
Crystalline-Rock	SIMAAN QUAIL ACRES, LLC	NC0279157	Community	ROCKINGHAM	WELL #5	21	505	QUAIL ACRES MHP	152 TURFWOOD CIRCLE	STOKESDALE
Crystalline-Rock	SMITH-STACEY, LYNN	NC0285521	Non-Community Transient	STOKES	WELL #1	10	168	SMITHS GROCERY & GRILL	2294 PINE HALL ROAD	PINE HALL
Early Mesozoic Basin	STOKES COUNTY SCHOOLS	NC0285428	Non-Transient, Non-Community	STOKES	WELL #1	50	175	PINE HALL ELEM SCHOOL	1400 PINE HALL ROAD	PINE HALL
Crystalline-Rock	THALMAN, JOHN	NC0279692	Community	ROCKINGHAM	WELL #1	70	160	GIDEON GROVE TP NO 1	WEST OF 145 BERNICE DRIVE	STOKESDALE
Early Mesozoic Basin	WALNUT COVE, TOWN OF	NC0285015	Community	STOKES	WELL #1-FIRE STATION	140	1230	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic Basin	WALNUT COVE, TOWN OF	NC0285015	Community	STOKES	WELL #2 - FOWLER PARK	95	1150	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic Basin	WALNUT COVE, TOWN OF	NC0285015	Community	STOKES	WELL #3	35	600	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic Basin	WALNUT COVE, TOWN OF	NC0285015	Community	STOKES	WELL #4-CLUB STREET	55	805	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic Basin	WALNUT COVE, TOWN OF	NC0285015	Community	STOKES	WELL #5-HWY 311	36	605	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic Basin	WALNUT COVE, TOWN OF	NC0285015	Community	STOKES	WELL #6-BICYCLES WELL	40	903	WALNUT COVE, TOWN OF	208 WEST THIRD STREET	WALNUT COVE
Early Mesozoic Basin	WIELAND COPPER PRODUCTS LLC	NC0285473	Non-Transient, Non-Community	STOKES	WELL #1	100	465	WIELAND COPPER PRODUCTS LLC	3990 U.S. 311 HWY NORTH	PINE HALL
Early Mesozoic Basin	WIELAND COPPER PRODUCTS LLC	NC0285473	Non-Transient, Non-Community	STOKES	WELL #5	195	312	WIELAND COPPER PRODUCTS LLC	3990 U.S. 311 HWY NORTH	PINE HALL

Table 2.2-22
Public Water Supply Wells Identified Within the Project Vicinity
(Sheet 5 of 5)

Aquifer	Owner	PWS ID	PWS Type	County	Source	Well Yield (gpm)	Well Depth (ft. bgs)	System Name	System Address	System City
Early Mesozoic Basin	WIELAND COPPER PRODUCTS LLC	NC0285473	Non-Transient, Non-Community	STOKES	WELL #6	200	268	WIELAND COPPER PRODUCTS LLC	3990 U.S. 311 HWY NORTH	PINE HALL
Early Mesozoic Basin	WIELAND COPPER PRODUCTS LLC	NC0285473	Non-Transient, Non-Community	STOKES	WELL #7	85	300	WIELAND COPPER PRODUCTS LLC	3990 U.S. 311 HWY NORTH	PINE HALL
Early Mesozoic Basin	WIELAND COPPER PRODUCTS LLC	NC0285473	Non-Transient, Non-Community	STOKES	WELL #8	125	400	WIELAND COPPER PRODUCTS LLC	3990 U.S. 311 HWY NORTH	PINE HALL

Source: NCGICC, 2023
Note:
"-" = data were not reported.
Key: bgs = below ground surface; ft.= foot; gpm = gallons per minute; PWS = public water supply

Table 2.2-23
North Carolina Current Groundwater Withdrawals in the Project Vicinity

Year	County	Energy (mgd)	Industrial (mgd)	Public Water Supply (mgd)	Recreation (mgd)	Total (mgd)
2022	Forsyth	–	–	0.22	–	0.22
2021	Forsyth	–	–	0.25	–	0.25
2020	Forsyth	–	–	0.23	–	0.23
2019	Forsyth	–	–	0.22	–	0.22
2022	Guilford	–	0.04	0.86	0.05	0.95
2021	Guilford	–	0.04	0.89	0.08	1.00
2020	Guilford	–	0.04	0.84	0.04	0.93
2019	Guilford	–	0.08	0.90	0.07	1.05
2022	Rockingham	–	–	0.10	–	0.10
2021	Rockingham	–	–	0.10	–	0.10
2020	Rockingham	–	–	0.09	–	0.09
2019	Rockingham	–	–	0.08	–	0.08
2022	Stokes	0.10	–	0.01	–	0.11
2021	Stokes	0.03	–	0.00	–	0.04
2020	Stokes	–	–	0.00	–	0.00
2019	Stokes	–	–	0.01	–	0.01

Source: NCDEQ, 2024a
Note: "—" = data were not reported.
Key: mgd = million gallons per day

Table 2.2-24
Privately Owned Water Supplied Wells Identified in the Project Vicinity

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Source: Guilford County, 2024b; Rockingham County; 2024b, USEPA, 2024c.
Notes:
"—" = wells were not identified within that aquifer.
Wells identified in Forsyth and Stokes counties are estimates.

Table 2.2-25
On-Site Streams Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 1 of 4)

Constituent	Units	(On-Site Streams)		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Temperature	Deg C	5.4 – 22.7	14.96	Not to exceed 2.8°C (5.04°F) above the natural water temperature and in no case to exceed 32°C (89.6°F) for lower piedmont and coastal plain waters[a]		NE	NE
pH units	SU	5.79 – 7.91	6.82	6.0-9.0[a]	6.5-9.0[b]	5.0-9.0	NE
Specific Conductance	ms/cm	0.06 – 0.21	0.10	NE	NE	NE	NE
Dissolved Oxygen	mg/L	3.66 – 11.56	7.18	≥ 4.0 instantaneous[a]	≥ 5.0 daily average[a]	NE	NE
Oxidation Reduction Potential	mV	-8.6 – 196.7	92.19	NE	NE	NE	NE
Turbidity	NTU	0.81 – 61.36	12.56	50 in streams[a], 25 in lakes or reservoirs[a]	NE	20	NE
Alkalinity, Total (as $CaCO_3$)	mg/L	8.19 – 85.4	39.34	NE	20[b]	NE	NE
Total Dissolved Solids (TDS)[c]	mg/L	54.5 – 144	81.43	≤500[a,d]	NE	250	NE
Total Suspended Solids (TSS)	mg/L	3.8 – 38.4	11.5	NE	NE	NE	NE
Nitrogen, Total Organic	mg/L	0.21 – 2.02	0.5	NE	NE	NE	NE
Fecal Coliform	mpn/ 100mL	3.00 – 727	176.96	<400/100[a,e]	NE	NE	NE
E. coli MPN	mpn/ 100mL	3.00 – 5475	534.73	<400/100[a,e]	NE	NE	NE
Total Coliform	mpn/ 100mL	71.7 – 10,462	2857	NE	NE	NE	NE
Mercury[f]	ng/L	0.52 – 8.7	1.97	1400[b]	770[b],12[a]	NE	NE
Aluminum	ug/L	61.4 – 280	141.75	NE	NE	1000	NE
Barium[c]	ug/L	10 – 54.6	25.48	1000[a,d]	NE	NE	NE
Beryllium[g,h]	ug/L	0.62 – 0.62	0.62	65[a,i]	6.5[a,j]	NE	NE
Boron	ug/L	51.9 – 66.2	59.1	NE	NE	NE	NE

Table 2.2-25
On-Site Streams Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 2 of 4)

Constituent	Units	(On-Site Streams)		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Calcium	ug/L	4160 – 20,900	8210	NE	NE	NE	NE
Chromium[g,h]	ug/L	< 1.10	< 1.10	232.65[a,k,l]	30.26 [a,l,m]	NE	NE
Cobalt	ug/L	<1.40	<1.40	NE	NE	NE	NE
Copper[g,h]	ug/L	<3.20	<3.20	4.8 [a,l,n]	3.52 [a,l,o]	1300	NE
Magnesium	ug/L	1560 - 6800	3154	NE	NE	NE	NE
Manganese[p]	ug/L	7.86 - 195	51.88	NE[p]	NE[p]	50	100
Nickel[c,g,h]	ug/L	<3.30	<3.30	185.63 [a,l,q], 25[a,d], 470[b]	20.62 [a,l,r], 52[b]	610	4600
Potassium	ug/L	724 - 4010	1903.13	NE	NE	NE	NE
Silver[g,h]	ug/L	<1.50	<1.50	0.49[a,l,s], 3.2[b]	0.06[a,t]	NE	NE
Sodium	ug/L	3900 – 12,800	6664.35	NE	NE	NE	NE
Vanadium	ug/L	1.05 – 3.08	1.95	NE	NE	NE	NE
Zinc[g,h]	ug/L	<8.70	<8.70	46.39[a,l,u] 120[b]	46.77[a,l,v] 120[b]	7400	26000
Antimony	ug/L	<0.52	<0.52	NE	NE	5.6	640
Arsenic[c,g,h]	ug/L	1.47 – 1.47	1.47	340[a,b,w],10[a,d]	150[a,b]	0.018	0.14
Cadmium[g,h,y]	ug/L	<0.078	<0.078	1.06[a,l,w,x] 1.8[b]	0.19[a,l,z] vacated[b]	NE	NE
Lead[g,h]	ug/L	0.37 – 0.85	0.56	19.28[a,l,aa] 65[b]	0.75[a,l,bb], 2.5[b]	NE	NE
Selenium[cc]	ug/L	<1.20	<1.20	NE	Lentic (30-day avg) = 1.5; Lotic (30-day avg) = 3.1	170	4200
Thallium	ug/L	<0.26	<0.26	NE	NE	0.24	0.47
Uranium	ug/L	0.17 – 0.65	0.38	NE	NE	NE	NE
Chloride[c]	mg/L	1.76 – 16.10	4.86	230[a,w]/250[a,d], 860[b]	230[b]	NE	NE
Fluoride	mg/L	0.06 – 1.82	0.41	1.8[a]	NE	NE	NE
Nitrogen, nitrate[c]	mg/L	0.04 – 1.83	0.28	10[a]	NE	10	NE
Nitrogen, nitrite	mg/L	<0.023	<0.023	NE	NE	NE	NE
Sulfate[c]	mg/L	0.55 – 49.10	11.58	250[a,d]	NE	NE	NE

Table 2.2-25
On-Site Streams Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 3 of 4)

Constituent	Units	(On-Site Streams)		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Total Kjeldahl Nitrogen (TKN)	mg/L	0.11 – 2.02	0.48	NE	NE	NE	NE
Phosphorus, Total as P	mg/L	0.05 – 0.28	0.15	NE	NE	NE	NE
Alpha, Gross	pci/L	1.30 – 4.12	2.65	15[a,dd]	15[a,dd]	NE	NE
Beta, Gross	pci/L	1.09 – 4.71	2.37	8[ee] 20,000[ff] 50[gg]	8[ee] 20,000[ff] 50[gg]	NE	NE
Cyanide, Free	mg/L	<0.005	<0.005	0.005[a,hh], 22[b]	5.2[b]	4	400
Chlorophyll-a	ug/L	0.05 – 4.59	1.23	NE	NE	NE	NE
Pheophytin-a	ug/L	0.06 – 32,000	1455	NE	NE	NE	NE
Hardness, Total as $CaCO_3$[c]	mg/L	18.2 – 80.2	33.5	≤100[a,d]	NE	NE	NE
Ammonia	mg/L	0.14 – 0.26	0.20	NE	NE	NE	NE
Phosphate as P, Ortho	mg/L	0.02 – 0.02	0.02	NE	NE	NE	NE
Biochemical Oxygen Demand (BOD)	mg/L	3.95 – 5.67	4.81	NE	NE	NE	NE
Chemical Oxygen Demand (COD)	mg/L	6.59 – 16	10.09	NE	NE	NE	NE

Table 2.2-25
On-Site Streams Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 4 of 4)

Notes:

(a) NCDEQ Surface Water Quality Standards Rules 15A NCAC 02B.0100 through.0300 (NCDEQ, 2022b).
(b) National Recommended Water Quality Criteria for aquatic freshwater life and human health (USEPA, 2024e, 2024f).
(c) Surface water criteria are specific to surface water body classifications (NCDEQ, n.d.[a]).
(d) Class IV and V waters.
(e) Not to exceed value in more than 20 percent of the samples examined during a 30-day period in which of five samples are taken. Not to exceed geometric mean of 200/100ml (MF Count).
(f) Mercury water quality standards shall be based upon measurement of the total recoverable metal.
(g) The Water Effect Ratio (WER) shall be assigned a value equal to one unless determined otherwise under Sub-Item (11(b)) of Subchapter 02B – Surface Water and Wetland Standards (NCDEQ, 2022b).
(h) Acute and chronic freshwater aquatic life standards for metals shall be based upon measurement of the dissolved fraction of the metal.
(i) WER·65.
(j) WER·6.5.
(k) WER· [0.316 · e^{0.8190[ln hardness]+3.7256}].
(l) Average hardness of 33.5 mg/L has been used to determine the site-specific NC 2B Water Quality Standards for specific metals.
(m) WER· [0.860 · e^{0.8190[ln hardness]+0.6848}].
(n) not used.
(o) WER· [0.960 · e^{0.8545[ln hardness]-1.702}].
(p) Manganese has been monitored by NCDEQ and has been shown to have elevated background level concentrations that are somewhat flow related and are caused by the geology of the region. NCDEQ removed manganese as a standard as there was no evidence of to conclude that discharges of manganese will impact any beneficial uses of North Carolina's waters (NCDENR, 2015c).
(q) WER· [0.998 · e^{0.8460[ln hardness]+2.255}].
(r) WER· [0.997 · e^{0.8460[ln hardness]+0.0584}].
(s) WER· [0.85 · e^{1.72[ln hardness]-6.59].
(t) WER·0.06.
(u) WER· [0.978 · e^{0.8473[ln hardness]+0.884}].
(v) WER· [0.986 · e^{0.8473[ln hardness]+0.884}].
(w) Class C waters.
(x) WER·[{1.136672-[ln hardness](0.041838)} · e^{0.9789 [ln hardness]-3.443}].
(y) Non-trout waters.
(z) WER·[{1.101672-[ln hardness](0.041838)} · e^{0.7977[ln hardness]-3.909}].
(aa) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-1.460}].
(bb) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-4.705}].
(cc) The standard for chronic selenium has the following components: fish egg/ovary tissue, fish whole body or muscle tissue, and water column (lentic and lotic). These components shall be used in the following order of preference provided data is available: 1. Fish egg/ovary tissue; 2. Fish whole body or muscle tissue; 3. Water column (NCDEQ, 2022b).
(dd) Alpha Emitters: the average annual gross alpha particle activity (including radium-226 but excluding radon and uranium).
(ee) Beta Emitters: Not to exceed this average annual activity level for strontium-90.
(ff) Beta Emitters: Not to exceed this average annual activity level for tritium.
(gg) Beta Emitters: Not to exceed the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radionuclides).
(hh) Available or total.

Key: µg/L = micrograms per liter; BRL = Below Reporting Limit; °C = degrees Celsius; MDL = Method Detection Limit; MF = membrane filter procedure for bacteriological analysis; mg/L = milligrams per liter; mg/m3 = milligrams per cubic meter; mpn/100mL= most probable number per 100 milliliters; ms/cm = millisiemens per centimeter; mV = millivolts; NCDEQ = North Carolina Department of Environmental Quality; NE = Regulatory standard not established for this constituent; ng/L = nanograms per liter; NTU = nephelometric turbidity unit; pci/L = picocuries per liter; QC = quality control; WER = Water Effect Ratio.

Table 2.2-26
Surface Water Body Classifications for Belews Lake, Dan River, and Town Fork Creek Water Segments within Project Vicinity

Stream Name	Stream Segment	Freshwater Stream Classification	Protected Uses				
			Aquatic Life	Secondary Recreation[a]	Primary Recreation[b]	Water Supply	Shellfish
Belews Creek (including Belews Lake below elevation 725)	22-27-(7.5)	WS-IV[c]	x	x	–	x	–
Arm of Belews Lake immediately southeast of Belews Lake Dam (Below elevation 725)	22-27-10	WS-IV[c], B	x	x	x	x	–
West Belews Creek (West Belews Creek Arm of Belews Lake below elevation 725)	22-27-9-(4)	WS-IV[c]	x	x	–	x	–
West Belews Creek (West Belews Creek Arm of Belews Lake below elevation 725)	22-27-9-(3)	C	x	x	–	–	–
Belews Creek (including Belews Lake below elevation 725)	22-27-(7)	C	x	x	–	–	–
East Belews Creek (East Belews Creek Arm of Belews Lake below elevation 725)	22-27-8-(2)	B	x	x	x	–	–
Belews Creek (Belews Creek Arm of Belews Lake below elevation 725)	22-27-(6)	B	x	x	x	–	–
Dan River	22-(8)	WS-V[d]	x	x	–	x	–
Dan River	22-(25.5)	WS-IV[c]	x	x	–	x	–
Town Fork Creek	22-25	C	x	x	–	–	–

Source: NCDEQ, n.d. (a), NCDEQ, 2017a
Notes:
(a) Secondary contact recreation means wading, boating, other uses not involving human body contact with water, and activities involving human body contact with water where such activities take place on an infrequent, unorganized, or incidental basis.
(b) Primary contact recreation means swimming, diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis.
(c) Water Supply-IV are defined as waters used as sources of water supply for drinking, culinary, or food processing purposes where a WS-I, II or III classification is not feasible.
(d) Water Supply-V are defined as waters protected as water supplies which are generally upstream and draining to Class WS-IV waters or waters used by industry to supply their employees with drinking water or as waters formerly used as water supply.
Key: B = Primary Contact Recreation, Fresh Water; C = Aquatic Life, Secondary Contact Recreation, Fresh Water; WS = Water Supply

Table 2.2-27
Surface Water Quality Values for Belews Lake from 2020 316(a) Sampling Program

Constituent	Units	BLSW (Thirteen Monitoring Locations)	
		Mean	Range
Temperature	°C	21.48	9.4 – 37.6
Dissolved Oxygen	mg/L	8.67	7.2 – 10.6
pH, Field	pH units	7.45	6.9 – 8.5
Specific Conductance	µs/cm	77.5	45 – 83
Phosphorus, Total as P	mg/L	0.0448	0.006 – 0.123
Phosphate as P, Ortho	mg/L	0.028	<0.005 – <0.05
Ammonia	mg/L	< 0.06	<0.02 – <0.10
Nitrite+Nitrate	mg/L	0.139	< 0.02 – 0.282
Total Kjeldahl Nitrogen (TKN)	mg/L	0.306	0.1 – 0.74
Carbon, Total Organic (TOC)	mg/L	3.36	2.7 – 5.6
Chloride	mg/L	5.1	2.7 – 5.9
Sulfate	mg/L	5.64	2.7 – 6.6
Turbidity	NTU	14.398	1.57 – 97
Secchi Depth	m	1.72	0.1 – 3.1
Alkalinity, Total (as $CaCO_3$)	mg/L	21.2	14 – 24
Total Dissolved Solids (TDS)	mg/L	65.8	54 – 88
Calcium	mg/L	5.19	4.34 – 5.67
Magnesium	mg/L	2.47	2.0 – 2.8
Arsenic	µg/L	< 1	< 1 – < 1
Copper, Total	µg/L	1.565	< 1.00 – 3.07
Mercury, low-level	ng/L	1.9965	<0.500 – 6.43
Selenium	µg/L	< 1	<1 – < 1
Zinc	µg/L	5.24	< 5.00 - 5.48
Hardness, Total as $CaCO_3$	mg/L	23.15	19.1 – 25.7
Chlorophyll-a (Summer)	µg/L	1.04	< 2.0 – 36.4
Chlorophyll-a (Winter)	µg/L	6.2	< 2.0 – 4.0

Source: Duke Energy, 2021
Key: BLSW = Belews Lake Surface Water; $CaCO_3$ = Calcium Carbonate; °C = degrees Celsius; mg/L = milligrams per liter; µs/cm = microsiemens per centimeter; ng/L = nanograms per liter; NTU = nephelometric turbidity unit; µg/L = micrograms per liter

Table 2.2-28
Dan River Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 1 of 4)

Constituent	Units	DRSW		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Temperature	°C	1.4 – 25.8	15.73	Not to exceed 2.8 degrees C (5.04 degrees F) above the natural water temperature and in no case to exceed 32°C (89.6 °F) for lower piedmont and coastal plain waters[a]		NE	NE
pH, Field	pH units	6.39 – 7.85	7.23	6.0-9.0[a]	6.5-9.0[b]	5.0-9.0	NE
Specific Conductance	ms/cm	0.05 – 0.12	0.08	NE	NE	NE	NE
Dissolved Oxygen	mg/L	4.75 – 12.84	9.34	≥ 4.0 instantaneous[a]	≥ 5.0 daily average[a]	NE	NE
Oxidation Reduction Potential	mV	16.4 – 372.6	122.48	NE	NE	NE	NE
Turbidity	NTU	0.81 – 41.11	8.58	50 in streams[a], 25 in lakes or reservoirs[a]	NE	NE	NE
Alkalinity, Total (as $CaCO_3$)	mg/L	15.7 – 88.1	28.88	NE	20[b]	NE	NE
Total Dissolved Solids (TDS)[c]	mg/L	34.5 – 109	54.63	≤500[a,d]	NE	250	NE
Total Suspended Solids (TSS)	mg/L	5.2 – 24	10.48	NE	NE	NE	NE
Nitrogen, Total Organic	mg/L	0.23 – 0.48	0.39	NE	NE	NE	NE
Fecal Coliform	mpn/ 100mL	13.4 – 548	129.52	<400/100[a,e]	NE	NE	NE
E. coli MPN	mpn/ 100mL	6.3 – 219	83.62	<400/100[a,e]	NE	NE	NE
Total Coliform	mpn/ 100mL	56.3 – 8664	2321.25	NE	NE	NE	NE
Mercury[f]	ng/L	0.63 – 3.02	1.5	1400[b]	770[b],12[a]	NE	NE
Aluminum	ug/L	82.2 – 237	136.45	NE	NE	NE	NE
Barium[c]	ug/L	15.4 – 26.8	21.43	1000[a,d]	NE	1000	NE
Beryllium[g,h]	ug/L	0.33 -0.33	0.33	65[a,i]	6.5[a,j]	NE	NE
Boron	ug/L	85.1 – 421	199.68	NE	NE	NE	NE

Table 2.2-28
Dan River Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 2 of 4)

Constituent	Units	DRSW		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Calcium	ug/L	3810 – 14,400	6436.88	NE	NE	NE	NE
Chromium[g,h]	ug/L	<1.10	<1.10	185.22[a,k,l]	24.09[a,l,m]	NE	NE
Cobalt	ug/L	<1.40	<1.40	NE	NE	NE	NE
Copper[g,h]	ug/L	<3.20	<3.20	3.69[a,l,n]	2.77[a,l,o]	1300	NE
Magnesium[p]	ug/L	1480 – 4120	2253.13	NE[p]	NE[p]	NE	NE
Manganese[p]	ug/L	10.5 – 114	36.67	NE	NE	50	100
Nickel[c,g,h]	ug/L	<3.30	<3.30	146.68[a,l,q], 25[a,d], 470[b]	16.29[a,l,r], 52[b]	610	4600
Potassium	ug/L	1050 – 3600	1853	NE	NE	NE	NE
Silver[g,h]	ug/L	<1.50	<1.50	0.30[a,l,s], 3.2[b]	0.06[a,t]	NE	NE
Sodium	ug/L	2720 – 4420	3601.88	NE	NE	NE	NE
Vanadium	ug/L	1.07 – 1.68	1.34	NE	NE	NE	NE
Zinc[g,h]	ug/L	26 – 26	26	36.64[a,l,u], 120[b]	36.94[a,l,v], 120[b]	7400	26,000
Antimony	ug/L	0.69 -0.69	0.69	NE	NE	5.6	640
Arsenic[c,g,h]	ug/L	<0.86	<0.86	340[a,b,w],10[a,d]	150[a,b]	0.018	0.14
Cadmium[g,h,y]	ug/L	0.08 -0.08	0.08	0.83[a,l,w,x], 1.8[b]	0.15[a,l,z], vacated[b]	NE	NE
Lead[g,h]	ug/L	0.35 – 1.15	0.54	14.11[a,l,aa], 65[b]	0.55[a,l,bb], 2.5[b]	NE	NE
Selenium[cc]	ug/L	<1.20	<1.20	NE	Lentic (30-day avg) = 1.5; Lotic (30-day avg) = 3.1	170	4200
Thallium	ug/L	<0.26	<0.26	NE	NE	0.24	0.47
Uranium	ug/L	0.23 – 0.38	0.29	NE	NE	NE	NE
Chloride[c]	mg/L	2.83 – 21.5	6.19	230[a,w]/250[a,d], 860[b]	230[b]	NE	NE

Table 2.2-28
Dan River Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 3 of 4)

Constituent	Units	DRSW		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Fluoride	mg/L	0.04 – 0.12	0.09	1.8[a]	NE	NE	NE
Nitrogen, nitrate[c]	mg/L	0.19 – 0.36	0.28	10[a]	NE	10	NE
Nitrogen, nitrite	mg/L	<0.023	<0.023	NE	NE	NE	NE
Sulfate[c]	mg/L	1.81 – 9.4	4.34	250[a,d]	NE	NE	NE
Total Kjeldahl Nitrogen (TKN)	mg/L	0.13 – 0.48	0.23	NE	NE	NE	NE
Phosphorus, Total as P	mg/L	0.04 – 0.31	0.12	NE	NE	NE	NE
Alpha, Gross	pci/L	1.44 – 2.62	2.03	15[a,dd]	15[a,dd]	NE	NE
Beta, Gross	pci/L	1.14 – 2.65	1.48	8[ee] 20,000[ff] 50[gg]	8[ee] 20,000[ff] 50[gg]	NE	NE
Cyanide, Free	mg/L	<0.005	<0.005	0.005[a,hh], 22[b]	5.2[b]	4	400
Chlorophyll-a	ug/L	0.11 – 4.48	2.09	NE	NE	NE	NE
Pheophytin-a	ug/L	0.10 – 3.5	1.52	NE	NE	NE	NE
Hardness, Total as $CaCO_3$[c]	mg/L	15.6 – 52.9	25.36	≤100[a,d]	NE	NE	NE
Ammonia	mg/L	<0.046-<0.10	<0.046-<0.10	NE	NE	NE	NE
Phosphate as P, Ortho	mg/L	0.02 – 0.04	0.03	NE	NE	NE	NE
Biochemical Oxygen Demand (BOD)	mg/L	7.02 – 10.8	8.91	NE	NE	NE	NE
Chemical Oxygen Demand (COD)	mg/L	5.66 – 11.1	7.56	NE	NE	NE	NE

Table 2.2-28
Dan River Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 4 of 4)

Notes:
(a) NCDEQ Surface Water Quality Standards Rules 15A NCAC 02B.0100 through.0300 (NCDEQ, 2022b).
(b) National Recommended Water Quality Criteria for aquatic freshwater life and human health (USEPA, 2024e, 2024f).
(c) Surface water criteria are specific to surface water body classifications (NCDEQ, n.d.[a]).
(d) Class IV and V waters.
(e) Not to exceed value in more than 20 percent of the samples examined during a 30-day period in which of five samples are taken. Not to exceed geometric mean of 200/100ml (MF Count).
(f) Mercury water quality standards shall be based upon measurement of the total recoverable metal.
(g) The Water Effect Ratio (WER) shall be assigned a value equal to one unless determined otherwise under Sub-Item (11(b)) of Subchapter 02B – Surface Water and Wetland Standards (NCDEQ, 2022b).
(h) Acute and chronic freshwater aquatic life standards for metals shall be based upon measurement of the dissolved fraction of the metal.
(i) WER·65.
(j) WER·6.5.
(k) WER· [0.316 · e^{0.8190[ln hardness]+3.7256}].
(l) Average hardness of 25.36 mg/L has been used to determine the site-specific NC 2B Water Quality Standards for specific metals.
(m) WER· [0.860 · e^{0.8190[ln hardness]+0.6848}]
(n) WER· [0.960 · e^{0.9422[ln hardness]-1.700}].
(o) WER· [0.960 · e^{0.8545[ln hardness]-1.702}].
(p) Manganese has been monitored by NCDEQ and has been shown to have elevated background level concentrations that are somewhat flow related and are caused by the geology of the region. NCDEQ removed manganese as a standard as there was no evidence of to conclude that discharges of manganese will impact any beneficial uses of North Carolina's waters (NCDENR, 2015c).
(q) WER· [0.998 · e^{0.8460[ln hardness]+2.255}].
(r) WER· [0.997 · e^{0.8460[ln hardness]+0.0584}].
(s) WER· [0.85 · e^{1.72[ln hardness]-6.59].
(t) WER·0.06.
(u) WER· [0.978 · e^{0.8473[ln hardness]+0.884}].
(v) WER· [0.986 · e^{0.8473[ln hardness]+0.884}].
(w) Class C waters.
(x) WER·[{1.136672-[ln hardness](0.041838)} · e^{0.9789 [ln hardness]-3.443}].
(y) Non-trout waters.
(z) WER·[{1.101672-[ln hardness](0.041838)} · e^{0.7977[ln hardness]-3.909}].
(aa) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-1.460}].
(bb) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-4.705}].
(cc) The standard for chronic selenium has the following components: fish egg/ovary tissue, fish whole body or muscle tissue, and water column (lentic and lotic). These components shall be used in the following order of preference provided data is available: 1. Fish egg/ovary tissue; 2. Fish whole body or muscle tissue; 3. Water column (NCDEQ, 2022b).
(dd) Alpha Emitters: the average annual gross alpha particle activity (including radium-226 but excluding radon and uranium).
(ee) Beta Emitters: Not to exceed this average annual activity level for strontium-90.
(ff) Beta Emitters: Not to exceed this average annual activity level for tritium.
(gg) Beta Emitters: Not to exceed the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radionuclides).
(hh) Available or total.

Key: µg/L = micrograms per liter; °C = degrees Celsius; BRL = Below Reporting Limit; DRSW = Dan River Surface Water; MDL = Method Detection Limit; MF = membrane filter procedure for bacteriological analysis; mg/L = milligrams per liter; mg/m^3 = milligrams per cubic meter; mpn/100mL= most probable number per 100 milliliters; ms/cm = millisiemens per centimeter; mV = millivolts; NCDEQ = North Carolina Department of Environmental Quality; NE = Regulatory standard not established for this constituent; ng/L = nanograms per liter; NTU = nephelometric turbidity unit; pci/L = picocuries per liter; QC = quality control; WER = Water Effect Ratio.

Table 2.2-29
Town Fork Creek Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 1 of 4)

Constituent	Units	TFCSW		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Temperature	°C	5.30 – 26.10	16.88	Not to exceed 2.8 degrees C (5.04 degrees F) above the natural water temperature and in no case to exceed 32°C (89.6 °F) for lower piedmont and coastal plain waters[a]		NE	NE
pH, Field	pH units	7.09 – 7.66	7.39	6.0-9.0[a]	6.5-9.0[b]	5.0-9.0	NE
Specific Conductance	ms/cm	0.09 – 0.10	0.10	NE	NE	NE	NE
Dissolved Oxygen	mg/L	7.50 – 11.58	9.2	≥ 4.0 instantaneous[a]	≥ 5.0 daily average[a]	NE	NE
Oxidation Reduction Potential	mV	9.6 – 144.7	69.63	NE	NE	NE	NE
Turbidity	NTU	1.52 – 34.97	13.9	50 in streams[a], 25 in lakes or reservoirs[a]	NE	NE	NE
Alkalinity, Total (as $CaCO_3$)	mg/L	30.9 – 46.9	39.93	NE	20[b]	NE	NE
Total Dissolved Solids (TDS)[c]	mg/L	68.5 – 83.5	75.63	≤500[a,d]	NE	250	NE
Total Suspended Solids (TSS)	mg/L	3 – 25.8	9.98	NE	NE	NE	NE
Nitrogen, Total Organic	mg/L	0.21 – 0.53	0.29	NE	NE	NE	NE
Fecal Coliform	mpn/ 100mL	33.1 – 2420	764.53	<400/100[a,e]	NE	NE	NE
E. coli MPN	mpn/ 100mL	17.3 – 548	213.2	<400/100[a,e]	NE	NE	NE
Total Coliform	mpn/ 100mL	488 – 2420	1199.67	NE	NE	NE	NE
Mercury[f]	ng/L	1.09 – 3.55	2.31	1400[b]	770[b],12[a]	NE	NE
Aluminum	ug/L	58.6 – 180	115.83	NE	NE	NE	NE
Barium[c]	ug/L	23.9 – 49.3	32.93	1000[a,d]	NE	1000	NE
Beryllium[g,h]	ug/L	<0.30	<0.30	65[a,i]	6.5[a,j]	NE	NE
Boron	ug/L	<27.0	<27.0	NE	NE	NE	NE

Table 2.2-29
Town Fork Creek Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 2 of 4)

Constituent	Units	TFCSW		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Calcium	ug/L	6560 – 11,100	8720	NE	NE	NE	NE
Chromium[g,h]	ug/L	< 0.1^(1)	<1.1	244.42[a,k,l]	31.79[a,l,m]	NE	NE
Cobalt	ug/L	<1.4	<1.4	NE	NE	NE	NE
Copper[g,h]	ug/L	<3.2	<3.2	5.05[a,l,n]	3.70[a,l,o]	1300	NE
Magnesium	ug/L	2520 – 4390	3350	NE	NE	NE	NE
Manganese[p]	ug/L	51.2 – 161	92.53	NE[p]	NE[p]	50	100
Nickel[c,g,h]	ug/L	<3.30	<3.30	195.34[a,l,q], 25[a,d], 470[b]	2.70[a,l,r], 52[b]	610	4600
Potassium	ug/L	1740 – 3170	2367.5	NE	NE	NE	NE
Silver[g,h]	ug/L	<1.50	<1.50	0.54[a,l,s], 3.2[b]	0.06[a,t]	NE	NE
Sodium	ug/L	4850 - 6950	5740	NE	NE	NE	NE
Vanadium	ug/L	1.02 – 2.22	1.5	NE	NE	NE	NE
Zinc[g,h]	ug/L	11.3 – 11.3	11.3	48.82[a,l,u], 120[b]	49.22[a,l,v], 120[b]	7400	26,000
Antimony	ug/L	<0.52	<0.52	NE	NE	5.6	640
Arsenic[c,g,h]	ug/L	<0.86	<0.86	340[a,b,w],10[a,d]	150[a,b]	0.018	0.14
Cadmium[g,h,y]	ug/L	<0.078	<0.078	1.11[a,l,w,x], 1.8[b]	0.19[a,l,z], vacated[b]	NE	NE
Lead[g,h]	ug/L	0.44 – 0.44	0.44	20.63[a,l,aa], 65[b]	0.80[a,l,bb], 2.5[b]	NE	NE
Selenium[cc]	ug/L	<1.2	<1.2	NE	Lentic (30-day avg) = 1.5; Lotic (30-day avg) = 3.1	170	4200
Thallium	ug/L	<0.26	<0.26	NE	NE	0.24	0.47
Uranium	ug/L	0.2 -0.2	0.2	NE	NE	NE	NE
Chloride[c]	mg/L	4.24 – 6.32	5.09	230[a,w]/250[a,d], 860[b]	230[b]	NE	NE
Fluoride	mg/L	0.09 – 0.11	0.10	1.8[a]	NE	NE	NE

Table 2.2-29
Town Fork Creek Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025
(Sheet 3 of 4)

Constituent	Units	TFCSW		Aquatic Life Freshwater Acute[a,b]	Aquatic Life Freshwater Chronic[a,b]	Human Health Water & Fish[b]	Human Health Fish Only[b]
		Range	Mean				
Nitrogen, nitrate[c]	mg/L	0.17 – 0.44	0.28	10[a]	NE	10	NE
Nitrogen, nitrite	mg/L	<0.023	<0.023	NE	NE	NE	NE
Sulfate[c]	mg/L	1.89 – 3.93	2.83	250[a,d]	NE	NE	NE
Total Kjeldahl Nitrogen (TKN)	mg/L	0.21 – 0.53	0.29	NE	NE	NE	NE
Phosphorus, Total as P	mg/L	0.06 – 0.13	0.10	NE	NE	NE	NE
Alpha, Gross	pci/L	<0.928-<1.61	<0.928 - <1.61	15[a,dd]	15[a,dd]	NE	NE
Beta, Gross	pci/L	1.59 – 2.49	2.19	8[ee] 20,000[ff] 50[gg]	8[ee] 20,000[ff] 50[gg]	NE	NE
Cyanide, Free	mg/L	<0.005	<0.005	0.005[a,hh], 22[b]	5.2[b]	4	400
Chlorophyll-a	ug/L	1.84 – 5.87	3.68	NE	NE	NE	NE
Pheophytin-a	ug/L	1.08 – 3.26	2.07	NE	NE	NE	NE
Hardness, Total as $CaCO_3$[c]	mg/L	26.8 – 45.8	35.58	≤100[a,d]	NE	NE	NE
Ammonia	mg/L	<0.046-<0.1	<0.046 - <0.1	NE	NE	NE	NE
Phosphate as P, Ortho	mg/L	0.02 – 0.02	0.02	NE	NE	NE	NE
Biochemical Oxygen Demand (BOD)	mg/L	<2.0	<2.0	NE	NE	NE	NE
Chemical Oxygen Demand (COD)	mg/L	6.96 – 8.48	7.72	NE	NE	NE	NE

Table 2.2-29
Town Fork Creek Surface Water Quality Values from the Preapplication Monitoring Program from April 2024 through January 2025 (Sheet 4 of 4)

Notes:
(a) NCDEQ Surface Water Quality Standards Rules 15A NCAC 02B.0100 through.0300 (NCDEQ, 2022b).
(b) National Recommended Water Quality Criteria for aquatic freshwater life and human health (USEPA, 2024e, 2024f).
(c) Surface water criteria are specific to surface water body classifications (NCDEQ, n.d.[a]).
(d) Class IV and V waters.
(e) Not to exceed value in more than 20 percent of the samples examined during a 30-day period in which of five samples are taken. Not to exceed geometric mean of 200/100ml (MF Count).
(f) Mercury water quality standards shall be based upon measurement of the total recoverable metal.
(g) The Water Effect Ratio (WER) shall be assigned a value equal to one unless determined otherwise under Sub-Item (11(b)) of Subchapter 02B – Surface Water and Wetland Standards (NCDEQ, 2022b).
(h) Acute and chronic freshwater aquatic life standards for metals shall be based upon measurement of the dissolved fraction of the metal.
(i) WER·65.
(j) WER·6.5.
(k) WER· [0.316 · e^{0.8190[ln hardness]+3.7256}].
(l) Average hardness of 35.58 mg/L has been used to determine the site-specific NC 2B Water Quality Standards for specific metals.
(m) WER· [0.860 · e^{0.8190[ln hardness]+0.6848}].
(n) WER· [0.960 · e^{0.9422[ln hardness]-1.700}].
(o) WER· [0.960 · e^{0.8545[ln hardness]-1.702}].
(p) Manganese has been monitored by NCDEQ and has been shown to have elevated background level concentrations that are somewhat flow related and are caused by the geology of the region. NCDEQ removed manganese as a standard as there was no evidence of to conclude that discharges of manganese will impact any beneficial uses of North Carolina's waters (NCDENR, 2015c).
(q) WER· [0.998 · e^{0.8460[ln hardness]+2.255}].
(r) WER· [0.997 · e^{0.8460[ln hardness]+0.0584}].
(s) WER· [0.85 · e^{1.72[ln hardness]-6.59].
(t) WER·0.06.
(u) WER· [0.978 · e^{0.8473[ln hardness]+0.884}].
(v) WER· [0.986 · e^{0.8473[ln hardness]+0.884}].
(w) Class C waters.
(x) WER·[{1.136672-[ln hardness](0.041838)} · e^{0.9789 [ln hardness]-3.443}].
(y) Non-trout waters.
(z) WER·[{1.101672-[ln hardness](0.041838)} · e^{0.7977[ln hardness]-3.909}].
(aa) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-1.460}].
(bb) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-4.705}].
(cc) The standard for chronic selenium has the following components: fish egg/ovary tissue, fish whole body or muscle tissue, and water column (lentic and lotic). These components shall be used in the following order of preference provided data is available: 1. Fish egg/ovary tissue; 2. Fish whole body or muscle tissue; 3. Water column (NCDEQ, 2022b).
(dd) Alpha Emitters: the average annual gross alpha particle activity (including radium-226 but excluding radon and uranium).
(ee) Beta Emitters: Not to exceed this average annual activity level for strontium-90.
(ff) Beta Emitters: Not to exceed this average annual activity level for tritium.
(gg) Beta Emitters: Not to exceed the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radionuclides).
(hh) Available or total.

Key: µg/L = micrograms per liter; BRL = Below Reporting Limit; °C = degrees Celsius; MDL = Method Detection Limit; MF = membrane filter procedure for bacteriological analysis; mg/L = milligrams per liter; mg/m^3 = milligrams per cubic meter; mpn/100mL= most probable number per 100 milliliters; ms/cm = millisiemens per centimeter; mV = millivolts; NCDEQ = North Carolina Department of Environmental Quality; NE = Regulatory standard not established for this constituent; ng/L = nanograms per liter; NTU = nephelometric turbidity unit; pci/L = picocuries per liter; QC = quality control; TFCSW = Town Fork Creek Surface Water; WER = Water Effect Ratio

Table 2.2-30
Belews Creek Groundwater and Surface Water Sampling Analysis Parameter List
(Sheet 1 of 2)

Constituent	Analysis Method	
	Groundwater	Surface Water
Temperature(a)	Horiba/YSI or equivalent	Horiba/YSI or equivalent
Turbidity(a)	HACH or equivalent	HACH or equivalent
pH(a)	Horiba/YSI or equivalent SM4500-H+ B	Horiba/YSI or equivalent SM4500-H+ B
Conductivity(a)	Horiba/YSI or equivalent	Horiba/YSI or equivalent
Dissolved Oxygen(a)	Horiba/YSI or equivalent	Horiba/YSI or equivalent
Color(a)	Aesthetic	Aesthetic
Odor(a)	Aesthetic	Aesthetic
Total Suspended Solids (TSS)	SM 2540D	SM 2540D
Total Dissolved Solids (TDS)	SM 2540C	SM 2540C
Hardness	SM 2340B	SM 2340B
Biological Oxygen Demand (BOD)	SM 5210B	SM 5210B
Chemical Oxygen Demand (COD)	SM 5220D	SM 5220D
Phosphorus, Total	MCAWW 365.4	MCAWW 365.4
Phosphorus, Orthophosphate	4500_P_F_Ortho	MCAWW 365.4
Ammonia	SM4500NH3_G	SM4500NH3_G
Nitrate	MCAWW 300.0	MCAWW 300.0
Nitrite	MCAWW 300.0	MCAWW 300.0
Organic Nitrogen	Calculated	Calculated
Nitrogen, Total Kjeldahl	MCAWW 351.2	MCAWW 351.2
Alkalinity (total)	SM 2320B	SM 2320B
Bicarbonate	SM 2320B	Not Measured
Chloride	MCAWW 300.0	MCAWW 300.0
Sulfate	MCAWW 300.0	MCAWW 300.0
Fluoride	MCAWW 300.0	MCAWW 300.0
Aluminum	MCAWW 200.7	MCAWW 200.7
Barium	MCAWW 200.7	MCAWW 200.7
Beryllium	MCAWW 200.7	MCAWW 200.7
Boron	MCAWW 200.7	MCAWW 200.7
Calcium	MCAWW 200.7	MCAWW 200.7
Chromium	MCAWW 200.7	MCAWW 200.7
Cobalt	MCAWW 200.7	MCAWW 200.7
Copper	MCAWW 200.7	MCAWW 200.7
Iron	MCAWW 200.7	Not Measured
Magnesium	MCAWW 200.7	MCAWW 200.7

Table 2.2-30
Belews Creek Groundwater and Surface Water Sampling Analysis Parameter List
(Sheet 2 of 2)

Constituent	Analysis Method	
	Groundwater	Surface Water
Manganese	MCAWW 200.7	MCAWW 200.7
Nickel	MCAWW 200.7	MCAWW 200.7
Potassium	MCAWW 200.7	MCAWW 200.7
Silica	MCAWW 200.7	Not Measured
Silver	MCAWW 200.7	MCAWW 200.7
Sodium	MCAWW 200.7	MCAWW 200.7
Vanadium	MCAWW 200.7	MCAWW 200.7
Zinc	MCAWW 200.7	MCAWW 200.7
Antimony	MCAWW 200.8	MCAWW 200.8
Arsenic	MCAWW 200.8	MCAWW 200.8
Cadmium	MCAWW 200.8	MCAWW 200.8
Lead	MCAWW 200.8	MCAWW 200.8
Selenium	MCAWW 200.8	MCAWW 200.8
Thallium	MCAWW 200.8	MCAWW 200.8
Uranium	MCAWW 200.8	MCAWW 200.8
Mercury	MCAWW 245.1	MCAWW 1631E
Cyanide, Free	OIA-1677	OIA-1677
Phytoplankton (Chlorophyll-*a*)	Not Measured	SM 10200H
Total Coliform	SM9223B	SM9223B
Fecal/*E.coli* Coliform	Colilert-18 MPN	Colilert-18 MPN
Gross Alpha	MCAWW 900.0	MCAWW 900.0
Gross Beta	MCAWW 900.0	MCAWW 900.0

Note:

(a) Measured in the field.

Key: MCAWW = Methods for Chemical Analysis of Water and Wastes; mg/L = milligrams per liter; MPN = most probable number; OIA = OI Analytical; SM = Standard Method

Table 2.2-31
Observation Well Quarterly Groundwater Data Summary
(Sheet 1 of 3)

Constituent	Method	Units	Range	Mean	USEPA MCL[a]	NCDEQ 2L Standard[b]
Dissolved Oxygen	Field Measure	mg/L	0.63 – 11.82	5.38	NE	NE
Oxidation Reduction Potential	Field Measure	mV	-64.4 – 273.70	114.9	NE	NE
pH	Field Measure	pH units	4.52 - 8.08	5.99	6.5-8.5	6.5-8.5
Specific Conductance	Field Measure	ms/cm	0.03 - 0.37	0.13	NE	NE
Temperature	Field Measure	°C	12.50 - 20.90	15.87	NE	NE
Turbidity	Field Measure	NTU	0.12 - 85.30	11.01	NE	NE
Alkalinity, Bicarbonate (as $CaCO_3$)	A2320B	mg/L	3.75 - 152	50.99	NE	NE
Alkalinity, Total (as $CaCO_3$)	A2320B	mg/L	3.75 - 152	50.99	NE	NE
Carbon Dioxide, Free	A2320B	mg/L	3.58 - 222	32.01	NE	NE
Total Dissolved Solids (TDS)	A2540C	mg/L	37.50 - 278	100.72	500	500
Total Suspended Solids (TSS)	A2540D	mg/L	2.60 - 57.10	12.52	NE	NE
Nitrogen, Total Organic	CALC	mg/L	0.21 - 1.60	0.49	NE	NE
Fecal Coliform	Colilert-18	mpn/100ml	1.0 - 1.0	1.00	MCL(c)	NE
Aluminum	E200.7	µg/L	54.20 - 1020	222.30	50-200	24000
Barium	E200.7	µg/L	6.30 - 90.20	24.37	200	700
Beryllium	E200.7	µg/L	< 0.30 - < 0.30	< 0.300	4.0	4.0
Boron	E200.7	µg/L	< 27.0 - < 27.0	< 27.0	NE	700
Calcium	E200.7	µg/L	1790 - 47000	12881	NE	NE
Chromium	E200.7	µg/L	1.12 - 5.41	2.25	100	10
Cobalt	E200.7	µg/L	1.43 - 74.10	14.73	NE	1.0
Copper	E200.7	µg/L	3.93 - 33.0	11.41	1300	1000
Iron	E200.7	µg/L	20.50 - 1250	197.26	300	300
Magnesium	E200.7	µg/L	878 - 11300	3284	NE	NE
Manganese	E200.7	µg/L	1.88 - 492	56.82	50	50
Nickel	E200.7	µg/L	3.67 - 125	27.87	NE	100
Potassium	E200.7	µg/L	1320 - 25400	3464	NE	NE
Silver	E200.7	µg/L	< 1.50 - < 1.50	< 1.50	100	20

Table 2.2-31
Observation Well Quarterly Groundwater Data Summary
(Sheet 2 of 3)

Constituent	Method	Units	Range	Mean	USEPA MCL[a]	NCDEQ 2L Standard[b]
Silica	E200.7	µg/L	15900 - 45800	29452	NE	NE
Sodium	E200.7	µg/L	2580 - 69000	8110	NE	NE
Vanadium	E200.7	µg/L	1.08 - 3.44	1.89	NE	7.0
Zinc	E200.7	µg/L	9.66 - 129	34.81	5000	1000
Antimony	E200.8	µg/L	0.62 - 0.88	0.75	6.0	1.0
Arsenic	E200.8	µg/L	0.87 - 65.0	12.12	10	10
Cadmium	E200.8	µg/L	0.09 - 0.87	0.36	5.0	2.0
Lead	E200.8	µg/L	0.39 - 11.40	2.14	15	15
Selenium	E200.8	µg/L	1.22 - 9.82	2.80	50	20
Thallium	E200.8	µg/L	< 0.260 - < 0.260	< 0.260	2.0	2.0
Uranium	E200.8	µg/L	0.15 - 4.04	1.11	30	NE
Mercury	E245.1	µg/L	< 0.08 - < 0.08	< 0.08	2.0	1.0
Chloride	E300	mg/L	1.09 - 7.22	3.08	250	250
Fluoride	E300	mg/L	0.04 - 1.27	0.26	4.0	2.0
Nitrogen, nitrate	E300	mg/L	0.05 - 15.10	1.80	10	10
Nitrogen, nitrite	E300	mg/L	1.24 - 1.71	1.48	1.0	1.0
Sulfate	E300	mg/L	0.44 - 76.70	12.0	250	250
Total Kjeldahl Nitrogen	E351.2	mg/L	0.10 - 1.65	0.36	NE	NE
Mercury	E245.1	µg/L	< 0.08 - < 0.08	< 0.08	2.0	1.0
Phosphorus, Total as P	E365.4	mg/L	0.05 - 0.37	0.12	NE	NE
Alpha, Gross	E900	pci/L	1.23 – 5.39	2.83	15	15
Beta, Gross	E900	pci/L	1.00 - 23.0	3.43	4 millirems/year	NE
Cyanide, Free	OIA1677	mg/L	0.006 – 0.009	0.007	0.2	0.07
Hardness, Carbonate (as CO_3)	SM2340B	mg/L	4.47 - 117	32.16	NE	NE
Hardness, Magnesium (as $CaCO_3$)	SM2340B	mg/L	3.62 - 46.5	13.53	NE	NE
Hardness, Total as $CaCO_3$	SM2340B	mg/L	8.09 - 132	45.70	NE	NE
Ammonia	SM4500-NH3H	mg/L	0.05 - 0.18	0.10	NE	NE
Phosphate as P, Ortho	SM4500-PF	mg/L	0.03 - 0.13	0.06	NE	NE

Table 2.2-31
Observation Well Quarterly Groundwater Data Summary
(Sheet 3 of 3)

Constituent	Method	Units	Range	Mean	USEPA MCL[a]	NCDEQ 2L Standard[b]
Biochemical Oxygen Demand (BOD)	SM5210B	mg/L	2.09 - 39.60	8.85	NE	NE
Chemical Oxygen Demand (COD)	SM5220D	mg/L	7.26 - 37.80	17.81	NE	NE
E. coli MPN	SM9223B	mpn/100ml	148 - 148	148	MCL[c]	NE
Total Coliform	SM9223B	mpn/100ml	1.00 - 2420	450.48	5%	1 per 100 ml

Notes:

(a) National Primary Drinking Water Regulations: MCLs (USEPA, 2024r).

(b) NCDEQ Groundwater Standards Rule 15A NCAC 02L .0202 (NCDEQ, 2022b).

(c) A routine sample that is fecal coliform-positive or *E. coli*-positive triggers repeat samples- -if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or *E. coli* negative triggers repeat samples--if any repeat sample is fecal coliform-positive or *E. coli*-positive, the system has an acute MCL violation. See also total coliforms.

Key: BOD = biological oxygen demand; COD = chemical oxygen demand; °C = degrees Celsius; MCL = minimum contaminant level; mg/L = milligrams per liter; ml = milliliter; mpn/100ml = most probable number per 100 ml; ms/cm = millisiemens per centimeter; mV = millivolts; NE = No regulatory standard established for this constituent; NTU = nephelometric turbidity unit; pci/L = picocuries per liter; TDS = total dissolved solids; TSS = total suspended solids; µg/L = micrograms per liter

Table 2.2-32
North Carolina Department of Environmental Quality Monitoring Stations
(Sheet 1 of 2)

Organization Identifier	Monitoring Location Name[a]	Monitoring Location Identifier	Station Type	Characteristic Groups Sampled[b]	Sample Dates[c]
21NC01WQ	Town Fork At Walnut Cove Inact 750126	21NC01WQ-N0700000	Stream	Information, minor inorganic metals, microbiological, organics (other), physical	1968-1975
21NC03WQ	Town Fork Cr	21NC03WQ-NB19	River/Stream	Biological counts	1988-2004
21NC03WQ	Dan Riv Nr Ceramic Inact 750127	21NC01WQ-N0900000	River/Stream	Information, minor inorganic metals, microbiological, organics (other), physical	1974-1975
21NC01WQ	Dan Riv At Hwy 772 At Pine Hall	21NC01WQ-N1000000	River/Stream	Information, major inorganic metals, minor inorganic metals, minor inorganic non-metals, microbiological, organics (other), physical, nutrient	1973-1984
21NC01WQ	Belews Lake at Mouth of Ash Basin Nr Walnut Cve	21NC01WQ-N1019050	Reservoir	Information, biological, minor inorganic metals, nutrient, physical	1987-1994
21NC01WQ	Belews Lake at Mouth of Ash Basin Nr Walnut Cve	21NC01WQ-N1019051	Reservoir	Minor inorganic metals, minor inorganic non-metals, physical, microbiological	1987-1994
21NC01WQ	Belews Lake at Mouth of Ash Basin Nr Walnut Cve	21NC01WQ-N1019052	Reservoir	Nutrient	1987-1994
21NC01WQ	Belews Lake at Pine Hall Access Area Cln Lakes	21NC01WQ-N1019062	Reservoir		1983-1994
21NC01WQ	Belews Lake at Pine Hall Access Area Cln Lakes	21NC01WQ-N1019061	Reservoir	Minor inorganic metals, minor inorganic non-metals, physical, microbiological	1983-1994
21NC01WQ	Belews Lake at Pine Hall Access Area Inact 81071	21NC01WQ-N1019060	Reservoir	Information, biological, minor inorganic metals, major inorganic metals, minor inorganic non-metals, nutrient, physical, microbiological	1980-1994
21NC01WQ	Belews Lake at Mouth E Belews Crk Nr Pine Hall Cln Lk	21NC01WQ-N1019070	Reservoir		
21NC01WQ	Belews Lk at Mth E Belews Ck Nr Pine Hall Cln Lk	21NC01WQ-N1019072	Reservoir	Nutrient	1983-1994
21NC01WQ	Belews Lk at Mth E Belews Ck Nr Pine Hall Cln Lk	21NC01WQ-N1019071	Reservoir	Minor inorganic metals, minor inorganic non-metals, physical, microbiological	1983-1994
21NC01WQ	Belews Lake at Rockingham Access Area Clean Lake	21NC01WQ-N1018830	Reservoir	Information, biological, minor inorganic metals, major inorganic metals, minor inorganic non-metals, nutrient, physical	1980-1994
21NC01WQ	Belews Lake At Rockingham Access Area Clean Lake	21NC01WQ-N1018831	Reservoir	Minor inorganic metals, minor inorganic non-metals, physical, microbiological	1983-1994

Table 2.2-32
North Carolina Department of Environmental Quality Monitoring Stations
(Sheet 2 of 2)

Organization Identifier	Monitoring Location Name[a]	Monitoring Location Identifier	Station Type:	Characteristic Groups Sampled[b]	Sample Dates[c]
21NC01WQ	Belews Lake At Rockingham Access Area Clean Lake	21NC01WQ-N1018832	Reservoir	Nutrient	1983-1994
21NC03WQ	Belews Lake	21NC03WQ-ROA009E	Lake	Physical, Nutrient, Biological, Algae, Phytoplankton, Photosynthetic Pigments	2002-2022[d]
21NC03WQ	Belews Lake	21NC03WQ-ROA009J	Lake		
21NC03WQ	Belews Lake	21NC03WQ-ROA009H	Lake		
21NC03WQ	Belews Lake	21NC03WQ-ROA009G	Lake		
21NC01WQ	Dan Riv Nr Pine Hall Inact 750120	21NC01WQ-N0500000	River/Stream	Information, Minor inorganic metals, Microbiological, Physical	1968-1975
21NC01WQ	W Belews Crk at Nwy 65 N Belews Inact 820721	21NC01WQ-N1007500	River/Stream	Physical, Biological, Nutrient	1982-1982
21NC01WQ	Sandy Br at Sr 1941 Nr Walnut Cove Inact 750120	21NC01WQ-N0600000	River/Stream	Information, Minor inorganic metals, Microbiological, Physical	1968-1975
21NC03WQ	Town Fork Cr	21NC03WQ-NB77	River/Stream		1988-1988
21NC03WQ	UT Dan R	21NC03WQ-NB13	River/Stream	Counts biological	1987-1987
21NC03WQ	UT Dan R	21NC03WQ-NB12	River/Stream		1987-1987
21NC03WQ	UT Dan River at U.S. 311 Hwy N nr Pine Hall	21NC03WQ-N1050000	River/Stream	Counts biological, Major inorganic metals, Minor inorganic metals, Minor inorganic non-metals, Nutrient, Other organics, PCBs organics, Pesticide organics, Physical, Stable isotopes	2019-2020

Source: NWQMC, n.d.
Notes:
(a) The Monitoring Location Name is listed as described in the NWQMC listing.
(b) Not all characteristic groups were sampled each year and at the same frequency.
(c) Date ranges may contain gap years.
(d) Stations are measured as part of the Basinwide Assessment Report created every five years.

Table 2.2-33
USGS Monitoring Station

Site Identification Number	Site Name	Daily Data	Date Range
02069000	Dan River at Pine Hall, NC	Precipitation, total, inches	06/02/2009 - Current
		Discharge, cubic feet per second	10/01/1923 - Current[(a)]
		Gage height, feet	12/02/2008 - Current

Source: USGS, n.d. (a)
Note:
(a) The stream gage was inactive during certain years within this date range.
Key: USGS = U.S. Geological Survey

2.3 ECOLOGICAL RESOURCES

This section describes the terrestrial, wetland, and aquatic ecology of the Project Region, Project Vicinity, and the Project site. Section 2.3.1 describes the potentially affected terrestrial resources and Section 2.3.2 describes the potentially affected aquatic resources. Consultations with the USFWS, USACE, NCDEQ, NCWRC, North Carolina Forest Service (NCFS), and NCNHP were initiated to acquire information regarding ecological resources within and near the Project site. Consultation is used to obtain agency input regarding threatened and endangered species, sensitive habitats, commercial and recreational species, and other ecological characteristics for the Project site and Project Vicinity. This section was prepared using U.S. Nuclear Regulatory Commission (NRC) guidance from NUREG-1555 and NRC Regulatory Guide 4.2 Rev. 3. Supporting terrestrial and aquatic environmental studies were executed in accordance with Regulatory Guide 4.11 Rev.2 and Regulatory Guide 4.24 Rev. 0, respectively.

2.3.1 TERRESTRIAL ECOLOGY

2.3.1.1 Terrestrial Habitats

2.3.1.1.1 Ecoregions

Ecoregions are geographic areas that are generally similar in terms of biotic, abiotic, terrestrial, and aquatic ecosystem components. Ecoregions serve as a spatial framework for the monitoring, research, and assessment of ecosystems and their components. The U.S. Environmental Protection Agency (USEPA) defines ecoregions in hierarchical levels from Level I to Level IV, increasing in detail as the level increases. The USEPA maintains the mapping of ecoregions (USEPA, 2024g).

NC is divided into 27 Level IV Ecoregions nested under four Level III Ecoregions. The Project Region is located within the Piedmont and Blue Ridge Level III Ecoregions, as depicted in Figure 2.3-1. The Blue Ridge Ecoregion is located northwest of the Project site and Project Vicinity. The Blue Ridge extends from southern Pennsylvania to northern Georgia and varies in topography, including narrow ridges, hilly plateaus, and mountainous areas. The Blue Ridge Ecoregion contains a high diversity of flora and fauna. Natural vegetation within this ecoregion in NC includes Appalachian oak forests with hemlock communities, cove hardwoods, and pine communities. Soils are mostly mesic, and elevations range from 1000 ft. (304.8 m) to 5000 ft. (1524 m) (Griffith et al., 2002).

The Project site and the Project Vicinity are located within the Piedmont Ecoregion, as depicted in Figure 2.3-1. The Piedmont Ecoregion is a transitional area between the mountainous Appalachians to the northwest and the relatively flat coastal plain to the southeast. It has an erosional terrain of dissected irregular plains with some hills, comprised of metamorphic and igneous rocks. Rare animals and plants are often found on scattered granitic domes and rock flats. Soils contain more clay and less sand than soils within the coastal plain areas. Land cover has changed over the last 200 years, shifting from forest to farm, then back to forest, and now reflect a greater abundance of developed land cover types resulting from growing urbanization. Historic forests consisted of white oak (*Quercus alba*), southern red oak (*Quercus falcata*), post oak (*Quercus stellata*), and hickory (*Carya* sp.), with some shortleaf pine (*Pinus echinata*) and loblolly pine (*Pinus taeda*). Historic farming for cotton, corn, tobacco, and wheat caused moderate to severe erosion in most Piedmont soils. Much of the area now is planted pine or has reverted to successional hardwood and pine woodlands with some pasture (Griffith et al., 2002).

More specifically, the Project site is located within the Northern Inner Piedmont Level IV Ecoregion (Figure 2.3-1). The Northern Inner Piedmont generally has more isolated small mountains, higher elevations, and more rugged topography than other areas of the Piedmont. It is generally characterized by colder temperatures, increased levels of snowfall and has a shorter growing season than other areas of the Piedmont. Soils within the Northern Inner Piedmont are predominantly mesic, which is different from the mostly thermic soils covering other areas of the Piedmont. Virginia pine (*Pinus virginiana*) is more prevalent within this ecoregion, along with chestnut oak (*Quercus montana*) and disjunct plant communities within the mountainous areas (Griffith et al., 2002).

The associated off-site wastewater pipeline corridor is located partially within the Triassic Basins Level IV Ecoregion (Figure 2.3-1). The Triassic Basins Ecoregion within NC occur in four narrow bands and have unusual Piedmont geology of unmetamorphosed shales, sandstones, mudstones, siltstones, and conglomerates. Triassic Basins contain lower elevations and rocks that erode more easily than those within the Northern Inner Piedmont. Soils are often clayey with poor permeability. Land cover within the Triassic Basins includes a mosaic of mixed and deciduous forest, pasture, cropland, and developed land. Large bottomland forests occurred in the wider floodplains before being covered by reservoir water (Griffith et al., 2002).

2.3.1.1.2 Topography and Land Cover

General topography on the Project site is typical of the Piedmont and the Project Vicinity, characterized by rolling hills and long low ridges with a few hundred feet of elevation difference between ridges and valleys. Figure 2.1-7 shows topography of the Project Vicinity. As discussed in Section 2.1, the Project site consists of rolling hills and steep slopes with elevations ranging from approximately 725 ft. (219.5 m) near the shore of Belews Lake to approximately 890 ft. (271 m) along the ridgetops. Topography is discussed in additional detail in Section 2.1, and a map of the topography of the Project site is found in Figure 2.1-10.

The NLCD data indicate the most prevalent land cover type found within the Project Vicinity is deciduous forest (36,003 ac. [14,570 ha]), followed by hay/pasture (17,088 ac. [6915 ha]), evergreen forest (9578 ac. [3876 ha]), and mixed forest (8497 ac. [3439 ha]).The land cover in the approximately 1187-ac. (480-ha) Project site and the 40-ac. (16-ha) associated off-site pipeline corridor is characterized predominantly by evergreen forest (463 ac. [187 ha]), which is the most prevalent land cover type. Other common land cover types include deciduous forest (330 ac. [134 ha]), mixed forest (151 ac. [61 ha]), and herbaceous land (130 ac. [53 ha]) (Figure 2.3-2 and Table 2.3-1).

Field surveys of vegetation on the Project site were conducted in the spring (April 8 to 12, 2024), summer (July 15 to 18, 2024), and fall (October 21 to 24, 2024). Evergreen forests can be found throughout the site, though they are slightly more common on the northern and southern portions of the site. These areas are not highly diverse and are characterized by near-monoculture stands of pine with little to no herbaceous cover. Approximately 18 percent of evergreen forests are currently composed of planted loblolly plantations, not including other areas of the Project site that have regenerated naturally since being harvested. Deciduous forests and mixed forests, which are the second and third most common land cover types, have a more diverse tree layer along with a slightly more diverse herbaceous layer. Combined forest types make up approximately 77 percent of the Project site land cover. The remaining 23 percent of land cover can be attributed to herbaceous, scrub shrub, open water, and developed or barren lands.

The plant communities found within the Project site are common and well represented throughout the local region. These communities contain substantial populations of non-native plant species and successional communities, which indicate significant past anthropogenic disturbance, non-native species invasion, and a disruption to natural disturbance patterns (e.g., fire). Loblolly pine plantations are scattered throughout the Project site.

Much of the Project site has remained or become forested since Belews Lake was created in the late 1960s to early 1970s. However, human disturbance to vegetation in the area was already prevalent and signatures of agriculture (pastureland) and an extensive patchwork of pine plantations are evident from historical aerial imagery. Since the late 1990s and early 2000s, significant forest clearing has taken place within the northern and western portions of the main Project site footprint and in uplands along the associated off-site wastewater pipeline corridor. These areas have, for the most part, since been allowed to naturally succeed back into forest. Areas currently characterized by herbaceous, scrub shrub, and evergreen land cover comprise the most disturbed portions of the Project site and represent consistently cleared lands, newly regenerated formerly cleared lands, and lands which have remained in pine plantation or naturally regenerated back into pine from logged pine plantations. Deciduous forest within the Project site is typically found in the most mature and undisturbed lands. While considered native, thick stands of young to fairly mature loblolly pine have created near monocultures with little else growing in the canopy, subcanopy, and herbaceous layer in extensive portions of upland found within the Project site.

Mature deciduous-forested, small low-gradient stream valleys located within the Project site contain the highest quality vegetation community and highest number of conservative species, including a number of fern and orchid species. This community is concentrated at stream seep heads and low, rich stream terraces and embankments. During surveys of the Project Vicinity, a higher quality example of this community was visited in the nearby Rock Branch Natural Area in Stokesdale, NC. Small stream valleys in the Rock Branch Natural Area are embedded in a more mature forested matrix and small terraces and embankments contain a more diverse shrub and herb assemblage than are present on the Project site. Species of note include southern wild raisin (*Viburnum nudum*), winterberry (*Ilex verticillata*), mapleleaf viburnum (*Viburnum acerifolium*), yellowroot (*Xanthorhiza simplicissima*), small green wood orchid (*Platanthera clavallata*), showy orchid (*Galearis spectabilis*), cucumber root (*Medeola virginiana*), and Carolina lily (*Lilium michauxii*).

2.3.1.2 Wetlands

As defined in Title 33 of the CFR Part 328.3 (33 CFR 328.3), wetlands are those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Types of wetlands include swamps, marshes, bogs, and similar areas. Wetlands and wetland fringe areas can also be found along the edges of many watercourses and impounded waters (both natural and human-made). Wetland habitat provides valuable public benefits, including flood storage, erosion control, water quality improvement, wildlife habitat, and recreational opportunities (33 CFR 320.4(b)).

2.3.1.2.1 Wetlands within the Project Vicinity

In the Northern Inner Piedmont Ecoregion, where the Project site is located (Section 2.3.1.1) (USEPA, 2024g), wetlands are often located along streams and rivers either as swamps or bottomland hardwood forests or as headwater forests near the origins of streams. They tend to

be mainly forested, although some freshwater emergent features are present. Depressional wetlands and seeps also occur (NC DWR, 2018-2024). In the Northern Inner Piedmont, more rugged topography may contribute to narrower riparian wetlands like those observed on the Project site (USEPA, 2024g). Historically, the greatest disturbance threat to wetlands in the Carolinas was attributable to wetland loss and conversion to agricultural land through ditching and draining. In 2002, the U.S. Forest Service found that the most significant threats to forested wetlands in the Carolinas were development, agriculture, and silviculture (Carolina Wetlands Association, 2022).

According to the USFWS NWI data, approximately 7517 ac. (3042 ha) of wetland, riparian, and deepwater habitats are mapped within the Project Vicinity. Wetland types found in the Project Vicinity include freshwater emergent wetlands (88 ac. [35 ha]), freshwater forested wetlands (1855 ac. [751 ha]), freshwater scrub shrub wetlands (312 ac. [126 ha]), freshwater ponds (438 ac. [177 ha]), lakes (3833 ac. [1551 ha]), and riverine features (992 ac. [402 ha]) (USFWS, 2024a) (Figure 2.3-3). They appear to be characteristic of Northern Inner Piedmont systems, generally confined to narrow areas along river corridors and drainageways.

Additional land uses in the Project Vicinity can be found in Section 2.1.1. No special wetland land uses were noted.

2.3.1.2.2 Project Site Wetlands

Wetlands located within the Project site are subject to jurisdiction under Section 401 and Section 404 of the CWA (33 U.S. Code [USC] 1251). The USACE regulates the discharge of dredged or fill material into WOTUS, including wetlands, under the CWA Section 404 permit program (33 USC 1344). Under Section 401 of the CWA, a Section 401 Water Quality Certification is required for any project requiring a federal construction permit or license for activities that may result in any discharge into navigable waters. In NC, the Division of Water Resources of the NCDEQ is responsible for issuing Section 401 water quality certifications through the USACE and NCDEQ Joint Pre-Construction Notification application (NCDEQ, 2017b).

Screening of habitats on the Project site for the potential occurrence of WOTUS initially involved a review of the USGS topographic map, USFWS NWI data, Natural Resources Conservation Service soil survey data, FEMA flood insurance rate maps, and current and historic aerial photography. Within the Project site, NWI data indicate only the presence of lake (25 ac. [10 ha]) and riverine features (1 ac. [0.4 ha]) (Figure 2.3-4). The lake features include portions of Belews Lake contained within the Project site and the canal that extends through the middle portion of the site. The riverine feature is an unnamed tributary located in the southwestern portion of the Project site which drains to Belews Lake.

Subsequently, field WOTUS delineation surveys were performed April 16 – 19, April 24 – 26, and May 10, 2024, within the Project site, specifically within the delineation survey area as depicted on Figure 2.3-5. Wetland identifications were performed in accordance with USACE methods outlined in the Wetlands Delineation Manual (USACE, 1987a), which requires documentation of hydrophytic vegetation, hydric soils, and wetland hydrology. Field identifications of potential WOTUS were performed according to the Wetlands Delineation Manual (USACE, 1987a) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont region, Version 2.0 (Regional Supplement) (USACE, 2012).

Eighteen features, totaling 2.94 ac. (1.19 ha), qualify as wetlands in accordance with the Regional Supplement (Table 2.3-2). Each feature was assigned a Cowardin designation (Cowardin et al., 1979) and was evaluated using the North Carolina Wetland Assessment Method (NCWAM), per the methodology outlined in the NCWAM User Manual (Version 5), effective February 2016 (NC Wetland Functional Assessment Team, 2016). NCWAM is a functional assessment which assigns wetlands a score of high, medium, or low based on a field assessment of 22 metrics.

All 18 wetland features were identified as palustrine systems associated with topographic crenulation or streams, in a geomorphic floodplain, or contiguous with an open water 20 ac. or larger. Most are either narrow or small features, due to the degree of topographic relief on the site, and therefore are not a dominant feature of the Project site. Of the 18 total and 2.94 ac. (1.19 ha) of delineated wetland features, 13 features, totaling 1.45 ac. (0.59 ha), were classified as palustrine forested (PFO) systems; four features, totaling 1.27 ac. (0.51 ha), were classified as palustrine emergent (PEM); and one feature, totaling 0.22 ac. (0.09 ha), consists of both forested and emergent vegetation (Table 2.3-2). One PEM system is located in a relict stormwater management pond. The other PEM features are characterized by emergent vegetation due to their full or partial occupation of a maintained overhead utility easement. It is assumed that the natural condition of these features would otherwise be forested.

Common tree species observed within PFO features consisted of tulip poplar (*Liriodendron tulipifera*), American sycamore (*Platanus occidentalis*), mockernut hickory (*Carya tomentosa*), American beech (*Fagus grandifolia*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*). Common sapling and shrub species within the PFO features included smooth alder (*Alnus serrulata*), red maple, musclewood (*Carpinus caroliniana*), mockernut hickory, tulip poplar, spicebush (*Lindera benzoin*) black tupelo (*Nyssa sylvatica*), southern sugar maple (*Acer floridanum*), and sweetgum. Common herbaceous species within PFO features included Gray's sedge (*Carex grayi*), Christmas fern (*Polystichum acrostichoides*), velvet panicgrass (*Dichanthelium scoparium*), cinnamon fern (*Osmundastrum cinnamomeum*), Japanese stiltgrass (*Microstegium vimienieum*), and lizard's tail (*Saururus cernuus*).

PEM features were generally characterized by the following herbaceous vegetation: common rush (*Juncus effusus*), woolgrass (*Scirpus cyperinus*), bladder sedge (*Carex intumescens*), and velvet panicgrass.

Of the 18 identified features, 11 features, totaling 1.37 ac. (0.55 ha), were assigned a function score of high according to NCWAM, five features totaling 0.52 ac. (0.21 ha) were assigned a function score of medium, and two features totaling 1.05 ac. (0.42 ha) were assigned a function score of low (Table 2.3-2). Table 2.3-2 contains relevant information for the 18 identified features, including size, Cowardin and NCWAM designation, potential jurisdictional status, NCWAM functional rating, and location. In addition, the locations of each of these wetland features are shown on Figure 2.3-5.

WOTUS are subject to the regulatory authority of the USACE pursuant to Section 404 of the CWA. Of the 18 wetland features identified within the Project site, all are considered potentially jurisdictional due to direct or indirect surface water connections with Belews Lake and the Dan River; however, these recommendations for potential regulatory features are preliminary and are subject to regulatory jurisdictional determination by the USACE. A delineation survey area, subject to potential impacts from the Project, includes 1041 ac. (421 ha) adjacent to the BCSS and an existing approximately 3.7-mi. (5.95-km) associated off-site wastewater pipeline corridor

(Figure 2.3-5). Following the field survey, a WOTUS report and request for delineation concurrence was completed. The delineation concurrence request was submitted to USACE on October 22, 2024. The USACE performed a site visit on December 10, 2024, to field verify the WOTUS delineation. On January 16, 2025, the USACE issued a Jurisdictional Delineation Concurrence letter confirming the delineation (Figure 2.3-5) is a sufficiently accurate representation of the geographic boundaries of the aquatic resources located on the site within the delineation survey area. No surveys for WOTUS were conducted outside of the delineation survey area, as Project impacts are not anticipated beyond this boundary. Duke Energy will continue to coordinate with the USACE to expand the delineation concurrence request to include any areas outside of the delineation survey area, if necessary.

2.3.1.3 Wildlife

To document seasonal wildlife use of the Project site and the immediate Project Vicinity, seasonal pedestrian surveys were conducted during spring (April 8 to 12, 2024), summer (July 15 to 18, 2024), fall (October 21 to 24, 2024), and winter (January 27 to 30, 2025). A pedestrian site reconnaissance survey was conducted each season using a semiquantitative meandering approach within the Project site to record encountered terrestrial faunal species presence (visual, audible, or other signs such as tracks, scat, nests) within each of the on-site habitats (Figure 2.3-6). The field studies for wildlife included surveys for avifauna, mammals, and herpetofauna.

Additionally, a semiquantitative roadside survey approach was used to make observations of terrestrial faunal species along prescribed stops of existing roadways within the Project site and Project Vicinity (Figure 2.3-6). At each of the 17 stops, field biologists recorded birds observed (visible and audible cues) during a 3-minute period for two mornings per seasonal survey period with observations initiated within 1 hour of sunrise each day. The distances between prescribed stops were generally 0.5 mi. (0.8 km) with some stopping points focused on potential habitat features (e.g., vegetation changes, stream corridors, waterbodies). Notable wildlife travel corridors, if any, were also documented.

Incidental observations of wildlife species and habitats outside the Project site were also recorded opportunistically through general reconnaissance within the Project Vicinity. Climatic conditions, such as estimated wind intensity (no wind, slight, gusty, strong wind), temperature (degrees Fahrenheit), and cloud cover, were recorded for each survey event.

As discussed in Section 2.3.1.1, many of the terrestrial communities and associated habitats within the Project site are predominantly composed of disturbed and previously disturbed communities consisting of developed lands or marginal evergreen, herbaceous, and scrub shrub habitat. Wildlife habitat value and associated wildlife communities are considered limited in these areas. However, deciduous forest and associated stream valley habitats, which are more mature and less disturbed, provide higher quality wildlife habitat. Small wetlands on the site provide breeding and nesting areas for wildlife. Belews Lake provides habitat for migratory birds. The sections below summarize relevant information obtained from each survey and provide other data and descriptions of the terrestrial ecology in the area.

2.3.1.3.1 Avifauna

Field studies for avian species included pedestrian meandering on the Project site and general field reconnaissance and roadside survey methods in the Project Vicinity.

In total, 68 species were observed during the spring 2024 surveys, including 45 species observed within the Project Vicinity driving route, 44 species as part of the Project Vicinity general reconnaissance, and 51 species as part of the surveys within the Project site (Table 2.3-3 and Table 2.3-4). Abundant and common bird species observed within the Project site during the spring 2024 Project site field surveys included tufted titmouse (*Baeolophus bicolor*), northern cardinal (*Cardinalis cardinalis*), turkey vulture (*Cathartes aura*), American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), red-bellied woodpecker (*Melanerpes carolinus*), wild turkey (*Meleagris gallopavo*), brown-headed cowbird (*Molothrus ater*), eastern towhee (*Pipilo erythrophthalmus*), Carolina chickadee (*Poecile carolinensis*), blue-gray gnatcatcher (*Polioptila caerulea*), pine warbler (*Setophaga pinus*), American goldfinch (*Spinus tristis*), chipping sparrow (*Spizella passerina*), Carolina wren (*Thryothorus ludovicianus*), American robin (*Turdus migratorius*), mourning dove (*Zenaida macroura*), and white-throated sparrow (*Zonotrichia albicollis*) (Table 2.3-3).

Fifty-one bird species were observed during the summer 2024 surveys, including 41 species observed within the Project Vicinity driving routes, 34 species as part of the Project Vicinity general reconnaissance, and 38 species within the Project site (Table 2.3-3 and Table 2.3-4). Abundant and common bird species observed within the Project site during summer 2024 Project site field surveys included tufted titmouse, Canada goose (*Branta canadensis*), northern cardinal, yellow-billed cuckoo (*Coccyzus americanus*), eastern wood-pewee (*Contopus virens*), blue jay, red-bellied woodpecker, osprey (*Pandion haliaetus*), indigo bunting (*Passerina cyanea*), eastern towhee, Carolina chickadee, blue-gray gnatcatcher, American goldfinch, Carolina wren, American robin, red-eyed vireo (*Vireo olivaceus*), and mourning dove (Table 2.3-3).

Fifty bird species were observed during the fall 2024 surveys, including 38 species observed within the Project Vicinity driving routes, 34 species as part of the Project Vicinity general reconnaissance, and 34 species within the Project site (Table 2.3-3 and Table 2.3-4). Abundant and common bird species observed during fall 2024 Project site field surveys included northern cardinal, turkey vulture, American crow, blue jay, hairy woodpecker (*Dryobates villosus*), red-bellied woodpecker, wild turkey, song sparrow (*Melospiza melodia*), Carolina chickadee, golden-crowned kinglet (*Regulus satrapa*), eastern bluebird (*Sialia sialis*), brown-headed nuthatch (*Sitta pusilla*), mourning dove, and white-throated sparrow (Table 2.3-3).

Fifty bird species were observed during the winter 2025 surveys including 36 species observed within the Project Vicinity driving routes, 31 species as part of the Project Vicinity general reconnaissance, and 35 species within the Project site (Table 2.3-3 and Table 2.3-4). Abundant and common bird species observed during the winter 2025 Project site field surveys included tufted titmouse, northern cardinal, turkey vulture, American crow, dark-eyed junco (*Junco hyemalis*), song sparrow, Carolina chickadee, golden-crowned kinglet, brown-headed nuthatch, and mourning dove (Table 2.3-3).

While much of the Project site is previously disturbed and in varying stages of secondary growth, large trees typically used for raptor nesting are primarily limited to areas near the shoreline of Belews Lake within the Project site. No raptor nests were observed in trees within the Project site during seasonal ecology field surveys; however, an actively used osprey nest platform was observed in the north portion of the Project site (Figure 2.3-7). Waterfowl and water dependent bird species were observed in close association with Belews Lake. Belews Lake provides valuable habitat for migratory birds. Waterfowl noted as using Belews Lake for foraging, swimming, or wading in 2020 included double-crested cormorant (*Nannopterum auritum*), Canada goose, osprey, great blue heron (*Ardea herodias*), killdeer (*Charadrius*

vociferus), wood duck (*Aix sponsa*), common loon (*Gavia immer)*, great egret (*Ardea alba*), and belted kingfisher (*Megaceryle alcyon)* (Duke Energy, 2021).

The complete list of birds observed within the Project Vicinity and Project site for each seasonal survey is recorded in Tables 2.3-3 and 2.3-4. No bird species federally listed under the Endangered Species Act were identified on the Project site or in the Project Vicinity. Bald eagle (*Haliaeetus leucocephalus*), identified by USFWS as a migratory bird of conservation concern and protected under the Bald and Golden Eagle Protection Act, was observed within the Project Vicinity during spring 2024 and observed in the Project site in the fall of 2024 and winter of 2025. No bald eagle nests were observed within the Project site; however, a bald eagle nest was previously observed at the BCSS, which is located in close proximity to the Project site, adjacent to the Craig Road Landfill (Duke Energy, 2023a). Grasshopper sparrow (*Ammodramus savannarum*), also identified by USFWS as a migratory bird of conservation concern, was observed within the Project Vicinity during summer 2024. Red-headed woodpecker (*Melanerpes erythrocephalus*), also identified by USFWS as a migratory bird of conservation concern, was observed within the Project Vicinity during fall 2024. Information about important terrestrial species is found in Section 2.3.1.5.

Regional data concerning occurrence of birds during the breeding season are derived from the annual North American Breeding Bird Survey, which is a long-term international avian monitoring program. These roadside surveys are conducted in June each year and are 24.5 mi. (39 km) long with 3-minute stops every 0.5 mi. (0.8 km) to document avian species presence within 0.25 mi. (0.40 km) (USGS Eastern Ecological Science Center, 2024a). The closest breeding bird survey route to the Project site is Eden (Number 63126). The Eden route winds through Rockingham County to the northeast of the Project site (USGS Eastern Ecological Science Center, 2024b). Sixty-four avian species were observed during the most recent breeding bird survey (2022) of this route. The most abundant species included northern cardinal, European starling (*Sturnus vulgaris*), tufted titmouse, American crow, and chimney swift (*Chaetura pelagica*) (USGS Eastern Ecological Science Center, 2024c).

The Christmas Bird Count (CBC) is a community science initiative started in 1900 to measure avian diversity during the winter period. CBCs occur between December 14 and January 5 each year, and a compiler chooses a single calendar day to count birds within a predetermined 15-mi. (24-km) diameter circle. Count volunteers follow specified routes through the circle, counting every bird they see or hear all day (Audubon, 2024a). The nearest CBC to the Project site is in Rockingham County, Code NCRO, which is centered on the U.S. 220 Business Bridge over Mayo River, just north of Mayodan, NC. This CBC is to the northeast of the Project site (Audubon, 2024b). The number of avian species observed during the NCRO CBC from 2012 through 2022 ranged from 58 to 78 species per survey (Audubon, 2024c). During the latest CBC (2023), 77 species were recorded. The most abundant species included Canada goose, dark-eyed junco, white-throated sparrow, European starling, and American robin (Audubon, 2024d).

2.3.1.3.2 Mammals

Field surveys for mammals on the Project site consisted of general field surveys and acoustic surveys. General field surveys for mammal species included field reconnaissance and incidental observations during pedestrian surveys.

Mammal species observed within the Project Vicinity include coyote (*Canis latrans*), opossum (*Didelphis virginiana*), groundhog (*Marmota monax*), striped skunk (*Mephitis mephitis)*, white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), eastern gray squirrel (*Sciurus*

carolinensis), and gray fox (*Urocyon cinereoargenteus*). These mammals were also observed on the Project site. Other mammals observed on the Project site include beaver (*Castor canadensis*), eastern mole (*Scalopus aquaticus*), fox squirrel (*Sciurus niger*), eastern cottontail (*Sylvilagus floridanus*), and eastern chipmunk (*Tamias striatus*). Mammal occurrence within the Project site is likely driven by available habitats (developed lands, herbaceous, scrub shrub, open water, and fragmented deciduous, evergreen, and mixed forests) and previous disturbance within and surrounding the Project site. The list of mammals observed within and near the Project site is recorded in Table 2.3-5.

Acoustic surveys for bats were conducted from August 4 to August 15, 2023. Species identified on the Project site included: big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), silver-haired bat (*Lasionycteris noctivagans*), evening bat (*Nycticeius humeralis*), Brazilian free-tailed bat (*Tadarida brasiliensis*), and tricolored bat (*Perimyotis subflavus*). Gray bat (*Myotis grisescens*), little brown bat (*Myotis lucifugus*), and eastern small-footed bat (*Myotis leibii*) were considered absent from the Project site (WSP, 2025). The tricolored bat is proposed for federal listing. Information on important terrestrial species is provided in Section 2.3.1.5.

2.3.1.3.3 Herpetofauna

Herpetofauna were recorded based on field reconnaissance and incidental observations during the pedestrian ecological surveys.

Within the Project Vicinity, herpetofauna species observed during surveys were species uncommon to abundant in the Piedmont. Eastern river cooter (*Pseudemys concinna concinna*), uncommon to common in the Piedmont; eastern box turtle (*Terrapene carolina*), common in the Piedmont; and Cope's gray treefrog (*Hyla chrysoscelis*), common to abundant, were observed (LeGrand, H., and Howard, T., 2024) (Table 2.3-6).

Amphibians encountered on the Project site considered abundant or common in the Piedmont included frogs and treefrogs, toads, and salamanders. Specific species were the northern cricket frog (*Acris crepitans*), green frog (*Lithobates clamitus*), spring peeper (*Pseudacris crucifer*), Cope's gray treefrog, southern leopard frog (*Lithobates sphenocephalus*), upland chorus frog (*Pseudacris feriarum*), American toad (*Anaxyrus americanus*), northern dusky salamander (*Desmognathus fuscus*), and southern two-lined salamander (*Eurycea cirrigera*) (LeGrand, H., and Howard, T., 2024). One uncommon to common amphibian, the pickerel frog (*Rana palustris*), was also observed on the Project site (LeGrand, H., and Howard, T., 2024) (Table 2.3-6).

Reptile species encountered on the Project site considered abundant or common in the Piedmont included worm snake (*Carphophis amoenus*), eastern painted turtle (*Chrysemys picta picta*), black racer (*Coluber constrictor*), black rat snake (*Pantherophis alleghaniensis*), eastern fence lizard (*Sceloporus undulatus*), eastern box turtle, and yellow-bellied slider (*Trachemys scripta scripta*) (LeGrand, H., and Howard, T., 2024). The non-native red-eared slider (*Trachemys scripta elegans*) was also observed on the Project site. Table 2.3-6 lists the herpetofauna observed within and near the Project site. As expected, due to the hibernation period for herpetofauna, no herpetofauna were observed during the winter 2025 ecology survey.

Other amphibian species not observed in the Project Vicinity or site but that are common or abundant in the Piedmont include spotted salamander (*Ambystoma maculatum)*, marbled salamander (*Ambystoma opacum)*, eastern newt (*Notophthalmus viridescens),* red salamander (*Pseudotriton ruber*), Fowler's toad (*Anaxyrus fowleri*), and American bullfrog (*Lithobates*

catesbeianus). Other reptile species not observed in the Project Vicinity or site but that are common or abundant in the Piedmont include common snapping turtle (*Chelydra serpentina),* eastern mud turtle (*Kinosternon subrubrum*), Dekay's brownsnake (*Storeria dekayi),* eastern garter snake (*Thamnophis sirtalis),* and copperhead (*Agkistrodon contortrix*) (LeGrand, H., and Howard, T., 2024).

2.3.1.3.4 Insects

No insect studies were conducted as part of site characterization work at the Project site. However, the Project site is expected to support a large diversity of insect species corresponding to the range of habitat types within the Project site. Pollinators are an insect group that is of particular interest in ecosystem management as they perform an important role in ensuring reproductive success of plant communities. Pollinators are also often indicators of healthy, diverse terrestrial ecosystems. Herbaceous and wooded areas around the Project site may provide suitable habitat for common pollinator species such as spicebush swallowtail (*Papilio troilus*), gray hairstreak (*Strymon melinus*), variegated fritillary (*Euptoieta hegesia*), mining bees (*Andrena* sp.), and sweat bees (family Halictidae) (North Carolina Wildlife Federation, 2020).

2.3.1.4 Plant Communities

Vegetation assessment included pedestrian surveys to record plant species encountered within the Project site, characterize plant communities present, and verify land cover. To account for seasonal variability of the vegetation within the site, surveys were conducted in the spring (April 8 to 12, 2024), summer (July 15 to 18, 2024), and fall (October 21 to 24, 2024). No vegetation surveys were conducted during the dormant winter months.

To effectively characterize plant communities in the Project site, the relative abundance of each species occurring within each distinctive NLCD land cover type was assessed. Within individual land cover types, each unique plant community observed was described. Plant community descriptions were based on dominant and characteristic species observed. Species' concepts and nomenclature followed Weakley's *Flora of the Southeastern United States* (2024). Land cover types and parcels assessed as part of the vegetation assessment are illustrated in Figure 2.3-2. The relative abundance of each species recorded through a terrestrial meandering approach within the Project site was assessed qualitatively. The terrestrial meandering approach provided characterization of plant communities within available on-site habitats. Plant species abundance was visually scored for each vegetation layer (overstory, midstory, herbaceous, woody vine) based on the professional judgment of the field biology team using the following commonly used relative abundance scale:

- A: abundant (the dominant plants throughout and near the Project site)
- C: common (locally abundant or frequently encountered)
- O: occasional (occasionally encountered, or locally common but absent or infrequent across much of the study area)
- U: uncommon (infrequently encountered)
- R: rare (very few plants encountered)

Qualitative characteristics of habitats within the Project Vicinity and their associated flora were also recorded opportunistically via windshield surveys where accessible. Particular attention was given to identifying important species and habitats as defined in NUREG-1555 Section 2.4.

As discussed in Section 2.3.1.1, the plant communities found within the Project site are common and well represented throughout the local region. Many of these communities are successional and contain substantial populations of non-native plants, indicating significant past anthropogenic disturbance and a disruption to natural disturbance patterns. Deciduous forests within the Project site are generally less disturbed when compared to other plant communities and stream valleys contain the highest number of conservative species. Vicinity surveys showed habitat and landcover to be similar to those within the Project site although there was one higher quality example of a stream valley embedded in a more mature forested matrix that contained more plant diversity than on the Project site. The key characteristics of land cover types and the diversity of plant associations found within each type identified within the site are described in the sections below. A list of plants documented on the Project site is found in Table 2.3-7.

2.3.1.4.1 Evergreen Forest

Evergreen forest is scattered throughout uplands within the Project site and is represented by two types: loblolly and Virginia pine–dominated forests, although both species were occasionally observed mixing together. Loblolly forest is primarily found in timber plantations where it can be observed growing in rows, and in areas formerly in plantation where it has regenerated naturally since being harvested. Relatively few species are found in association as loblolly was commonly observed growing in near monoculture; however, moderate amounts of tulip poplar, red maple, Virginia pine, and black cherry (*Prunus serotina*) can be found in the canopy. Flowering dogwood (*Benthamidia florida*), tulip poplar, American beech, and musclewood are frequently encountered in the subcanopy. The herbaceous layer is nearly always depauperate but may include a few species such as muscadine (*Muscadinia rotundifolia* var. *rotundifolia*), common greenbriar (*Smilax rotundifolia*), and seedlings from various canopy species. The woody vine layer is also not significantly developed but includes cross vine (*Bignonia capreolata*), Japanese honeysuckle, and Chinese wisteria.

Virginia pine–dominated forest occurs in younger- and older-aged stands. Similar to loblolly forest, Virginia pine forest is typically species poor. However, Virginia pine forest can be found in slightly drier topographic positions and does not occur in planted timber stands. Associated species are consistent with those found in loblolly forests within the Project site, but Virginia pine forests may possess slightly more herbaceous species diversity.

2.3.1.4.2 Deciduous Forest

Deciduous forest represents the most mature land cover type found within the Project site, although it may also be found in more disturbed lands located within suitable landscape positions on side slopes, ravines, creek valleys, and in the floodplain of the Dan River. Several different deciduous forest associations were observed dependent on local site moisture availability, history of disturbance, and underlying geology.

Mature upland deciduous forest found in the southeastern portion of the Project site was characterized by white oak, northern red oak (*Quercus rubra*), tulip poplar, American beech, and red maple. The shrub layer was commonly occupied by beech, sourwood (*Oxydendrum arboreum*), striped wintergreen (*Chimaphila maculata*), deerberry (*Vaccinium stamineum*), hillside blueberry (*Vaccinium pallidum*), strawberry bush (*Euonymus americanus),* and

muscadine. Where this forest association occurred along low-gradient, small stream valleys, additional shrub and herbaceous species were typically accompanying. Low terraces, seep heads, and embankments of these small streams included within the deciduous-forested matrix possessed the highest quality vegetation communities found within the Project site. Additional shrub species observed included pawpaw (*Asimina triloba*), musclewood, spicebush (*Lindera benzoin*), sweetgum, and pink azalea (*Rhododendron periclymenoides*). The herbaceous layer here often included rattlesnake-root (*Nabalus* sp.), mayapple (*Podophyllum peltatum*), star chickweed (*Stellaria pubera*), hooded blue violet (*Viola cucullata*), heartleaf foamflower (*Tiarella cordifolia*), fan clubmoss (*Diphasiastrum digitatum*), dwarf iris (*Iris cristata*), small green wood orchid, showy orchid, and a number of fern species.

Sub-xeric, mature deciduous forest growing along the east and north facing slopes of Belews Lake located north of the transmission corridor of the Project site is characterized by a drier assemblage of species. These species include white oak, chestnut oak, scarlet oak (*Quercus coccinea*), and beech in the canopy. Beech is also found in the sparse shrub layer where it grows over the scant herbaceous layer of hillside blueberry.

Dry, deciduous forest found along exposed south facing ravine slopes north of the transmission line corridor include red maple, beech, chestnut oak, sourwood, and post oak in the canopy with sourwood, red maple, shortleaf pine, and pink azalea in the subcanopy. The herbaceous layer here is mostly absent but infrequently includes tree seedlings and other woody species such as whiteleaf greenbriar (*Smilax glauca*).

Deciduous forest found in the floodplain of the Dan River crossed by the associated off-site pipeline corridor is in various stages of successional regrowth. An area cleared for hay became fallow in the mid-2010s and has since returned to ruderal floodplain forest. As late as 2020, one small adjoining hayfield was allowed to grow over and is still in scrub shrub. The oldest example of deciduous-forested Dan River floodplain in the Project site is located immediately adjacent to the river. This floodplain appears to have been cleared as recently as the early 1980s, and the current species composition reflects its ruderal condition. The canopy here is occupied by box elder (*Acer negundo*), tulip poplar, sweetgum, sycamore, and river birch (*Betula nigra*). Box elder is also found in the shrub layer along with musclewood and spicebush. Wild ginger (*Asarum canadense*), Virginia wildrye (*Elymus virginicus*), wild chervil (*Chaerophyllum procumbens*), sticky willy (*Galium aparine*), creeping Charlie (*Glechoma hederacea*), Japanese honeysuckle, and Japanese stiltgrass were found in the herbaceous layer here.

2.3.1.4.3 Mixed Evergreen – Deciduous Forest

Mixed evergreen-deciduous forest is not significantly abundant across the Project site and typically occurs in the transitional zones between deciduous forest and naturally vegetated pine stands. Species composition varies depending on aspect and moisture availability. Common canopy species include loblolly, Virginia pine, beech, tulip poplar, red maple, black cherry, and various oak species. In the shrub layer, flowering dogwood, beech, sourwood, musclewood, and Chinese privet were frequently observed. The herbaceous layer is scant as within deciduous and evergreen forests on-site and may include fan clubmoss, strawberry bush, Japanese stiltgrass, muscadine, Japanese honeysuckle, and blueberry and huckleberry species.

2.3.1.4.4 Scrub Shrub

Scrub shrub land cover is found in limited areas within the Project site and is most common in areas recently disturbed and in early stages of natural succession. Ruderal upland scrub shrub

is similar throughout the site and resembles disturbed upland herbaceous vegetation in other areas of the Project site, just at a slightly later successional stage. The shrubs found in this landcover type are composed primarily of younger specimens of the evergreen species found throughout the rest of the Project site. These species include Virginia pine, loblolly pine, and eastern red cedar (*Juniperus virginiana*). A majority of this land cover type is localized in the central area of the Project site, directly south of the southernmost section of the associated off-site pipeline corridor. The common species found in these areas include broomsedge (*Andropogon virginicus*), southern crownbeard (*Verbesina occidentalis*), sericea lespedeza, common dog fennel (*Eupatorium capillifolium*), and sawtooth blackberry (*Rubus argutus*).

A small scrub shrub area is located adjoined to the meteorological tower cleared area to its northeast. The trees in this area were cut down but were left lying in this section of the clearing. At the point of observation, not many herbaceous species were growing in this area, and most plants present were young tree species. These tree species included tulip poplar, loblolly pine, red maple, tree of heaven (*Ailanthus altissima*), and persimmon (*Diospyros virginiana*).

2.3.1.4.5 Herbaceous

Herbaceous land cover is predominantly found in upland areas along powerline corridors, reclaimed landfills, roadsides, and recently cleared portions of the Project site. These dry herbaceous communities can be found in old field conditions, regularly maintained turf, and restored tall grass prairie. Old field is the dominant community found in periodically cleared powerline corridors and revegetated landfills, and species composition varies depending on local soil conditions and recency of disturbance. Some of the frequently occurring species in these areas include common dog fennel, Japanese brome (*Bromus japonicus*), sericea lespedeza, tall fescue (*Lolium arundinaceum*), velvet witchgrass, southern crownbeard, silver plume grass (*Erianthus alopecuroides*), and sawtooth blackberry. Young woody species, like eastern red cedar and loblolly pine, which have established since the last clearing events, were occasionally observed.

An approximately 1.2-ac. (0.49 ha) area of warm season and prairie forb dominated upland grassland was found just south of the transmission line corridor bordering the lake on the east side of the Project site. The species recorded here were uncharacteristic of the other herbaceous areas of the Project site as a whole and are common in prairie restoration seed mixes. Signs of a possible pipeline installation at some point in the recent past were observed and may suggest that these species were seeded following land disturbance in the area to restore habitat. Characteristic species observed include rattlesnake master (*Eryngium yuccifolium*), narrow-pod white wild indigo (*Baptisia albescens*), tall white beardtongue (*Penstemon digitalis*), switchgrass (*Panicum virgatum*), and little bluestem (*Schizachyrium scopparium*). This upland grassland may be particularly meaningful as pollinator habitat given the native wildflowers found there. Other herbaceous areas, such as roadsides and most of the powerline corridor, were more dominated by invasive species with fewer native pollinator plant species.

Regularly mowed upland turf occurs along road margins and developed trailer sites of the Project site. These areas are primarily composed of smooth crab grass (*Digitaria ischaemum*), Carolina lovegrass (*Eragrostis pectinacea*), dallis grass (*Paspalum dilatum*), and sericea lespedeza. In some cases, steeper cleared road embankments have been stabilized with weeping lovegrass (*Eragrostis curvula*) plantings. Other species present on these embankments include Japanese stilt grass, sericea lespedeza, and common dog fennel.

An approximately 25.4-ac. (10.3 ha) area of cleared forest surrounding the meteorological tower was observed near the northernmost area of the Project site. The area most immediately surrounding the tower was primarily composed of grasses and forbs that colonized the bare ground after clearing. This included spreading panic grass (*Panicum dichotomiflorum*), tall fescue, sericea lespedeza and smooth crab grass. The rest of this cleared area was covered with a layer of mulch that has discouraged germination in some areas resulting in a widely varied community of weedy species with no clear dominant species. Species present included Japanese stilt grass, fireweed (*Erechtites hieraciifolius*), jimsonweed (*Datura stramonium*), beaked panic grass (*Coleataenia anceps*), and woolly mullein (*Verbascum thapsus*).

2.3.1.4.6 Woody Wetlands

Within the WOTUS delineation survey area (Figure 2.3-5), woody wetlands were identified and are represented by several different vegetation types, varying by local disturbance, water availability, and soil conditions. Of the 18 total and 3.05 ac. (1.25 ha) of delineated wetland features, 13 features, totaling 1.56 ac. (0.63 ha), were classified as PFO systems (Table 2.3-2). WOTUS-delineated wetlands and features are described in Section 2.3.1.2, including common tree species, sapling and shrub species and herbaceous species observed within PFO features.

One quality woody wetland community that possesses intact structure and a unique plant assemblage was observed within the Project site. This woody wetland (Wetland Y; Figure 2.3-5) was observed in the middle portion of the Project site just north of the canal. This wetland is situated in a mixed forest matrix along the low-grade reach of a small stream which has become partly impounded and flooded a small flat valley. No mature trees were observed rooted in the wetland itself and the woody growth was limited to scattered tag alder and red maple shrubs. Although some species indicative of an intact woody wetland system were observed, including rice cut grass (*Leersia oryzoides*), short-fringed sedge (*Carex crinita*), swamp nettle (*Boehmeria cylindrica*), Virginia bugleweed (*Lycopus virginicus*), and starved aster (*Symphyotrichum lateriflorum*), the presence of quick spreading invasives, especially Japanese stilt grass, have impacted the floristic diversity of this on-site isolated, woody wetland.

2.3.1.4.7 Emergent Herbaceous Wetlands

Emergent herbaceous wetland communities were identified during the WOTUS delineation survey. Of the 18 total delineated wetland features, four features, totaling 1.27 ac. (0.51 ha), were classified as PEM (Table 2.3-2). WOTUS-delineated features can be found in Figure 2.3-5. Information on plant communities in these wetlands is included above in Section 2.3.1.2.2.

Three emergent herbaceous wetland communities were observed in the transmission line corridor and within a human-made detention basin just south of the southern terminus of the associated off-site wastewater pipeline corridor. The human-made detention basin wetland (Wetland VVVV; Figure 2.3-5) was composed primarily of common cattail (*Typha latifolia*), woolgrass, swamp nettle, and common rush extending most of the basin and a fringe of black willow (*Salix nigra*). Wetlands observed in the transmission corridor (Wetlands CCC, T, and U; Figure 2.3-5) had similar species and structures, mostly composed of wetland sedge and rush species and a few obligate wetland forbs. Most of the cover in these wetlands can be attributed to swamp nettle, woodland bulrush (*Scirpus expansus*), black bulrush (*Scirpus atrovirens*), and common rush but includes other characteristic species such as Maryland meadow-beauty (*Rhexia mariana* var. *mariana*) and arrowleaf tearthumb (*Persicaria sagittata*).

2.3.1.5 Important Terrestrial Species

NRC guidance (NUREG-1555 and Regulatory Guide 4.2, Preparation of Environmental Reports for Nuclear Power Stations) identifies important species as those that are:

- Federally listed as threatened or endangered.
- Proposed for or candidates for federal listing.
- State listed or have another state status due to rarity.
- Commercially or recreationally valuable.
- Essential to the maintenance and survival of species that are rare and commercially or recreationally valuable.
- Critical to the structure and function of the local terrestrial ecosystem.
- Serving or may serve as biological indicators to monitor the effects of the facilities on the terrestrial environment.

Duke Energy coordinated with several agencies that provided input on important terrestrial species. Duke Energy initially met with NCWRC on May 21, 2024, and the USFWS on May 23, 2024, to provide an initial overview of planned NRC permitting activities for the Project site. Formal agency coordination letters were sent to the NCWRC on June 14, 2024 and the USFWS on June 19, 2024; the NCNHP on August 20, 2024; and the Catawba Indian Nation on August 20, 2024. USFWS provided comments on July 16, 2024, and expressed concerns about potential impacts to tricolored bat, Schweinitz's sunflower (*Helianthus schweinitzii*), monarch butterfly (*Danaus plexippus*), bald eagles, migratory birds, and pollinators (USFWS, 2024b). NCWRC provided comments on July 26, 2024, about tricolored bat, Schweinitz's sunflower, monarch butterfly, and pollinators (NCWRC, 2024a). NCNHP provided comments on September 30, 2024, regarding queries in the NCNHP database for rare species, important natural communities, natural areas, and conservation/managed areas, identifying some of these within 1 mi. (1.6 km) of the Project boundary (NCNHP, 2024). The Catawba Indian Nation responded on September 24, 2024, but did not have any comments related to important species or other terrestrial ecology assets (Catawba Indian Nation, 2024). Comments received that related to ecological resources are included in Appendix 1A; recommendations related to project activities and operations are provided in Chapters 4 and 5.

Prior to the ecological field surveys, a desktop analysis was performed to identify important species and habitats that may be present in the Project site. As part of the desktop analysis for the ecological surveys, biologists reviewed existing literature including information from the USFWS Information for Planning and Consultation (IPaC) system, NCNHP database records, USFWS NWI, and NLCD. During the pedestrian surveys, any observations of such plant or wildlife species were considered important and the habitat that supports them was noted. A list of protected species potentially occurring within or near the Project site was developed and is presented in Table 2.3-8 and summarized in the following sections. Table 2.3-9 summarizes the important species within or near the Project site.

2.3.1.5.1 Federally Listed Species

The USFWS IPaC identified two terrestrial endangered species: gray bat, Schweinitz's sunflower; one terrestrial proposed endangered species: tricolored bat; one terrestrial threatened species (listed threatened due to similarity of appearance to the northern

population): bog turtle (*Glyptemys muhlenbergii*); and one terrestrial proposed threatened species: monarch butterfly (Table 2.3-8).

Gray bats are federally endangered medium-sized insectivorous bats that occur year-round in limestone karst areas of the southeastern and midwestern U.S. However, summer gray bat colonies have been documented using dams, mines, quarries, concrete box culverts, and the undersides of bridges. Gray bats feed on flying insects (such as mayflies, caddisflies, stoneflies, beetles, and moths) over bodies of water. Gray bat females become pregnant in the spring, and pups are born in late May and early June. Newborns are typically able to fly within 21 to 33 days after birth. Threats to this species include human disturbance to roosting bats, environmental contamination, impoundment of waterways, and roost modification or destruction (USFWS, 2024c). Gray bats were considered absent from the Project site during 2023 acoustic monitoring and were not observed during general wildlife surveys on the Project site (WSP, 2025). Suitable gray bat foraging habitat may be present on the Project site in the form of stream corridors, but no suitable roosting habitat is present on the Project site.

Schweinitz's sunflower is a federally endangered perennial plant found in the central Piedmont region of North and South Carolina. Schweinitz's sunflower is usually approximately 6.6 ft. (2.01 m) tall, but stressed plants (such as those that are mowed) tend to be shorter. Schweinitz's sunflower prefers soils known to be poor for agricultural use with increased rock fragments. This species also prefers soils that are shallow and clayey, with increased quantities of slaty rock from weathered metasedimentary rocks. Appropriate soil types include Iredell, Enon, Badin, Cecil, Misenheimer, Gaston, and Zion. This plant typically occurs on upland flats and gentle slopes where plants are in full to partial sun. Many remaining populations of this plant occur along roadsides. The species blooms from late August to when frost begins. Mowing during the summer in August or September limits seed production if the mowed plants cannot flower or fruit (USFWS, 2024d). Schweinitz's sunflower was not observed on-site but suitable habitat does occur along open roadsides in the low-intensity developed areas in prairie-like conditions through the central portion of the Project site, the transmission corridor, and within open wooded areas near Belews Lake shoreline. Figure 2.3-2 illustrates the Project site landcover, including areas along roadsides, the transmission corridor, and the shoreline. This species main range is concentrated to the south of the Project site in the southern portion of the NC Piedmont and reports of it from Stokes, Forsyth, and Guilford counties are only found in the literature and not supported by collections. Additionally, soil types including Cid, Georgeville, Mecklenburg, Secrest, Tatum, Iredell, Enon, Badin, Cecil, Misenheimer, Gaston, Uwharrie, and Zion that have been documented in association with this species are not found within the Project site.

Tricolored bats are proposed for endangered listing. Tricolored bats are small, insectivorous bats that live across the eastern and central U.S. In the winter, these bats inhabit caves and abandoned mines. In the southern U.S., where caves are sparse, tricolored bats roost in road-associated culverts where torpor is shorter, and they forage during warm nights. Summer roosting habitat for this species consists of a wide variety of forested habitats needed for roosting, foraging, and traveling. Tricolored bats roost in a variety of tree species, especially oaks. They often select roosts in tall, large diameter trees but will roost in smaller diameter trees when potential roost substrate is present. Potential roost substrate includes leaf clusters of live and recently dead deciduous trees, Spanish moss, and beard lichen. Tricolored bats commonly roost in the mid to upper canopy of trees. However, males occasionally roost in dead leaves at lower heights, and females occasionally roost in Spanish moss at lower heights (WSP, 2025). A notable threat to this species is white-nose syndrome, which impacts cave-dwelling bats across the country (USFWS, 2024e). The acoustic bat surveys assumed that the Project site consisted of potentially suitable roosting habitat for the tricolored bat, and the species was documented

during acoustic surveys in 2023 (WSP, 2025). Suitable habitat for this species exists on the Project site in deciduous, evergreen, and mixed forest; as well as woody wetlands (Figure 2.3-8).

Bog turtles are listed in NC (part of the southern population) as threatened due to the similarity of appearance to the northern population. The southern population of this species occurs from southwest Virginia through Georgia, while the other distinct northern population of this species is found in Maryland through New England. Bog turtles live in shallow wetland habitats, and are semiaquatic, spending time in both the water and on land. Preferred wetlands for this species are open-canopy herbaceous sedge bogs, fens, or wet meadows. Microhabitats include soft, muddy bottoms, interspersed wet and dry pockets, vegetation dominated by low-growing grasses or sedges, and a low volume of standing or slow-moving water. Bog turtles hibernate from mid-September through mid-April in more densely vegetated areas under the roots of trees, rock walls, or muskrat burrows. They lay eggs in elevated areas, such as on top of hummock-forming tussock sedge, in approximately May to June, and each nest has approximately three to five eggs. Hatching begins in late August or September (USFWS, 2024f). This species is omnivorous, feeding on worms, beetles, snails, and plants including small berries. Threats to this species include habitat destruction due to draining and filling of wetlands for development, watershed and hydrology changes, vehicles, overabundant predators, and illegal collection (Graeter and Weeks, 2018). The bog turtle was not observed on-site but has the potential to occur within the Project site based on the presence of preferred emergent wetlands in the eastern-central corner of the site.

The federally proposed threatened monarch butterfly occurs across the U.S. Monarch butterflies require milkweed (*Asclepias* spp.) and flowering plants: adults feed on the nectar of a variety of flowers during migration and breeding, but they can only lay eggs on milkweed plants. They migrate in the fall to their overwintering sites and then mate at the overwintering sites in early spring. A specific microclimate is required for overwintering monarchs to protect against the elements and prevent freezing (USFWS, 2024g). This species was not documented during on-site wildlife surveys. Suitable breeding habitat is limited on the Project site: milkweed host plant species were rare in occurrence in the southwest portion of the Project site and along the associated off-site wastewater pipeline corridor during surveys (Figure 2.3-8). Suitable foraging habitat for monarchs exists on the Project site in the form of herbaceous areas, especially the grassland found just south of the transmission line corridor bordering the lake on the east side of the Project site. This area hosts native wildflowers (not including milkweed), while other herbaceous areas are dominated by invasive species.

The USFWS IPaC also identified nine migratory birds of conservation concern that have the potential to occur within the Project site: bald eagle, black-billed cuckoo (*Coccyzus erythropthalmus*), chimney swift, eastern whip-poor-will (*Antrostomus vociferus*), grasshopper sparrow, prairie warbler (*Setophaga discolor*), red-headed woodpecker, rusty blackbird (*Euphagus carolinus*), and wood thrush (*Hylocichla mustelina*). Bald eagles and rusty blackbird are considered important species per the definition provided in NUREG-1555 as both are listed as threatened by the NCA. Bald eagles are discussed in Section 2.3.1.5.2, and rusty blackbirds are discussed in Section 2.3.1.5.3. None of these other migratory birds are considered important species.

2.3.1.5.2 Species Protected under the Bald and Golden Eagle Protection Act

Bald eagles are protected under the Bald and Golden Eagle Protection Act and are listed as state threatened. Bald eagles are found throughout NC. These birds inhabit areas near lakes,

large rivers, and bay shorelines. Nesting requires a tall, living tree, as nests are up to 8 ft. (2.44 m) wide and 20 ft. (6.1 m) deep. Bald eagle pairs often return to the same nest each year and add new nest material, growing the nest over time. Bald eagles consume live and dead fish, water birds, rabbit, and carrion (NCWRC, 2024b). At the BCSS, a bald eagle nest has been identified in the top branches of a red oak, adjacent to the Craig Road Landfill. Protective buffers help shield bald eagle nests from activities that may result in detrimental impacts to breeding and successful production of chicks. The standard buffer distance for bald eagle nests during the nesting season is a 660-foot radius measured out from the base of the nest (Duke Energy, 2023a) (Figure 2.3-7). The BCSS bald eagle nest is approximately 0.23 mi. (0.37 km) west of the Project site (Figure 2.3-8). Other suitable bald eagle nesting habitat exists within the Project site along the shoreline of Belews Lake. Duke Energy has developed a Bald Eagle Nest Management Plan for the BCSS, which details general bald eagle nest disturbance guidelines, activity guidelines during vegetation management, activity guidelines during utility structure or electrical maintenance, and guidelines for removal and beneficiation of coal ash (Duke Energy, 2023a).

2.3.1.5.3 State-Listed Species

Rusty blackbirds nest in remote boreal areas but winter across most of NC. They feed within swamps, bottomlands, wet fields, croplands, or feedlots and are seldom far from wooded cover. This species roosts at night with other blackbirds in swamps and wet thickets. In general, rusty blackbirds are uncommon relative to most other blackbird species in the state. Within the Piedmont, rusty blackbirds are winter residents with noticeable migratory movements and mainly occur between early November and early April (LeGrand et al., 2024a). Rusty blackbirds were not observed on-site but have the potential to occur within the Project site based on the presence of preferred hardwood forest along the shoreline of Belews Lake.

Based on the Project site, the NCNHP did not identify any rare species on the Project site. However, several rare species were identified within 1 mi. (1.61 km) of the Project site and may have potential to occur on the Project site if suitable habitat exists. Coppery emerald (*Somatochlora georgiana*), creeping sunrose (*Crocanthemum propinquum*), granite flatsedge (*Cyperus granitophilus*), and marsh St. John's-wort (*Triadenum tubulosum*) were documented within 1 mi. (1.61 km) of the Project site. Potentially suitable habitat exists on the Project site for coppery emerald and marsh St. John's-wort.

The coppery emerald is NCNHP-designated "significantly rare" dragonfly that occurs in the eastern Piedmont and western two-thirds of the coastal plain within NC. This species inhabits creeks and other slow-moving acidic streams in forested areas. Flight occurs between late June and mid-August. Adults are most often seen flying 30 or more feet above the ground, perched on twigs, or patrolling over streams (LeGrand et al., 2023). Suitable habitat for this species exists on the Project site in the form of perennial streams in forested areas spread around the Project site; however, as discussed below in Section 2.3.2.1.1, streams in the Project site are primarily first order small streams and thus, suitable habitat for the coppery emerald is limited on the Project site.

Marsh St. John's-wort is a NCNHP-designated "significantly rare" plant primarily found in the southeastern states, ranging north to Maryland and Missouri and south to western Florida and eastern Texas. The species is widely scattered in the Piedmont and occurs in shallow water or mud, in non-flowing waters such as pond and lake margins, wooded pools, or old river oxbows. Important habitats are drawdown zones of lakes and river sloughs. Marsh St. John's-wort blooms in August and September and fruits shortly thereafter (LeGrand et al., 2024b). Marsh St.

John's-wort was not observed within the Project site; however, suitable habitat does occur within coves and along low, wetland shorelines of Belews Lake.

Creeping sunrose is a state-listed threatened plant found throughout the Appalachian Mountains and on the northeastern coastal plain and ranges from Massachusetts south to northeastern Georgia and eastern Tennessee. It is also found barely into the western Piedmont in the Sauratown Mountains located in Stokes County. Creeping sunrose grows in high elevations on rocky summits, open and rocky woods, and rarely in fields. The species blooms in June and July and fruits from August to October (LeGrand et al., 2024c). Suitable habitat for this species was not observed on the Project site, and site surveys did not document this species.

Granite flatsedge is state listed as threatened and is found in Virginia and Tennessee south to Georgia and Alabama. This species occurs only within the Piedmont and is localized to granitic flatrocks and to a mafic outcrop in Granville County. It is often found at the edges of granitic flatrocks in moss or lichen mats. Granite flatsedge flowers and fruits in July through October (LeGrand et al., 2024d). Suitable habitat is not located on the Project site, and site surveys did not document this species.

In addition, two plant species considered "watch list" W1 (rare but relatively secure) species by the NCNHP were observed on the Project site. Narrow-pod white wild indigo (*Baptisia albescens*) was found within an approximately 1.2-ac. (0.49 ha) grassland just south of the transmission line corridor bordering the lake on the east side of the Project site. As mentioned above in Section 2.3.1.4.5, species within this area may have been seeded following land disturbance in the area to restore habitat. Aloe yucca (*Yucca aloifolia*), another "watch list" species, was observed in several locations within the Project site around what appeared to be old homesites or otherwise previously developed areas. This species is cultivated as an ornamental and is known to persist after introduction; scattered individuals seen within the Project site are almost certainly in this category.

2.3.1.5.4 Species of Commercial or Recreational Value

Most of the Project site has been leased to a hunt club for several years. Three to five deer are harvested from the Project site annually, usually during a youth hunting event.

White-tailed deer, gray fox, opossum, raccoon, fox squirrel, gray squirrel, striped skunk, and eastern cottontail rabbit are recreationally valuable as game species on the Project site, while coyotes are nongame species hunted in NC. Beaver, opossum, groundhog, striped skunk, coyote, gray fox, and raccoon are recreationally valuable as furbearers on the Project site as listed by NCWRC hunting regulations (NCWRC 2024f).

Wood duck, mallard (*Anas platyrhynchos*), Canada goose, wild turkey, and mourning dove were species observed within the Project site that are recreationally valuable because they are game species as listed by NCWRC hunting regulations (NCWRC, 2024f). Species observed in the Project Vicinity that NCWRC hunting regulations indicate are recreationally valuable as game species (NCWRC, 2024f) include mallard, Canada goose, wild turkey, red-breasted merganser (*Mergus serrator*), and mourning dove.

Although not observed, frogs, most commonly bullfrogs, are nongame species hunted and trapped in NC (NCWRC, 2024f) that are expected within the Project site and Vicinity.

No commercially valuable species, species essential to the maintenance and survival of rare or

commercially or recreationally valuable species, species critical to the structure and function of local ecosystems, or species that could serve as biological indicators of effects on local ecosystems were observed in the Project site.

2.3.1.6 Important Habitats

NRC guidance (NUREG-1555 and Regulatory Guide 4.2) identifies important terrestrial habitats as the following:

- Federally designated or proposed critical habitat.
- Wildlife sanctuaries, refuges, and preserves.
- Wetlands, floodplains, or other resources specifically protected by federal or state regulations.
- Habitats identified by federal or state agencies as unique, rare, or a priority for protection.
- Other habitats of known or indicated interest.

As indicated by a review of the IPaC database, no federally designated or proposed critical habitat for terrestrial species is found on the Project site. Discussion of critical habitat for aquatic species is provided in Section 2.3.2.4.

Wetlands are considered an important terrestrial habitat on the Project site, and discussion is included in Section 2.3.1.2.

As determined by the NCNHP, there are no natural areas documented within a 1-mi. (1.61 km) radius of the Project site. There is one managed area within 1 mi. (1.61 km) of the Project area, which is located south of the Project site along Craig Road. As discussed in Section 2.4.2.6.2, this managed area (Belews Lake Park) is a planned park being developed by Forsyth County and will have trails, fishing piers, a shelter, a playground, and natural areas.

Coordination was initiated with the NCFS on January 23, 2025. The NCFS is planning the development of an Educational State Forest on the Shoebuckle property adjacent to the Dan River, northeast of the Project site. Currently, this Dan River Educational State Forest is unstaffed, but the future goal is to provide educational programs for children and provide hiking trails for the general public.

The only other important habitat of interest within the Project Vicinity is the Knight Brown Nature Preserve, as discussed in Section 2.1.1.2. This preserve contains a wooded valley and two streams.

2.3.1.7 Disease Vector and Pest Species

Disease vectors and pest species on the Project site include disease-carrying wildlife species, nuisance wildlife species, and invasive plant species.

2.3.1.7.1 Disease-Carrying and Nuisance Wildlife Species

The Project site contains potential disease vectors such as ticks and mosquitoes. While there are no known vector-borne diseases resulting from these species reported on the Project site,

ticks may carry diseases. Ticks feed on a wide variety of animals and are most common along trails and feeding and resting areas of their hosts. Dog ticks and lone star ticks can both carry Rocky Mountain Spotted Fever, which causes a skin rash and high fever in humans. Black-legged ticks transmit Lyme disease which initially has flu-like symptoms and a bull's-eye red rash at the bite site. However, Lyme disease can invade the neurological system, cardiovascular system, or joints of the body months or years after the initial bite. Imbedded ticks need 12 to 24 hours to transmit Rocky Mountain Spotted Fever or Lyme disease (Sparks and Gray, 2022).

Other pest wildlife species potentially present on the Project site include bees, fire ants, caterpillars with venomous spines, fleas, and chiggers (Sparks and Gray, 2022).

Nuisance species, such as groundhogs, have been observed on the Project site during surveys. While not observed on the Project site or within the Project Vicinity during surveys, a problematic nuisance species in the state is feral swine. Feral swine cause significant damage to wildlife habitat and plant communities during rooting activities. They prey on native ground nesting birds and white-tailed deer fawns. Feral swine damage crops, landscaping, and cultural sites. They carry a variety of diseases and are considered invasive and undesirable as free-ranging animals in the state (NCWRC, 2024c). Trapping is used on the Project site to remove some nuisance animal species.

2.3.1.7.2 Invasive Plants

Invasive plants in NC have a variety of detrimental effects to the economy, environment, and human health. Invasive species are often spread by humans through such actions as installation of plants as garden ornamentals, erosion control, habitat enhancement, or not cleaning vehicles or equipment when moving from place to place. Invasive plants can displace native vegetation, such as longleaf pine, and this displacement interrupts fire regimes and modifies soil characteristics. Invasive plants can also change the landscape (NC-IPC, 2024).

Invasion from non-native vascular plant species is extensive and problematic across much of the Project site. Especially problematic species on-site include Chinese wisteria (*Wisteria sinensis*), Chinese privet (*Ligustrum sinense*), Japanese stiltgrass (*Microstegium vimineum*), Japanese honeysuckle (*Lonicera japonica*), and sericea lespedeza (*Lespedeza cuneata*). The North Carolina Invasive Plant Council (NC-IPC) has compiled a list of invasive plants that occur in the state with input from representatives of the NCNHP, U.S. Department of Agriculture Forest Service, North Carolina Botanical Garden, North Carolina Department of Agriculture and Consumer Services, Piedmont Land Conservancy, North Carolina Native Plant Society, and other groups and individuals (NC-IPC, 2023). A number of plants on this list have been documented on the Project site during plant surveys:

- **Rank 1 – Severe Threat:** Exotic plant species that have invasive characteristics and spread rapidly into native plant communities, displacing native vegetation. Plants within this group include some of the most problematic on the Project site, which are denoted with an asterisk. The following species occur in the tree, shrub, herbaceous, and woody vine strata on the Project site:

  Tree of heaven (*Ailanthus altissima*)

  Silktree (*Albizia julibrissin*)

  Sericea lespedeza*

Chinese privet*

Japanese honeysuckle*

Japanese stiltgrass*

Chinese silver grass

Princess tree (*Paulownia tomentosa*)

Bradford pear (*Pyrus calleryana*)

Multiflora rose (*Rosa multiflora*)

Chinese wisteria*

**These are considered some of the most problematic on the Project site*

- **Rank 2 – Significant Threat:** Exotic plant species that display some invasive characteristics, but do not appear to present as great a threat to native communities as the species listed in Rank 1. The following species within this category were observed in the herbaceous or shrub stratum across the Project site and are overall rare or uncommon:

  Field garlic (*Allium vineale*)

  Creeping Charlie

  Leatherleaf mahonia (*Mahonia bealei*)

  Beefsteak plant (*Perilla frutescens*)

  Longbristle smartweed (*Persicaria longiseta*)

  Common chickweed (*Stellaria media*)

- **Rank 3 – Lesser Threat:** Exotic plant species that spread into or around disturbed areas and are considered a low threat to native plant communities. The following species from this category were observed in the herbaceous stratum across the Project site and are overall rare or uncommon:

  Japanese brome

  Bull thistle (*Cirsium vulgare*)

  Korean lespedeza (*Kummerowia stipulacea*)

  Dallis grass

  Yellow foxtail (*Setaria pumila*) – also on the NC Noxious Weed List

- **Watch List A:** Exotic plants that naturalize and may become problematic in the future; includes species that are or could become widespread in NC. At this time, more information is needed. The species listed below were observed in the herbaceous stratum across the Project site and are overall rare:

  Weeping lovegrass (*Eragrostis curvula*)

  Tall fescue

  Woolly mullein (*Verbascum thapsus*)

- **Watch List B:** Exotic plant species that cause problems in adjacent states but have not yet been reported to cause problems in NC. No plants documented on-site are within this group.

No plants on the federal noxious weed list were documented on the Project site. Yellow foxtail, as noted above, is on the NC Noxious Weed List and was documented on the Project site, though it was limited in location.

2.3.1.8 Wildlife Travel Corridors

The peninsula on which the Project site is located is a travel corridor for mobile wildlife species moving through different habitats as well as traveling to Belews Lake in search of water. The man-made canal in the middle of the Project site interrupts this corridor, although wildlife that can swim could travel across. Tracks of wildlife species, such as white-tailed deer, raccoon, opossum, and coyote, were observed throughout much of the Project site during the seasonal field surveys. These common species do not appear to be impacted by the current level of human and industrial activities occurring near the site. These mobile species and others observed on-site, such as eastern cottontail, groundhog, gray fox, gray squirrel, and fox squirrel (and other terrestrial mammals not observed but likely to occur such as rodents), collectively create and use travel corridors across various on-site biotic communities and to and from adjacent properties. White-tailed deer typically establish the longest and most complex travel corridors. Other species may use portions of these regularly traveled trails.

The Project site is located within the Atlantic Flyway migration route, which up to 500 different species of birds use for migration. Birds use this migration route from late July through early December to travel from Greenland to the Caribbean, and Central and South America to overwinter. In the Piedmont, fall migration is most active during September and October (Craps, 2023).

2.3.1.9 Existing Ecological Effects and Environmental Stresses

As mentioned in Section 2.3.1.1, the Project site has been shaped by timber harvesting, wildfires, and non-native plant invasion. Most of the native pine in the Project area was harvested 20 to 30 years ago and replanted with loblolly pine. Areas currently characterized by herbaceous, scrub shrub, and evergreen land cover comprise the most disturbed portions of the Project site and represent consistently cleared lands, newly regenerated formerly cleared lands, and lands which have remained in pine plantation or naturally regenerated back into pine from logged pine plantations.

Two wildfires occurred in 2024 in the Project Vicinity (Figure 2.3-9). The Steam Station Fire occurred on the western part of the Project site on March 20, 2024. The cause of the fire was most likely a worker smoking behind a warehouse, igniting ground material that was adjacent to pallets. The pallets caught on fire and then ignited nearby pine trees. High winds caused the burning materials to be carried across a small cove of the lake to ignite the woods. Approximately Fifty-four ac. (21.9 ha) of timber burned, and the fire was contained within 3 hours of attack. The Belews Lake Big Island Fire occurred on an island on Belews Lake north of the Project site on July 5, 2024. The cause of the fire was an unattended campfire, but only approximately 0.17 ac. (0.07 ha) of hardwood litter burned. The fire was contained within less than an hour of attack.

In addition to fire and timber harvesting, non-native plant invasion has also shaped the Project site. As discussed above in Section 2.3.1.7, the Project site contains a variety of invasive species. Chemicals and prescribed burns are used to manage nuisance plant species (such as wisteria, Japanese stiltgrass, or privet) annually throughout the Project site.

2.3.1.10 Transmission Corridor Habitats and Species

As discussed in Section 1.1.4, additional transmission lines that extend outside of the existing Project site boundary are not required. As described in Section 3.2, transmission improvements within the existing site boundary include a new switchyard and other transmission line improvements. Because these improvements are located within the site boundary, discussion of habitats and species within transmission corridors is included in previous sections of Section 2.3.1.

2.3.2 AQUATIC ECOLOGY

Potentially affected aquatic resources include any reservoirs, ponds, lakes, rivers, and streams on the Project site and in the Project Vicinity. Wetlands and riparian habitats are discussed in conjunction with terrestrial ecology in Section 2.3.1. This section describes the ecological characteristics of the aquatic resources that the Project could affect.

2.3.2.1 Aquatic Habitats

Surface water features present on the Project site and in the Project Vicinity are described in Section 2.2.1 and are shown on Figure 2.2-2. Aquatic habitats with the potential to be affected by the Project include on-site streams and ponds, Belews Lake, and the Dan River. The ecological characteristics of these potentially affected waterbodies are described below.

2.3.2.1.1 On-site Streams

There are approximately 21,733 lineal ft. (6,624 m) of streams on the Project site. On-site streams are characterized as primarily first order streams that are predominately located within forested areas and drain to Belews Lake. These low-flow streams are characterized as having silt to clay substrates, high levels of biological debris (i.e., leaf and woody debris), and generally little to no aquatic vegetation within the stream channel. Most of the on-site streams are characterized by a relatively high gradient. Additional information regarding on-site stream hydrology and physical characteristics is provided in Section 2.2.1.

2.3.2.1.2 Belews Lake

Belews Lake is the primary surface water feature supporting aquatic habitats within the Project Vicinity. Belews Lake is a reservoir constructed principally as a cooling water source for the BCSS and consists of distinct areas that are important in the characterization of aquatic ecosystems. These areas relate to tributaries (i.e., West Belews Creek, Belews Creek, and East Belews Creek) and their proximity to the Belews Dam. The term “uplake” is used to refer to the area nearest the tributary headwaters and the term “downlake” is the area nearest the dam. A transitional “midlake” area encompasses the area between the uplake and downlake areas on the Belews Creek arm (Duke Energy, 2021).

West Belews Creek receives heated effluent from the BCSS once-through CCW system. This area is physically separated from the remainder of Belews Lake, except for a 0.9 mi (1.5 km), man-made canal that facilitates the return of heated CCW effluent to the main Belews Creek arm (Figure 2.2-3). A forced circulation pattern is induced in Belews Lake by the operation of the combined 2337.8-ft.^{3}/s (66.2-m^3/s) capacity BCSS CCW pumps, which significantly exceed typical tributary inflow rates. Station pumping effectively maintains a circulation pattern within the epilimnion of the downlake region, particularly during the thermally stratified portion of the

year. Areas near Belews Dam and East Belews Creek lie within the outer areas of the thermal plume (Duke Energy, 2021).

The shoreline of Belews Lake is mostly steep and consists of undeveloped forest with sparse residential development. Habitat formers in the reservoir are primarily made up of sparse aquatic plant communities, including those classified as submerged, floating leaf, free-floating, and emergent. Highly vegetated zones are located in the upper reaches of the arms of Belews Lake. These areas are characterized by relatively shallow water and an expansive littoral zone that is suitable for aquatic plant growth; conversely, poorly vegetated zones are located in the more expansive deepwater portions of the reservoir with less shallow water suitable for aquatic plant growth. Much of the nutrient load from the watershed is also sequestered in the upper reaches of the lake resulting in an in-lake productivity gradient from uplake to downlake areas (Duke Energy, 2021). Large woody debris from the surrounding riparian areas provides some additional aquatic habitat in the reservoir.

A more detailed description of the characteristics of surface water features present on the Project site and in the Project Vicinity is presented in Section 2.2.1. Such information includes Belews Lake bathymetric maps and information regarding on-site stream gradients and stream cross sections.

2.3.2.1.3 Dan River and Belews Creek

Belews Creek is a 1-mi (1.6 km) tributary that flows to the Dan River from the Belews Lake Dam, as described in Section 2.2.1. The creek channel is an excavated feature immediately downstream of the Belews Lake spillway that extends downstream to its confluence with the original Belews Creek channel. Aquatic habitats in Belews Creek are characterized upstream by rocky substrate, while downstream, near the confluence with the Dan River, substrate is characterized by sand and cobble, with smaller substrates (silt, clay) near the shorelines.

The Dan River lies within the Roanoke River basin. The Dan River is approximately 110 mi. (177 km) long and flows from along the NC and Virginia border until its confluence with the Roanoke River. Habitat within the Dan River includes a series of riffle-run complexes typical of a Piedmont River system. Substrates are variable and consist of bedrock, gravel, sand, and woody debris. Shorelines are comprised by patches of mud and woody debris. The water clarity is variable based on location and antecedent rainfall conditions and ranges from clear to turbid (Duke Energy, 2024a). Downstream of the confluence with Belews Creek, habitats are characterized by sand and cobble bars, with increased presence of boulders shallow riffles. A more detailed description of surface water features present on the Project site and in the Project Vicinity can be found in Section 2.2.1.

2.3.2.2 Aquatic Biota

This section characterizes the aquatic biota found on the Project site and in the Project Vicinity within the aquatic habitats described in Section 2.3.2.1.

2.3.2.2.1 On-site Streams

Aquatic biota in on-site streams were characterized during seasonal surveys in 2024. Macroinvertebrates were surveyed in spring and fall 2024. On-site streams were sampled using USEPA's Benthic Macroinvertebrate Protocols (USEPA, 2012a). Locations sampled are indicated in Figure 2.3-10. In spring 2024 sampling, 1,049 individual macroinvertebrates were

encountered in on-site streams (Table 2.3-10). A total of distinct 74 macroinvertebrate taxa were observed within streams on the Project site. The most abundant taxa on the Project site included a bivalve (*Pisidium* sp.) and a chironomid, (*Polypedilum* sp.). Over 53 percent of macroinvertebrate individuals captured in on-site streams were classified as midges (Chironomids). In fall 2024 sampling, 65 distinct taxa were observed on the Project site (Table 2.3-11). The most abundant taxa on the Project site in the fall were bivalves (*Pisidium* sp.) and snails (*Physa* sp.). In fall sampling, midges only accounted for 22 percent of the total individuals observed. In general, across spring and fall sampling, the presence of pollutant tolerant taxa (i.e., Dipterans) and the low numbers of pollution intolerant taxa (i.e., mayflies [Ephemeroptera]), indicates lower overall water and habitat quality in on-site streams. This may be attributed to the intermittent nature of many on-site stream sampling locations.

Streams were surveyed for fish in the spring, summer, and fall of 2024. Sampling methodologies included backpack electrofishing and seining at on-site sampling locations indicated in Figure 2.3-10. Fish species observed in seasonal sampling are presented in Table 2.3-12. Fish were only observed in four of the six sampled streams on-site. Fish species observed in on-site streams included Eastern Mosquitofish (*Gambusia holbrooki*), Redbreast Sunfish (*Lepomis auritus*), Redear Sunfish (*Lepomis microlophus*), and Bluegill (*Lepomis macrochirus*). Eastern Mosquitofish accounted for 98.9 percent, 97.2 percent, and 96.9 percent of all fish encountered in spring, summer, and fall sampling, respectively. Low fish diversity is attributed to the small size and intermittent nature of many of the on-site streams that are connected to Belews Lake. It is unlikely that there are self-sustaining populations of fishes in on-site streams as fish were only observed near Belews Lake.

2.3.2.2.2 Belews Lake

2.3.2.2.2.1 Macrophytes

Past surveys of aquatic macrophytes in Belews Lake revealed limited growth of submersed and floating leaf aquatic plants. Several locations with varying densities of emergent plants were identified. Relative density of macrophytes in Belews Lake is presented in Figure 2.3-11. The most dominant aquatic plant species was water willow (*Justicia americana*), which was found in each zone of Belews Lake. Other common species included arrowhead (*Sagittaria lancifolia*), arrow-arum (*Peltandra virginica*), button bush (*Cephalanthus occidentalis*), bulrush (*Scirpus* sp.), and umbrella sedge (*Cyperus* sp.). Isolated populations of swamp rose mallow (*Hibiscus moscheutos*), cattail (*Typha* sp.), giant cutgrass (*Zizaniopsis miliacea*), and giant reed (*Arundo donax*) were also identified (Duke Energy, 2021). Aquatic macrophyte density was greatest in the uplake, shallower portions of the reservoir, whereas deeper portions of the reservoir support a reduced density of aquatic macrophyte (Duke Energy, 2021).

2.3.2.2.2.2 Benthic Macroinvertebrates

Benthic macroinvertebrate populations were surveyed in 2011–2015 by Duke Energy as a part of an assessment of the aquatic populations within Belews Lake. Mean annual macroinvertebrate densities ranged from 1325 individuals per square meter in 2013 to 13,457 individuals per square meter in 2011 within the lake. The total number of taxa observed per year varied from 17 to 37 during the 5-year study. During 2011 to 2015, macroinvertebrate samples were comprised primarily of annelid worms (Oligochaeta) and flies and midges (Diptera) at all locations surveyed. Roundworms (Nematoda) and Asiatic clams (*Corbicula* sp.) were abundant in some locations surveyed. Low numbers of the burrowing mayfly (*Hexagenia* sp.*)* were observed during spring and summer sampling periods.

2.3.2.2.2.3 Mussels

A qualitative mussel survey within Belews Lake was conducted by Duke Energy in August 2020. Two species of freshwater mussels were documented in 2020 surveys: Eastern Elliptio (*Elliptio complanata*) and the Paper Pondshell (*Utterbackia imbecillis*). Eastern Elliptio was the most abundant mussel species encountered, representing 99.6 percent of the 4036 mussels collected (Duke Energy, 2021). Young individuals of Eastern Elliptio were observed, indicating that recruitment occurs in this system, and that suitable habitat conditions for this species are present in Belews Lake (Duke Energy, 2021). One non-native bivalve species, the Asiatic Clam (*Corbicula fluminea*) is present in the lake, with areas of comparatively high densities present (Duke Energy, 2016). The low diversity of mussel communities in Belews Lake is expected as mussel communities in reservoirs tend to reflect changes in substrate, with species shifts from those that prefer sand or gravel substrate to those species that are tolerant of silt substrate, primarily as a shift from lotic to lentic condition, with considerable loss of original mussel fauna (Watters, 1999). Hydraulics (Watters, 1999) and host fish also play important roles in mussel fauna distributions (Daniel, W. and Brown, K., 2013).

2.3.2.2.2.4 Fish

A fish community assessment was conducted in Belews Lake in 2020 as a part of Duke Energy's Balanced and Indigenous Community Study Report (Duke Energy, 2021). Sample methods included electrofishing and experimental gill netting in Belews Lake. Fish species collected during the 2020 survey in Belews Lake are shown in Table 2.3-13. Twenty-four distinct species and one hybrid were encountered in the 2020 quarterly sampling of Belews Lake. The most abundant species in electrofishing was Bluegill. and the species with the highest biomass in sampling was Alabama Bass (*Micropterus henshalli*). Catch rates were higher in areas of Belews Lake with higher nutrient levels (i.e., uplake areas). Areas with higher thermal influences (i.e., West Belews Creek arm) did not exhibit catch rates outside of that which would be expected based on nutrient levels present in those areas (Duke Energy, 2021). Largemouth Bass (*Micropterus nigricans*) catch-per-unit-effort (CPUE) was lower in the deeper, clearer portions of the reservoir where they have likely been displaced by Alabama Bass through congeneric competition (Duke Energy, 2021).

Species diversity was similar in all areas of the lake, regardless of thermal influence. The fish community was dominated by indigenous species (73 percent). While non-indigenous species such as Alabama Bass and Redear Sunfish were abundant in areas of the lake that were thermally influenced by operation of the BCSS, these species were found throughout Belews Lake. Some indigenous species, such as Largemouth Bass, exhibited lower CPUE in 2020 than had been observed in historical surveys of Belews Lake, but this change was not related to operation of BCSS (Duke Energy, 2021). Fish communities included multiple trophic guilds. No areas of the lake were dominated by pollution-tolerant species. The overall size-structure of the fish community indicated reproductive, self-sustaining populations in all areas of the Belews Lake. No threatened or endangered species were encountered in Belews Lake during 2020 quarterly sampling (Duke Energy, 2021).

Thermal impacts from BCSS were found to be more pronounced in summer and winter than in fall or spring. The overall mean catch rate was significantly higher in the areas of the lake that were subject to thermal influence from BCSS operation. Some apparent patterns in distribution seemed to be impacted by natural seasonal temperature and nutrient variations. For example, Gizzard Shad (*Dorosoma cepedianum*) catch varied across zones of the lake depending on

season. Additionally, vertical distribution of fish varied throughout the year indicating seasonal changes in optimal habitats and forage throughout the water column (Duke Energy, 2021).

2.3.2.2.2.5 Summary of Belews Lake Aquatic Community

In general, recent monitoring on Belews Lake reflected the presence of a balanced and indigenous aquatic biological community. The presence of macrophytes was limited to shallower areas of the reservoir. Benthic macroinvertebrate communities were dominated by pollution-tolerant species; however, the presence of pollution intolerant mayflies in spring and summer were indicators of moderate to good water quality. The fish community was characterized by multiple trophic guilds, with a size-structure that indicated reproductive, self-sustaining populations.

2.3.2.2.3 Dan River and Belews Creek

2.3.2.2.3.1 Benthic Macroinvertebrates

Benthic macroinvertebrates were sampled in conjunction with the preapplication monitoring program, in the Dan River in spring and fall 2024. Sampling occurred at four locations, as indicated in Figure 2.3-10. Sampling methodology included D net sampling of overhanging vegetation, root wads, benthic substrate, and other appropriate macroinvertebrate habitat, as determined by field personnel.

Macroinvertebrates encountered in spring 2024 sampling in the Dan River are listed in Table 2.3-10. In spring 2024 macroinvertebrate sampling, 69 distinct taxa were observed in the Dan River. The most abundant taxa in the Dan River included a mayfly (*Pseudocloen* sp.), a chironomid (*Polypedilum* sp.), and an annelid worm (Naididae [Tubificidae] spp.). In spring sampling, 29 percent of the individuals captured belonged to the order Ephemeroptera (mayflies), which are, in general, pollutant intolerant and therefore indicators of good water quality. Five stonefly (Plecoptera) individuals were captured in the Dan River, while no caddisfly (Trichoptera) individuals were observed in the Dan River. Dragonflies (Odonata) accounted for approximately 1.5 percent of individuals captured in the Dan River. Diversity within flies and midges (Diptera) was high, with 25 taxa observed within this order.

Macroinvertebrates encountered in fall 2024 sampling in the Dan River are listed in Table 2.3-11. In fall 2024 macroinvertebrate sampling, a total of 86 distinct taxa were observed in the Dan River. The most abundant taxa included flathead mayfly (*Maccaffertium* sp.) and two chironomids (*Polypedilum* sp. and *Tanytarsus* sp.). Pollution intolerant taxa accounted for 28 percent of the total individuals observed in the Dan River in fall sampling, indicating generally good water quality.

2.3.2.2.3.2 Mussels

A mussel survey was conducted in the Dan River in 2014 near Eden, NC downstream of the Project site (Alderman and Alderman, 2014). The 2014 survey consisted of 3-mi. survey reaches throughout the Dan River subbasin, including the reach of the Dan River within the Project Vicinity. Freshwater mussels were collected via visual and tactile survey methods using bathyscopes, snorkeling, and SCUBA, and the widest possible diversity of habitats was surveyed at each site. Nine species of freshwater mussels were identified as extant within the survey area on the Dan River. These species included common Eastern Elliptio, Variable Spike (*Elliptio icterina*), Carolina Lance (*Elliptio angustata*), Roanoke Slabshell (*Elliptio roanokensis*),

Atlantic Pigtoe (*Fusconaia masoni*), Triangle Floater (*Alasmidonta undulata*), Green Floater (*Lasmigona subviridis*), Notched Rainbow (*Villosa constricta*), and Yellow Lampmussel (*Lampsilis cariosa*) (Alderman and Alderman, 2014).

In conjunction with the preapplication monitoring program, an additional mussel survey was conducted on July 31 and August 1, 2024, in the Dan River. A total of three species of freshwater mussels were observed in the four sites (Figure 2.3-10). No mussels were observed at the most upstream sampling location (DRSW1). Mussel species observed at the other three locations included Eastern Elliptio, Green Floater, and Notched Rainbow (represented by only a shell) (Duke Energy, 2024a). Mussels were most abundant at the downstream sampling locations (DRSW4). In general, mussel habitats at the survey locations were dominated by excessive amounts of sand, but patches of suitable mussel habitat were present. Substrate at the upstream sampling location (DRSW1) consisted of bedrock and sand, with excessive amounts of woody debris. Substrate at sites DRSW2 and DRSW3 consisted of sand and gravel with patches of mud along the shoreline. At DRSW4, benthic habitat was dominated by sand and gravel, with woody debris present along the shoreline (Duke Energy, 2024a). In general, mussel habitat was limited at the sampling locations upstream of the BCSS MWIS (i.e., DRSW1 and DRSW2), while at and below the pump station (i.e., DRSW3 and DRSW4), mussel habitat was more widespread.

See Section 2.3.2.3 for additional discussion regarding sensitive mussel species within the Dan River.

2.3.2.2.3.3 Fish

Fisheries surveys on the Dan River were conducted from 2015 to 2017 by Duke Energy upstream and downstream of the BCSS MWIS (HDR, 2022). This MWIS is located at the confluence of Belews Creek and the Dan River. Survey methodologies included boat electrofishing, backpack electrofishing, fyke netting, and seining at two transects. The upstream sampling location was located north of Walnut Cove, NC, at river mi. (RM) 130. The downstream sampling location was located near Leaksville, NC, at RM 93. Species captured during Dan River sampling from 2015 to 2017 are shown in Table 2.3-14 (HDR, 2022).

At the upstream sampling location, 36 fish species representing six families were collected. Four families made up 96.6 percent of the total number collected: Cyprinidae (comprised of Cyprinidae and Leuciscidae) (49.1 percent); Centrarchidae (18.5 percent); Ictaluridae (17.4 percent); and Catostomidae (11.6 percent). Cyprinids (comprised of Cyprinidae and Leuciscidae) collected included ten species. The most dominant cyprinid species were White Shiner (*Luxilus albeolus*) and Bull Chub (*Nocomis raneyi*). Five species of centrarchids were collected, with Redbreast Sunfish as the most numerous species collected. The catfish family (Ictaluridae) was the third most abundant family. Snail Bullhead (*Ameiurus brunneus*) made up 62.3 percent of the catfish species collected. The Catostomidae family (suckers) consisted of nine species with Blacktip Jumprock (*Moxostoma cervinum*) and Golden Redhorse (*M. erythrurum*) as the most abundant species (HDR, 2022).

At the downstream sampling location, 39 fish taxa representing five families were collected. The most abundant family was Catostomidae (39.8 percent) with Golden Redhorse and V-Lip Redhorse (*Moxostoma pappillosum*) as the most abundant sucker species collected. The Centrarchidae family (37.0 percent) was the second most abundant family, with Redbreast Sunfish as the most abundant, followed by Largemouth Bass. The Cyprinidae family (comprised of Cyprinidae and Leuciscidae) (19.2 percent) was the third most abundant family collected with

White Shiner and Comely Shiner (*Notropis amoenus*) as the most abundant species collected (HDR, 2022).

In conjunction with the preapplication monitoring program, seasonal surveys were conducted on the Dan River in 2024 to characterize the aquatic resources. Surveys were conducted in spring, summer, and fall 2024. Sampling methodology included boat electrofishing, backpack electrofishing, and seining. Sampling locations are indicated in Figure 2.3-10. Fish species collected during quarterly sampling in 2024 are shown in Tables 2.3-15 through 2.3-17.

In spring 2024, 34 fish species and one hybrid were observed during fish surveys. A total of 719 fish were observed with abundant species including White Shiner (n=180), Redbreast Sunfish (n=131), and Golden Redhorse (n=62). A summary of fish species observed in the spring 2024 survey is shown in Table 2.3-15. Game fish observed in the spring 2024 survey include Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass, Bluegill, Redbreast Sunfish, Green Sunfish (*Lepomis cyanellus*), Redear Sunfish, Warmouth (*Lepomis gulosus*), and Black Crappie (*Pomoxis nigromaculatus*). Abundant Leuciscids (i.e., minnows and shiners) included White Shiner, Comely Shiner, Bull Chub (*Nocomis raneyi*), Satinfin Shiner (*Cyprinella analostana*), Redlip Shiner (*Hydrophlox chiliticus*), and Rosefin Shiner (*Lythrurus ardens*). Catastomids (i.e., suckers) were also abundant, with the most abundant species being Golden Redhorse, V-Lip Redhorse, and White Sucker (*Catostomus commersonii*).

A summary of fish species observed in summer surveys is shown in Table 2.3-16. within the Dan River, water levels precluded boat electrofishing at most sites; therefore, boat electrofishing was only employed in one location, DRSW3, while other locations were sampled via backpack electrofishing. Seining was conducted at each location. In the summer 2024 survey, 975 individual fish of 32 distinct species were observed in Dan River. Abundant species observed included Comely Shiner, Redlip Shiner, and Rosefin Shiner. Game fish observed included Largemouth Bass, Smallmouth Bass, Bluegill, Redbreast Sunfish, Green Sunfish, Redear Sunfish, Warmouth, and Black Crappie. Abundant Catastomids (i.e., suckers) included Golden Redhorse and V-Lip Redhorse. The most abundant Ictalurid (i.e., catfishes) was the Margined Madtom (*Noturus insignis*).

A summary of fish species observed in the fall survey are shown in Table 2.3-17. In Dan River, water levels precluded boat electrofishing at all locations. All sites were therefore sampled using backpack electrofishing. Seining was conducted at each location. As the sampling crew were unable to access DRSW4 at the time of the fall aquatic ecology survey, an alternative sampling location (DRSW4-ALT) was identified and sampled. This downstream alternate sampling location was comprised of similar aquatic habitat as those samples at DRSW4 (i.e., riffles and runs). A total of 93 fish of 14 distinct species were observed in Dan River in the fall 2024 survey. Abundant species observed included Comely Shiner and Redbreast Sunfish. The only Catastomid (sucker) observed was Blacktip Jumprock (*Moxostoma cervinum*). Low numbers of observed fish taxa in fall 2024 surveys may be related to sedimentation related to recent flooding associated with Hurricane Helene in September 2024. Game fish observed included Redbreast Sunfish and Bluegill. One non-native species, Goldfish (*Carassius auratus*), was observed at DRSW2.

2.3.2.2.3.4 Summary of Dan River Aquatic Community

In general, recent monitoring of the Dan River suggests the presence of a diverse macroinvertebrate and fisheries community. Macroinvertebrate sampling observed a high presence of pollution intolerant taxa, which serves as an indicator of good water quality (e.g.,

low pollution). High diversity was observed in the Dan River fish community that reflects the presence of a variety of habitat and substrate types throughout the reach in the Project Vicinity. Further, the presence of sensitive species, as described in Section 2.3.2.3 indicates suitable fish conditions for these sensitive species that may include good water quality, suitable foraging, low pollutant loads, and a variety of substrate/habitat types within the Dan River. The mussel community present in Dan River in the Project Vicinity indicates conditions that are conducive to mussel community presence.

2.3.2.3 Important Aquatic Species

According to NUREG-1555, important species may include:

- Rare species, including:
  - Species federally listed as threatened or endangered.
  - Species that are proposed for federal listing.
  - Species that are candidates for federal listing.
  - Species that are state listed as threatened, endangered, or a species of concern.
  - Commercially or recreationally valuable species.
  - Species that are essential to the maintenance and survival of rare or commercially or recreationally valuable species.
  - Species that are critical to the structure and function of the local ecosystem.
  - Species that may serve as biological indicators to monitor the effects of the proposed facility on the environment.
  - Nuisance species that could cause problems for facility operations (as described in Section 2.3.2.6).

2.3.2.3.1 Federally Listed Species

Federally listed aquatic species that may occur on the Project site or in the Project Vicinity include James Spinymussel (*Parvaspina collina*), and Green Floater (Table 2.3-8).

The federally endangered mussel, James Spinymussel, may potentially be present in the Project Vicinity. James Spinymussel is found in the James River basin in Virginia and West Virginia and in the Upper Dan River subbasin of the Roanoke River basin in Virginia and NC. Suitable habitat for James Spinymussel includes free-flowing streams with a variety of flow regimes and water depths. These mussels are typically found in areas with substrate that is free from silt. James spinymussel filter feed on plankton collected from flowing water passed over the gills (USFWS, 2024h). No critical habitat has been designated for James Spinymussel.

Green Floater is a federally proposed threatened mussel species. Habitat for Green Floater consists of small streams and rivers with low-to-moderate gradients in pools and eddies with gravelly and sandy bottoms. Host fish for the larval life stage of this species include Mottled Sculpin (*Cottus bairdii*), Rock Bass (*Ambloplites rupestris*), Central Stoneroller (*Campostoma anomalum*), Blacknose Dace (*Rhinichthys atratulus*), and Margined Madtom. Adults are filter feeders that consume phytoplankton, zooplankton, bacteria, and suspended detritus. Green Floater is found in small and isolated populations with limited recruitment, resulting in reduced genetic variation and increased risk of localized extirpation. Threats to this species include

dams and water withdrawals, invasive species, sedimentation, impacts to water quality, and habitat loss due to climate change (NatureServe, 2024a). As described in Section 2.3.2.2.3.2, Green Floater has been documented within the Dan River in the Project Vicinity. Additionally, critical habitat for this species has been proposed within the Project Vicinity and is described in Section 2.3.2.4.

2.3.2.3.2 State-Listed Species

The NCNHP provides records showing locations where rare species have been observed to occur within the Project Vicinity. Such records indicate observation within the Project Vicinity of one freshwater bivalve and four freshwater fish. The freshwater bivalve is Green Floater, which is state listed as endangered, and federally proposed as threatened. Green Floater is described in Section 2.3.2.3.1. The four state-listed fish species that have the potential to occur within the Project Vicinity are Quillback (*Carpiodes cyprinus*), Riverweed Darter (*Etheostoma podostemone*), Bigeye Jumprock (*Moxostoma ariommum*), and Roanoke Logperch (*Percina rex*) (Table 2.3-8). Roanoke logperch is state listed as endangered and was recently delisted from the Endangered Species Act. Bigeye Jumprock is state listed as threatened, while Quillback and Riverweed Darter are listed as significantly rare species.

The Roanoke Logperch is a state-endangered darter found in larger streams in the upper Roanoke, Smith, Pigg, Otter, and Nottoway River systems, and Goose Creek in Virginia, and in the Dan, Mayo, and Smith River systems and Big Beaver Island Creek in NC. It is a large darter that can grow up to six inches. Habitat for this species includes medium-to-large, warm, usually clear streams and small rivers of moderate-to-low gradient. Adults are typically found in the main body of stream pools, runs, and riffles, and areas with exposed, silt-free gravel substrate. Roanoke Logperch actively feed in warmer months by flipping over stones with their snout and ingesting the exposed prey that consists of bottom-dwelling macroinvertebrates (USFWS, 2024c). Roanoke Logperch have been visually observed in the Dan River in the Project Vicinity.

Bigeye Jumprock is found only in the upper Roanoke River drainage in NC and Virginia. This species is found in warm, generally clear small to medium rivers. They typically congregate in deep runs and heads of pools in rubbles and boulders. Potential threats to populations include impoundments, siltation and runoff, and habitat fragmentation (NatureServe, 2024b). A total of four Bigeye Jumprock were encountered in the Dan River during spring 2024 aquatic ecology surveys.

Quillback are found across eastern North America. They inhabit pools, backwaters, and main channels of creeks and small to large rivers, as well as lakes. They primarily feed on benthic materials such as plant detritus, and invertebrates, including insects, mollusks, and crustaceans (FishBase, 2024a). A total of two Quillback were encountered in the Dan River during spring 2024 aquatic ecology surveys.

Riverweed Darter is a state-listed species in NC identified as a significantly rare species. They occur only in the upper Roanoke River drainage in Virginia and NC. Primary habitat for riverweed darter are rocky riffles in creeks and small rivers (FishBase, 2024b). Thirteen Riverweed Darters were encountered in the Dan River during the spring 2024 aquatic ecology survey, and eight were encountered during the summer 2024 survey.

2.3.2.3.3 Species of Commercial or Recreational Value

Recreationally important species in Belews Lake include Alabama Bass (*Micropterus henshalli*), Black Crappie, Bluegill, Largemouth Bass, Warmouth, Redbreast Sunfish, Redear Sunfish, White Crappie (*Pomoxis annularis*), Common Carp (*Cyprinus carpio*), Blue Catfish (*Ictalurus furcatus*), Flathead Catfish (*Pylodictis olivaris*), Channel Catfish (*Ictalurus punctatus*), White Perch (*Morone americana*), and Yellow Perch (*Perca flavescens*) (Duke Energy, 2021).

Recreationally important species in the Dan River include Brown Trout (*Salmo trutta*), Brook Trout (*Salvelinus fontinalis*), Rainbow Trout (*Oncorhynchus mykiss*), Black Crappie, Bluegill, Largemouth Bass, Warmouth, Redbreast Sunfish, Redear Sunfish, White Crappie, Common Carp, Blue Catfish, Flathead Catfish, and Channel Catfish. Stocking of Brook Trout, Rainbow Trout, and Brown Trout in the Dan River is done annually by the NCWRC. In 2024, stocking occurred in March through June. A total of 2680 brook trout, 2680 rainbow trout, and 1335 brown trout were stocked in the Dan River. Stocking is done from the Virginia border upstream of the Project Vicinity to 200 yards downstream of the end of SR 1421 (NCWRC, 2024d). Stocking is focused upstream where habitat conditions are more conducive to supporting populations of trout.

There is no commercial harvest of aquatic species within Belews Lake or the Dan River.

2.3.2.4 Important Aquatic Habitats

NUREG-1555 identifies important aquatic habitats as follows:

- Wildlife sanctuaries, refuges, and preserves.
- Habitats identified by the State Natural Heritage Program, the USFWS, or the National Marine Fisheries Service as unique, rare, or of priority for protection.
- Wetlands, floodplains, or other resources protected by federal regulations or executive orders or by state regulations.
- Critical habitats designated by the USFWS to protect listed species.

Wetlands are discussed in Section 2.3.1, Terrestrial Ecology, and floodplains are discussed in Section 2.2, Water Resources (Surface Water and Groundwater).

The NCNHP classifies the Dan River as a natural area, with a rating of R1 (Exceptional), as described in Section 2.2.3.1.3.4. This rating indicates a natural area's potential to contribute to a collection of the best locations for biodiversity elements in the state. The exceptional rating is given to natural areas with some of the best examples of critically imperiled, imperiled, or vulnerable endemic species present. As described in Section 2.2.3.1.3.4, the North Carolina Environmental Management Commission has not classified this segment as an outstanding resource water, and therefore, no additional water quality restrictions are required.

Critical habitat for federally listed species are defined under 50 CFR 424.02 as "(1) The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (a) Essential to the conservation of the species, and (b) Which may require special management considerations or protection; and (2) Specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species."

Critical habitat for Green Floater was proposed in 2023 for approximately 1586 river mi. (2553 river km) across the species range. Within the Dan River, approximately 137.5 river mi. (221.3 river km) have been proposed as critical habitat for Green Floater, including the length of the Dan River in the Project Vicinity. This subunit of critical habitat would encompass the Dan River in Caswell, Rockingham, and Stokes counties in NC, and Halifax, Henry, Patrick, and Pittsylvania counties in Virginia. Critical habitat would include the river channel up to the OHWM (USFWS, 2023).

2.3.2.5 Key Indicator Organisms

Freshwater mussels can be considered key indicator organisms in the Dan River, as they are highly sensitive to changes in water quality and impacts to habitat. The mussel community in the Dan River was characterized in 2024, as described in Section 2.3.2.2.3.2.

2.3.2.6 Nuisance Species

Nuisance species found in Belews Lake and Dan River include Hydrilla (*Hydrilla verticillata*), Asiatic Clam *(Corbicula fluminea)*, Blue Catfish, and Alabama Bass.

Asiatic Clam is an invasive clam that is native to Asia, Africa, and Australia. They are widespread throughout freshwater and some estuarine habitats in the U.S. Their presence is known to directly impact native freshwater mussel species, resulting in reduced growth of native mussels in the presence of Asiatic clams (USDA, 2024a). Asiatic Clams were observed in macroinvertebrate sampling within Dan River.

Hydrilla is an aquatic macrophyte species that is classified as a nuisance species in the U.S. It was introduced through the aquarium trade. Hydrilla has been known to crowd out native species and impede irrigation and boating in waterways (USDA, 2024b). Hydrilla has been observed in Belews Lake.

Non-native fish species found in Belews Lake include Alabama Bass, Green Sunfish, Redear Sunfish, Threadfin Shad (*Dorosoma petenense*), Alewife (*Alosa pseudoharengus*), White Crappie, Common Carp, Grass Carp (*Ctenopharyngodon idella*), Blue Catfish, Channel Catfish, Flathead Catfish, and White Perch. Alabama Bass is considered a threat to native bass fisheries. They compete directly with native bass species and tend to dominate in less productive lake systems with high-water clarity. They are also known to hybridize with other bass species, such as Smallmouth Bass and Largemouth Bass in systems in which they are both found (NCWRC, 2024e). Blue Catfish are native to the Mississippi River Basin. They are considered an aquatic nuisance species in NC as they may displace native catfishes and directly compete with other species for prey items (NCWRC, 2015).

2.3.2.7 Existing Ecological Effects and Environmental Stresses

BCSS has operated on Belews Lake since 1974. Per the requirements of the NPDES operating permit, the plant has a 316(a) thermal variance. NPDES thermal compliance discharge limit for the steam plant is an ambient water temperature of 89.6° Fahrenheit (32° Celsius) and is defined as the daily average discharge water temperature when a discharge from the lake dam occurs. Discharges from the lake dam are primarily used to maintain lake level. Thermal discharge limits were met throughout 2017 through 2024.

To comply with NPDES permit requirements, Duke Energy conducted an initial and comprehensive 1-year demonstration study on Belews Lake in 2020 to support a thermal variance request under §316(a) of the CWA. The goals of this study were to complete a temperature analysis of Belews Lake and to demonstrate a self-sustaining, balanced, and indigenous biological population of fish and shellfish in Belews Lake. The 2020 study determined that under the current thermal compliance point, the survival, reproduction, development, and growth of the fish and shellfish community within Belews Lake have not been appreciably reduced due to operation of the steam plant. Additionally, operations have not blocked or inhibited access to any potential spawning habitat, spawning activities, or the development of early juvenile individuals (Duke Energy, 2021).

Fish and macroinvertebrate contaminant levels were monitored in Belews Lake following a fisheries collapse related to ash basin effluent from BCSS (Duke Energy, 2016). Selenium concentrations in macroinvertebrates during 2011 to 2015 sampling indicated low concentrations of selenium when compared to historical records (Duke Energy, 2016). Annual mean selenium concentrations were measured in the muscle tissue of Redear Sunfish and Largemouth Bass in Belews Lake from 2011 to 2015. Annual mean selenium concentrations in the muscle tissue of Redear Sunfish and Largemouth Bass collected from Belews Lake ranged from 0.83 to 2.96 µg/g (wet weight) and from 0.92 to 2.73 µg/g, respectively. This study indicated that mean selenium concentrations in Redear Sunfish have declined at areas sampled since 1995 and remained consistent in Largemouth Bass since 2007. Concentrations present are below levels considered detrimental for fish reproduction and well below the concentration considered safe for human consumption (Duke Energy, 2016).

Table 2.3-1
Land Cover within the Project Site and Vicinity

Land Cover Class	Project Site (ac.)	6-mi. Vicinity (ac.)
Open Water	8	4,116
Developed, Open Space	2	7,747
Developed, Low Intensity	113	3,339
Developed, Medium Intensity	<1	743
Developed, High Intensity	0	305
Barren Land	7	373
Deciduous Forest	330	36,003
Evergreen Forest	463	9,578
Mixed Forest	151	8,497
Scrub shrub	21	2,387
Herbaceous	130	2,917
Hay/Pasture	0	17,088
Cultivated Crops	0	3,098
Woody Wetlands	2	2,178
Emergent Herbaceous Wetlands	1	146
Total	**1,227**	**98,515**

Source: NLCD data (Dewitz and USGS, 2021)
Note:
Modified based on field observations. Includes the 40-acre associated off-site pipeline corridor.

Table 2.3-2
Potential Wetlands Identified within the Project Site
(Sheet 1 of 2)

Name	Acreage within the Defined Delineation Survey Area	Acreage within the Project Site[a]	Cowardin Designation	Potential Jurisdictional Status[b][c]	NCWAM Designation	NCWAM Rating	Latitude	Longitude
AA	0.04	0.04	PFO	Jurisdictional	Bottomland Hardwood Forest	Medium	36.271012	-80.060844
BB	0.20	0.20	PFO	Jurisdictional	Bottomland Hardwood Forest	Medium	36.268439	-80.064162
CCC	0.71	0.71	PEM	Jurisdictional	Headwater Forest	Low	36.27739	-80.050454
DDD	0.03	0.03	PFO	Jurisdictional	Headwater Forest	High	36.262975	-80.062188
EE	0.12	0.12	PFO	Jurisdictional	Bottomland Hardwood Forest	High	36.261888	-80.074528
EEE	0.08	0.08	PFO	Jurisdictional	Headwater Forest	High	36.262563	-80.061906
R	0.04	0.03	PFO	Jurisdictional	Riverine Swamp Forest	High	36.283824	-80.049365
S	0.04	0.03	PFO	Jurisdictional	Bottomland Hardwood Forest	High	36.280121	-80.045033
T	0.06	0.06	PEM	Jurisdictional	Headwater Forest	Medium	36.278444	-80.047258
U	0.16	0.16	PEM	Jurisdictional	Headwater Forest	Medium	36.277757	-80.044344
V	0.22	0.22	PEM/PFO	Jurisdictional	Headwater Forest	High	36.276103	-80.047572
VVVV	0.34	0.34	PEM	Jurisdictional	Headwater Forest	Low	36.272749	-80.053951
W	0.11	0.06	PFO	Jurisdictional	Bottomland Hardwood Forest	Medium	36.273152	-80.050626
WJ	0.26	0.26	PFO	Jurisdictional	Floodplain Pool	High	36.308147	-80.077355
WL	0.14	0.14	PFO	Jurisdictional	Bottomland Hardwood Forest	High	36.274169	-80.060141
X	0.05	0.01	PFO	Jurisdictional	Bottomland Hardwood Forest	High	36.272301	-80.053532
Y	0.44	0.44	PFO	Jurisdictional	Headwater Forest	High	36.271126	-80.059213

Table 2.3-2
Potential Wetlands Identified within the Project Site
(Sheet 2 of 2)

Name	Acreage within the Defined Delineation Survey Area	Acreage within the Project Site[a]	Cowardin Designation	Potential Jurisdictional Status[b][c]	NCWAM Designation	NCWAM Rating	Latitude	Longitude
Z	0.01	0.01	PFO	Jurisdictional	Headwater Forest	High	36.27046	-80.060297
Total	3.05	2.94						

Source: Cowardin et al., 1979, WSP, 2024
Notes:
(a) Because of variations in the Project site boundary as compared to the delineation survey area, the acreages of four wetland features (Wetlands R, S, W, and X) are reduced within the Project site. These values represent areas of the features within the Project Site only.
(b) Based on current interpretations of the WOTUS Rule.
(c) Based on WSP's professional opinion and pending USACE confirmation.
Key: NCWAM = North Carolina Wetland Assessment Method; WSP = WSP USA Inc.

Table 2.3-3
Avifauna Species Observed on the Project Site[(a)]
(Sheet 1 of 3)

Scientific Name	Common Name	Spring 2024 Project Site Abundance	Summer 2024 Project Site Abundance	Fall 2024 Project Site Abundance	Winter 2025 Project Site Abundance
Aix sponsa	Wood duck	R	–	–	–
Anas platyrhynchos	Mallard	R	–	–	–
Ardea herodias	Great blue heron	R	R	–	–
Baeolophus bicolor	Tufted titmouse	A	A	R	C
Branta canadensis	Canada goose	U	A	–	–
Buteo jamaicensis	Red-tailed Hawk	R	–	–	R
Buteo lineatus	Red-shouldered hawk	R	R	R	R
Cardinalis cardinalis	Northern cardinal	A	A	C	C
Cathartes aura	Turkey vulture	A	U	C	C
Catharus guttatus	Hermit thrush	U	–	O	R
Certhia americana	Brown creeper	–	–	–	R
Charadrius vociferus	Killdeer	R	–	R	–
Coccyzus americanus	Yellow-billed cuckoo	–	A	–	–
Colaptes auratus	Northern flicker	R	R	R	U
Contopus virens	Eastern wood-pewee	–	C	–	–
Coragyps atratus	Black vulture	–	–	–	R
Corthylio calendula	Ruby-crowned kinglet	O	–	O	R
Corvus brachyrhynchos	American crow	A	U	A	A
Corvus corax	Common raven	R	–	–	–
Corvus ossifragus	Fish crow	U	R	R	–
Cyanocitta cristata	Blue jay	A	C	A	O
Dryobates pubescens	Downy woodpecker	R	R	R	U
Dryobates villosus	Hairy woodpecker	U	R	C	R
Dryocopus pileatus	Pileated woodpecker	U	–	R	R
Falco sparverius	American kestrel	–	–	R	–
Geothlypis trichas	Common yellowthroat	O	–	–	–
Haemorhous mexicanus	House finch	–	–	–	R
Haliaeetus leucocephalus	Bald eagle	–	–	R	R
Icteria virens	Yellow-breasted chat	–	R	–	–
Junco hyemalis	Dark-eyed junco	–	–	–	C

Table 2.3-3
Avifauna Species Observed on the Project Site[a]
(Sheet 2 of 3)

Scientific Name	Common Name	Spring 2024 Project Site Abundance	Summer 2024 Project Site Abundance	Fall 2024 Project Site Abundance	Winter 2025 Project Site Abundance
Larus delawarensis	Ring-billed gull	–	–	–	U
Melanerpes carolinus	Red-bellied woodpecker	C	C	A	O
Meleagris gallopavo	Wild turkey	C	U	C	–
Melospiza melodia	Song sparrow	R	–	C	A
Mimus polyglottos	Northern mockingbird	R	–	–	–
Molothrus ater	Brown-headed cowbird	A	–	–	–
Nannopterum auritum	Double-crested cormorant	R	U	–	–
Pandion haliaetus	Osprey	R	C	–	–
Parkesia motacilla	Louisiana waterthrush	R	–	–	–
Passerina caerulea	Blue grosbeak	–	R	–	–
Passerina cyanea	Indigo bunting	–	A	–	–
Pipilo erythrophthalmus	Eastern towhee	A	A	R	R
Piranga rubra	Summer tanager	–	R	–	–
Podilymbus podiceps	Pied-billed grebe	R	–	–	–
Poecile carolinensis	Carolina chickadee	A	A	A	A
Polioptila caerulea	Blue-gray gnatcatcher	A	A	–	–
Regulus satrapa	Golden-crowned kinglet	–	–	A	A
Sayornis phoebe	Eastern phoebe	U	–	–	–
Seiurus aurocapilla	Ovenbird	R	–	–	–
Setophaga americana	Northern parula	O	–	–	–
Setophaga coronata	Yellow-rumped warbler	–	–	–	R
Setophaga palmarum	Palm warbler	R	–	–	–
Setophaga pinus	Pine warbler	A	R	R	–
Sialia sialis	Eastern bluebird	U	R	A	R
Sitta carolinensis	White-breasted nuthatch	R	U	O	U
Sitta pusilla	Brown-headed nuthatch	R	R	C	C
Sphyrapicus varius	Yellow-bellied sapsucker	–	–	–	R
Spinus tristis	American goldfinch	C	A	U	–
Spizella passerina	Chipping sparrow	C	R	R	O
Spizella pusilla	Field sparrow	–	R	R	–

Table 2.3-3
Avifauna Species Observed on the Project Site[(a)]
(Sheet 3 of 3)

Scientific Name	Common Name	Spring 2024 Project Site Abundance	Summer 2024 Project Site Abundance	Fall 2024 Project Site Abundance	Winter 2025 Project Site Abundance
Stelgidopteryx serripennis	Northern rough-winged swallow	O	–	–	–
Strix varia	Barred owl	U	–	–	–
Thryothorus ludovicianus	Carolina wren	A	A	O	O
Troglodytes hiemalis	Winter wren	–	–	O	R
Turdus migratorius	American robin	C	C	–	U
Tyrannus tyrannus	Eastern kingbird	–	R	–	–
Vireo griseus	White-eyed vireo	R	R	–	–
Vireo olivaceus	Red-eyed vireo	–	C	–	–
Vireo solitarius	Blue-headed vireo	R	–	R	–
Zenaida macroura	Mourning dove	A	A	A	C
Zonotrichia albicollis	White-throated sparrow	C	–	C	O
Species Richness		**51**	**38**	**34**	**35**

Note:
(a) Species identified along the bird transect routes at designated stopping points or during pedestrian on-site surveys.
Key: A = abundant; C = common; O = occasional; R = rare; U = uncommon

Table 2.3-4
Avifauna Species Observed in the Project Vicinity[(a)]
(Sheet 1 of 7)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**
Accipiter cooperii	Cooper's hawk	–	X	–	–	–	–	–	X
Agelaius phoeniceus	Red-winged blackbird	R	–	–	–	–	X	–	–
Ammodramus savannarum	Grasshopper sparrow	–	–	–	X	–	–	–	–
Anas platyrhynchos	Mallard	–	–	–	X	–	X	–	X
Ardea herodias	Great blue heron	–	X	–	X	–	–	–	–
Baeolophus bicolor	Tufted titmouse	A	X	C	X	R	X	C	X
Branta canadensis	Canada goose	C	X	A	X	–	X	R	X
Buteo jamaicensis	Red-tailed Hawk	–	–	R	X	–	–	R	–
Buteo lineatus	Red-shouldered hawk	–	–	–	–	R	–	–	X
Cardinalis cardinalis	Northern cardinal	A	X	C	X	A	X	C	X
Cathartes aura	Turkey vulture	A	–	A	X	A	X	A	X
Catharus guttatus	Hermit thrush	–	X	–	–	R	X	–	–

Table 2.3-4
Avifauna Species Observed in the Project Vicinity[(a)]
(Sheet 2 of 7)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**
Charadrius vociferus	Killdeer	U	X	–	X	R	X	–	–
Coccyzus americanus	Yellow-billed cuckoo	–	–	C	–	–	–	–	–
Colaptes auratus	Northern flicker	O	–	R	X	R	–	R	X
Columba livia	Rock pigeon	–	–	–	–	C	–	R	–
Contopus virens	Eastern wood-pewee	–	–	C	–	–	–	–	–
Coragyps atratus	Black vulture	–	X	–	–	–	–	A	X
Corthylio calendula	Ruby-crowned kinglet	O	X	–	–	R	–	U	–
Corvus brachyrhynchos	American crow	C	X	A	X	A	X	A	X
Corvus corax	Common raven	–	–	–	–	–	X	–	X
Corvus ossifragus	Fish crow	U	X	R	X	R	X	R	–
Cyanocitta cristata	Blue jay	A	X	A	X	A	X	A	X
Dryobates pubescens	Downy woodpecker	–	–	R	X	–	–	R	X
Dryobates villosus	Hairy woodpecker	R	–	R	–	C	X	R	–
Dryocopus pileatus	Pileated woodpecker	U	X	–	–	–	–	–	–

Table 2.3-4
Avifauna Species Observed in the Project Vicinity[(a)]
(Sheet 3 of 7)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**
Falco sparverius	American kestrel	–	X	–	–	–	–	R	–
Gavia immer	Common loon	R	–	–	–	–	–	–	–
Geothlypis trichas	Common yellowthroat	O	–	U	X	–	–	–	–
Haemorhous mexicanus	House finch	O	X	–	–	–	X	R	–
Haliaeetus leucocephalus	Bald eagle	R	–	–	–	R	–	–	–
Hirundo rustica	Barn swallow	–	X	C	–	–	–	–	–
Icteria virens	Yellow-breasted chat	–	–	R	–	–	–	–	–
Junco hyemalis	Dark-eyed junco	–	–	–	–	–	–	R	X
Larus delawarensis	Ring-billed gull	–	–	–	–	–	–	A	–
Megaceryle alcyon	Belted kingfisher	R	X	–	–	–	–	–	X
Melanerpes carolinus	Red-bellied woodpecker	U	X	C	X	U	X	O	X
Melanerpes erythrocephalus	Red-headed woodpecker	–	–	–	–	–	X	–	–
Meleagris gallopavo	Wild turkey	O	X	U	X	R	X	A	–

Table 2.3-4
Avifauna Species Observed in the Project Vicinity[(a)]
(Sheet 4 of 7)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**
Melospiza melodia	Song sparrow	–	–	–	–	A	X	C	X
Mergus serrator	Red-breasted merganser	–	X	–	–	–	–	–	–
Mimus polyglottos	Northern mockingbird	O	X	C	X	C	X	O	X
Molothrus ater	Brown-headed cowbird	A	X	–	–	R	–	–	–
Myiarchus crinitus	Great-crested flycatcher	–	–	R	X	–	–	–	–
Nannopterum auritum	Double-crested cormorant	R	–	C	–	C	–	–	–
Pandion haliaetus	Osprey	R	X	U	X	–	–	–	–
Passerculus sandwichensis	Savannah sparrow	–	–	–	–	–	X	–	–
Passerina caerulea	Blue grosbeak	–	–	C	–	–	–	–	–
Passerina cyanea	Indigo bunting	–	–	A	X	–	–	–	–
Petrochelidon pyrrhonota	Cliff swallow	–	X	A	X	–	–	–	–
Pipilo erythrophthalmus	Eastern towhee	A	X	A	–	A	X	R	X
Podilymbus podiceps	Pied-billed grebe	R	–	–	–	R	–	R	X

Table 2.3-4
Avifauna Species Observed in the Project Vicinity[(a)]
(Sheet 5 of 7)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**
Poecile carolinensis	Carolina chickadee	A	X	C	X	A	X	A	X
Polioptila caerulea	Blue-gray gnatcatcher	C	X	R	X	–	–	–	–
Quiscalus quiscula	Common grackle	C	X	–	–	–	–	–	–
Regulus satrapa	Golden-crowned kinglet	–	–	–	–	U	X	A	X
Sayornis phoebe	Eastern phoebe	U	X	R	X	C	–	–	–
Seiurus aurocapilla	Ovenbird	–	X	–	–	–	–	–	–
Setophaga americana	Northern parula	U	X	–	–	–	–	–	–
Setophaga coronata	Yellow-rumped warbler	–	X	–	–	–	–	–	–
Setophaga dominica	Yellow-throated warbler	–	X	–	–	–	–	–	–
Setophaga palmarum	Palm warbler	–	X	–	–	–	–	–	–
Setophaga pinus	Pine warbler	A	X	–	–	R	–	–	–
Sialia sialis	Eastern bluebird	U	X	A	X	A	X	C	X

Table 2.3-4
Avifauna Species Observed in the Project Vicinity[(a)]
(Sheet 6 of 7)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**
Sitta carolinensis	White-breasted nuthatch	–	–	C	–	U	X	C	X
Sitta pusilla	Brown-headed nuthatch	–	–	U	X	U	X	U	–
Sphyrapicus varius	Yellow-bellied sapsucker	–	–	–	–	–	–	R	–
Spinus tristis	American goldfinch	U	X	A	X	O	X	O	–
Spiza americana	Dickcissel	–	–	R	–	–	–	–	–
Spizella passerina	Chipping sparrow	A	X	R	–	–	–	C	–
Spizella pusilla	Field sparrow	–	–	C	–	R	–	–	X
Stelgidopteryx serripennis	Northern rough-winged swallow	C	X	–	–	–	–	–	–
Strix varia	Barred owl	–	–	–	–	–	X	–	–
Sturnus vulgaris	European starling	O	X	–	X	A	X	–	X
Thryothorus ludovicianus	Carolina wren	A	X	A	X	A	X	A	X
Toxostoma rufum	Brown thrasher	R	X	–	X	–	–	–	X
Troglodytes hiemalis	Winter wren	–	–	–	–	U	X	R	–

Table 2.3-4
Avifauna Species Observed in the Project Vicinity[(a)]
(Sheet 7 of 7)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**	**Driving Route Abundance**	**Vicinity General Recon**
Turdus migratorius	American robin	C	X	R	X	O	X	O	X
Tyrannus tyrannus	Eastern kingbird	–	–	R	–	–	–	–	–
Vireo griseus	White-eyed vireo	R	–	–	X	–	–	–	–
Vireo olivaceus	Red-eyed vireo		–	A	–	–	–	–	–
Vireo solitarius	Blue-headed vireo	R	–	–	–	R	–	–	–
Zenaida macroura	Mourning dove	A	X	A	X	A	X	C	X
Zonotrichia albicollis	White-throated sparrow	R	–	–	–	U	X	–	X
Zonotrichia leucophrys	White-crowned sparrow	R	–	–	–	–	–	–	–
Species Richness		**45**	**44**	**41**	**34**	**38**	**34**	**36**	**31**

Note:
(a) Species identified along the bird transect routes at designated stopping points or during general vicinity reconnaissance.
Key: Abundance Categories: A = abundant; C = common; O = occasional; U = uncommon; R = rare; X = documented.

Table 2.3-5
Mammal Species Observed on the Project Site and Project Vicinity

		Spring 2024		Summer 2024		Fall 2024		Winter 2025	
Scientific Name	**Common Name**	**On-site**	**Vicinity**	**On-site**	**Vicinity**	**On-site**	**Vicinity**	**On-site**	**Vicinity**
Canis latrans	Coyote	X	X	X	X	X	–	X	–
Castor canadensis	Beaver	X	–	–	–	–	–	–	–
Didelphis virginiana	Opossum	X	–	X	–	–	–	–	X
Marmota monax	Groundhog	X	–	X	X	–	–	–	–
Mephitis mephitis	Striped skunk	–	–	–	–	–	X	X	–
Odocoileus virginianus	White-tailed deer	X	–	X	X	X	X	X	X
Procyon lotor	Raccoon	X	X	–	X	X	X	X	X
Scalopus aquaticus	Eastern mole	X	–	–	–	–	–	X	–
Sciurus carolinensis	Eastern gray squirrel	X	X	X	–	X	X	X	X
Sciurus niger	Fox squirrel	X	–	–	–	X	–	–	–
Sylvilagus floridanus	Eastern cottontail	X	–	–	–	–	–	X	–
Tamias striatus	Eastern chipmunk	–	–	–	–	X	–	–	–
Urocyon cinereoargenteus	Gray fox	–	–	X	X	X	–	–	–

Table 2.3-6
Herpetofauna Species Observed on the Project Site and Project Vicinity
(Sheet 1 of 2)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025[(a)]	
Scientific Name	**Common Name**	**On-site**	**Vicinity**	**On-site**	**Vicinity**	**On-site**	**Vicinity**	**On-site**	**Vicinity**
Acris crepitans	Northern cricket frog	X	–	–	–	X	–	–	–
Anaxyrus americanus	American toad	–	–	X	–	–	–	–	–
Carphophis amoenus	Worm snake	X	–	–	–	–	–	–	–
Chrysemys picta picta	Eastern painted turtle	X	–	–	–	–	–	–	–
Coluber constrictor	Black racer	X	–	–	–	–	–	–	–
Desmognathus fuscus	Northern dusky salamander	X	–	–	–	X	–	–	–
Eurycea cirrigera	Southern two-lined salamander	X	–	–	–	–	–	–	–
Hyla chrysoscelis	Cope's gray treefrog	–	–	X	X	–	–	–	–
Lithobates clamitus	Green frog	X	–	–	–	–	–	–	–
Lithobates sphenocephalus	Southern leopard frog	–	–	X	–	–	–	–	–

Table 2.3-6
Herpetofauna Species Observed on the Project Site and Project Vicinity
(Sheet 2 of 2)

		Spring 2024		Summer 2024		Fall 2024		Winter 2025[(a)]	
Scientific Name	**Common Name**	**On-site**	**Vicinity**	**On-site**	**Vicinity**	**On-site**	**Vicinity**	**On-site**	**Vicinity**
Pantherophis alleghaniensis	Black rat snake	X	–	–	–	X	–	–	–
Pseudacris crucifer	Spring peeper	X	–	–	–	–	–	–	–
Pseudacris feriarum	Upland chorus frog	–	–	X	–	X	–	–	–
Pseudemys concinna concinna	Eastern river cooter	–	X	–	–	–	–	–	–
Rana palustris	Pickerel frog	–	–	X	–	X	–	–	–
Sceloporus undulatus	Eastern fence lizard	X	–	X	–	X	–	–	–
Terrapene carolina	Eastern box turtle	X	X	X	–	X	–	–	–
Trachemys scripta elegans	Red-eared slider	X	–	–	–	–	–	–	–
Trachemys scripta scripta	Yellow-bellied slider	–	–	X	–	–	–	–	–

Note:
(a) Due to the hibernation period for herpetofauna, no herpetofauna were observed during winter 2025 surveys.

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 1 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Tree		
Acer negundo	box elder	C
Acer rubrum	red maple	A
Ailanthus altissima	tree of heaven	U
Albizia julibrissin	silktree	R
Betula nigra	river birch	U
Carya cordiformis	bitternut hickory	R
Carya glabra	pignut hickory	U
Carya tomentosa	mockernut hickory	O
Celtis laevigata	sugarberry	R
Diospyros virginiana	persimmon	U
Fagus grandifolia	beech	A
Fraxinus americana	white ash	U
Fraxinus pennsylvanica	green ash	R
Gleditsia triacanthos	honey locust	R
Juglans nigra	black walnut	U
Juniperus virginiana	eastern red cedar	O
Liquidambar styraciflua	sweetgum	C
Liriodendron tulipifera	tulip poplar	A
Nyssa sylvatica	black gum	U
Oxydendrum arboreum	sourwood	A
Paulownia tomentosa	princess tree	R
Pinus echinata	shortleaf pine	O
Pinus taeda	loblolly pine	A
Pinus virginiana	Virginia pine	A
Platanus occidentalis	sycamore	O
Prunus serotina	black cherry	O
Quercus alba	white oak	C
Quercus coccinea	scarlet oak	U
Quercus falcata	southern red oak	U
Quercus montana	chestnut oak	U

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 2 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Quercus phellos	willow oak	R
Quercus rubra	northern red oak	O
Quercus stellata	post oak	R
Salix nigra	black willow	U
Shrub		
Acer negundo	box elder	O
Acer rubrum	red maple	O
Alnus serrulate	tag alder	U
Amelanchier arborea	downy serviceberry	U
Asimina triloba	pawpaw	U
Benthamidia florida	flowering dogwood	C
Carpinus caroliniana	musclewood	C
Carya tomentosa	mockernut hickory	U
Cercis canadensis	eastern redbud	R
Diospyros virginiana	persimmon	U
Fagus grandifolia	Beech	A
Fraxinus americana	white ash	U
Gaylussacia frondosa	dangleberry	R
Hamamelis virginiana	northern witch-hazel	R
Ilex opaca	American holly	O
Juniperus virginiana	eastern red cedar	O
Kalmia latifolia	mountain laurel	O
Lespedeza procumbens	downy trailing lespedeza	R
Ligustrum sinense	Chinese privet	U
Lindera benzoin	Spicebush	U
Liquidambar styraciflua	Sweetgum	O
Liriodendron tulipifera	tulip poplar	O
Mahonia bealei	leatherleaf mahonia	R
Malus angustifolia	wild crabapple	R
Nyssa sylvatica	black gum	U
Oxydendrum arboreum	Sourwood	A
Pinus echinata	shortleaf pine	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 3 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [a]
Pinus taeda	loblolly pine	U
Platanus occidentalis	Sycamore	R
Prunus angustifolia	Chickasaw plum	R
Prunus serotina	black cherry	O
Pyrus calleryana	Bradford pear	R
Quercus alba	white oak	C
Quercus stellata	post oak	R
Rhododendron calendulaceum	flame azalea	R
Rhododendron periclymenoides	pink azalea	R
Rhus copallinum	eastern winged sumac	R
Rosa multiflora	multiflora rose	U
Rubus argutus	sawtooth blackberry	U
Smilax rotundifolia	common greenbriar	O
Ulmus alata	winged elm	R
Vaccinium fuscatum	hairy highbush blueberry	R
Vaccinium pallidum	hillside blueberry	O
Herbaceous		
Acer rubrum	red maple	U
Acer negundo	box elder	R
Actaea racemosa	black-cohosh	U
Agrimonia pubescens	downy agrimony	R
Allium vineale	field garlic	R
Amauropelta noveboracensis	New York fern	U
Ambrosia artemisiifolia	common ragweed	R
Amelanchier arborea	downy serviceberry	R
Amphicarpaea bracteata	hog-peanut	C
Andropogon gerardi	big bluestem	U
Andropogon ternarius	splitbeard bluestem	R
Andropogon virginicus	broomsedge	O
Antennaria parlinii	Parlin’s pussytoes	U
Antennaria plantaginifolia	plantain pussytoes	R
Aplectrum hyemale	puttyroot	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 4 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Apocynum cannabinum	hemp dogbane	R
Arabidopsis thaliana	mouse-ear cress	R
Arisaema triphyllum	Jack-in-the-pulpit	R
Aristida purpurascens	arrowfeather	R
Arnoglossum atriplicifolium	pale Indian-plantain	R
Arundinaria tecta	switch cane	R
Asarum canadense	wild ginger	R
Asclepias syriaca	common milkweed	R
Asplenium platyneuron	ebony spleenwort	U
Athyrium asplenioides	southern lady fern	R
Baptisia albescens [(b)]	narrow-pod white wild indigo	R
Bidens aristosa	midwestern tickseed-sunflower	R
Bidens frondosa	Devil's beggar-ticks	U
Bignonia capreolata	cross vine	U
Boehmeria cylindrica	swamp nettle	U
Botrypus virginiana	botrypus virginianus	R
Brachyelytrum erectum	common shorthusk	U
Bromus japonicus	Japanese brome	U
Bromus pubescens	eastern brome	R
Campsis radicans	trumpet-creeper	U
Carex crinita	short-fringed sedge	U
Carex hirsutella	hairy-leaved sedge	R
Carex intumescens	bladder sedge	U
Carex lupulina	hop sedge	O
Carex lurida	sallow sedge	U
Carex nigromarginata	black-edged sedge	R
Carex prasina	drooping sedge	R
Carex rosea	rosy sedge	U
Carex tribuloides	blunt broom sedge	R
Carex vulpinoidea	fox sedge	U
Carya glabra	pignut hickory	R
Celtis laevigata	sugarberry	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 5 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Chaerophyllum procumbens	wild chervil	R
Chasmanthium latifolium	river oats	U
Chasmanthium laxum	slender spikegrass	C
Chasmanthium sessiliflorum	longleaf spikegrass	R
Chimaphila maculata	striped wintergreen	O
Cicuta maculata	water-hemlock	R
Cinna arundinacea	common woodreed	R
Circaea canadensis	Canada Enchanter's-nightshade	R
Cirsium vulgare	bull thistle	R
Claytonia virginica	spring-beauty	R
Clematis virginiana	virgin's-bower	R
Coleataenia anceps	beaked panic grass	U
Cuscuta campestris	field dodder	R
Cyperus erythrorhizos	redrooted flatsedge	R
Cyperus strigosus	straw flatsedge	U
Cystopteris protrusa	lowland bladder fern	R
Danthonia spicata	poverty oat-grass	U
Datura stramonium	jimsonweed	R
Dichanthelium acuminatum	woolly witchgrass	R
Dichanthelium clandestinum	deer-toungue panic grass	U
Dichanthelium commutatum	variable witchgrass	U
Dichanthelium dichotomum	forked witchgrass	R
Dichanthelium scoparium	velvet witchgrass	O
Digitaria ischaemum	smooth crab grass	U
Diodia virginiana	large buttonweed	R
Diphasiastrum digitatum	fan clubmoss	O
Elephantopus tomentosus	common elephant's-foot	R
Elymus villosus	downy wild rye	R
Elymus virginicus	Virginia wildrye	R
Epifagus virginiana	beechdrops	R
Epilobium coloratum	bronze willow-herb	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 6 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Eragrostis curvula	weeping lovegrass	R
Eragrostis minor	little lovegrass	R
Eragrostis pectinacea	Carolina lovegrass	R
Erigeron pusillus	southern horseweed	R
Erigeron strigosus	common rough fleabane	R
Erianthus alopecuroides	silver plume grass	U
Erianthus giganteus	sugarcane plume grass	R
Erechtites hieraciifolius	fireweed	U
Eryngium yuccifolium	rattlesnake master	R
Euonymus americanus	strawberry bush	O
Eupatorium capillifolium	dog fennel	C
Eupatorium hyssopifolium	hyssopleaf eupatorium	R
Eupatorium serotinum	late eupatorium	U
Eurybia divaricata	common white heart-leaved aster	R
Fraxinus americana	white ash	O
Galearis spectabilis	showy orchid	R
Galium aparine	sticky willy	U
Galium circaezans	forest bedstraw	U
Galium pilosum	hairy bedstraw	R
Galium triflorum	sweet-scented bedstraw	R
Gaylussacia baccata	black huckleberry	U
Geum canadense	white avens	U
Glechoma hederacea	creeping Charlie	U
Goodyera pubescens	downy rattlesnake-orchid	U
Helenium amarum	bitterweed	R
Hepatica americana	round-lobed hepatica	R
Heuchera americana	American alumroot	R
Hexastylis minor	little heartleaf	R
Holcus lanatus	velvet grass	R
Huperzia lucidula	shining firmoss	R
Hypericum hypericoides	St. Andrew’s cross	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 7 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Hypericum mutilum	common dwarf St. John's-wort	R
Hypericum punctatum	spotted St. John's-wort	R
Hypericum stragalum	low St. John's-wort	R
Hypopitys species 3 (Hypopitys monotropa)	common eastern pinesap	R
Ilex opaca	American holly	U
Ipomoea purpurea	common morning-glory	R
Iris cristata	dwarf iris	R
Juncus acuminatus	shar-fruited rush	R
Juncus coriaceus	leathery rush	U
Juncus effusus	common rush	O
Juncus tenuis	path rush	R
Juncus validus	vigorous rush	R
Juniperus virginiana	eastern red cedar	R
Krigia virginica	Virginia dwarf-dandelion	R
Kummerowia stipulacea	Korean lespedeza	R
Leersia oryzoides	rice cut grass	O
Leersia virginica	white grass	O
Lespedeza cuneata	sericea lespedeza	C
Lespedeza procumbens	downy trailing lespedeza	R
Ligustrum sinense	Chinese privet	U
Lindera benzoin	spicebush	R
Liquidambar styraciflua	sweetgum	R
Lolium arundinaceum	tall fescue	R
Lobelia inflata	Indian-tobacco	R
Lonicera japonica	Japanese honeysuckle	C
Lonicera sempervirens	coral honeysuckle	R
Lorinsera aureolata	netted chain fern	R
Ludwigia palustris	common water-purselane	U
Luzula echinata	spreading wood-rush	R
Lycopus virginicus	Virginia bugleweed	U
Maianthemum racemosum	eastern Solomon's-plume	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 8 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Medeola virginiana	cucumber root	R
Melica mutica	two-flower medic	R
Menispermum canadense	moonseed	R
Microstegium vimineum	Japanese stiltgrass	A
Mimosa microphylla	eastern sensitive-briar	R
Mimulus alatus	winged monkey flower	R
Mimulus ringens	Allegheny monkeyflower	R
Miscanthus sinensis	Chinese silver grass	U
Mitchella repens	partridge-berry	U
Muscadinia rotundifolia var. *rotundifolia*	muscadine	C
Nabalus sp.	rattlesnake-root	U
Nemophila aphylla	white nemophila	R
Obolaria virginica	pennywort	R
Onoclea sensibilis	sensitive fern	R
Ophioglossum pycnostichum	southern adder's-tongue	R
Osmundastrum cinnamomeum	cinnamon fern	R
Oxalis dillenii	southern yellow wood-sorrel	R
Oxalis stricta	common yellow wood-sorrel	R
Packera anonyma	Appalachian ragwort	R
Panicum dichotomiflorum	spreading panicgrass	R
Panicum virgatum	switchgrass	R
Parthenocissus quinquefolia	Virginia creeper	O
Paspalum dilatum	dallis grass	U
Paspalum laeve	smooth lense grass	R
Passiflora incarnata	purple passionflower	R
Peltandra virginica	green arrow-arum	R
Penstemon digitalis	tall white beardtongue	R
Perilla frutescens	beefsteak plant	R
Persicaria lapathifolia	pale smartweed	R
Persicaria longiseta	longbristle smartweed	R
Persicaria sagittata	arrowleaf tearthumb	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 9 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Persicaria virginiana	jumpseed	R
Phegopteris hexagonoptera	broad beech fern	U
Phoradendron leucocarpum	American mistletoe	R
Phytolacca americana	common pokeweed	R
Pinus taeda	loblolly pine	U
Pinus virginiana	Virginia pine	U
Piptochaetium avenaceum	eastern needlegrass	R
Platanthera clavellata	small green wood orchid	R
Podophyllum peltatum	mayapple	R
Polygonatum biflorum	small Solomon's seal	R
Polystichum acrostichoides	Christmas fern	C
Prunus serotina	black cherry	U
Pseudognaphalium obtusifolium	eastern rabbit-tobacco	U
Pteridium latiusculum	eastern bracken	R
Pycnanthemum tenuifolium	slender mountain-mint	R
Quercus alba	white oak	R
Quercus falcata	southern red oak	U
Quercus montana	chestnut oak	R
Quercus phellos	willow oak	R
Ranunculus recurvatus	hooked buttercup	R
Rhexia mariana	Maryland meadow-beauty	R
Rhododendron periclymenoides	pink azalea	R
Robinia hispida	bristly locust	R
Robinia pseudoacacia	black locust	R
Rosa multiflora	multiflora rose	R
Rubus flagellaris	common dewberry	R
Rumex crispus	curly dock	R
Rhynchospora glomerata	clustered beaksedge	R
Rudbeckia hirta	black-eyed susan	R
Salvia lyrata	lyreleaf sage	R
Sambucus canadensis	common elderberry	R
Sanguinaria canadensis	bloodroot	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 10 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [(a)]
Sanicula canadensis	black snakeroot	U
Sassafras albidum	sassafras	R
Schizachyrium scoparium	little bluestem	R
Scirpus atrovirens	black bulrush	U
Scirpus cyperinus	woolgrass	U
Scirpus expansus	woodland bulrush	R
Scirpus georgianus	Georgia bulrush	R
Scirpus polyphyllus	leafy bulrush	R
Senega verticillata	whorled milkwort	R
Setaria pumila	yellow foxtail	R
Smilax bona-nox	catbriar	R
Smilax glauca	whiteleaf greenbriar	U
Smilax rotundifolia	common greenbriar	U
Solanum carolinense	Carolina horse-nettle	R
Solidago caesia	axillary goldenrod	R
Solidago rugosa var. aspera	rough goldenrod	R
Stellaria media	common chickweed	R
Stellaria pubera	star chickweed	R
Strophostyles umbellata	perennial sand bean	R
Symphoricarpos orbiculatus	coralberry	R
Symphyotrichum lanceolata	panicled aster	R
Symphyotrichum lateriflorum	starved aster	U
Syphyotrichum pilosum	hairy aster	R
Symphyotrichum puniceum	swamp aster	R
Thalictrum thalictroides	rue-anemone	R
Tiarella cordifolia	heartleaf foamflower	R
Tilia americana	basswood	R
Tipularia discolor	cranefly orchid	R
Toxicodendron radicans	poison ivy	U
Tridens flavus	redtop	R
Tripsacum dactyloides	gama grass	R
Typha angustifolia	narrowleaf cattail	R

Table 2.3-7
Plant Species Documented on the Project Site
(Sheet 11 of 11)

Scientific Name	Common Name	Project Site Overall Abundance [a]
Typha latifolia	common cattail	U
Uvularia perfoliata	perfoliate bellwort	R
Vaccinium fuscatum	hairy highbush blueberry	R
Vaccinium pallidum	hillside blueberry	O
Vaccinium stamineum	deerberry	U
Verbascum thapsus	woolly mullein	R
Verbesina alternifolia	common wingstem	U
Verbesina occidentalis	southern crownbeard	C
Viburnum acerifolium	mapleleaf viburnum	R
Viola cucullata	hooded blue violet	R
Viola pedata	bird's foot violet	R
Viola rafinesquei	wild pansy	R
Viola sororria	common blue violet	U
Xanthorhiza simplicissima	yellowroot	R
Yucca aloifolia[b]	Spanish dagger	R
Woody Vine		
Bignonia capreolata	cross vine	U
Lonicera japonica	Japanese honeysuckle	O
Lonicera sempervirens	coral honeysuckle	R
Muscadinia rotundifolia var. *rotundifolia*	muscadine	U
Smilax rotundifolia	common greenbriar	R
Toxicodendron radicans	poison ivy	U
Vitis sp.	grape	U
Wisteria sinensis	Chinese wisteria	O

Notes:
(a) Relative abundance (qualitative) for occurrence in the Project site: A = Abundant; C = Common; O = Occasional; U = Uncommon; R = Rare.
(b) Likely planted. *Baptisia albescens* (W1; S3) presumably from seed mix in restored tallgrass prairie; *Yucca aloifolia* (W1; S2) located near old homesite and developed area and presumable holdover from intentional plantings.

Table 2.3-8
Protected Species Potentially Occurring within or near the Project Site

Common Name	Scientific Name	Status		
		Federal[a]	State[b]	Suitable Habitat Present on Project Site[c]
Reptiles and Amphibians				
Bog turtle	*Glyptemys muhlenbergii*	SAT	T	P
Insects				
Monarch butterfly	*Danaus plexippus*	PT		P
Coppery emerald	*Somatochlora georgiana*		SR	P
Mollusks				
Green Floater	*Lasmigona subviridis*	PT	E	N
James Spinymussel	*Parvaspina collina*	E	E	N
Fish				
Bigeye Jumprock	*Moxostoma ariommum*		T	N
Quillback	*Carpiodes cyprinus*		SR	N
Riverweed Darter	*Etheostoma podostemone*		SR	N
Roanoke Logperch	*Percina rex*		E	N
Mammals				
Gray bat	*Myotis grisescens*	E	E	N[d]
Tricolored bat	*Perimyotis subflavus*	PE	E	P
Birds				
Rusty blackbird	*Euphagus carolinus*		T	P
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	T	P
Plants				
Creeping sunrose	*Crocanthemum propinquum*		T	N
Granite flatsedge	*Cyperus granitohilus*		T	N
Schweinitz's sunflower	*Helianthus schweinitzii*	E	E	P
Marsh St. John's-wort	*Triadenum tubulosum*		SR	P

Notes:
(a) Federal Status Codes: BGEPA = Protected under the Bald and Golden Eagle Protection Act; E = Listed Endangered; PE = Proposed Endangered; SAT = Listed Threatened due to similarity of appearance to the northern population; PT = Proposed Threatened.
(b) State Status Codes: E = Listed Endangered; SR = Significantly Rare; T = Listed Threatened.
(c) Habitat Codes: N = No records of species within the Project site and/or no suitable habitat is present; P = Suitable habitat is present.
(d) Suitable foraging habitat may be present on the Project site in the form of stream corridors, but no suitable roosting habitat is present on the Project site.
(e) Suitable foraging habitat is present on the Project site in the form of herbaceous areas, but suitable breeding habitat is limited. See Section 2.3.1.5.1 for more details.

Table 2.3-9
Important Species within or near the Project Site
(Sheet 1 of 2)

Common Name	Scientific Name	Important Species Rationale[(a)]	Species Documented?	Suitable Habitat Present on Project Site
Reptiles and Amphibians				
Bog turtle	*Glyptemys muhlenbergii*	SAT, ST	No	Yes
American bullfrog	*Lithobates catesbeianus*	Nongame species	No	Yes
Insects				
Monarch butterfly	*Danaus plexippus*	PT	No but host plant documented on Project site	Yes[(b)]
Coppery emerald	*Somatochlora georgiana*	SR	No	Yes
Mollusks				
Green Floater	*Lasmigona subviridis*	PFT, ST	Yes, in Dan River	No
James Spinymussel	*Parvaspina collina*	FE, SE	No	No
Fish				
Bigeye Jumprock	*Moxostoma ariommum*	ST	Yes, in Dan River	No
Quillback	*Carpiodes cyprinus*	SR	Yes, in Dan River	No
Riverweed Darter	*Etheostoma podostemone*	SR	Yes, in Dan River	No
Roanoke Logperch	*Percina rex*	SE	Yes, in Dan River	No
Mammals				
Coyote	*Canis latrans*	Nongame species	Yes, on Project site	Yes
Beaver	*Castor canadensis*	Game species, furbearer	Yes, on Project site	Yes
Opossum	*Didelphis virginiana*	Game species, furbearer	Yes, on Project site	Yes
Groundhog	*Marmota monax*	Nongame species, furbearer	Yes, on Project site	Yes
Striped skunk	*Mephitis mephitis*	Game species, furbearer	Yes, on Project site	Yes
White-tailed deer	*Odocoileus virginianus*	Game species	Yes, on Project site	Yes
Tricolored bat	*Perimyotis subflavus*	PFE, SE	Yes, on Project site	Yes

Table 2.3-9
Important Species within or near the Project Site
(Sheet 2 of 2)

Common Name	Scientific Name	Important Species Rationale[(a)]	Species Documented?	Suitable Habitat Present on Project Site
Mammals (continued)				
Raccoon	*Procyon lotor*	Game species, furbearer	Yes, on Project site	Yes
Gray squirrel	*Sciurus carolinensis*	Game species	Yes, on Project site	Yes
Fox squirrel	*Sciurus niger*	Game species	Yes, on Project site	Yes
Eastern cottontail	*Sylvilagus floridanus*	Game species	Yes, on Project site	Yes
Gray fox	*Urocyon cinereoargenteus*	Game species	Yes, on Project site	Yes
Birds				
Wood duck	*Aix sponsa*	Game species	Yes, on Project site	Yes
Mallard	*Anas platyrhynchos*	Game species	Yes, on Project site	Yes
Canada goose	*Branta canadensis*	Game species	Yes, on Project site	Yes
Rusty blackbird	*Euphagus carolinus*	ST	No	Yes
Bald eagle	*Haliaeetus leucocephalus*	BGEPA, ST	Yes, nest within Project Vicinity and seen on Project site	Yes
Wild turkey	*Meleagris gallopavo*	Game species	Yes, on Project site	Yes
Red-breasted merganser	*Mergus serrator*	Game species	Yes, within Project Vicinity	Yes
Mourning dove	*Zenaida macroura*	Game species	Yes, on Project site	Yes
Plants				
Schweinitz's sunflower	*Helianthus schweinitzii*	FE, SE	No	Yes
Marsh St. John's-wort	*Triadenum tubulosum*	SR	No	Yes

Notes:
(a) BGEPA = Protected under the Bald and Golden Eagle Protection Act; FE = Listed Federally Endangered; PFE = Proposed Federally Endangered; PFT = Proposed Federally Threatened; SAT = Listed Federally threatened due to similarity of appearance to the northern population; SE = Listed State Endangered; SR = State Significantly Rare; ST = Listed State Threatened.
(b) Suitable foraging habitat is present on the Project site in the form of herbaceous areas, but suitable breeding habitat is limited. See Section 2.3.1.5.1 for more details.

Table 2.3-10
Macroinvertebrates Encountered in the Vicinity of the Project Site by Water Body, Spring 2024
(Sheet 1 of 3)

Common Name	Family	Taxa (genus)	Project Site	Dan River	Total	Percent of Total
Amphipods	Hyalellidae	*Hyallela* sp.	15	4	19	0.97
Annelid Worms (Olicochaetae)	Oligochaete		2		2	0.10
	Enchytraeidae		1	1	2	0.10
	Lumbriculidae		25	9	34	1.73
	Naididae		1	1	2	0.10
	Naididae (Group III)			1	1	0.05
		Dero sp.	19	42	61	3.10
		Limnodrilus sp.	2	3	5	0.25
		Nais sp.		2	2	0.10
		Pristina sp.	2	2	4	0.20
		Slavina sp.	2	4	6	0.31
		Stylaria sp.	11	1	12	0.61
	Tubificidae (Group V)		8	228	236	12.01
Beetles (Coleoptera)	Dryopidae	*Helicus* sp.	3		3	0.15
	Dytiscidae	*Acilius* sp.	1		1	0.05
		Coptotomus sp.	3	1	4	0.20
		Laccophilus sp.	1		1	0.05
	Elmidae	*Ancyronyx* sp.		3	3	0.15
		Dubiraphia sp.		1	1	0.05
		Heterelmis sp.		5	5	0.25
		Ordobrevia sp.	2		2	0.10
	Gyrinidae	*Gyrinus* sp.		4	4	0.20
	Hydrophilidae	*Sperchopsis* sp.		3	3	0.15
Bivalves (Bivalvia)	Sphaeriidae	*Pisidium* sp.	273		273	13.89
Caddisflies (Trichoptera)	Hydropsychidae		1		1	0.05
	Lepidostomatidae	*Lepidostoma* sp.	3		3	0.15
		Theliopsyche sp.	1		1	0.05
	Molannidae	*Molanna* sp.	1		1	0.05
	Odontoceridae	*Psilotreta* sp.	3		3	0.15
	Psychomyiidae	*Lype* sp.	1		1	0.05
Crustaceans (Decapoda)	Cambaridae		19		19	0.97
Damselflies/ Dragonflies (Odonata)	Aeshnidae	*Boyeria* sp.		2	2	0.10
	Calopterygidae	*Calopteryx* sp.	2		2	0.10
	Coenagrionidae	*Argia* sp.		1	1	0.05
	Cordulegastridae	*Cordulegaster* sp.	2	2	4	0.20
	Corduliidae	*Somatochlora* sp.	2		2	0.10
	Gomphidae	*Dromogomphus* sp.		1	1	0.05

Table 2.3-10
Macroinvertebrates Encountered in the Vicinity of the Project Site by Water Body, Spring 2024
(Sheet 2 of 3)

Common Name	Family	Taxa (genus)	Project Site	Dan River	Total	Percent of Total
		Hagenius sp.		1	1	0.05
		Progomphus sp.		3	3	0.15
		Stylurus sp.		1	1	0.05
	Macromiidae	*Macromia* sp.		3	3	0.15
Flies and Midges (Diptera)			1		1	0.05
	Ceratopogonidae	*Bezzia* sp.	1		1	0.05
	Chaoboridae	*Chaoborus* sp.	2		2	0.10
	Chironomidae		35	10	45	2.29
		Ablabesmyia sp.	2	4	6	0.31
		Apedilum sp.	2		2	0.10
		Chironominae	4	15	19	0.97
		Chironomus sp.	8	10	18	0.92
		Corynoneura sp.	5		5	0.25
		Cricotopus/Orthocladius sp.	3	19	22	1.12
		Cryptochironomus sp.	3	1	4	0.20
		Cryptotendipes sp.		1	1	0.05
		Hydrobaenus sp.	82	5	87	4.43
		Krenopelopia sp.	10		10	0.51
		Microspectra sp.	1		1	0.05
		Orthocladiinae	2	9	11	0.56
		Paracladopelma sp.	11	4	15	0.76
		Paralauterborniella sp.	3	1	4	0.20
		Paratendipes sp.	3		3	0.15
		Polypedilum sp.	179	133	312	15.88
		Procladius sp.		1	1	0.05
		Rheotanytarsus sp.		2	2	0.10
		Smittia sp.		1	1	0.05
		Stempellinella sp.	67		67	3.41
		Tanypodinae	18	18	36	1.83
		Tanytarsini	14	36	50	2.54
		Tanytarsus sp.	28	5	33	1.68
		Thienemanniela sp.	4	1	5	0.25
		Zavrelimyia sp.	78	12	90	4.58
	Culicidae	*Anopheles* sp.		3	3	0.15
		Deinocerites sp.	2		2	0.10
	Dixidae	*Dixa* sp.	3		3	0.15
	Empididae	*Hemerodromia* sp.	1		1	0.05

Table 2.3-10
Macroinvertebrates Encountered in the Vicinity of the Project Site by Water Body, Spring 2024
(Sheet 3 of 3)

Common Name	Family	Taxa (genus)	Project Site	Dan River	Total	Percent of Total
	Psychodidae		6	1	7	0.36
		Psychoda sp.	5		5	0.25
		Maruina sp.	1		1	0.05
	Ptychopteridae	*Ptychoptera* sp.	1		1	0.05
	Simuliidae		4		3	0.15
		Simulium sp.	3		4	0.20
	Stratiomyidae	*Nemotelus* sp.		2	2	0.10
	Tabanidae	*Tabanus* sp.	5		5	0.25
	Tipulidae			2	2	0.10
		Leptotarsus sp.	2	5	7	0.36
		Megistocera sp.	9		9	0.46
Gastropods (Gastropoda)	Physidae	*Physa* sp.	7		7	0.36
	Planorbidae	*Menetus* sp.	1		1	0.05
Ispods (Isopoda)	Asellidae	*Asellus* sp.		1	1	0.05
Mayflies (Ephemeroptera)	Baetidae			4	4	0.20
		Baetis sp.	1	35	36	1.83
		Callibaetis sp.		56	56	2.85
		Paracloedes sp.		14	14	0.71
		Pseudocloen sp.		126	126	6.41
	Caenidae	*Brachycercus* sp.		1	1	0.05
	Ephemerellidae	*Eurylophella* sp.		6	6	0.31
	Ephemeridae	*Ephemera* sp.	1		1	0.05
	Heptageniidae	*Maccaffertium* sp.	1	16	17	0.87
		Stenonema temeratum		1	1	0.05
	Isonychiidae	*Isonychia* sp.		8	8	0.41
	Leptophlebiidae	*Habrophlebiodes* sp.	6		6	0.31
		Paraleptophlebia sp.	9		9	0.46
Moths (Lepidoptera)	Crambidae			1	1	0.05
Nematoda				1	1	0.05
Stoneflies (Plecoptera)	Perlidae	*Acroneuria* sp.		1	1	0.05
		Perlesta sp.		4	4	0.20
True Bugs (Hemiptera)	Belostomatidae	*Belostoma* sp.		1	1	0.05
	Corixidae	*Trichocorixia* sp.	3		3	0.15
	Gerridae	*Gerris* sp.	2		2	0.10
		Trepobates sp.		6	6	0.31
	Veliidae	*Microvelia* sp.	4		4	0.20
		Rhagovelia sp.		4	4	0.20
		Total	**1049**	**916**	**1965**	**100.00**
		Total Taxa Observed	**74**	**69**	**111**	

Table 2.3-11
Macroinvertebrates Encountered in the Vicinity of the Project Site by Water Body, Fall 2024
(Sheet 1 of 4)

Common Name	Family	Taxa (genus)	Project Site	Dan River	Total	Percent of Total
Amphipods	Hyalellidae	*Hyallela* sp.	1	2	3	0.25
Annelid Worms (Olicochaetae)	Enchytraeidae		1	1	2	0.17
	Lumbriculidae		10	2	12	1.00
	Naididae		3	3	6	0.50
		Allonais sp.	2		2	0.17
		Aulodrilus sp.		2	2	0.17
		Branchiodrilus sp.		4	4	0.33
		Dero sp.	9	2	11	0.92
		Limnodrilus sp.		5	5	0.42
		Nais sp.	11	18	29	2.43
		Pristina sp.	3	4	7	0.59
		Slavina sp.	11		11	0.92
		Stylaria sp.	10		10	0.84
	Tubificidae (Group V)		16	14	30	2.51
Beetles (Coleoptera)	Dryopidae	*Helicus* sp.		1	1	0.08
	Dytiscidae	*Coptotomus* sp.	3		3	0.25
		Hydroporus sp.	2		2	0.17
		Laccophilus sp.		1	1	0.08
		Liodessus sp.	1		1	0.08
		Neoporus sp.	2		2	0.17
		Thermonectus sp.	1		1	0.08
	Elmidae	*Ancyronyx* sp.		13	13	1.09
		Heterelmis sp.		9	9	0.75
		Hexacylloepus sp.		7	7	0.59
		Stenelmis sp.		10	10	0.84
	Haliplidae	*Peltodytes* sp.	1		1	0.08
	Hydrophilidae	*Berosus* sp.		1	1	0.08
	Psephenidae	*Ectopria* sp.		1	1	0.08
Springtails (Symphypleona)	Sminthuridae		1		1	0.08
		Sminthurus sp.	1		1	0.08
Copepoda		*Cyclopoida* sp.	1		1	0.08
Bivalves (Bivalvia)	Cyrenidae	*Corbicula* sp.	11		11	0.92
	Sphaeriidae	*Pisidium* sp.	81		81	6.78
	Unionida		1		1	0.08
Caddisflies (Trichoptera)	Hydropsychidae	*Cheumatopysche* sp.		20	20	1.67
		Hydropsyche sp.		3	3	0.25
	Leptoceridae		1		1	0.08

Table 2.3-11
Macroinvertebrates Encountered in the Vicinity of the Project Site by Water Body, Fall 2024
(Sheet 2 of 4)

Common Name	Family	Taxa (genus)	Project Site	Dan River	Total	Percent of Total
	Limnephilidae		1	1	2	0.17
	Molannidae	*Molanna* sp.	1		1	0.08
	Psychomyiidae	*Lype* sp.		9	9	0.75
Crustaceans (Decapoda)	Cambaridae		13	1	14	1.17
Damselflies/Dragonflies (Odonata)	Aeshnidae	*Boyeria* sp.		4	4	0.33
	Calopterygidae	*Calopteryx* sp.	8	3	11	0.92
	Coenagrionidae	*Argia* sp.		3	3	0.25
	Cordulegastridae	*Cordulegaster* sp.	5		5	0.42
	Corduliidae	*Somatochlora* sp.		2	2	0.17
	Gomphidae	*Dromogomphus* sp.		7	7	0.59
		Hagenius sp.		1	1	0.08
		Progomphus sp.		8	8	0.67
	Lestidae	*Lestes* sp.	4	4	8	0.67
		Leucorrhinia sp.		4	4	0.33
	Libellulidae	*Libellula* sp.	2		2	0.17
	Macromiidae	*Macromia* sp.		3	3	0.25
Dobsonflies/Alderflies (Megaloptera)	Corydalidae	*Corydalus* sp.	1		1	0.08
	Sialidae		1		1	0.08
Flies and Midges (Diptera)			1		1	0.08
	Axymyiidae		1		1	0.08
	Ceratopogonidae		1		1	0.08
	Chaoboridae	*Chaoborus* sp.		5	5	0.42
	Chironomidae		3	12	15	1.26
		Ablabesmyia sp.	3	40	43	3.60
		Chironominae		10	10	0.84
		Chironomini sp.	4		4	0.33
		Corynoneura sp.	5	2	7	0.59
		Cricotopus/Orthocladius	1	25	26	2.18
		Cryptochironomus sp.	2	8	10	0.84
		Dicrotendipes sp.	1		1	0.08
		Krenopelopia sp.		2	2	0.17
		Labrundinia sp.		15	15	1.26
		Macropelopia sp.	3		3	0.25
		Meropelopia sp.	14		14	1.17
		Microspectra sp.		4	4	0.33
		Microtendipes sp.		2	2	0.17
		Nanocladius sp.	1	2	3	0.25
		Paracladopelma sp.		1	1	0.08

Table 2.3-11
Macroinvertebrates Encountered in the Vicinity of the Project Site by Water Body, Fall 2024
(Sheet 3 of 4)

Common Name	Family	Taxa (genus)	Project Site	Dan River	Total	Percent of Total
		Paralauterborniella sp.		4	4	0.33
		Paratendipes sp.	1	5	6	0.50
		Phaenospectra sp.	17	15	32	2.68
		Polypedilum sp.	17	70	87	7.28
		Psectrocladius sp.		4	4	0.33
		Pseudochironomus sp.		1	1	0.08
		Rheotanytarsus sp.		9	9	0.75
		Tanypodinae	3	2	5	0.42
		Tanytarsini spp.	7	22	29	2.43
		Tanytarsus sp.	5	78	83	6.95
		Thienemanniella sp.		3	3	0.25
		Zavrelia sp.	1		1	0.08
		Zavrelimyia sp.	16	6	22	1.84
	Culicidae	*Anopheles* sp.	4		4	0.33
		Deinocerites sp.		1	1	0.08
		Haemogogus sp.	39		39	3.26
	Dixidae	*Dixa* sp.		1	1	0.08
		Dixella sp.	1		1	0.08
	Drosophilidae			1	1	0.08
	Empididae		1	2	3	0.25
	Limoniidae	*Hexatoma* sp.		1	1	0.08
	Simuliidae			1	14	1.17
		Simulium sp.		14	1	0.08
	Syrphidae			1	1	0.08
	Tanyderidae			1	1	0.08
Gastropods (Gastropoda)				10	10	0.84
	Lymnaeidae	*Lymnaea* sp.		3	3	0.25
	Physidae	*Physa* sp.	63		63	5.27
	Planorbidae	*Menetus* sp.		1	1	0.08
Mayflies (Ephemeroptera)	Baetidae	*Baetis* sp.		27	27	2.26
		Callibaetis sp.		1	1	0.08
		Paracloedes sp.		2	2	0.17
		Procloeon sp.		2	2	0.17
	Caenidae	*Amercaenis* sp.		7	7	0.59
	Ephemerellidae	*Eurylophella* sp.	1	6	7	0.59
	Ephemeridae	*Ephemera* sp.		6	6	0.50
	Heptageniidae			29	29	2.43
	Heptageniidae	*Maccaffertium* sp.		65	65	5.44
	Isonychiidae	*Isonychia* sp.		3	3	0.25

Table 2.3-11
Macroinvertebrates Encountered in the Vicinity of the Project Site by Water Body, Fall 2024
(Sheet 4 of 4)

Common Name	Family	Taxa (genus)	Project Site	Dan River	Total	Percent of Total
Stoneflies (Plecoptera)	Leptophlebiidae	*Paraleptophlebia* sp.	5		5	0.42
	Perlidae			4	4	0.33
		Neoperla sp.		1	1	0.08
		Perlesta sp.		4	4	0.33
	Perlodidae			15	15	1.26
True Bugs (Hemiptera)	Cicadellidae		1		1	0.08
	Corixidae	*Trichocorixa* sp.	12		12	1.00
	Notonectidae	*Notonecta* sp.	1		1	0.08
	Ochteridae	*Ochterus* sp.		1	1	0.08
	Veliidae	*Microvelia* sp.	10		10	0.84
		Total	**465**	**730**	**1195**	**100.00**
		Total Taxa Observed	**65**	**86**	**124**	

Table 2.3-12
Fish Species Observed within Project Site Streams on the Project Site, 2024

		Spring 2024		Summer 2024		Fall 2024	
Common Name	**Scientific Name**	**Number**	**Weight (g)**	**Number**	**Weight (g)**	**Number**	**Weight (g)**
Eastern Mosquitofish	*Gambusia holbrooki*	84	45.4	35	16.0	32	3.5
Redbreast Sunfish	*Lepomis auritus*	1	13.0	-	-	-	-
Redear Sunfish	*Lepomis microlophus*	-	-	1	9.0	-	-
Bluegill	*Lepomis macrochirus*	-	-	-	-	1	1.0
Total		**85**		**36**		**33**	
Species Richness		**2**		**2**		**2**	

Table 2.3-13
Fish Species Captured in Belews Lake during Quarterly Sampling with Electrofishing and Gill Nets, 2020
(Sheet 1 of 2)

Family	Common Name	Scientific Name	Belews Lake
Catostomidae	Creek Chubsucker	*Erimyzon oblongus*	0
	Golden Redhorse	*Moxostoma erythrurum*	0
	Notchlip Redhorse	*Moxostoma collapsum*	0
	Quillback	*Carpiodes cyprinus*	1
	White Sucker	*Catostomus commersonii*	0
Centrarchidae	Alabama Bass	*Micropterus henshalli*	1325
	Black Crappie	*Pomoxis nigromaculatus*	94
	Bluegill	*Lepomis macrochirus*	6301
	Green Sunfish	*Lepomis cyanellus*	159
	Largemouth Bass	*Micropterus nigricans*	470
	Pumpkinseed	*Lepomis gibbosus*	2
	Redbreast Sunfish	*Lepomis auritus*	503
	Redear Sunfish	*Lepomis microlophus*	501
	Sunfish (Hybrid)	*Lepomis* sp.	218
	Warmouth	*Lepomis gulosus*	22
	White Crappie	*Pomoxis annularis*	17
Clupeidae	Alewife	*Alosa pseudoharengus*	20
	Blueback Herring	*Alosa aestivalis*	0
	Gizzard Shad	*Dorosoma cepedianum*	471
	Threadfin Shad	*Dorosoma petenense*	243
Cyprinidae[(a)]	Common Carp	*Cyprinus carpio*	16
	Creek Chub	*Semotilus atromaculatus*	0
	Golden Shiner	*Notemigonus crysoleucas*	2
	Grass Carp	*Ctenopharyngodon idella*	1
	Satinfin Shiner	*Cyprinella analostana*	16
Esocidae	Chain Pickerel	*Esox niger*	0
Ictaluridae	Blue Catfish	*Ictalurus furcatus*	4
	Brown Bullhead	*Ameiurus nebulosus*	0
	Channel Catfish	*Ictalurus punctatus*	267
	Flat Bullhead	*Ameiurus platycephalus*	0
	Flathead Catfish	*Pylodictis olivaris*	16

Table 2.3-13
Fish Species Captured in Belews Lake during Quarterly Sampling with Electrofishing and Gill Nets, 2020
(Sheet 2 of 2)

Family	Common Name	Scientific Name	Belews Lake
	Snail Bullhead	*Ameiurus brunneus*	0
	White Catfish	*Ameiurus catus*	0
	Yellow Bullhead	*Ameiurus natalis*	0
Moronidae	White Perch	*Morone americana*	80
Percidae	Yellow Perch	*Perea flavescens*	16
Poeciliidae	Eastern Mosquitofish	*Gambusia holbrooki*	3
Number of Species			25
Shannon's *H*			1.61

Note:
(a) Cyprinidae has been divided into three distinct families: Xenocyprididae (Grass Carp), Cyprinidae (Common Carp and Goldfish), and Leuciscidae (all other minnows and shiners).
Source: Duke Energy, 2021

Table 2.3-14
Fish Species Observed in the Dan River during Quarterly Sampling
2015–2017
(Sheet 1 of 3)

Scientific Name	Common Name	Upstream[b]	Downstream[c]	Total	Percent
Catostomidae	**Suckers**				
Carpiodes cyprinus	Quillback	4	37	41	0.5
Catostomus commersonii	White Sucker	29	45	74	0.8
Moxostoma ariommum	Bigeye Jumprock	33	0	33	0.4
M. cervinum	Blacktip Jumprock	208	4	212	2.4
M. erythrurum	Golden Redhorse	172	879	1051	11.8
M. collapsum	Notchlip Redhorse	3	29	32	0.4
M. pappillosum	V-Lip Redhorse	85	393	478	5.4
Hypentelium nigricans	Northern Hogsucker	53	32	85	1
H. roanokense	Roanoke Hogsucker	36	2	38	0.4
Centrarchidae	**Sunfishes**				
Lepomis macrochirus	Bluegill	10	153	163	1.8
L. cyanellus	Green Sunfish	0	12	12	0.1
L. auritus	Redbreast Sunfish	841	929	1770	19.8
L. microlophus	Redear Sunfish	1	62	63	0.7
L. (Hybrid)	Sunfish (hybrid)	0	4	4	0
L. gulosus	Warmouth	0	1	1	0
Micropterus nigricans	Largemouth Bass	2	102	104	1.2
M. dolomieu	Smallmouth Bass	138	37	175	2
Pomoxis nigromaculatus	Black Crappie	0	4	4	0
P. annularis	White Crappie	0	1	1	0
Ambloplites cavifrons	Roanoke Bass	0	15	15	0.2
A. rupestris	Rock Bass	0	1	1	0
Cyprinidae[a]	**Carps and Minnows**				
Nocomis leptocephalus	Bluehead Chub	220	28	248	2.8
N. raneyi	Bull Chub	530	78	608	6.8
Campostoma anomalum	Central Stoneroller	14	0	14	0.2

Table 2.3-14
Fish Species Observed in the Dan River during Quarterly Sampling
2015–2017
(Sheet 2 of 3)

Scientific Name	Common Name	Upstream[(b)]	Downstream[(c)]	Total	Percent
Notropis amoenus	Comely Shiner	15	221	236	2.6
N. chiliticus	Redlip Shiner	24	0	24	0.3
N. hudsonius	Spottail Shiner	36	35	71	0.8
N. procne	Swallowtail Shiner	0	4	4	0
Unidentified *Notropis*	Unidentified	0	1	1	0
Cyprinus carpio	Common Carp	0	9	9	0.1
C. carpio x carrasius	Common Carp x Goldfish hybrid	1	0	1	0
Luxilus cerasinus	Crescent Shiner	45	1	46	0.5
Notemigonus crysoleucas	Golden Shiner	0	1	1	0
Cyprinella lutrensis	Red Shiner	0	6	6	0.1
C. analostana	Satinfin Shiner	420	26	446	5
Lythrurus ardens	Rosefin Shiner	477	50	527	5.9
Luxilus albeolus	White Shiner	845	226	1071	12
Unidentified Cyprinids	Unidentified Cyprinid	1	0	1	0
Ictaluridae	**North American Catfishes**				
Ameiurus brunneus	Snail Bullhead	581	75	656	7.4
A. platycephalus	Flat Bullhead	182	24	206	2.3
Ictalurus furcatus	Blue Catfish	0	1	1	0
Ictalurus punctatus	Channel Catfish	1	27	28	0.3
Noturus insignis	Margined Madtom	168	5	173	1.9
Pylodictis olivaris	Flathead Catfish	0	2	2	0
Percidae	**Perches**				
Etheostoma flabellare	Fantail Darter	8	0	8	0.1
E. vitreum	Glassy Darter	4	3	7	0.1
E. nigrum	Johnny Darter	1	0	1	0
E. podostemone	Riverweed Darter	73	0	73	0.8
Percina nevisense	Chainback Darter	8	3	11	0.1
P. roanoka	Roanoke Darter	85	0	85	1
Salmonidae	**Trouts and Salmons**				

Table 2.3-14
Fish Species Observed in the Dan River during Quarterly Sampling
2015–2017
(Sheet 3 of 3)

Scientific Name	Common Name	Upstream[(b)]	Downstream[(c)]	Total	Percent
Salmo trutta	Brown Trout	1	0	1	0.0
Total Number Collected		**5355**	**3568**	**8923**	**100**
Number of Distinct Taxa		36	**39**		

Source: HDR, 2022
Note:
Cyprinidae has been divided into three distinct families: Xenocyprididae (Grass Carp), Cyprinidae (Common Carp and Goldfish), and Leuciscidae (all other minnows and shiners).
Key: Upstream location = RM 130; Downstream location = RM 93

Table 2.3-15
Fish Species Observed in the Dan River, Spring 2024
(Sheet 1 of 2)

Common Name	Scientific Name	Number	Percent Number	Weight (g)	Percent Weight	Location Observed				Method Collected
						DRSW1	DRSW2	DRSW3	DRSW4	
White Shiner	*Luxilus albeolus*	180	25.0	559.6	1.1	X	X	X	X	EF, SE
Redbreast Sunfish	*Lepomis auritus*	131	18.2	3981.8	8.1	X	X	X	X	EF, SE
Golden Redhorse	*Moxostoma erythrurum*	62	8.6	16841.8	34.4	X	X	X	X	EF
Comely Shiner	*Notropis amoenus*	46	6.4	51.7	0.1	X	X	X	X	EF, SE
V-lip Redhorse	*Moxostoma pappillosum*	43	6.0	5321.5	10.9	X	X	X	X	EF
Bull Chub	*Nocomis raneyi*	37	5.1	1318.5	2.7	X	X	X	X	EF, SE
White Sucker	*Catostomus commersonii*	34	4.7	4605.7	9.4	X	X	X	X	EF
Bluegill	*Lepomis macrochirus*	25	3.5	249.1	0.5	X	X	X	X	EF, SE
Satinfin Shiner	*Cyprinella analostana*	24	3.3	191.4	0.4	X	X	X	X	EF, SE
Largemouth Bass	*Micropterus salmoides*	18	2.5	8590.0	17.6	X	X	X	X	EF
Redlip Shiner	*Notropis chiliticus*	16	2.2	208.4	0.4	X	X	X	X	EF
Riverweed Darter	*Etheostoma podostemone*	13	1.8	36.0	0.1	X	X	X	X	EF, SE
Rosefin Shiner	*Lythrurus ardens*	13	1.8	24.9	0.1	X	X	X	X	EF, SE
Northern Hogsucker	*Hypentelium nigricans*	10	1.4	638.0	1.3	X	X	X	X	EF
Bluehead Chub	*Nocomis leptocephalus*	9	1.3	24.7	0.1	X		X	X	EF
Flat Bullhead	*Ameiurus platycephalus*	7	1.0	1072.0	2.2	X	X	X	X	EF
Eastern Mosquitofish	*Gambusia holbrooki*	6	0.8	5.0	0.0			X	X	EF, SE
Snail Bullhead	*Ameiurus brunneus*	5	0.7	688.0	1.4	X	X	X		EF, SE
Smallmouth Bass	*Micropterus dolomieu*	5	0.7	2500.0	5.1	X		X		EF
Swallowtail Shiner	*Notropis procne*	7	1.0	5.3	< 0.1	X				EF
Glassy Darter	*Etheostoma vitreum*	4	0.6	6.0	< 0.1	X	X		X	EF, SE
Bigeye Jumprock	*Moxostoma ariommum*	4	0.6	181.0	0.4		X		X	EF
Margined Madtom	*Noturus insignis*	3	0.4	50.4	0.1		X			EF
Green Sunfish	*Lepomis cyanellus*	3	0.4	124.0	0.3		X	X		EF
Roanoke Darter	*Percina roanoka*	2	0.3	1.8	< 0.1			X	X	EF, SE

Table 2.3-15
Fish Species Observed in the Dan River, Spring 2024
(Sheet 2 of 2)

Common Name	Scientific Name	Number	Percent Number	Weight (g)	Percent Weight	Location Observed				Method Collected
						DRSW1	DRSW2	DRSW3	DRSW4	
Hybrid Sunfish (Bluegill x Redbreast Sunfish)	*Lepomis macrochirus x Lepomis auritus*	2	0.3	78.0	0.2		X	X		EF
Quillback	*Carpiodes cyprinus*	2	0.3	970.0	2.0	X	X			EF
Roanoke Hogsucker	*Hypentelium roanokense*	2	0.3	158.0	0.3		X		X	EF
Spottail Shiner	*Notropis hudsonius*	1	0.1	3.4	< 0.1	X				EF
Golden Shiner	*Notemigonus crysoleucas*	1	0.1	1.1	< 0.1	X				SE
Black Crappie	*Pomoxis nigromaculatus*	1	0.1	294.0	0.6			X		EF
Blacktip Jumprock	*Moxostoma cervinum*	1	0.1	36.0	0.1				X	EF
Redear Sunfish	*Lepomis microlophus*	1	0.1	107.0	0.2			X		EF
Warmouth	*Lepomis gulosus*	1	0.1	9.0	< 0.1			X		EF
Total		**719**	**100.0**	**48933.1**	**100.0**					
Species Richness		**34**								

Key: EF = Electrofishing; SE = Seine

Table 2.3-16
Fish Species Observed in the Dan River, Summer 2024
(Sheet 1 of 2)

Common Name	Scientific Name	Number	Percent Number	Weight (g)	Percent Weight	Location Observed				Method Collected
						DRSW1	DRSW2	DRSW3	DRSW4	
Comely Shiner	*Notropis amoenus*	589	60.4	481.4	2.8	X	X	X	X	EF, SE
Redlip Shiner	*Notropis chiliticus*	65	6.7	171.6	1.0		X	X		EF, SE
Rosefin Shiner	*Lythrurus ardens*	59	6.1	75.3	0.4		X	X		EF, SE
Swallowtail Shiner	*Notropis procne*	59	6.1	74.6	0.4		X	X		EF
Redbreast Sunfish	*Lepomis auritus*	43	4.4	1137.7	6.6	X	X	X		EF, SE
White Shiner	*Luxilus albeolus*	34	3.5	56.5	0.3	X	X			SE
Golden Redhorse	*Moxostoma erythrurum*	26	2.7	8726.0	50.9			X		EF
Bluegill	*Lepomis macrochirus*	12	1.2	354.0	2.1		X	X		EF
Margined Madtom	*Noturus insignis*	12	1.2	83.3	0.5		X	X	X	EF
V-lip Redhorse	*Moxostoma pappillosum*	10	1.0	2087.5	12.2		X	X		EF, SE
Riverweed Darter	*Etheostoma podostemone*	8	0.8	20.6	0.1		X	X	X	EF, SE
Flat Bullhead	*Ameiurus platycephalus*	6	0.6	55.0	0.3		X	X	X	EF, SE
Roanoke Darter	*Percina roanoka*	6	0.6	8.9	0.1		X	X	X	EF, SE
Chainback Darter	*Percina nevisense*	6	0.6	13.4	0.1		X	X		EF, SE
Satinfin Shiner	*Cyprinella analostana*	6	0.6	30.2	0.2			X		EF
Bull Chub	*Nocomis raneyi*	7	0.7	60.1	0.4		X	X	X	EF
Blacktip Jumprock	*Moxostoma cervinum*	5	0.5	148.0	0.9			X		EF
Largemouth Bass	*Micropterus salmoides*	4	0.4	2198.0	12.8			X		EF
Northern Hogsucker	*Hypentelium roanokense*	3	0.3	196.0	1.1			X		EF
Snail Bullhead	*Ameiurus brunneus*	2	0.2	137.0	0.8		X			EF
Smallmouth Bass	*Micropterus dolomieu*	2	0.2	458.0	2.7			X		EF
White Sucker	*Catostomus commersonii*	2	0.2	458.0	2.7			X		EF
Bluehead Chub	*Nocomis leptocephalus*	2	0.2	5.2	< 0.1			X		EF
Fantail Darter	*Etheostoma flabellare*	2	0.2	1.3	< 0.1				X	EF
Redear Sunfish	*Lepomis microlophus*	1	0.1	34.0	0.2			X		EF, SE
Eastern Mosquitofish	*Gambusia holbrooki*	1	0.1	0.0	< 0.1		X			EF

Table 2.3-16
Fish Species Observed in the Dan River, Summer 2024
(Sheet 2 of 2)

Common Name	Scientific Name	Number	Percent Number	Weight (g)	Percent Weight	Location Observed				Method Collected
						DRSW1	DRSW2	DRSW3	DRSW4	
Glassy Darter	*Etheostoma vitreum*	1	0.1	1.2	< 0.1		X			EF
Black Crappie	*Pomoxis nigromaculatus*	1	0.1	73.0	0.4			X		EF
Green Sunfish	*Lepomis cyanellus*	1	0.1	1.0	< 0.1			X		EF
Totals		**975**	**100.0**	**17146.8**	**100.0**					
Species Richness		**29**								

Key: EF = Electrofishing; SE = Seine

Table 2.3-17
Fish Species Observed in the Dan River, Fall 2024

Common Name	Scientific Name	Number	Percent Number	Weight (g)	Percent Weight	Location Observed				Method Collected
						DRSW1	DRSW2	DRSW3	DRSW4-ALT	
Comely Shiner	*Notropis amoenus*	20	21.5	20.0	4.0		X	X	X	SE, EF
Redbreast Sunfish	*Lepomis auritus*	13	14.0	166.0	33.1	X	X	X	X	EF
Bull Chub	*Nocomis raneyi*	12	12.9	73.0	14.6		X		X	SE, EF
Redlip Shiner	*Notropis chiliticus*	12	12.9	47.0	9.4		X	X	X	SE, EF
Roanoke Darter	*Percina roanoka*	12	12.9	17.0	3.4		X		X	EF
Margined Madtom	*Noturus insignis*	7	7.5	71.0	14.2	X	X	X		EF
Riverweed Darter	*Etheostoma podostemone*	7	7.5	8.0	1.6		X	X	X	EF
White Shiner	*Luxilus albeolus*	3	3.2	1.0	0.2				X	EF
Blacktip Jumprock	*Moxostoma cervinum*	2	2.2	47.0	9.4				X	EF
Flat Bullhead	*Ameiurus platycephalus*	2	2.2	7.0	1.4		X		X	EF
Bluegill	*Lepomis macrochirus*	1	1.1	6.0	1.2	X				EF
Goldfish	*Carassius auratus*	1	1.1	36.0	7.2		X			EF
Swallowtail Shiner	*Notropis procne*	1	1.1	2.0	0.4			X		EF
Total		**93**	**100.0**	**501.0**	**100.0**					
Species Richness		**13**								

Key: EF = Electrofishing; SE = Seine

2.4 SOCIOECONOMICS

This section describes the socioeconomic characteristics of the areas that could be impacted by construction, operation, and decommissioning of several advanced reactors at the Project site. The analysis focuses on demography and community characteristics in the potentially affected areas.

The demographic region is defined as the Project site and the surrounding area within a 50-mi. (80-km) radius from the Project site center point bounding limit, as described in Section 2.1.1.3. The economic region or "region of influence" (ROI) for the socioeconomic analysis is defined by the areas where the construction and operations workforce and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region.

To determine the ROI for the socioeconomic analysis, it is assumed that the residential distribution of the construction and operations workforce for the Project mimics the residential distribution of the BCSS workforce. This assumption applies in terms of the geographic area from which the workforce would be drawn and accordingly those areas that would experience most social and economic impacts. The BCSS workforce comprises approximately 150 employees from five states and 29 counties. Three employees list mailing addresses in Florida, South Carolina, and West Virigina and are excluded from analysis, bringing the total number of existing on-site BCSS employees to 147. The largest percentage of workers employed by BCSS reside in Rockingham County (28 percent) and Stokes County (25 percent) in NC. The neighboring counties of Forsyth and Guilford in NC provide 11 percent and 10 percent of the total workers employed by BCSS, respectively. Employees from these four counties account for approximately 75 percent of the on-site BCSS workforce. Therefore, Rockingham, Stokes, Forsyth, and Guilford counties represent the ROI and serve as the basis for the assessment of social and economic impacts from the Project.

2.4.1 DEMOGRAPHY

This section describes the current and projected resident population distribution within the demographic region, demographic characteristics of the population residing within the ROI, and a discussion of transient populations. Population data presented are based on 2020 census data from the U.S. Census Bureau (USCB) and, where applicable, more recent data from the USCB 2018–2022 American Community Survey (ACS) five-year estimates. Future populations were projected following guidance in NUREG-0800, Regulatory Guide 1.70, and Regulatory Guide 4.7. These projections are based on state planning agency projections and studies or other appropriate federal agency sources.

2.4.1.1 Population Data by Sector

Current and projected resident population data by sector within 50-mi. (80-km) of the Project site center point are summarized in Table 2.4-1. Current (2020) population data by sector within 20 mi. (32 km) of the Project site center point is shown on Figure 2.4-1 and current population data within 20 to 50-mi. (32 to 80-km) are shown in Figure 2.4-2.

The population distribution in the area up to a 50-mi. (80-km) radius surrounding the Project site is estimated from 2020 USCB decennial census data. The population distribution is divided into distance bands and directional sectors from the established Project site center point at the following distances: 0-0.3 mi. (0-0.5 km); 0.3-1 mi. (0.5–2 km); 1-2 mi. (2-3 km); 2-3 mi. (3-5

km); 3-4 mi. (5-6 km); 4-5 mi. (6-8 km); 5-6 mi. (8-10 km); 6-7 mi. (10-11 km); 7-8 mi. (11-13 km); 8-9 mi. (12.9-14.5 km); 9-10 mi. (15-16 km); 10-20 mi. (16-32 km); 20-30 mi. (32-48 km); 30-40 mi. (48-64 km); and 40-50-mi. (64-80-km). For each sector, the percentage of each Census Block Group's (CBG) land area that falls either partially or entirely within that sector is calculated. The equivalent percentage of each CBG's population is then assigned to that sector. If two or more CBGs fall within the same sector, the proportional population estimates for the CBGs are summed to obtain the total population estimate for that sector.

Projected population levels during the anticipated year of plant approval and start of commercial operation of the first reactor (2034), the start of commercial operation of the last reactor (2039), and for census years over the 40-year plant operating license period (2039 through 2079) are based on state planning agency projections and studies or other appropriate federal agency sources. Where these planning agency projections do not cover the required period, population projections are extrapolated based on calculated growth rates.

2.4.1.2 Demographic Characteristics of the ROI

The following demographic characterization, which includes current, historic, and projected population data, age and sex distribution, income distribution, and racial and ethnic distribution, within the ROI.

Table 2.4-2 shows the 2020 population of each county within the ROI and of each USCB-recognized "place" (i.e., city, town, or census-designated place) within those counties. Where USCB-recognized places intersect multiple counties, the place is listed under the county where most of the population resides. The 2020 resident population of the four counties that compose the ROI was 1,059,505. The closest places to the Project site center point bounding limit are Stokesdale (population 5924), approximately 0.6 mi. (0.95 km) to the southeast in Guilford County, and Walnut Cove (population 1586), approximately 3 mi. (4.9 km) to the west in Stokes County (Figure 2.4-3). Guilford County, to the southeast, is the most populated county in the ROI and also contains Greensboro (population 299,035), the largest population center in the ROI. Three other large population centers (defined as areas with a population greater than 25,000) are located in Forsyth and Guilford counties: Kernersville, Winston-Salem, and High Point. There are no large population centers in Rockingham or Stokes counties.

Historic and projected population within the ROI is shown in Table 2.4-3. The table includes historic data for the three most recent decennial censuses (2000, 2010, 2020) and projections through 2079, the expected end of licensing period, derived from projected population data published by the North Carolina Office of State Budget and Management (NCOSBM) (NCOSBM, 2023a). Stokes County, where the Project site is located, experienced population growth of approximately 0.6 percent annually between 2000 and 2010 and subsequently declined by 0.6 percent annually between 2010 and 2020. Similarly, Rockingham County experienced population growth of approximately 0.2 percent annually between 2000 and 2010 and subsequently declined by approximately 0.3 percent annually between 2010 and 2020. Forsyth and Guilford counties both experienced average annual population growth rates of 1 percent or nearly 1 percent for the same period. The population of Stokes and Rockingham counties is projected to stay relatively consistent over the licensing period. The population in Forsyth and Guilford counties is projected to continue to grow, but at a slower rate, until 2050. Overall, the ROI population as a whole is projected to continue to grow at a rate of approximately 0.8 percent annually throughout the licensing period, led by growth in Guilford and Forsyth counties.

Age and gender distribution within the ROI and NC are shown in Table 2.4-4. The age distribution of the ROI is generally similar to the state, with a slightly younger median age and larger percentage of population ages 15 to 24. However, in Rockingham and Stokes counties, the median age is between 6 and 8 years older than that of the state. Similar to the state of NC, women in the ROI account for slightly more than half of the population.

Table 2.4-5 presents household income and federal poverty level data for the ROI counties and the state of NC. Median household income and the percentage of households with income of $150,000 or more are lower for the ROI counties compared to the state. The percentage of households below the poverty level in the ROI is higher than that of the state. Within the ROI, Rockingham County has the highest percentage of population living below the poverty level.

Racial and minority populations within the ROI and the state of NC are shown in Table 2.4-6. Racial and ethnic minorities within the ROI (46.4 percent) make up a larger percentage of the population compared to the state (39.5 percent). Black or African American residents comprise the largest racial or ethnic minority group in all four ROI counties. Table 2.4-7 presents trends in racial and ethnic population distribution in the ROI counties from 2010 to 2020, and projections for 2030 through 2050. The aggregate minority population in the ROI is projected to surpass the white population by 2040; and by 2050, roughly 54 percent (711,930 people) of the ROI will identify as a racial or ethnic minority. This shift is most evident in Guilford County, where the aggregate minority population is expected to increase by approximately 20 percent between 2010 and 2050 (NCOSBM, 2023b).

2.4.1.3 Transient Population

As described in Regulatory Guide 4.7, Rev. 3, *General Site Suitability for Nuclear Power Stations*, transient populations are defined as “people (other than those just passing through the area) who work, reside part-time, or engage in recreational activities, and are not permanent residents of the area.”

Significant sources of transient populations include airports, major employers, schools, medical facilities, lodging facilities, event venues, and recreation areas. Transient facilities within 20 mi. (32 km) of the Project site center point are shown in Table 2.4-8. Estimates of transient populations associated with the facilities identified in Table 2.4-8 were obtained primarily by reviewing government agency websites and other public sources of information on employers, schools, recreation areas, medical facilities (hospitals and nursing homes), and lodging facilities (hotels, motels, recreational vehicle [RV] parks, and vacation rentals). Employee counts for industrial employers were sourced, if possible, from company websites. If unavailable, estimates were obtained from job resource websites and news sources. Approximately 230,756 transients associated with 631 facilities were identified within a 20-mi. (32-km) radius.

In addition to the transient populations identified in association with the facilities listed above, nonpermanent residents of the area also include migrant laborers whose employment requires travel that prevents the worker from returning to their permanent place of residence the same day. The U.S. Department of Agriculture conducts a census of agriculture that collects information on migrant workers. Results of the 2022 census indicate that there are 83 farms within the ROI that employ 434 migrant workers (USDA, 2022a).

2.4.2 COMMUNITY CHARACTERISTICS

2.4.2.1 Economy

Table 2.4-9 details employment trends for the four counties in the ROI. In 2022, the ROI had a total labor force of 531,242 people, of which 500,924 individuals were employed. In 2022, Guilford County had the largest employed population of the four ROI counties (263,584), followed by Forsyth County (178,260). A total of 28,836 individuals in the ROI were unemployed in 2022, resulting in an unemployment rate of 5.4 percent. All four of the counties in the ROI had similar unemployment rates, ranging from 5.2 percent (Guilford County) to 6.5 percent (Rockingham County). Overall, unemployment in the ROI decreased from 9.7 percent in 2011 to 5.4 percent in 2022, which is similar to NC as a whole, where unemployment decreased from 9.5 percent to 5.0 percent over the same period.

Table 2.4-10 presents total employment levels by industry sector for the four counties in the ROI. In 2022 the educational services, healthcare, and social assistance sector employed 25 percent of the workers in the ROI, followed by manufacturing at 13.3 percent. The transportation, warehousing, and utilities sector experienced the largest employment growth in the ROI from 2011 to 2022 (43.4 percent increase). The information sector experienced the largest employment decline in the ROI from 2011 to 2022 (24.6 percent decrease). Additionally, the construction labor industry within the ROI comprises 5.9 percent of the existing labor force, which is a 3.7 increase from 2011 to 2022.

Table 2.4-11 lists the top employers in the ROI for 2023. Major employers were concentrated in Forsyth and Guilford counties, with a combined 45 employers with over 1000 workers. There were two employers within Rockingham County that employed over 1000 workers: Consolidated School System and Wal-Mart Associates Inc. There were no employers with over 1000 workers within Stokes County; the largest employer in Stokes County was Stokes County Schools with 500 to 999 employees.

Income distribution by household is detailed in Table 2.4-5. In 2022, the median household income ranged from $50,737 (Rockingham County) to $62,880 (Guilford County) and was lower than the state of NC, which was $66,186. Per capita income is the average income for every individual in a particular group and is derived by dividing the total income of a particular group by the total population in that group (USCB, 2024a). Table 2.4-12 details per capita income trends for the four counties in the ROI. Per capita income ranged from $29,239 (Rockingham County) to $36,563 (Guilford County) in 2022. Between 2011 and 2022, Stokes County experienced the greatest increase in per capita income (55.1 percent) among the ROI counties. Forsyth, Guilford, and Rockingham counties experienced lower increases in per capita income than the state during this same time period (49.0 percent).

2.4.2.2 Transportation

This section describes the transportation network serving the Project site, the Project Vicinity, and the Project Region. Available transportation resources in the Project Vicinity and Project Region include a diverse road network, rail lines, airports, waterways, and public transportation. Figure 2.1-4 illustrates the road, highway, railroad, and airports systems in the area.

2.4.2.2.1 Roads

As shown in Figure 2.1-4, there are four interstate highways within the Project Region: Interstate (I) 40, I-74, I-77, and I-85. The closest interstate highway to the Project site is I-40, which runs east to west 9.9 mi. (15.9 km) south of the Project site at its closest border. Large population centers in the ROI are described in Section 2.4.1.2. Winston-Salem, NC, is located along I-40, 9.3 mi. (14.9 km) to the southwest, and Greensboro, NC, is located 8.5 mi (13.7 km) to the southeast. I-74 runs east to west 14.8 mi. (23.9. km) south of the Project site at its closest border. I-77 runs north to south 40.4 mi. (65.0 km) west of the Project site at its closet border and I-85 runs southwest to northeast 20.7 mi. (33.2 km) south of the Project site.

The road and highway transportation systems in the Project Vicinity are shown in Figure 2.4-4. Two U.S. highways and one state highway serve the Project Vicinity and provide access to the Project site. U.S. 311 runs north–south/southwest connecting Stokes and Forsyth counties, 3.9 mi. (6.3 km) northwest of the Project site boundary. U.S. 158 runs northeast-southwest connecting Forsyth and Guilford counties, approximately 2.2 mi. (3.6 km) south of the Project site center point; and NC Highway 65 runs northwest–southeast connecting Guilford, Forsyth, and Stokes counties 1.1 mi. (1.8 km), south of the Project site center point. SRs and local roads in the Project Vicinity include SR-1908/SR-1977 (Pine Hall Road), SR 1965 (Belews Creek Road), SR 2042 (Craig Road), Martin Luther King Jr. Road, and Fisherman Road.

Primary roadways providing access to the Project site are shown on Figure 2.4-4. Pine Hall Road provides direct access to the Project site from the west, and Craig Road provides direct access from the south. The intersection of Pine Hall Road and SR 2034 (Duke Power Steam Plant Road) is stop-controlled for SR 2034 only. Craig Road ends at the BCSS Entrance, which is gate controlled. Commuting workers coming from the surrounding region to the north are likely to take U.S. 311 to Pine Hall Road. Commuting workers traveling from east and west are likely to take U.S. 311 or U.S. 158 to Belews Creek Road to Craig Road. Other commuting workers traveling within Stokes, Forsyth, and Guilford counties are likely to use county and local roads and connect to Pine Hall Road and Craig Road.

2.4.2.2.2 Road Conditions and Mileage

Each of the four counties in the ROI has hundreds of mi. of publicly maintained roadways. Stokes County contains 59 mi. (95 km) of unpaved and 846 mi. (1362 km) of paved state highway system. Guilford County contains 49 mi. (79 km) of unpaved and 1826 mi. (2939 km) of paved state highway system. Forsyth County contains 16 mi. (26 km) of unpaved and 955 mi. (1537 km) of paved state highway system. Rockingham County contains 92 mi. (148 km) of unpaved and 1128 mi. (1815 km) of paved state highway system.

2.4.2.2.3 Traffic Conditions

Vehicle volume on roads is provided by the NCDOT in the form of estimated annual average daily traffic (AADT) counts. AADT is the total volume of motorized vehicle traffic on a highway or roadway segment for 1 year divided by 365 days in the year (Florida Department of Transportation [FDOT], 2023). The AADT counts and functional classification for the primary access roads to the Project site are shown in Table 2.4-13 (NCDOT, 2024a, 2024b).

The primary roadways within the Project Vicinity that are used to access the Project site are listed in Table 2.4-13. These include U.S. 158 which is classified as an “other” principal arterial

roadway in the Project Vicinity. U.S. 311 and NC Highway 65 are classified as minor arterial roadways. Pine Hall Road and Belews Creek Road, west of NC Highway 65, are classified as major collector roadways. Pine Hall Road east of NC Highway 65 is classified as a local roadway and Belews Creek Road west of NC Highway 65 is a minor arterial roadway. Pine Hall Road east of Hawkins Farm Road is classified as a minor collector roadway. Fisherman Road and Hawkins Farm Road are classified as minor collector roadways. Ellisboro Road, running north–south is classified as a minor collector roadway (NCDOT, 2024b). The remaining local roadways in the Project Vicinity are two-lane undivided roadways.

Level of Service (LOS) is a quantitative stratification of a performance measure or measures representing quality of service. The Highway Capacity Manual (HCM) defines six levels of service, ranging from A to F, for each service measure or combination of service measures. LOS A represents the best operating conditions from the traveler's perspective and LOS F represents the worst (FDOT, 2023).

The HCM describes LOS A through F as follows:

- LOS A: free-flow operations on freeway or multilane highways and high operating speeds and little difficulty in passing on two-way highways.
- LOS B: reasonably free-flow operations, and the ability to maneuver within the traffic stream is slightly restricted on freeway or multilane highways; on two-way highways, passing demand and passing capacity are balanced with some speed reductions present.
- LOS C: freedom to maneuver within the traffic stream is noticeably restricted, and lane changes require more care and vigilance on the part of the driver on freeway or multilane highways; speeds are noticeably reduced on two-way highways.
- LOS D: freedom to maneuver within the traffic stream is seriously limited, and drivers experience reduced physical and psychological comfort levels on freeway or multilane highways; platooning increases significantly on two-way highways.
- LOS E: operation is at or near capacity, and there are virtually no usable gaps within the traffic stream on freeway or multilane highways; passing is virtually impossible on two-way highways.
- LOS F: describes unstable flow with queues forming behind bottlenecks on multilane highways; operating conditions are unstable, and heavy congestion exists on two-way highways.

Based on a standard motor vehicle arterial generalized service volume for a two-lane roadway in a rural town having a maximum AADT of 13,800, the AADTs presented in Table 2.4-13 indicate that the primary roadways in the Project Vicinity operate at an acceptable LOS C or better (FDOT, 2023).

2.4.2.2.4 Roadway Freight Network

The National Highway Freight Network in NC includes Primary Highway Freight System (PHFS) and Non-PHFS Interstate roadways. Within the ROI, I-77 and I-40 are part of the PHFS

network. Minor collectors and local roadways are used to directly access the Project site. (Federal Highway Administration [FHWA], 2024)

2.4.2.2.5 Road Improvements

NCDOT maintains and programs the roadway network in the ROI counties. In Forsyth County, NCDOT is building a multilane freeway that loops around the northern part of Winston-Salem (NCDOT, 2024c). This project began in 2014 and is currently under construction. In Forsyth County, NCDOT has two projects in development: Big Mill Farm/Hopkins Road Improvements, scheduled for construction in 2025, and US 158 (Reidsville Road) Improvements, which began construction in 2024. In Guilford County there are also two projects in development: Johnson Street and Sandy Ridge Road Widening and US 220 Widening (Greensboro). There are no high-profile NCDOT projects or studies currently identified in Rockingham or Stokes counties.

2.4.2.2.6 Railroads

The CSX Winston-Salem Yard, which is operated by NS, is located in the Project Region. The NS railroad in the Project Region runs north–south in Forsyth, Stokes, and Rockingham counties and east–west in Forsyth and Guilford counties. The Yadkin Valley Railroad in the Project Region extends east–west across Forsyth County. The Winston-Salem Southbound Railway railroad in the Project Region extends north–south in Forsyth County.

NS is the primary operator of the rail lines within the ROI. Yadkin Valley Railroad and Winston-Salem Southbound Railway have shorter lines located on the outskirts of the ROI. In the Project Vicinity, NS has a 3.4 mi. (5.5 km) spur that branches off to connect to the BCSS (NCDOT, 2024d and 2024e).

2.4.2.2.7 Waterways

Belews Lake is a reservoir in Forsyth, Stokes, Guilford, and Rockingham counties that is primarily used for support of power generation and secondarily used for recreational purposes (Belews Lake, 2024). The Dan River flows north of the Project site and provides opportunities for paddling, canoeing, tubing, and kayaking. These waterways are not used for transportation-related purposes.

2.4.2.2.8 Airports

As shown on Figure 2.1-4, there are two public airports within the Project Region. Piedmont Triad International (GSO) is the only regional airport that offers international services (Piedmont Triad International Airport, 2024). While there are no regularly scheduled passenger services outside of the U.S., the airport had approximately 350 international flights in 2023. Piedmont Triad International (GSO) functions like an independent municipality with its own police force, fire department, operations, parking facilities, and administration. Smith Reynolds (INT) is a general aviation airport that provides operations for corporate aircraft, air charter services, general aviation, and air cargo (Smith Reynolds Airport, NC 2024). The airport facilities include areas for aircraft maintenance, repair, and overhaul and aviation-related industrial and commercial development. There are no public airports located within the Project Vicinity.

2.4.2.2.9 Public Transportation

Several public transit services serve the ROI; however, there are no transit services that provide direct access to the Project site. In Guilford County, there are five transit providers that operate bus/van services: Guilford Transit Authority, High Point Transit System, Piedmont Authority for Regional Transportation, Guilford County Transportation and Mobility Services, and NC Greyhound. In Forsyth County, three transit providers operate bus services: Winston-Salem Transit Authority, Piedmont Authority for Regional Transportation, and NC Greyhound. In Rockingham County, two transit providers operate bus services: Rockingham Community Access Transit Services and Piedmont Authority for Regional Transportation. In Stokes County, two transit providers operate bus services: Yadkin Valley Public Transportation and Piedmont Authority for Regional Transportation.

2.4.2.3 Taxes

Table 2.4-14 presents annual tax revenues from property taxes, sales taxes, occupancy tax, and other taxes for the four counties in the ROI for fiscal year (FY) 2019 through FY 2023. Property tax in NC is locally assessed and collected by the counties. The North Carolina Department of Revenue (NCDOR) supervises the valuation and taxation of property by taxing units throughout the state. Property tax is levied upon real property, personal property, and motor vehicles (NCDOR, 2024a). The 2024 tax rates and levies for each county in the ROI are shown in Table 2.4-15.

For tax year 2023, the NC individual income tax rate was 4.75 percent, which is lower than the rate from the 2022 tax year (4.99 percent). During the next three tax years (2024, 2025, and 2026), the respective individual income tax rates are expected to continue to decrease to 4.5 percent, 4.25 percent, and 3.99 percent, respectively (NCDOR, 2024b).

All domestic and foreign corporations in NC are subject to franchise tax (NCDOR, 2024c). In addition, a 2.5 percent income tax is levied on the net taxable income of certified corporations in NC (NCDOR, 2024d). However, in 2019, NC enacted the 2021 Appropriations Act, which phases out the current 2.5 percent corporate income tax rate over a 5-year period starting in 2025 to reach a zero percent rate by 2030 (EY, 2024).

NC imposes a sales and use tax of 4.25 percent. Individual counties may impose an additional 2.0 to 2.75 percent as a county sales and use tax (NCDOR, 2024e). This tax is applicable to the sale price of each article of tangible personal property (NCDOR, 2024f). In addition, NC also imposes a tax from the sale of electricity at 7 percent (NCDOR, 2024g). In 2023, Duke Energy operations throughout the Carolinas collected $301,759,828 in sales taxes.

The Project site is developed on an existing Duke Energy–owned parcel (see Section 2.1), which had an assessed property value of $27,259,600 in 2024. In 2024, Duke Energy paid Stokes County $6.8 million in property taxes. Duke Energy currently has not entered into or negotiated any special property tax abatements or agreements.

2.4.2.4 Political Structure

There are 50 senate districts and 14 congressional districts within NC. Within the four-county ROI, there are four congressional districts and two state senate districts (NCGA, 2023a, 2024).

The North Carolina General Assembly (NCGA) established the Board of County Commissioners as the governing body of each of the 100 counties. Counties are governed by a board of five or more commissioners whose members are both the legislative and executive leaders of the government.

The incorporated cities and towns within the ROI are shown on Table 2.4-2. The Stokes County seat is Danbury, which is located approximately 11 mi. (18 km) northwest of the Project site. Winston-Salem is the county seat for Forsyth County, Greensboro is the county seat for Guilford County, and Wentworth is the county seat for Rockingham County.

2.4.2.5 Land Use

As stated in Section 2.1, all counties in the ROI have adopted countywide comprehensive plans. Each plan identifies goals for increasing economic growth and attracting businesses, developing a variety of housing options, protecting and preserving natural resources, and improving transportation and utilities.

2.4.2.6 Aesthetics and Recreation

2.4.2.6.1 Aesthetics

As detailed in Section 2.1, the Project site lies within the NC western Piedmont, which is characterized by gently rolling, well-rounded hills and long low ridges ranging in a few hundred feet of elevation difference between the hills and valleys. The immediate area around the Project site features several notable visual resources:

- Belews Lake, a scenic body of water used to support power plant operation and which also allows for recreation uses (see Section 2.4.2.6.2) (NCWRC, 2012).
- Forested land.
- The BCSS, located adjacent to the Project site to the west, encompasses approximately 700 ac. (283 hectares [ha]) (North Carolina Division of Energy, Mineral, and Land Resources, 2016). The coal-fired plant is a significant industrial feature in the area.
- Rural/low-density residential lands to the south and east of the Project site.

These elements together create a diverse visual environment around the Project site.

Sensitive visual receptors, which are potentially affected by visual intrusions of the Project, include recreators on Belews Lake, residences just south of the Project site boundary, and residences to the east of the Project site across Belews Lake. Additional sensitive visual receptors include visitors to the recreation areas within the Project Vicinity and residences and facilities located along access roads to the Project site. Primary roadways in the Project Vicinity are shown on Figure 2.4-4. Pine Hall Road (SR 1908) and Craig Road (SR 2042) provide the best opportunity for the public to view the Project site. Because the surrounding topography consists of rolling hills and steep slopes with forested land, there is visual screening for the Project site from area roadways.

2.4.2.6.2 Recreation

Recreational areas that could be affected by the construction and operation of the Project primarily consist of outdoor, nature-oriented activities, such as boating, fishing, hunting, camping, bicycling, and hiking. The recreation areas within the Project Vicinity are shown on Figure 2.4-5.

Duke Energy owns all the land within and immediately adjacent to Belews Lake. Duke Energy grants shoreline access leases to adjacent property owners for permission to access the lake across Duke Energy property. There are approximately 63 permitted private docks/structures on Belews Lake. Once leased, the shoreline property may be used for access to Belews Lake for recreational use and for other permitted uses as specified in the lease or in the Guidelines for Use of Shoreline Property at Belews Lake. At a full pool elevation of 725 ft. (221 m.) AMSL the lake has approximately 88 mi. (142 km) of shoreline and 3863 ac. (1563 ha) of surface area. Duke Energy provides recreational access to the lake through two public boat launch areas maintained and managed by the NCWRC: Piney Bluff Access Area and Pine Hall Access Area. Additionally, the commercial docks, Carolina Marina and Humphrey's Ridge, provide access to Belews Lake from the eastern side.

Belews Lake is a popular destination for fishing and other water-related activities in the area. Largemouth bass, spotted bass, and Black Crappie are primarily the targeted species for fishing; however, Belews Lake is also fished for white bass, channel catfish, white catfish, Bluegill, and sunfish. Due to its warm temperatures resulting from the BCSS discharge, Belews Lake is one of the state's more productive lakes for fishing in the winter. Since July 2023, NCWRC issued 40 fishing tournament permits involving 1037 boats for two access areas on Belews Lake. However, introduction of non-native species, such as Hydrilla and the Asiatic Clam may negatively affect water-related activities in the lake (see Section 2.3.2.6). Additionally, Duke Energy–owned lands have 11 leases to hunting clubs that cover approximately 5000 ac. (2023 ha) on the Project site and in the vicinity. Together, these clubs have approximately 100 members. Of the 11 hunting leases, the Belews Creek Hunt Club has the largest lease area (approximately 2518 ac. [1019 ha]), which covers most of the Project site. The remaining 10 hunting leases are located adjacent to the lake on Duke Energy–owned property. NCWRC offers hunting permits and licenses for various types of animals, including deer, turkeys, bears, ducks, waterfowl, and small game animals.

The Dan River flows north of the Project site and provides opportunities for paddling, canoeing, tubing, fishing, and kayaking. Among the 214 mi. (344 km) of river, 90 mi. (145 km) were authorized as a state paddle trail in 2021 in Surry, Stokes, and Rockingham counties. There are several public paddle access points located throughout these counties; however, they are located outside of the Project Vicinity (North Carolina Triad Outdoors, 2024). Although not listed as a public access point, river access (Pine Hall Access) near the Project site is located at an unimproved access point within the NCDOT corridor along Pine Hall Road (Dan River Basin Association, 2024).

South of the Project site, Forsyth County is developing Belews Lake Park. Phase 1 of the park completed in early 2025, the 215-ac. (87-ha) park includes natural areas, trails, fishing piers, a shelter, and a playground. Forsyth County is developing the park in multiple construction phases, with the construction of Phase II anticipated to begin as early as 2025.

As stated in Section 2.1.1.2, the Knight Brown Nature Preserve is located within the Project Vicinity (see Figure 2.1-6). The Knight Brown Nature Preserve is approximately 147 ac. (60 ha) with almost 5 mi. (8 km) of walking trails through a wooded valley, which includes two streams.

Additional recreation facilities in the vicinity are several community parks (Walnut Cove Lion's Park, London Park, Dr. Jack Fowler Park, East Walnut Cove Community Park, Stokesdale Town Park at Martin's Meadow, and Stokesdale Community Park); two golf courses (Riverview Golf Course and Pine Knolls Golf Club); a fishing lake (Hilltop Carp Lake); hiking trails (Cascades Preserve, Mountain to Sea Trail, Dan River Trail, Keyauwee Loop Trail, Falling Waters, Atlantic & Yadkin Greenway, and Hogan's Creek Park); and a campground (R&K Campground). R&K Campground is an RV park that offers short-term and long-term stay options.

Popular recreational destinations in the ROI include Hanging Rock State Park, Mayo River State Park, and Haw River State Park (see Figure 2.1-6). Hanging Rock State Park, the largest state park located within the ROI, is located in Stokes County and offers a variety of recreational opportunities including hiking, biking, horseback riding, swimming, paddling, fishing, picnicking, camping, and rock climbing. Old Salem, located in Forsyth County, is a famous historic district in Winston-Salem that is made up of various shops, historic buildings, gardens, and a history museum. The Old Salem history museum serves as an educational museum on the Moravians of NC who established the Central NC community in the late 18th century. As noted in Section 2.6.2, there are four properties listed on the National Register of Historic Places (NRHP) within a 10-mi. (16-km) radius of the Project site.

2.4.2.7 Housing

Table 2.4-16 details total housing units and occupation status in each of the counties within the ROI in 2022. Of the 469,243 housing units within the ROI, most are located in Guilford (233,332) and Forsyth (171,040) counties. Throughout the ROI, occupancy ranges from 88.8 percent (Rockingham County) to 91.2 percent (Guilford County). Within the ROI, 62.3 percent of units are owner occupied and the remaining 37.7 percent are renter occupied. In 2022, the median mortgage in the ROI was $1291 per month and the median rent in the ROI was $886 per month (see Table 2.4-17). Table 2.4-18 details vacant housing within the ROI, including units for rent or sale. In 2022, less than 10 percent of the total housing units in the ROI were vacant. Of the vacant units, 25.1 percent (11,455 units) were available for rent and 7.5 percent (3,047 units) were for sale.

As shown in Table 2.4-19, within the ROI, the largest increase in new home construction occurred between 1990 and 1999 (16 percent). However, housing construction slowed over the next two decades, dropping from 15.6 percent in the 2000s to 8.7 percent in the 2010s. Table 2.4-20 details residential building permits issued for each of the ROI counties in 2010 and 2020 through 2023. Overall, issuance of residential building permits has increased in all four ROI counties from 2010 to 2020, with the largest increase seen in Forsyth County. Building permits issued for multifamily buildings decreased in Forsyth and Guilford counties from 2010 to 2020. However, from 2020 to 2023 building permits for multifamily buildings in Forsyth and Guilford counties increased. From 2010 to 2023, Rockingham and Stokes counties saw little change in the number of multifamily building permits issued, with no permits issued in 2022 and 2023. While the number of permits issued has increased in the ROI, this does not directly correlate to new housing built, only the issuance of a permit for construction.

Temporary housing within the ROI includes hotels, seasonal homes (for long-term rentals), and RV parks and campgrounds (see Section 2.4.2.6.2 for RV parks and campground within the Project Vicinity). Within the Greensboro (Guilford County) and Winston-Salem (Forsyth County) area there are 163 hotels, 25 bed and breakfasts, and 28 camping and RV sites (Economic Development Partnership of North Carolina, 2024). Additionally, Table 2.4-18 shows that within the ROI there were 3908 seasonal, recreation, or occasional use housing units available in 2022.

2.4.2.8 Community Infrastructure

This section describes public water and wastewater treatment systems, police and fire departments, medical facilities, and schools. Schools are described in Section 2.4.2.9. The other infrastructure and service elements are described in the following sections.

2.4.2.8.1 Public Water Supply and Wastewater Treatment Systems

There are 14 public water systems providing potable water to the residents of Stokes, Forsyth, Guilford, and Rockingham counties. Table 2.4-21 summarizes the population served, total available supply, service area demand, total demand (service area demand, sales, future sales), and demand as percentage of supply for each of the water systems in the ROI. Water systems in the four ROI counties operate below capacity.

Wastewater treatment in the ROI is provided by 10 WWTPs. Table 2.4-22 details the public wastewater treatment facilities, their capacities, and the average wastewater flow for Stokes, Forsyth, Guilford, and Rockingham counties, all of which are operating below capacity.

2.4.2.8.2 Police, Fire, Emergency Services, and Medical Services

2.4.2.8.2.1 Police

Information regarding law enforcement officers is based on Federal Bureau of Investigation (FBI) data for full-time sworn officers, current as of 2019 (FBI, 2019) and is shown in Table 2.4-23. Within the ROI counties, the number of law enforcement officers (sworn officers) ranges from 73 to 1276, with a total of 2379. In 2019, the nationwide ratio of law enforcement officers to citizens was approximately 2.4 per 1000 citizens, which is consistent with the ROI ratio of 2.2 per 1000 citizens.

2.4.2.8.2.2 Fire Services

Fire departments staffed by volunteer, career, and paid firefighters provide fire services in the ROI. In 2020, the National Fire Protection Association (NFPA) estimated that there were 1,041,200 career and volunteer firefighters in the U.S. (NFPA, 2024). According to USCB data, the population of the U.S. in 2020 was 331,449,281 citizens (USCB, 2020), resulting in a firefighter-to-citizen ratio of 1 to 318. The number of firefighters and residents in the ROI are listed in Table 2.4-24. Within the counties in the ROI, the ratio of firefighters to residents ranged from 1 to 123 to 1 to 368. The ratio of firefighters to residents in the ROI was 1 to 300. Forsyth County and Guilford County exceed the national average for firefighter-to-resident ratio, while Rockingham County and Stokes County fall under the national average (see Table 2.4-24).

2.4.2.8.2.3 Emergency Management

The North Carolina Emergency Management (NCEM) agency helps oversee disaster recovery, hazard mitigation and risk management, search and rescue, nuclear emergency preparedness, and emergency communications. The NCEM actively collaborates, communicates, and coordinates to prevent, mitigate, respond, and recover from disasters. The agency deploys state resources when needed and coordinates with neighboring states and the federal government to augment staffing and resources (NCDPS, 2024).

2.4.2.8.2.4 Medical

Table 2.4-25 identifies hospitals and number of beds within the ROI. There are 11 medical centers in the ROI with a total of 3595 beds. Most of these medical centers are located in Forsyth and Guilford counties. Adult care homes and nursing home facilities and associated number of beds are identified in Table 2.4-26. There are 18 adult care homes and nursing home facilities with a total of 764 beds in the ROI.

The number of physicians and dentists within the ROI by county and the ratio of these professionals to residents are detailed in Table 2.4-27. Within the ROI, there are a total of 917 physicians and 630 dentists. The ROI has a resident-to-physician ratio of 1169 to 1 and a resident-to-dentist ratio of 1702 to 1.

2.4.2.9 Education

A total of 271 public and 44 private, elementary, middle, and high schools, are located in the ROI, most of which are in Guilford County. A summary of these schools' statistics, including student enrollment and student-to-teacher ratios for the 2023 private school year and 2024 public school year are provided in Table 2.4-28.

The state of NC has limitations on class sizes. Kindergarten classrooms must have 18 or fewer students per teacher. For first grade, there must be one teacher per 16 students. For second and third grade, there must be one teacher per 17 students. There are no class size requirements detailed for grades 4 through 12 (NCGA, 2023b). As shown in Table 2.4-28, student-to-teacher ratios for the public school districts within the ROI are 15.4 to 1 or lower, with the average across public schools being 14.9 to 1. Student–teacher ratios for private schools within the ROI is 10.6 to 1. The average student-to-teacher ratio within the ROI in public schools is lower than that of the state of NC, where the average ratio is 17.2 to 1.

In addition to primary and secondary schools, there are 17 college campuses, with a total student population of 72,768 individuals, located within the ROI (see Table 2.4-29). Most of the colleges and universities are located within Guilford County, which has nine colleges or universities with a total enrollment of 46,306 students. Table 2.4-30 details the number of individuals enrolled in pre-kindergarten, elementary, secondary and post-secondary schools. In the ROI, 274,358 individuals attend various levels of educational institutions.

Table 2.4-31 details the educational attainment of individuals 25 years and older within the ROI in 2022. Of this population, 9.2 percent have achieved an associate's degree, 21.2 percent have achieved a bachelor's degree, and 12.7 percent have a graduate or professional degree. These percentages are similar to those of NC as a whole.

Table 2.4-1
Projected Resident Population for Each Sector within 50-Mile (80-Kilometer) of the Project Site
(Sheet 1 of 7)

Year	0-0.3 (mi.)	0.3-1 (mi.)	1-2 (mi.)	2-3 (mi.)	3-4 (mi.)	4-5 (mi.)	5-6 (mi.)	6-7 (mi.)	7-8 (mi.)	8-9 (mi.)	9-10 (mi.)	10-20 (mi.)	20-30 (mi.)	30-40 (mi.)	40-50 (mi.)	Total 0-50 (mi.)
East																
2020	10	47	102	263	412	529	579	506	563	434	403	9415	12,974	8930	9970	
2034	10	47	103	265	415	533	584	513	573	443	412	9707	13,419	9118	10,066	
2039	10	47	103	265	415	533	584	514	576	446	415	9815	13,584	9164	10,113	
2049	10	47	103	265	415	533	585	517	581	451	421	10,026	13,898	9220	10,171	
2059	10	47	103	265	415	533	586	520	586	456	427	10,237	14,209	9262	10,215	
2069	10	47	103	265	415	533	587	523	592	462	433	10,452	14,527	9303	10,259	
2079	10	47	103	265	415	533	588	526	597	467	439	10,671	14,851	9346	10,303	
ENE																
2020	8	46	103	253	339	357	389	388	431	402	326	7795	18,388	19,413	36,696	
2034	8	46	104	255	341	359	392	391	434	405	328	7849	18,497	18,225	34,077	
2039	8	46	104	255	341	359	392	391	434	405	328	7849	18,492	17,847	33,288	
2049	8	46	104	255	341	359	392	391	434	405	328	7849	18,482	17,112	31,886	
2059	8	46	104	255	341	360	392	391	434	405	328	7850	18,472	16,398	30,529	
2069	8	46	104	255	341	360	392	391	434	405	328	7850	18,462	15,713	29,229	
2079	8	46	104	255	341	360	392	391	434	405	328	7851	18,452	15,056	27,983	
ESE																
2020	8	46	140	269	427	594	680	808	1039	1258	1530	49,611	32,374	114,312	55,696	
2034	8	46	145	287	463	650	748	889	1143	1384	1683	54,567	35,719	135,545	65,273	
2039	8	46	147	295	479	676	779	926	1191	1442	1754	56,878	37,246	142,512	68,529	

Table 2.4-1
Projected Resident Population for Each Sector within 50-Mile (80-Kilometer) of the Project Site
(Sheet 2 of 7)

Year	0-0.3 (mi.)	0.3-1 (mi.)	1-2 (mi.)	2-3 (mi.)	3-4 (mi.)	4-5 (mi.)	5-6 (mi.)	6-7 (mi.)	7-8 (mi.)	8-9 (mi.)	9-10 (mi.)	10-20 (mi.)	20-30 (mi.)	30-40 (mi.)	40-50 (mi.)	Total 0-50 (mi)
2049	8	46	151	311	512	728	844	1003	1290	1562	1899	61,591	40,355	156,464	75,038	
2059	8	46	155	327	546	784	912	1084	1394	1688	2053	66,563	43,636	171,261	81,929	
2069	8	46	158	344	582	843	985	1172	1507	1824	2219	71,937	47,183	187,458	89,453	
2079	8	46	163	362	621	907	1065	1266	1628	1971	2398	77,744	51,019	205,187	97,668	
North																
2020	7	24	54	114	154	188	214	226	267	307	341	2953	8000	11,819	13,276	
2034	7	26	57	121	164	200	228	240	283	324	360	2969	7199	10,867	13,016	
2039	7	26	58	122	164	201	228	240	283	325	360	2938	6905	10,609	13,338	
2049	7	26	58	122	164	201	228	241	283	325	361	2879	6408	10,208	14,163	
2059	7	26	58	122	164	201	228	241	284	325	361	2818	5928	9796	15,018	
2069	7	26	58	122	164	201	229	241	284	325	361	2759	5483	9398	15,921	
2079	7	26	58	122	165	201	229	241	284	326	361	2700	5070	9016	16,879	
NE																
2020	7	34	101	143	196	274	324	366	408	585	467	8575	22,481	13,088	22,653	
2034	7	35	102	144	197	276	326	369	411	589	470	8635	21,519	12,113	21,005	
2039	7	35	102	144	197	276	326	369	411	589	470	8635	21,168	11,905	20,728	
2049	7	35	102	144	197	276	326	369	411	589	470	8635	20,576	11,643	20,453	
2059	7	35	102	144	197	276	326	369	411	589	470	8635	19,976	11,393	20,209	
2069	7	35	102	144	197	276	326	369	411	589	470	8636	19,392	11,147	19,968	
2079	7	35	102	144	197	276	326	369	411	589	470	8636	18,825	10,907	19,729	

Table 2.4-1
Projected Resident Population for Each Sector within 50-Mile (80-Kilometer) of the Project Site
(Sheet 3 of 7)

Year	0-0.3 (mi.)	0.3-1 (mi.)	1-2 (mi.)	2-3 (mi.)	3-4 (mi.)	4-5 (mi.)	5-6 (mi.)	6-7 (mi.)	7-8 (mi.)	8-9 (mi.)	9-10 (mi.)	10-20 (mi.)	20-30 (mi.)	30-40 (mi.)	40-50 (mi.)	Total 0-50 (mi.)
NNE																
2020	7	24	63	116	189	278	343	409	696	1186	1980	5898	25,435	20,792	8048	
2034	7	26	66	120	193	282	346	412	701	1194	1994	5860	22,778	18,839	7739	
2039	7	26	66	120	193	282	346	412	701	1194	1994	5830	21,755	18,210	7853	
2049	7	26	66	120	193	282	346	412	701	1194	1994	5776	19,996	17,157	8175	
2059	7	26	66	120	193	282	346	412	701	1194	1994	5719	18,296	16,099	8500	
2069	7	26	66	120	193	282	346	412	701	1194	1994	5663	16,734	15,102	8836	
2079	7	26	66	120	193	282	346	412	701	1194	1994	5607	15,305	14,166	9186	
NNW																
2020	7	24	62	132	138	156	182	196	238	246	213	2769	6106	3311	7592	
2034	7	26	66	140	147	166	194	209	253	262	227	2899	5575	3043	7646	
2039	7	26	66	141	147	166	194	209	254	262	227	2893	5382	2949	7763	
2049	7	26	66	141	147	167	194	209	254	263	227	2877	5067	2800	8099	
2059	7	26	66	141	147	167	194	209	254	263	227	2859	4763	2654	8445	
2069	7	26	66	141	147	167	194	209	254	263	227	2840	4476	2515	8806	
2079	7	26	66	141	147	167	194	209	254	263	228	2822	4206	2384	9182	
NW																
2020	7	24	68	180	238	291	353	340	310	344	347	2468	4421	6266	8390	
2034	7	26	72	192	253	310	376	362	330	366	369	2626	4375	5823	8017	
2039	7	26	73	192	254	310	376	363	331	367	370	2632	4315	5684	7971	
2049	7	26	73	192	254	311	377	363	331	367	370	2634	4208	5476	7986	

Table 2.4-1
Projected Resident Population for Each Sector within 50-Mile (80-Kilometer) of the Project Site
(Sheet 4 of 7)

Year	0-0.3 (mi.)	0.3-1 (mi.)	1-2 (mi.)	2-3 (mi.)	3-4 (mi.)	4-5 (mi.)	5-6 (mi.)	6-7 (mi.)	7-8 (mi.)	8-9 (mi.)	9-10 (mi.)	10-20 (mi.)	20-30 (mi.)	30-40 (mi.)	40-50 (mi.)	Total 0-50 (mi)
2059	7	26	73	192	254	311	377	363	331	367	370	2635	4100	5273	8012	
2069	7	26	73	192	254	311	377	363	331	367	371	2636	3994	5077	8037	
2079	7	26	73	192	254	311	377	363	331	367	371	2637	3891	4888	8063	
South																
2020	16	63	136	224	395	494	753	1895	2954	3422	5311	60,802	82,247	20,273	11,188	
2034	18	71	153	252	444	555	845	2123	3305	3825	5933	67,927	90,952	22,244	12,251	
2039	18	74	159	262	463	578	880	2213	3445	3987	6184	70,730	93,939	22,893	12,603	
2049	19	80	172	284	501	626	952	2394	3727	4314	6691	76,383	99,913	24,187	13,303	
2059	21	86	186	306	540	675	1028	2584	4024	4658	7224	82,327	106,122	25,524	14,028	
2069	22	93	201	331	583	729	1109	2789	4344	5028	7800	88,732	112,715	26,935	14,792	
2079	23	100	217	357	629	787	1198	3011	4690	5429	8421	95,637	119,719	28,425	15,598	
SE																
2020	7	68	226	333	474	795	975	1057	1125	1546	2208	164,666	80,803	17,126	20,463	
2034	7	74	249	366	521	874	1072	1163	1237	1700	2429	181,114	88,860	18,829	24,348	
2039	7	76	259	382	543	911	1118	1212	1290	1772	2531	188,786	92,615	19,480	25,687	
2049	7	80	281	413	588	987	1210	1312	1397	1919	2741	204,430	100,272	20,783	28,316	
2059	7	84	303	447	636	1067	1308	1418	1509	2074	2962	220,933	108,348	22,139	31,109	
2069	7	88	328	483	687	1153	1414	1533	1631	2242	3202	238,769	117,074	23,583	34,178	
2079	7	93	354	522	743	1246	1528	1656	1763	2423	3460	258,044	126,504	25,122	37,549	

Table 2.4-1
Projected Resident Population for Each Sector within 50-Mile (80-Kilometer) of the Project Site
(Sheet 5 of 7)

Year	0-0.3 (mi.)	0.3-1 (mi.)	1-2 (mi.)	2-3 (mi.)	3-4 (mi.)	4-5 (mi.)	5-6 (mi.)	6-7 (mi.)	7-8 (mi.)	8-9 (mi.)	9-10 (mi.)	10-20 (mi.)	20-30 (mi.)	30-40 (mi.)	40-50 (mi.)	Total 0-50 (mi.)
SSE																
2020	12	63	164	324	486	885	1021	1131	1692	1885	1451	80,326	43,404	41,036	37,472	
2034	13	71	183	359	536	974	1123	1244	1861	2073	1596	88,350	47,000	43,545	39,763	
2039	13	74	191	374	559	1015	1171	1297	1940	2161	1664	92,092	48,550	44,456	40,595	
2049	14	80	207	405	605	1099	1268	1404	2101	2340	1801	99,723	51,679	46,279	42,260	
2059	14	86	223	437	653	1188	1370	1517	2270	2529	1947	107,774	54,934	48,149	43,967	
2069	15	93	241	472	706	1283	1480	1640	2453	2733	2104	116,474	58,394	50,093	45,743	
2079	15	100	260	510	763	1387	1600	1772	2651	2954	2274	125,877	62,072	52,117	47,590	
SSW																
2020	13	56	128	176	240	654	1349	2321	2083	1975	4036	61,487	36,486	49,063	62,754	
2034	14	63	144	198	270	735	1516	2609	2341	2220	4536	69,265	41,390	55,680	69,421	
2039	15	66	150	206	281	766	1580	2719	2440	2314	4728	72,120	42,949	57,773	71,719	
2049	15	71	162	223	304	829	1709	2941	2639	2503	5114	77,841	46,066	61,959	76,090	
2059	16	77	175	241	328	894	1845	3174	2849	2701	5519	83,848	49,324	66,334	80,841	
2069	16	83	189	260	354	965	1991	3426	3074	2915	5957	90,318	52,813	71,019	85,889	
2079	17	89	204	280	382	1042	2149	3697	3318	3146	6429	97,287	56,550	76,034	91,252	
SW																
2020	7	40	100	140	200	558	932	1143	856	1491	2509	135,721	73,108	22,183	23,619	
2034	7	44	112	157	225	627	1047	1285	962	1676	2820	152,538	83,002	25,561	27,159	
2039	7	46	117	164	234	654	1092	1339	1003	1747	2939	159,003	86,561	26,737	28,390	
2049	7	48	127	177	253	707	1181	1448	1085	1889	3179	171,971	93,684	29,086	30,746	

Table 2.4-1
Projected Resident Population for Each Sector within 50-Mile (80-Kilometer) of the Project Site
(Sheet 6 of 7)

Year	0-0.3 (mi.)	0.3-1 (mi.)	1-2 (mi.)	2-3 (mi.)	3-4 (mi.)	4-5 (mi.)	5-6 (mi.)	6-7 (mi.)	7-8 (mi.)	8-9 (mi.)	9-10 (mi.)	10-20 (mi.)	20-30 (mi.)	30-40 (mi.)	40-50 (mi.)	Total 0-50 (mi.)
2059	7	51	137	191	274	763	1275	1563	1171	2039	3431	185,603	101,171	31,562	33,278	
2069	7	54	148	207	295	824	1376	1687	1263	2201	3703	200,316	109,257	34,248	36,018	
2079	7	57	159	223	319	889	1485	1821	1364	2375	3997	216,195	117,988	37,164	38,984	
West																
2020	7	24	52	73	263	416	465	497	490	412	470	20,988	8785	13,615	21,963	
2034	7	26	55	78	280	444	498	534	528	445	508	22,790	8910	13,723	22,619	
2039	7	26	55	78	280	445	501	539	533	450	515	23,173	8923	13,723	22,906	
2049	7	26	56	78	281	447	507	547	543	459	526	23,866	8944	13,724	23,599	
2059	7	26	56	78	281	449	511	554	552	468	538	24,552	8965	13,724	24,374	
2069	7	26	56	78	281	450	516	562	562	478	550	25,257	8986	13,724	25,174	
2079	7	26	56	78	281	452	521	570	571	487	562	25,983	9007	13,725	26,001	
WNW																
2020	7	24	52	75	233	342	418	436	344	392	364	5946	12,953	34,291	11,199	
2034	7	26	55	80	248	364	445	464	366	417	387	6328	13,165	34,204	10,999	
2039	7	26	55	80	248	365	446	465	367	418	388	6341	13,172	34,180	10,953	
2049	7	26	56	80	249	365	446	465	367	418	389	6347	13,174	34,162	10,911	
2059	7	26	56	80	249	365	446	466	367	419	389	6348	13,175	34,145	10,872	
2069	7	26	56	80	249	365	446	466	367	419	389	6350	13,175	34,128	10,833	
2079	7	26	56	80	249	365	447	466	367	419	389	6352	13,176	34,111	10,794	

Table 2.4-1
Projected Resident Population for Each Sector within 50-Mile (80-Kilometer) of the Project Site
(Sheet 7 of 7)

Year	0-0.3 (mi.)	0.3-1 (mi.)	1-2 (mi.)	2-3 (mi.)	3-4 (mi.)	4-5 (mi.)	5-6 (mi.)	6-7 (mi.)	7-8 (mi.)	8-9 (mi.)	9-10 (mi.)	10-20 (mi.)	20-30 (mi.)	30-40 (mi.)	40-50 (mi.)	Total 0-50 (mi.)
WSW																
2020	7	24	72	123	186	241	386	467	457	481	618	56,409	21,718	16,205	12,998	
2034	7	26	78	136	208	271	434	525	514	541	695	63,398	23,051	17,391	16,032	
2039	7	26	80	141	216	282	452	547	535	564	724	66,086	23,469	17,730	17,058	
2049	7	26	82	149	233	305	489	592	579	609	783	71,476	24,275	18,372	19,059	
2059	7	26	85	158	250	330	528	639	625	658	845	77,141	25,087	19,014	21,184	
2069	7	26	88	167	268	356	570	689	675	710	912	83,256	25,927	19,679	23,546	
2079	7	26	91	177	288	384	615	744	728	766	984	89,856	26,794	20,368	26,171	
Year	**0-0.3 (mi.)**	**0.3-1 (mi.)**	**1-2 (mi.)**	**2-3 (mi.)**	**3-4 (mi.)**	**4-5 (mi.)**	**5-6 (mi.)**	**6-7 (mi.)**	**7-8 (mi.)**	**8-9 (mi.)**	**9-10 (mi.)**	**10-20 (mi.)**	**20-30 (mi.)**	**30-40 (mi.)**	**40-50 (mi.)**	**Total 0-50 (mi.)**
TOTAL																
2020	137	631	1623	2938	4570	7052	9363	12,186	13,953	16,366	22,574	675,829	489,683	411,723	363,977	2,032,605
2034	141	679	1744	3150	4905	7620	10,174	13,332	15,242	17,864	24,747	746,822	525,411	444,750	389,431	2,206,012
2039	142	692	1785	3221	5014	7819	10,465	13,755	15,734	18,443	25,591	775,801	539,025	455,852	399,494	2,272,833
2049	144	715	1866	3359	5237	8222	11,054	14,608	16,723	19,607	27,294	834,304	566,997	478,632	420,255	2,409,017
2059	147	740	1948	3504	5468	8645	11,672	15,504	17,762	20,833	29,085	895,842	596,506	502,727	442,510	2,552,893
2069	149	767	2037	3661	5716	9098	12,338	16,472	18,883	22,155	31,020	962,245	628,592	529,122	466,682	2,708,937
2079	151	795	2132	3828	5987	9589	13,060	17,514	20,092	23,581	33,105	1,033,899	663,429	558,016	492,932	2,878,110

Source: NCOSBM, 2023a; University of Virginia Weldon Cooper Center for Public Service, 2022; USCB, 2020
Note: Population estimates are rounded to the nearest whole number, accounting for potential discrepancies between the total value and the sum of individual distance bands.

Table 2.4-2
2020 Population within the ROI by Place
(Sheet 1 of 2)

County/Place[a]	2020 Population
Forsyth County	**382,590**
Berthania Town	344
Clemmons Village	21,163
Germanton CDP[b]	790
Kernersville Town[b]	26,449
Lewisville	13,381
Rural Hall Town	3,351
Tobaccoville Village[b]	2578
Walkertown Town	5692
Winston-Salem City	249,545
Guilford County	**541,299**
Forest Oaks CDP	4209
Gibsonville Town	8920
Greensboro City	299,035
High Point City[b]	114,059
Jamestown Town	3668
McLeansville CDP	1113
Oak Ridge Town	7474
Pleasant Garden Town	5000
Sedalia Town	676
Stokesdale Town	5924
Summerfield Town	10,951
Whitsett Town	584
Rockingham County	**91,096**
Eden City	15,241
Madison Town	2129
Mayodan Town	2418
Reidsville City	14,583
Ruffin CDP	322
Stoneville Town	1308
Wentworth Town	2662

Table 2.4-2
2020 Population within the ROI by Place
(Sheet 2 of 2)

County/Place[(a)]	2020 Population
Stokes County	**44,520**
Danbury Town	189
King City[(b)]	7197
Pinnacle	786
Walnut Cove Town	1586
ROI	**1,059,505**

Source: USCB, 2020
Notes:
(a) Per the USCB, "places" are categorized as cities, towns, or CDP.
(b) Place intersects two counties but is listed under the county where the majority of the population resides.
Key: CDP = Census Designated Place; ROI = region of influence; USCB = U.S. Census Bureau

Table 2.4-3
Historic and Projected Population within the ROI

	Forsyth County		Guilford County		Rockingham County		Stokes County		ROI	
Year	Population	Annual % Growth	Population	Annual % Growth	Population	Annual % Growth	Population	Annual % Growth	Population	Annual % Growth
Historic Population Data										
2000	306,067	–	421,048	–	91,928	–	44,711	–	863,754	–
2010	350,670	1.5%	488,406	1.6%	93,643	0.2%	47,401	0.6%	980,120	1.3%
2020	382,590	0.9%	541,299	1.1%	91,096	-0.3%	44,520	-0.6%	1,059,505	0.8%
Projected Population Data										
2030	416,948	0.9%	577,037	0.8%	91,571	>0.1%	47,168	0.6%	1,132,724	0.7%
2040	453,347	0.9%	629,975	0.9%	91,570	>0.1%	47,471	0.1%	1,219,453	0.8%
2050	490,117	0.8%	678,568	0.8%	91,573	0.0%	47,497	0.0%	1,307,755	0.7%
2060	529,191	0.8%	733,393	0.8%	91,573	0.0%	47,497	0.0%	1,401,654	0.7%
2070	571,380	0.8%	792,648	0.8%	91,573	0.0%	47,497	0.0%	1,503,098	0.7%
2079	612,218	0.8%	850,060	0.8%	91,573	0.0%	47,497	0.0%	1,601,348	0.7%

Source: USCB, 2000, 2010, 2020; NCOSBM, 2023a
Note: Population estimates are rounded to the nearest whole number, accounting for potential discrepancies between the total value and the sum of individual distance bands.
Key: ROI = region of influence

Table 2.4-4
2022 Age and Gender Distribution in the ROI and State

	Forsyth County		Guilford County		Rockingham County		Stokes County		ROI		North Carolina	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Age Group												
Under 5 years	21,950	5.7%	30,305	5.6%	4553	5.0%	1880	4.2%	58,733	5.5%	589,767	5.6%
5 to 14 years	49,445	12.9%	68,845	12.4%	10,411	11.4%	4613	10.3%	131,314	12.4%	1,289,272	12.3%
15 to 24 years	54,573	14.2%	84,822	15.7%	10,209	11.2%	5207	11.6%	154,811	14.6%	1,419,063	13.6%
25 to 44 years	96,500	25.1%	138,274	25.6%	20,307	22.3%	9184	20.5%	264,332	25.0%	2,716,388	25.9%
45 to 64 years	98,295	25.6%	135,453	25.1%	26,701	29.3%	14,037	31.4%	274,486	25.9%	2,707,799	25.9%
65 years and over	62,975	16.4%	83,813	15.5%	18,961	20.8%	9,775	21.9%	175,525	16.6%	1,747,925	16.7%
Total	**383,739**	**100%**	**539,557**	**100%**	**91,209**	**100%**	**44,696**	**100%**	**1,059,201**	**100%**	**10,470,214**	**100%**
Median Age (years)	38.4		37.2		45.1		47.4		38.7		39.1	
Gender												
Male	182,947	47.7%	256,731	47.6%	44,392	48.7%	21,931	49.1%	506,001	47.8%	5,131,370	49.0%
Female	200,792	52.3%	282,826	52.4%	46,817	51.3%	22,765	50.9%	553,200	52.2%	5,338,844	51.0%

Source: USCB, 2022
Key: ROI = region of influence

Table 2.4-5
2022 Household Income Distribution within the ROI

Income Range	Forsyth County	Guilford County	Rockingham County	Stokes County	ROI	North Carolina
Total Households	153,096	212,825	38,701	18,993	423,624	4,105,232
Less than $10,000	6.1%	5.9%	6.4%	3.6%	5.9%	5.1%
$10,000 to $14,999	4.6%	4.4%	7.1%	5.9%	4.8%	4.3%
$15,000 to $24,999	8.8%	7.8%	11.8%	9.4%	8.6%	8.1%
$25,000 to $34,999	10.0%	8.7%	9.5%	8.9%	9.3%	8.5%
$35,000 to $49,000	12.2%	14.1%	14.5%	14.9%	13.5%	12.3%
$50,000 to $74,999	17.0%	16.3%	17.3%	20.6%	16.8%	17.3%
$75,000 to $99,999	12.8%	12.7%	12.1%	15.4%	12.8%	12.9%
$100,000 to $149,999	14.9%	15.7%	14.2%	13.2%	15.2%	15.9%
$150,000 to $199,999	6.4%	6.5%	4.4%	5.1%	6.2%	7.2%
$200,000 or more	7.2%	7.8%	2.7%	3.0%	6.9%	8.5%
Median Household Income ($)	61,229	62,880	50,737	57,539	60,934	66,186
Mean Income ($)	86,880	90,034	68,574	75,020	86,260	92,878
Percentage of Population Below Poverty Level	15.2%	15.1%	18.8%	12.0%	15.3%	13.3%

Source: USCB, 2022
Key: ROI = Region of Influence

Table 2.4-6
2020 Racial and Ethnic Population Distribution within the ROI

Racial or Ethnic Category	Forsyth County	Guilford County	Rockingham County	Stokes County	ROI	North Carolina
Total population (persons)	382,590	541,299	91,096	44,520	1,059,505	10,439,388
White alone (Not Hispanic or Latino)	54.4%	47.2%	70.5%	89.0%	53.6%	60.5%
Racial and ethnic minorities	45.6%	52.8%	29.5%	11.0%	46.4%	39.5%
Hispanic or Latino	14.3%	9.6%	6.7%	3.3%	10.8%	10.7%
Black or African American	24.5%	33.1%	18.2%	3.6%	27.5%	20.2%
American Indian and Alaska Native	0.3%	0.4%	0.3%	0.3%	0.3%	1.0%
Asian	2.4%	5.3%	0.5%	0.4%	3.6%	3.3%
Native Hawaiian and Other Pacific Islander	0.1%	>0.1%	>0.1%	>0.1%	>0.1%	0.1%
Some other race	0.4%	0.5%	0.3%	0.2%	0.5%	0.4%
Multiracial	3.7%	3.8%	3.4%	3.3%	3.7%	3.9%

Source: USCB, 2020
Key: ROI = Region of Influence

Table 2.4-7
Historic and Projected Racial and Ethnic Minority Population within the ROI

	Forsyth County		Guilford County		Rockingham County		Stokes County		ROI	
Year	**Pop.**	**%**	**Pop.**	**%**	**Pop.**	**%**	**Pop.**	**%**	**Pop.**	**%**
Historic Population Data										
2010	**350,670**		**488,406**		**93,643**		**47,401**		**980,120**	
White alone	218,517	62.3	278,525	57.0	70,875	75.7	44,021	92.9	611,938	62.4
Aggregate minority	132,153	37.7	209,881	43.0	22,768	24.3	3380	7.1	368,182	37.6
2020	**382,590**		**541,299**		**91,096**		**44,520**		**1,059,505**	
White alone	208,517	54.4	255,640	47.2	64,218	70.5	39,609	89.0	567,593	53.6
Aggregate minority	174,464	45.6	285,659	52.8	26,878	29.5	4911	11.0	491,912	46.4
Projected Population Data										
2030	**416,948**		**577,037**		**91,571**		**47,168**		**1,132,724**	
White alone	222,233	53.3	251,588	43.6	63,459	69.3	41,319	87.6	578,599	51.1
Aggregate minority	194,715	46.7	325,449	56.4	28,112	30.7	5849	12.4	554,125	48.9
2040	**453,347**		**629,975**		**91,570**		**47,471**		**1,219,453**	
White alone	234,880	51.8	252,044	40.2	61,933	67.7	40,066	84.4	588,983	48.3
Aggregate minority	218,557	48.2	374,931	59.8	29,577	32.3	7405	15.6	630,470	51.7
2050	**490,117**		**678,568**		**91,573**		**47,497**		**1,307,755**	
White alone[(a)]	244,568	49.9	253,106	37.3	60,438	66.0	37,713	79.4	595,825	45.6
Aggregate minority[(b)]	245,549	50.1	425,462	62.7	31,135	34.0	9784	20.6	711,930	54.4

Source: USCB, 2020, 2010; NCOSBM, 2023b
Notes:
(a) "White alone" does not include those of Hispanic or Latino origin.
(b) "Aggregate minority" includes all those who are not "White alone" (i.e., those who identify as Hispanic and Latino, Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, some other race, or multiracial).
Key: Pop. = population; ROI = region of influence

Table 2.4-8
Transient Populations and Associated Facilities by Distance Band within 20 Miles (32 Kilometers)

	Airport		Daycare		Event Venue		Jail		Lodging		Major Employer		Medical/ Nursing		Public Recreation		School	
	Facility Count	Transient Population	Facility Count	Transient Population	Facility Count	Transient Population	Facility Count	Transient Population	Facility Count	Transient Population	Facility Count	Transient Population	Facility Count	Transient Population	Facility Count	Transient Population	Facility Count	Transient Population
0-0.3 (mi.)	–	–	–	–	1	175	–	–	–	–	–	–	–	–	–	–	–	–
0.3-1 (mi.)	–	–	–	–	–	–	–	–	1	306	–	–	–	–	1	144	–	–
1-2 (mi.)	–	–	–	–	1	120	–	–	1	252	2	23	1	6	4	484	1	126
2-3 (mi.)	–	–	–	–	1	125	–	–	–	–	1	23	–	–	2	189	1	102
3-4 (mi.)	–	–	2	118	–	–	–	–	–	–	8	754	1	60	1	–	1	444
4-5 (mi.)	1	123	5	240	–	–	–	–	3	258	15	469	2	153	–	–	2	593
5-6 (mi.)	3	21	1	54	–	–	–	–	1	102	4	171	1	60	1	45	2	245
6-7 (mi.)	–	–	8	582	–	–	–	–	2	66	15	578	–	–	1	100	4	1798
7-8 (mi.)	1	0	3	160	1	100	–	–	1	84	13	597	1	6	–	–	3	2009
8-9 (mi.)	1	0	11	864	2	150	–	–	2	14	35	2046	4	220	3	1184	11	5566
9-10 (mi.)	–	–	12	837	5	1150	–	–	4	663	32	3149	4	253	3	826	9	3887
10-20 (mi.)	2	4,723	–	–	1	200	5	2,392	1	384	325	121,531	3	2992	19	10,062	13	55,598
Total 0-20 (mi.)	**8**	**4867**	**42**	**2855**	**12**	**2020**	**5**	**2392**	**16**	**2,129**	**450**	**129,341**	**17**	**3750**	**35**	**13,034**	**47**	**70,368**

Notes:
Distance band developed from the Project site center point.
Transient population estimates are assumed to be representative of 2020 conditions.
"-" denotes values are not available.

Table 2.4-9
Employment Trends within the ROI

	2011	2022	Percent Change
Forsyth County			
Labor Force	175,075	189,556	8.3%
Employed	159,470	178,260	11.8%
Unemployed	15,293	10,536	-31.1%
Unemployment Rate	8.7%	5.6%	–
Guilford County			
Labor Force	256,934	278,662	8.5%
Employed	230,712	263,584	14.2%
Unemployed	25,793	14,457	-43.9%
Unemployment Rate	10.0%	5.2%	–
Rockingham County			
Labor Force	44,939	42,188	-6.1%
Employed	39,802	39,418	-1.0%
Unemployed	5061	2733	-46.0%
Unemployment Rate	11.3%	6.5%	–
Stokes County			
Labor Force	23,245	20,836	-10.4%
Employed	20,807	19,662	-5.5%
Unemployed	2438	1110	-54.5%
Unemployment Rate	10.5%	5.3%	–
ROI			
Labor Force	500,193	531,242	6.2%
Employed	453,229	500,924	10.5%
Unemployed	48,585	28,836	-40.6%
Unemployment Rate	9.7%	5.4%	–
North Carolina			
Labor Force	4,784,984	5,290,874	10.6%
Employed	4,241,650	4,925,500	16.1%
Unemployed	455,742	263,374	-42.2%
Unemployment Rate	9.5%	5.0%	–

Source: USCB, 2011, 2022
Note:
"-" denotes non-calculated values.
Key: ROI = region of influence

Table 2.4-10
Employment by Industry in the ROI
(Sheet 1 of 2)

	Forsyth County			Guilford County			Rockingham County			Stokes County			ROI			
Industry Type	**2011**	**2022**	**% Change**	**2011**	**2022**	**% Change**	**2011**	**2022**	**% Change**	**2011**	**2022**	**% Change**	**2011**	**2022**	**Percent of ROI Employment (2022)**	**% Change**
Civilian employed population 16 years and over	159,470	178,260	11.8%	230,712	263,584	14.2%	39,802	39,418	-1.0%	20,807	19,662	-5.5%	450,791	500,924		11.1%
Agriculture, forestry, fishing, hunting, and mining	476	653	37.2%	1,003	1,341	33.7%	670	415	-38.1%	271	123	-54.6%	2420	2532	0.5%	4.6%
Construction	10,594	11,889	12.2%	13,226	12,862	-2.8%	3073	3232	5.2%	1704	1673	-1.8%	28,597	29,656	5.9%	3.7%
Manufacturing	20,376	22,180	8.9%	29,595	33,384	12.8%	9626	7532	-21.8%	4796	3759	-21.6%	64,393	66,855	13.3%	3.8%
Wholesale trade	5126	3798	-25.9%	9415	8701	-7.6%	1286	790	-38.6%	558	590	5.7%	16,385	13,879	2.8%	-15.3%
Retail trade	16,762	19,711	17.6%	29,194	30,462	4.3%	4526	4199	-7.2%	2635	2235	-15.2%	53,117	56,607	11.3%	6.6%
Transportation, warehousing, and utilities	6653	8916	34.0%	11,757	18,469	57.1%	1922	2251	17.1%	1062	1040	-2.1%	21,394	30,676	6.1%	43.4%
Information	2784	1959	-29.6%	5311	3772	-29.0%	359	629	75.2%	316	250	-20.9%	8770	6610	1.3%	-24.6%
Finance and insurance, real estate, rental, and leasing.	12,083	12,971	7.3%	18,598	18,675	0.4%	1812	2112	16.6%	1030	656	-36.3%	33,523	34,414	6.9%	2.7%

Table 2.4-10
Employment by Industry in the ROI
(Sheet 2 of 2)

	Forsyth County			Guilford County			Rockingham County			Stokes County			ROI			
Industry Type	**2011**	**2022**	**% Change**	**2011**	**2022**	**% Change**	**2011**	**2022**	**% Change**	**2011**	**2022**	**% Change**	**2011**	**2022**	**Percent of ROI Employment (2022)**	**% Change**
Professional, scientific management and administration, and waste management services	15,586	19,438	24.7%	20,795	27,135	30.5%	2755	3199	16.1%	1405	1732	23.3%	40,541	51,504	10.3%	27.0%
Educational services, health care, and social assistance	42,877	48,422	12.9%	52,199	64,573	23.7%	8247	8351	1.3%	4098	4096	0.0%	107,421	125,442	25.0%	16.8%
Arts, entertainment, recreation, accommodation and food services	13,794	14,902	8.0%	22,482	23,514	4.6%	2190	3029	38.3%	1376	1207	-12.3%	39,842	42,652	8.5%	7.1%
Other services, except public administration	7732	8411	8.8%	10,717	12,788	19.3%	1982	2267	14.4%	856	1385	61.8%	21,287	24,851	5.0%	16.7%
Public administration	4627	5010	8.3%	6420	7908	23.2%	1354	1412	4.3%	700	916	30.9%	13,101	15,246	3.0%	16.4%

Source: USCB, 2011, 2022
Key: ROI = region of influence

Table 2.4-11
Top Employers Located in the ROI
(Sheet 1 of 2)

Company	Total Employees	Description
Forsyth County		
Wake Forest University Baptist Medical	1000+	Health Care and Social Assistance
Winston-Salem Forsyth County School	1000+	Educational Services
Forsyth Memorial Hospital Inc	1000+	Health Care and Social Assistance
Novant Health Inc	1000+	Health Care and Social Assistance
Wake Forest University	1000+	Educational Services
Wal-Mart Associates Inc.	1000+	Retail Trade
Hanesbrands, Inc	1000+	Transportation and Warehousing
City of Winston-Salem	1000+	Public Administration
Forsyth County	1000+	Public Administration
GMAC Insurance Management Corp	1000+	Finance and Insurance
Wells Fargo Bank, National Association (A Corp)	1000+	Finance and Insurance
Wake Forest University School of Medicine	1000+	Educational Services
Amazon.com Services Inc	1000+	Transportation and Warehousing
B E Aerospace	1000+	Manufacturing
Congruity HR	1000+	Administrative and Support and Waste Management and Remediation Services
Truist	1000+	Finance and Insurance
R J Reynolds Tobacco Company	1000+	Manufacturing
Axcess Staffing Services LLC	1000+	Administrative and Support and Waste Management and Remediation Services
Food Lion	1000+	Retail Trade
Forsyth Technical College	1000+	Educational Services
Guilford County		
Guilford County Board of Education	1000+	Educational Services
Cone Health	1000+	Health Care and Social Assistance
City Of Greensboro	1000+	Public Administration
University of North Carolina at Greensboro	1000+	Educational Services
U.S. Postal Service	1000+	Transportation and Warehousing
United Parcel Service Inc	1000+	Transportation and Warehousing
Guilford County Government	1000+	Public Administration
Wal-Mart Associates Inc.	1000+	Retail Trade
Wake Forest University Baptist Medicine	1000+	Health Care and Social Assistance
Harris Teeter	1000+	Transportation and Warehousing

Table 2.4-11
Top Employers Located in the ROI
(Sheet 2 of 2)

Company	Total Employees	Description
NC Agricultural and Technical State University	1000+	Educational Services
Volvo Group North America LLC	1000+	Wholesale Trade
FedEx Ground Package System Inc	1000+	Transportation and Warehousing
Food Lion	1000+	Retail Trade
Thomas Built Buses Inc	1000+	Manufacturing
City of High Point	1000+	Public Administration
Qorvo U.S.Inc.	1000+	Manufacturing
Truist	1000+	Management of Companies and Enterprises
Bank of America, National Association	1000+	Finance and Insurance
Procter & Gamble Manufacturing Co.	1000+	Manufacturing
Charter Communications LLC	1000+	Information
Adecco USA	1000+	Administrative and Support and Waste Management and Remediation Services
Haeco Airframe Services LLC	1000+	Transportation and Warehousing
Rockingham County		
Rockingham County Consolidated School System	1000+	Educational Services
Wal-Mart Associates Inc.	1000+	Retail Trade
Stokes County		
Stokes County Schools	500-999	Educational Services

Source: NCDOC, 2023
Note: For all counties except Stokes County, major employers are classified as businesses with 1000 or more employees. There are no businesses in Stokes County with over 1000 employees.
Key: Co. = Company; Corp. = Corporation; LLC = limited liability corporation; Inc. = incorporated; NC = North Carolina; ROI = region of influence

Table 2.4-12
Per Capita Income Trends in the ROI and State

Geographic Area	2011	2022	Percentage Change	Annual Average Growth (Percent)
Forsyth County	$26,424	$35,600	34.7%	3.2%
Guilford County	$26,644	$36,563	37.2%	3.4%
Rockingham County	$20,861	$29,239	40.2%	3.7%
Stokes County	$21,021	$32,601	55.1%	5.0%
North Carolina	$25,256	$37,641	49.0%	4.5%

Source: USCB 2011, 2022
Note: All dollar estimates are in thousands of dollars (adjusted for inflation for 2011 and 2022).
Key: ROI = region of influence

Table 2.4-13
Primary Roads Characteristics
(Sheet 1 of 2)

Primary Roads	Number of Lanes	Roadway Functional Classification	AADT	AADT Year
U.S. 158 (S of Belews Creek Road)	2	Other Principal Arterial	7400	2021
U.S. 311 (S of NC Highway 65)	2	Minor Arterial	3400	2021
U.S. 311 (N of NC Highway 65)	2	Minor Arterial	3400	2021
NC 65 (between Belews Creek Road and Pine Hall Road)	2	Minor Arterial	4000	2021
Pine Hall Road (S of NC 65)	2	Major Collector	1400	2021
Pine Hall Road (N of NC 65)	2	Local Roadway/Minor Collector	1700	2019
Belews Creek Road (W of NC 65)	2	Minor Arterial	1700	2021
Belews Creek Road (between Craig and NC 65)	2	Minor Arterial	1700	2021
Belews Creek Road (E of Craig Road)	2	Minor Collector	3800	2021
Fisherman Road	2	Minor Collector	1200	--
Hawkins Farm Road	2	Minor Collector	1200	--
Martin Luther King Jr. Road	2	Local Roadway	800	2022
Craig Road	2	Local Roadway	900	2019
NC 68 (N of U.S. 158)	2	Other Principal Arterial	6400	2021
U.S. 220 Hwy (N of NC 68	4	Other Principal Arterial	27,000	2021
U.S. 220 Hwy (S of NC 65)	4	Other Principal Arterial	27,000	2021

Table 2.4-13
Primary Roads Characteristics
(Sheet 2 of 2)

Primary Roads	Number of Lanes	Roadway Functional Classification	AADT	AADT Year
NC 68 (S of U.S. 158)	2	Other Principal Arterial	6,400	2021
U.S. 158 (between Belews Creek Road and NC 68)	2	Other Principal Arterial	9700	2021
U.S. 158 (E of NC 68)	2	Other Principal Arterial	9700	2021
NC 65 (between Pine Hall S and Pine Hall N)	2	Minor Arterial	4000	2021
NC 65 (between Pine Hall N and US 311)	2	Minor Arterial	4000	2021

Source: NCDOT, 2024a, 2024b
Key: AADT = Average Annual Daily Traffic; E = east; N = north; NC = North Carolina; S = south; US = United States; W = west; "--"=Year not available.

Table 2.4-14
Total Tax Revenues in the ROI

Fiscal Year	Forsyth County	Guilford County	Rockingham County	Stokes County
2019–2020	$365,823,314	$507,029,466	$74,900,522	$41,799,397
2020–2021	$398,769,866	$530,170,362	$77,598,605	$44,863,097
2021–2022	$418,261,699	$560,816,582	$84,784,282	$49,236,236
2022–2023	$428,066,788	$677,711,375	$90,046,462	$51,965,565

Source: Forsyth County, 2023; Guilford County, 2023; Rockingham County, 2023; Stokes County, 2021; Stokes County, 2023
Note: Total tax revenues include property tax, sales tax, occupancy tax, and other taxes.

Table 2.4-15
Tax Rates by County (2024)
(Sheet 1 of 4)

Taxing Unit	County	City	Other Entity
Forsyth County	0.6778		
Winston-Salem		0.725	
High Point		0.6475	
Kernersville		0.584	
King		0.47	
Rural Hall		0.34	
Walkertown		0.20	
Bethania		0.30	
Clemmons		0.15	
Lewisville		0.217	
Tobaccoville		0.05	
Winston-Salem (Business Improvement)			0.09
Countywide Fire Service District			0.0039
Beesons Crossroads			0.095
Beesons Crossroads Service District			0.095
Belews Creek			0.11
City View			0.1
Clemmons			0.08
Forest Hill			0.12
Griffith			0.11
Gumtree			0.1225
Horneytown			0.15
King			0.085
Lewisville			0.09
Mineral Springs			0.12
Mineral Springs Service District			0.12
Mount Tabor			0.085
Old Richmond			0.115
Piney Grove			0.14
Salem Chapel			0.14
South Fork			0.08
Suburban (Rural Hall)			0.105

Table 2.4-15
Tax Rates by County (2024)
(Sheet 2 of 4)

Taxing Unit	County	City	Other Entity
Talleys Crossing			0.1
Triangle			0.092
Union Cross			0.135
Vienna			0.085
Walkertown (Northeast)			0.1
West Bend			0.09
Guilford County	0.7305		
Archdale		0.3100	
Burlington		0.4836	
Gibsonville		0.490	
Greensboro		0.6725	
High Point		0.6175	
Jamestown		0.5850	
Kernsville		0.5590	
Oak Ridge		0.0800	
Pleasant Garden		0.0800	
Sedalia		0.275	
Stokesdale		0	
Summerfield		0.0275	
Whitsett		0.1500	
Gibsonville Rural Fire District			0.0774
Guilford College Fire District			0.1000
Kimsville Fire District			0.0890
Stokesdale Fire District			0.1250
Dunleath Historic District			0.0500
Greensboro Downtown Improvement District			0.0900
College Hill Historic District			0.0100
Sedgefield Sanitary District			0.0377
Horneytown Fire Protection Service District #1			0.1500
PTIA Fire Protection Service District			0.0495

Table 2.4-15
Tax Rates by County (2024)
(Sheet 3 of 4)

Taxing Unit	County	City	Other Entity
Climax Fire Protection Service District			0.1763
Guil-Rand Fire Protection Service District			0.1466
District 13 Fire Protection Service District			0.1600
District 14 Fire Protection Service District			0.0982
District 18 (Deep River) Fire Service District			0.1241
Colfax Fire Protection Service District			0.1359
Summerfield Fire Protection Service District			0.131
Guilford College Fire Protection District			0.0500
Pinecroft-Sedgefield Fire Protection Service District			0.1372
Northeast Fire Protection Service District			0.1599
District 28 (Frieden's) Fire Protection Service District			0.1590
Mcleansville Fire Protection Service District			0.1650
Pleasant Garden Fire Protection Service District			0.1688
Whitsett Fire Protection Service District			0.0927
Alamance Fire Protection Service District			0.1555
Julian Fire Protection Service District			0.1214
Mount Hope Fire Protection Service District			0.0800
Oak Ridge Fire Protection Service District			0.1227
Southeast Fire Protection Service District			0.1575
Rockingham County	0.5801		
Reidsville		0.660	
Eden		0.520	
Madison		0.700	
Mayodan		0.665	
Stoneville		0.690	
Downtown Reidsville		0.250	
Eden Draper Village		0.100	
Eden Old Leaksville		0.100	

Table 2.4-15
Tax Rates by County (2024)
(Sheet 4 of 4)

Taxing Unit	County	City	Other Entity
Eden The Boulevard		0.100	
Wentworth Fire District			0.0628
Stokesdale Fire District			0.1094
Bethany Fire District			0.0807
Northwest Fire District			0.0807
Huntsville Fire District			0.0819
Oregon Hill Fire District			0.0489
Shiloh Fire District			0.0696
Monroeton Fire District			0.0710
Williamsburg Fire District			0.0825
Summerfield Fire District			0.0659
Yanceyville Fire District			0.0606
Stoneview Fire District			0.0780
Casville Fire District			0.0711
Jacobs Creek Fire District			0.0848
Madison/Mayodan Fire District			0.0901
Stokes/Rockingham Fire District			0.0558
Ruffin Fire District			0.0923
Draper			0.061
Leaksville			0.0677
Stokes County	0.67		
City of King		0.47	
Town of Walnut Cove		0.40	
Town of Danbury		0.27	
Edu Debt Bldg Fund			
King Fire District			0.10
Rural Hall Fire District			0.08
Walnut Cove Fire District			0.10
Service District Fire District			0.10

Source: Forsyth County, 2024; Guilford County, 2024c; Rockingham County, 2024a; Stokes County, 2024
Note: Tax rates are per $100.00 assessed valuation.

Table 2.4-16
Housing in the ROI (2022)

County	Total Housing Units	Number Occupied	Percent Occupied	Number Owner Occupied	Percent Owner Occupied	Number Renter Occupied	Percent Renter Occupied
Forsyth County	171,040	153,096	89.5%	94,800	61.9%	58,296	38.1%
Guilford County	233,332	212,825	91.2%	126,702	59.5%	86,123	40.5%
Rockingham County	43,586	38,710	88.8%	27,615	71.3%	11,095	28.7%
Stokes County	21,285	18,993	89.2%	14,780	77.8%	4213	22.2%
ROI	469,243	423,624	90.3%	263,897	62.3%	159,727	37.7%
North Carolina	4,739,881	4,105,232	86.6%	2,717,961	66.2%	1,387,271	33.8%

Source USCB, 2022
Key: ROI = region of influence

Table 2.4-17
Median Mortgage and Rental Costs in the ROI (2022)

	Median Mortgage Cost per Month	Median Rent Cost per Month
Forsyth County	$1390	$969
Guilford County	$1434	$1049
Rockingham County	$1144	$743
Stokes County	$1196	$784
ROI	$1291	$886
North Carolina	$1496	$1093

Source USCB, 2022
Key: ROI = region of influence

Table 2.4-18
Vacant Housing in the ROI (2022)

	Vacant Units		For Rent		For Sale		For Seasonal, Recreational, or Occasional Use		Other Vacant		All Other Classifications of Vacant	
	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent
Forsyth County	17,944	10.5%	5531	30.8%	1401	7.8%	1342	7.5%	8724	48.6%	946	5.3%
Guilford County	20,507	8.8%	5405	26.4%	1404	6.8%	1448	7.1%	10,256	50.0%	1994	9.7%
Rockingham County	4876	11.2%	443	9.1%	251	5.1%	364	7.5%	3477	71.3%	341	7.0%
Stokes County	2292	10.8%	76	3.3%	351	15.3%	754	32.9%	996	43.5%	115	5.0%
ROI	45,619	9.7%	11,455	25.1%	3407	7.5%	3908	8.6%	23,453	51.4%	3396	7.4%
North Carolina	634,649	13.4%	103,964	16.4%	38,371	6.0%	194,988	30.7%	249,387	39.3%	47,939	7.6%

Source: USCB, 2022
Note: “Other Vacant” Includes rented, not occupied; sold, not occupied; and for migrant workers.
Key: ROI = region of influence

Table 2.4-19
Number of Structures Built by Decade in the ROI

	Forsyth County	Guilford County	Rockingham County	Stokes County	ROI	Percent Built by Decade
Built 2020 to 2022	849	1099	102	90	2140	0.5%
Built 2010 to 2019	15,363	21,894	2230	1127	40,614	8.7%
Built 2000 to 2009	25,181	39,343	5501	3187	73,212	15.6%
Built 1990 to 1999	25,326	39,001	6841	4076	75,244	16.0%
Built 1980 to 1989	24,741	33,045	5869	3364	67,019	14.3%
Built 1970 to 1979	27,432	31,667	7156	4654	70,909	15.1%
Built 1960 to 1969	17,962	24,491	4540	1985	48,978	10.4%
Built 1950 to 1959	16,942	21,195	4515	1033	43,685	9.3%
Built 1940 to 1949	6210	8631	3026	671	18,538	4.0%
Built 1939 or earlier	11,034	12,966	3806	1098	28,904	6.2%
Total housing units	**171,040**	**233,332**	**43,586**	**21,285**	**469,243**	

Source USCB, 2022
Key: ROI = region of influence

Table 2.4-20
Residential Building Permits Issued in the ROI
(Sheet 1 of 2)

	2010	2020	Percent Change 2010-2020	2021	2022	2023	Percent Change 2020-2023
Forsyth County							
Single Family	755	2890	283%	2427	2394	2022	-30%
Multifamily	22	1	-95%	14	42	49	4800%
Number of Multifamily Units	278	28	-90%	268	1430	1432	5014%
Total Permits	777	2891	272%	2441	2436	2071	-28%
Guilford County							
Single Family	881	1660	88%	1865	1495	1668	0%
Multifamily	77	29	-62%	61	44	42	45%
Number of Multifamily Units	599	906	51%	1363	828	1113	23%
Total Permits	958	1689	76%	1926	1539	1710	1%
Rockingham County							
Single Family	103	205	99%	243	270	279	36%
Multifamily	1	2	100%	3	0	0	-100%
Number of Multifamily Units	2	4	100%	6	0	0	-100%
Total Permits	104	207	99%	246	270	279	35%
Stokes County							
Single Family	40	110	175%	180	172	191	74%
Multifamily	0	1	--	0	0	0	--
Number of Multifamily Units	0	2	--	0	0	0	--
Total Permits	40	111	178%	180	172	191	72%
ROI							

Table 2.4-20
Residential Building Permits Issued in the ROI
(Sheet 2 of 2)

	2010	2020	Percent Change 2010-2020	2021	2022	2023	Percent Change 2020-2023
Single Family	1779	4865	173%	4715	4331	4160	-14%
Multifamily	100	33	-67%	78	103	91	176%
Number of Multifamily Units	879	940	7%	1637	2793	2545	171%
Total Permits	1879	4898	161%	4793	4804	4251	-13%

Source USCB, 2024b
Notes:
(a) Multifamily housing is defined as residential buildings containing units built one on top of another and those built side-by-side which do not have a ground-to-roof wall and/or have common facilities.
(b) Single-family dwelling is defined as fully detached, semidetached, row houses, and townhouses. In cases of attached units, each must be separated from the adjacent unit by a ground-to-roof wall.
Key: ROI = region of influence; "--" = not available

Table 2.4-21
Public Water Supply Systems and Capacities for Counties in the ROI

	Population Served	Total Available Supply (mgd)	Service Area Demand	Total Demand (Service Area Demand / Sales / Future Sales)	Demand as Percent of Supply
Stokes County					
City of King	23,198	50	1.694	1.694	3%
Town of Walnut Cove	2210	0.46	0.3066	0.3066	67%
Forsyth County					
Abington	NA	NA	NA	NA	NA
City of Winston-Salem	374,403	133	36.6723	37.0323	28%
Guilford County					
City of High Point	116,065	37.0565	13.7975	14.1754	38%
Town of Jamestown	6543	1.775	0.493	0.493	28%
Town of Stokesdale	1143	0.5	0.17	0.17	34%
City of Greensboro	318,057	49.93	34.7913	0.091	70%
Town of Gibsonville	8920	2.5	0.6102	0.6102	24%
Rockingham County					
Town of Madison	2116	16.1	0.395	0.459	3%
Town of Mayodan	2418	10	0.566	0.746	7%
Dan River Water Inc.	NA	NA	NA	NA	NA
City of Eden	15,023	24.17	3.155	4.211	17%
City of Reidsville	14,087	19	3.5773	4.641	24%

Source: USEPA, 2023b; NCDEQ, 2023c
Note: Water systems serving 1,000 individuals or more included.
Key: mgd = million gallons per day; NA = Not Available; ROI = region of influence

Table 2.4-22
Public Wastewater Treatment Facilities in the ROI

Wastewater Treatment System	Population Served	Total Design Flow (mgd)	Existing Total Flow (mgd)	Existing Flow as Percent of Design	Excess Capacity (mgd)
Stokes County					
Danbury WWTP	270	0.1	0.012	12.0%	0.09
Walnut Cove WWTP	1516	0.5	0.09	18.0%	0.41
Rockingham County					
Mebane Bridge (Eden) WWTP	16,000	13.5	6.7	49.6%	6.80
Reidsville WWTP	16,140	7.5	3.54	47.2%	3.96
Mayodan WWTP	5,881	4.5	1.333	29.6%	3.17
Guilford County					
High Point Eastside WWTP	75,103	26	8.23	31.7%	17.77
North Buffalo WWTP	83,043	16	14.3	89.4%	1.70
T.Z. Osbourne WWTP	155,000	40	21.9	54.8%	18.10
Forsyth County					
Archie Elledge WWTP	124,272	30	23.55	78.5%	6.45
Lower Muddy Creek WWTP	86,415	21	14.3	68.1%	6.70

Source: USEPA, 2012b
Note: Water systems serving 1,000 individuals or more included.
Key: mgd = million gallons per day; ROI = region of influence; WWTP = wastewater treatment plant

Table 2.4-23
Law Enforcement in 2019 in the ROI and State

Geographic Area	Law Enforcement Officers	Officer to Resident Ratio	Officers per 1,000 Residents
Stokes County	73	1: 610	1.6
Forsyth County	805	1: 475	2.1
Rockingham County	225	1:405	2.5
Guilford County	1276	1:424	2.4
ROI	2379	1:445	2.2
North Carolina	23,966	1:436	2.3

Source: FBI, 2019; USCB, 2020
Key: ROI = region of influence

Table 2.4-24
Fire Protection Services in the ROI
(Sheet 1 of 3)

Fire Protection Service	Number of Fire Fighters[a]	Ratio[b]
Forsyth County	**1125**	**1:340**
Beeson Crossroads Volunteer Fire & Rescue, Inc.	45	
Belews Creek Volunteer Fire & Rescue Department, Inc.	29	
City of Winston-Salem Fire Department	377	
City View Volunteer Fire Department, Inc.	42	
Forest Hill Volunteer Fire Department and Rescue	25	
Forsyth County Fire Department	28	
Griffith Volunteer Fire Department	41	
Horneytown Fire Department	28	
Kernersville Fire Rescue Department	92	
Lewisville Fire Department	50	
Mineral Springs Volunteer Fire & Rescue, Inc.	35	
Old Richmond Volunteer Fire Department and Rescue Squad, Inc.	40	
Piney Grove Volunteer Fire & Rescue Department, Inc.	33	
Rural Hall Fire Department	28	
Salem Chapel Volunteer Fire Department	32	
The Clemmons Fire Department	65	
Union Cross Fire Rescue	30	
Vienna Volunteer Fire Department Inc	43	
Walkertown Fire Department	62	
Guilford County	**1,470**	**1:368**
Alamance Community Fire District, Inc.	46	
Climax Fire Department	46	
Colfax Fire Department	46	
Fire District #13, Inc.	55	
Fire District 28	25	
Gibsonville Fire Department	32	
Greensboro Fire Department	441	
Guilford County Fire Marshal	52	
High Point Fire Department	233	
McLeansville Fire Department	47	
Mount Hope Community Fire Department	53	
Northeast Guilford Volunteer Fire Department, Inc.	48	
Oak Ridge Fire & Rescue Company	62	

Table 2.4-24
Fire Protection Services in the ROI
(Sheet 2 of 3)

Fire Protection Service	Number of Fire Fighters[a]	Ratio[b]
Piedmont Triad Airport Authority Fire Rescue Department	17	
Pinecroft-Sedgefield Fire District, Inc.	70	
Pleasant Garden Fire Department, Inc.	29	
Southeast Fire Department	33	
Stokesdale Fire District, Inc.	38	
Summerfield Fire District, Inc.	73	
Whitsett Fire Department	24	
Rockingham County	**580**	**1:157**
Bethany Fire Department	53	
Cherry Grove Volunteer Fire Department	25	
City of Reidsville Fire Department	38	
Draper Volunteer Fire Department	34	
Eden Fire Department	68	
Huntsville Volunteer Fire Department	22	
Jacobs Creek Fire Tax District, Inc.	28	
Leaksville Volunteer Fire Department	28	
Madison Fire Department	21	
Mayodan Fire Department	22	
North Stoneyview Volunteer Fire Department	19	
Oregon Hill Volunteer Fire Department	33	
Ruffin Volunteer Fire Department	30	
Shiloh Fire Department	42	
Stoneville Fire Department	30	
Wentworth Volunteer Fire Department	25	
Williamsburg Fire and Rescue	33	
Yanceyville Road Volunteer Fire Department	29	
Stokes County	**361**	**1:123**
Double Creek Volunteer Fire Department	27	
Fire Department - City of King	39	
Francisco Volunteer Fire Department Inc.	29	
Lawsonville Volunteer Fire Department	38	
Northeast Stokes Volunteer Fire Department & Rescue Squad	28	
South Stokes Volunteer Fire Department, Inc.	45	
Stokes-Rockingham Volunteer Fire Department & Rescue Services, Inc.	35	
The Pinnacle Volunteer Fire and Rescue, Inc.	29	

Table 2.4-24
Fire Protection Services in the ROI
(Sheet 3 of 3)

Fire Protection Service	Number of Fire Fighters[a]	Ratio[b]
The Sauratown Volunteer Fire Department, Inc.	30	
Walnut Cove Volunteer Fire Department	33	
Westfield Volunteer Fire Department	28	
ROI Total	**3536**	**1:300**

(a) Includes career, volunteer, and paid per call firefighters.
(b) Ratio=firefighter-to-citizen and is calculated using USCB 2020 population data.
Source: USFA, 2024; USBC 2020
Key: ROI = region of influence

Table 2.4-25
Hospitals in the ROI

Facility	Number of Beds
Forsyth County	**1940**
North Carolina Baptist Hospital	885
Novant Health Forsyth Medical Center	978
Novant Health Medical Park Hospital	9
Novant Health Rehabilitation Hospital	68
Guilford County	**1365**
Cone Health	883
High Point Regional Health	351
Kindred Hospital - Greensboro	101
Select Specialty Hospital - Greensboro	30
Rockingham County	**231**
Annie Penn Hospital	110
UNC Rockingham Hospital	121
Stokes County	**59**
LifeBrite Community Hospital of Stokes	59
ROI Total	**3595**

Source: North Carolina Department of Health and Human Services (NCHHS), 2024a.
Note: "Number of beds" includes beds used for general, psych, abuse, rehab, and hospice.
Key: ROI = region of influence

Table 2.4-26
Adult Care Homes and Nursing Homes in the ROI

Facility	Number of Beds
Forsyth County	**176**
Mill Creek Center for Nursing and Rehabilitation	14
Brookridge Retirement Community	36
Salemtowne	20
Arbor Acres United Methodist Retirement Community, Inc.	106
Guilford County	**413**
Blumenthal Health and Rehabilitation Center	20
Countryside	16
Friends Homes at Guilford	60
WhiteStone: A Masonic and Eastern Star Community	36
Maryfield Nursing Home	36
Well-Spring	72
Friends Homes West	40
Maple Grove Health and Rehabilitation Center	40
River Landing at Sandy Ridge	56
Heartland Living & Rehab at The Moses H. Cone Memorial Hospital	37
Rockingham County	**131**
Penn Nursing Center	10
UNC Rockingham Hospital	121
Stokes County	**44**
King Health and Rehabilitation Center	24
Village Care of King	20
ROI Total	**764**

Source: NCHHS, 2024b
Key: UNC – University of North Carolina; ROI = region of influence

Table 2.4-27
Physicians and Dentists in the ROI

	Population	Number of Physicians	Ratio of Physicians to Residents	Number of Dentists	Ratio of Dentists to Residents
Forsyth County	389,157	439	886	255	1526
Guilford County	546,101	438	1247	333	1640
Rockingham County	91,957	28	3284	35	2627
Stokes County	45,175	12	3765	7	6454
ROI	**1,072,390**	**917**	**1169**	**630**	**1702**

Source: County Health Rankings, 2024a, 2024b
Key: ROI = region of influence

Table 2.4-28
Schools in the ROI (For the 2022–2023 Public School Year and 2021–2022 Private School Year)

	Total Number of Schools	Student Enrollment	Teachers (FTEs)[a]	Student-to-Teacher Ratio
Forsyth County				
Public Schools	87	56,563	3,747.7	15.1
Private Schools	14	3533	280.5	12.6
Guilford County				
Public Schools	140	78,961	4,977.1	15.9
Private Schools	24	5404	565.5	9.6
Rockingham County[b]				
Public Schools	25	12,177	786.3	15.5
Private Schools	5	428	40.4	10.6
Stokes County				
Public Schools	19	5,606	378.6	14.8
Private Schools	1	227	16.6	13.7
ROI				
Public Schools	271	153,307	9,889.7	15.5
Private Schools	44	9592	903	10.6
North Carolina				
Public Schools	2740	1,541,722	98,631.3	15.6
Private Schools	542	107,651	10,168.7	10.6

Source: National Center for Education Statistics (NCES), 2023
Note:
(a) "FTE" includes part-time workers are reported as a fraction of one full-time worker.
(b) One school in this county did not have data that met NCES data quality standards.
Key: FTE = Full-Time Equivalent Employee; NCES = National Center for Education Statistics; ROI = region of influence

Table 2.4-29
Universities and Colleges in the ROI

Location	Type	Student Population
Forsyth County		**24,750**
Carolina Christian College	4-year, Private not-for-profit	70
Carolina University	4-year, Private not-for-profit	826
Salem College	4-year, Private not-for-profit	469
Winston-Salem State University	4-year, Public	5004
Wake Forest University	4-year, Private not-for-profit	8963
University of North Carolina School of the Arts	4-year, Public	1104
Forsyth Technical Community College	2-year, Public	8270
Guilford County		**46,306**
ECPI University-Greensboro	4-year, Private for-profit	N/A
Guilford College	4-year, Private not-for-profit	1167
South University-High Point	4-year, Private for-profit	51
Guilford Technical Community College	2-year, Public	10,067
Strayer University-North Carolina	4-year, Private for-profit	3074
University of North Carolina at Greensboro	4-year, Public	17,978
North Carolina Agricultural and Technical State University	4-year, Public	11,833
Bennett College	4-year, Private not-for-profit	168
Greensboro College	4-year, Private not-for-profit	826
Rockingham County		**1712**
Rockingham Community College	2-year, Public	1712
ROI		**72,768**

Source: NCES, 2024
Note:
(a) Stokes County does not have any universities or colleges.
(b) “NA” Graduation rate, transfer-out rate and the net price are not applicable to institutions that do not have full-time, first-time degree-seeking undergraduate students in the applicable cohort year or the financial aid year.
Key: ECPI = East Coast Polytechnical Institute; NA = Not Applicable; ROI = region of influence

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Table 2.4-30
Students Enrolled in Schools in the ROI and State

	Forsyth County	Guilford County	Rockingham County	Stokes County	ROI	North Carolina
Nursery School, Preschool	4723	6315	615	459	12,112	136,564
Kindergarten	4254	6237	1367	673	12,531	126,228
Grade 1 to grade 4	19,064	25,750	3910	1792	50,516	487,498
Grade 5 to grade 8	20,333	27,835	4489	1607	54,264	528,462
Grade 9 to grade 12	21,425	29,212	4692	2346	57,675	535,287
College, undergraduate	21,564	45,144	3088	1301	71,097	555,345
Graduate or professional school	6473	8927	452	311	16,163	133,180
Total	**97,836**	**149,420**	**18,613**	**8489**	**274,358**	**2,502,564**

Source: USCB, 2022
Key: ROI = region of influence

Table 2.4-31
Educational Attainment within the ROI and State

	Forsyth County		Guilford County		Rockingham County		Stokes County		ROI		North Carolina	
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total
Population 25 years and over	257,771		357,540		66,036		32,996		714,343		7,172,112	
High school graduate (includes equivalency)	64,070	24.9%	81,118	22.7%	23,110	35%	12,618	38.2%	180,906	25.3%	1,804,406	25.2%
Some college, no degree	52,129	20.2%	72,916	20.4%	14,960	22.7%	7435	22.5%	147,440	20.6%	1,460,120	20.4%
Associate's degree	22,768	8.8%	32,509	9.1%	6963	10.5%	3494	10.6%	65,734	9.2%	720,557	10%
Bachelor's degree	55,140	21.4%	85,562	23.9%	6974	10.6%	3471	10.5%	151,147	21.2%	1,533,552	21.4%
Graduate or professional degree	35,877	13.9%	50,028	14%	3224	4.9%	1848	5.6%	90,977	12.7%	895,338	12.5%

Source: USCB, 2022
Key: No. = number; ROI = region of influence

2.5 NOT USED

Deleted (Executive Order, 2025a, 2025b).

2.6 HISTORIC PROPERTIES

As defined by the National Historic Preservation Act (NHPA) of 1966, as amended (54 USC §306108) and its implementing regulations 36 CFR 800.16(l)(1), historic properties are those properties deemed eligible for listing or that are already listed in the NRHP. Issuance of an Early Site Permit (ESP) is subject to review and consultation under Section 106 of the NHPA which requires the applicant to "take into account the effect of the undertaking on any historic property" and afford the Advisory Council on Historic Preservation "a reasonable opportunity to comment with regard to the undertaking." This section focuses on a description of the existing archaeological resources and historic properties at the Project site and within the vicinity.

In accordance with 36 CFR 800.16(d) the area of potential effect (APE) means "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking."

The determination of the APE is based on the potential for both direct and indirect effects. Direct effects are defined as those that result from activities that could damage or destroy the physical integrity of a cultural resource. Direct effects are typically associated with construction activities. Indirect effects are those that do not directly destroy the physical integrity of a cultural resource but would rather adversely affect contributing elements of the cultural resource. For historic structures, this typically consists of visual effects to the viewshed of the cultural resource that may diminish its overall context.

The APE consists of approximately 1080 ac. [437.06 hectares (ha)]. This area includes a contiguous area on the Project site and a wastewater discharge pipeline corridor to the Dan River. Both are located on land owned by Duke Energy as indicated in Section 2.1.1.3 and are shown on Figure 2.6-1 and Figure 2.6-2. Based on consultation with and written confirmation from the North Carolina State Historic Preservation Office (NCSHPO), an architectural viewshed survey was not required; as such, an Indirect APE was not established. No portions of the APE include federal, state or tribal-owned lands.

2.6.1 CULTURAL BACKGROUND

The history of human activity in the Carolina Piedmont spans thousands of years. The earliest groups to leave a definitive material record of their presence were early Paleoindians who entered the region during the Late Pleistocene glacial epoch at least 12,000 years ago. Their descendants and the descendants of other Native American groups who migrated to the area later occupied the region the next 11 millennia. This long precontact era lasted until the arrival of European explorers in the sixteenth and seventeenth centuries.

While cultural change is a slow and continual process, archaeologists and other researchers divide the human history of a region into distinct cultural periods. Archaeologists and historians recognize five broadly defined precontact periods for the Piedmont region: Paleoindian [circa 10,000-8000 Before Common Era (B.C.E.)], Archaic (8000-1000 B.C.E.), Woodland [1000 B.C.E.-Common Era (C.E.) 900], Mississippian (C.E. 900-1540), and Contact/Protohistoric period (C.E. 1540-1672) .

Prior to fieldwork, a cultural resources records review and background study were conducted for the Phase I Investigation, discussed in Section 2.6.3.1, to identify previously documented

cultural resources and archaeological surveys within the Project site APE and within a 2-mi. (3.2-km) buffer surrounding the APE. The background literature search included a review of files at the North Carolina Office of State Archaeology (NCOSA) and was conducted on January 8 and 12, 2024. In addition, appropriate archival sources were examined including historic USGS topographic quadrangles, aerial imagery, and other historic mapping for information regarding unknown possible cultural resources within Project site APE and within a 2-mi. (3.2-km) buffer surrounding the APE. This research aided in developing a historic context for the Project site APE.

2.6.1.1 Historic Overview of Stokes County

Stokes County was established in 1789, from portions of Surry County, NC, following the ratification of the U.S. Constitution by the Fayetteville Convention (North Carolina History Project, 2024; Stokes County Historical Society, 2024). The county lies in the Piedmont region and is bounded by Forsyth, Surry, and Rockingham counties in NC, and Patrick and Henry counties, in southern Virginia. The community of Rockford was chosen as the first county seat in 1790; later, in 1851, Danbury became the county seat. The primary centers of population for the county are Danbury and King (North Carolina History Project, 2024).

2.6.1.2 Historic Overview of Forsyth County

Forsyth County was formed from a southern portion of Stokes County in 1849 and was named after Colonel Benjamin Forsyth who served during the War of 1812 (Fearnbach, 2007). The town of Winston, named after American Revolutionary War veteran, Major Joseph Winston, was appointed as the county seat in 1851 (Vocci, 2006). The county lies in the Piedmont region of NC and is bounded by Davidson, Davie, Guilford, Rockingham, Stokes, Surrey, and Yadkin counties of NC. The primary center of population for the county is the Winston-Salem Metropolitan Area (North Carolina History Project, 2024).

2.6.2 HISTORIC AND CULTURAL RESOURCES AT THE SITE AND IN THE VICINITY

A cultural resources records review and background study at the NCOSA to identify any previously documented cultural resources and archaeology surveys within a 10-mi. (16.1 km) buffer was also conducted. The background research included portions of Forsyth, Guilford, Rockingham, and Stokes counties. The results indicated there were no previously recorded archaeology sites within the APE; however, within the 10-mi. (16.1 km) buffer, there were 412 previously recorded archaeology sites. Of those 412 sites, [[

]][CRI]

Sites [[

]][CRI] The Dan River Navigation System was created in the 1820s as a reliable means of the transportation of goods and people and was critical for the success of NC. The navigation system was constructed by

the Roanoke Navigation Company and stretched 46 mi. (74 km) from the Virginia-NC State Line to Harriston Falls in Stokes County, NC (Clauser, 1983). [[

]]CRI

[[

]]CRI Little information was available for Site [[ ]]CRI other than that the site consisted of Precontact and Historic components. Site [[ ]]CRI is a [[ ]]CRI dating from 1870 to 1964 and consisted of [[

]]CRI

Although nominated for the NRHP, the site was anticipated to be likely destroyed due to road construction in the area. Very little information is available for site [[ ]]CRI as the site was reported by a local resident. The site is recorded as a Precontact site of unknown affiliation but has not undergone professional survey.

Additionally, [[ ]]CRI are identified as being study listed. NC's Study List is a preliminary review of cultural resources. The Study List screens resources which are not likely eligible or are eligible for listing in the NRHP to streamline nomination processes (NCSHPO, 2024). All [[ ]]CRI are within close vicinity to each other [[

]]CRI The Saura were a Siouan branch who inhabited the Dan River Valley as early as the fifteenth century. The [[ ]]CRI were routinely looted until an intensive archaeological investigation began in the 1960s. The [[ ]]CRI yielded a high number of artifacts which included [[

]]CRI

Features uncovered at the sites revealed the town was fortified with multiple home sites within the palisade. The Saura abandoned [[ ]]CRI around 1710 (NCDNCR 2024).

The Historic Preservation Office Web Service maintained by the NCSHPO was consulted for previously recorded historic architecture resources within the APE and a 10-mi. (16.1 km) buffer. According to the background research, there are no previously recorded historic resources within the APE and 1807 historic resources within the 10-mi. (16.1 km) buffer. Of those 1807 resources, 31 are listed in the NRHP, 17 are determined eligible for listing in the NRHP, 60 have been study listed, 919 are undetermined and will require further evaluation, and 780 are ineligible.

The NRHP listed historic resources include six historic districts: South Main Street Historic District (FY0716) and North Cherry Street Historic District (FY2042) in Forsyth County, Oak Ridge Military Academy Historic District (GF0167) and Summerfield Historic District (GF2060) in Guilford County, and Academy Street Historic District (RK0011) and Mayodan Downtown Historic District (RK1646) in Rockingham County. These six historic districts are located in the 10-mi. buffer and are not subject to any potential project impacts.

A review of historic maps of the APE was conducted to identify any resources not previously surveyed or recorded. The only historic maps showing structures prior to the 1970s were the soils maps of Forsyth County (U.S. Bureau of Soils, 1913), Guilford County (Jurney, et al, 1920), Rockingham County (U.S. Bureau of Chemistry and Soils, 1926), and Stokes County

(Davis, 1934). The historic maps depict approximately 34 structures within the APE and these 34 areas were treated as high probability areas to contain historic cultural resources.

2.6.3 CULTURAL RESOURCE SURVEYS

Duke Energy conducted cultural resource surveys within and surrounding the APE to facilitate compliance with the NHPA of 1966, as amended, and to meet the requirements of Section 106 of the NHPA. Cultural resource surveys were conducted by qualified professionals (Myers-Rinehart et al., 2024).

2.6.3.1 Phase I Investigation

The Phase I cultural resource survey was conducted to determine if any unidentified cultural resources were present. The Phase I fieldwork was performed between March 25 and June 26, 2024. A total of 2623 shovel test pits (STPs) were excavated as part of the archaeological survey, which resulted in the identification of [[ ]]^{CRI} within the APE. Table 2.6-1 lists each site with a description of site type and Figure 2.6-3 shows the location of each archaeological site in the APE. Of the [[ ]]^{CRI} sites [[ ]]^{CRI} were determined to be potentially eligible for the NRHP. NCSHPO concurred with the results of the Phase I survey regarding potential eligibility of each of the [[ ]]^{CRI} sites. Accordingly, Duke Energy conducted a Phase II survey of each of the [[ ]]^{CRI} sites as described in the following section.

2.6.3.2 Phase II Investigation

In May and June 2025 WSP conducted Phase II archaeological NRHP evaluation investigations on sites [[ ]]^{CRI} Phase II evaluation excavations were completed to assess the significance and eligibility for inclusion on the NRHP. The investigation included remote sensing on 4.65 acres (18,800 square meters), excavations on all sites, more extensive archival research, artifact analysis, and reporting. Background research was conducted to collect material for use in developing a context for evaluation of recorded resources and to provide background information. The research included online and local resources. Excavations on all sites included 52 test units, 174 STPs, and 36 cultural features.

Recommendations for NRHP eligibility for each site resulting from the Phase II investigation are shown in Table 2.6-2. Based on the preliminary study results, [[ ]]^{CRI} sites were recommended as not eligible for the NRHP under Criterion D and received NCSHPO concurrence. The remaining [[ ]]^{CRI} sites remain in consultation with NCSHPO. Duke Energy has committed to avoidance or mitigation of these sites if they are deemed eligible. If any site is deemed eligible and avoidance is not possible, archaeological mitigation including Phase III data recovery will be required to resolve adverse effects.

2.6.3.3 Regulatory Consultation

Initial coordination with the NCSHPO was submitted on March 19, 2024, the purpose of which was to provide a Scope of Work for the Cultural Resource Survey and request regulatory comment on the project pursuant to North Carolina Archaeological Investigations Standards and Guidelines (NCOSA, 2023). A response from the NCSHPO (ER 24-0833) was received in a

letter dated April 15, 2024 (Appendix 1A). In this letter, the NCSHPO indicated their concurrence with the proposed SOW methodology. Additionally, the NCSHPO determined that the project, as proposed, will not affect any historic structures.

Additional formal coordination with the NCSHPO was conducted on November 7, 2024, to submit the results of the cultural resource survey (Appendix 1A) and initiate Section 106 regulatory review pursuant to the NHPA. In a letter dated January 17, 2025, the NCSHPO concurred with the report of findings; sites [[ ]]^{CRI} have the potential for intact deposits and may contain data that would provide information pertinent to historic research questions, sites [[ ]]^{CRI} do not have the potential to contain information pertinent to prehistoric or historic research questions.

Duke Energy met twice with NRC staff to discuss tribal consultation, with both parties acknowledging that the Catawba Indian Nation was the only federally recognized tribe in need of consultation. This was accomplished in September 2024 through a phone call between Duke Energy and the Catawba Indian Nation's staff followed by a scoping letter sent to the tribe. In a letter dated September 24, 2024, from their THPO, the tribe concurred that the project will not affect Native American archaeological sites but requested to be notified if Native American artifacts or human remains are discovered. In addition to this consultation, NRC staff requested that state recognized tribes also be identified and consulted about the Project; however, there are no state recognized tribes in Stokes or Forsyth counties. As described in the Phase I cultural resources report, the Saura Indians were present along the Dan River prior to European contact; however, they abandoned their settlements by the early eighteenth century and ultimately joined with the Catawba Indians. Duke Energy also initiated correspondence with the Monacan Nation as they have tribal interest in Rockingham County, NC; however, no response was received from the Monacan Nation.

Additionally, site [[ ]]^{CRI}, the Branson Cemetery, is determined to be ineligible for the NRHP. However, cemeteries are protected under North Carolina General Statutes Chapter 14-148 and 14-149 and are afforded consideration under Chapter 65. If a cemetery cannot be avoided the provisions regarding exhumation and repatriation provided by North Carolina General Statute Chapter 65-106 must be followed.

Table 2.6-1
New Archaeological Sites at the Project Site and Phase I Recommendations
(Sheet 1 of 2)

[[

]]CRI

Table 2.6-1
New Archaeological Sites at the Project Site and Phase I Recommendations
(Sheet 2 of 2)

[[

]]CRI

Key: NRHP = National Register of Historic Places

Table 2.6-2
Archaeological Sites at the Project Site and Phase II Recommendations

[[

]]CRI

Key: NRHP = National Register of Historic Places

2.7 AIR RESOURCES

This section addresses the local and regional climatology and meteorology, as well as air quality, in the vicinity of the Project site. The information supports independent evaluations and assessments of atmospheric-dispersion characteristics and impacts on the environment.

The Project site is located in north-central NC in the southeastern portion of Stokes County and the northeastern portion of Forsyth County. Guilford and Rockingham counties are adjacent counties to the east of the Project site. The state of NC spans approximately 500 mi. (802 km) east to west and 186 mi. (301 km) north to south. The Project site is in north-central NC in the Northern Piedmont region which is east of the Blue Ridge Mountain Range. The mountain range barriers affect temperature, precipitation, and wind. The Project site is in a humid subtropical climate zone. Figure 2.7-1 shows an aerial view of the Project site with a 50-mi. (80.5 km) radius around the site.

Data sources for the preparation of this section include:

- Data from KGSO (Greensboro, NC), KINT (Winston-Salem, NC), and KRDU (Raleigh, NC) were utilized for the preparation of this section.

- Annual and monthly Local Climatological Data (LCD) summaries from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) were utilized. LCD summaries typically are available for meteorological stations located at airports. Summaries include climatic normals and extremes as well as thirty-year monthly historical values for mean temperature, total precipitation, total snowfall, and heating/cooling degree days. The LCD summaries also include a narrative description of the local climate.

- Statistical summaries of climatological data from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) were utilized for the preparation of this section (ASHRAE, 2021). ASHRAE provides climatic information for worldwide locations, including many U.S. airports and other U.S. locations with hourly surface weather stations. Parameters include dry bulb temperature (DBT), wet bulb temperature (WBT), dew point temperature (DPT), statistical design values of DBT with mean coincident WBT, design WBT with mean coincident DBT, and design DPT with mean coincident DBT. ASHRAE also provides a methodology and key inputs for estimating extreme DBT and WBT for various return intervals.

- American Society of Civil Engineers (ASCE) structural design standards (ASCE, 2021) were referenced and utilized for the preparation of this section. These standards provide minimum load requirements for the design of buildings/structures subject to building code requirements. Particularly useful are maps of 100-year, mean recurrence interval (MRI) 3-second wind gusts. ASCE also provides maps and charts of 50-year return-interval snowpack and a methodology for converting 50-year values extracted from those maps to other return intervals.

- Air quality summaries and monitoring data from the USEPA were utilized for the preparation of this section. The USEPA provides summaries of compliance status with the National Ambient Air Quality Standards (NAAQS) (USEPA, 2024h). The USEPA Green Book provides NAAQS designations, classifications, and

attainment/nonattainment status of areas (USEPA, 2024i). State environmental agencies track concentrations from monitors to assess compliance with the NAAQS.

- Weather event statistics from the NCEI Storm Events Database were utilized for the preparation of this section. The NCEI Storm Events Database contains chronological listings by state and county of tornadoes, thunderstorms, hail, lightning, wind, snow, temperature extremes, and other weather phenomena (NOAA NCEI Storm Events Database, 2024).

- NRC NUREG documents and Regulatory Guides are referenced.

- Various meteorological data publications, as cited in the References section.

2.7.1 CLIMATE

Information about regional climatology conditions was obtained from the National Climatological Data Center (NCDC) Storm Events Database and LCD for the cities of Winston-Salem and Greensboro. The Project site is located within the NCDC's NC Northern Piedmont Climate Division, or Climate Division 3. The nearest NWS Station is KGSO, which is approximately 14 mi. (22 km) to the southeast of the Project site. Meteorological Data from KINT and KRDU were also utilized. KGSO is located in Guilford County and is a reliable station for collecting regional meteorological data.

KGSO is centrally located between the mountains to the west and the coastline to the east and south, which provides a temperate climate. The mountains block cold air masses moving eastward; therefore, few days in the winter are below 20°F (-6.7°C]). KINT, located in Winston-Salem, NC, is within 50-miles (mi.) of the Project site, and experiences warm and muggy summers and very cold winters with variable snowfall. It is partly cloudy year-round.

The average minimum extreme annual temperature at KGSO is 11.4 ˚F (-11.4 ˚C) and at KINT the average minimum extreme annual temperature is 12.4 ˚F (-10.9 ˚C) (see Table 2.7-1). Tropical air brings warm temperatures and high humidity to the area during the summer months. During the summer, the average maximum annual temperatures at KGSO and KINT are 95.7 ˚F (35.4 ˚C) and 95.5 ˚F (35.3 ˚C), respectively.

Rainfall is fairly consistent throughout the year but varies significantly from year to year. July and August have the highest rainfall amounts, while October and November have the least. Summer rainfall is usually from thunderstorm activity that can also bring high winds and hail.

Snow, sleet, glaze, and ice accumulation are rare during the winter months and short-lived when experienced. Snowfall amounts vary greatly, with some winters experiencing only trace snowfall amounts. Glazing is more common in the Piedmont area of NC (where the Project site is located) than in the rest of the state.

According to *Estimated Ice and Wind Loads at the Earth's Surface for the Contiguous U.S.* prepared by Tattelman and Gringorten in October 1973, ice thickness greater than or equal to 2.5 cm (0.98 in.) occurred only twice in NC over a fifty-year period. From the Bennett 1959 study referenced in Tattelman and Gringorten's report a total of 9 to 17 glaze storms, without regard to thickness were observed. NC is in Region V in their report, five ice storms in 50 years with accumulation greater than or equal to 2.5 cm (0.98 in.). Since the Tattelman and Gringorton's publication in 1973 there have been multiple ice storms in the region. On December 4-5, 2002,

a high-pressure system over the northeast U.S. created a system in the western Piedmont where snow fell for up to 8 hours in Greensboro before transitioning to sleet and freezing rain. The freezing rain lasted for more than 12 hours with up to an inch of ice accumulation in parts of the Piedmont. Back-to-back ice storms occurred in 2020. The February 12-13 storm had a quarter-inch of ice accumulation in the Greensboro area and then the February 18-19 storm affecting areas along I-40 and U.S. 421 between Burlington and Boone generally received around a quarter-inch of glaze.

Tornadoes, hurricanes, and tropical storms and depressions are infrequent in the area of the Project site (NOAA NCEI, 2022a; NOAA NCEI, 2022b; Tattelman, P. and Gringorten, I.I., 1973; NOAA NCEI Storm Events Database, 2024).

2.7.1.1 Local Meteorology

Short-term site-specific meteorological data, collected from the Project site meteorological tower (MET tower) during February 7, 2024 – February 6, 2025, are the primary basis for this dispersion meteorology analysis. In addition to on-site measurements, data representative of the Project site or indicative of site conditions were also obtained from LCDs recorded at the NWS Stations at KGSO, KINT, and KRDU (NOAA NCEI, 2022a; State Climate Office of North Carolina, NC State University, 2024; NOAA NCEI, 2022b).

KGSO is located in Guilford County and is a reliable station for collecting meteorological data. It is located approximately 14 mi. (22.5 km) SSE of the Project site. The location of the MET tower, in Stokes County (adjacent to Guilford County), is in the same climatic zone as KGSO, therefore, it will experience similar effects from the mountain ranges as well as similar weather conditions. The selected tower location is positioned to provide sufficient and accurate meteorological data, and KGSO can be used as a backup if needed.

Meteorological measurements were made using one on-site tower, as listed in Table 2.7-2. Data from the on-site tower and regional towers were used to evaluate the impact of topography. The principal impact is on wind directions, as further described in Section 2.7.1.5.

Much of the following discussion considers the 10-meter (m) wind data because it is most representative of the local meteorological conditions closest to the ground where releases for dispersion modeling are expected. Local ground-level conditions are most important in evaluating ground-level releases because maximum air concentrations from contaminants released into the atmosphere generally occur close to the release point.

2.7.1.1.1 Normal, Mean, and Extreme Values

Long-term temperature and precipitation records were examined to determine if data collected at the Project site are consistent with regional conditions, both spatially and over time. This section presents the normal, mean, and extreme local meteorological parameters at nearby KGSO compared to the average measurements at Project site during the 2024 – 2025 collection period. Meteorological data collected at nearby KGSO are presented and evaluated in the following sections in more detail. Table 2.7-2 summarizes annual meteorological parameters from KGSO, including normal temperature and relative humidity (RH), mean wind speed, prevailing wind direction, and normal precipitation for the time period of 1991 – 2020.

Comparisons of common measurements for the different data periods have been made to determine if site meteorological conditions are changing significantly over time. Common

variables (except wind direction) can be compared directly, but wind direction is too dependent on topography for direct comparison particularly with off-site data. Comparing data from nearby off-site locations helps to determine if the Project site is consistent with regional conditions.

Comparison of the KGSO, KRDU, and KINT regional airport data to the Project site data in Table 2.7-3 shows that there is generally good agreement between the Project site and off-site regional locations over different data periods. The differences fall within the normally expected variations. Therefore, it is concluded that meteorological characteristics for the Project site have not changed significantly over time. Additionally, data from the Project site appear to be consistent with overall meteorological conditions in the vicinity. This is characteristic of the similarity in controlling synoptic influences throughout the region. Other meteorological parameters are subject to the same synoptic controls.

2.7.1.1.2 Wind

From February 2024 to February 2025, both 10-m and 60-m wind data were collected by the MET tower at the Project site. The meteorological facility generally met criteria for obtaining "data representative of the atmospheric conditions."

The following discussion considers the 10-m wind data from KGSO and the on-site MET tower as representative of potential ground-level releases for air dispersion modeling purposes. Local conditions are important in evaluating ground-level releases because maximum air concentrations from contaminants released into the atmosphere generally occur close to the release point.

2.7.1.1.2.1 Average Wind Direction and Wind Speed

Table 2.7-4 presents the KGSO 10-m wind speed and wind direction joint frequency distribution (JFD) for the 11-year period of January 2013 – December 2023 and Table 2.7-5 presents the Project site 10-m JFD for the 1-year collection period of February 2024 – February 2025. The distribution of 10-m wind direction frequency at KGSO and the Project site range from light to moderate.

Mean wind speeds recorded at KGSO for the 39-year period 1983 – 2022 (Table 2.7-6) were generally moderate with an average annual mean speed of 7.1 mi. per hour (mph) (11.4 km per hour [kph]). Wind gusts were recorded over a 27-year period, 1996 – 2022, with the maximum 2-minute wind speed recorded in May 2000 at 62 mph (100 kph). The maximum 3-second gust recorded was 82 mph (132 kph) on May 25, 2000, when Guilford and Alamance counties were impacted by a severe storm with reports of property damage and tornado sightings (Swoffard, S., 2000; NOAA SPC, 2024).

Wind speeds at the Project site during 2024 – 2025 were generally light with an average 10-m speed of 4.26 mph and prevailing wind direction from the west-southwest (WSW). The daily maximum 10-m (scalar) wind speed was 19.2 mph (Table 2.7-7).

The Project site and KGSO data indicate winds consistent with the SW to NE orientation of the terrain in the region. The geographic orientation of the ridges and valleys generally aligns with the prevailing regional winds from the southwest, but the gaps in the ridges permit wind flow from other directions as well. The local wind patterns are influenced by this terrain, with up-valley (SW-WSW) and down-valley (NE-ENE) flow patterns common and stable conditions with light to moderate winds frequently observed, especially during the summer and fall seasons.

2.7.1.1.2.2 Wind Direction Persistence

Wind roses for KGSO based on ten years of data (2013 – 2023), are presented in Figures 2.7-2 through 2.7-14. The Project site data are presented as wind roses at 10-m in Figures 2.7-15 through 2.7-27, and at 60-m in Figures 2.7-28 through 2.7-40. Wind roses for KGSO were developed using data from the NOAA NCEI Index of Public Data for the years of 2013 to 2023 (NOAA NCEI, 2024).

Generally, the longer the winds blow in the same direction, the lower the dilution potential because effluent is not dispersing significantly to the sides of the plume. Wind direction persistence is an indicator of the duration of atmospheric transport from each direction. For the Project site (Table 2.7-8), the maximum persistence at 10-m is 27 hours from the SW.

The wind data for KGSO and the Project site show a consistent pattern of wind directions with predominant winds from the southwest. There is moderate seasonal variation. Due to the combination of uniformly light to moderate winds speeds and surrounding terrain, there will often be times with little transport away from the site.

2.7.1.1.3 Air Temperature

Table 2.7-9 summarizes normal maximum and minimum temperatures recorded at KGSO for the time period of 1991 – 2020. Maximum temperatures recorded for the 30-year period 1991 – 2020 usually occur between the months of June and September. Minimum temperatures for the 30-year period 1991 – 2020 usually occur from November through March. Mean monthly temperatures range from the lower 30s (°F) (around 0 ˚C) in the winter to the upper 80s (°F) (around 30 ˚C) in the summer.

The extreme maximum temperature recorded at KGSO for the 94-year period 1928 – 2020 was 103°F (39.4 °C) in August 1988 and the extreme minimum temperature for the 94-year period was -8°F (-22.2 °C) recorded in January 1985 (NOAA NCEI, 2022a).

Table 2.7-10 summarizes average, daily minimum, and daily maximum DBT and WBT recorded at the Project site during the collection period from 2024 – 2025. The highest daily maximum temperatures for the collection period occurred during the months of June and July. The lowest daily minimum temperatures occurred in December and January. The average monthly DBTs range from the mid-30s (°F) (around 0˚C) in the winter, to the upper 70s (°F) (around 25 ˚C). The daily maxima recorded at the Project site was 97.3°F (July 2024), while the daily minimum was 15.8 °F (January 2025).

2.7.1.1.4 Atmospheric Moisture

Long-term RH and WBTs for KGSO are presented in Table 2.7-11. The normal annual RH is 69 percent at KGSO and ranges from 61 percent in April to 77 percent in September. Normal mean annual WBT averages are 50.1 °F (10.1 °C) at KGSO (NOAA NCEI, 2022a). Maximum monthly mean WBTs are 69.0 °F (20.6 °C) during July. Minimum monthly mean WBTs are recorded in January; 30.9 °F (-0.6 °C) (NOAA NCEI, 2022a).

Average RH and WBTs for the Project site, is summarized in Table 2.7-12. The average annual RH is 68 percent at the Project site and ranges from 53 percent in January to 80 percent in September. The average annual WBT is 54.7°F (12.6 °C). The highest daily maximum WBT is 71.8°F (22.1 °C) during July. The lowest daily minimum WBT was recorded in January at

30.5 °F (-0.8 °C). The Project site data match well with the long-term KGSO data.

2.7.1.1.5 Precipitation

Table 2.7-13 summarizes the precipitation recorded at KGSO. Precipitation falls an average of about 116 days per year, and the normal annual precipitation is nearly 44 inches (in.) (112 centimeters [cm]). The maximum monthly rainfall in the 94-year period 1928 – 2022 was 13.26 in. in September 1947. The minimum monthly amounts in the 94-year period were trace amounts in September 1985 and June 1990. The maximum precipitation in 24 hours (hr.) was 7.49 in. (19.02 cm) in September 1947. Except for late winter (which is slightly drier), precipitation is fairly uniformly distributed throughout the year. August and September are normally the wettest months of the year, and February is normally the driest.

Approximately 43 thunderstorms occur in a typical year (Table 2.7-13). Thunderstorm activity is greatest during the late spring and summer months, and the maximum frequency of thunderstorm days is normally in July.

The Project site precipitation data for the 2024 – 2025 collection period (Table 2.7-14) indicate drier than normal precipitation. The annual precipitation was 38.07 in. (96.70 cm). The maximum monthly rainfall was recorded in September with 7.08 in. (17.98 cm). The maximum precipitation in 1 hr. was 1.28 in. (3.25 cm) at 1:00 a.m. on July 19, 2024, and the maximum precipitation in 24 hr. was 4.23 in. (10.74 cm) on August 8 – 9, 2024.

2.7.1.1.5.1 Precipitation Wind Roses

Table 2.7-15 shows composite precipitation data for the 2024 – 2025 collection period based on the Project site hourly precipitation and wind directions (vector). The precipitation value used in the analysis is based on the amount that accumulated over the hour. Precipitation is most associated with wind direction from the W. There is a secondary maximum with wind direction from the west-northwest (WNW). The Project site composite precipitation and wind direction data are presented as precipitation wind roses at 10-m in Figures 2.7-41 through 2.7-53.

2.7.1.1.6 Snowfall

Appreciable snowfall is relatively infrequent in the area. Snowfall data are summarized in Table 2.7-16 for KGSO. Normal annual snowfall is about 7 in. (18 cm). Generally, significant snowfalls are limited to December through March. The 24-hr. maximum snowfall was 14.3 in. (36.3 cm) in December 1930. Recorded maximum monthly snowfall was 22.9 in. (58.2 cm) in January 1966.

2.7.1.2 Atmospheric Stagnation

Air pollution episodes are typically the result of persistent surface high-pressure systems that cause light and variable surface winds and stagnant meteorological conditions. In the eastern U.S. there is a relative minimum of stagnation in July, accompanied by a relative maximum stagnation in May-June and August-September. This mid-summer decrease in air stagnation is due to the impact of the Bermuda High-pressure system. The Bermuda High-pressure system plays a significant role in dictating the day-to-day weather in NC. The Bermuda High is a large area of semi-permanent high pressure, usually situated off the southeast U.S. Atlantic coast. This high many times will extend westward across the southeast during the summer. When the Bermuda High is displaced more south and westward, it can stretch its western edges close to and even over the East Coast. If and when this set-up occurs, the eastern U.S. coastline can be

extremely susceptible to hurricanes. The Bermuda High is strongest in July (Wang and Angell, 1999). This high-pressure system has a clockwise circulation, which puts the eastern U.S. in the position to receive south to southeast winds. These winds pump in heat and humid air from the Atlantic Ocean and Gulf of America into the east. It can often lead to many days or even weeks of hot and sticky weather, especially across the southeast. Therefore, the Bermuda High is a unique controlling factor for air stagnation conditions over the eastern U.S., besides the seasonal cycle of minimum wind in summer and maximum wind in winter. Another unique feature of air stagnation in the eastern U.S. is its early onset in May, compared to the onset in June in the west and central U.S. This results in a prolonged, but weaker air stagnation season in the eastern U.S..

Estimates of the stagnation frequency and duration are provided in Wang and Angell, 1999; Figures 1 and 2. Those estimates indicate that, on average, the Project site experiences approximately two to four cases of air stagnation per year. When stagnation occurs, stagnation lasts approximately five days. Wand and Angell also show that May–July have similar monthly occurrences of air stagnation days, with a peak in air stagnation in the fall (August–October).

2.7.1.2.1 Inversions

Atmospheric stability is based on the temperature difference (ΔT) between the 60-m and 10-m measurement levels. The Pasquill (classes A-G) atmospheric stability classes are described in Table 2.7-17 and the frequency occurrence of each class is presented in Table 2.7-18. While neutral lapse conditions (class D) occur most frequently (31.0 percent), stable lapse conditions (i.e., inversions) typically occur over 36.3 percent of the time. The most unstable class (class A) occurs 21.6 percent of the time, while the most stable class (class G) occurs 2.3 percent of the time.

Tables 2.7-19 and 2.7-20 present a summary of on-site persistence data, with a breakdown by stability class, for the 2024 – 2025 collection period. Inversion persistence is defined as two or more consecutive hours of a single stable class (or combination of stable classes). The longest contiguous period of inversion conditions were 19 hours.

2.7.1.3 Mixing Heights

Mixing heights for Greensboro, NC, were obtained from the U.S. Environmental Protection Agency (USEPA) Support Center for Regulatory Atmospheric Modeling (SCRAM).. The USEPA data are more current than the traditional Holzworth reference (Holzworth, George C., 1972) that is often used. Mixing heights vary during the day, with the lowest average mixing heights (approximately 379 m [1243 feet {ft.}]) generally recorded during the morning hours in the fall and the highest readings (approximately 1609 m [5278 ft.]) recorded during the afternoon in the summer for the 7-year period of record (1984-1987 and 1989-1991) used by the USEPA in the SCRAM dataset. (USEPA, 2024j). Approximate seasonal and annual estimates of mixing heights for the Project site, are presented in Table 2.7-21.

2.7.1.4 Severe Weather

2.7.1.4.1 Tornadoes

A tornado is defined as a rapidly rotating column of air extending vertically from the surface to the base of a cumuliform cloud (AMS, 2024). Tornado intensity is classified according to the Enhanced Fujita Tornado Intensity Scale (EF Scale). This scale correlates wind speeds from a tornado event to the magnitude of observed damage according to 28 indicators. The EF Scale

ranks tornadoes in categories EF-1 to EF-5 using more specific structural damage indicators than the original, previously used tornado intensity classification scale, the Fujita Scale, which was established in 1971 (NOAA SPC, 2021).

Tornadoes occur around the Project site, with 52 recorded in Guilford, Stokes, Rockingham, and Forsyth counties from 1950 to 2023. The strongest tornadoes recorded in the area (EF3) occurred in the months of March and May on the following dates and in these counties (NOAA NCEI Storm Events Database, 2024):

- May 1985 Forsyth County
- May 1989 Forsyth County
- March 1998 Rockingham County
- May 1998 Forsyth County
- May 2008 Forsyth County
- March 2010 Guilford County.

2.7.1.4.2 Hurricanes, Tropical Storms, and Tropical Depressions

Hurricanes, also known as tropical cyclones, have 1-minute average surface winds at 10-m (32.8 ft) exceeding 33 m/s (65 knots). Hurricanes originate from tropical depressions with winds up to 17 m/s (34 knots) which can develop into tropical storms, with winds of 18 – 32 m/s (35 – 64 knots) prior to being classified as a hurricane (AMS, 2024).

Other storms have impacted the area, but the centers of those storms remained beyond 50-mi. of the site center point. Twenty-two historical hurricane tracks are reported within 50-mi. of the site center point, by the NOAA Historical Hurricane Tracks website. Of these, only the unnamed 1893 storm-maintained hurricane strength (Category 1) in the area, which is also confirmed by the State Climate Office of North Carolina. Additionally, four tropical storms were recorded from 1859 to 2023. Hurricanes and tropical storms can produce heavy rainfall, severe thunderstorms, hail, high winds, and flooding in the area.

Other storms that impacted the area but not within 50-mi. of the site have centers that did not pass through the 50-mi. radius. The strongest hurricane which was within a 200 mi. radius and had rains impacting Forsyth County and Guilford County was Hurricane Fran (September 5, 1996), a category 3 hurricane (NOAA NWS, 2015; NOAA NCEI Storm Events Database, 2024). Hurricane Floyd made landfall on the NC's eastern coast and the hurricane-related rainfall (September 15, 1999) reached inland as far as Forsyth County and Guilford County (NOAA NWS, 2019; NOAA NCEI Storm Events Database, 2024).

2.7.1.4.3 Wind

The maximum high wind recorded in Forsyth County, Guilford County, Rockingham County, or Stokes County was 50 knots (kts [57.5 mph {92.6 kph}]) which occurred in Stokes County, April 2003 (NOAA NCEI Storm Events Database, 2024). The maximum high wind recorded in those counties was 60 kts (69 mph [111 kph]) which occurred in February 2003 and March 2004 in Rockingham County and Stokes County (NOAA NCEI Storm Events Database, 2024). The

thunderstorm wind maximum was 100 kts (115 mph [185 kph]) in Forsyth County in July 1962 (NOAA NCEI Storm Events Database, 2024). The database was queried from 1950 to 2023 for Forsyth County, Guilford County, Rockingham County, and Stokes County. The 100-year MRI 3-second wind gust is 93 mph (42 m/s) (ASCE, 2021).

The wind patterns are influenced by the local topography, which will affect the severe weather regionally. In the Piedmont region rainfall is modified by the mountain barrier, but to a lesser extent than in areas closer to the Appalachian Range. Shallow cold air masses from the west tend to be stopped or turned aside by the mountains, while deeper masses are lifted over the range, losing moisture and warming during the passage. Summer precipitation is largely from thunderstorms, which signal an unstable atmosphere, mostly local in character. Damaging storms are infrequent in the Northern Piedmont area. The highest winds to occur have been associated with thunderstorms and are of brief duration.

2.7.1.4.4 Thunderstorms and Lightning

Thunderstorms are defined as a local storm, invariably produced by a cumulonimbus cloud, and always accompanied by lightning and thunder, usually with strong gusts of wind, heavy rain, and sometimes hail (AMS, 2024). Lightning is an electrical discharge in the atmosphere that occurs due to strong electric fields between regions of cumulonimbus (thunderstorm) clouds (AMS, 2024).

Thunderstorms and lightning mainly occur in the spring and summer months. Thunderstorms are occasionally accompanied by high winds, heavy rain, and hail. Damaging thunderstorms are infrequent in the area of the Project site, according to the 75-year period reported on the KGSO and KRDU 2022 LCDs (NOAA NCEI, 2022a; NOAA NCEI, 2022b).

2.7.1.4.5 Hail

Precipitation in the form of balls or irregularly shaped lumps of ice is called hail. Hail has a diameter of five millimeters or greater and is always produced by convective clouds (AMS, 2024). Hail can occur with thunderstorms in Forsyth County, Guilford County, Rockingham County, and Stokes County. A total of 553 hail events are recorded in the NCEI Storm Events Database from 1950 to 2023 in these counties. The largest size of hailstones reported were 2.25 in. (5.72 cm) in Stokes County, June 2002; 2.75 in. (6.99 cm) in Guilford County, April 1983; Rockingham County, June 1998; and Forsyth County, March 2005 (NOAA NCEI Storm Events Database, 2024).

2.7.1.4.6 Winter Weather

Normal annual snowfall for the Project site is between 5.2 in. (13.2 cm) and 7.1 in. (18.0 cm). Maximum monthly snowfall ranges from 25.8 in. (65.5 cm) to 22.9 in. (58.2 cm). These measurements were recorded at KRDU and KGSO, respectively. The mountains to the west modify the winter temperatures and weather. This area experiences winter rain or snowfall amounts that are variable from year to year and rarely persist for more than a few days (NOAA NCEI, 2022a; NOAA NCEI, 2022b).

2.7.1.4.7 Droughts and Wildfires

Periods of abnormally dry weather that are long enough to create a serious hydrologic imbalance are called droughts (AMS, 2024). There were 40 drought events recorded in the

NCEI Storm Events Database from 1950 to 2023 in Forsyth County, Guilford County, Rockingham County, and Stokes County. Two weather-related wildfires occurred during that timeframe, one in Rockingham County (February 2011) and the other in Stokes County (December 2021) (NOAA NCEI Storm Events Database, 2024). The two on-site wildfires that occurred in 2024 are discussed in Section 2.3.1.9.

2.7.1.4.8 Fog

Fog is defined as water droplets suspended in the atmosphere in the vicinity of the Earth's surface that affect visibility. Fog reduces visibility below 1 km (0.62 mi.) (AMS, 2024). The number of days with heavy fog (visibility equal to or less than one-quarter mi.) at the Project site, was determined based on data from the KGSO LCD and KRDU LCD (NOAA NCEI, 2022a; NOAA NCEI, 2022b). Fog data for KGSO is presented in Table 2.7-22. These data indicate that heavy fog occurs about 27 days per year, with the winter normally the foggiest season.

2.7.1.4.9 Precipitation

Precipitation events were obtained from the NCEI Storm Events Database for Guilford County and Stokes County. Records indicate heavy rain is mostly associated with thunderstorms and tropical weather (hurricanes and tropical storms). The Storm Events Database defines heavy rain as an unusually large amount of rain which does not cause a Flash Flood or Flood event but causes damage. The AMS [2024h] defines heavy rain as rain at a rate of accumulation exceeding the geographically dependent value. There are a total of three heavy rain events recorded in the NCEI Storm Events Database for Guilford County and Stokes County. The first was the rain event of February 3-4, 1998, when Goldsboro recorded 2.25 in., then on May 18, 2018, the COOP observer at King recorded 2.70 in. over a 24 hr. period, which was the highest daily May rainfall at that station. More recently on February 6-7, 2020, the station at Danbury set a February two-day record with 4.89 in.

Maximum possible precipitation, estimated by statistical analysis of regional precipitation data, is given in Table 2.7-23 for return periods of one to 100 years and for rainfall durations of from five minutes to ten days. Probable maximum precipitation (PMP), sometimes called maximum possible precipitation, for a given area and duration is the depth which can be reached but not exceeded under known meteorological conditions (USACE, 1987b). This data was taken from the NOAA Atlas 14, Volume 2, Version 3 (NOAA, 2006) and the NOAA Atlas 14 Point Precipitation Frequency Estimates (NOAA, 2025) for the area nearest the Project site. For the Project site, using a 100-year return period, the PMP for 6, 12, 24, and 48 hours is 5.1, 6.4, 7.8, and 8.8 in., respectively.

Floods are defined as the overflowing of the normal stream or body of water, or the accumulation of water over areas not normally submerged (AMS, 2024), whereas flash floods are rapidly rising water levels in waterways, usually as a result of intense rainfall (AMS, 2024). The NCEI Storm Events Database recorded a total of 55 flood events and 254 flash flood events for the time period from 1950 to 2023 in Forsyth County, Guilford County, Rockingham County, and Stokes County for a total of 309 flooding events (NOAA NCEI Storm Events Database, 2024). Floods are discussed in further detail in ER Section 2.1.1. Hydrology.

2.7.1.4.10 Ground Snow Load

From the ASCE-7 Hazard Tool (ASCE/SEI 7-22, Figures 7.6-1 and 7.6-2 A-D), the 20-year MRI snow load value for the Belews Lake area is determined to be 9.33 lb/ft^2 (45.55 kg/m^2). The 20-

year MRI value is, on average, 80% of the 50-year MRI ground snow. Using the 80% estimate generates a 50-year MRI of 11.66 lb/ft^2 (56.94 kg/m^2) (ASCE, 2021).

NRC Interim Staff Guidance DC/COL-ISG-007 (NRC, 2009) provides an algorithm that converts a historical maximum snowpack depth to a ground snow load. The algorithm relates the snowpack depth in inches (in.) (D) to the resulting ground snow load (L) in lb/ft^2. The mathematical equation for calculating ground snow load is:

$$L = (0.279)(D^{1.36}) \qquad \text{(Equation 2.7-1)}$$

Using this equation and the maximum snowpack depth recorded at KGSO, 15 in. (38.1 cm), the maximum ground snow load is 11.1 in. (28.2 cm)

NRC Interim Staff Guidance DC/COL-ISG-007 also provides an algorithm that converts a snowfall event to a ground snow load. The algorithm relates the snowfall depth in inches (S) to the resulting ground snow load (L) in lb/ft^2. The mathematical equation is as follows:

$$L = (0.15)(S)(5.2) \qquad \text{(Equation 2.7-2)}$$

In Equation 2.7-2, the constant (0.15) represents the ratio of the volume of melt water derived from a snow sample and the constant (5.2) is the weight of 1 in. of water in lb/ft^2. Using this algorithm and the maximum snowfall in 24 hr. (14.3 in./24-hr. [36.3 cm/24-hr.]) recorded at KGSO, the maximum ground snow load based on the maximum snowfall event in 24 hr. is 1.64 lb/ft^2 (8.01 kilograms per square meter).

2.7.1.4.11 Dry and Wet Bulb Temperature

The mean DBT at KGSO is 58.3 °F (14.6 °C) with a mean maximum of 77.8 °F (25.4 °C) and mean minimum of 39.0 °F (3.9 °C). The mean WBT at KGSO is 50.1 °F (10.1 °C) with a mean maximum of 69.0 °F (20.6 °C) and mean minimum of 30.9 °F (-0.6 °C) (NOAA NCEI, 2022a; NOAA NCEI, 2022b).

Design-basis DBTs and WBTs were estimated for the Project site, using data from KGSO, KRDU, and KINT (Table 2.7-25 for items a-q and Table 2.7-1 for items r and s). These include the following temperatures:

a. Normal DBT

b. Mean DBT

c. Mean WBT

d. Maximum Normal DBT

e. Maximum Mean DBT

f. Maximum Mean WBT

g. Minimum Normal DBT

h. Minimum Mean DBT

i. Minimum Mean WBT

j. DBT with Annual Exceedance Probability of 0.4 percent

k. Mean Coincident WBT With Annual Exceedance Probability of 0.4 percent

l. DBT With Annual Exceedance Probability of 1.0 percent

m. Mean Coincident WBT With Annual Exceedance Probability of 1.0 percent

n. DBT With Annual Exceedance Probability of 2.0 percent

o. Mean Coincident WBT With Annual Exceedance Probability of 2.0 percent

p. WBT (Non-Coincident) With Annual Exceedance Probability of 0.4 percent

q. WBT (Non-Coincident) With Annual Exceedance Probability of 1.0 percent

r. 100-year extreme maximum and minimum DBT

s. 100-year extreme maximum and minimum non-coincident WBT

The 100-year return interval extreme maximum and minimum DBT and WBT ([r] and [s] in the above list) are estimated using a technique described in ASHRAE, 2021. This technique calculates the n-year return interval extreme maximum or minimum temperature using the average and standard deviation of a series of annual maximum and minimum temperatures with the following equation:

$$T_n = M + IF_s \qquad \text{(Equation 2.7-3)}$$

Where:

Tn = n-year return period value of the extreme temperature computed (years)

M = mean annual extreme temperature

I = +1 if the maximum temperature is being computed, -1 if the minimum temperature is being computed

s = standard deviation of the annual extreme temperature

n = return period in years (e.g., n = 100 for a 100-year return interval)

$$F=-\sqrt{6}/\pi \{0.5772+\ln\{\ln[(n/(n-1)]\} \qquad \text{(Equation 2.7-4)}$$

Where:

F = a function that converts the standard deviation of annual extreme temperature parameters to a new variable that is linearly related to the n-year return interval extreme temperature (Tn).

ASHRAE, 2021, provides the mean annual extreme maximum and mean annual extreme minimum temperature (M) and the corresponding standard deviation(s) used in Equation 2.7-3. The 100-year return minimum and maximum annual extreme DBT and non-coincident WBT are computed using Equations 2.7-3 and 2.7-4 for KGSO, KINT, and KRDU and are listed in Table 2.7-1.

Winter Storm Elliott presented a cold event in December 2022 with a minimum temperature of 5 ˚F (-15.0 °C) recorded at KGSO. An arctic cold front swept across the foothills and the Piedmont area of western NC during the morning of December 23, 2022 and introduced the coldest air mass in more than five years. Temperatures in the single digits and lower teens combined with 10 to 20 mph (16.1 – 32.2 kph) winds to produce wind chill values in the 0˚ to -15 ˚F (-18 to -26 ˚C) range from the evening of the December 23, 2022 through December 24, 2022. While winds abated through December 25, 2022, unseasonably cold weather persisted for the better part of four days. There were numerous reports of frozen and burst pipes along with mostly minor damage to infrastructure throughout the area. Using the 5 ˚F (-15.0 °C) minimum temperature in the ASHRAE calculation for return intervals a return interval of nine years is computed.

2.7.1.5 Topographic Description and Potential Modifications

The Project site is located at an elevation of approximately 810 ft. (247 m) AMSL on a peninsula surrounded to the north, east and west by Belews Lake. Most of the terrain in the vicinity of the Project site (Figure 2.7-54), is characterized by Belews Lake and the foothills of the Blue Ridge mountains to the NW. Belews Lake was formed from Belews Creek, a small tributary of the Dan River, under the authorization of the North Carolina Department of Water and Air Resources specifically to provide cooling water to the BCSS. The location is at the southwestern edge of the Dan River Basin. The Dan River runs parallel to the northwest boundaries of Belews Lake. The Dan River rises from springs on Belcher Mountain on the Blue Ridge Plateau in Patrick County, Virginia then flows 214 mi. (344 km) across the state border into Stokes County, NC. The lake sits in the foothills of the Blue Ridge Mountains and the land gradually rises to the NW. Outcroppings southeast of the Blue Ridge rise into peaks occasionally exceeding 2500 ft. (762 m). The Blue Ridge forms a NE to SW barrier about 50-mi. (80-km) from the Project site.

The Sauratown Mountains are located within Stokes and Surry counties and lie WNW of the Project site. The range is home to two state parks located within a 25 mi. (40 km) radius of the Project site. Pilot Mountain State Park, which includes Pilot Mountain, peak elevation 2241 ft. (683 m), is approximately 24 mi. (39 km) west, and Hanging Rock State Park, peak elevation 2159 ft. (658 m), is approximately 14 mi. (23 km) NW of the Project site.

Terrain in the vicinity of the Project site (Figure 2.7-54), is characterized as alternating ridges and valleys oriented along a NE to SW axis. Nearby ridges reach an elevation of 1100 ft. (335 m) AMSL (approximately 300 ft. [91 m] above plant grade). The structures in two of the three areas (North, Middle, South) are located at a distance from the MET tower that would meet the offset requirement in Regulatory Guide 1.23, Rev. 1 that states the sensors should be located over level, open terrain at a distance of at least ten times the height of any nearby obstruction. The MET tower is approximately 1217 ft. (371 m) ENE of the closest turbine and reactor building (the North Plant Complex). Because the turbine and reactor building is 120 ft. (37 m) tall, the tower would meet the 10:1 offset distance requirement for the North Plant Complex to prevent adverse building wake effects. This assumes that the maximum obstruction height is the turbine and reactor building, which is roughly 120 ft. above grade. A topographic map outlining a 5 mi. boundary from the Project site center point is shown in Figure 2.7-54.

Figures 2.7-55 through 2.7-62 provide elevation profiles of the maximum elevation at the 16 compass directions radiating out from the Project site, to a distance of 50-mi. (80.5 km). Figure 2.7-63 provides a topographic map of the elevation profile radials.

The geographic orientation of the ridges and valleys generally aligns with the prevailing regional winds from the SW, but gaps in the ridges permit wind flow from other directions as well.

2.7.1.6 Potential Influence of Plant and its Facilities on Local Air Meteorology

Larger structures on-site would influence wind conditions (wind speed, direction, and turbulence), although these effects are not expected to be significant beyond ten building/structure heights from the building or structure in question, per Regulatory Guide 1.23.

The only nearby feature which may have any noticeable effects on the local meteorology is the new on-site Ash Basin Landfill. The Ash Basin Landfill is planned to:

- be located partially within the former footprint of the ash impoundment, at the BCSS, adjacent to Pine Hall Road.
- be approximately 90 ac.
- be designed to contain approximately 14.1 million cubic yards of coal ash.
- stand 168 ft. tall (from primary liner to top of final closure cap), rising approximately 125 ft. above Pine Hall Road.

The new landfill is approximately 2 mi. (3.2 km) NW of the Project site. While there could be some localized blockage and diversion of winds around the new landfill, the distance of the new landfill from the Project is too far away to produce downstream effects. Impacts on the proposed nuclear facility are expected to be minimal.

Project-related facilities which may have any noticeable effects on the local meteorology is the new cooling tower. The nearest cooling tower is in the North Plant Complex and is 1,061 ft. (324 m) to the MET tower. If linear mechanical draft cooling towers (LMDCTs) are used, they are expected to produce elevated plumes that somewhat alter overall local frequencies of overhead clouds. LMDCTs may also produce small increases of ground-level fog, rime icing, and drift deposition as potential impacts.

Cooling tower impacts are addressed in Section 5.7.1.

There may be some minor impacts on local air quality during construction. Construction impacts are mitigated using construction best management practices according to Duke Energy procedures and state air permits. Sections 4.7 and 5.7 contain information about air quality impacts from constructing and operating the plant.

2.7.1.7 Global Climate Change

Historical long-term meteorological data are considered in the Project's impact on the surroundings of the Project site. Though the impact of global climate change is uncertain, projected trends are discussed in this section. Consistent with NRC Interim Staff Guidance COL/ESP-ISG-026 (NRC, 2014), the project lifetime, decommissioning period, and resources

that may be impacted by climate change are considered. The first unit at the Project site is estimated to be online in 2034 as the earliest possible commercial operation date, with a planned 12-month stagger between units for units 2 – 6 to come online. The initial operating license for each unit is for 40 years and license renewals could extend the operating period an additional 40 years. Thus with the initial license and renewals, the units could operate up to 80 years, with potential in the future to extend the operating life up to a total of 100 years.

The North Carolina Climate Science Report (NCCSR) (Kunkel, K. E., et al., 2020) assesses historical climate trends and potential future climate change in NC under increased GHG concentrations and provides projected changes for the climate of NC for two hypothetical climate futures: a higher scenario (Representative Concentration Pathway 8.5, or RCP8.5), in which GHG emissions continue to increase through the end of the century, and a lower scenario (RCP4.5), in which emissions increase at a slower rate, peak around the middle of the century, and then begin to decrease.

Sea level along the northeastern coast of NC has risen about twice as fast as along the southern half of the coast, averaging 1.8 in. per decade since 1978 at Duck, NC, and 0.9 in. per decade since 1935 at Wilmington, NC (Kunkel, K. E., et al., 2020). A more recent study considered the effect of relative sea level rise; on historical water levels observed along the NC coast and found that under the higher scenario (RCP8.5) after 2050, water levels that currently have a 10% probability of occurring each year would have nearly a 100% probability of occurring each year in Wilmington. Furthermore, water levels that currently have a 1% probability of occurring each year would have nearly a 60% probability of occurring each year from 2050 to 2100. Threats associated with these coastal conditions would not have a direct effect on the Project site, due to its inland location.

The NCCSR projects that it is very likely that NC temperatures and extreme precipitation frequency and intensity will increase, and it is likely that the frequency and severity of inland flooding will increase (Kunkel, K. E., et al., 2020).

The National Climate Assessment (NCA) Report provides detailed information related to the potential effects of climate change on the U.S. by region (U.S. Global Change Research Program (USGCRP), 2023). The Project site is located in the southeast (SE) region of the U.S. as defined by the report. In general, the NCA report states that the SE region is vulnerable to sea level rise and coastal flooding, extreme heat events, hurricanes, and tropical cyclones, and increasing wildfire risk (USGCRP, 2023).

The NCA report found that heatwaves in the SE are happening more frequently and are occurring during a longer heat season, with some cities also showing increasing trends in heatwave duration and intensity:

The number of extreme warm days (above 95 °F [35 °C]) is expected to continue increasing with every increment of global warming. Further, there have been an increasing number of days that exceed 95 °F (35 °C) and nights that exceed 75 °F (24 °C) and a decrease in the number of “extremely cold” days since 1900. (USGCRP, 2023).

Temperatures have steadily increased across the SE since the 1970s. Climate models agree that annual temperatures will continue to increase in the future, with an average annual increase of 3 – 5 °F (approximately 1.7 – 2.8 °C) by 2041 – 2070. Simulated temperature increases for winter and spring are between 2.5 – 5 °F (1.4 – 2.8 °C). For summer the simulated temperature increases from 3.5 – 6 °F (1.9 – 3.3 °C), and during the fall the increase is between 3 – 5 °F (1.7

– 2.8 °C) (USDA, 2024c). These are probabilistic predictions; however, if these numbers are simply interpolated for the next 50 years, results indicate an approximate total increase of 2 °F (1.1 °C) to 4 °F (2.2 °C) during the operating lifetime of the Project site. The report also finds that days with maximum temperatures exceeding 95 °F (35 °C) are predicted to increase, with more than 35 additional days occurring in central Florida and 20 – 30 additional days across the rest of the region, and there is likely to be a decrease in days with freezing temperatures (USGCRP, 2023).

The NCA report states that the SE region is more prone to extreme drought due to higher rates of evapotranspiration than other parts of the eastern U.S.. Longer-term droughts in the region appear to be increasing in severity but do not appear to be occurring more frequently (USGCRP, 2023).

The NCA report states that the SE has received increasing precipitation in the fall, but over the past few decades there has been a decreasing trend in rainfall in summer. Most climate models forecast that the decrease in summer rainfall will continue with mean annual precipitation expected to decrease across the western portion of the SE. Extreme rainfall events have occurred more frequently across the SE in the past 20 years. Average annual precipitation from 2002 to 2021 was 5 percent to 15 percent higher relative to the 1901 – 1960 average in the central and eastern U.S. (USGCRP, 2023).

The NCA has investigated severe weather events including hurricanes, tropical storms, and tornadoes. The NCA report states that warmer temperature projections would result in a decrease in tropical storms globally, however, there has been a slight increase in the frequency of tropical storms in the Atlantic, and the number of major hurricanes (category 3 – 5) has increased over the past few decades (USDA, 2024c). The Project site is located inland and not likely to experience the most severe impacts of hurricanes. However, extreme rain events are a risk with or without tropical systems. The study reports that the number of major tornadoes has increased in the past 50 years, however, there is “no statistically significant trend.” The study indicates that the increase in the number of tornadoes reported may be attributable to expanded and better reporting of tornadoes (USGCRP, 2023).

Based on the NCA report, the greatest potential effects of climate change are increased temperatures and reduced water availability for the Project site, and its surroundings. At the same time, stormwater from extreme precipitation events may increase. As the models used to develop these projections are based on future estimates of population growth, land use, energy consumption, emissions patterns, etc., there is a level of uncertainty associated with the events and meteorological conditions predicted. The Project site is required to continuously monitor meteorological and environmental conditions throughout the life cycle of the project to ensure it remains within its allowable licensed limits of operation.

2.7.2 AIR QUALITY

2.7.2.1 Regional Air Quality

The Clean Air Act (CAA) was enacted in 1970 to protect public health and welfare and authorizes the USEPA to set NAAQS for six common pollutants, called criteria pollutants. There are also provisions to regulate hazardous air pollutants, which are pollutants that are harmful to human health and/or the environment, as well as greenhouse gases (GHGs), primarily carbon dioxide (CO_2) (42 USC §7401 et seq).

The CAA requires the USEPA to set NAAQS for pollutants considered to be harmful to public health and the environment. Primary NAAQS provide public health protection including protecting the health of sensitive populations (asthmatics, children, elderly, etc.). Secondary NAAQS provide public welfare protection against decreased visibility and damage to animals, crops, vegetation, and buildings (USEPA, 2024h).

The USEPA on February 7, 2024, issued its final rule reconsidering the particulate matter NAAQS (40 CFR Parts 50, 53, and 58). USEPA is revising the level of the primary (health-based) annual standard for fine particles (particulate matter with a diameter of 2.5 micrometers or smaller, $PM_{2.5}$) from the current level of 12 micrograms (µg) per m^3 to 9 µg per m^3. The NAAQS are presented in Table 2.7-26. NC reached full attainment with all NAAQS across the entire state in 2015. The most recent pollutant to be redesignated was ozone. On July 28, 2015, the USEPA redesignated to attainment the NC portion of the Charlotte-Rock Hill, NC-SC, nonattainment area for the 2008 8-hour ozone NAAQS, effective August 27, 2015.

2.7.2.2 Class I Areas

The CAA defines Class I areas as national parks greater than 6000 ac., wilderness areas greater than 5000 ac., national memorial parks greater than 5000 ac., and international parks that were in existence as of August 1977. These areas are potentially sensitive to visibility impairment. The USEPA states that a Class I visibility impact analysis is necessary for a major source within 100 km (62.1 mi.) of a Class I area (USEPA, 1990). Discussion of construction impacts are discussed in ER Section 4.7 of this report and operation impacts are in ER Section 5.7.

The USEPA promulgated the Regional Haze Rule to Improve visibility in Class I areas in 1999 with the ultimate goal of restoring natural background visibility by 2064 (Federal Register Vol. 64, 1999). This rule was amended in 2005 to require certain industrial facilities to install emission controls to reduce emissions of air pollutants that reduce visibility (USEPA, 2024k; Federal Register Vol. 70, 2005). These pollutants include particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$) and compounds that contribute to $PM_{2.5}$ formation, such as nitrogen oxides, sulfur dioxide, certain volatile organic compounds, and ammonia. The USEPA defines all proposed major sources or major modifications within 50 km to 300 km of a Class I area as those with the potential for air quality impacts on a Class I area. There are five Class I areas within NC and one each in South Carolina, Virginia, and Georgia that may be impacted by Prevention of Significant Deterioration (PSD) sources in NC. The closest Class I areas to the Project site, are Linville Gorge Wilderness Area, located in NC roughly 168 km (104.4 mi) to the SW, Shenandoah National Park, located in Virginia approximately 230.5 km (143.2 mi.) to the north-northeast (NNE), and the Great Smoky Mountains National Park, located in NC and Tennessee approximately 280.3 km (174.2 mi.) to the SW. There are no Class I areas within 100 km (62 mi.) of the Project site, therefore, no Class I areas are affected (USEPA, 2024k). The nearest state park is Mayo River State Park located approximately 16.1 km (10 mi.) to the northeast of the Project site. NC's state rules, under 15A NCAC 02D Section .0530 PSD, implements a program for the PSD of air quality as required by 40 CFR 51.166. The minimum requirements of 40 CFR 51.166 are adopted as the requirements of the NC rule. PSD regulations require a single-source impact analysis be conducted for all new major sources or major modification project sources with the potential for air quality impacts on a Class I area. The Class I Area Increment single-source impact analysis evaluates the significant project emissions increase in potential or permitted allowable emissions of a PSD pollutant from a proposed new source. As stated above, no Class I areas are affected by the Project site and air quality dispersion modeling of potential impacts at state parks is not required.

2.7.2.3 Greenhouse Gas Emissions

Global net anthropogenic GHG emissions have been estimated to be 59 ± 6.6 gigaton CO_2-equivalent ($GtCO_2$-eq) in 2019, about 12 percent (6.5 $GtCO_2$-eq) higher than in 2010 and 54 percent (21 $GtCO_2$-eq) higher than in 1990, with the largest share and growth in gross GHG emissions occurring in CO_2 from fossil fuels combustion and industrial processes (IPCC, 2023). At the national level, net GHG emissions in the U.S. in 2022 totaled 6343.2 million metric tons (MT) CO_2-eq after accounting for sequestration from the land sector (USEPA, 2024m). The increase in total GHG emissions was driven largely by an increase in CO_2 emissions from fossil fuel combustion. In 2022, CO_2 emissions from fossil fuel combustion increased by 1 percent relative to the previous year. This increase in fossil fuel consumption emissions was from increased energy use, due in part to the continued rebound in economic activity after the height of the COVID-19 pandemic. GHG emissions in 2022 (after accounting for sequestration from the land sector) were 17 percent below 2005 levels (USEPA, 2024l). At the state level, GHG emissions in NC are 115.6 MT total CO_2 (EIA, 2024).

The impact of estimated GHG emissions resulting from the Project site on air quality is compared to state and national GHG emissions. Emissions from generic 1000-megawatt electric (MWe) reactor lifetime GHG footprint is 10.5 MT CO2eq. (Table A-3. Nuclear Power Plant Lifetime GHG Footprint NRC, 2014). Using the emissions from the generic 1000 MWe reactor provides a conservative estimate. Lifetime GHG emissions from a new power plant are an estimated 9.1 percent of annual 2022 GHG emission in the state of NC (10.5 million to 115.6 MT) and 0.17 percent of the annual 2022 carbon equivalent emissions in the U.S. (10.5 million to 6343.5 MT).

2.7.3 ATMOSPHERIC DISPERSION

Short-term dispersion estimates for use in evaluation of dose from design-basis accidents (DBAs) and long-term dispersion and deposition estimates for evaluation of radiological impacts from normal releases are included in Section 2.7.3.1 and Section 2.7.3.2, respectively. Section 2.7.3.2 provides estimates of annual average atmospheric-dispersion factors (χ/Q) and relative dry deposition factors (D/Q) to a distance of 50 mi. (80 km) from the Project site.

2.7.3.1 Short-Term Diffusion Estimates

This section presents the methodology and results used to evaluate short-term atmospheric-dispersion conditions applicable to a DBA for the Project site. The evaluation supports demonstration of compliance with 10 CFR 100.11 and has been performed consistent with the guidance contained in NRC RG 1.145, Atmospheric-Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants. Atmospheric dispersion consists of two components: (1) atmospheric transport, or the movement of gaseous effluents through the atmosphere, and (2) atmospheric diffusion, or the spread of gaseous effluents through the atmosphere. Atmospheric-dispersion conditions are represented by χ/Q factors at specified receptor distances, primarily at the Exclusion Area Boundary (EAB) and the outer boundary of the Low Population Zone (LPZ). The evaluations support the siting requirements by demonstrating that appropriate protective measures can be taken in response to a postulated accidental release.

2.7.3.1.1 Calculation Methodology and Assumptions

Atmospheric-dispersion calculations are performed using the PAVAN computer program,

NUREG/CR-2858, PAVAN: An Atmospheric-Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations. The PAVAN program implements the guidance provided in NRC RG 1.145. PAVAN is designed to calculate χ/Q factors using JFDs of wind direction, wind speed, and atmospheric stability class.

Meteorological data is collected and processed in accordance with NRC RG 1.23. Wind direction and speed data are measured at 10 m above ground level, and temperature data is collected at appropriate vertical levels for determining atmospheric stability. JFDs are compiled into 16 cardinal sectors with wind speed and stability classifications. As noted in Section 2.7.3 of RG 4.2, two consecutive annual cycles of meteorological data should be provided at the time of submittal; however, if two years of on-site data are not available at the time the application is submitted, at least one annual cycle of meteorological data collected on-site should be provided at submittal.

JFDs for each stability class, consistent with NUREG/CR-2858 and RG 1.23, are included as Tables 2.7-27 through 2.7-34, and 2.7-35 through 2.7-42, respectively.

Dispersion factors are calculated for various time intervals post-accident, typically 0-2 hours for the EAB and 0-8 hours and 4-30 days for the LPZ. The analysis uses a ground-level release assumption for conservatism, as defined by RG 1.145 and excludes credit for building wake effects.

For each receptor (EAB and LPZ), χ/Q factors are calculated using both directionally dependent (maximum sector) and directionally independent (overall site) methods. The bounding χ/Q factor is the greater of the two values, consistent with RG. 1.145 guidance. In the directionally dependent approach, χ/Q factors are determined for each sector and the 0.5 percent exceedance value is used. For the directionally independent approach, a site-wide cumulative distribution is compiled, and the 5 percent exceedance value is used. As noted in RG 4.2, RG 1.206 states that the χ/Q factors at the EAB and LPZ for appropriate time periods using realistic (50^{th} percentile) meteorology should be provided. Using the site-wide cumulative distribution and 5 percent exceedance values, the 50^{th} percentile χ/Q factors were determined for each Plant Complex using logarithmic interpolation.

Building wake effects are excluded (building height and cross-sectional area set to zero) for conservatism. Ground-level release is modeled since it results in the highest downwind concentrations. Plume meander is considered for neutral or stable conditions and wind speeds below 6 m/s. For higher wind speeds or unstable conditions, plume meander is neglected.

Effluent release points are represented by a conservatively defined release boundary enclosing all potential sources within each Plant Complexes nuclear power block, determined using the aggregate power block footprint from all technologies being evaluated for implementation. The EAB is determined by assembling a composite of the EAB distances provided as inputs from the selected technologies to have the limiting EAB distance in every direction (limiting in this case meaning nearest to the potential release points). The outer boundary of the LPZ is assumed to be equivalent to the EAB for the purposes of the evaluation. Table 2.7-43 lists the minimum distances from the perimeter of the release envelop (the power block footprint) for each of the 16 downwind direction sectors for each of the three Plant Complexes.

2.7.3.1.2 Results and Conclusions

The PAVAN modeling results provide χ/Q factors for use in accident dose consequence

assessments as required by 10 CFR Part 100. The 50th percentile EAB and LPZ χ/Q values for each plant complex are presented in Tables 2.7-44 through 2.7-46. The bounding 50th percentile χ/Q values for all three Plant Complexes are documented in Table 2.7-47.

2.7.3.2 Long-Term Diffusion Estimates

This section presents the methodology and provides the χ/Q and D/Q factors for routine releases associated with the Project site. The Project site is separated into three Plant Complexes: the North Plant Complex, Middle Plant Complex, and South Plant Complex. Each complex will include multiple advanced reactors. The analysis is prepared in accordance with the guidance provided in NRC RG 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors and uses site-specific meteorological data.

The χ/Q and D/Q factors are calculated at locations as a function of downwind distance from the Project site effluent release points that are located within the North, Middle, and South Plant Complex areas. The χ/Q and D/Q locations include receptors on the EAB or property line (i.e., site boundary) for each Plant Complex in each of the 16 directional sectors and at two off-site locations, i.e., the nearest resident and nearest vegetable garden (greater than 50 m^2 [538 ft^2]). The minimum distance between the release point and the receptor on the unrestricted area boundary, i.e., the distance to the EAB or to the site boundary, is used as the distance in each sector for χ/Q and D/Q determination. The longest distance from the EAB or site boundary to the Plant Complex boundary is used to determine what unrestricted area boundary is used. In addition, general and segmented χ/Q and D/Q factors are calculated radially out to 50 mi. (80.5 km) from the Project site. For all the locations considered, the χ/Q factors are calculated as a ground-level release considering scenarios of no depletion/no decay, no depletion/2.26-day half-life, and depletion/8-day half-life. The χ/Q and D/Q factors are calculated as average values over a period of one year.

2.7.3.2.1 Calculation Methodology and Assumptions

The site-specific meteorological data is collected and processed for a time period of one year from February 7, 2024 to February 6, 2025 to evaluate routine releases at the Project site. As noted in Section 2.7.3.1, two consecutive annual cycles of meteorological data should be provided at the time of submittal; however, if two years of on-site data are not available at the time the application is submitted, at least one annual cycle of meteorological data collected on-site should be provided at submittal.

The wind data consists of an hourly JFD of speed, direction, and Pasquill stability class derived from the MET tower location at the Project site.

The XOQDOQ code module of the NRCDose, version 2.3.10, computer code is used to calculate the χ/Q and D/Q factors. Using XOQDOQ module contained in the NRCDose computer code implements the assumptions outlined in Section C (excluding C.1.a and C.1.b) of RG 1.111.

The XOQDOQ code module of NRCDose is based on the theory that material released to the atmosphere will be normally distributed (Gaussian distribution) about the plume centerline. In predicting concentrations for longer time periods, the horizontal plume distribution is assumed to be evenly distributed within the directional sector. A straight-line trajectory is assumed between the point releases and all receptors in the models.

The XOQDOQ code uses the JFD to estimate the χ/Q and D/Q factors for each of the 16 sectors (22.5°), relative to the release location envelope, extending 50 mi. (80.5 km) radially outward at 16 radial distances for each sector. In the analysis, the release location envelope is at ground level over an area that covers the release point for each Plant Complex at the Project site. The unrestricted area boundary χ/Q and D/Q factors for the 16 sectors for each Plant Complex are conservatively estimated using the minimum distance from the Plant Complexes boundary to the unrestricted area boundary. Figures 2.7-64 through 2.7-66 present the shortest distances from the Plant Complexes boundary to the unrestricted area boundary for each directional sector for the North, Middle, and South Plant Complexes, respectively. Table 2.7-48 presents the distances from the Plant Complexes boundary to the unrestricted area boundary (i.e., EAB or site boundary) for each directional sector and each plant complex.

Many of the dose consequence analyses utilizing the χ/Q and D/Q factors determined in the analysis are prepared to address regulations applicable to the entire project site. Using the bounding χ/Q and D/Q factors for each Plant Complex is overly conservative because the bounding χ/Q and D/Q factors determined for each Plant Complex are not located at the same geographical location. Therefore, it is reasonable to determine χ/Q and D/Q factors for the three Plant Complexes at an unrestricted area boundary Maximally Exposed Location (MEL) that provides less conservative combined χ/Q and D/Q factors than the combined bounding χ/Q and D/Q factors for each Plant Complex. The unrestricted area boundary MEL is a fixed point for a receptor and could be in different sectors for each Plant Complex.

For the analysis, a sensitivity was performed to determine the unrestricted area boundary MEL that results in the maximum combined χ/Q and D/Q factors from all Plant Complexes at the Project site. The unrestricted area boundary MEL is determined to be located along the North Plant Complex EAB, in the northeast sector. The distances from the Middle and South Plant Complex power block boundary to the unrestricted area boundary MEL are shown in Table 2.7-48.

For conservatism, the MEL χ/Q factors for the Middle and South Plant Complexes are those for the directional sector that provides the largest χ/Q factors at a distance equal to the MEL distance from the Middle and South Plant Complexes. Tables 2.7-56 through 2.7-59 show the bounding χ/Q direction for distances of 0.25 mi. (0.40 km) and greater for the Project site is in the north directional sector. Therefore, the χ/Q factors for the Middle and South Plant Complexes are those in the north directional sector. The bounding D/Q direction for the Project site for distances 0.25 mi. (0.40 km) and greater is the northeast directional sector, which is the sector of the unrestricted area boundary MEL.

In addition, the χ/Q and D/Q factors are estimated for off-site receptor locations from the power block boundary of each Plant Complex. The off-site receptor locations are determined using the guidance from NUREG-1555. As such, per Section 5.4: Radiological Impacts of Normal Operation of NUREG-1555, off-site receptors that are to be considered for evaluation up to 5 mi. (8 km) from the site include the nearest residence, milk animals, meat animals, and vegetable gardens larger than 50 m^2 (538 ft^2). These receptors (nearest resident and nearest vegetable garden) and the associated data are listed in Table 2.7-49. No milk animals or meat animals are identified within 5 mi. (8 km) of the Project site; therefore, locations of milk animals or meat animals are not evaluated.

In accordance with RG 1.111, radiological decay and dry deposition are considered. For conservative estimates of radioactive decay, an overall half-life of 2.26 days is acceptable for short-lived noble gases released to the atmosphere and an overall half-life of eight days is

acceptable for iodines released to the atmosphere. In accordance with Regulatory Position 3.c of RG 1.111, wet deposition usually does not have a significant effect on the associated doses. Plume depletion via wet deposition is therefore not modeled in the analysis.

The maximum wind speed utilized in the analysis is 13 meters per second (m/s) (42.65 feet per second [ft/s]). The JFD information provides the highest wind speed interval that is not closed, referring to any wind in excess of 8 m/s (26.25 ft/s) without specifying the maximum value. The XOQDOQ code requires the minimum and maximum values for the wind speed interval to be specified (closed interval). Per NUREG/CR-2919, XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations (NRC, 1982), the maximum speed of an open interval can be assumed to be capped with a value that is five units greater than the largest specified interval limit. As such, use of 13 m/s (42.65 ft/s) is appropriate.

No building wake effect is credited in the XOQDOQ model (i.e., the building cross-sectional area for the dispersion analysis is assumed to be zero). Consistent with NUREG/CR-2919 (NRC, 1982), no credit for building wake reduces dispersion and is therefore conservative.

The XOQDOQ release model is developed assuming all routine effluent releases occur at ground level. No plume rise is calculated, and no elevated terrain corrections are applied. This assumption is conservative because the receptors are located at the ground level, and the ground release model for this scenario provides the bounding values for the χ/Q and D/Q values. The following parameters are utilized in the XOQDOQ model for ground release:

- The vent average velocity is 0 m/s (0 ft/s), consistent with Table 2.1 of NUREG/CR-2919 (NRC, 1982) for ground release.
- The vent inside diameter is 0 m (0 ft.), consistent with Table 2.1 of NUREG/CR-2919 for ground release.
- The height of the vent release point is 10-m (32.81 ft.) above plant grade level because XOQDOQ treats a ground release as a release that is 10 m (32.81 ft.) above ground level.
- The height of the vent's building is 10-m (32.81 ft.) above plant grade level, which is the same as the release height (for a ground release).
- The wind height used for the vent elevated release is 10-m (32.81 ft.) above plant grade level, consistent with Table 2.1 of NUREG/CR-2919 for ground release.
- The vent heat emission rate is 0 cal/s because this results in no additional plume rise due to buoyancy of the effluent.
- Default open terrain (e.g., recirculation) factors are utilized to represent plume recirculation in calm or light wind conditions.
- The option to correct χ/Q and D/Q values using standard correction factors for open terrain correction is used in the absence of site-specific diffusion test data. This is consistent with NUREG/CR-2919.

2.7.3.2.2 Summary of XOQDOQ Results

The χ/Q and D/Q factors for the Project site unrestricted area boundary for each Plant Complex are provided in Tables 2.7-50 through 2.7-52. The Project site unrestricted area boundary χ/Q and D/Q factors at the MEL for the North, Middle, and South Plant Complexes are provided in Table 2.7-53.

The off-site receptor χ/Q and D/Q factors for the nearest resident and nearest vegetable garden are provided in Tables 2.7-54 and 2.7-55, respectively.

The general χ/Q and D/Q factors as a function of distance from the release point for each Plant Complex at the Project site, extending to a distance of 50 mi. (80.5 km), are provided in Table 2.7-56 through Table 2.7-59. The largest values for the χ/Q and D/Q factors, for all 16 sectors within 50 mi. (80.5 km) of the envelope, are in the N sector for χ/Q factors and in the NE sector for D/Q factors. χ/Q and D/Q factors for segmented distances out to 50 mi. (80.5 km) from the Project site release envelope are provided in Tables 2.7-60 through 2.7-63.

The χ/Q and D/Q factors will be used to determine the radiological consequences of routine airborne releases from the Project site.

2.7.4 METEOROLOGICAL MONITORING

The primary source of meteorological data during early site permitting through construction is an on-site multi-level MET tower. The meteorological parameters measured at the on-site MET tower are listed below. The Meteorological Monitoring System at the Project site meets Regulatory Guide 1.23.

- Wind speed and direction – measured on an open-lattice tower at approximately 10 m (33 ft.) and 60 m (197 ft.) above ground level (AGL).
- Sigma-theta, the standard deviation of wind direction. Calculated for both the 10 m and 60 m level wind direction.
- Vertical temperature gradient, DeltaT is used to determine the Pasquill atmospheric stability class for air dispersion modeling.
- Ambient temperature – monitored at approximately 10 m (33 ft.) AGL. Temperature is also measured on the MET tower at the 60m level to determine the vertical temperature gradient and stability class.
- Precipitation – measured near ground level near the base of the MET tower.
- Atmospheric moisture based on DPT and RH measured at 10m AGL.

Table 2.7-24 shows that the specifications of the meteorological instruments installed on the MET tower comply with the guidance contained in Regulatory Guide 1.23.

Per Regulatory Guide 1.23, the tower or mast utilized to obtain these measurements should be placed in a location that can provide data representative of the atmospheric conditions into which material may be released and transported. The MET tower is located at latitude 36˚ 17’

10.067” N and longitude 80˚ 2’ 39.038” W at elevation 810 ft (246.9 m) and at the approximate grade level of the plant. The location of the on-site tower is shown in Figure 2.7-54.

In accordance with Regulatory Guide 1.23, Rev 1 meteorological instrument calibration and maintenance procedures support meeting a data recovery rate of at least 90 percent on an annual basis for each meteorological variable and annual JFDs of wind speed, wind direction, and stability class. Meteorological data are available in real-time for analysis. Time average accuracies for digital systems meet the criteria listed in Table 2 of Regulatory Guide 1.23.

Calibration of instruments and maintenance of the MET tower is performed or overseen by Duke Energy technical staff. The MET tower instrumentation maintenance and service scheduling intended to support compliance with Regulatory Guide 1.23, Rev 1 are summarized below (Duke Energy, 2024b).

- Instrument maintenance and servicing schedules. Semi-annual calibrations, daily data review, and monthly site checks.
- Data reduction and compilation. The ESC 8864 data logger meets the digital sampling and display rate requirements.
- Guy wires are inspected annually, and the guy wire anchors are inspected once every three years.

Table 2.7-1
Computed 100-Year Return-Interval Extreme Temperatures

Airport NWS Station	Design Temperature	Means and Standard Deviations of Extreme Annual Temperatures (°F)				Computed 100-Year Return Interval Extreme Temperatures (°F)	
		Mean		Std. Deviation			
		Min	Max	Min	Max	Min	Max
KGSO (1994 – 2019)	Dry Bulb	11.4	95.7	5.1	2.5	-4.6	103.5
	Wet Bulb (Non-Coincident)	9.3	78.3	4.5	1.4	-4.8	82.7
KINT (1994 – 2019)	Dry Bulb	12.4	95.5	5.1	2.6	-3.6	103.7
	Wet Bulb (Non-Coincident)	10.6	78.6	4.1	2.9	-2.3	87.7
KRDU (1994 – 2019)	Dry Bulb	12.3	99.0	5.3	3.0	-4.3	108.4
	Wet Bulb (Non-Coincident)	10.4	80.6	4.9	1.3	-5.0	84.7

Source: ASHRAE, 2021

Table 2.7-2
Annual Summary of KGSO National Weather Station Measurements
(1991 – 2020)

	Normal Dry Bulb Temp (˚F)	Normal Relative Humidity (%)	Mean Wind Speed (mph)	Prevailing Wind Direction[(a)] (degrees)	Normal Liquid Precipitation (in.)
Annual (1991 – 2020)	59.6	69	7.1	220	43.95

Source: NOAA NCEI, 2022a
Note:
(a) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.

Table 2.7-3
Annual Comparison of Meteorological Tower Measurements

	Measurement Level	Average Dry Bulb Temp (˚F)	Average Relative Humidity (%)	Average Wind Speed (mph)	Prevailing Wind Direction[(a)] (degrees)	Total Liquid Precipitation (in.)
Project site (2024-2025)	10-Meters	61.0	67.9	4.3	247	38.07
	60-Meters	60.4	--	7.8	285	--
KGSO (2022)	10-Meters	59.6	66.0	7.1	220	47.79
KRDU (2022)	10-Meters	62.7	67.0	6.0	240	44.74
KINT (1964)	10-Meters	59.3	69.0	7.5	240	47.34

Sources:
Project site = Belews Creek MET tower measurements; Total precipitation data from Belews Creek Nuclear Site Meteorological Data Recovery Document. Data Period: February 7, 2024–February 6, 2025
KGSO = NOAA NCEI, 2022a
KRDU = NOAA NCEI, 2022b
KINT = State Climate Office of North Carolina, NC State University, 2024
Note:
(a) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.

Table 2.7-4
10-Meter Joint Frequency Distribution by Wind Speed and Direction (2013 – 2023)
Recorded at KGSO

	Wind Speed										
Wind Direction	**< 0.5 (mph**	**0.50 - 1.10 (mph)**	**1.10 - 1.60 (mph)**	**1.60 - 2.10 (mph)**	**2.10 - 3.10 (mph)**	**3.10 - 4.10 (mph)**	**4.10 - 5.10 (mph)**	**5.10 - 6.10 (mph)**	**6.10 - 8.10 (mph)**	**>= 8.10 (mph)**	**Frequency of Wind Direction (%)**
Calm	16.40%	-	-	-	-	-	-	-	-	-	16.40%
N	0.00%	0.00%	1.13%	0.00%	1.73%	0.86%	0.42%	0.16%	0.08%	0.00%	4.39%
NNE	0.00%	0.00%	1.12%	0.00%	2.43%	1.73%	0.91%	0.41%	0.25%	0.03%	6.88%
NE	0.00%	0.00%	0.61%	0.00%	1.50%	1.65%	1.39%	0.94%	0.77%	0.20%	7.06%
ENE	0.00%	0.00%	0.52%	0.00%	1.34%	1.45%	1.08%	0.65%	0.54%	0.11%	5.69%
E	0.00%	0.00%	0.34%	0.00%	0.82%	0.70%	0.37%	0.19%	0.10%	0.02%	2.54%
ESE	0.00%	0.00%	0.20%	0.00%	0.44%	0.35%	0.20%	0.08%	0.03%	0.01%	1.30%
SE	0.00%	0.00%	0.23%	0.00%	0.46%	0.31%	0.20%	0.06%	0.03%	0.01%	1.28%
SSE	0.00%	0.00%	0.26%	0.00%	0.67%	0.59%	0.37%	0.16%	0.13%	0.04%	2.23%
S	0.00%	0.00%	0.47%	0.00%	1.41%	1.28%	0.85%	0.46%	0.31%	0.13%	4.91%
SSW	0.00%	0.00%	0.94%	0.00%	3.02%	2.15%	1.27%	0.73%	0.66%	0.19%	8.94%
SW	0.00%	0.00%	1.02%	0.00%	3.10%	2.99%	2.01%	1.26%	1.08%	0.36%	11.82%
WSW	0.00%	0.00%	0.60%	0.00%	2.02%	2.01%	1.34%	0.76%	0.59%	0.15%	7.47%
W	0.00%	0.00%	0.54%	0.00%	1.31%	1.29%	0.80%	0.44%	0.41%	0.17%	4.95%
WNW	0.00%	0.00%	0.46%	0.00%	0.99%	0.89%	0.71%	0.53%	0.67%	0.37%	4.61%
NW	0.00%	0.00%	0.55%	0.00%	1.16%	1.12%	1.00%	0.69%	0.95%	0.64%	6.10%
NNW	0.00%	0.00%	0.56%	0.00%	1.00%	0.78%	0.48%	0.31%	0.22%	0.07%	3.42%
Frequency of Wind Speed (%)	16.40%	0.00%	9.52%	0.00%	23.40%	20.15%	13.40%	7.82%	6.82%	2.49%	

Source: NOAA NCEI, 2024. Index of Public Data, U.S. Air Force Station ID: 723170, NCDC WBAN Number: 13723, 2013 – 2023

Table 2.7-5
10-Meter Joint Frequency Distribution by Wind Speed and Direction
Recorded at the Project Site (10 Meters) (2024 – 2025)

	Wind Speed										
Wind Direction	**< 0.5 (mph**	**0.50 - 1.10 (mph)**	**1.10 - 1.60 (mph)**	**1.60 - 2.10 (mph)**	**2.10 - 3.10 (mph)**	**3.10 - 4.10 (mph)**	**4.10 - 5.10 (mph)**	**5.10 - 6.10 (mph)**	**6.10 - 8.10 (mph)**	**>= 8.10 (mph)**	**Frequency of Wind Direction (%)**
Calm	3.47%	-	-	-	-	-	-	-	-	-	3.47%
N	0.12%	0.60%	1.28%	1.05%	1.20%	0.24%	0.00%	0.00%	0.00%	0.00%	4.49%
NNE	0.12%	0.55%	1.03%	1.28%	0.58%	0.13%	0.04%	0.00%	0.00%	0.00%	3.72%
NE	0.27%	0.52%	1.15%	1.56%	0.62%	0.04%	0.01%	0.00%	0.00%	0.00%	4.17%
ENE	0.24%	0.71%	1.93%	2.25%	0.96%	0.01%	0.01%	0.00%	0.00%	0.00%	6.11%
E	0.12%	0.82%	2.16%	2.73%	1.49%	0.07%	0.00%	0.00%	0.00%	0.00%	7.38%
ESE	0.18%	0.78%	1.01%	1.18%	1.00%	0.18%	0.01%	0.05%	0.02%	0.00%	4.41%
SE	0.42%	0.70%	0.55%	0.51%	0.27%	0.01%	0.02%	0.00%	0.00%	0.00%	2.48%
SSE	0.30%	1.00%	1.30%	0.77%	0.87%	0.07%	0.05%	0.11%	0.06%	0.00%	4.52%
S	0.39%	1.08%	1.79%	2.14%	2.35%	0.43%	0.12%	0.02%	0.00%	0.00%	8.31%
SSW	0.12%	0.68%	1.73%	2.99%	3.39%	0.9%	0.30%	0.04%	0.01%	0.00%	10.14%
SW	0.27%	1.09%	1.66%	2.55%	4.54%	1.49%	0.46%	0.14%	0.02%	0.00%	12.22%
WSW	0.12%	1.01%	1.33%	1.11%	2.63%	1.00%	0.28%	0.01%	0.00%	0.00%	7.49%
W	0.18%	0.96%	0.97%	1.11%	1.62%	0.94%	0.21%	0.12%	0.01%	0.00%	6.13%
WNW	0.15%	0.96%	0.95%	1.11%	2.46%	1.54%	0.76%	0.34%	0.05%	0.00%	8.32%
NW	0.30%	1.03%	1.00%	0.55%	1.08%	1.14%	0.91%	0.43%	0.06%	0.01%	6.49%
NNW	0.21%	0.84%	0.88%	0.58%	0.59%	0.38%	0.12%	0.01%	0.00%	0.00%	3.61%
Frequency of Wind Speed (%)	3.47%	13.32%	20.7%	23.49%	25.64%	8.56%	3.31%	1.27%	0.24%	0.01%	

Source: Belews Creek MET tower measurements. Data Period: February 7, 2024–February 6, 2025

Table 2.7-6
Mean Wind Speeds and Prevailing Wind Direction Observed at KGSO

Month	Mean Wind Speed[a] (mph)	Prevailing Wind Direction[b][d][f] (degrees)	Max 2-Minute Speed[c] (mph)	Wind Direction for Max 2-Minute Wind Speed[c][d][f] (degrees)	Max 3-Second Speed[c] (mph)	Wind Direction for Max 3-Second Wind Speed[c][d][f] (degrees)
January	7.6	220	41	190	54	60
February	8.0	220	43	260	54	230
March	8.5	220	49	300	61	290
April	8.6	220	43	160	62	280
May	7.4	220	62	270	82	260
June	6.7	240	47	290	60	290
July	6.3	230	53	290	74	290
August	5.8	230	40	120	59	280
September	6.2	30	46	260	60	250
October	6.2	30	40	180	51	180
November	6.7	220	38	20	48	240
December	7.0	220	39	290	53	300
Annual	7.1	220	62[e]	270[e]	82[e]	260[e]

Source: NOAA, NCEI, 2022a
Notes:
(a) 1983 – 2022.
(b) 1969 – 2022.
(c) 1996 – 2022.
(d) Direction from which the wind blows.
(e) May 2000.
(f) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.

Table 2.7-7
Average Wind Speeds and Prevailing Wind Direction Recorded at the Project Site (10 Meters) (2024-2025)

Month	Average Wind Speed (mph)	Prevailing Wind Direction (degrees)[(a)]	Daily Maximum Wind Speed (mph)
January	5.1	287	13.9
February	4.9	246	16
March	4.6	170	14.6
April	5.4	227	15.7
May	3.7	219	11.1
June	4.0	209	9.3
July	4.1	210	9.5
August	3.4	261	19.2
September	3.8	81	17.3
October	3.4	320	9.8
November	4.2	284	11.9
December	4.5	317	17.1
Annual	4.3	247	19.2

Source: Belews Creek MET tower measurements. Data Period: February 7, 2024–February 6, 2025
Note:
(a) Wind direction in the upwind direction from which the wind is coming. Zero degrees indicates a wind from the north.

Table 2.7-8
Wind Direction Persistence Distribution (Hours) for the Project Site (10 Meters) (2024-2025)

	Hours									
Direction	**1**	**2**	**3**	**4**	**5-6**	**7-8**	**9-10**	**11-12**	**13-14**	**>15**
N	128	39	15	9	9	3	0	1	0	0
NNE	150	37	16	0	5	0	1	0	0	0
NE	159	44	14	7	4	0	0	0	0	0
ENE	213	71	29	7	5	1	0	0	0	0
E	185	62	32	17	10	2	4	1	2	0
ESE	158	38	15	4	5	2	0	0	0	1
SE	118	26	3	1	1	0	0	0	0	0
SSE	147	48	16	6	5	2	1	0	0	0
S	231	86	38	9	16	5	1	0	0	0
SSW	305	86	44	17	14	8	0	2	1	0
SW	297	112	51	31	22	7	2	1	0	1
WSW	276	78	21	17	9	2	0	0	0	0
W	243	70	15	10	7	0	0	0	0	0
WNW	209	61	21	15	18	4	7	2	2	0
NW	179	55	16	14	13	4	4	0	0	0
NNW	141	30	17	6	2	1	0	0	0	0

Source: 2024–2025 composite based on Belews Creek hourly wind direction and speed. Data Period: February 7, 2024–February 6, 2025

Table 2.7-9
Air Temperatures Recorded at KGSO

	Normal Daily Maximum (˚F)	Normal Dry Bulb (˚F)	Normal Daily Minimum (˚F)	Highest Daily Maximum (˚F)	Lowest Daily Minimum (˚F)
Period of Record (years)	**30**[(a)]	**30**[(a)]	**30**[(a)]	**94**[(d)]	**94**[(d)]
January	49.3	39.7	30.1	78	-8
February	53.3	43.0	32.7	81	-4
March	61.3	50.3	39.3	90	5
April	71.0	59.4	47.9	94	21
May	78.0	67.5	57.1	98	32
June	85.2	75.3	65.4	102	42
July	88.5	78.9	69.3	102	48
August	86.6	77.3	68.0	103	45
September	80.4	71.0	61.5	100	35
October	71.0	60.2	49.4	95	20
November	60.6	49.7	38.9	85	10
December	52.0	42.5	33.0	78	0
Annual	69.8	59.6	49.4	103[(b)]	-8[(c)]

Source: NOAA, NCEI, 2022a
Notes:
(a) 1991 – 2020.
(b) August 1988.
(c) January 1985.
(d) 1928 – 2022.

Table 2.7-10
Air Temperatures Recorded at the Project Site (10 Meters) (2024-2025)

	Dry Bulb Temperature			Wet Bulb Temperature		
	Daily Average (˚F)	Daily Minimum (˚F)	Daily Maximum (˚F)	Daily Average (˚F)	Daily Minimum (˚F)	Daily Maximum (˚F)
January	36.1	15.8	66.7	30.5	12.6	59.9
February	48.7	29.3	72.9	42.3	24	61.5
March	54.4	32.7	80.4	46.6	27.1	60.5
April	61.9	38.3	84.9	53.7	32.9	66.9
May	68.6	51.8	85.6	62.7	47.9	71.5
June	76.6	54.5	94.1	68.2	54.2	78.0
July	78.8	61.7	97.3	71.8	57.4	77.8
August	76.1	60.6	93.9	70.6	60.3	78.2
September	70.7	56.5	84.9	66.2	51.4	76.5
October	62.0	42.1	79.3	56.0	39	71.3
November	55.0	30.7	80.6	49.6	25.8	69.4
December	42.8	23.4	66.7	38.9	19.9	61.7
Annual	61.0	15.8	97.3	54.8	12.6	78.2

Source: Belews Creek MET Tower measurements. Data Period: February 7, 2024–February 6, 2025

Table 2.7-11
Humidity Values Recorded at KGSO

	Mean Dry Bulb Temperature (°F)[a]	Mean Wet Bulb Temperature (°F)[b]	Mean Dewpoint Temperature (°F)[b]	Normal Relative Humidity (%)	Mean Absolute Humidity (grams/cubic meter)
January	39.0	30.9	30.0	67	4
February	39.9	33.9	32.1	64	4
March	49.2	39.1	38.4	62	6
April	57.7	47.6	46.9	61	7
May	66.9	57.7	57.1	70	12
June	73.6	65.2	64.9	72	15
July	77.8	69.0	68.8	74	17
August	76.5	68.3	68.1	76	17
September	69.6	62.5	62.2	77	14
October	59.5	52.0	51.2	73	10
November	48.5	41.1	40.8	69	6
December	41.0	34.4	32.8	68	5
Annual	58.3	50.1	49.4	69	9

Source: Humidity from Singh, 2024**.** Temperatures and Dewpoints (°F) and Normal Relative Humidity from NOAA, NCEI, 2022a.
Notes:
(a) Period of record = 120 years.
(b) Period of record = 38 years.

Table 2.7-12
Humidity Values Recorded at the Project Site (2024-2025)

	Daily Average Dry Bulb Temperature (°F)	Daily Average Wet Bulb Temperature (°F)	Daily Average Dewpoint Temperature (°F)	Daily Average Relative Humidity (%)	Daily Average Absolute Humidity (grams/cubic meter)
January	36.1	30.47	18.97	53	3
February	48.7	42.3	33.4	59	5
March	54.4	46.6	36.7	58	6
April	61.9	53.7	46.3	60	9
May	68.6	62.7	58.9	75	13
June	76.6	68.2	63.8	67	15
July	78.8	71.8	68.5	73	18
August	76.1	70.6	68.0	78	18
September	70.7	66.2	63.7	80	15
October	62.0	56.0	51.3	71	10
November	55.0	49.6	43.9	69	8
December	42.8	38.9	32.5	70	5
Annual	61.0	54.7	48.8	68	10

Sources:
Humidity = Singh, 2024.
Temperatures and Dewpoints (°F) and Relative Humidity = Belews Creek MET Tower measurements. Data Period: February 7, 2024–February 6, 2025

Table 2.7-13
Historical Precipitation Data Recorded at KGSO

	Normal Monthly (in.)	Maximum Monthly (in.)	Minimum Monthly (in.)	Maximum in 24 hours (in.)	Normal No. Days with Precipitation (≥ 0.01 in.)	Days with Thunderstorms
Period of Record (years)	30[a]	94	94	94	30[a]	75
January	3.39	8.24	0.66	3.06	9.8	0.5
February	2.81	7.23	0.49	3.69	9.5	0.6
March	3.72	8.76	0.67	3.62	10.9	2.0
April	3.78	8.03	0.41	4.42	9.7	3.4
May	3.49	9.45	0.37	3.25	10.8	6.3
June	4.09	10.50	Trace[e]	4.91	10.6	7.7
July	4.18	12.72	0.98	4.43	11.3	10.1
August	4.36	12.53	0.71	5.14	10.2	7.8
September	4.59	13.26	Trace[f]	7.49[d]	8.3	3.1
October	3.10	12.59	0.26	6.24	7.5	1.0
November	3.27	8.26	0.24	3.56	8.2	0.5
December	3.17	6.99	0.33	3.60	9.2	0.3
Annual	43.95	13.26[b]	0.24[c]	7.49[d]	116.0	43.3

Notes:
(a) 1991-2020.
(b) September 1947.
(c) November 2012.
(d) September 1947.
(e) June 1990.
(f) September 1985.
Source: NOAA, NCEI, 2022a

Table 2.7-14
Precipitation (Inches) Recorded at the Project Site (2024-2025)[(a)]

	Monthly Total (in.)	Maximum in 1 hour (in.)	Maximum in 24 hours (in.)
January	1.74	0.31	1.06
February	1.82	0.29	1.13
March	4.64	0.28	1.09
April	2.27	0.77	1.47
May	5.15	0.52	1.64
June	1.87	0.96	1.3
July	2.89	1.28	1.79
August	5.98	0.83	4.23
September	7.08	0.60	3.11
October	0.45	0.15	0.25
November	1.35	0.23	0.87
December	2.83	0.17	1.36
Annual	38.07	1.28	4.23

Source: Belews Creek MET Tower measurements; Monthly and Annual Totals from Belews Creek Nuclear Site Meteorological Data Recovery Document.
Note:
(a) Data Period: February 7, 2024–February 6, 2025.

Table 2.7-15
Precipitation Frequency by Wind Speed Direction for the Project Site (2024-2025)[(a)]

Project site Wind Direction (blowing from)	Percent Occurrence of Belews Creek Precipitation						
	All Precipitation	Precip. 0.5 - 2.1 mm/hr	Precip. 2.1 - 3.6 mm/hr	Precip. 3.6 – 5.7 mm/hr	Precip. 5.7 – 8.8 mm/hr	Precip. 8.8 – 11.1 mm/hr	Precip. >11.1 mm/hr
N	0.48	0.24	0.07	0.09	0.05	0.01	0.02
NNE	0.47	0.28	0.01	0.13	0.02	0.00	0.03
NE	0.51	0.32	0.08	0.06	0.05	0.00	0.01
ENE	0.20	0.17	0.00	0.02	0.00	0.00	0.01
E	0.26	0.15	0.02	0.08	0.00	0.00	0.01
ESE	0.22	0.13	0.05	0.02	0.00	0.02	0.00
SE	0.10	0.07	0.01	0.02	0.00	0.00	0.00
SSE	0.09	0.05	0.01	0.01	0.00	0.01	0.01
S	0.34	0.24	0.05	0.02	0.00	0.00	0.03
SSW	0.33	0.21	0.05	0.05	0.01	0.01	0.01
SW	0.28	0.13	0.03	0.03	0.05	0.01	0.03
WSW	0.42	0.22	0.03	0.10	0.00	0.02	0.05
W	0.90	0.44	0.09	0.15	0.10	0.05	0.08
WNW	0.64	0.39	0.06	0.02	0.06	0.03	0.08
NW	0.18	0.10	0.02	0.02	0.01	0.00	0.02
NNW	0.17	0.15	0.01	0.01	0.00	0.00	0.00

Source: Belews Creek MET Tower measurements; Belews Creek Nuclear Site Meteorological Data Recovery Document. Data Period: February 7, 2024–February 6, 2025
Note:
Precipitation wind roses developed using WRPlot software are only in mm/hr. The precipitation frequency displayed in WRPLOT represents the percentage of time that rain of a particular intensity occurred. During this data period, rain occurred 5.59% of the time.

Table 2.7-16
Historical Snowfall Data Recorded at KGSO

	Normal Monthly (in.)	Maximum Monthly (in.)	Maximum in 24 hours (in.)	Maximum Snow Depth (in.)	Normal Number of Days with Snowfall ≥ 1.0 in.
Period of Record (years)	30[(a)]	94	94	74	30[(a)]
January	2.9	22.9[(b)]	14.0	15 [(d)]	0.8
February	2.0	16.3	9.3	13	0.7
March	0.9	21.3	11.1	14	0.3
April	0.0	Trace	Trace	0	0.0
May – October	0.0	Trace	Trace	0	0.0
November	0.1	5.9	5.0	4	0.0
December	1.2	14.3	14.3[(c)]	10	0.4
Annual	7.1	22.9[(b)]	14.3[(c)]	15[(d)]	2.2

Notes:
(a) 1991-2020.
(b) January 1966.
(c) December 1930.
(d) January 1966.
Source: NOAA, NCEI, 2022a

Table 2.7-17
Classification of Pasquill Atmospheric Stability

Stability Classification	Pasquill Categories	Temperature change with height (°C/100m)
Extremely unstable	A	$\Delta T \leq -1.9$
Moderately unstable	B	$-1.9 < \Delta T \leq -1.7$
Slightly unstable	C	$-1.7 < \Delta T \leq -1.5$
Neutral	D	$-1.5 < \Delta T \leq -0.5$
Slightly stable	E	$-0.5 < \Delta T \leq 1.5$
Moderately stable	F	$1.5 < \Delta T \leq 4.0$
Extremely stable	G	$\Delta T > 4.0$

Notes:
(a) This table is listed as Table 1 in Regulatory Guide 1.23.
(b) ΔT is the 60-10 m temperature differential (Delta-T). Actual DeltaT data must be normalized to a standard 100m vertical separation distance between instrument levels to compare to RG 1.23 ranges for determining stability categories. This may be referred to as the normalized lapse rate, derived from the DeltaT measurements.

Table 2.7-18
Total Distribution in Each Stability Class for the Project Site

Stability Class	Hours	Percentage
A	1,860	21.6%
B	466	5.4%
C	494	5.7%
D	2,671	31.0%
E	2,343	27.2%
F	589	6.8%
G	200	2.3%
Unstable (Classes A-C)	2,820	32.7%
Neutral (Class D)	2,671	31.0%
Stable (Class E-G)	3,132	36.3%

Source: Belews Creek, NC Site February 7, 2024, through February 6, 2025

Table 2.7-19
Frequency Distribution of Consecutive Hours in Each Stability Class for the Project Site (Stability Class A through D)

Persistence (Number of Consecutive Hours)	Number of Occurrences			
	A ($\Delta T \leq -1.9$)	B ($-1.9 < \Delta T \leq -1.7$)	C ($-1.7 < \Delta T \leq -1.5$)	D ($-1.5 < \Delta T \leq -0.5$)
2	15	49	47	113
3	6	16	24	55
4	11	9	14	56
5	8	5	7	36
6	9	2	6	25
7	17	3	0	31
8	23	1	0	41
9	33	0	0	19
10	30	1	0	15
11	24	1	0	11
12	15	0	0	3
13	13	0	0	3
14	1	0	0	4
15	1	0	0	7
16	2	0	0	5
17	0	0	0	1
18	0	0	0	1
19	0	0	0	0
20	2	0	0	2
21	1	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	2
25	0	0	0	1
26	0	0	0	1
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	1
32	0	0	0	0

Notes:
ΔT is the 60–10 m temperature differential.
This table shows the number of cases when each stability class persisted for two or more hours.
Data Period: Belews Creek, NC Site February 7, 2024, through February 6, 2025.

Table 2.7-20
Frequency Distribution of Consecutive Hours in Each Stability Class for the Project Site (Stability Class E through G)

Persistence (Number of Consecutive Hours)	Number of Occurrences			
	E (-0.5 < ΔT ≤ 1.5)	F (1.5<ΔT≤4.0)	G (ΔT>4.0)	All Inversion Conditions (E-G)
2	107	57	11	175
3	50	25	14	89
4	34	16	4	54
5	30	9	4	43
6	28	8	3	39
7	12	6	3	21
8	16	1	0	17
9	8	3	0	11
10	10	4	1	15
11	11	0	2	13
12	4	0	0	4
13	9	0	0	9
14	8	1	0	9
15	8	0	0	8
16	12	0	0	12
17	8	0	0	8
18	4	0	0	4
19	1	0	0	1
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0

Notes:
ΔT is the 60–10 m temperature differential.
This table shows the number of cases when each stability class persisted for two or more hours.
Data Period: Belews Creek, NC Site February 7, 2024, through February 6, 2025.

Table 2.7-21
Seasonal and Annual Average Mixing Heights at Greensboro, NC

	Morning		Afternoon	
Season[a,b,c]	**(m)**	**(ft.)**	**(m)**	**(ft.)**
Winter	465	1526	858	2816
Spring	476	1562	1538	5046
Summer	472	1547	1609	5278
Fall	379	1243	1143	3749
Annual	448	1470	1299	4262

Notes:
(a) Source: USEPA, 2024k.
(b) POR 1984-1987 and 1989-1991 (SCRAM station #13723.
(c) The USEPA SCRAM data files were last modified Jan. 5, 2001, and the SCRAM description indicates they were originally created on July 7, 1992.
Key: ft. = feet; m = meter.

Table 2.7-22
Fog Occurrence at KGSO

Month	Number of Days with Heavy Fog (visibility ≤ 0.25 mi.)
January	3.8
February	2.8
March	2.4
April	1.3
May	1.5
June	1.2
July	1.3
August	1.8
September	2.3
October	2.3
November	2.6
December	3.3
Annual	26.6
Period of Record (years)	59

Source: NOAA, NCEI, 2022a

Table 2.7-23
Point Precipitation (Inches) by Recurrence Interval for Region

Duration	Recurrence Intervals (Years)						
	1	2	5	10	25	50	100
5 minutes	0.4	0.4	0.5	0.6	0.6	0.7	0.7
10 minutes	0.6	0.7	0.8	0.9	1.0	1.1	1.1
15 minutes	0.7	0.9	1.1	1.2	1.3	1.3	1.4
30 minutes	1.0	1.2	1.5	1.7	1.9	2.0	2.2
1 hour	1.3	1.5	1.9	2.2	2.5	2.7	3.0
2 hours	1.5	1.8	2.3	2.6	3.1	3.4	3.8
3 hours	1.6	2.0	2.5	2.8	3.3	3.7	4.1
6 hours	2.0	2.4	3.0	3.5	4.1	4.6	5.1
12 hours	2.4	2.9	3.6	4.2	5.0	5.7	6.4
24 hours	2.8	3.4	4.3	5.0	6.1	6.9	7.8
2 days	3.3	4.0	5.0	5.8	6.9	7.8	8.8
4 days	3.7	4.5	5.6	6.4	7.7	8.7	9.7
7 days	4.2	5.1	6.2	7.2	8.5	9.5	10.6
10 days	4.8	5.7	7.0	7.9	9.3	10.4	11.5

Notes:
Data from the NOAA Atlas 14, Volume 2, Version 3, Point Precipitation Frequency Estimates: NC.

Table 2.7-24
Summary of Meteorological Equipment Used at the Project Site

Meteorological Equipment Upgrade	Specifications	Measurement Levels	Meets Guidance[c]	
			Yes	No
RM Young 05305V Wind Monitor-AQ (wind speed)	±0.2 m/s (±0.45 mph) or 5% of observed wind speed starting threshold < 0.4 m/s (0.89 mph)	60 m and 10 m	X	
RM Young 05305V Wind Monitor-AQ (wind direction)	±5 degree starting threshold < 0.4 m/s (0.89 mph)	60 m and 10 m	X[d]	
RM Young 41342VC Temperature Probe Delta[a]	±0.1 °C (±0.18 °F)	60 m and 10 m	X	
RM Young 41342VC Temperature Probe	±0.5 °C (±0.9 °F)	60 m and 10 m	X	
RM Young 52202-20 Rain Gage	±10% for a volume equivalent to 2.54 mm (0.1 in.) of precipitation at a rate < 50 mm/hr (<2 in/hr)	Ground	X	
RM Young Aspirated Radiation Shield	Required for NIST	60 m and 10 m	X	
ESC 8864 Data Logger	N/A	N/A	X	
Sierra Wireless Modem – Duke Energy Approved	N/A	N/A	X	
RM Young Model 41382VC Relative Humidity / Temperature[b]	±4%	10 m	X	

Notes:
(a) Delta-T is derived from the ambient temperature measurements between 60 m and 10 m. The two temperature probes are matched and calibrated together to achieve higher accuracy for Delta-T (i.e., ±0.1 °C or ±0.18 °F) than would be achievable from using individual temperature readings.
(b) For computation of the dewpoint temperature.
(c) Applicable guidance is RG 1.23 Rev 1 or ANS-3.11-2024.
(d) The RM Young specs state that the starting threshold for the wind direction sensor (05305V) is 0.5 m/s at 10-degree displacement, but incorrectly states that 0.5 m/s would be equivalent to 1 mph (0.5 m/s =1.12 mph, so it does not completely meet RG 1.23 guidance for starting threshold). However, the RM Young wind direction does meet guidance in ANS-3.11-2024 for a starting threshold of 0.5 m/s (ref. Section 3.1.2 in ANS-3.11-2024) and accuracy of 5 degrees. It would, however, meet the ANS-3.11-2024 guidance for accuracy and starting threshold.
Key: mm = millimeter, N/A = not applicable, NIST = National Institute of Standards and Technology

Table 2.7-25
Design-Basis Temperatures for KGSO, KRDU, and KINT
(Sheet 1 of 2)

Temperature Variable	KGSO (˚F)	KRDU (˚F)	KINT(˚F)
Normal DBT	59.6	61.2	59.7
Mean DBT	58.3	60.0	58.0
Mean WBT	50.1	52.0	50.7
Maximum Normal DBT	69.8	72.0	NA
Maximum Mean DBT	95.7	99.0	95.5
Maximum Mean WBT	78.3	80.6	78.6
Minimum Normal DBT	49.4	50.5	NA
Minimum Mean DBT	11.4	12.3	12.4
Minimum Mean WBT	9.3	10.4	10.6
DBT with Annual Exceedance Probability of 0.4 %	92.4	95.0	92.2
Mean Coincident WBT With Annual Exceedance Probability of 0.4%	74.0	75.6	73.5
DBT With Annual Exceedance Probability of 1.0 %	90.3	92.6	90.3
Mean Coincident WBT With Annual Exceedance Probability of 1.0%	73.5	75.1	73.0
DBT With Annual Exceedance Probability of 2.0 %	88.2	90.3	88.3
Mean Coincident WBT With Annual Exceedance Probability of 2.0%	72.9	74.5	72.4
WBT (Non-Coincidence) With Annual Exceedance Probability of 0.4%	77.0	78.4	76.4
WBT (Non-Coincidence) With Annual Exceedance Probability of 1.0%	75.8	77.4	75.3
Mean Coincident WBT With Annual Exceedance Probability of 1.0%	73.5	75.1	73.0
DBT With Annual Exceedance Probability of 2.0%	88.2	90.3	88.3

Table 2.7-25
Design-Basis Temperatures for KGSO, KRDU, and KINT
(Sheet 2 of 2)

Temperature Variable	KGSO (˚F)	KRDU (˚F)	KINT (˚F)
Mean Coincident WBT With Annual Exceedance Probability of 2.0%	72.9	74.5	72.4
WBT (Non-Coincidence) With Annual Exceedance Probability of 0.4%	77.0	78.4	76.4
WBT (Non-Coincidence) With Annual Exceedance Probability of 1.0%	75.8	77.4	75.3

Source: ASHRAE, 2021; NCEI 2022a; NCEI 2022b; State Climate Office of North Carolina, 2024.

Table 2.7-26
National Ambient Air Quality Standards

Pollutant	Primary/ Secondary Standard	Averaging Period	Level ($\mu g/m^3$)	Level (ppm)
CO [(a)]	Primary	1 hr.	--	35
CO [(a)]	Primary	8 hr.	--	9
Lead [(b)]	Primary and secondary	Rolling 3-month average	0.15	--
NO_2 [(c)]	Primary	1 hr.	--	0.1
NO_2	Primary and secondary	Annual	--	0.053
Ozone [(d)]	Primary and secondary	8 hr.	--	0.070
$PM_{2.5}$ [(e)]	Primary and secondary	24 hr.	35	--
$PM_{2.5}$	Primary	Annual	9.0	--
$PM_{2.5}$	Secondary	Annual	15.0	--
PM_{10} [(f)]	Primary and secondary	24 hr.	150	--
SO_2 [(g)]	Primary	1 hr.	--	0.075
SO_2 [(a)]	Secondary	3 hr.	--	0.5

Notes:
(a) Not to be exceeded more than once per year.
(b) In areas designated nonattainment for the Pb standards prior to promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have been submitted and approved, the previous standards (1.5 $\mu g/m^3$ calendar quarter average) also remain in effect.
(c) 98th percentile of 1-hr. daily maximum concentrations averaged over three years.
(d) Annual fourth-highest daily maximum 8-hr. concentration averaged over three years.
(e) 98th percentile averaged over three years.
(f) Not to be exceeded more than once per year on average over three years.
(g) 99th percentile of 1-hr. daily maximum concentrations averaged over three years.
Key: CO = carbon monoxide; NO_2 = nitrogen dioxide; Pb = lead; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than 2.5 µm; PM_{10} = particulate matter with an aerodynamic diameter less than 10 µm; SO_2 = sulfur dioxide

Table 2.7-27
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class A (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	1	1	4	5	7	1	0	0	0	0	0	19
NNE		0	0	2	4	7	22	7	1	1	0	0	0	44
NE		0	0	1	6	12	28	19	2	1	0	0	0	69
ENE		0	2	2	11	27	94	45	1	1	0	0	0	183
E		0	0	3	14	41	82	70	3	0	0	0	0	213
ESE		0	1	5	8	11	41	28	2	0	0	0	0	96
SE		0	0	2	4	7	23	14	1	1	0	0	0	52
SSE		0	0	1	9	12	23	30	2	1	5	1	0	84
S		0	0	4	3	5	30	49	13	1	0	0	0	105
SSW		0	1	1	3	5	15	46	25	7	1	0	0	104
SW		0	2	5	4	7	33	105	68	20	8	1	0	253
WSW		0	0	3	6	10	26	88	50	18	0	0	0	201
W		0	2	3	7	5	20	38	27	8	10	1	0	121
WNW		0	1	3	8	10	14	46	46	22	21	4	0	175
NW		1	0	1	5	10	7	3	8	16	7	0	1	59
NNW		0	0	1	6	5	6	2	1	0	0	0	0	21
Total	0	1	10	38	102	179	471	591	250	97	52	7	1	1799

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-28
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class B (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	0	0	0	0	5	2	2	0	0	0	0	9
NNE		0	0	0	2	1	7	2	0	0	0	0	0	12
NE		0	0	0	3	4	6	6	0	0	0	0	0	19
ENE		2	1	5	3	6	13	16	0	0	0	0	0	46
E		0	0	8	15	14	39	11	2	0	0	0	0	89
ESE		0	1	3	3	6	7	8	0	0	0	0	0	28
SE		0	0	3	1	3	1	4	0	0	0	0	0	12
SSE		0	0	1	0	5	5	6	2	1	1	0	0	21
S		0	0	0	2	3	4	12	0	0	0	0	0	21
SSW		0	0	0	2	1	14	20	5	4	1	1	0	48
SW		0	1	4	2	2	6	19	6	4	1	1	0	46
WSW		0	1	3	1	0	3	9	3	1	0	0	0	21
W		0	0	3	3	2	4	12	1	0	0	0	0	25
WNW		0	0	2	2	2	5	5	4	1	1	0	0	22
NW		0	0	2	1	2	2	3	4	8	3	1	0	26
NNW		0	0	1	1	1	0	2	1	0	0	0	0	6
Total	2	2	4	35	41	52	121	137	30	19	7	3	0	453

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-29
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class C (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	0	1	2	1	7	6	1	0	0	0	0	18
NNE		0	0	0	2	2	9	5	0	0	0	0	0	18
NE		0	0	0	3	3	16	4	0	0	0	0	0	26
ENE		0	0	2	10	7	7	9	0	0	0	0	0	35
E		0	5	4	13	9	21	9	0	0	0	0	0	61
ESE		0	3	4	4	5	7	10	1	0	0	0	0	34
SE		0	0	1	1	3	2	2	0	0	0	0	0	9
SSE		0	0	1	0	2	2	5	1	1	1	0	0	13
S		0	0	0	1	3	13	14	2	1	1	0	0	35
SSW		0	0	0	2	2	15	24	13	3	1	0	0	60
SW		0	0	1	6	2	6	23	1	3	3	0	0	45
WSW		0	0	0	1	2	8	8	3	0	0	0	0	22
W		1	1	0	4	2	2	6	2	0	0	0	0	18
WNW		0	0	0	4	2	5	10	4	5	0	0	0	30
NW		1	0	0	4	0	5	10	13	8	2	3	0	46
NNW		0	0	0	0	1	8	4	0	1	0	0	0	14
Total	1	2	9	14	57	46	133	149	41	22	8	3	0	485

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-30
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class D (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		0	2	8	24	24	30	42	11	0	0	0	0	141
NNE		0	4	10	25	24	52	30	10	2	0	0	0	157
NE		0	7	10	20	21	73	21	1	0	0	0	0	153
ENE		1	7	19	35	43	66	11	0	0	0	0	0	182
E		1	6	13	19	28	60	28	1	0	0	0	0	156
ESE		3	8	9	19	11	28	26	9	1	4	2	0	120
SE		3	3	8	11	5	14	3	0	1	0	0	0	48
SSE		2	3	8	10	7	16	16	1	1	2	4	0	70
S		1	3	6	13	27	33	62	14	3	1	0	0	163
SSW		0	5	7	17	29	81	122	24	8	0	0	0	293
SW		2	7	14	16	16	63	138	28	7	0	0	0	291
WSW		2	10	15	17	21	20	78	22	4	1	0	0	190
W		2	7	16	9	12	24	27	38	7	0	0	0	142
WNW		2	8	9	11	14	36	61	44	30	2	0	0	217
NW		2	5	8	13	8	9	36	45	37	23	1	0	187
NNW		2	2	15	11	8	16	14	22	8	1	0	0	99
Total	21	23	87	175	270	298	621	715	270	109	34	7	0	2630

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-31
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class E (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		1	10	19	14	32	40	50	6	0	0	0	0	172
NNE		3	13	14	13	6	17	4	0	0	0	0	0	70
NE		6	10	12	15	10	8	2	0	0	0	0	0	63
ENE		3	12	6	13	7	10	0	0	0	0	0	0	51
E		1	9	14	15	13	28	8	0	0	0	0	0	88
ESE		2	10	12	7	9	16	12	3	0	0	0	0	71
SE		6	15	14	6	4	3	0	0	0	0	0	0	48
SSE		4	6	13	12	7	6	12	0	0	0	0	0	60
S		7	9	21	26	26	56	41	7	5	0	0	0	198
SSW		3	8	14	29	28	94	65	8	3	0	0	0	252
SW		3	20	19	28	29	85	88	23	5	0	0	0	300
WSW		2	18	24	23	19	33	38	6	1	0	0	0	164
W		3	14	20	24	11	41	48	11	3	0	0	0	175
WNW		3	15	18	12	9	32	86	32	6	5	0	0	218
NW		5	18	23	22	9	23	39	26	8	1	0	0	174
NNW		5	9	23	21	13	19	28	8	1	0	0	0	127
Total	87	57	196	266	280	232	511	521	130	32	6	0	0	2318

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-32
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class F (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		2	4	1	2	0	0	0	0	0	0	0	0	9
NNE		1	1	1	0	1	1	1	0	0	0	0	0	6
NE		3	1	2	0	0	0	0	0	0	0	0	0	6
ENE		2	1	3	1	0	0	0	0	0	0	0	0	7
E		1	6	1	1	0	0	0	0	0	0	0	0	9
ESE		1	9	0	2	0	1	0	0	0	0	0	0	13
SE		5	5	3	1	0	0	0	0	0	0	0	0	14
SSE		2	11	18	13	8	5	3	0	0	0	0	0	60
S		2	12	16	18	8	39	15	0	0	0	0	0	110
SSW		1	7	5	7	15	31	8	0	0	0	0	0	74
SW		2	9	5	14	12	19	9	0	0	0	0	0	70
WSW		0	4	4	4	6	4	1	0	0	0	0	0	23
W		0	8	4	3	0	3	6	0	0	0	0	0	24
WNW		0	12	12	5	1	2	0	0	0	0	0	0	32
NW		0	8	19	7	2	0	0	0	0	0	0	0	36
NNW		0	7	10	4	3	0	0	0	0	0	0	0	24
Total	48	22	105	104	82	56	105	43	0	0	0	0	0	565

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-33
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class G (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		1	3	1	0	0	0	0	0	0	0	0	0	5
NNE		0	1	0	0	0	0	0	0	0	0	0	0	1
NE		0	0	1	0	0	1	0	0	0	0	0	0	2
ENE		0	0	0	0	0	0	0	0	0	0	0	0	0
E		1	0	0	0	0	0	0	0	0	0	0	0	1
ESE		0	1	0	0	0	0	0	0	0	0	0	0	1
SE		0	2	3	0	0	0	0	0	0	0	0	0	5
SSE		2	11	11	17	8	8	1	0	0	0	0	0	58
S		3	7	13	11	5	6	5	0	0	0	0	0	50
SSW		0	5	4	6	0	2	1	1	0	0	0	0	19
SW		2	3	2	1	1	3	1	0	0	0	0	0	13
WSW		0	3	0	2	0	0	0	0	0	0	0	0	5
W		0	2	1	0	0	0	0	0	0	0	0	0	3
WNW		0	0	1	0	0	0	0	0	0	0	0	0	1
NW		1	1	2	1	0	0	0	0	0	0	0	0	5
NNW		0	2	1	0	0	0	0	0	0	0	0	0	3
Total	17	10	41	40	38	14	20	8	1	0	0	0	0	189

Source: Belews Creek Site February 7, 2024, through February 6, 2025

Table 2.7-34
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class A through G (NUREG/CR-2858)

Wind Direction	Wind Speed (m/s)												
	Calm	0.00 - 0.50	0.50 – 0.75	0.75 – 1.00	1.00 – 1.25	1.25 – 1.50	1.50 – 2.00	2.00 – 3.00	3.00 – 4.00	4.00 – 5.00	5.00 – 6.00	6.00 – 8.00	>8.00	Total
N		4	20	31	46	62	89	101	20	0	0	0	0	373
NNE		4	19	27	46	41	108	49	11	3	0	0	0	308
NE		9	18	26	47	50	132	52	3	1	0	0	0	338
ENE		8	23	37	73	90	190	81	1	1	0	0	0	504
E		4	26	43	77	105	230	126	6	0	0	0	0	617
ESE		6	33	33	43	42	100	84	15	1	4	2	0	363
SE		14	25	34	24	22	43	23	1	2	0	0	0	188
SSE		10	31	53	61	49	65	73	6	4	9	5	0	366
S		13	31	60	74	77	181	198	36	10	2	0	0	682
SSW		4	26	31	66	80	252	286	76	25	3	1	0	850
SW		9	42	50	71	69	215	383	126	39	12	2	0	1018
WSW		4	36	49	54	58	94	222	84	24	1	0	0	626
W		6	34	47	50	32	94	137	79	18	10	1	0	508
WNW		5	36	45	42	38	94	208	130	64	29	4	0	695
NW		10	32	55	53	31	46	91	96	77	36	5	1	533
NNW		7	20	51	43	31	49	50	32	10	1	0	0	294
Total	176	117	452	672	870	877	1982	2164	722	279	107	20	1	8439

Source: Belews Creek Site February 7, 2024, through February 6, 2025

Table 2.7-35
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class A (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		0	2	9	7	1	0	0	0	0	0	0	19
NNE		0	2	11	22	7	1	1	0	0	0	0	44
NE		0	1	18	28	19	2	1	0	0	0	0	69
ENE		0	4	38	94	45	1	1	0	0	0	0	183
E		0	3	55	82	70	3	0	0	0	0	0	213
ESE		0	6	19	41	28	2	0	0	0	0	0	96
SE		0	2	11	23	14	1	1	0	0	0	0	52
SSE		0	1	21	23	30	2	1	5	1	0	0	84
S		0	4	8	30	49	13	1	0	0	0	0	105
SSW		0	2	8	15	46	25	7	1	0	0	0	104
SW		0	7	11	33	105	68	20	8	1	0	0	253
WSW		0	3	16	26	88	50	18	0	0	0	0	201
W		0	5	12	20	38	27	8	10	1	0	0	121
WNW		0	4	18	14	46	46	22	21	4	0	0	175
NW		1	1	15	7	3	8	16	7	0	0	0	59
NNW		0	1	11	6	2	1	0	0	0	0	0	21
Total	0	1	48	281	471	591	250	97	52	7	1	0	1799

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-36
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class B (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		0	0	0	5	2	2	0	0	0	0	0	9
NNE		0	0	3	7	2	0	0	0	0	0	0	12
NE		0	0	7	6	6	0	0	0	0	0	0	19
ENE		2	6	9	13	16	0	0	0	0	0	0	46
E		0	8	29	39	11	2	0	0	0	0	0	89
ESE		0	4	9	7	8	0	0	0	0	0	0	28
SE		0	3	4	1	4	0	0	0	0	0	0	12
SSE		0	1	5	5	6	2	1	1	0	0	0	21
S		0	0	5	4	12	0	0	0	0	0	0	21
SSW		0	0	3	14	20	5	4	1	1	0	0	48
SW		0	5	4	6	19	6	4	1	1	0	0	46
WSW		0	4	1	3	9	3	1	0	0	0	0	21
W		0	3	5	4	12	1	0	0	0	0	0	25
WNW		0	2	4	5	5	4	1	1	0	0	0	22
NW		0	2	3	2	3	4	8	3	1	0	0	26
NNW		0	1	2	0	2	1	0	0	0	0	0	6
Total	2	2	39	93	121	137	30	19	7	3	0	0	453

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-37
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class C (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		0	1	3	7	6	1	0	0	0	0	0	18
NNE		0	0	4	9	5	0	0	0	0	0	0	18
NE		0	0	6	16	4	0	0	0	0	0	0	26
ENE		0	2	17	7	9	0	0	0	0	0	0	35
E		0	9	22	21	9	0	0	0	0	0	0	61
ESE		0	7	9	7	10	1	0	0	0	0	0	34
SE		0	1	4	2	2	0	0	0	0	0	0	9
SSE		0	1	2	2	5	1	1	1	0	0	0	13
S		0	0	4	13	14	2	1	1	0	0	0	35
SSW		0	0	4	15	24	13	3	1	0	0	0	60
SW		0	1	8	6	23	1	3	3	0	0	0	45
WSW		0	0	3	8	8	3	0	0	0	0	0	22
W		1	1	6	2	6	2	0	0	0	0	0	18
WNW		0	0	6	5	10	4	5	0	0	0	0	30
NW		1	0	4	5	10	13	8	2	3	0	0	46
NNW		0	0	1	8	4	0	1	0	0	0	0	14
Total	1	2	23	103	133	149	41	22	8	3	0	0	485

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-38
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class D (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		0	10	48	30	42	11	0	0	0	0	0	141
NNE		0	14	49	52	30	10	2	0	0	0	0	157
NE		0	17	41	73	21	1	0	0	0	0	0	153
ENE		1	26	78	66	11	0	0	0	0	0	0	182
E		1	19	47	60	28	1	0	0	0	0	0	156
ESE		3	17	30	28	26	9	1	4	2	0	0	120
SE		3	11	16	14	3	0	1	0	0	0	0	48
SSE		2	11	17	16	16	1	1	2	4	0	0	70
S		1	9	40	33	62	14	3	1	0	0	0	163
SSW		0	12	46	81	122	24	8	0	0	0	0	293
SW		2	21	32	63	138	28	7	0	0	0	0	291
WSW		2	25	38	20	78	22	4	1	0	0	0	190
W		2	23	21	24	27	38	7	0	0	0	0	142
WNW		2	17	25	36	61	44	30	2	0	0	0	217
NW		2	13	21	9	36	45	37	23	1	0	0	187
NNW		2	17	19	16	14	22	8	1	0	0	0	99
Total	21	23	262	568	621	715	270	109	34	7	0	0	2630

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-39
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class E (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		1	29	46	40	50	6	0	0	0	0	0	172
NNE		3	27	19	17	4	0	0	0	0	0	0	70
NE		6	22	25	8	2	0	0	0	0	0	0	63
ENE		3	18	20	10	0	0	0	0	0	0	0	51
E		1	23	28	28	8	0	0	0	0	0	0	88
ESE		2	22	16	16	12	3	0	0	0	0	0	71
SE		6	29	10	3	0	0	0	0	0	0	0	48
SSE		4	19	19	6	12	0	0	0	0	0	0	60
S		7	30	52	56	41	7	5	0	0	0	0	198
SSW		3	22	57	94	65	8	3	0	0	0	0	252
SW		3	39	57	85	88	23	5	0	0	0	0	300
WSW		2	42	42	33	38	6	1	0	0	0	0	164
W		3	34	35	41	48	11	3	0	0	0	0	175
WNW		3	33	21	32	86	32	6	5	0	0	0	218
NW		5	41	31	23	39	26	8	1	0	0	0	174
NNW		5	32	34	19	28	8	1	0	0	0	0	127
Total	87	57	462	512	511	521	130	32	6	0	0	0	2318

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-40
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class F (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		2	5	2	0	0	0	0	0	0	0	0	9
NNE		1	2	1	1	1	0	0	0	0	0	0	6
NE		3	3	0	0	0	0	0	0	0	0	0	6
ENE		2	4	1	0	0	0	0	0	0	0	0	7
E		1	7	1	0	0	0	0	0	0	0	0	9
ESE		1	9	2	1	0	0	0	0	0	0	0	13
SE		5	8	1	0	0	0	0	0	0	0	0	14
SSE		2	29	21	5	3	0	0	0	0	0	0	60
S		2	28	26	39	15	0	0	0	0	0	0	110
SSW		1	12	22	31	8	0	0	0	0	0	0	74
SW		2	14	26	19	9	0	0	0	0	0	0	70
WSW		0	8	10	4	1	0	0	0	0	0	0	23
W		0	12	3	3	6	0	0	0	0	0	0	24
WNW		0	24	6	2	0	0	0	0	0	0	0	32
NW		0	27	9	0	0	0	0	0	0	0	0	36
NNW		0	17	7	0	0	0	0	0	0	0	0	24
Total	48	22	209	138	105	43	0	0	0	0	0	0	565

Source: Belews Creek Site February 7, 2024 through February 6, 2025

Table 2.7-41
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class Pasquill Stability Class G (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		1	4	0	0	0	0	0	0	0	0	0	5
NNE		0	1	0	0	0	0	0	0	0	0	0	1
NE		0	1	0	1	0	0	0	0	0	0	0	2
ENE		0	0	0	0	0	0	0	0	0	0	0	0
E		1	0	0	0	0	0	0	0	0	0	0	1
ESE		0	1	0	0	0	0	0	0	0	0	0	1
SE		0	5	0	0	0	0	0	0	0	0	0	5
SSE		2	22	25	8	1	0	0	0	0	0	0	58
S		3	20	16	6	5	0	0	0	0	0	0	50
SSW		0	9	6	2	1	1	0	0	0	0	0	19
SW		2	5	2	3	1	0	0	0	0	0	0	13
WSW		0	3	2	0	0	0	0	0	0	0	0	5
W		0	3	0	0	0	0	0	0	0	0	0	3
WNW		0	1	0	0	0	0	0	0	0	0	0	1
NW		1	3	1	0	0	0	0	0	0	0	0	5
NNW		0	3	0	0	0	0	0	0	0	0	0	3
Total	17	10	81	52	20	8	1	0	0	0	0	0	189

Source: Belews Creek Site February 7, 2024, through February 6, 2025

Table 2.7-42
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class
Pasquill Stability Class A through G (RG 1.23)

Wind Direction	Wind Speed (m/s)												
	Calm	< 0.50	0.50 - 1.00	1.00 - 1.50	1.50 - 2.00	2.00 - 3.00	3.00 - 4.00	4.00 - 5.00	5.00 - 6.00	6.00 - 8.00	8.00 - 10.00	>10.00	Total
N		4	51	108	89	101	20	0	0	0	0	0	373
NNE		4	46	87	108	49	11	3	0	0	0	0	308
NE		9	44	97	132	52	3	1	0	0	0	0	338
ENE		8	60	163	190	81	1	1	0	0	0	0	504
E		4	69	182	230	126	6	0	0	0	0	0	617
ESE		6	66	85	100	84	15	1	4	2	0	0	363
SE		14	59	46	43	23	1	2	0	0	0	0	188
SSE		10	84	110	65	73	6	4	9	5	0	0	366
S		13	91	151	181	198	36	10	2	0	0	0	682
SSW		4	57	146	252	286	76	25	3	1	0	0	850
SW		9	92	140	215	383	126	39	12	2	0	0	1018
WSW		4	85	112	94	222	84	24	1	0	0	0	626
W		6	81	82	94	137	79	18	10	1	0	0	508
WNW		5	81	80	94	208	130	64	29	4	0	0	695
NW		10	87	84	46	91	96	77	36	5	1	0	533
NNW		7	71	74	49	50	32	10	1	0	0	0	294
Total	176	117	1124	1747	1982	2164	722	279	107	20	1	0	8439

Source: Belews Creek Site February 7, 2024, through February 6, 2025

Table 2.7-43
Distance from Belews Creek Release Points to EAB/LPZ

Downwind Sector	Minimum Distance to EAB/LPZ (m)		
	South Plant Complex	Middle Plant Complex	North Plant Complex
N	339	409	377
NNE	343	385	361
NE	328	382	242
ENE	328	253	242
E	328	253	250
ESE	328	250	250
SE	322	250	329
SSE	249	355	394
S	221	425	452
SSW	221	468	447
SW	298	402	350
WSW	320	354	350
W	320	351	321
WNW	415	337	321
NW	415	337	362
NNW	339	438	409

Table 2.7-44
South Plant Complex 50th Percentile EAB/LPZ χ/Q Values

Time Period	50th Percentile χ/Q Value (s/m3)
EAB, 0-2 Hours	2.616E-04
LPZ, 0-8 Hours	2.483E-04
LPZ, 8-24 Hours	2.419E-04
LPZ, 1-4 Days	2.287E-04
LPZ, 4-30 Days	2.109E-04

Note:
The χ/Q factors are for short-term (accident release).

Table 2.7-45
Middle Plant Complex 50th Percentile EAB/LPZ χ/Q Values

Time Period	50th Percentile χ/Q Value (s/m3)
EAB, 0-2 Hours	2.203E-04
LPZ, 0-8 Hours	2.138E-04
LPZ, 8-24 Hours	2.107E-04
LPZ, 1-4 Days	2.040E-04
LPZ, 4-30 Days	1.947E-04

Note:
The χ/Q factors are for short-term (accident release).

Table 2.7-46
North Plant Complex 50th Percentile EAB/LPZ χ/Q Values

Time Period	50th Percentile χ/Q Value (s/m^3)
EAB, 0-2 Hours	2.452E-04
LPZ, 0-8 Hours	2.549E-04
LPZ, 8-24 Hours	2.599E-04
LPZ, 1-4 Days	2.711E-04
LPZ, 4-30 Days	2.879E-04

Note:
The χ/Q factors are for short-term (accident release).

Table 2.7-47
Duke Energy Belews Creek Limiting 50th Percentile EAB/LPZ χ/Q Factors

Time Period	50th Percentile χ/Q Value (s/m³)	Plant Complex
EAB, 0-2 Hours	2.616E-04	South
LPZ, 0-8 Hours	2.549E-04	North
LPZ, 8-24 Hours	2.599E-04	North
LPZ, 1-4 Days	2.711E-04	North
LPZ, 4-30 Days	2.879E-04	North

Note:
The χ/Q factors are for short-term (accident release).

Table 2.7-48
Distances from Belews Creek Plant Complex Release Points to Unrestricted Area Boundary

Sector	Boundary 1[a] (Degrees,°)	Boundary 2[a] (Degrees,°)	North Plant Complex[b] (ft.)	Middle Plant Complex[b] (ft.)	South Plant Complex[b] (ft.)
N	348.75	11.25	**1238**	2238	1262
NNE	11.25	33.75	2473	**1264**	3000
NE[c]	33.75	56.25	**797**	**1256** (5868)	2496 (8055)
ENE	56.25	78.75	**864**	**830**	1833
E	78.75	101.25	**820**	**834**	**1076**
ESE	101.25	123.75	**1082**	833	**1150**
SE	123.75	146.25	1984	**1165**	**1057**
SSE	146.25	168.75	2285	1753	2052
S	168.75	191.25	2679	1892	1454
SSW	191.25	213.75	3181	4084	1143
SW	213.75	236.25	**1148**	2499	1999
WSW	236.25	258.75	**1159**	**1163**	**1051**
W	258.75	281.25	**1053**	**1153**	**1461**
WNW	281.25	303.75	**1188**	**1107**	**1363**
NW	303.75	326.25	**1407**	1629	**1496**
NNW	326.25	348.75	**1343**	2112	**1115**

Notes:
(a) Sector boundaries are 22.5° apart and 0° is centered along the north direction.
(b) Bolded values are distances to the EAB. Values that not bolded are distances to the site boundary.
(c) The values in parenthesis are the distances to the unrestricted area boundary MEL.

Table 2.7-49
Off-site Receptor Distances

Off-site Receptor No.	Receptor Description[(a)]	Distance from Site Boundary to Receptor(m)	Sector	Distance from North Plant Complex(m)	Distance from Middle Plant Complex(m)	Distance from South Plant Complex(m)
1	Nearest Residence	13	SSW	2228	1258	362
2	Nearest Vegetable Garden	521	SSW	2735	1766	870

Note:
(a) The off-site receptor locations were identified by the land use survey conducted in December of 2024.

Table 2.7-50
North Plant Complex Unrestricted Area Boundary χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q ($1/m^2$)
		No Decay	2.26-day Decay	8-day Decay	
		Undepleted	Undepleted	Depleted	
N	0.23	1.30E-04	1.30E-04	1.30E-04	2.10E-07
NNE	0.47	3.20E-05	3.20E-05	3.00E-05	8.80E-08
NE	0.15	2.60E-04	2.60E-04	2.50E-04	6.00E-07
ENE	0.16	1.30E-04	1.30E-04	1.20E-04	3.20E-07
E	0.16	1.30E-04	1.30E-04	1.20E-04	2.80E-07
ESE	0.20	9.20E-05	9.20E-05	8.80E-05	2.60E-07
SE	0.38	3.50E-05	3.50E-05	3.20E-05	8.00E-08
SSE	0.43	2.00E-05	2.00E-05	1.80E-05	3.60E-08
S	0.51	1.70E-05	1.70E-05	1.60E-05	3.40E-08
SSW	0.60	9.10E-06	9.10E-06	8.20E-06	2.20E-08
SW	0.22	6.80E-05	6.80E-05	6.50E-05	1.20E-07
WSW	0.22	6.70E-05	6.70E-05	6.40E-05	1.70E-07
W	0.20	8.30E-05	8.30E-05	7.90E-05	2.40E-07
WNW	0.22	5.30E-05	5.30E-05	5.00E-05	1.20E-07
NW	0.27	5.00E-05	5.00E-05	4.70E-05	5.30E-08
NNW	0.25	8.20E-05	8.10E-05	7.70E-05	1.00E-07

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-51
Middle Plant Complex Unrestricted Area Boundary χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q ($1/m^2$)
		No Decay	2.26-day Decay	8-day Decay	
		Undepleted	Undepleted	Depleted	
N	0.42	5.10E-05	5.10E-05	4.70E-05	8.50E-08
NNE	0.24	1.00E-04	1.00E-04	9.60E-05	2.50E-07
NE	0.24	1.20E-04	1.20E-04	1.20E-04	3.10E-07
ENE	0.16	1.40E-04	1.40E-04	1.30E-04	3.40E-07
E	0.16	1.20E-04	1.20E-04	1.20E-04	2.80E-07
ESE	0.16	1.40E-04	1.40E-04	1.40E-04	3.80E-07
SE	0.22	8.50E-05	8.50E-05	8.10E-05	1.80E-07
SSE	0.33	3.10E-05	3.10E-05	2.90E-05	5.40E-08
S	0.36	3.10E-05	3.10E-05	2.90E-05	6.00E-08
SSW	0.77	5.80E-06	5.80E-06	5.10E-06	1.40E-08
SW	0.47	1.80E-05	1.80E-05	1.60E-05	3.60E-08
WSW	0.22	6.70E-05	6.70E-05	6.40E-05	1.70E-07
W	0.22	7.10E-05	7.10E-05	6.70E-05	2.10E-07
WNW	0.21	6.00E-05	6.00E-05	5.70E-06	1.30E-07
NW	0.31	3.90E-05	3.90E-05	3.60E-05	4.20E-08
NNW	0.40	3.90E-05	3.90E-05	3.60E-05	5.10E-08

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-52
South Plant Complex Unrestricted Area Boundary χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q ($1/m^2$)
		No Decay	2.26-day Decay	8-day Decay	
		Undepleted	Undepleted	Depleted	
N	0.24	1.30E-04	1.30E-04	1.20E-04	2.10E-07
NNE	0.57	2.30E-05	2.30E-05	2.10E-05	6.50E-08
NE	0.47	3.80E-05	3.80E-05	3.50E-05	1.00E-07
ENE	0.35	3.50E-05	3.50E-05	3.20E-05	1.00E-07
E	0.20	8.10E-05	8.10E-05	7.70E-05	1.90E-07
ESE	0.22	8.30E-05	8.30E-05	7.90E-05	2.40E-07
SE	0.20	1.00E-04	1.00E-04	9.50E-05	2.10E-07
SSE	0.39	2.40E-05	2.40E-05	2.20E-05	4.20E-08
S	0.28	4.80E-05	4.80E-05	4.60E-05	9.00E-08
SSW	0.22	5.30E-05	5.30E-05	5.10E-05	1.10E-07
SW	0.38	2.60E-05	2.60E-05	2.40E-05	5.10E-08
WSW	0.20	8.00E-05	8.00E-05	7.60E-05	2.00E-07
W	0.28	4.70E-05	4.60E-05	4.40E-05	1.50E-07
WNW	0.26	4.20E-05	4.20E-05	3.90E-05	9.70E-08
NW	0.28	4.50E-05	4.50E-05	4.20E-05	4.80E-08
NNW	0.21	1.10E-04	1.10E-04	1.00E-04	1.40E-07

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-53
Unrestricted Area Boundary MEL χ/Q and D/Q Factors

Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q ($1/m^2$)
		No Decay	2.26-day Decay	8-day Decay	
		Undepleted	Undepleted	Depleted	
North Plant Complex					
NE	0.15	2.60E-04	2.60E-04	2.50E-04	6.00E-07
Middle Plant Complex					
N	1.11	7.20E-06	7.10E-06	6.20E-06	1.20E-08
NE	1.11	6.30E-06	6.20E-06	5.50E-06	1.80E-08
South Plant Complex					
N	1.53	3.40E-06	3.30E-06	2.90E-06	5.50E-09
NE	1.53	3.00E-06	2.90E-06	2.50E-06	8.10E-09

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-54
Nearest Resident Receptor χ/Q and D/Q Factors

Plant Complex	Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q ($1/m^2$)
			No Decay	2.26-day Decay	8-day Decay	
			Undepleted	Undepleted	Depleted	
South	SSW	0.22	5.00E-05	5.00E-05	4.70E-05	1.00E-07
Middle	SSW	0.78	5.60E-06	5.60E-06	5.00E-06	1.40E-08
North	SSW	1.38	1.30E-06	1.30E-06	1.10E-06	3.10E-09

Notes:
The nearest resident location was identified by the land use survey conducted in December of 2024.
The χ/Q factors are for long-term (routine release).

Table 2.7-55
Nearest Vegetable Garden χ/Q and D/Q Factors

Plant Complex	Sector	Distance (mi.)	χ/Q (s/m^3)			D/Q ($1/m^2$)
			No Decay	2.26-day Decay	8-day Decay	
			Undepleted	Undepleted	Depleted	
South	SSW	0.54	1.10E-05	1.10E-05	1.00E-05	2.60E-08
Middle	SSW	1.10	2.40E-06	2.30E-06	2.10E-06	5.60E-09
North	SSW	1.70	8.40E-07	8.20E-07	7.00E-07	1.90E-09

Notes:
The nearest vegetable garden location was identified by the land use survey conducted in December of 2024.
The χ/Q factors are for long-term (routine release).

Table 2.7-56
General χ/Q Factors for No-Decay, No-Depletion (s/m³)

Sector	Distance from Facility (mi.)																					
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	5.692E-05	1.769E-05	8.839E-06	4.243E-06	1.601E-06	8.399E-07	5.219E-07	3.593E-07	2.648E-07	2.049E-07	1.643E-07	1.355E-07	6.891E-08	4.441E-08	2.532E-08	1.709E-08	1.263E-08	9.885E-09	8.040E-09	6.728E-09	5.752E-09	5.002E-09
SSW	4.153E-05	1.256E-05	6.241E-06	2.981E-06	1.116E-06	5.807E-07	3.584E-07	2.453E-07	1.798E-07	1.385E-07	1.106E-07	9.087E-08	4.550E-08	2.899E-08	1.626E-08	1.085E-08	7.947E-09	6.169E-09	4.986E-09	4.148E-09	3.529E-09	3.055E-09
SW	5.382E-05	1.634E-05	8.117E-06	3.880E-06	1.456E-06	7.600E-07	4.702E-07	3.226E-07	2.370E-07	1.828E-07	1.463E-07	1.204E-07	6.071E-08	3.889E-08	2.199E-08	1.476E-08	1.086E-08	8.461E-09	6.860E-09	5.724E-09	4.882E-09	4.236E-09
WSW	5.328E-05	1.555E-05	7.613E-06	3.615E-06	1.348E-06	6.996E-07	4.309E-07	2.944E-07	2.156E-07	1.659E-07	1.324E-07	1.088E-07	5.465E-08	3.492E-08	1.970E-08	1.322E-08	9.728E-09	7.585E-09	6.153E-09	5.138E-09	4.385E-09	3.808E-09
W	5.563E-05	1.623E-05	7.915E-06	3.752E-06	1.398E-06	7.262E-07	4.479E-07	3.065E-07	2.248E-07	1.732E-07	1.385E-07	1.140E-07	5.775E-08	3.716E-08	2.121E-08	1.439E-08	1.068E-08	8.386E-09	6.845E-09	5.747E-09	4.928E-09	4.298E-09
WNW	4.400E-05	1.312E-05	6.469E-06	3.081E-06	1.152E-06	5.995E-07	3.701E-07	2.534E-07	1.859E-07	1.432E-07	1.145E-07	9.413E-08	4.738E-08	3.032E-08	1.714E-08	1.152E-08	8.489E-09	6.625E-09	5.378E-09	4.493E-09	3.836E-09	3.332E-09
NW	5.536E-05	1.719E-05	8.568E-06	4.113E-06	1.557E-06	8.190E-07	5.103E-07	3.521E-07	2.601E-07	2.016E-07	1.620E-07	1.338E-07	6.846E-08	4.433E-08	2.544E-08	1.724E-08	1.278E-08	1.002E-08	8.170E-09	6.848E-09	5.864E-09	5.106E-09
NNW	8.371E-05	2.690E-05	1.345E-05	6.505E-06	2.495E-06	1.327E-06	8.345E-07	5.804E-07	4.317E-07	3.367E-07	2.720E-07	2.259E-07	1.180E-07	7.754E-08	4.550E-08	3.134E-08	2.353E-08	1.865E-08	1.534E-08	1.296E-08	1.118E-08	9.795E-09
N	1.212E-04	3.846E-05	1.922E-05	9.268E-06	3.534E-06	1.870E-06	1.171E-06	8.115E-07	6.017E-07	4.680E-07	3.772E-07	3.125E-07	1.617E-07	1.056E-07	6.134E-08	4.197E-08	3.135E-08	2.474E-08	2.028E-08	1.708E-08	1.469E-08	1.284E-08
NNE	9.385E-05	2.890E-05	1.439E-05	6.894E-06	2.597E-06	1.360E-06	8.441E-07	5.805E-07	4.276E-07	3.306E-07	2.650E-07	2.185E-07	1.110E-07	7.147E-08	4.074E-08	2.750E-08	2.033E-08	1.591E-08	1.294E-08	1.083E-08	9.262E-09	8.055E-09
NE	1.117E-04	3.433E-05	1.707E-05	8.181E-06	3.091E-06	1.623E-06	1.010E-06	6.956E-07	5.131E-07	3.973E-07	3.189E-07	2.633E-07	1.343E-07	8.683E-08	4.974E-08	3.369E-08	2.497E-08	1.958E-08	1.596E-08	1.338E-08	1.146E-08	9.978E-09
ENE	6.157E-05	1.852E-05	9.180E-06	4.385E-06	1.648E-06	8.606E-07	5.328E-07	3.656E-07	2.687E-07	2.074E-07	1.659E-07	1.366E-07	6.893E-08	4.418E-08	2.500E-08	1.678E-08	1.235E-08	9.627E-09	7.808E-09	6.517E-09	5.560E-09	4.825E-09
E	5.725E-05	1.734E-05	8.613E-06	4.113E-06	1.544E-06	8.062E-07	4.990E-07	3.424E-07	2.517E-07	1.942E-07	1.554E-07	1.280E-07	6.461E-08	4.142E-08	2.345E-08	1.575E-08	1.160E-08	9.042E-09	7.335E-09	6.123E-09	5.224E-09	4.534E-09
ESE	6.526E-05	1.973E-05	9.792E-06	4.678E-06	1.757E-06	9.174E-07	5.679E-07	3.897E-07	2.864E-07	2.210E-07	1.768E-07	1.456E-07	7.342E-08	4.704E-08	2.659E-08	1.784E-08	1.312E-08	1.022E-08	8.287E-09	6.913E-09	5.895E-09	5.114E-09
SE	6.898E-05	2.132E-05	1.063E-05	5.094E-06	1.920E-06	1.006E-06	6.244E-07	4.296E-07	3.165E-07	2.448E-07	1.963E-07	1.619E-07	8.225E-08	5.299E-08	3.021E-08	2.040E-08	1.508E-08	1.180E-08	9.600E-09	8.034E-09	6.870E-09	5.974E-09
SSE	5.038E-05	1.554E-05	7.766E-06	3.720E-06	1.400E-06	7.325E-07	4.543E-07	3.122E-07	2.297E-07	1.775E-07	1.422E-07	1.171E-07	5.923E-08	3.802E-08	2.154E-08	1.447E-08	1.065E-08	8.302E-09	6.732E-09	5.618E-09	4.791E-09	4.157E-09

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-57
General χ/Q Factors for 2.26-Day-Decay, No-Depletion (s/m³)

Sector	Distance from Facility (mi.)																					
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	5.679E-05	1.761E-05	8.778E-06	4.203E-06	1.579E-06	8.242E-07	5.096E-07	3.491E-07	2.561E-07	1.971E-07	1.573E-07	1.291E-07	6.405E-08	4.027E-08	2.186E-08	1.407E-08	9.920E-09	7.412E-09	5.765E-09	4.618E-09	3.784E-09	3.157E-09
SSW	4.144E-05	1.250E-05	6.198E-06	2.954E-06	1.100E-06	5.700E-07	3.501E-07	2.384E-07	1.740E-07	1.333E-07	1.060E-07	8.664E-08	4.235E-08	2.635E-08	1.410E-08	8.981E-09	6.287E-09	4.671E-09	3.617E-09	2.886E-09	2.357E-09	1.961E-09
SW	5.366E-05	1.624E-05	8.041E-06	3.831E-06	1.429E-06	7.409E-07	4.555E-07	3.104E-07	2.266E-07	1.737E-07	1.380E-07	1.129E-07	5.508E-08	3.415E-08	1.811E-08	1.142E-08	7.913E-09	5.816E-09	4.455E-09	3.518E-09	2.845E-09	2.344E-09
WSW	5.315E-05	1.547E-05	7.555E-06	3.578E-06	1.327E-06	6.851E-07	4.197E-07	2.853E-07	2.078E-07	1.590E-07	1.262E-07	1.032E-07	5.045E-08	3.139E-08	1.681E-08	1.072E-08	7.512E-09	5.585E-09	4.327E-09	3.456E-09	2.824E-09	2.352E-09
W	5.551E-05	1.616E-05	7.862E-06	3.718E-06	1.379E-06	7.130E-07	4.376E-07	2.980E-07	2.175E-07	1.668E-07	1.327E-07	1.087E-07	5.376E-08	3.377E-08	1.839E-08	1.192E-08	8.462E-09	6.365E-09	4.982E-09	4.016E-09	3.310E-09	2.778E-09
WNW	4.389E-05	1.306E-05	6.421E-06	3.051E-06	1.135E-06	5.877E-07	3.610E-07	2.459E-07	1.795E-07	1.376E-07	1.094E-07	8.957E-08	4.398E-08	2.747E-08	1.480E-08	9.502E-09	6.693E-09	5.000E-09	3.890E-09	3.117E-09	2.556E-09	2.134E-09
NW	5.514E-05	1.705E-05	8.466E-06	4.048E-06	1.520E-06	7.932E-07	4.903E-07	3.356E-07	2.459E-07	1.891E-07	1.507E-07	1.235E-07	6.076E-08	3.783E-08	2.010E-08	1.264E-08	8.713E-09	6.364E-09	4.840E-09	3.792E-09	3.041E-09	2.484E-09
NNW	8.348E-05	2.676E-05	1.334E-05	6.435E-06	2.455E-06	1.299E-06	8.122E-07	5.619E-07	4.157E-07	3.225E-07	2.592E-07	2.141E-07	1.089E-07	6.977E-08	3.893E-08	2.554E-08	1.829E-08	1.384E-08	1.088E-08	8.803E-09	7.274E-09	6.115E-09
N	1.209E-04	3.827E-05	1.908E-05	9.177E-06	3.482E-06	1.833E-06	1.142E-06	7.876E-07	5.810E-07	4.496E-07	3.606E-07	2.972E-07	1.500E-07	9.559E-08	5.295E-08	3.459E-08	2.470E-08	1.866E-08	1.465E-08	1.184E-08	9.785E-09	8.226E-09
NNE	9.370E-05	2.881E-05	1.432E-05	6.851E-06	2.573E-06	1.343E-06	8.308E-07	5.696E-07	4.181E-07	3.222E-07	2.575E-07	2.116E-07	1.058E-07	6.707E-08	3.705E-08	2.427E-08	1.741E-08	1.323E-08	1.046E-08	8.508E-09	7.077E-09	5.990E-09
NE	1.115E-04	3.419E-05	1.696E-05	8.112E-06	3.052E-06	1.595E-06	9.880E-07	6.778E-07	4.978E-07	3.837E-07	3.067E-07	2.520E-07	1.258E-07	7.956E-08	4.366E-08	2.836E-08	2.018E-08	1.521E-08	1.193E-08	9.638E-09	7.961E-09	6.693E-09
ENE	6.146E-05	1.846E-05	9.133E-06	4.355E-06	1.631E-06	8.488E-07	5.237E-07	3.581E-07	2.623E-07	2.017E-07	1.609E-07	1.320E-07	6.550E-08	4.129E-08	2.261E-08	1.470E-08	1.048E-08	7.922E-09	6.233E-09	5.049E-09	4.183E-09	3.527E-09
E	5.715E-05	1.728E-05	8.564E-06	4.082E-06	1.526E-06	7.940E-07	4.896E-07	3.347E-07	2.451E-07	1.884E-07	1.502E-07	1.232E-07	6.107E-08	3.845E-08	2.100E-08	1.362E-08	9.691E-09	7.308E-09	5.737E-09	4.637E-09	3.834E-09	3.226E-09
ESE	6.515E-05	1.966E-05	9.741E-06	4.645E-06	1.738E-06	9.046E-07	5.580E-07	3.816E-07	2.794E-07	2.149E-07	1.714E-07	1.406E-07	6.969E-08	4.390E-08	2.400E-08	1.559E-08	1.111E-08	8.389E-09	6.596E-09	5.341E-09	4.423E-09	3.728E-09
SE	6.883E-05	2.122E-05	1.056E-05	5.047E-06	1.893E-06	9.872E-07	6.100E-07	4.177E-07	3.063E-07	2.358E-07	1.882E-07	1.545E-07	7.667E-08	4.826E-08	2.629E-08	1.698E-08	1.202E-08	9.019E-09	7.041E-09	5.660E-09	4.653E-09	3.894E-09
SSE	5.027E-05	1.547E-05	7.712E-06	3.686E-06	1.381E-06	7.191E-07	4.439E-07	3.036E-07	2.224E-07	1.711E-07	1.364E-07	1.119E-07	5.532E-08	3.473E-08	1.884E-08	1.213E-08	8.570E-09	6.418E-09	5.004E-09	4.019E-09	3.302E-09	2.761E-09

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-58
General χ/Q Factors for 8-Day-Decay, Depletion (s/m³)

Sector	Distance from Facility (mi.)																					
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	5.383E-05	1.614E-05	7.862E-06	3.704E-06	1.355E-06	6.918E-07	4.199E-07	2.831E-07	2.047E-07	1.555E-07	1.227E-07	9.964E-08	4.756E-08	2.900E-08	1.508E-08	9.422E-09	6.501E-09	4.776E-09	3.665E-09	2.902E-09	2.355E-09	1.947E-09
SSW	3.928E-05	1.145E-05	5.551E-06	2.603E-06	9.439E-07	4.783E-07	2.884E-07	1.933E-07	1.390E-07	1.052E-07	8.260E-08	6.682E-08	3.142E-08	1.895E-08	9.699E-09	5.992E-09	4.100E-09	2.991E-09	2.282E-09	1.799E-09	1.453E-09	1.197E-09
SW	5.090E-05	1.490E-05	7.214E-06	3.384E-06	1.230E-06	6.248E-07	3.775E-07	2.534E-07	1.826E-07	1.383E-07	1.088E-07	8.811E-08	4.162E-08	2.516E-08	1.292E-08	7.989E-09	5.464E-09	3.983E-09	3.034E-09	2.386E-09	1.924E-09	1.582E-09
WSW	5.039E-05	1.418E-05	6.770E-06	3.155E-06	1.140E-06	5.758E-07	3.464E-07	2.318E-07	1.665E-07	1.258E-07	9.876E-08	7.989E-08	3.765E-08	2.275E-08	1.169E-08	7.255E-09	4.981E-09	3.645E-09	2.788E-09	2.203E-09	1.783E-09	1.472E-09
W	5.262E-05	1.480E-05	7.040E-06	3.276E-06	1.183E-06	5.982E-07	3.604E-07	2.415E-07	1.738E-07	1.315E-07	1.034E-07	8.382E-08	3.988E-08	2.428E-08	1.265E-08	7.946E-09	5.511E-09	4.068E-09	3.135E-09	2.494E-09	2.032E-09	1.687E-09
WNW	4.161E-05	1.196E-05	5.752E-06	2.689E-06	9.742E-07	4.936E-07	2.977E-07	1.996E-07	1.436E-07	1.087E-07	8.544E-08	6.918E-08	3.269E-08	1.980E-08	1.021E-08	6.357E-09	4.377E-09	3.211E-09	2.461E-09	1.948E-09	1.581E-09	1.307E-09
NW	5.233E-05	1.566E-05	7.610E-06	3.584E-06	1.313E-06	6.721E-07	4.087E-07	2.759E-07	1.997E-07	1.519E-07	1.200E-07	9.749E-08	4.664E-08	2.845E-08	1.477E-08	9.196E-09	6.317E-09	4.618E-09	3.525E-09	2.776E-09	2.240E-09	1.842E-09
NNW	7.916E-05	2.453E-05	1.196E-05	5.677E-06	2.110E-06	1.092E-06	6.708E-07	4.568E-07	3.332E-07	2.553E-07	2.029E-07	1.658E-07	8.128E-08	5.053E-08	2.703E-08	1.723E-08	1.208E-08	8.995E-09	6.980E-09	5.584E-09	4.572E-09	3.812E-09
N	1.146E-04	3.507E-05	1.709E-05	8.090E-06	2.989E-06	1.540E-06	9.418E-07	6.391E-07	4.648E-07	3.552E-07	2.815E-07	2.296E-07	1.116E-07	6.891E-08	3.654E-08	2.315E-08	1.615E-08	1.198E-08	9.267E-09	7.393E-09	6.039E-09	5.025E-09
NNE	8.878E-05	2.637E-05	1.281E-05	6.024E-06	2.200E-06	1.122E-06	6.807E-07	4.586E-07	3.315E-07	2.519E-07	1.987E-07	1.614E-07	7.717E-08	4.715E-08	2.464E-08	1.548E-08	1.075E-08	7.942E-09	6.129E-09	4.883E-09	3.985E-09	3.315E-09
NE	1.056E-04	3.131E-05	1.518E-05	7.144E-06	2.616E-06	1.337E-06	8.127E-07	5.485E-07	3.969E-07	3.020E-07	2.384E-07	1.938E-07	9.294E-08	5.688E-08	2.977E-08	1.869E-08	1.296E-08	9.562E-09	7.366E-09	5.856E-09	4.769E-09	3.958E-09
ENE	5.824E-05	1.690E-05	8.169E-06	3.831E-06	1.395E-06	7.098E-07	4.295E-07	2.887E-07	2.082E-07	1.579E-07	1.244E-07	1.008E-07	4.789E-08	2.911E-08	1.510E-08	9.430E-09	6.513E-09	4.795E-09	3.688E-09	2.929E-09	2.385E-09	1.979E-09
E	5.416E-05	1.582E-05	7.663E-06	3.593E-06	1.307E-06	6.647E-07	4.020E-07	2.702E-07	1.949E-07	1.478E-07	1.164E-07	9.436E-08	4.482E-08	2.724E-08	1.412E-08	8.816E-09	6.086E-09	4.477E-09	3.441E-09	2.731E-09	2.221E-09	1.842E-09
ESE	6.173E-05	1.800E-05	8.713E-06	4.087E-06	1.488E-06	7.566E-07	4.577E-07	3.077E-07	2.219E-07	1.683E-07	1.325E-07	1.074E-07	5.099E-08	3.098E-08	1.605E-08	1.002E-08	6.913E-09	5.085E-09	3.908E-09	3.102E-09	2.523E-09	2.093E-09
SE	6.525E-05	1.944E-05	9.455E-06	4.447E-06	1.624E-06	8.284E-07	5.025E-07	3.385E-07	2.447E-07	1.859E-07	1.466E-07	1.190E-07	5.682E-08	3.465E-08	1.804E-08	1.129E-08	7.800E-09	5.740E-09	4.411E-09	3.499E-09	2.843E-09	2.355E-09
SSE	4.765E-05	1.417E-05	6.907E-06	3.248E-06	1.184E-06	6.034E-07	3.656E-07	2.460E-07	1.776E-07	1.348E-07	1.062E-07	8.616E-08	4.095E-08	2.488E-08	1.288E-08	8.024E-09	5.526E-09	4.055E-09	3.109E-09	2.461E-09	1.997E-09	1.652E-09

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-59
General D/Q Factors (1/m^2)

Sector	Distance from Facility (mi.)																					
	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	15	20	25	30	35	40	45	50
S	1.045E-07	3.532E-08	1.814E-08	8.622E-09	3.097E-09	1.536E-09	9.043E-10	5.922E-10	4.167E-10	3.088E-10	2.380E-10	1.890E-10	8.398E-11	5.087E-11	2.571E-11	1.556E-11	1.043E-11	7.477E-12	5.614E-12	4.365E-12	3.487E-12	2.846E-12
SSW	8.638E-08	2.921E-08	1.500E-08	7.131E-09	2.561E-09	1.270E-09	7.479E-10	4.897E-10	3.446E-10	2.554E-10	1.968E-10	1.563E-10	6.945E-11	4.207E-11	2.127E-11	1.287E-11	8.630E-12	6.184E-12	4.643E-12	3.610E-12	2.884E-12	2.354E-12
SW	9.707E-08	3.283E-08	1.685E-08	8.013E-09	2.878E-09	1.427E-09	8.405E-10	5.503E-10	3.872E-10	2.870E-10	2.211E-10	1.757E-10	7.805E-11	4.728E-11	2.390E-11	1.446E-11	9.697E-12	6.949E-12	5.218E-12	4.057E-12	3.241E-12	2.645E-12
WSW	1.416E-07	4.787E-08	2.458E-08	1.169E-08	4.198E-09	2.082E-09	1.226E-09	8.026E-10	5.648E-10	4.185E-10	3.225E-10	2.562E-10	1.138E-10	6.895E-11	3.485E-11	2.109E-11	1.414E-11	1.013E-11	7.610E-12	5.917E-12	4.726E-12	3.858E-12
W	1.711E-07	5.785E-08	2.970E-08	1.412E-08	5.072E-09	2.515E-09	1.481E-09	9.698E-10	6.824E-10	5.057E-10	3.897E-10	3.096E-10	1.375E-10	8.332E-11	4.211E-11	2.549E-11	1.709E-11	1.225E-11	9.195E-12	7.149E-12	5.711E-12	4.661E-12
WNW	1.018E-07	3.443E-08	1.768E-08	8.404E-09	3.019E-09	1.497E-09	8.815E-10	5.772E-10	4.061E-10	3.010E-10	2.319E-10	1.843E-10	8.186E-11	4.959E-11	2.506E-11	1.517E-11	1.017E-11	7.288E-12	5.472E-12	4.255E-12	3.399E-12	2.774E-12
NW	5.785E-08	1.956E-08	1.005E-08	4.776E-09	1.715E-09	8.507E-10	5.009E-10	3.280E-10	2.308E-10	1.710E-10	1.318E-10	1.047E-10	4.652E-11	2.818E-11	1.424E-11	8.620E-12	5.780E-12	4.141E-12	3.110E-12	2.418E-12	1.931E-12	1.576E-12
NNW	1.048E-07	3.542E-08	1.819E-08	8.647E-09	3.106E-09	1.540E-09	9.070E-10	5.939E-10	4.179E-10	3.097E-10	2.387E-10	1.896E-10	8.422E-11	5.102E-11	2.579E-11	1.561E-11	1.046E-11	7.499E-12	5.631E-12	4.378E-12	3.497E-12	2.854E-12
N	1.930E-07	6.525E-08	3.350E-08	1.593E-08	5.721E-09	2.837E-09	1.671E-09	1.094E-09	7.697E-10	5.704E-10	4.396E-10	3.492E-10	1.551E-10	9.397E-11	4.750E-11	2.875E-11	1.928E-11	1.381E-11	1.037E-11	8.064E-12	6.442E-12	5.258E-12
NNE	2.351E-07	7.951E-08	4.083E-08	1.941E-08	6.972E-09	3.457E-09	2.036E-09	1.333E-09	9.380E-10	6.951E-10	5.357E-10	4.256E-10	1.891E-10	1.145E-10	5.788E-11	3.503E-11	2.349E-11	1.683E-11	1.264E-11	9.827E-12	7.850E-12	6.407E-12
NE	2.833E-07	9.579E-08	4.918E-08	2.338E-08	8.399E-09	4.165E-09	2.453E-09	1.606E-09	1.130E-09	8.374E-10	6.454E-10	5.127E-10	2.278E-10	1.380E-10	6.973E-11	4.221E-11	2.830E-11	2.028E-11	1.523E-11	1.184E-11	9.457E-12	7.719E-12
ENE	1.731E-07	5.855E-08	3.006E-08	1.429E-08	5.134E-09	2.546E-09	1.499E-09	9.816E-10	6.907E-10	5.119E-10	3.944E-10	3.134E-10	1.392E-10	8.433E-11	4.262E-11	2.580E-11	1.730E-11	1.239E-11	9.306E-12	7.236E-12	5.780E-12	4.718E-12
E	1.413E-07	4.779E-08	2.454E-08	1.166E-08	4.190E-09	2.078E-09	1.223E-09	8.011E-10	5.637E-10	4.178E-10	3.219E-10	2.558E-10	1.136E-10	6.882E-11	3.479E-11	2.106E-11	1.412E-11	1.012E-11	7.596E-12	5.906E-12	4.718E-12	3.851E-12
ESE	1.925E-07	6.509E-08	3.342E-08	1.589E-08	5.708E-09	2.830E-09	1.667E-09	1.091E-09	7.679E-10	5.691E-10	4.385E-10	3.484E-10	1.548E-10	9.375E-11	4.739E-11	2.868E-11	1.923E-11	1.378E-11	1.035E-11	8.045E-12	6.426E-12	5.245E-12
SE	1.495E-07	5.055E-08	2.595E-08	1.234E-08	4.432E-09	2.198E-09	1.294E-09	8.474E-10	5.963E-10	4.419E-10	3.405E-10	2.705E-10	1.202E-10	7.280E-11	3.680E-11	2.227E-11	1.493E-11	1.070E-11	8.035E-12	6.247E-12	4.990E-12	4.073E-12
SSE	8.328E-08	2.816E-08	1.446E-08	6.874E-09	2.469E-09	1.225E-09	7.211E-10	4.721E-10	3.322E-10	2.462E-10	1.897E-10	1.507E-10	6.696E-11	4.056E-11	2.050E-11	1.241E-11	8.320E-12	5.962E-12	4.476E-12	3.481E-12	2.780E-12	2.269E-12

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-60
Segmented General χ/Q Factors for No-Decay, No-Depletion (s/m^3)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	8.764E-06	1.850E-06	5.416E-07	2.690E-07	1.657E-07	7.282E-08	2.591E-08	1.272E-08	8.067E-09	5.764E-09
SSW	6.196E-06	1.293E-06	3.725E-07	1.828E-07	1.116E-07	4.825E-08	1.669E-08	8.010E-09	5.005E-09	3.537E-09
SW	8.062E-06	1.685E-06	4.884E-07	2.408E-07	1.475E-07	6.428E-08	2.253E-08	1.094E-08	6.885E-09	4.892E-09
WSW	7.601E-06	1.564E-06	4.480E-07	2.192E-07	1.336E-07	5.792E-08	2.020E-08	9.801E-09	6.176E-09	4.394E-09
W	7.913E-06	1.623E-06	4.656E-07	2.285E-07	1.397E-07	6.109E-08	2.172E-08	1.075E-08	6.867E-09	4.937E-09
WNW	6.441E-06	1.335E-06	3.846E-07	1.889E-07	1.155E-07	5.019E-08	1.757E-08	8.552E-09	5.397E-09	3.844E-09
NW	8.504E-06	1.797E-06	5.293E-07	2.641E-07	1.633E-07	7.226E-08	2.599E-08	1.287E-08	8.196E-09	5.875E-09
NNW	1.335E-05	2.867E-06	8.642E-07	4.380E-07	2.741E-07	1.240E-07	4.632E-08	2.366E-08	1.538E-08	1.119E-08
N	1.907E-05	4.069E-06	1.214E-06	6.107E-07	3.801E-07	1.702E-07	6.256E-08	3.154E-08	2.033E-08	1.471E-08
NNE	1.428E-05	3.002E-06	8.763E-07	4.343E-07	2.672E-07	1.173E-07	4.169E-08	2.048E-08	1.299E-08	9.280E-09
NE	1.695E-05	3.570E-06	1.048E-06	5.212E-07	3.215E-07	1.419E-07	5.085E-08	2.514E-08	1.601E-08	1.148E-08
ENE	9.125E-06	1.906E-06	5.533E-07	2.730E-07	1.674E-07	7.297E-08	2.561E-08	1.244E-08	7.836E-09	5.571E-09
E	8.553E-06	1.787E-06	5.183E-07	2.557E-07	1.568E-07	6.838E-08	2.402E-08	1.168E-08	7.361E-09	5.234E-09
ESE	9.727E-06	2.033E-06	5.898E-07	2.910E-07	1.783E-07	7.772E-08	2.725E-08	1.322E-08	8.317E-09	5.907E-09
SE	1.054E-05	2.219E-06	6.482E-07	3.215E-07	1.979E-07	8.693E-08	3.091E-08	1.519E-08	9.632E-09	6.883E-09
SSE	7.696E-06	1.619E-06	4.716E-07	2.334E-07	1.433E-07	6.266E-08	2.206E-08	1.073E-08	6.756E-09	4.801E-09

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-61
Segmented General χ/Q Factors for 2.26-Day-Decay, No-Depletion (s/m^3)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	8.708E-06	1.827E-06	5.293E-07	2.602E-07	1.587E-07	6.794E-08	2.249E-08	1.002E-08	5.799E-09	3.799E-09
SSW	6.157E-06	1.276E-06	3.641E-07	1.769E-07	1.069E-07	4.508E-08	1.454E-08	6.359E-09	3.640E-09	2.367E-09
SW	7.993E-06	1.657E-06	4.735E-07	2.304E-07	1.393E-07	5.862E-08	1.870E-08	8.011E-09	4.487E-09	2.859E-09
WSW	7.547E-06	1.542E-06	4.367E-07	2.114E-07	1.274E-07	5.370E-08	1.734E-08	7.597E-09	4.355E-09	2.836E-09
W	7.865E-06	1.603E-06	4.552E-07	2.212E-07	1.339E-07	5.709E-08	1.893E-08	8.545E-09	5.009E-09	3.322E-09
WNW	6.398E-06	1.317E-06	3.754E-07	1.825E-07	1.104E-07	4.677E-08	1.526E-08	6.765E-09	3.913E-09	2.566E-09
NW	8.411E-06	1.759E-06	5.092E-07	2.499E-07	1.520E-07	6.451E-08	2.073E-08	8.822E-09	4.876E-09	3.057E-09
NNW	1.325E-05	2.826E-06	8.418E-07	4.220E-07	2.613E-07	1.149E-07	3.983E-08	1.844E-08	1.094E-08	7.298E-09
N	1.894E-05	4.015E-06	1.185E-06	5.900E-07	3.635E-07	1.585E-07	5.427E-08	2.492E-08	1.473E-08	9.817E-09
NNE	1.422E-05	2.977E-06	8.629E-07	4.249E-07	2.597E-07	1.121E-07	3.804E-08	1.757E-08	1.051E-08	7.099E-09
NE	1.685E-05	3.529E-06	1.026E-06	5.058E-07	3.093E-07	1.333E-07	4.484E-08	2.038E-08	1.200E-08	7.988E-09
ENE	9.082E-06	1.889E-06	5.442E-07	2.666E-07	1.623E-07	6.952E-08	2.324E-08	1.058E-08	6.265E-09	4.197E-09
E	8.508E-06	1.769E-06	5.088E-07	2.491E-07	1.515E-07	6.483E-08	2.160E-08	9.786E-09	5.767E-09	3.847E-09
ESE	9.680E-06	2.014E-06	5.799E-07	2.840E-07	1.729E-07	7.398E-08	2.468E-08	1.122E-08	6.630E-09	4.438E-09
SE	1.048E-05	2.191E-06	6.337E-07	3.113E-07	1.898E-07	8.133E-08	2.704E-08	1.214E-08	7.080E-09	4.670E-09
SSE	7.646E-06	1.599E-06	4.612E-07	2.261E-07	1.376E-07	5.873E-08	1.939E-08	8.659E-09	5.033E-09	3.314E-09

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-62
Segmented General χ/Q Factors for 8-Day-Decay, Depletion (s/m^3)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	7.852E-06	1.582E-06	4.377E-07	2.083E-07	1.239E-07	5.089E-08	1.566E-08	6.590E-09	3.692E-09	2.366E-09
SSW	5.552E-06	1.106E-06	3.010E-07	1.416E-07	8.344E-08	3.374E-08	1.011E-08	4.161E-09	2.301E-09	1.461E-09
SW	7.220E-06	1.440E-06	3.938E-07	1.860E-07	1.099E-07	4.464E-08	1.345E-08	5.545E-09	3.058E-09	1.934E-09
WSW	6.810E-06	1.337E-06	3.618E-07	1.697E-07	9.979E-08	4.041E-08	1.218E-08	5.053E-09	2.810E-09	1.792E-09
W	7.092E-06	1.388E-06	3.763E-07	1.770E-07	1.045E-07	4.271E-08	1.314E-08	5.583E-09	3.157E-09	2.041E-09
WNW	5.772E-06	1.142E-06	3.107E-07	1.463E-07	8.631E-08	3.507E-08	1.063E-08	4.439E-09	2.480E-09	1.588E-09
NW	7.610E-06	1.533E-06	4.258E-07	2.033E-07	1.211E-07	4.986E-08	1.533E-08	6.405E-09	3.552E-09	2.251E-09
NNW	1.196E-05	2.450E-06	6.976E-07	3.389E-07	2.047E-07	8.640E-08	2.790E-08	1.222E-08	7.024E-09	4.591E-09
N	1.709E-05	3.478E-06	9.802E-07	4.729E-07	2.841E-07	1.188E-07	3.778E-08	1.635E-08	9.328E-09	6.064E-09
NNE	1.281E-05	2.571E-06	7.096E-07	3.375E-07	2.007E-07	8.254E-08	2.557E-08	1.089E-08	6.172E-09	4.003E-09
NE	1.519E-05	3.054E-06	8.470E-07	4.041E-07	2.407E-07	9.933E-08	3.087E-08	1.313E-08	7.418E-09	4.791E-09
ENE	8.181E-06	1.632E-06	4.479E-07	2.121E-07	1.256E-07	5.131E-08	1.569E-08	6.604E-09	3.715E-09	2.396E-09
E	7.666E-06	1.530E-06	4.193E-07	1.985E-07	1.175E-07	4.801E-08	1.468E-08	6.171E-09	3.466E-09	2.232E-09
ESE	8.720E-06	1.740E-06	4.774E-07	2.260E-07	1.338E-07	5.464E-08	1.669E-08	7.009E-09	3.937E-09	2.535E-09
SE	9.449E-06	1.898E-06	5.238E-07	2.491E-07	1.481E-07	6.080E-08	1.873E-08	7.906E-09	4.443E-09	2.857E-09
SSE	6.895E-06	1.385E-06	3.812E-07	1.808E-07	1.073E-07	4.385E-08	1.339E-08	5.604E-09	3.132E-09	2.006E-09

Note:
The χ/Q factors are for long-term (routine release).

Table 2.7-63
Segmented D/Q Factors (1/m^2)

Sector	Segmented Distance from Facility (mi)									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.773E-08	3.631E-09	9.479E-10	4.257E-10	2.408E-10	9.261E-11	2.679E-11	1.062E-11	5.671E-12	3.510E-12
SSW	1.466E-08	3.003E-09	7.839E-10	3.521E-10	1.992E-10	7.659E-11	2.216E-11	8.782E-12	4.690E-12	2.903E-12
SW	1.647E-08	3.374E-09	8.809E-10	3.956E-10	2.238E-10	8.607E-11	2.490E-11	9.869E-12	5.270E-12	3.262E-12
WSW	2.403E-08	4.921E-09	1.285E-09	5.770E-10	3.264E-10	1.255E-10	3.631E-11	1.439E-11	7.686E-12	4.757E-12
W	2.903E-08	5.947E-09	1.552E-09	6.972E-10	3.944E-10	1.517E-10	4.388E-11	1.739E-11	9.287E-12	5.748E-12
WNW	1.728E-08	3.539E-09	9.239E-10	4.150E-10	2.347E-10	9.027E-11	2.612E-11	1.035E-11	5.527E-12	3.421E-12
NW	9.818E-09	2.011E-09	5.250E-10	2.358E-10	1.334E-10	5.130E-11	1.484E-11	5.882E-12	3.141E-12	1.944E-12
NNW	1.778E-08	3.641E-09	9.506E-10	4.269E-10	2.415E-10	9.288E-11	2.687E-11	1.065E-11	5.687E-12	3.520E-12
N	3.275E-08	6.707E-09	1.751E-09	7.864E-10	4.449E-10	1.711E-10	4.949E-11	1.962E-11	1.048E-11	6.484E-12
NNE	3.990E-08	8.174E-09	2.134E-09	9.583E-10	5.421E-10	2.085E-10	6.031E-11	2.390E-11	1.277E-11	7.901E-12
NE	4.807E-08	9.847E-09	2.571E-09	1.155E-09	6.531E-10	2.512E-10	7.266E-11	2.880E-11	1.538E-11	9.519E-12
ENE	2.938E-08	6.019E-09	1.571E-09	7.057E-10	3.992E-10	1.535E-10	4.441E-11	1.760E-11	9.400E-12	5.818E-12
E	2.398E-08	4.912E-09	1.282E-09	5.759E-10	3.258E-10	1.253E-10	3.625E-11	1.437E-11	7.672E-12	4.749E-12
ESE	3.267E-08	6.691E-09	1.747E-09	7.846E-10	4.438E-10	1.707E-10	4.938E-11	1.957E-11	1.045E-11	6.469E-12
SE	2.537E-08	5.196E-09	1.356E-09	6.092E-10	3.446E-10	1.325E-10	3.834E-11	1.520E-11	8.115E-12	5.023E-12
SSE	1.413E-08	2.895E-09	7.558E-10	3.394E-10	1.920E-10	7.384E-11	2.136E-11	8.467E-12	4.521E-12	2.799E-12

Note:
The χ/Q factors are for long-term (routine release).

2.8 NONRADIOLOGICAL HEALTH

This section describes aspects of the environment at the Project site and within the Project Vicinity with respect to existing nonradiological human health. The section also provides the basis for evaluation of impacts on nonradiological human health from the building and operation of advanced reactors at the Project site.

2.8.1 PUBLIC AND OCCUPATIONAL HEALTH

The Occupational Safety and Health Administration (OSHA) is responsible for developing and enforcing workplace safety regulations. OSHA was created by the Occupational Safety and Health Act of 1970 (29 USC 651 et seq.), which was enacted to safeguard the health of workers. With regard to nuclear power plants, plant conditions that result in an occupational risk but do not affect the safety of licensed radioactive materials are under the statutory authority of OSHA rather than the NRC, as set forth in a Memorandum of Understanding between the NRC and OSHA (OSHA, 2013). OSHA regulations regarding public and occupational health that are applicable to the Project site include Occupational Health and Safety Standards (29 CFR Part 1910), Safety and Health Regulations for Construction (29 CFR Part 1926), and Identification Classification and Regulation of Potential Occupational Carcinogens (29 CFR Part 1990). These regulations establish a federal framework to protect and promote the safety and health of employees working under the authority of the Department of Labor and certain state agencies across the United States.

In 2020, approximately 91,393 people lived within 10 mi. (16 km) of the Project site. Population distribution details are provided in Section 2.4.1. The resident population is primarily concentrated in the cities of Greensboro and Winston-Salem. The nearest residence is approximately 44 feet (13.4 meters) from the Project site at its closest point and approximately 1.1 mi. (1.8 km) from the Project site center point. As described in Section 2.1.1.2, much of the land in the vicinity of the site is undeveloped forest or pastureland; however, concentrated areas of developed land are associated with BCSS and surrounding municipalities such as Walnut Cove and Stokesdale. Stokes County, which contains most of the Project site, is designated by the Stokes County Comprehensive Plan as being “Open Space: Rural Community”; and, the Project Vicinity is characterized by rural, low-density residential lands and recreational areas, with pockets of commercial and industrial areas of relatively higher densities. BCSS is the closest industrial facility to the Project site with approximately 147 on-site employees and Belews Lake is the closest recreational facility with 63 private lake access leases and two public boat ramps.

People and communities most vulnerable to nonradiological health impacts from construction and operation-related activities include those within proximity to the Project site. Occupational injuries, chemical hazards, and etiological agents primarily impact people in the immediate vicinity of a hazardous activity or material, such as employees and construction workers within the Project site; however, chemical hazards have the potential to transport outside of the Project site, within the Project Vicinity, and could make nearby residents and recreational visitors potentially vulnerable to nonradiological health impacts.

2.8.1.1 Occupational Injuries

In general, occupational health risks to workers and on-site personnel engaged in activities related to building and operating nuclear power plants would be predominantly occupational injuries (e.g., falls, electric shock, asphyxiation) or occupational illnesses. The Bureau of Labor

Statistics (BLS) collects information from U.S. companies on occupational injuries, illnesses, and fatalities. BLS defines nonfatal incidence rates as the number of recordable cases per 100 full-time equivalent workers and fatal incidence rates as the number of recordable cases per 100,000 full-time equivalent workers (BLS, 2023a, 2023b). Nonfatal occupational illness and injury data from the Survey of Occupational Injuries and Illnesses (SOII), as well as fatality data from the Census of Fatal Occupational Injuries (CFOI), are often organized by industry; in such cases, nuclear electric power generation is classified under the North American Industry Classification System (NAICS) code for utilities (BLS, 2024a). The industry classification for nuclear electric power generation consists of occupations associated with the construction, operation, and maintenance of nuclear facilities, including management, engineering, office and administrative support, construction, installation, maintenance, production, and transportation (BLS, 2024b).

Table 2.8-1 summarizes the national and state incidence rates of nonfatal occupational injuries and illnesses in 2022 for industries applicable to the construction and operation of nuclear facilities. The nonfatal occupational injury and illness incidence rate for construction in NC is less than that of the U.S. (BLS, 2023a, 2023c).

Unlike nonfatal incidence rates calculated by BLS with data from the SOII, fatal incidence rates calculated by the BLS with data from the CFOI use different methodologies between the national and state rates, meaning state industry rates are not directly comparable with national industry rates (BLS, 2020). Tables 2.8-2 and 2.8-3 provide national and state incidence rates of fatal occupational injuries in 2022 for industries applicable to the construction and operation of nuclear facilities. The national fatal injury incidence rate for the utilities industry is 3.4 recordable cases per 100,000 full-time equivalent workers. No further breakdown of the utilities industry was reported (BLS, 2023b). In NC, the fatal injury incidence rate for the utilities industry is grouped into the estimate of the incidence rate for transportation, leading to a higher reported incidence of fatal injury for the transportation and utilities industry category than that for the utilities industry alone. The transportation and utilities incidence rate in NC was 13.3 recordable cases per 100,000 full-time equivalent workers, higher than the construction industry category (BLS, 2023d).

Duke Energy maintains an Environmental Health and Safety (EHS) manual that outlines EHS-related policies, employee responsibilities, and management systems specific to Duke Energy employees and contractors. Additional supplements are provided by Duke Energy business units for the supplemental requirements of contractors. Duke Energy's EHS manual includes policies and guidance on a variety of health and safety topics aimed at preventing and minimizing occupational health and safety risks to employees and contractors, including fall protection, fire prevention and protection, hazard awareness, heat and cold exposure, natural gas and fuel gas safety, office safety, safety sign and barricades, and personal protective equipment. Additionally, the EHS manual includes policies and guidance on a variety of environmental topics, including air permitting, containment systems, fugitive dust, chemical management, spill plans, and waste management, to help prevent and minimize health and safety risks to the environment, (Duke Energy, 2023b).

The USEPA Facility Registry Service (FRS) is a centrally managed database that identifies facilities or sites subject to environmental regulation. Sources of facility information come from a variety of USEPA programs, including the Assessment, Cleanup and Redevelopment Exchange System (ACRES), Integrated Compliance Information System (ICIS), Superfund Enterprise Management System (SEMS), National Priority List (NPL), and Toxics Release Inventory (TRI), which tracks compliance with the NPDES and the CAA. The USEPA's Envirofacts Multisystem

Search Form allows users to search multiple environmental databases for facility information, including toxic chemical releases, water discharge permit compliance, hazardous waste handling processes in compliance with the Resource Conservation and Recovery Act (RCRA), Superfund status, and air emission estimates. USEPA's Enforcement and Compliance History Online tool within Envirofacts allows users to access integrated site-specific compliance data from a variety of the USEPA data systems compiled in one location.

A search of the Project site was conducted using the FRS GIS data from the ACRES, SEMS, NPDES, ICIS-Air, NPL, RCRA Info, and TRI databases to identify potential sources of existing issues involving hazardous chemicals on or near the site, including brownfields, superfund sites, and toxic releases (Figure 2.8-1). No superfund sites, or brownfields are located within the Project Vicinity. The BCSS is the nearest site identified as being a toxic release site and includes water discharges regulated by the NPDES, air releases regulated by the CAA, and chemical handling and storage regulated under RCRA (USEPA, 2024m, 2024n).

In addition to the current regulated chemical discharges identified using the FRS, BCSS also stores and utilizes [[
]]SRI, which is regulated under OSHA's *Process Safety Management of Highly Hazardous Chemicals* (PSM) Standard, is a chemical that OSHA considers to be highly hazardous (29 CFR 1910.119). [[

]]SRI Because BCSS stores more than the threshold quantity of [[ ]]SRI, Duke Energy is required to complete a process hazard analysis report, consistent with 29 CFR 1910.119 and USEPA's Risk Management Program Rule (40 CFR Part 68). In 2023, Duke Energy completed a revalidation of the 2016 process hazard analysis for the [[
]]SRI The purpose of revalidating the process is to help Duke Energy identify possible deviations from the process design, maintenance, inspection, or operating practices. These deviations could potentially lead to toxicity from [[ ]]SRI and could potentially result in impacts to personnel (on-site), the public (off-site), property damage (on-site), and the environment. The analysis considered various causes of potential hazard events and their frequency, process safeguards, and hazard event severity, likelihood, and consequences. Overall, BCSS uses the strategies in 29 CFR 1910.111 and 29 CFR 1910.119 to avoid and minimize the occurrence and severity of hazardous events, including the establishment of operating procedures for [[ ]]SRI, training for personnel involved in the operation and maintenance of [[ ]]SRI the implementation of management-of-change procedures, the investigation of incidents that could potentially result in a hazardous event, and the implementation of emergency response procedures.

2.8.1.2 Etiological Agents and Emerging Contaminants

2.8.1.2.1 Etiological Agents

Etiological agents are infectious substances or materials known or reasonably expected to contain a pathogen or disease-causing microorganism that affects human health (CDC, 2009). Etiological agents associated with nuclear power plant operations can be found in cooling ponds or towers or thermal discharges. Microorganisms of concern include enteric pathogens (such as *Salmonella* spp. and *Pseudomonas aeruginosa*), bacteria (including *Legionella* spp. and *Vibrio* spp.), free-living amoeba (such as *Naegleria fowleri* and *Acanthamoeba* spp.), thermophilic fungi, blue-green algae, and dinoflagellates (*Karenia brevis*).

Information from the CDC National Outbreak Reporting System was reviewed to identify the number and nature of cases associated with non-foodborne related etiological outbreaks within NC from 2011 to 2021. The statistics for NC are summarized in Table 2.8-4 and Figure 2.8-2. *Campylobacter* spp., *Clostridium* spp., *Cryptosporidium* spp., *E. coli*, *Legionella* spp., *Norovirus* spp., *Salmonella* spp., *Sapovirus* spp., *Shigella* spp., and *Rotavirus* spp., are enteric pathogens with recorded outbreaks throughout the state from 2011 to 2021 (CDC, 2023). These enteric pathogens can cause intestinal infection, or enteric disease, and can be spread through contact with contaminated water, animals, people, or contaminated soil (Kolling et al., 2012; State of West Virginia, 2024; Center for Health Protection, 2023; CDC, 2024a, 2024b). The pathogen responsible for the most non-foodborne related outbreaks within the state is *Norovirus* spp., which is a virus transferred mostly through human contact or contact with contaminated water sources. Based on data from the CDC, water sources within NC known to act as exposure pathways of enteric pathogens include treated recreational water, such as that found in waterparks and swimming pools, untreated recreational water, such as that from a river or stream, and drinking water from community drinking-water facilities (CDC, 2023).

Of the known enteric pathogen outbreaks within NC, *Legionella* spp. is associated with the most outbreaks from contact with contaminated water sources. Waterborne pathogens like *Legionella* spp. can grow in water, whereas *Norovirus* spp. and *Cryptosporidium* spp. do not grow in water but are able to persist in it. Water quality characteristics, such as warm temperatures, permit the growth of *Legionella* spp. (WHO, 2022). The temperature range that supports the growth of *Legionella* spp. falls between 77°F (25°C) and 109°F (43°C) (NASEM, 2019). The Project site is surrounded by Belews Lake. From May to October 2017, water temperature in the Belews Creek arm of Belews Lake fell between 54°F (12°C) and 100°F (38°C), which is within the range of temperatures that permit the growth of *Legionella* spp. (Duke Energy, 2021).

Thermophilic fungi are fungi species that can grow in temperatures above 68°F (20°C), with a maximum growth temperature at or above 122°F (50°C) (Salar and Aneja, 2007). They are known to occur naturally in soil and habitats comprised of decomposing plant material where warm, humid, and aerobic conditions comprise the basic environment for their development (Salar and Aneja, 2007). Although uncommon, multiple species of thermophilic fungi have been known to cause allergic reactions or infections in humans, specifically from the repeated inhalation of fungal spores released during habitat disturbances; however, the most commonly infectious species of thermophilic fungi, *Aspergillus fumigatus,* is viewed as a weak pathogen, primarily impacting immunocompromised individuals and those with an allergy (e.g., Farmer's lung) (Hutchinson et al., 2019; Mares et al., 2019; Latge, 1999). The existence of thermophilic fungi within the Project site is not well documented; however, due to their naturally widespread presence, it is likely that thermophilic fungi are present within the Project site, particularly within the undisturbed wooded areas that provide leaf litter and organic material suitable for growth.

Blue-green algae, commonly referred to as cyanobacteria, can quickly grow out of control, or "bloom," in waterbodies, particularly those with warm, slow-moving, and nutrient-rich conditions (CDC, 2024c). Various types of blue-green algae are known to produce toxins, called "cyanotoxins," which can make algal blooms harmful to people and animals. Consumption or contact with cyanotoxins can impair liver function or cause respiratory failure, paralysis, neurological disease, or death (Wiltsie et al., 2018). The presence of blue-green algae was confirmed in Belews Lake in 2012, and the genes of one type of cyanotoxin were also found; however, the toxin itself was not confirmed (Grubbs, 2014).

Similar to blue-green algae, many species of dinoflagellates can bloom and produce toxins (Canion, 2004). For example, the species *Karenia brevis* is known to produce brevetoxins,

which can cause a variety of neurological and gastrointestinal symptoms in people when ingested, as well as respiratory problems if inhaled as an aerosol (Woods Hole Oceanographic Institution, 2019). Dinoflagellates can be found in both marine and freshwater environments with *Karenia brevis* only capable of surviving in marine habitats (Canion, 2004; State of Florida, 2024). Unlike marine species, freshwater species are less dangerous and are not as well documented as marine species. However, the presence of various dinoflagellate species has been found in freshwater lakes throughout the U.S. (Canion, 2004). Currently, no known records exist of the presence of dinoflagellates in Belews Lake.

2.8.1.2.2 Emerging Contaminants

The USEPA has recognized the growing concern surrounding emerging contaminants in drinking water and has launched a new initiative to address perfluoroalkyl and polyfluoroalkyl substances (PFAS) and other emerging contaminants, particularly in small or disadvantaged communities. In April 2024, USEPA issued the PFAS National Primary Drinking Water Regulation to protect communities from exposure to harmful PFAS, also known as “forever chemicals.” Exposure to PFAS has been linked to adverse health impacts that include some cancers, liver and heart disease, and immune and developmental damage to infants and children (USEPA, 2024t). Other contaminants of concern are trihalomethanes (TTHMs) and Haloacetic acids (HAAs) which are formed as byproducts of water treatment disinfection processes (USEPA, 2024u).

The Town of Madison is located downstream of the Project site and obtains drinking water from the Dan River (Section 2.2.2.1.2.1). Madison monitors water quality and includes testing for TTHMs and HAAs. Annual drinking water quality reports indicated that TTHM and HAAs concentrations were below the established maximum contaminant level (Town of Madison, 2024).

2.8.2 NOISE

Noise is defined as the intensity, duration, and character of sounds from all sources. Sound waves are characterized by frequency, measured in hertz (Hz), and sound pressure is expressed as decibels (dB). The human threshold of audibility ranges from about 60 dB (at a frequency of 31 Hz) to less than about 1 dB (between 900 Hz and 8000 Hz). For regulatory purposes, noise levels for perceptible frequencies are weighted to provide an A-weighted sound level (A-weighted decibels [dBA]) that correlates highly with individual community response to noise. Sound levels outside the range of human hearing are not considered noise in a regulatory sense, even though wildlife may hear sounds at these frequencies (PNNL, 2007).

Noise levels are often reported as the equivalent sound level (L_{eq}). The L_{eq} is the equivalent steady sound level that, if continuous during a specified time period (usually 1 hour or 24 hours), would contain the same total energy as the actual time-varying sound over the monitored or modeled time period (PNNL, 2007).

As noted in Section 2.1, the Project site consists of rolling hills and steep slopes ranging in elevation from approximately 725 feet (ft.) (219.5 meters [m]) NAVD 88 near the shoreline of Belews Lake to approximately 890 ft. (271 m) NAVD 88 along the ridgetops. Although a portion of the Project site supports the BCSS, most is composed of undeveloped forested land. Additional details regarding land uses in the Project Vicinity are described in Section 2.1.

Noise-sensitive receptors typically include residences, recreational areas, public buildings or other developed sites where frequent public use occurs. The nearest noise-sensitive receptor to the Project site is a residence located along Craig Road, approximately 44 ft. (13.4 m) south of Project site at its closest point and approximately 1.1 mi. (1.8 km) from the Project site center point. The nearest recreational area is Belews Lake, located adjacent to the Project site. The BCSS is the nearest industrial site; however, it is not publicly accessible, and high noise levels at this facility are consistent with its industrial land use. Additional sensitive receptors nearby include recreational areas on Belews Lake, a mobile home park to the east, and Belews Lake Park.

2.8.2.1 Ambient Noise Survey

An ambient noise survey was conducted in June 2024. Environmental sound monitors were placed at eight locations around the Project site. The noise monitoring (NM) locations were chosen to characterize the baseline acoustical conditions at the Project site and at the nearest noise-sensitive receptors. The NM locations are described below and shown on Figure 2.8-3:

- NM-1 is located near the middle-west portion of the Project site along Duke Power Steam Plant Road. This location provides representation of activity along one of the roadways accessing the existing BCSS.
- NM-2 is on the west side of the Project site near the existing BCSS. Noise levels captured at this location represent typical noise emissions from the BCSS.
- NM-3 is near the northern boundary of the Project site and is representative of the residential receptors to the east across Belews Lake.
- NM-4 is near the middle-eastern boundary of the Project site near a high-voltage transmission line crossing. This location is also representative of the residential receptors to the east across Belews Lake.
- NM-5 is adjacent to the eastern boundary of the Project site located near Belews Lake. This location is wooded and represents boaters and other lake users.
- NM-6 is adjacent to the southern boundary of the Project site, near Windswept Drive, and represents the single-family residential community to the south of the Project site.
- NM-7 is located to the west of plant access road near the southern gate entrance to BCSS and provides a representation of activity at the southern end of the Project site.
- NM-8 is located on the southwestern portion of the Project site, near the BCSS Fly Ash Landfill and is representative of noise levels from the existing BCSS on the adjacent portion of Belews Lake.

2.8.2.1.1 Methodology

Ambient noise measurements were collected using a sound-level meter that complies with the requirements of the American National Standards Institute (ANSI) Methods for Electroacoustics Sound-Level Meters (ANSI, 2019). The sound-level meter was calibrated within the previous 24 months by a certified laboratory and was field calibrated prior to and after the field measurements. Instrument settings were selected to use the hourly equivalent noise level ($L_{eq[1hr]}$) averaging routine in the dBA scale prior to the field measurements. The sound-level meters were secured to elevated locations, such as trees, to prevent tampering, and windscreens were used during all readings.

Ambient noise levels were sampled in 1-hour intervals, recording the $L_{eq(1hr)}$ maximum, minimum, and percentile levels over the measurement period. A minimum of a 24-hour measurement period was collected at each location. The noise levels were measured between Thursday, June 6 and Monday, June 10, 2024.

2.8.2.1.2 Weather Conditions during the Sound Survey

Based on field observations, the weather conditions at the Project site during the field survey were mostly clear to partly cloudy, with winds ranging from relatively calm to occasional gusts up to 20 mph (32 km per hour). Temperatures ranged from 60 to 85°F (15.6 to 29.4°C). Some light precipitation occurred on the last day of the survey.

Monthly and annual summaries of meteorological data and a description of the regional climate are provided in Section 2.7. Ambient noise levels are somewhat variable based on seasonal changes and weather conditions; however, the results of the noise survey are generally representative of typical ambient conditions due to the absence of precipitation or other weather extremes during the NM survey period.

2.8.2.1.3 Sources of Noise Observed

Natural and human-generated noise sources were observed during the ambient noise survey. The dominant noise sources recorded during the survey included the noise from the existing BCSS, vehicles on roadways, boats on Belews Lake, and natural noises (e.g., birds, insects, and trees).

2.8.2.1.4 Monitoring Results

Ambient NM results for each monitoring location are shown in Table 2.8-5. The calculated community noise levels remained relatively consistent over the duration of the noise measurement survey, with the greatest variation occurring during the last 24-hour period (Sunday to Monday). The increase in noise level at the monitoring locations is attributed to an event that occurred around 6:00 p.m. on Sunday (June 9, 2024). The source of the event is unknown, but it caused an approximate 20-dBA increase in the $L_{eq(1hr)}$ at some of the monitoring locations. Overall, average ambient community noise levels at the Project site varied between 49 and 53 dBA day-night or community noise level (L_{dn}).

While there may have been short-term noise events that caused an increase in noise level at the monitoring locations, the L_{dn} at all but NM-1 remained below 55 dBA during each 24-hour period recorded. The L_{dn} at NM-1 only exceeded 55 dBA over the last 24-hour period (Sunday to Monday). NM-1, as well as NM-2 and NM-7, are located along Duke Power Station Plant Road and are more representative of noise generated by the BCSS operations, including traffic on Duke Power Station Plant Road. Consequently, noise levels at these locations were generally greater than other locations over the same time period. Locations NM-3, NM-4, NM-5, and NM-6 are located further from the existing BCSS and are more representative of noise environments associated with the residences near the Project site and recreational activity on Belews Lake.

2.8.2.2 Sound-Level Regulations

There are no municipal, county, or state-level regulations that establish quantitative noise level limits applicable to the Project site. USEPA guidelines recommend outdoor noise levels do not

exceed L_{dn} of 55 dBA, which is sufficient to protect the public from the effect of broadband environmental noise in typical outdoor and residential areas. This level is not a regulatory requirement but is intentionally conservative to protect the most sensitive portion of the American population with an additional margin of safety (USEPA, 1974). The average measured sound level at each monitoring location is below the USEPA public health and welfare L_{dn} of 55 dBA for outdoor residential areas and other places where quiet is a basis for use (USEPA, 1974).

2.8.3 TRANSPORTATION

Section 2.4.2.2 includes a description of the roadway network within the Project Region. Interstates (I) I-40, I-74, I-77, and I-85 provide the regional access to the Project site. Primary access to the Project site within the Project Vicinity is provided by several minor arterials and other principal arterials, including U.S. Route 311, U.S. Route 158, and NC Highway 65, as well as SRs and local roads, including SR 1908/SR 1977 (Pine Hall Road), SR 1965 (Belews Creek Road), SR 2042 (Craig Road), Martin Luther King Jr. Road, Hawkins Farm Road, and Fisherman Road (see Figure 2.4-4).

As described in Section 2.4.2.2.2, each of the four counties in the ROI have hundreds of mi. of publicly maintained roads. The county crash statistics of each of these four counties from the past 5 years (2019 to 2023) are shown on Table 2.8-6. Guilford County has the lowest ranking (26 in 2023) and Stokes County has the highest (best) ranking (57 in 2023).

Crash data from a 5-year period (September 2019 to August 2024) were obtained from the NCDOT for the roadways around the Project site and in the Project Vicinity. Crash data on these roadways were analyzed to determine the total crashes, crash severity, and crash rates. As shown in Table 2.8-7, no crashes occurred on the Fisherman Road and Hawkins Farm Road segments. There were 55 crashes on Pine Hall Road during this period. The crash-level severity is the most severe injury sustained by any individual involved in a crash. The severity index of 8.4 was used as a benchmark per the state of NC Traffic Engineering Accident Analysis System. Locations with a severity index above 8.4 are likely to experience more serious crashes with more severe injuries than other locations. All the roadways analyzed in the Project Vicinity are below the severity index threshold (8.4), indicating that they tend to have less severe crashes compared to locations with a higher severity index (see Table 2.8-7). The crash rates shown in Table 2.8-8 are the total number of crashes per 100 million vehicle mi. traveled and are all below NCDOT's statewide average total crash rate of 308.11.

AADT and planned roadway improvements in the ROI are identified in Section 2.4.2.2. As noted in Section 2.4.1, the ROI population is projected to continue to grow at a rate of approximately 0.8 percent over the licensing period. Given this relatively small growth rate, it is not expected that associated increases in AADT will notably affect roadways in the Project Vicinity. Impacts to area roadways resulting from the proposed Project are discussed in Sections 4.4.1 and 4.8.3.

2.8.4 ELECTROMAGNETIC FIELDS

All nuclear power plants have power transmission systems associated with them. Operation of power transmission systems generates both electrical and magnetic fields, referred to collectively as electromagnetic fields (EMFs). Public and worker health can be compromised by acute and chronic exposure to the EMFs produced by transmission lines.

EMFs vary in time as the current and voltage change, so that the frequency of the EMF is the same (e.g., 60 Hz for standard alternating current). Electrical fields can be shielded by objects such as trees, buildings, and vehicles. Magnetic fields, however, penetrate most materials, but their strength decreases with increasing distance from the source (NRC, 2024a).

Power lines associated with nuclear power plants usually have voltages of 230 kilovolts (kV), 345 kV, 500 kV, or 765 kV (a voltage used primarily in the eastern U.S.). EMF strength at ground level varies greatly under these lines, generally being stronger for higher voltage lines, a flat configuration of conductors, relatively flat terrain, terrain with no shielding obstructions (e.g., trees or shrubs), and a closer approach of the lines to the ground. At locations where the field strength is at a maximum, the measured values under 500 kV lines often average about 4 kilovolts per meter (kV/m) but sometimes exceed 6 kV/m. Maximum electric field strengths at ground level are 9 kV/m for 500 kV lines and 12 kV/m for 765 kV lines (NRC, 2024a).

Potential hazards associated with transmission lines include both acute and chronic effects. Acute effects are related to the potential for shock hazard. The potential for shock hazard is addressed by referencing the National Electric Safety Code, which provides practical safeguards of persons during the installation, operation, or maintenance of electric supply and communication lines and associated equipment (NRC, 2024a).

The EMFs resulting from 60 Hz power transmission lines fall under the category of nonionizing radiation. Much of the general population has been exposed to power line fields since near the turn of the 20th century. There was little concern about health effects from such exposures until the 1960s. A series of events during the 1960s and 1970s heightened public interest in the possibility of health effects from nonionizing radiation exposures and resulted in increased scientific investigation in this area. Epidemiological studies have suggested a correlation between proximity to high-current wiring configurations and incidence of childhood leukemia. However, no consistent evidence linking harmful effects with 60 Hz exposures has been presented. Many studies have been conducted on the safety of the electric field, but no health effects have been associated with the magnitude of the electric fields that are associated with electrical power usage (NRC, 2024a).

More recently, the National Cancer Institute provided a summary of research on the health effects from EMFs, including potential effects associated with exposure from power lines. Several studies have analyzed the data from multiple studies of power line exposure and childhood leukemia:

- A pooled analysis of nine studies reported a twofold increase in risk of childhood leukemia among children with exposures of 0.4 microteslas (μT) or higher. Less than 1 percent of the children in the studies experienced this level of exposure.
- A meta-analysis of 15 studies observed a 1.7-fold increase in childhood leukemia among children with exposures of 0.3 μT or higher. A little more than 3 percent of children in the studies experienced this level of exposure.
- More recently, a pooled analysis of seven studies published after 2000 reported a 1.4-fold increase in childhood leukemia among children with exposures of 0.3 μT or higher. However, less than one-half of 1 percent of the children in the studies experienced this level of exposure.

For the two pooled studies and the meta-analysis, the number of highly exposed children was too small to provide stable estimates of the dose-response relationship. This means that the

findings could be interpreted to reflect linear increases in risk, a threshold effect at 0.3 or 0.4 μT, or no significant increase. Therefore, as stated in the National Cancer Institute analysis, the interpretation of the finding of increased childhood leukemia risk among children with the highest exposures (at least 0.3 μT) is unclear (National Cancer Institute, 2022).

The existing transmission corridors at the Project site are described in Section 3.2. Long-term or chronic exposure to power transmission lines has been extensively studied. The scientific evidence regarding the chronic health effects from EMFs, including the potential effects associated with exposure of electrical fields that are associated with electric power usage, does not conclusively link EMF exposure to adverse health impacts.

Table 2.8-1
National and State Nonfatal Occupational Injury and Illness Incidence Rates, 2022

NAICS Industry Category	National Incidence	NC Incidence
Construction	2.4	1.5
Utilities	1.7	-
Electric Power Generation, Transmission, and Distribution	1.7	-
Electric Power Generation	1.0	-

Source: BLS, 2023a, 2023b
Note: Incidence rates are measured as recordable cases per 100 full-time workers.
Key: "-" = Category not reported ; NAICS = North American Industry Classification System

Table 2.8-2
National Fatal Occupational Injury and Illness Incidence Rates, 2022

NAICS Industry Category	National Incidence
Construction	9.6
Utilities	3.4

Source: BLS, 2023c
Note: Incidence rates are measured as recordable cases per 100,000 full-time workers.
Key: "-" = Category not reported; NAICS = North American Industry Classification System

Table 2.8-3
State Fatal Occupational Injury Incidence Rates, 2022

NAICS Industry Category	NC Incidence
Construction	11.5
Transportation and Utilities	13.3

Source: BLS, 2023d
Note: Incidence rates are measured as recordable cases per 100,000 full-time workers.
Key: NAICS = North American Industry Classification System

Table 2.8-4
Number of Pathogen Outbreaks within North Carolina from 2011 to 2021

Pathogen Genus	Number of Outbreaks
Norovirus	639
Salmonella	90
Shigella	38
Cryptosporidium	9
Legionella	9
Escherichia coli	6
Campylobacter	2
Clostridium	2
Rotavirus	2
Sapovirus	1

Source: CDC, 2023

Table 2.8-5
Ambient Community Noise Level Results

	24-Hour Average Noise Level (dBA L_{dn})				
Monitoring Location No.	**Thurs-Fri 6/6-6/7/2024**	**Fri-Sat 6/7-6/8/2024**	**Sat-Sun 6/8-6/9/2024**	**Sun-Mon 6/9-6/10/2024**	**Average**
NM-1	52.6	50.2	46.2	56.7	51.4
NM-2	52.4	-	-	-	52.4
NM-3	50.3	48.5	49.5	53.4	50.4
NM-4	52.2	50.5	52.1	54.0	52.2
NM-5	48.0	48.9	47.6	53.8	49.6
NM-6	50.7	49.7	-	-	50.2
NM-7	53.4	-	-	-	53.4
NM-8	48.3	46.9	45.5	53.1	48.5

Notes:
The noise measurement data at locations NM-1, NM-3, NM-4, NM-5, and NM-8 represent data recorded over the entire four-day period, whereas location NM-6 represents a two-day period, and NM-2 and NM-7 represent one 24-hour period. This was due to equipment limitations.
Daytime events occur between 7:00 a.m. and 10:00 p.m.
Nighttime events occur between 10:00 p.m. and 7:00 a.m. A 10 dBA penalty was added to the measured nighttime noise levels in calculating the average community noise level to reflect the sensitivity of receptors during those hours.
Key: dBA = A-weighted decibel; L_{dn} = day-night average community noise level

Table 2.8-6
ROI County Crash Data

		2019		2020		2021		2022		2023	
	Reportable	**Crashes**	**Injuries**	**Crashes**	**Injuries**	**Crashes**	**Injuries**	**Crashes**	**Injuries**	**Crashes**	**Injuries**
Forsyth	Fatal	30	34	43	44	44	46	45	46	49	55
	Nonfatal Injury	3380	5062	2703	3954	3152	4650	3019	4490	3011	4478
	PDO	9371		7203		8168		8823		8951	
	Total	12,781	5096	9949	3998	11,364	4696	11,887	4536	12,011	4533
	County Ranking	**46**		**45**		**46**		**43**		**37**	
Guilford	Fatal	61	64	65	73	92	97	63	67	57	57
	Nonfatal Injury	5305	8247	4790	7309	5035	7831	4840	7492	5105	7991
	PDO	9264		8004		8722		8921		9414	
	Total	14,630	8311	12,859	7382	13,849	7928	13,824	7559	14,576	8048
	County Ranking	**32**		**33**		**29**		**29**		**26**	
Rockingham	Fatal	15	15	21	23	20	20	15	16	13	15
	Nonfatal Injury	533	767	459	687	560	803	457	688	536	802
	PDO	1563		1508		1509		1457		1528	
	Total	2111	782	1988	710	2089	823	1929	704	2077	817
	County Ranking	**72**		**52**		**48**		**48**		**54**	
Stokes	Fatal	6	7	2	2	6	6	15	15	5	5
	Nonfatal Injury	228	336	225	302	239	339	223	319	211	300
	PDO	583		522		515		538		600	
	Total	817	343	749	304	760	345	776	334	816	305
	County Ranking	**75**		**86**		**81**		**59**		**57**	

Source: NCDOT, 2024e
Key: PDO = Property Damage Only

Table 2.8-7
Number of Crashes by Type (September 2019 to August 2024)

Crash Type	Number of Crashes					
	Craig Road	Pine Hall Road[a]	NC 65[b]	Fisherman Road	Hawkins Farm Road	Martin Luther King Jr. Road[c]
Total Crashes	1	55	41	0	0	6
Fatal Crashes	0	1	0	0	0	0
Nonfatal Injury Crashes	0	19	12	0	0	3
Total Injury Crashes	0	20	12	0	0	3
Property Damage Only Crashes	1	35	29	0	0	3
Severity Index	1.0	6.18	3.17	0	0	4.70

Source: NCDOT, 2024f
Notes:
(a) From U.S. 311 to NC 65
(b) From Fisherman Road to Craig Road
(c) From NC 65 to Pine Hall Road

Table 2.8-8
Crash Rates Per 100 Million Vehicle Miles Traveled

Crash Rate	Craig Road Crashes Per 100 Million Vehicle mi.	Pine Hall Road[a] Crashes Per 100 Million Vehicle mi.	NC 65[b] Crashes Per 100 Million Vehicle mi.	Fisherman Road Crashes Per 100 Million Vehicle mi.	Hawkins Farm Road Crashes Per 100 Million Vehicle mi.	Martin Luther King Jr. Road[c] Crashes Per 100 Million Vehicle mi.
Total Crash Rate	55.09	280.35	188.75	0	0	101.71
Fatal Crash Rate	0	5.1	0	0	0	0
Non-Fatal Crash Rate	0	96.85	55.24	0	0	50.85
Night Crash Rate	55.09	132.53	69.05	0	0	33.90
Wet Crash Rate	0	56.07	13.81	0	0	0
EPDO Rate	55.09	1732.05	597.55	0	0	478.02
EPDO Crash Index	1.0	339.80	129.80	0	0	28.20

Source: NCDOT, 2024f
Notes:
(a) From U.S. 311 to NC 65.
(b) From Fisherman Road to Craig Road.
(c) From NC 65 to Pine Hall Road.
Key: EPDO = Equivalent Property Damage Only

2.9 ENVIRONMENT AND RADIOLOGICAL MONITORING

This section discusses the preoperational radiological environmental monitoring program (REMP) and discusses the background radiological characteristics at the Project site.

2.9.1 PREOPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The preoperational REMP is used to establish the baseline for the local radiation environment, measuring background levels and their variations along the anticipated critical pathways in the area surrounding the Project site. Baseline radiological conditions are used to identify and assess radiological environmental impacts resulting from plant operation. Programs for radiological environmental monitoring are based on the guidance provided in the NRC RG 4.1, Rev. 2, Radiological Environmental Monitoring for Nuclear Power Plants, and the requirements of 10 CFR 20.1501. Preoperational monitoring programs are implemented two years before initial facility operation.

The elements for both the preoperational and operational REMP phases are essentially the same. As such, Section 5.9.6, Radiological Monitoring, provides a description of both preoperational and operational REMP, including exposure environmental pathways, number and location of proposed sample collection points and measuring devices for direct radiation and effluents, sample collection frequency, type of analysis, reporting requirements, and the quality assurance program.

2.9.2 BACKGROUND RADIATION EXPOSURE

Section 2.9 of RG 4.2, Rev. 3, Preparation of Environmental Reports for Nuclear Power Stations, requires a characterization of the background radiation at the Project site.

The average background radiation dose to the public is 620 millirem per year (mrem/yr) (6.2 millisievert per year [mSv/yr]) in the U.S., with approximately half from medical procedures and man-made sources and half from natural sources (USEPA, 2024q).

2.9.2.1 Natural Sources

The NRC separates natural sources of radiation into three categories: cosmic, internal, and terrestrial. Cosmic radiation is the result of radiation received from extraterrestrial sources, such as the sun and other stars, that penetrate the Earth's atmosphere. Internal radiation is the result of naturally occurring potassium-40 (K-40) and carbon-14 (C-14) in all humans. Lastly, terrestrial radiation is the result of radiation received from naturally occurring uranium, thorium, and radium found in soil and rock. In addition to these three categories, there is radon and thoron gas which seeps through the ground and into the air where it is inhaled. The inhaled radon and thoron gas represents about two-thirds of the natural background radiation dose for an average member of the public whereas, cosmic, internal, and terrestrial radiation account for the rest (NRC, 2024b).

Based on information in the following sections, there are no natural features in the vicinity of the Project site that would result in natural background radiation at levels higher than the U.S. average. Therefore, the estimated radiation dose from natural background radiation at the Project site is taken to be the national average of 310 mrem/yr (3.1 mSv/yr). Natural background

radiation doses attributed to cosmic, internal, and terrestrial radiation, and inhalation of radon and thoron gases are discussed in the following sections.

2.9.2.1.1 Cosmic Radiation

Cosmic radiation exposure depends on the site elevation. As stated in Section 2.7, the Project site is located at an elevation of approximately 810 ft (247 m) AMSL on a peninsula surrounded to the east and west by Belews Lake. The annual dose due to cosmic radiation at elevations up to 1000 ft (305 m) AMSL is 28 mrem/yr (0.28 mSv/yr) (USEPA, 2024p). Therefore, it is appropriate to use the average annual dose due to cosmic radiation of 33 mrem/yr (0.33 mSv/yr) (USEPA, 2024q).

2.9.2.1.2 Internal Radiation

The average annual dose due to internal radiation, 29 mrem/yr (0.29 mSv/yr), is applicable to the Project site (USEPA, 2024q).

2.9.2.1.3 Terrestrial Radiation

The national average for terrestrial radiation of 21 mrem/yr (0.21 mSv/yr), which includes uranium, thorium, and radium found in soil and rock, is applicable to the Project site (USEPA, 2024q).

2.9.2.1.4 Radon and Thoron Gas

As mentioned in Section 2.9.2.1, the average annual dose due to radon and thoron gas is estimated to be two-thirds of the natural background dose or 228 mrem/yr (2.28 mSv/yr). The estimated annual dose from radon and thoron gas at the Project site is 211 mrem/yr (2.11 mSv/yr) (USEPA, 2024p). Therefore, it is appropriate to use the average annual dose associated with radon and thoron gas.

2.9.2.2 Man-Made Sources

A portion of background radiation comes from human activities. Man-made sources of radiation to the public include medical sources, consumer products, nuclear reactor facilities, and ash wastes from coal-fired power plants as discussed below. Trace amounts of radioactive elements have dispersed in the environment from nuclear weapons tests and accidents like the one at the Chernobyl nuclear power plant in Ukraine. Background dose due to fallout from nuclear weapons tests contribute about 1 mrem/yr (1E-02 mSv/yr) (USEPA, 2024p). Normally operating nuclear reactors emit small amounts of radioactive elements (USEPA, 2024q).

Based on the information in the following sections, there are no abnormal sources of radiation located in the vicinity of the Project site; therefore, the estimated radiation dose from man-made radiation sources at the Project site is taken to be the national average of 310 mrem/yr (3.1 mSv/yr) (NRC, 2024b).

2.9.2.2.1 Medical Sources

Medical procedures like X-rays and CT scans provide the majority of man-made radiation exposure to the public. Medical personnel may receive a higher radiation dose than the non-medical public. Radiation exposures from diagnostic medical examinations are generally low

and are almost always justified by the benefits of accurate diagnosis of possible disease conditions. There is no direct evidence of radiation causing any harm at the exposure levels encountered with diagnostic radiological examinations. Therapeutic uses of radiation naturally involve higher exposures and physicians will consider the risks of the treatment against the potential benefits. In diagnostic uses, there are theoretical models that suggest the possibility of cancer risks, but these models all extrapolate results from higher exposures to these low levels, and no one is certain about whether or not any real risks are involved. The exposures are usually comparable to those that we receive routinely from natural radiation all around us, and the benefits of the medical exams are of course very significant (HPS, 2024). Medical exposures are about 48% of the average background dose, which is estimated at 310 mrem/yr (3.0 mSv/yr) and are therefore comparable to doses received routinely from natural sources of radiation.

2.9.2.2.2 Consumer Products

Radiation dose from the use of consumer products (i.e., tobacco, fertilizer, welding rods, exit signs, luminous watch dials, and smoke detectors) will fluctuate based on the lifestyle of the individual population. As such, a best estimate of the average annual dose due to consumer products of 13 mrem/yr (0.13 mSv/yr) is used (USEPA, 2024q).

2.9.2.2.3 Nuclear Reactor Facilities

The McGuire Nuclear Station and the Shearon Harris Nuclear Power Plant are located approximately 76 mi. (122 km) southwest and 80 mi. (129 km) southeast of the Project site, respectively. As documented in their respective 2023 annual radioactive effluent release reports on the NRC website, the radiation exposure at the Project site from the McGuire Nuclear Station and the Shearon Harris Nuclear Power Plant is expected to be lower than 1.07 mrem/yr (1.07E-02 mSv/yr) and 8.22E-01 mrem/yr (8.22E-03 mSv/yr) due to the distance between the site and the nuclear reactor facilities mentioned previously.

As mentioned in Section 2.1, U.S. Highway 311, U.S. Highway 158, and NC Highway 65 are located within 5 mi. of the Project site. U.S. Highway 311, U.S. Highway 158, and NC Highway 65 are all located approximately 4.35 mi. (7 km) northwest, 3.0 mi. (4.8 km) south, and 1.6 mi. (2.6 km) south from the Project site, respectively. Additionally, a NS railroad line runs to the north of the Project site. The railroad throughline is 2.2 mi. (3.5 km) to the north of the Project site. As stated in 49 CFR 173.441, the maximum dose rate at any point 6.6 feet (2 m) from the outer lateral surfaces of a vehicle transporting radioactive material is limited to 10 mrem/hr (0.1 mSv/hr). As such, there could be trace and insignificant amounts of radiation exposure to the public from the transportation of radioactive material along the pathways discussed above.

2.9.2.2.4 Coal-Fired Power Plants

Coal is a fossil fuel used to produce power in the U.S. Coal contains trace amounts of naturally occurring radioactive elements (i.e., uranium, thorium, radium, and radon). The process of burning coal at coal-fired power plants, called combustion, produces waste that contains small amounts of naturally occurring radioactive material. The three main types of ash waste (fly ash, bottom ash, and boiler slag) are only slightly more radioactive than the average soil in the U.S. The amount of natural radiation in waste from coal-fired power plants is so small that no precautions need to be taken (USEPA, 2024r).

As discussed in Section 2.1, the Project site is located adjacent to the BCSS. Section 2.7 states that the BCSS's new on-site ash landfill is being constructed partially within the former footprint of the ash impoundment at the BCSS. Additionally, the ash landfill is planned to be approximately 90 ac. (36 hectares), contain roughly 14.1 million cubic yards (10.8 million cubic meters) of coal ash, and is expected to be closed with a geosynthetic closure cap. In addition to the new ash landfill, the BCSS site contains other existing landfills that contribute to the estimated dose from the BCSS.

The expected contribution from the BCSS within 50-mi. is estimated to be roughly 0.03 mrem/yr (3.0E-04 mSv/yr) (USEPA, 2024p).

2.10 GEOLOGY

2.10.1 GEOLOGICAL CONDITIONS

The geological conditions at the Project site are summarized in this section. The Project site information is subdivided into three categories: physiography, stratigraphy, and structural geology. Geological conditions are described for the Project site, Project Vicinity, and Project Region.

Section 2.5 of the SSAR presents detailed geology, seismologic, and geotechnical information for the Project site and surrounding area.

2.10.2 PHYSIOGRAPHY

The two physiographic provinces represented within the Project Region are the Piedmont physiographic province (Piedmont) and the Blue Ridge physiographic province (Blue Ridge) (Figure 2.10-1). The Piedmont extends approximately 1000 mi. (1600 km) from Alabama to southern New York and consists mainly of metamorphic and igneous rocks that have been thoroughly weathered over time. The metamorphic rocks are primarily schist and gneiss, and the igneous rocks are mainly granites, commonly slightly metamorphosed. Structural basins, which are the result of faulting, are filled with sedimentary Mesozoic sediments. These basins, commonly called “Triassic-Jurassic basins,” are present within the Piedmont (NPS, 2018a).

The Blue Ridge is a mountainous belt stretching from Pennsylvania southwest to Georgia. The mountains are made of highly deformed metamorphic rocks of largely Precambrian ages. These include schists, gneisses, slates, and quartzites, and are extensively intruded by igneous bodies (NPS, 2018b).

The Project site and Project Vicinity lie within the NC western Piedmont (Golder, 2007). The NC Piedmont lies between the Coastal Plain physiographic province (Coastal Plain) and the Blue Ridge. The Piedmont occupies about 45 percent of the land area in the state. Along the border between the Piedmont and the Coastal Plain, elevations range from 300 to 600 feet (ft.) (91 to 183 meters [m]) above sea level. To the west, elevations gradually rise to about 1500 ft. (457 m) above sea level at the foot of the Blue Ridge. The Piedmont is characterized by gently rolling, well-rounded hills and long, low ridges with a few hundred feet of elevation difference between the hills and valleys (NCDENR, 2015a).

Major streams and rivers draining the Blue Ridge flow west into the Mississippi River, and east across the Piedmont and Coastal Plain into the Atlantic Ocean (USGS, 2018c). Rivers within the Piedmont typically flow to the southeast, toward the Atlantic Ocean (Golley, 2004).

The Project site drains to Belews Lake via the main Belews Creek arm and the West Belews Creek arm. Belews Lake then flows into Belews Creek, which discharges to the Dan River (HDR, 2014). The Dan River originates along the eastern slopes of the Blue Ridge Mountains in Patrick County, Virginia, and flows east until it empties into the Roanoke River at the John H. Kerr Reservoir, near Clarksville, Virginia (VDWR, 2024). The Roanoke River eventually drains into the Albemarle Sound of NC (NCDEQ, 2018).

As stated in Section 2.1, the Project site consists of rolling hills and steep slopes with surface elevations ranging from approximately 725 ft. (221 m) NAVD 88 near the shoreline of Belews

Lake to approximately 890 ft. (271m) NAVD 88 along the ridgetops. These steep slopes act as preferential pathways for drainage into Belews Lake as unnamed tributaries, shown on the Surface Water Map in Section 2.2. Topography is discussed in additional detail in Section 2.1.

2.10.3 STRATIGRAPHY

2.10.3.1 Regional Stratigraphy

The geologic framework of the Piedmont and Blue Ridge is complex. The Blue Ridge is generally faulted over Paleozoic strata of the Valley and Ridge physiographic province, while the rocks of the Piedmont continue in the subsurface beneath the Coastal Plain. Mesozoic rift basins overlie parts of the Piedmont crystalline rocks and contain hundreds to thousands of meters of Early Triassic to Jurassic sediment and igneous rocks. The oldest rocks, Grenville basement, were formed 1.3 to 1.0 billion years ago (bya) as crystalline gneisses and granitoids. The Grenville basement is exposed in mountain ranges within the Blue Ridge and Piedmont. Neoproterozoic to Paleozoic metasedimentary and metavolcanic rocks compose most of the different Appalachian terranes, both Laurentian and exotic, and record the Mesoproterozoic to Paleozoic accretion and collision of different terranes to the Laurentian margin (USGS, 2018c).

The Piedmont is predominantly an erosional terrain with narrow, elongated, and ridge-like landforms between valleys that range from 0.3 to 1.2 mi. (0.5 to 2 km) wide and are convex upward. Valleys are as narrow as 0.06 to 0.31 mi. (0.1 to 0.5 km) and generally V-shaped in cross section. Alluvial terraces are rare and discontinuous. Soils in the Piedmont typically have less sand and more clay than coastal plain soils. Infiltration rates for Piedmont soils are low at 2.4 to 5.9 inches (in.) (6 to 15 centimeters [cm]) per hour. The soil/saprolite, soil/rock, and saprolite/rock boundaries are characterized by ponding and lateral movement of water (Markewich et al., 1990).

The geology which makes up the water-bearing zones of the Piedmont and Blue Ridge can be composed of bedrock only, regolith-bedrock, or regolith, transition zone, and bedrock, depending on whether weathered material (regolith) overlies the bedrock and whether a local transition zone has developed between the shallow regolith and deeper bedrock (USGS, 2013). The transition zone lies between the regolith and bedrock and consists of coarse fragments of partially weathered bedrock and lesser amounts of saprolite (LeGrand, 2004). In the Blue Ridge, little if any regolith may be present. If present, regolith is often debris flow, colluvium, or alluvium in stream valleys. In the Piedmont, generally there is at least a two-part system with the weathered regolith overlying fractured bedrock. The regolith consists of soil, residuum, saprolite, and possibly colluviums, alluvium, and debris flow. Residuum and saprolite from in situ weathering of the bedrock creates a blanket of decomposed or partially decomposed rock that is usually thick and clayey. Saprolite retains the texture and structure of the parent bedrock from which it is derived. The regolith is more porous and more permeable than the underlying bedrock. Because the crystalline bedrock formed under intense heat and pressure during metamorphism and igneous intrusion, the bedrock has few primary pore spaces, and the porosity and permeability of the unweathered and unfractured bedrock is extremely low (USGS, 2013).

Groundwater at the Project Region, Project Vicinity, and Project site is described further in Section 2.2.

2.10.3.2 Project Vicinity and Project Site Stratigraphy

Within the Project Vicinity, the geology is diverse and complex, reflecting the multiple phases of compressional and extensional deformation experienced in this area (Golder, 2007). As shown on Figure 2.10-2, four main geologic terranes/features lie within the Project Vicinity (from the southeast to the northwest): the Late Paleozoic intrusives, the Milton terrane, the Triassic basin-Dan River basin, and the Sauratown Mountains anticlinorium (NCDENR, 2015b).

The Late Paleozoic intrusives comprise igneous rocks granite and granodiorite. These rocks intruded as giant blobs of molten rock during the formation of the Appalachian Mountain chain (approximately 280 to 320 million years ago [mya]) (NCDENR, 2015b). As shown in Figure 2.10-2, geologic dikes intrude the Late Paleozoic intrusives, Milton terrane, and Triassic basin-Dan River basin. These dikes are ultra-mafic Jurassic diabase dikes that trend north-northwest and are typically steeply to vertical dipping (Golder, 2018).

The Milton terrane comprises nearly two-thirds of the Project Vicinity and is situated northwest of the Late Paleozoic intrusives. The Milton terrane consists of gneiss, schists, and metamorphosed intrusive rocks. The rocks are about 460 to 470 mya. Generally, the rocks of the Milton terrane are interpreted to have been part of a chain of volcanic islands (NCDENR 2015b).

Sedimentary rocks of the Triassic basin-Dan River basin occur northwest of the Milton terrane and trend northeast toward Danville, Virginia. The Chatham Fault Zone separates the Triassic rocks from the metamorphic rocks of the Sauratown Mountain anticlinorium and the Milton terrane. The Pinehall Formation, Cow Branch Formation, and Stoneville Formations are present in the Triassic basin-Dan River basin and occur northwest of the Milton terrane (Golder, 2007).

The Pinehall Formation is generally composed of red to brown basin margin sandstones and conglomerates that interfinger with sandstones and mudstones of the Cow Branch and Stoneville Formations. The Cow Branch Formation ranges in thickness between 180 to 1,000 ft. (55 to 305 m) and largely consists of black and gray cyclically and rhythmically bedded lake sedimentary deposits of shale, mudstones, and sandstones, with thin coal seams at the base of the unit. The Stoneville Formation is an approximately 500-foot-thick (152-meter-thick) sequence of fluvial to alluvial red and brown sandstone and mudstones, with rhythmic fining upward sequences of trough cross bedded sandstones, grading upward into ripple cross laminated finer sandstones and mudstones (Golder, 2007).

The geological feature that is furthest northwest within the Project Vicinity is the Sauratown Mountain anticlinorium (Figure 2.10-2). Within Stokes County, the Sauratown Mountain anticlinorium comprises the Miller Creek Complex, Pilot Mountain Gneiss, Volunteer Gneiss, and Hogan Creek Formation (Golder, 2007).

The Miller Creek Complex comprises calc-silicate granofels. The granofels predominantly comprise bladed amphibole, quartz, feldspar, chlorite, and epidote. The Pilot Mountain Gneiss is made up of medium-grained muscovite biotite quartz feldspar gneiss with minor amounts of garnet, calcite, and epidote. The Volunteer Gneiss is part of the lowermost thrust sheet of the Sauratown Mountain anticlinorium. This unit comprises granitic gneiss with minor augen gneiss and biotite granitic gneiss predominately (Golder, 2007). The Hogan Creek Formation consists of metagraywacke interlayered with muscovite schist (USGS, 2024).

As shown in Figure 2.10-2, the Project site is located entirely within the Milton terrane. Figure 2.10-3 shows the rock units within the Project site are predominantly biotite gneiss and schist. Subsurface investigations identified the vadose zone thickness to range from approximately 10 ft. (3 m) to 65 ft. (20 m) and is comprised mainly of unconsolidated overburden OB sediment (residual soil, saprolite, and regolith) PWR, and fractured crystalline bedrock. OB sediments consist of soil and saprolite formed from in-place weathering of the underlying bedrock parent material. At the Project site, the regolith is generally described as a moist, yellowish/reddish to brown silty medium-grained sand to a sandy silt. Clay layers are common within the upper portion (upper 5 ft. [1.5 m]) of the vadose zone. Trace amounts of gravel-sized rock fragments are commonly observed in the deeper portions of the vadose zone. Relic rock structure and cobble-sized and larger intact rock fragments are observed in the PWR. Most of the crystalline bedrock encountered is gneiss and schist, with lesser amounts of granofels. texture. As regolith grades downward into PWR, both porous- and fracture-medium characteristics may exist because some of the textural features of the bedrock, including stratigraphic layering, foliation, and fractures are retained.

Detailed information regarding the stratigraphy of the Project site is provided in Section 2.5.1 of the SSAR. A geologic cross section from the Project site stratigraphy is shown on Figure 2.10-4.

2.10.4 STRUCTURAL GEOLOGY

The Piedmont and Blue Ridge are made of various lithostratigraphic terranes assembled during multiple orogenies (USGS, 2018c). Collectively, the orogenies experienced by the Blue Ridge and Piedmont include Grenville orogeny (1.3 to 1.0 bya), Taconic orogeny (460 to 450 mya), Acadian/Neoacadian orogeny (395 to 340 mya), and Alleghenian orogeny (335 to 260 mya). These orogenic events were punctuated by periods of extension, including intracontinental rifting (780 to 750 mya), the breakup of supercontinent Rodinia and the opening of the Iapetus ocean (approximately 570 mya), and finally the breakup of supercontinent Pangea and the opening of the modern Atlantic Ocean (approximately 200 mya).These orogenic events are responsible for the crustal structure, fracture and fault zones, mineralization and ore deposits, geochemical, and geophysical properties of the Piedmont and Blue Ridge. Major faults, which bound these terranes, developed highly foliated or fractured rocks that are weak and more susceptible to landslides and other forms of mass wasting (USGS, 2018c). The major rock units in the Piedmont and Blue Ridge occur as northeast-southwest-trending belts that correspond to the trend of the regional geologic structure (LeGrand, 2004). These geologic belts are predominantly bounded by thrust faults (Thigpen et al., 2022).

The Milton terrane, Late Paleozoic intrusives, Triassic basin-Dan River basin, and the Sauratown Mountain anticlinorium are northeast-trending geologic features, as shown in Figure 2.10-2. The Sauratown Mountain anticlinorium is characterized by a nearly symmetrical distribution of basement rocks. Within the Sauratown Mountain anticlinorium, there are stacked thrust sheets or units of Middle Proterozoic basement rocks that have been pushed one on top of the other through the mountain-building processes that formed the Appalachian Mountains. The erosion of these “stacked rock sheets” reveals the structural relationships between each of the thrust sheets (Golder, 2007).

Southeast of the Sauratown Mountains anticlinorium is the Triassic basin-Dan River basin, which is an asymmetric graben bounded to the north by the Chatham fault (Horton, 1994). The Triassic basin-Dan River basin is one of a series of continental rift basins that formed during the breakup of Pangea from the Permian to Early Jurassic (Olson, et al., 2015).

Further discussion regarding the geologic conditions within the Project site can be found in Section 2.5 of the SSAR.

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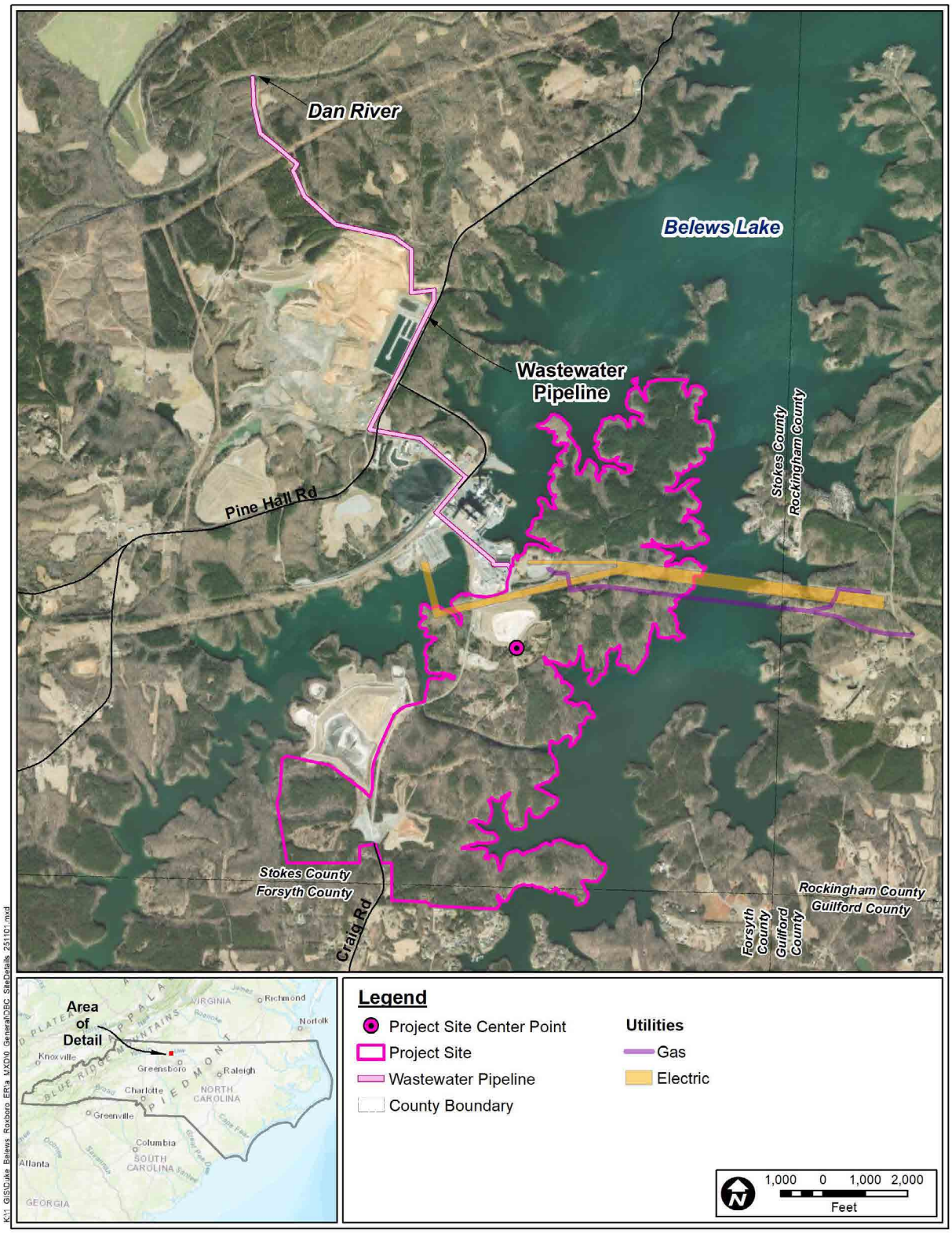
Figure 2.1-1
Project Site Location and Utility Locations



Key: Rd = Road

Figure 2.1-2
High Oblique Aerial Photograph of the Project Site

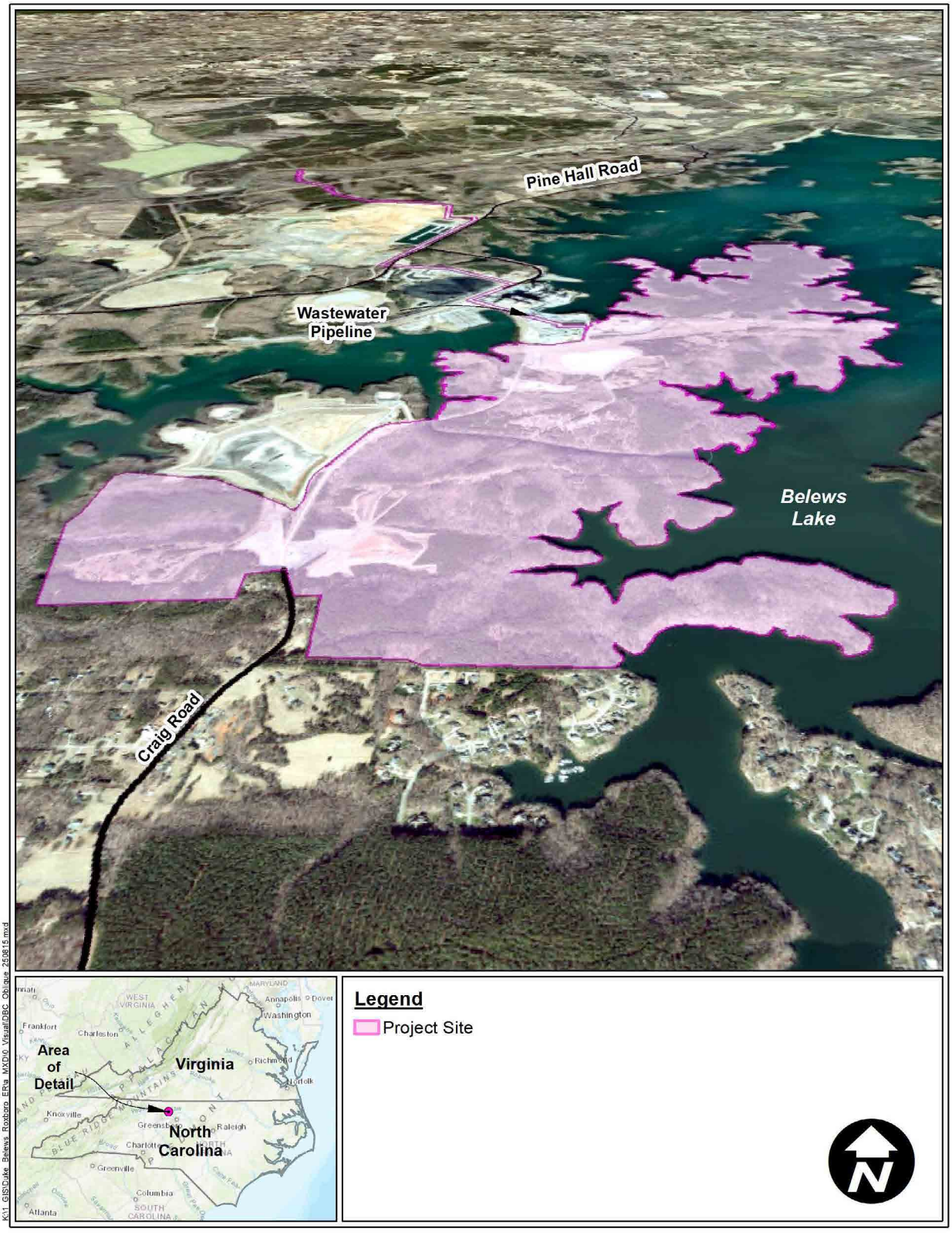


Figure 2.1-3
Project Vicinity and Project Region

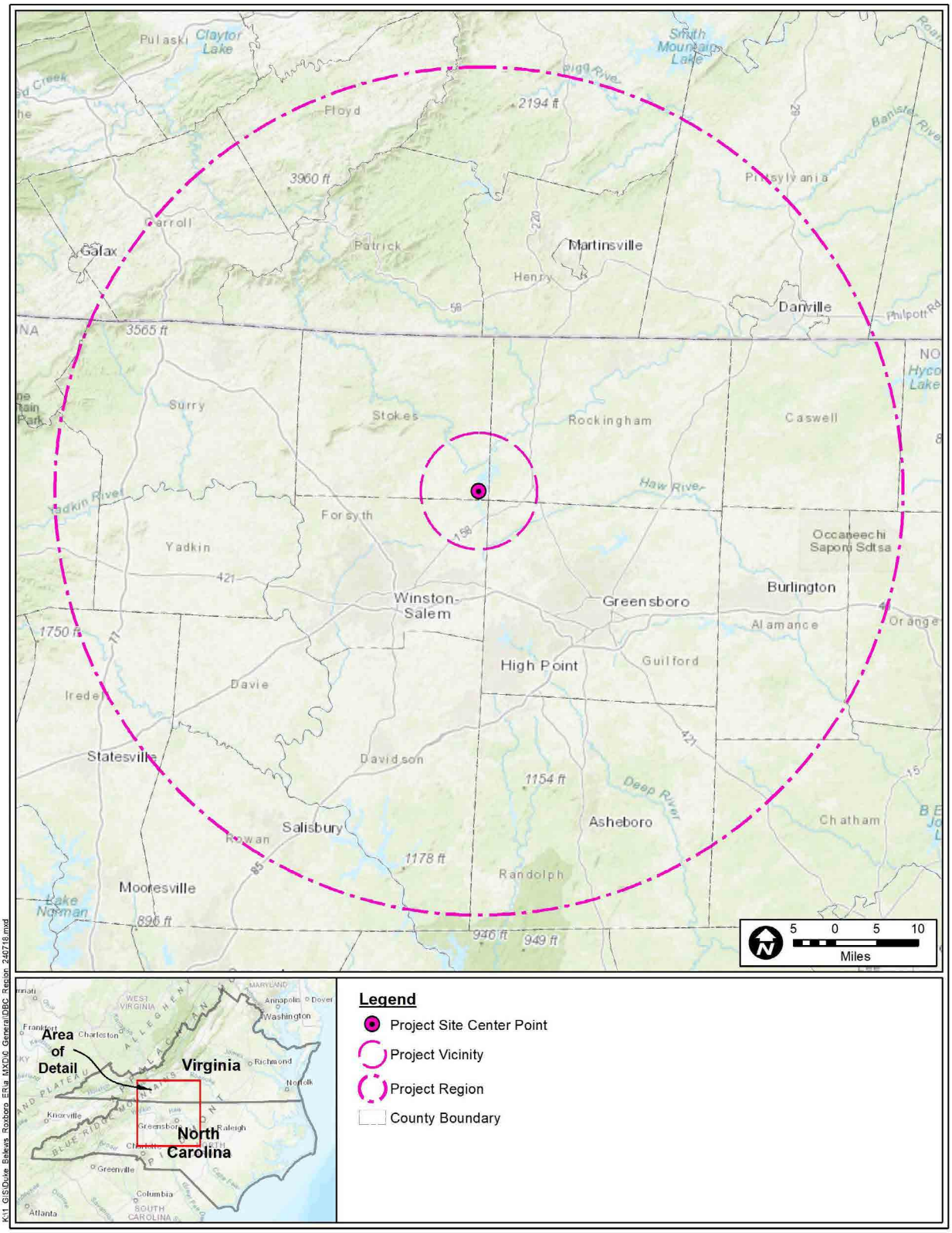


Figure 2.1-4
Transportation within the Project Vicinity and Project Region

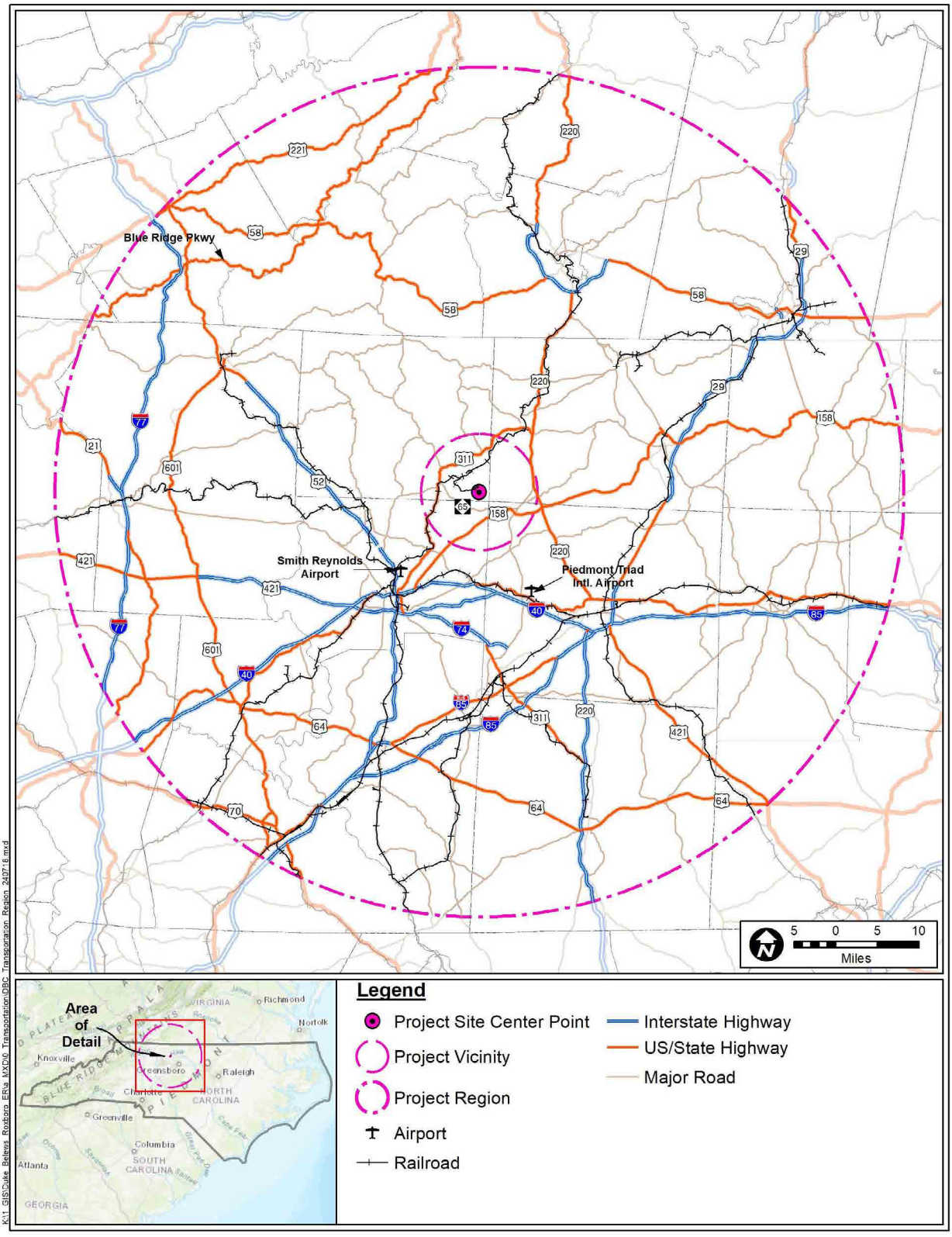


Figure 2.1-5
Land Cover within the Project Region

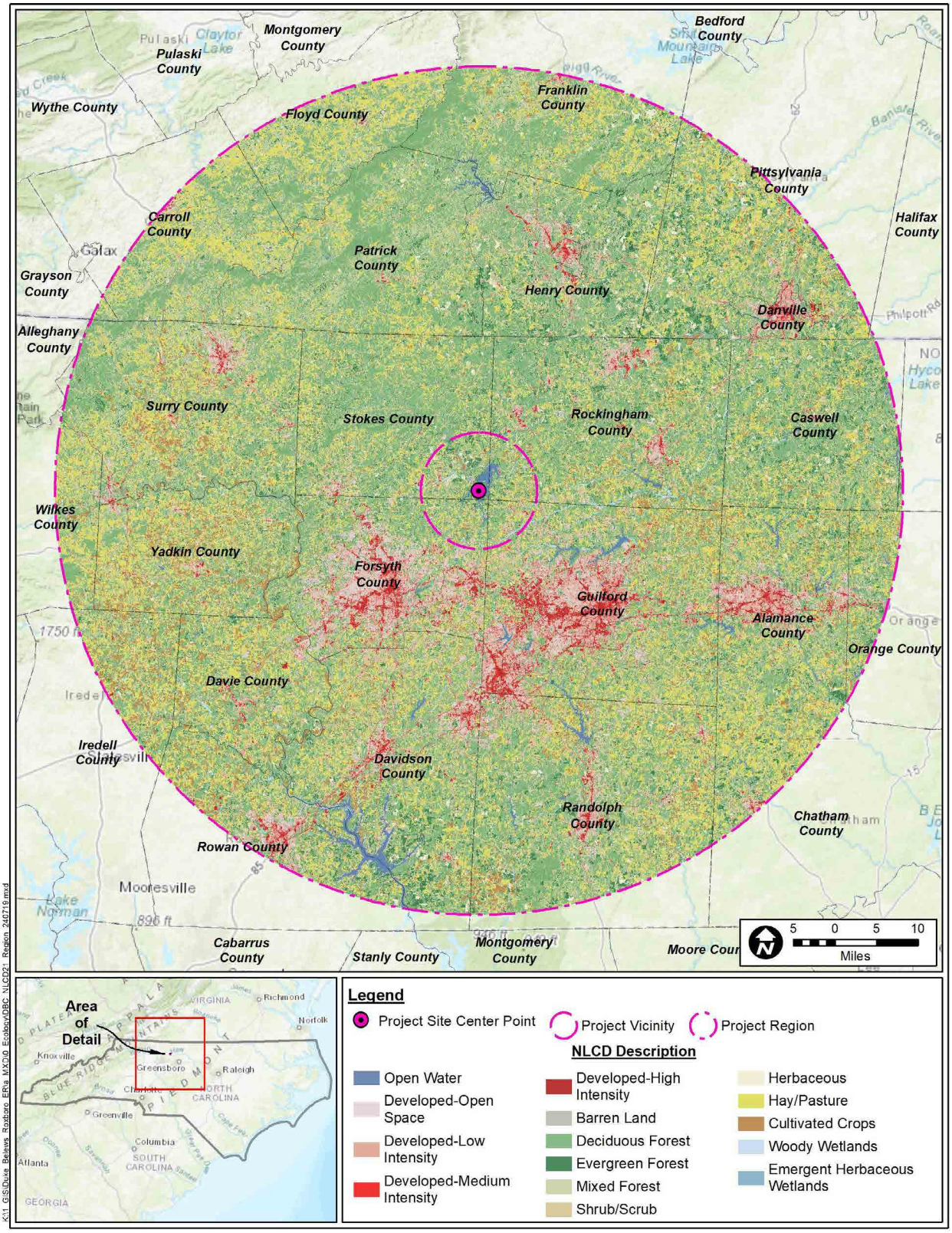


Figure 2.1-6
Special Land Uses within the Project Vicinity and Project Region

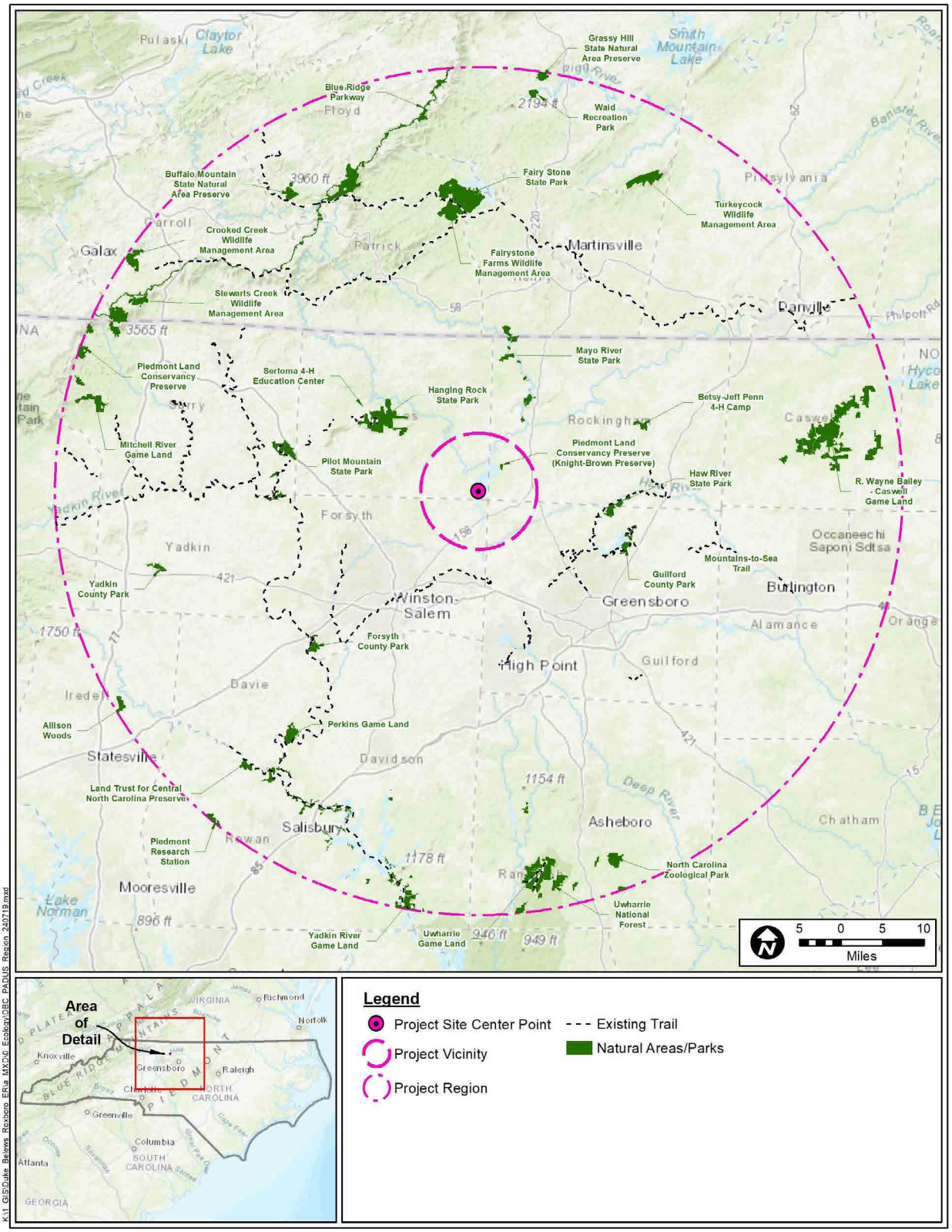


Figure 2.1-7
Topography of the Project Vicinity

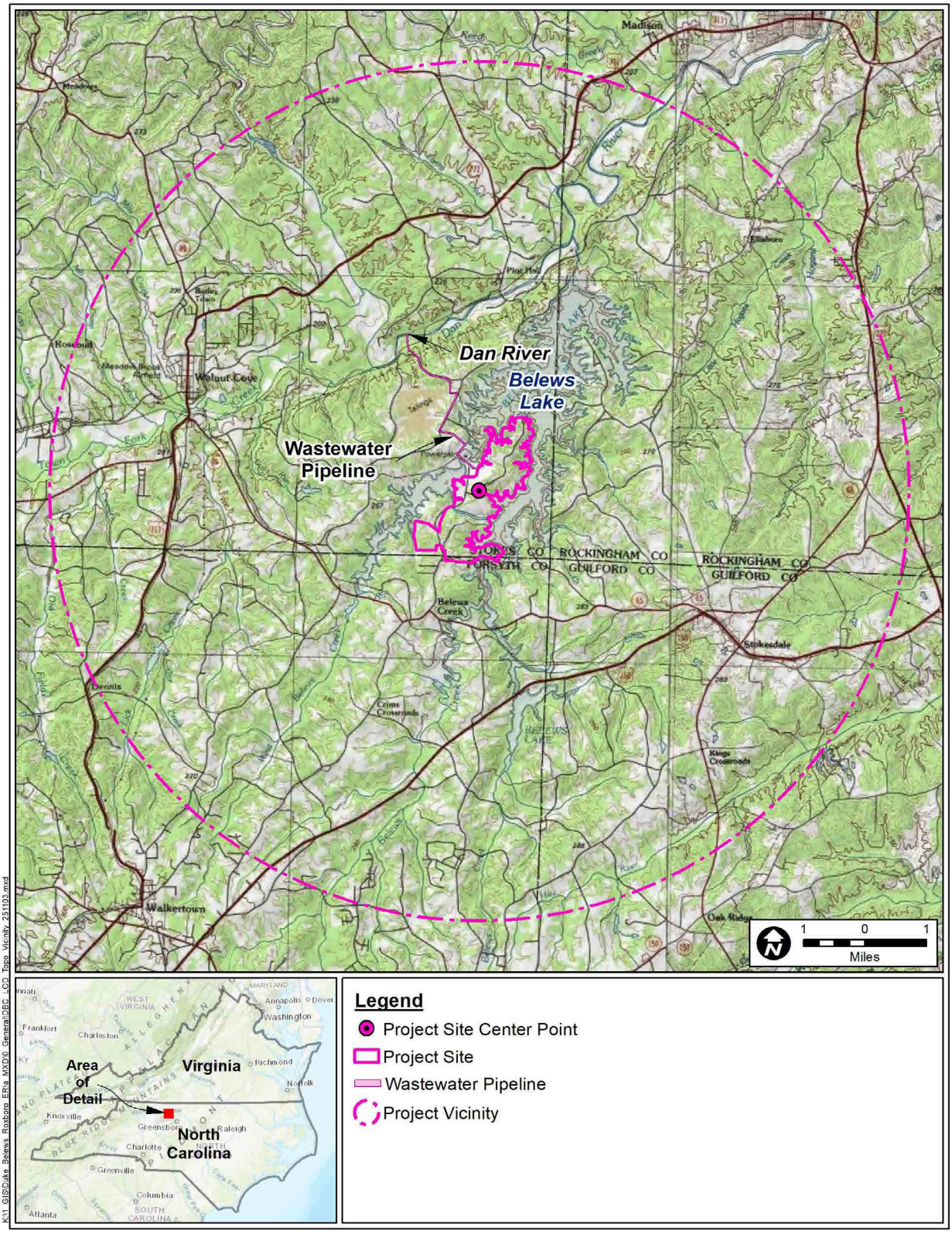


Figure 2.1-8
Land Cover within the Project Site and Project Vicinity

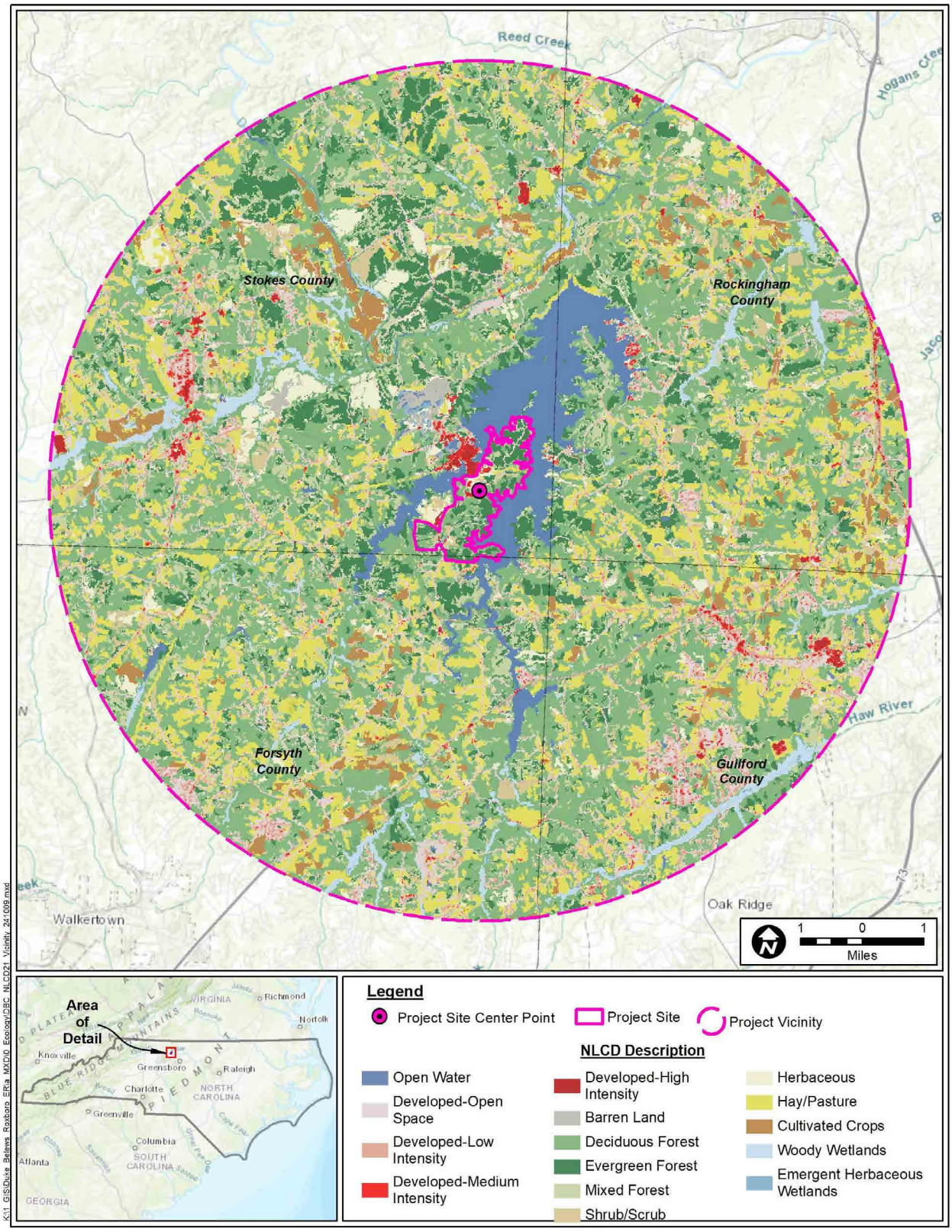


Figure 2.1-9
Prime Farmland within the Project Site and Project Vicinity

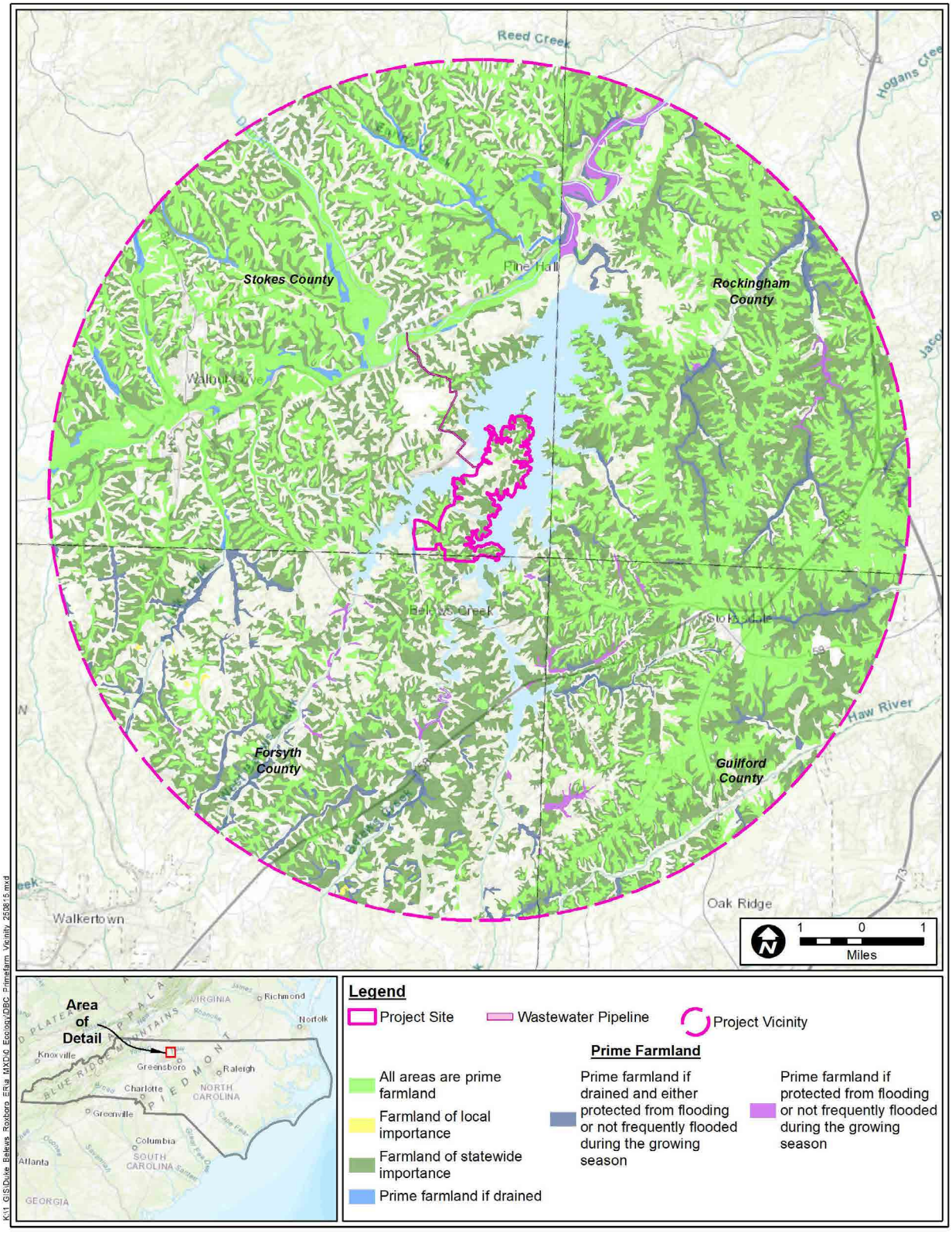


Figure 2.1-10
Topography of the Project Site

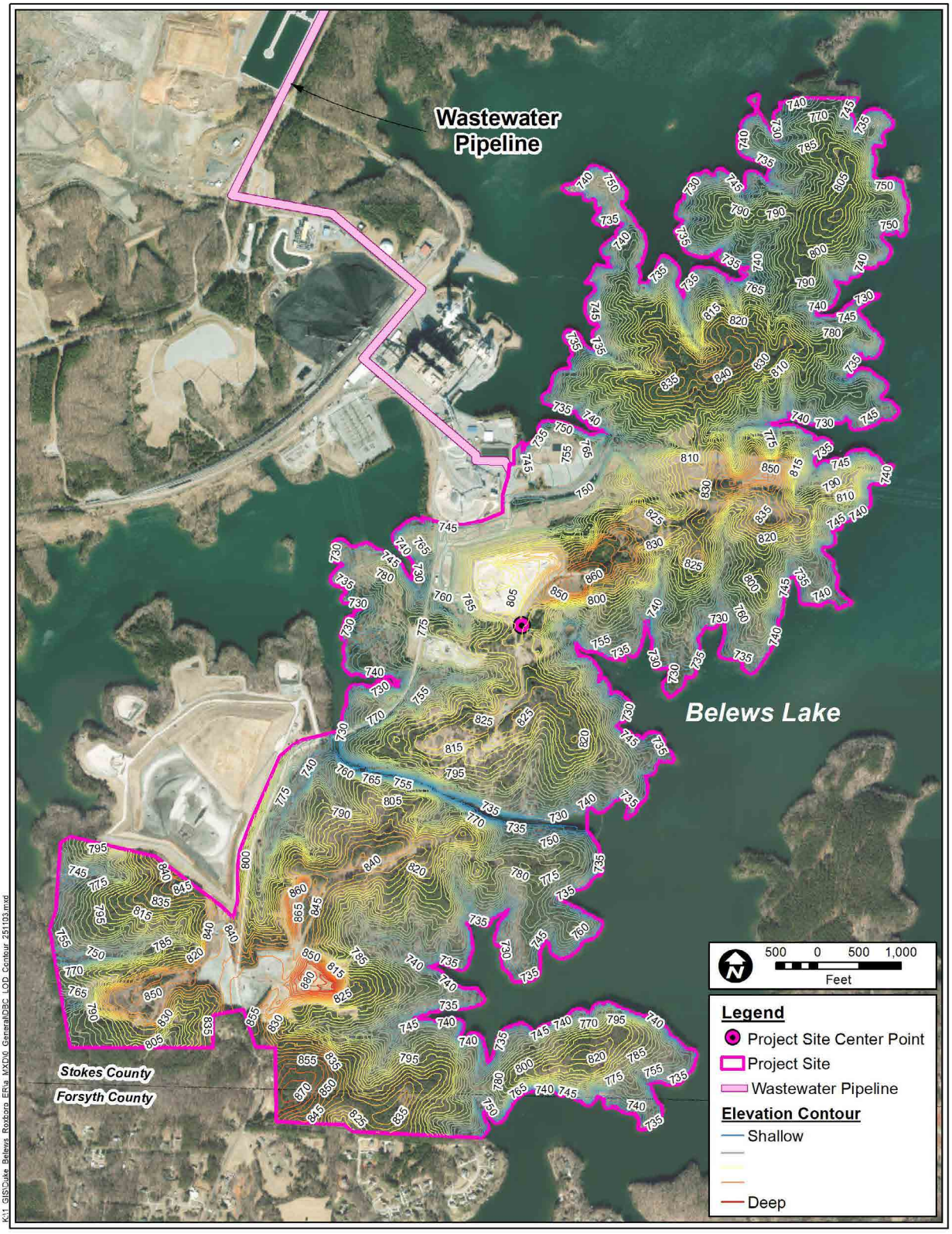


Figure 2.2-1
Surface Water Resources in the 50-Miles (80-Kilometers) Project Region

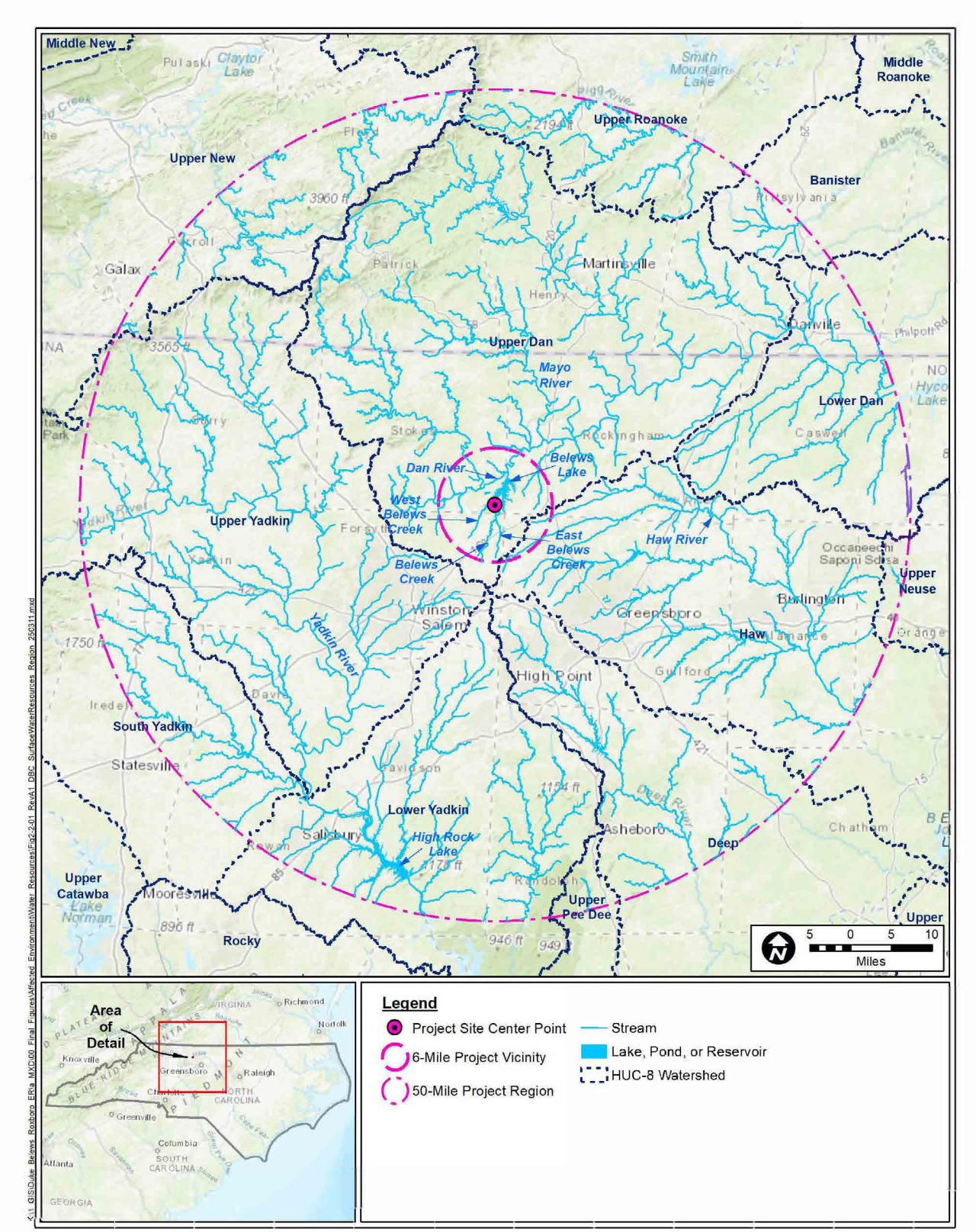


Figure 2.2-2
Surface Water Resources in the 6-Miles (10-Kilometers) Project Vicinity

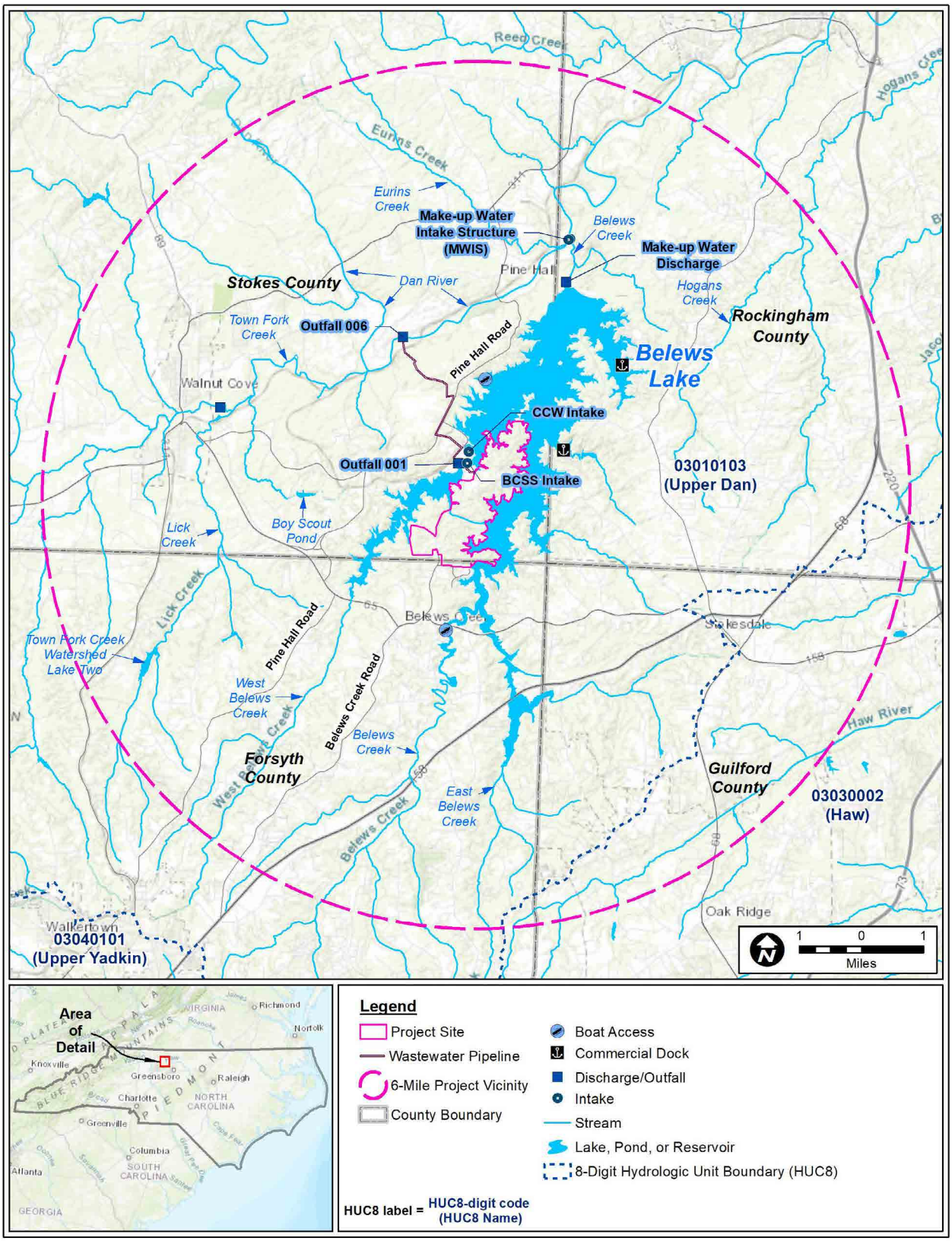


Figure 2.2-3
Representative Features of Belews Lake

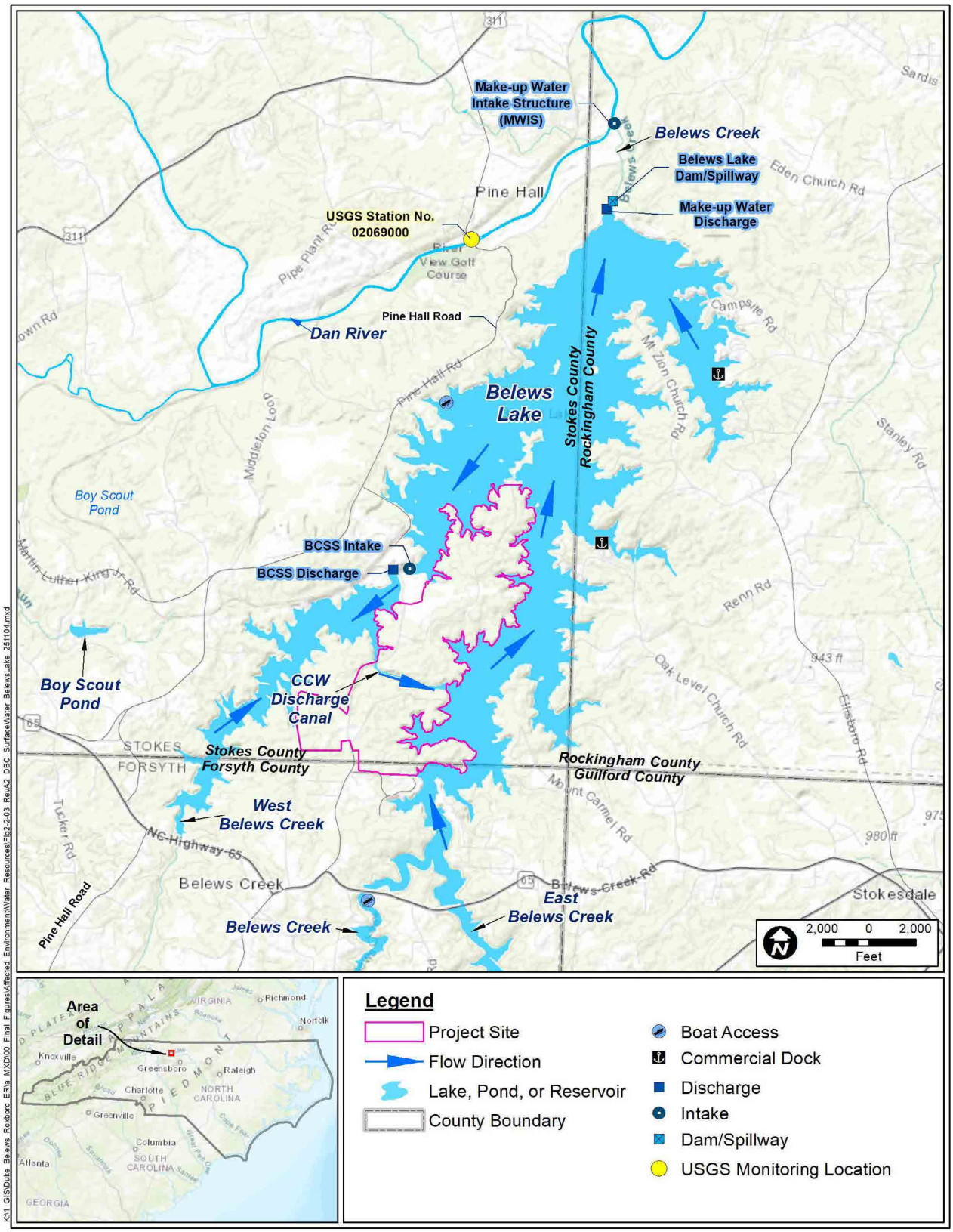
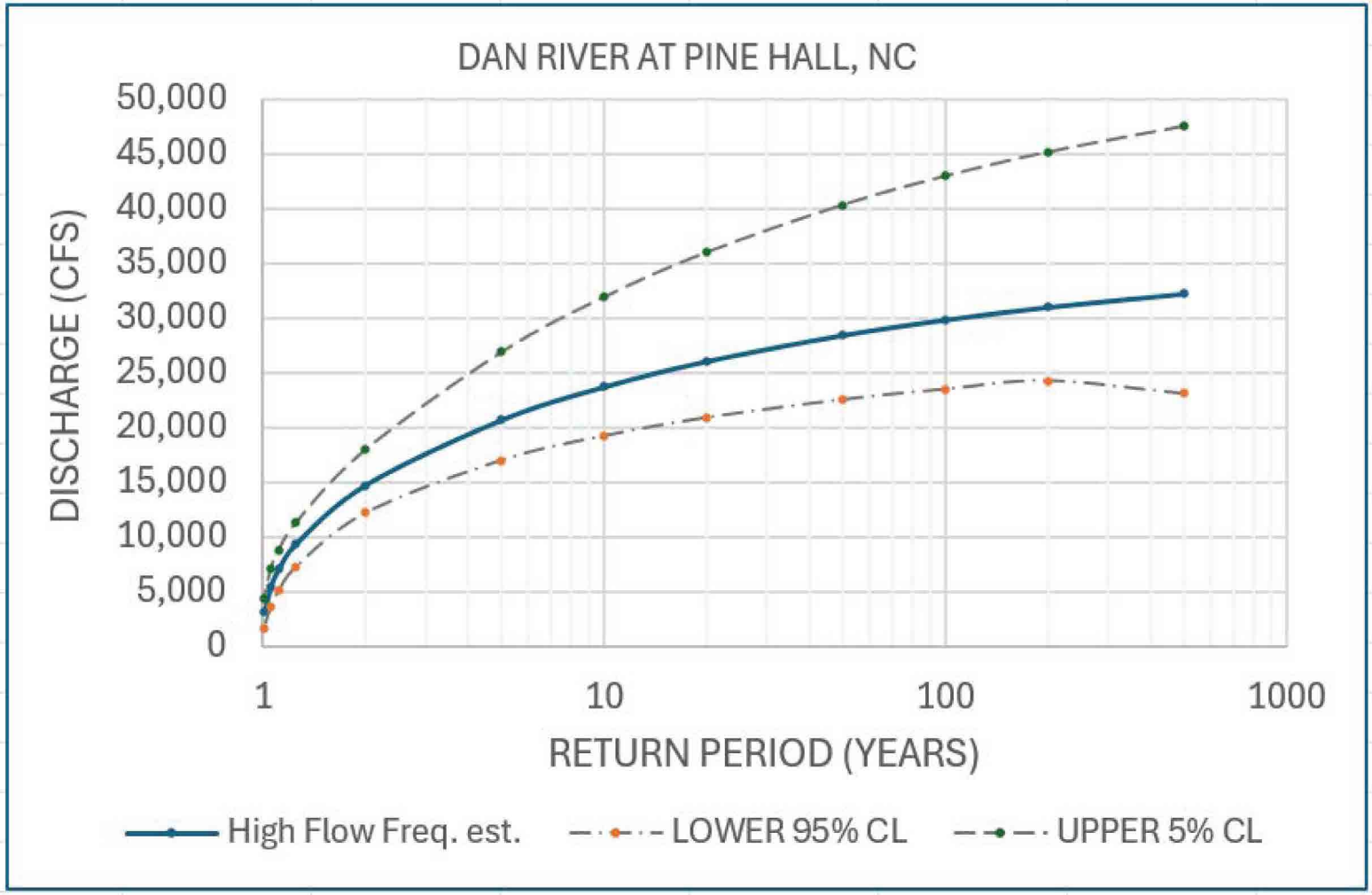
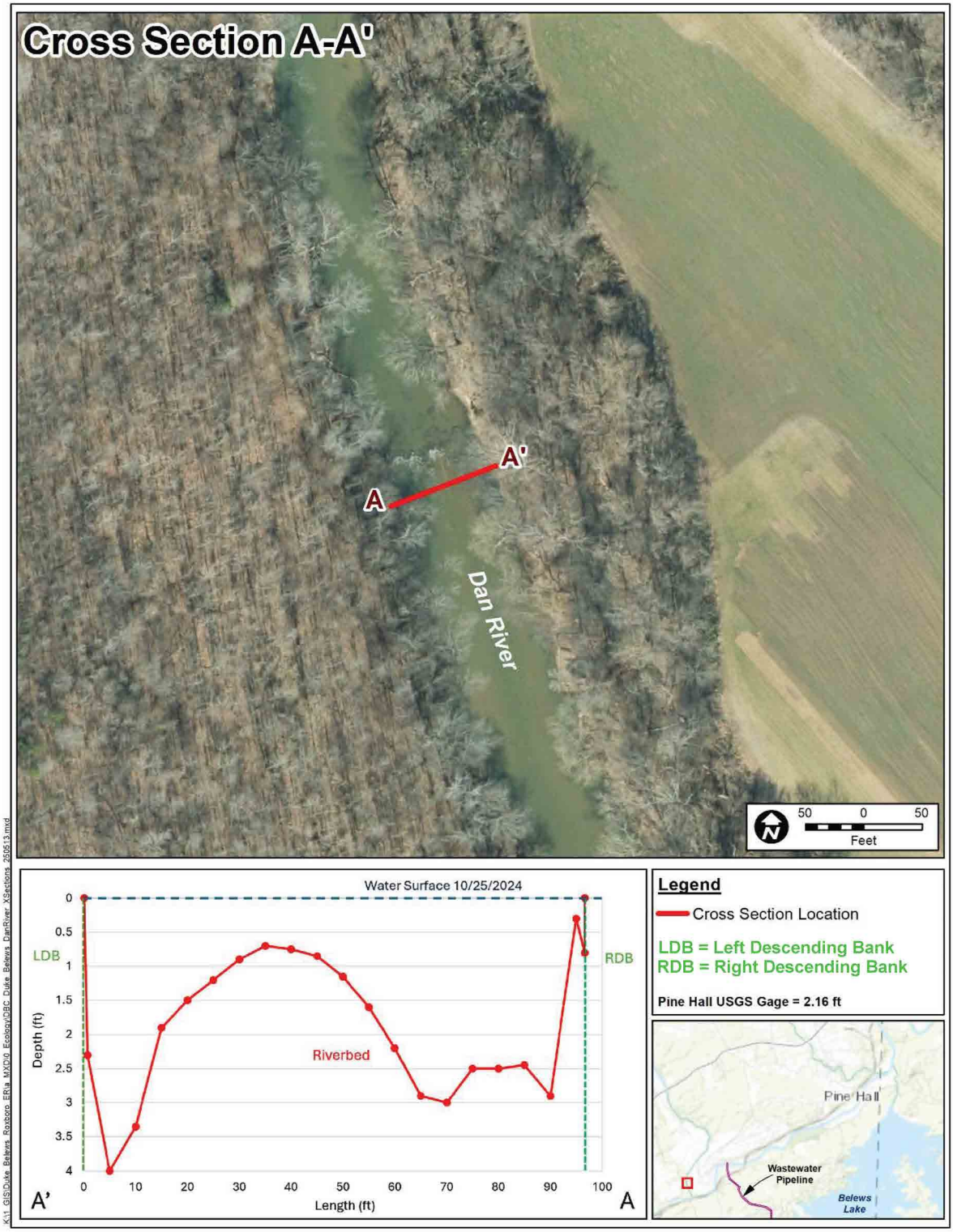


Figure 2.2-4
Flow Frequency Distributions of the Dan River at Pine Hall



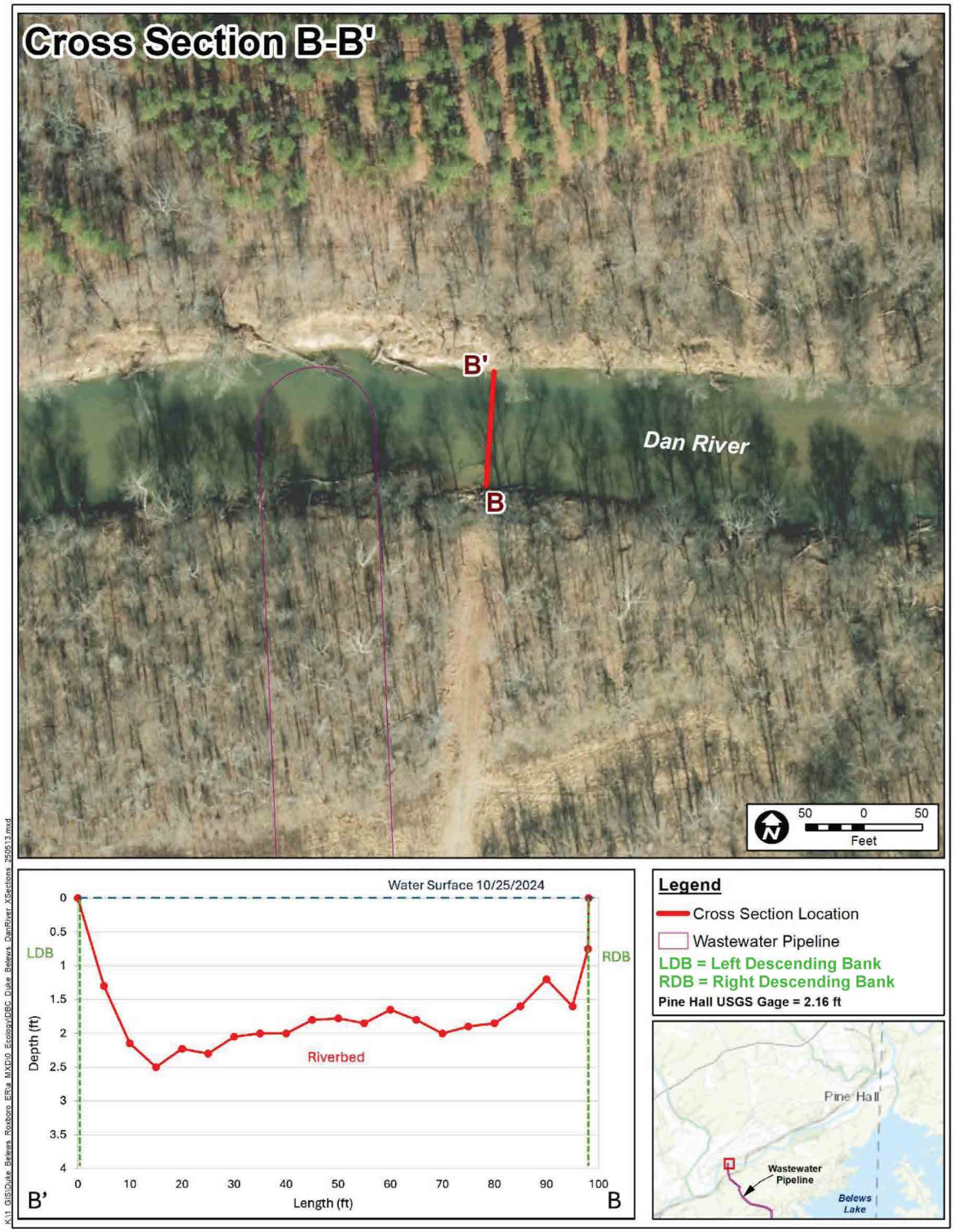
Key: CFS = cubic feet per second; CL = Confidence Limit; NC = North Carolina

Figure 2.2-5
Cross-Sectional Depths of the Dan River at Sample Location DRSW1



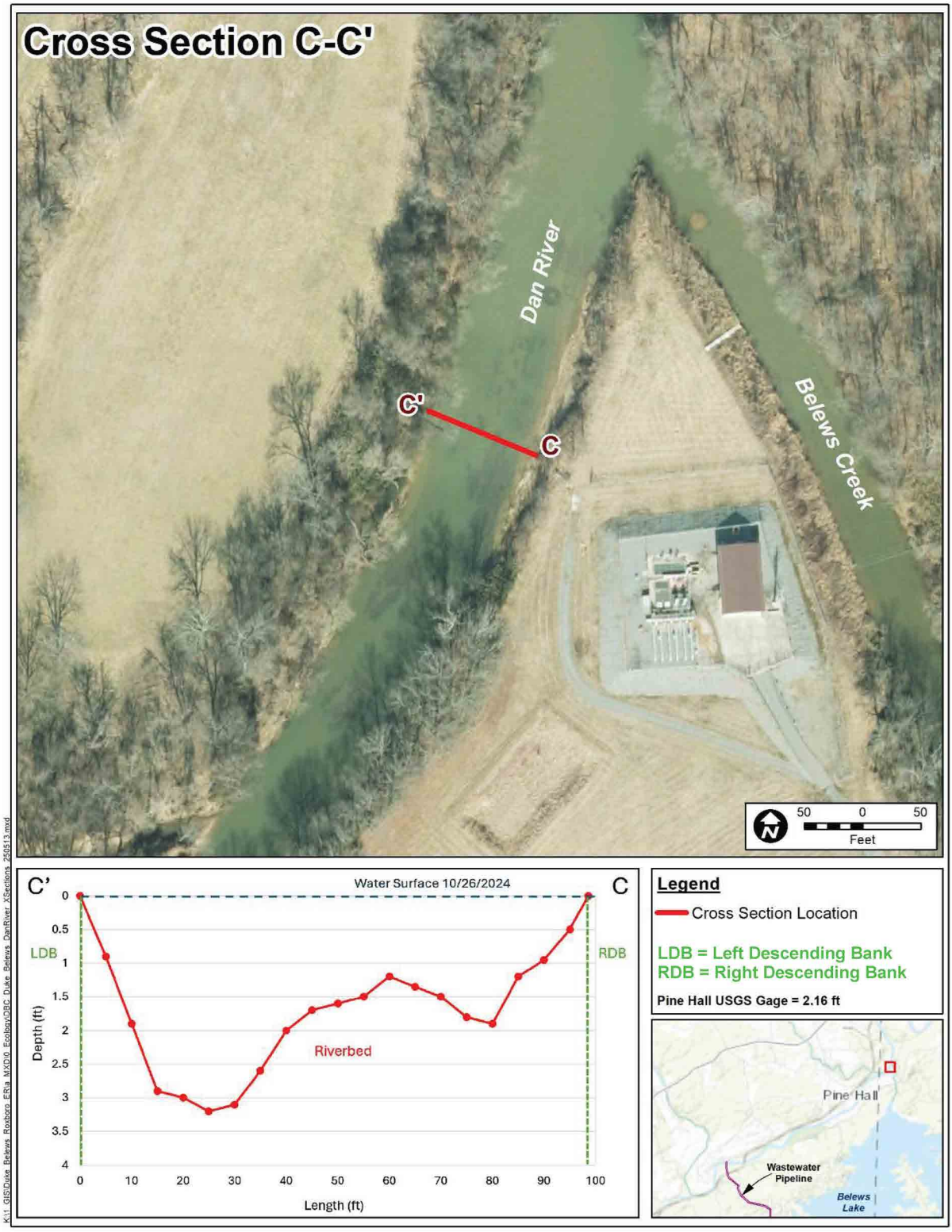
Key: ft = feet

Figure 2.2-6
Cross-Sectional Depths of the Dan River at Sample Location DRSW2



Key: ft = feet

Figure 2.2-7
Cross-Sectional Depths of the Dan River at Sample Location DRSW3

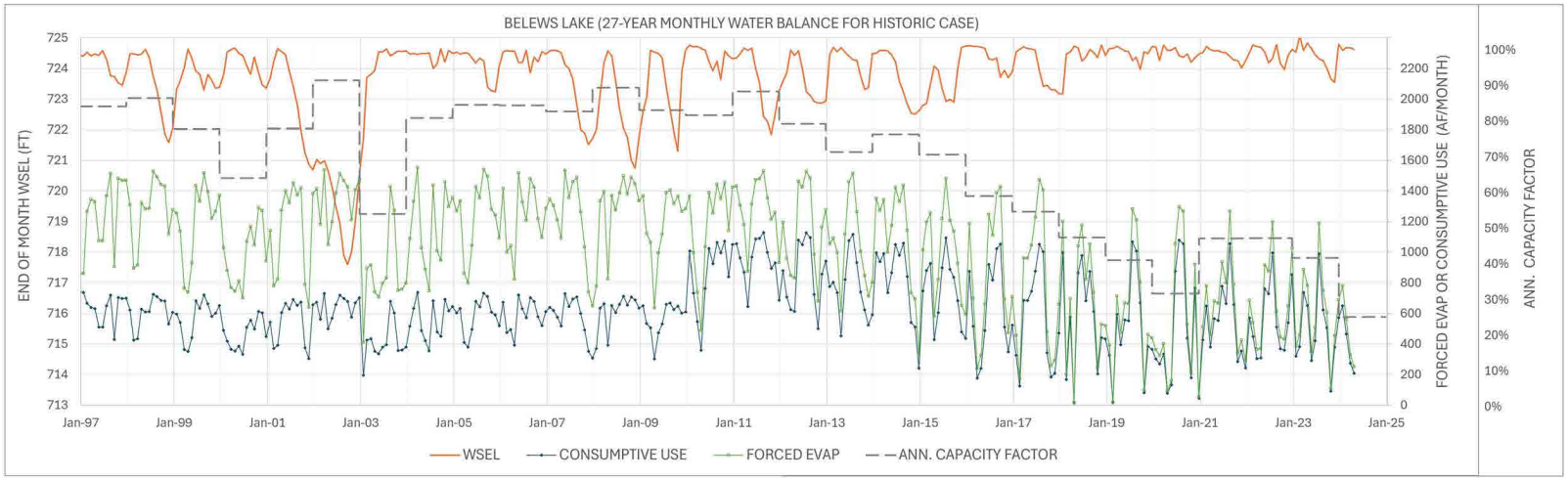


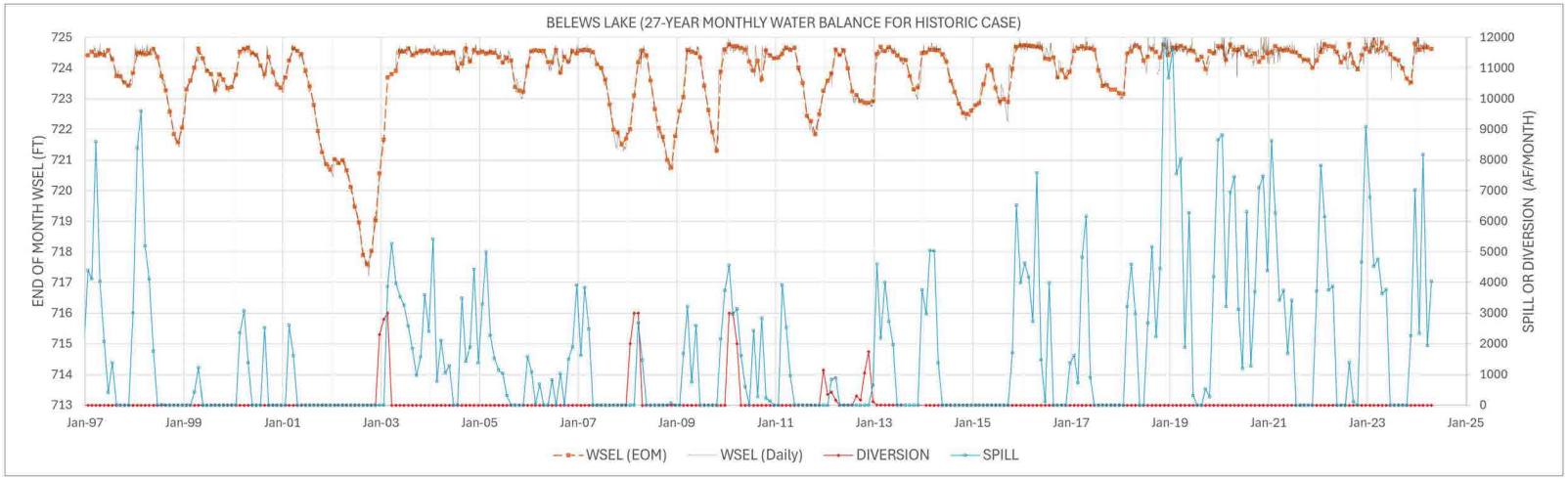
Key: ft = feet

Figure 2.2-8
Cross-Sectional Depths of the Belews Creek at Sample Location BLSW1

Key: ft = feet

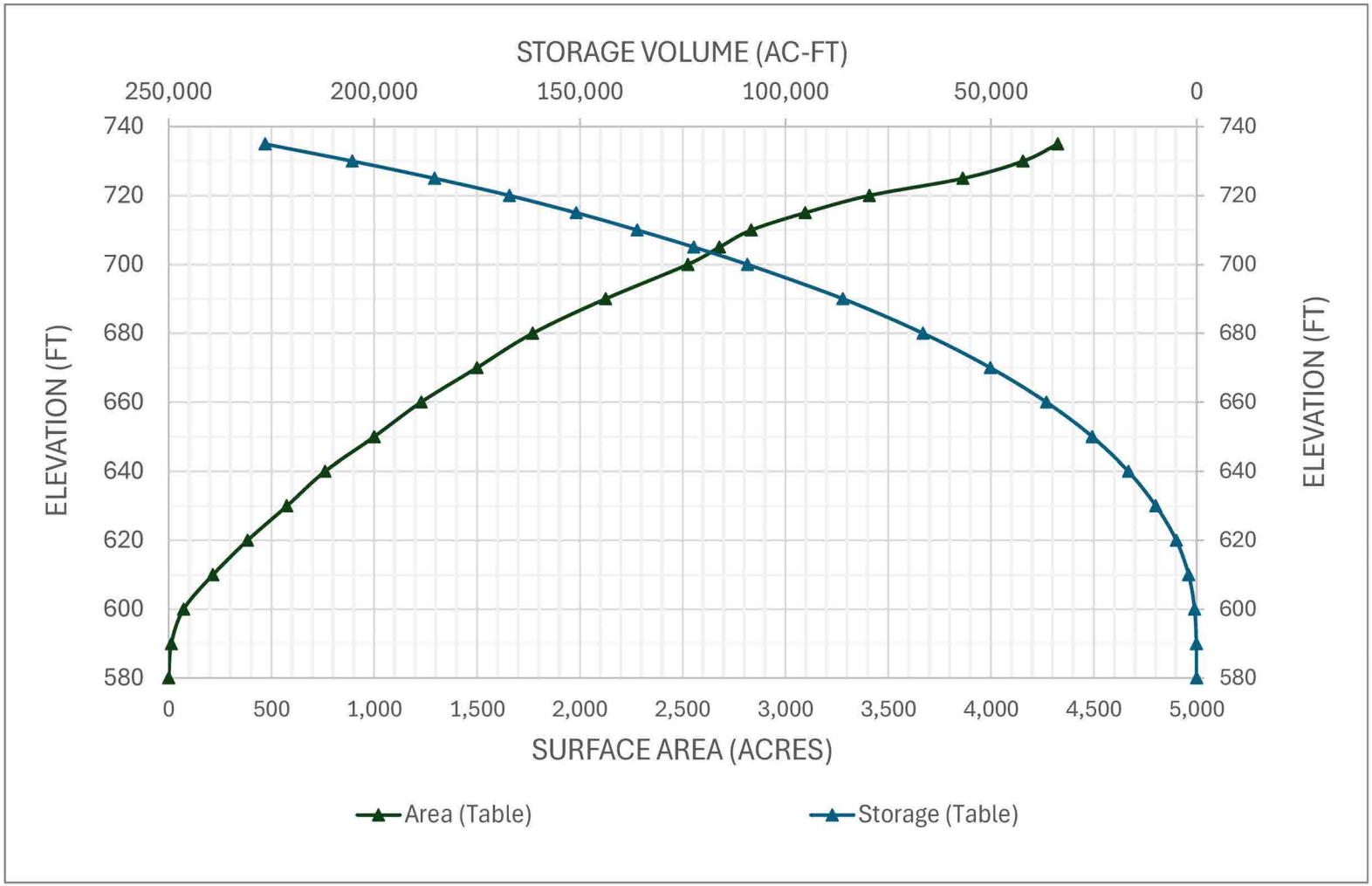
Figure 2.2-9
Water Budget Analysis of Belews Lake Level and other Selected Parameters from 1997 to 2024





Key:
EOM = End of Month; Forced Evap = Forced Evaporation; Key: SPILL = Spillway; WSEL = Water Surface Elevation

Figure 2.2-10
Belews Lake Elevation – Area – Storage Data Based on Original Lake Design



Key: ac-ft = acre foot; ft = feet

Figure 2.2-11
Overview of Belews Lake Bathymetry

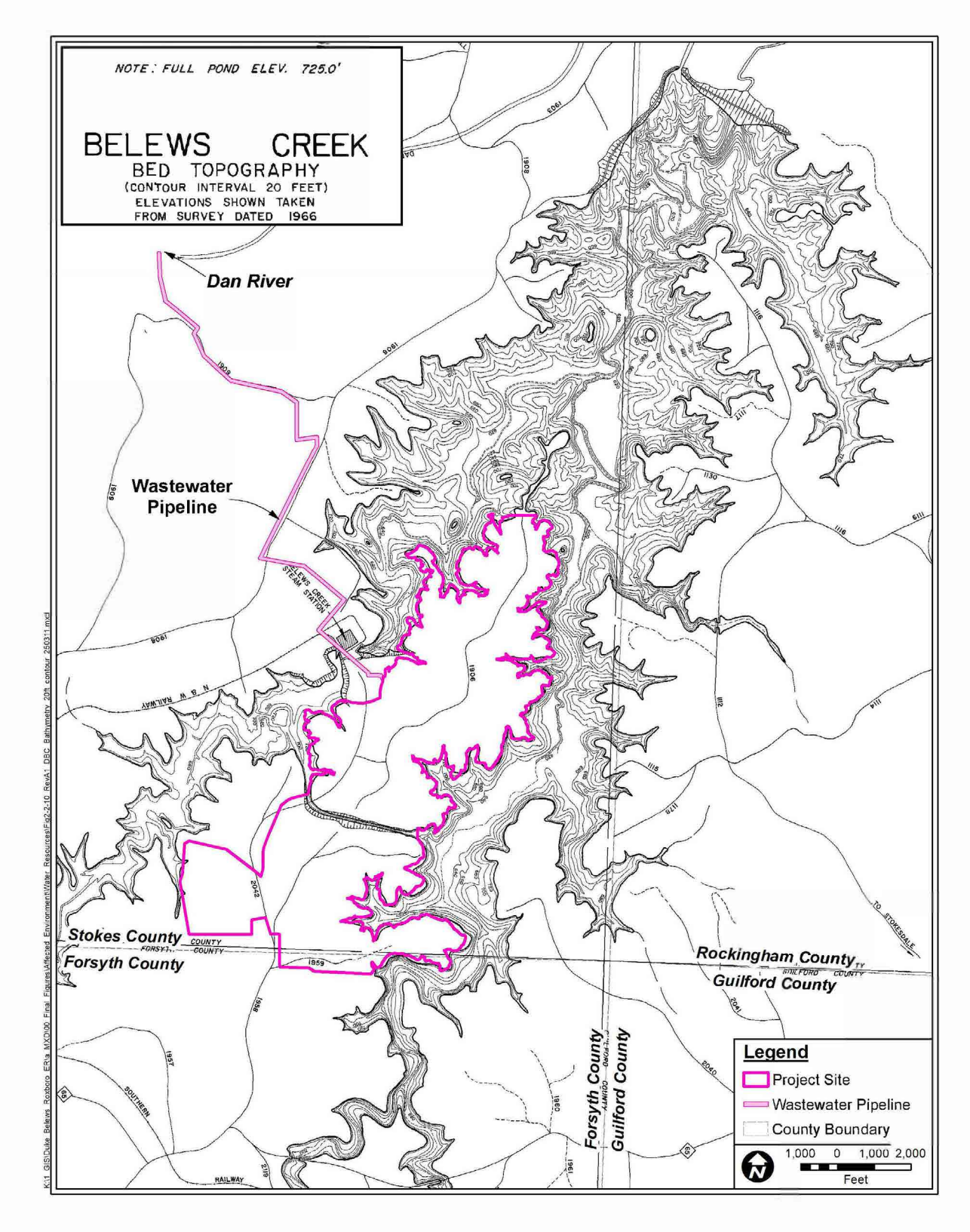


Figure 2.2-12
Pre-impoundment Bathymetry of Belews Lake within the Belews Creek Arm

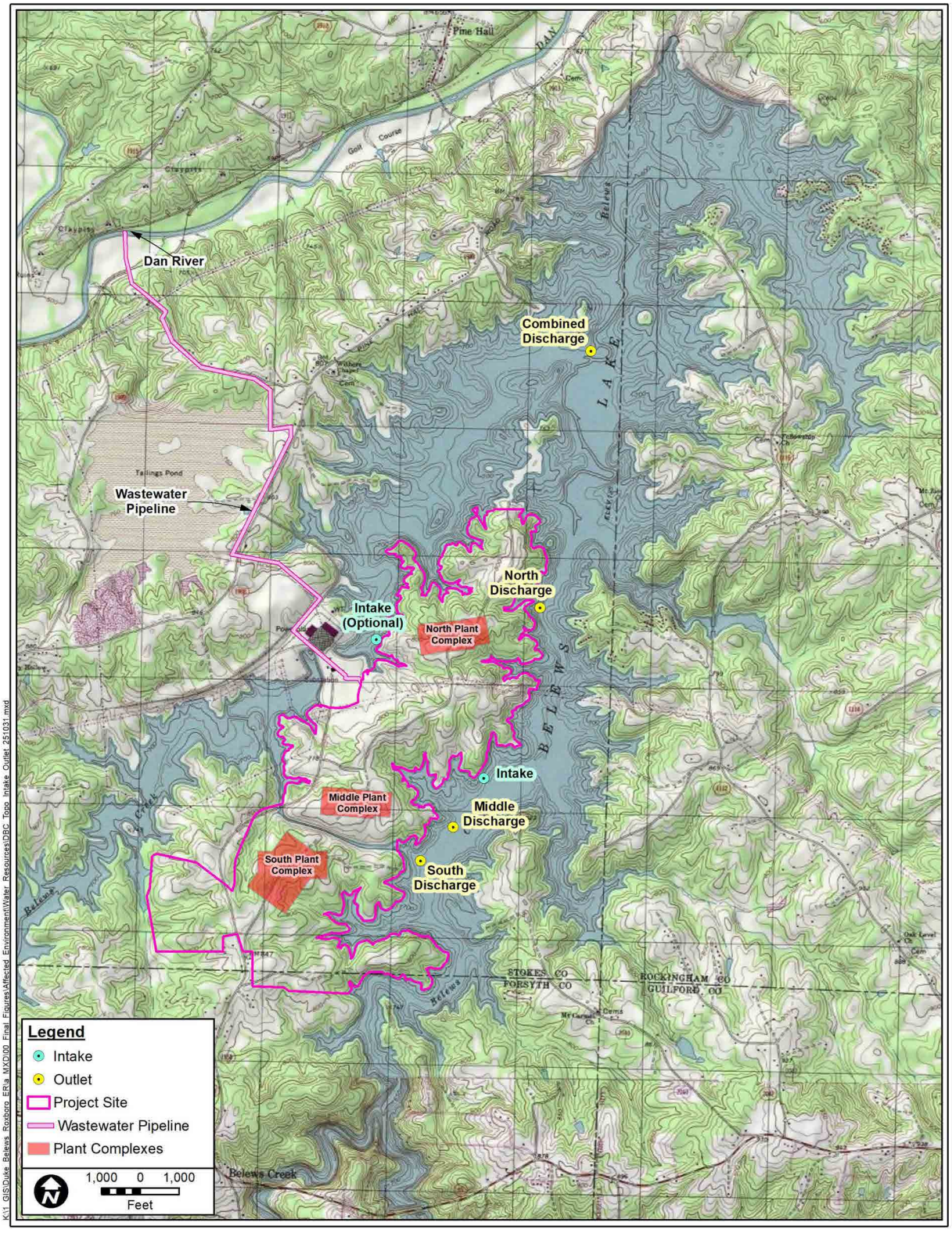


Figure 2.2-13
Focused Bathymetry in the Vicinity of Proposed Intake Locations

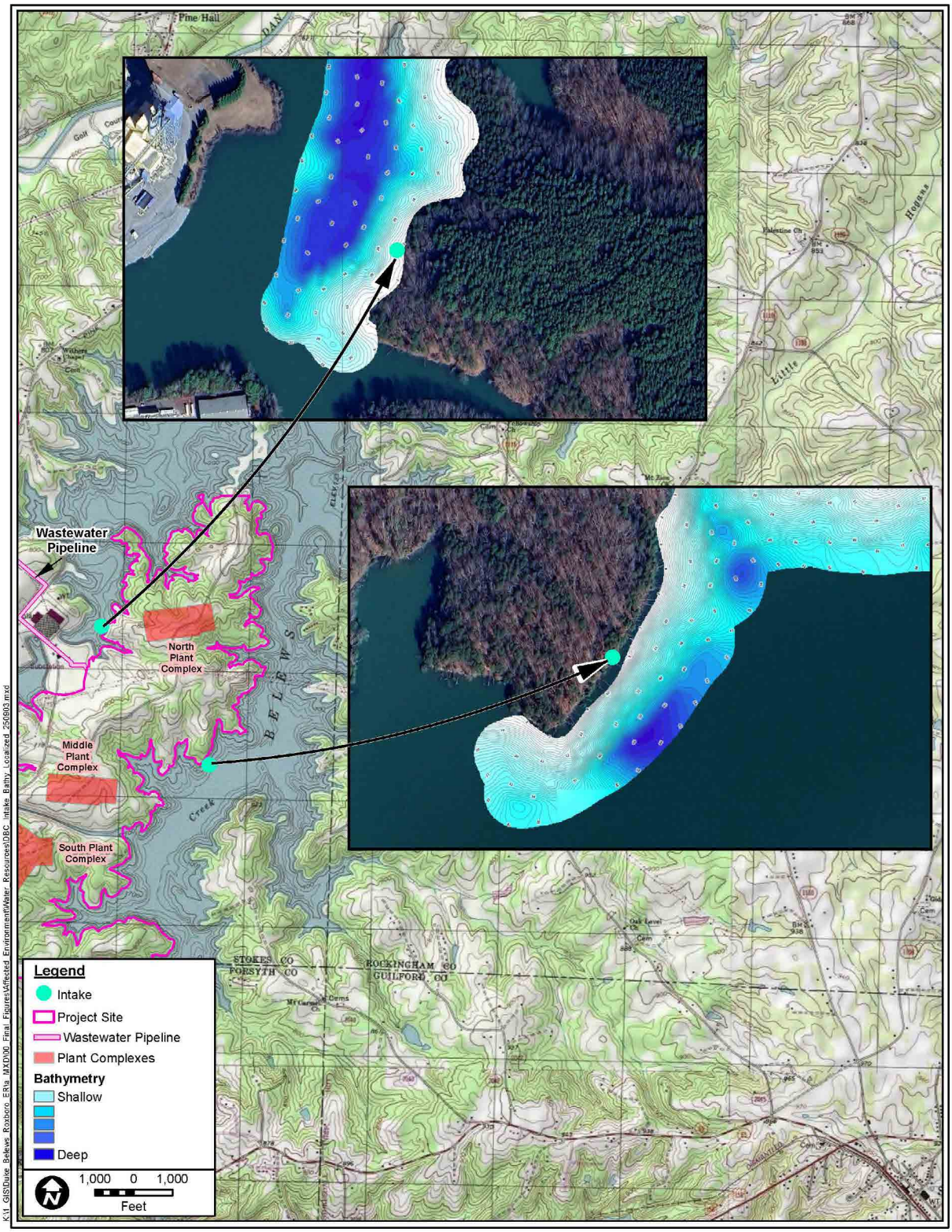


Figure 2.2-14
Focused Bathymetry in the Vicinity of Proposed Discharge Locations

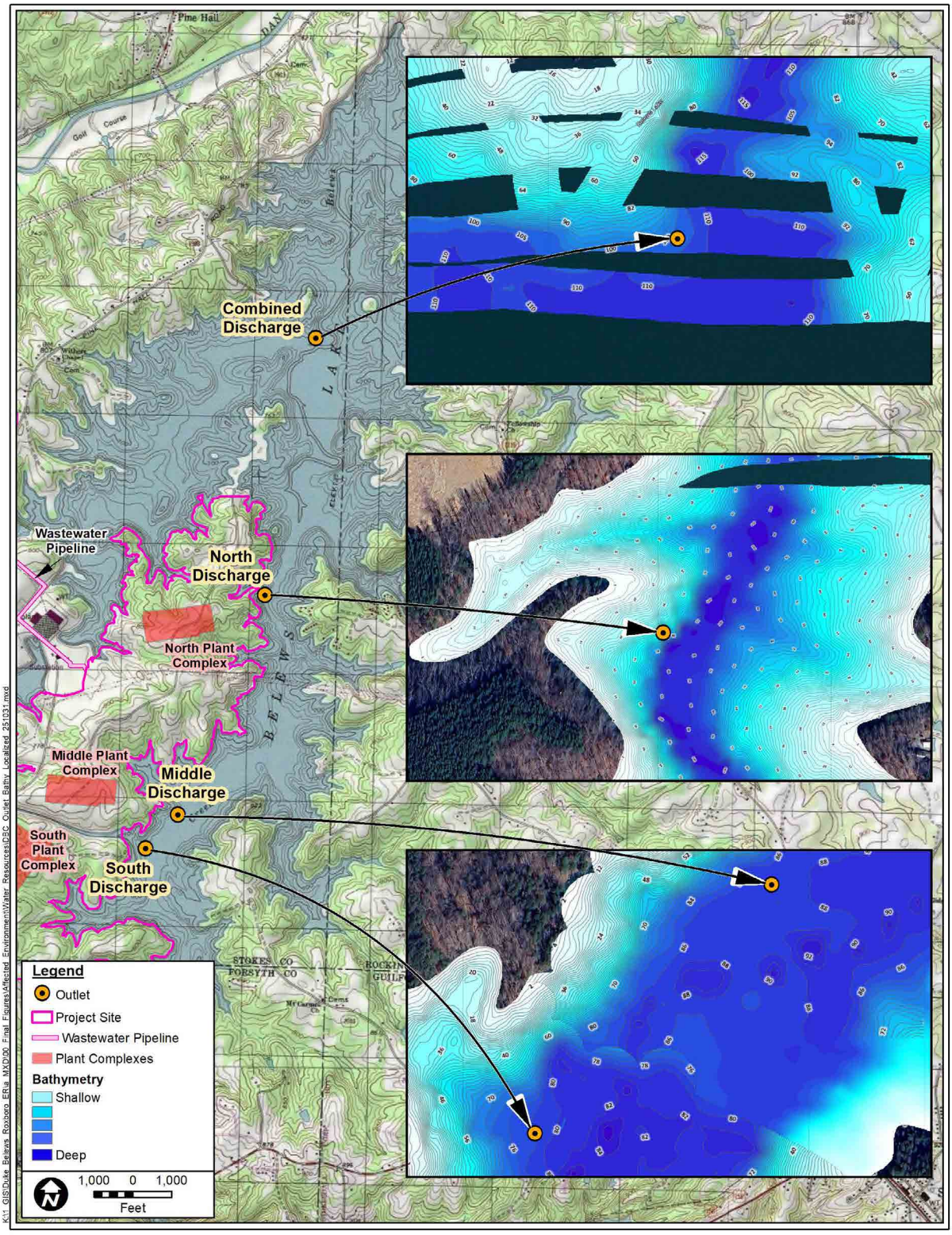
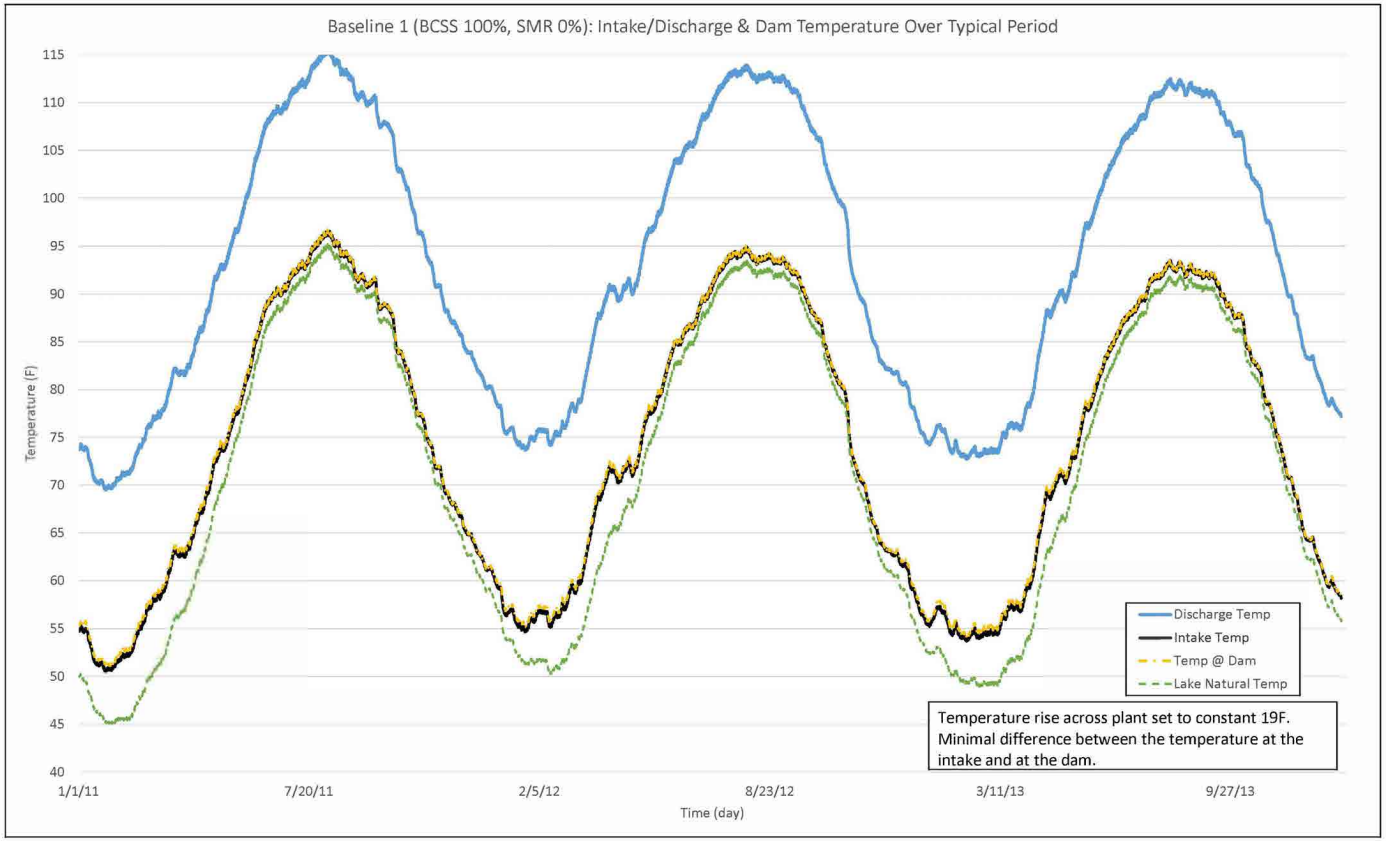
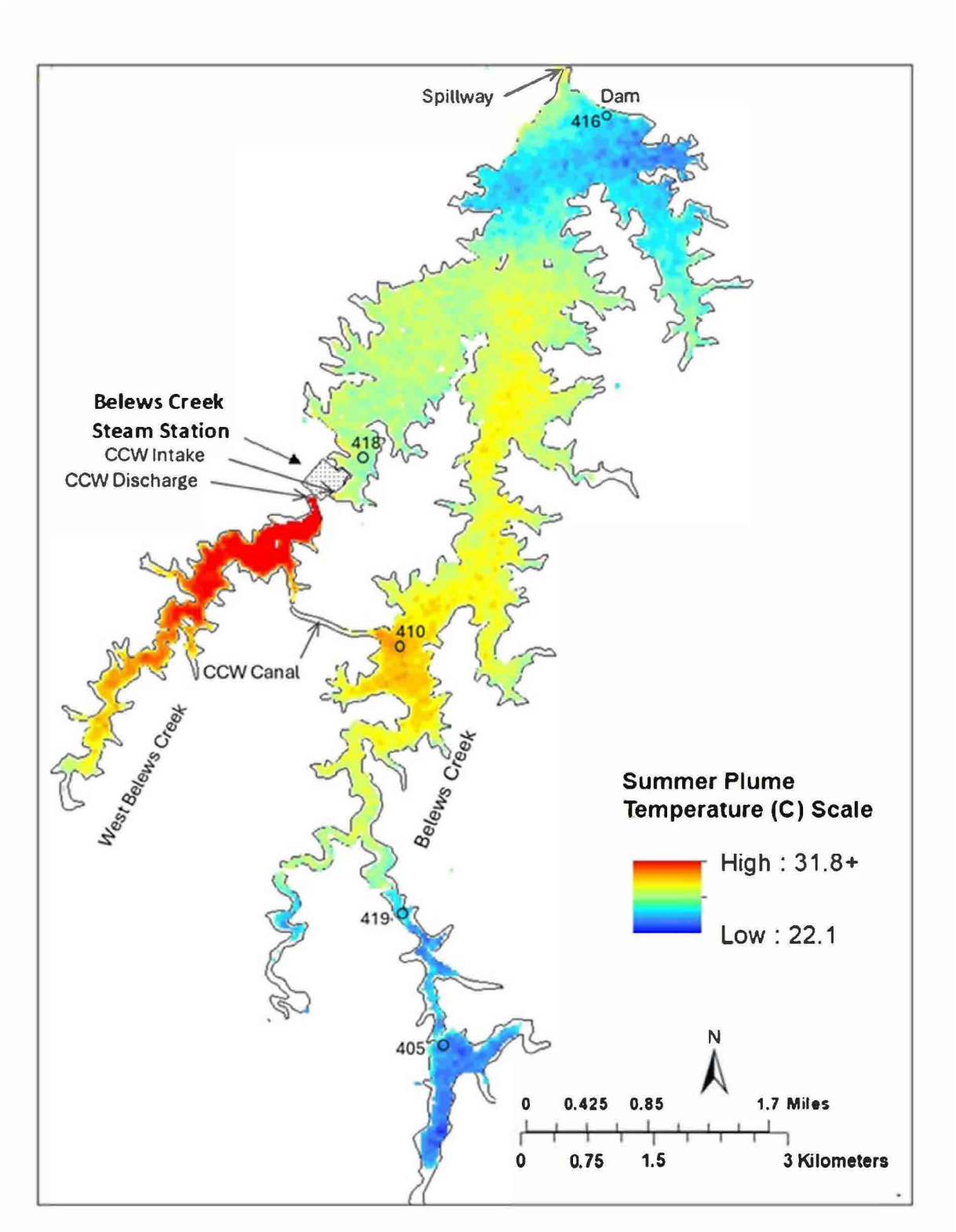


Figure 2.2-15
Temperature Profile of Belews Lake and BCSS Intake and Discharge



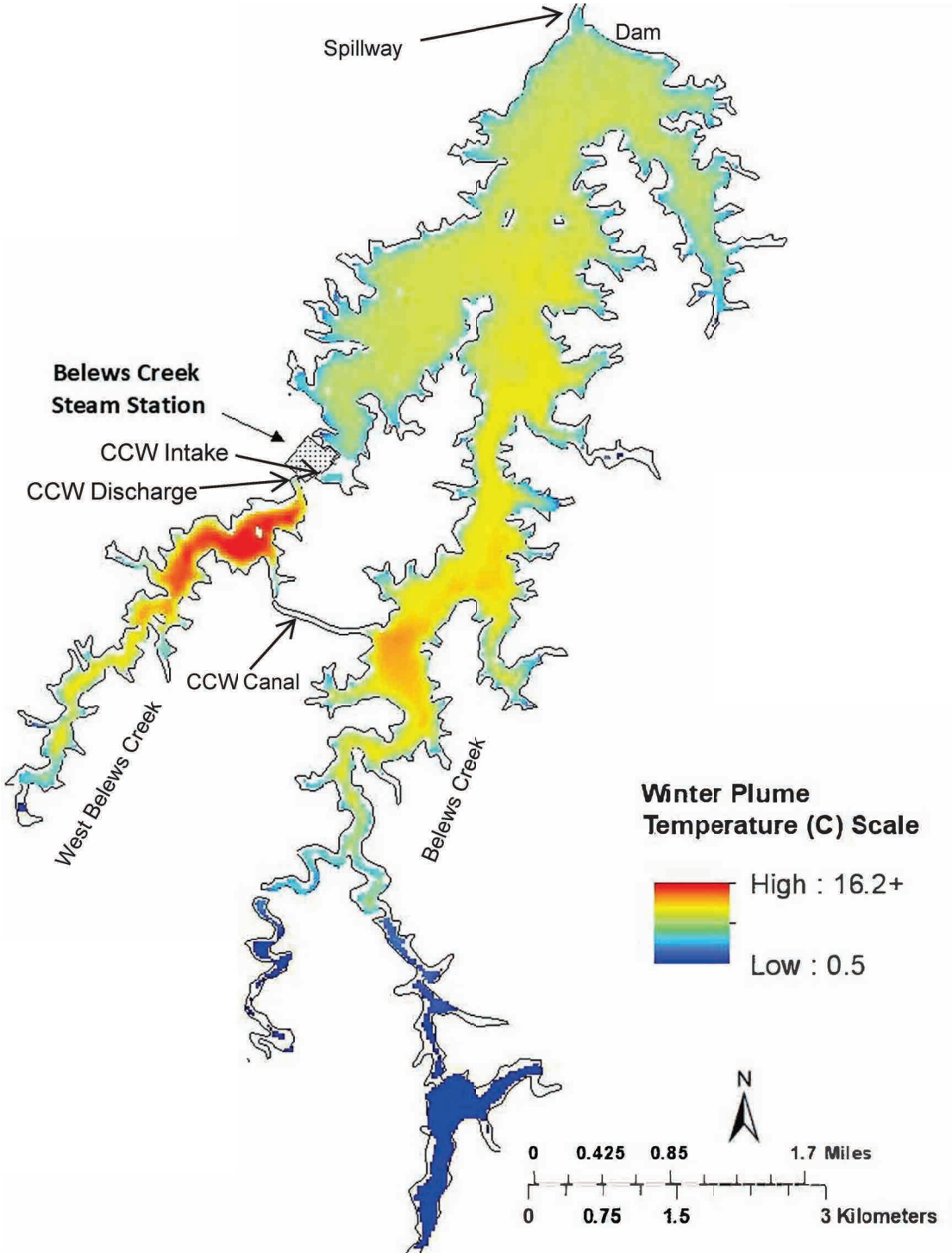
Key: BCSS = Belews Creek Steam Station; SMR = small modular reactor

Figure 2.2-16
Belews Lake Extreme Summer Surface Water Temperatures, July 2002



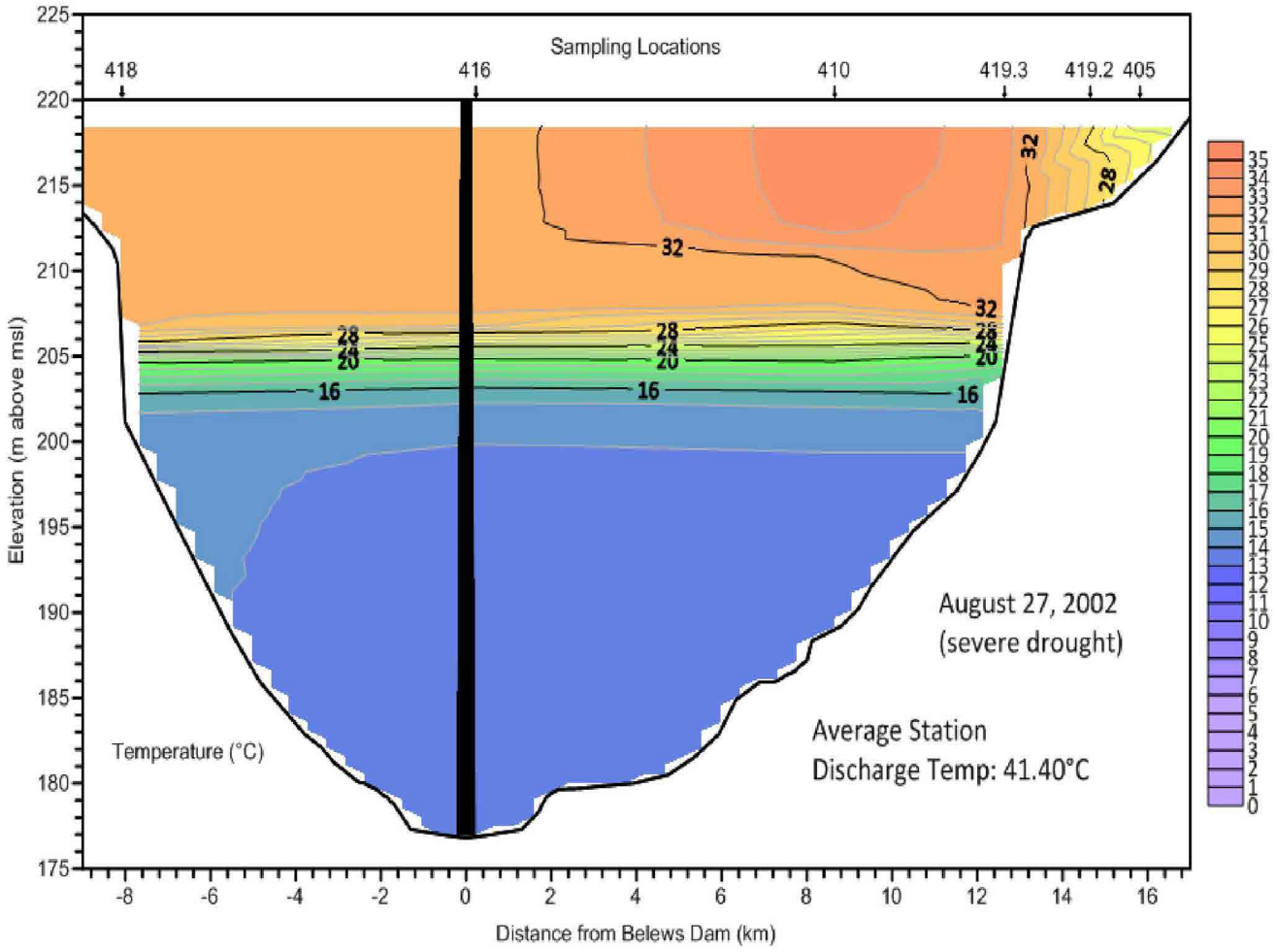
Key: CCW = condenser cooling water

Figure 2.2-17
Belews Lake Extreme Winter Surface Water Temperatures, January 2018



Key: CCW = condenser cooling water

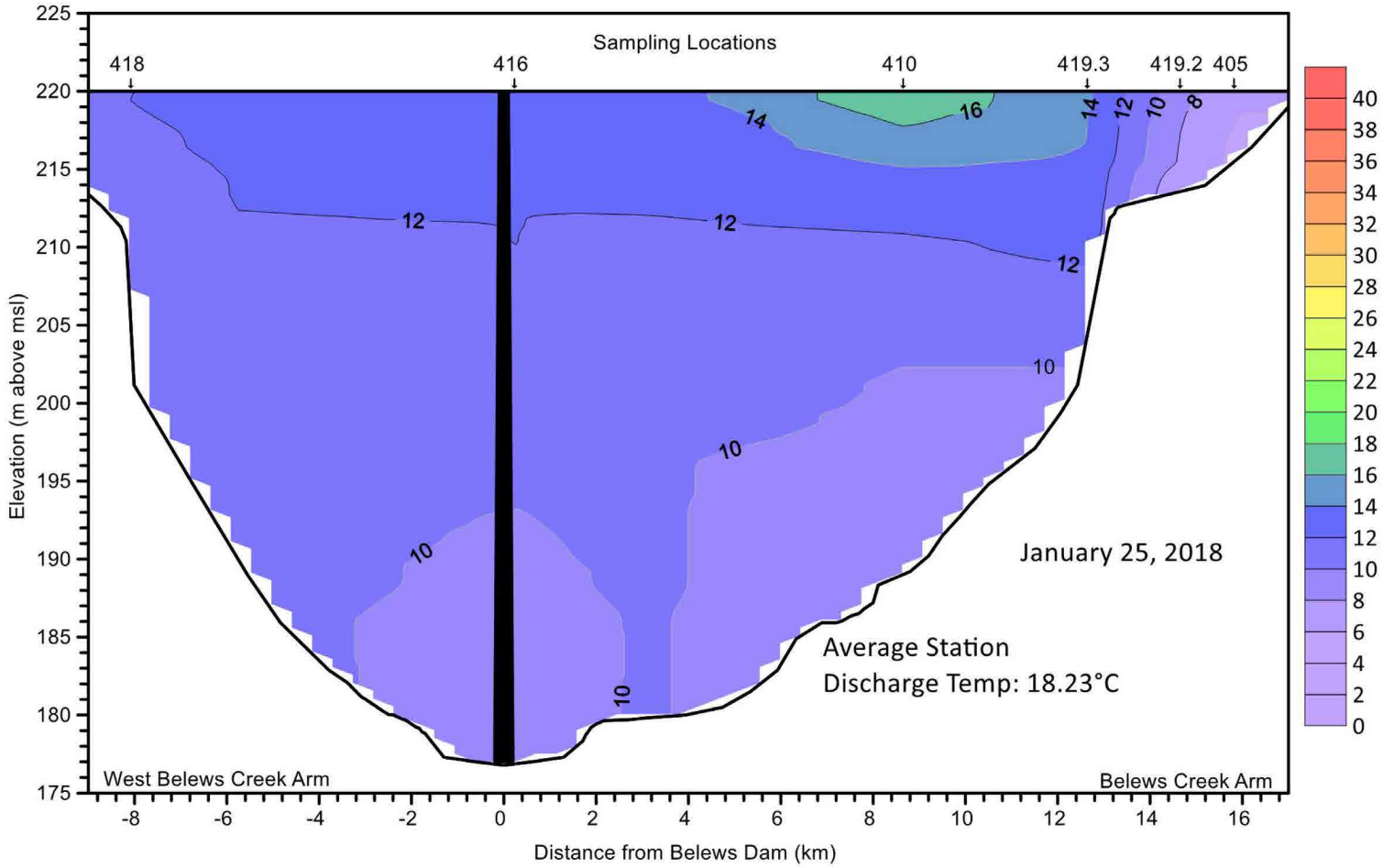
Figure 2.2-18
Belews Lake Water Temperature Profile, August 2002



Note: Near extreme summer scenario isotherm plot on Belews Lake. Plot generated from water temperature profile data measured on August 27, 2002. Temperatures in degrees Celsius.

Key: m = meter; msl = mean sea level; km = kilometer

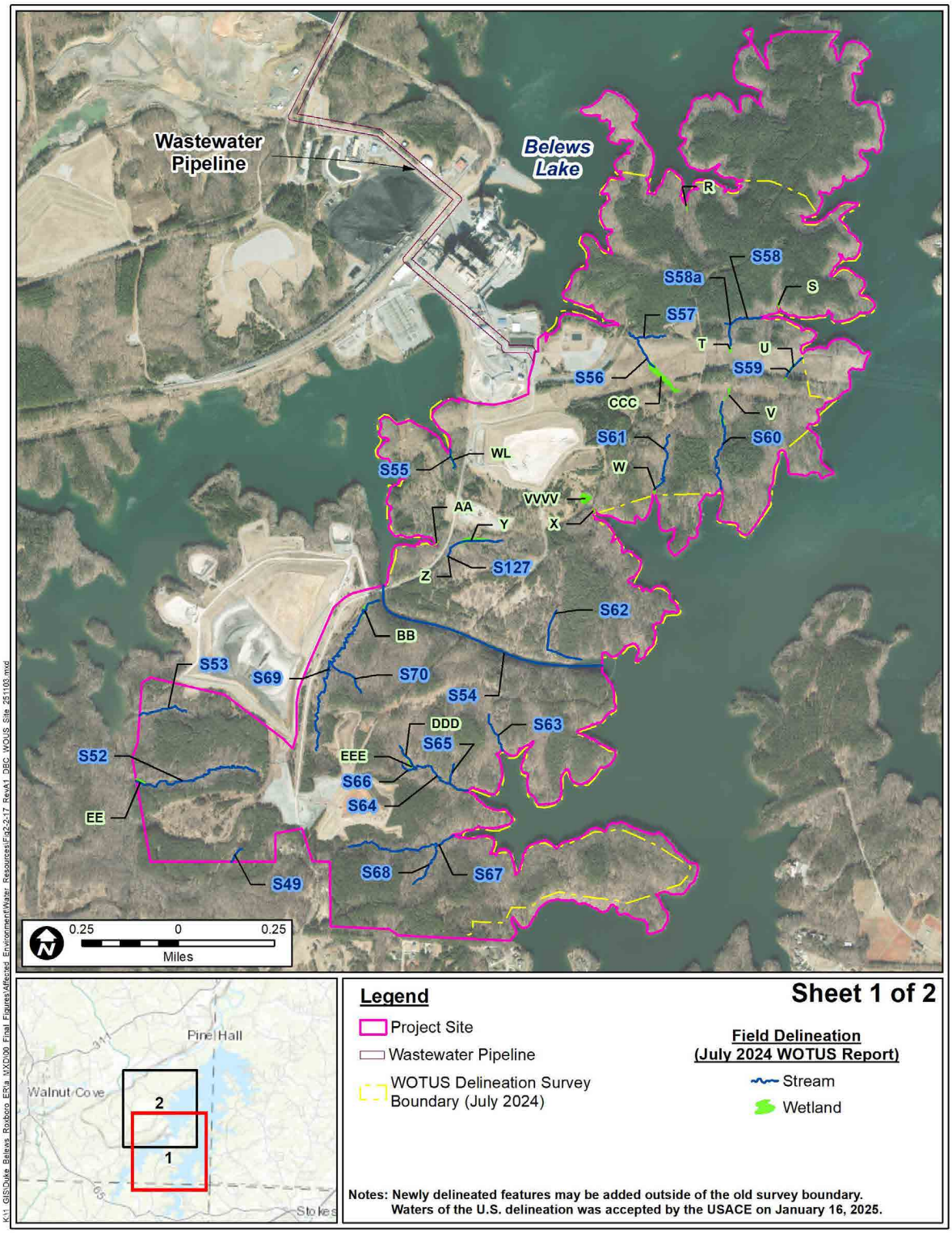
Figure 2.2-19
Belews Lake Water Temperature Profile, January 2018



Note: Near extreme winter scenario isotherm plot on Belews Lake. Plot generated from water temperature profile data measured on January 25, 2018. Temperatures in degrees Celsius.

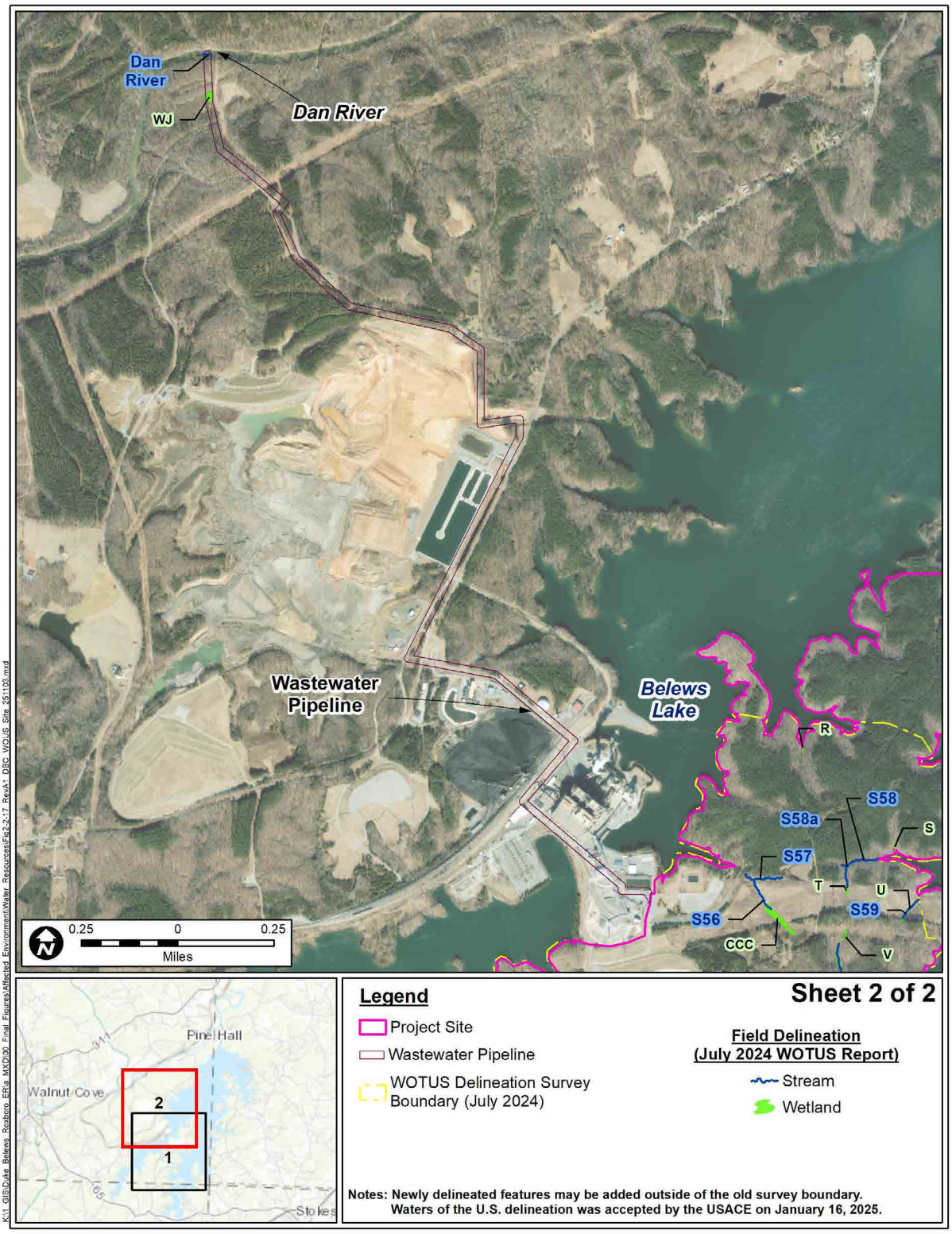
Key: m = meter; msl = mean sea level; km = kilometer

Figure 2.2-20
Waters of the U.S. Identified on the Project Site
(Sheet 1 of 2)



Key: USACE = U.S Army Corps of Engineers; WOTUS = Waters of the U.S.

Figure 2.2-20
Waters of the U.S. Identified on the Project Site
(Sheet 2 of 2)



Key: USACE = U.S Army Corps of Engineers; WOTUS = Waters of the U.S.

Figure 2.2-21
Gradients and Cross Sections of Selected Project Site Streams

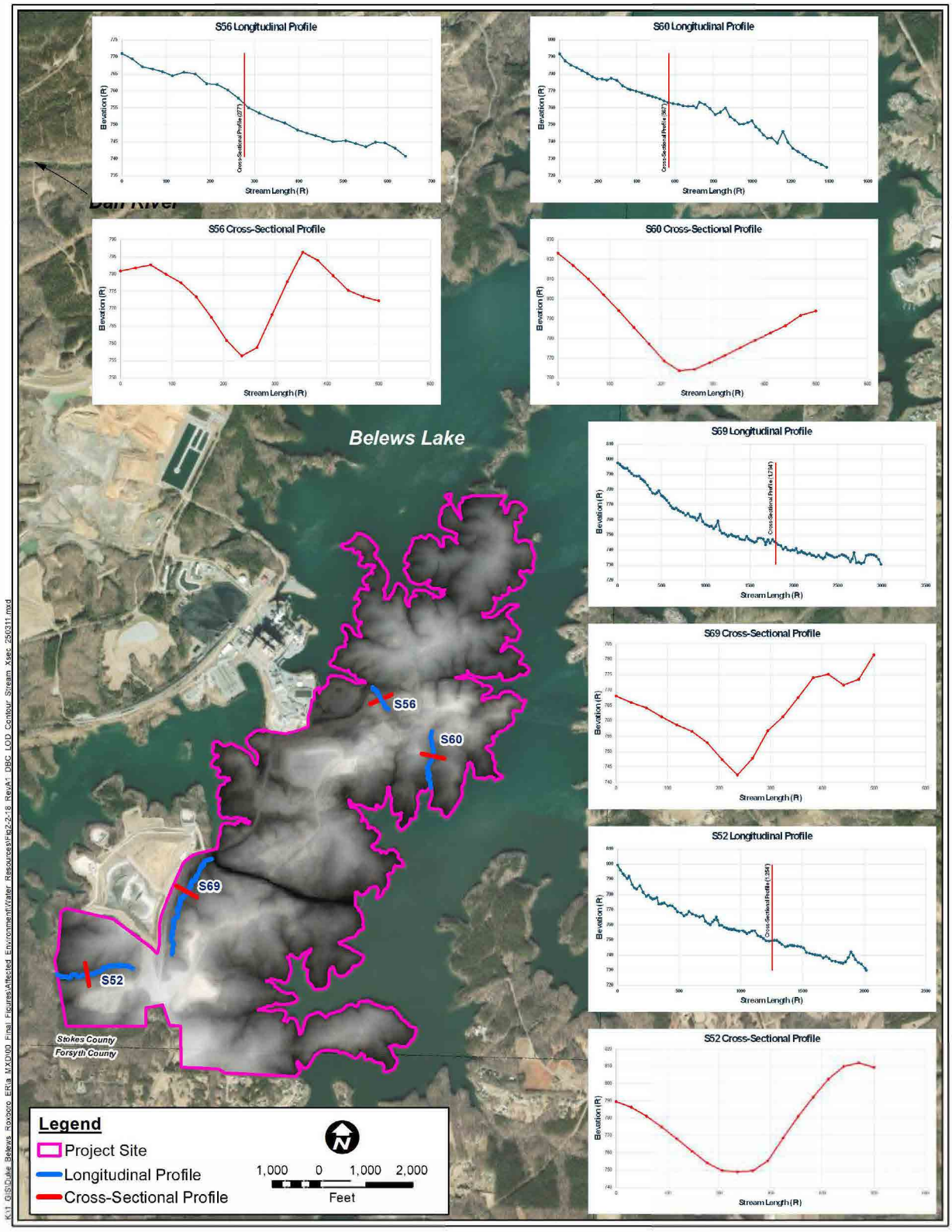
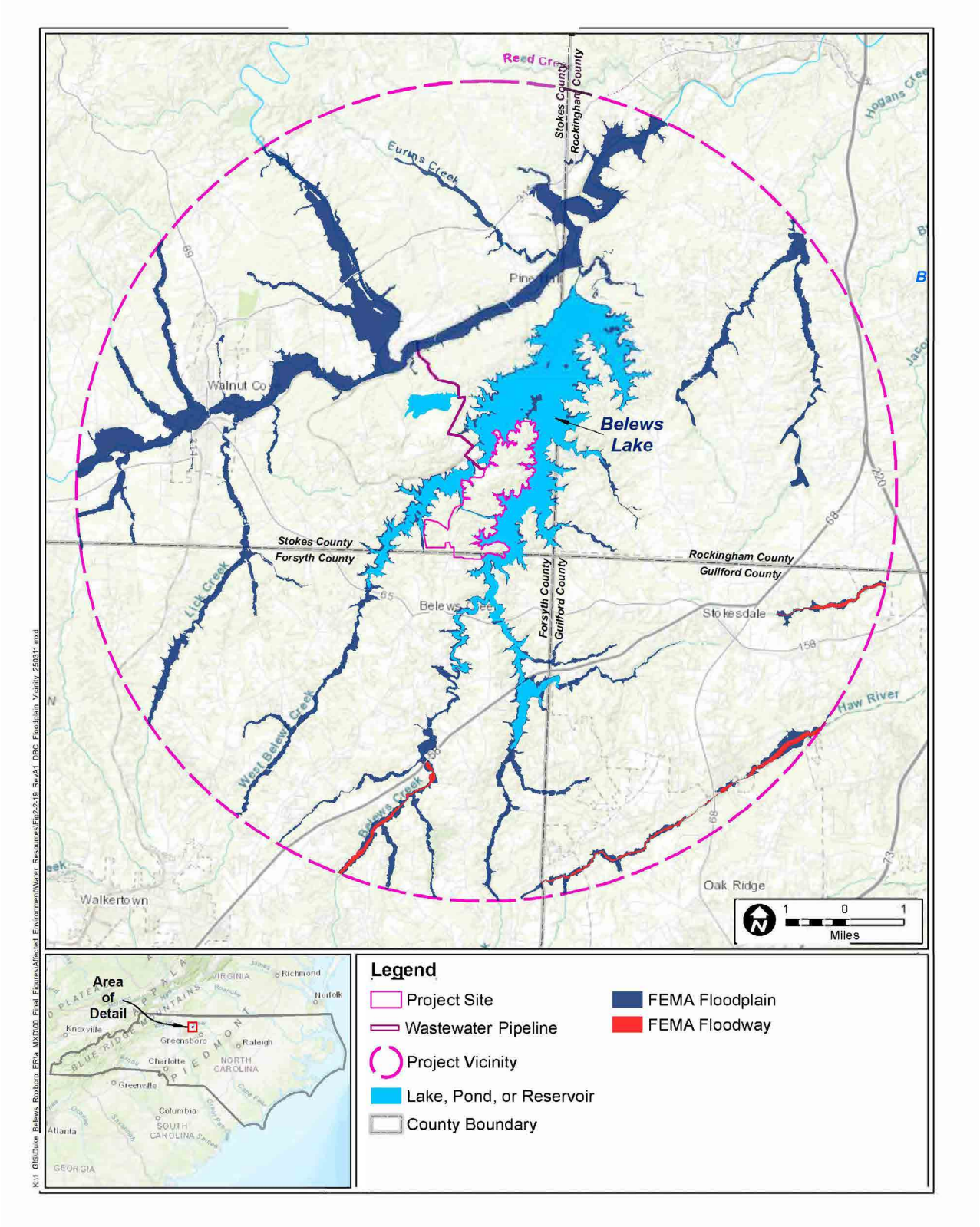


Figure 2.2-22
Floodplains within the Study Area



Key: FEMA = Federal Emergency Management Agency

Figure 2.2-23
Principal Aquifers within Project Region

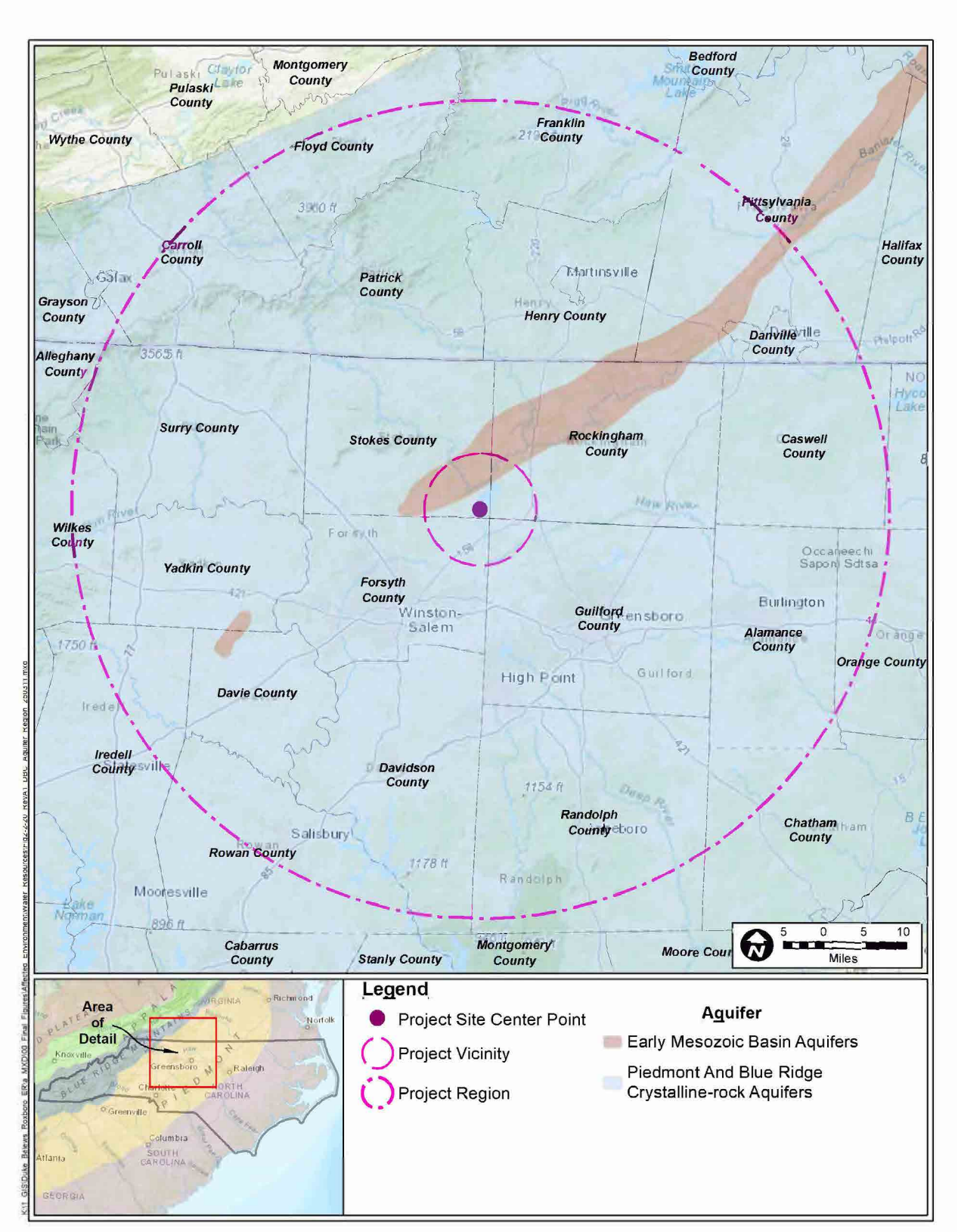
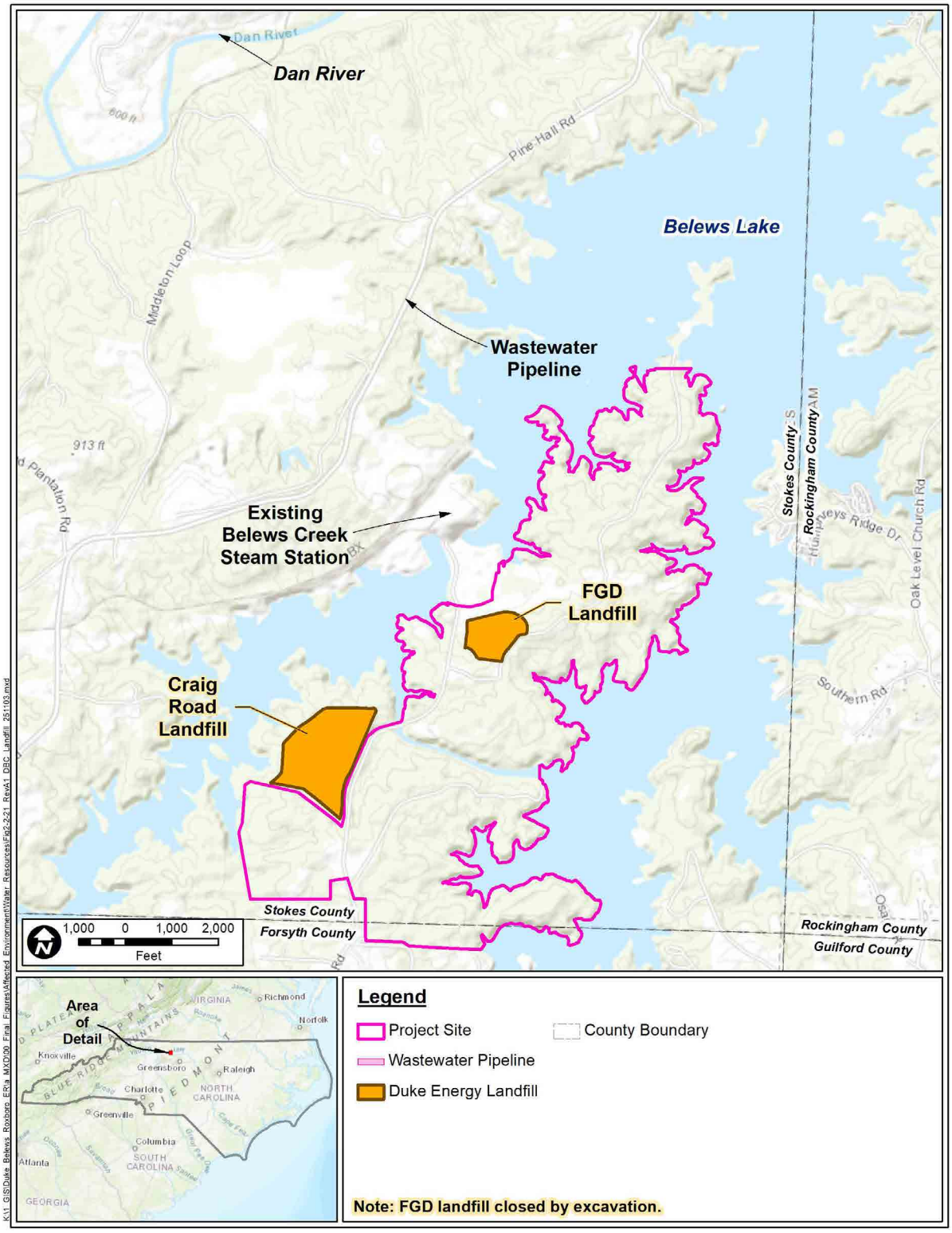


Figure 2.2-24
BCSS Landfills on the Project Site



Key: FGD = flue gas desulfurization

Figure 2.2-25
Craig Road Landfill Potentiometric Map (July 2024)

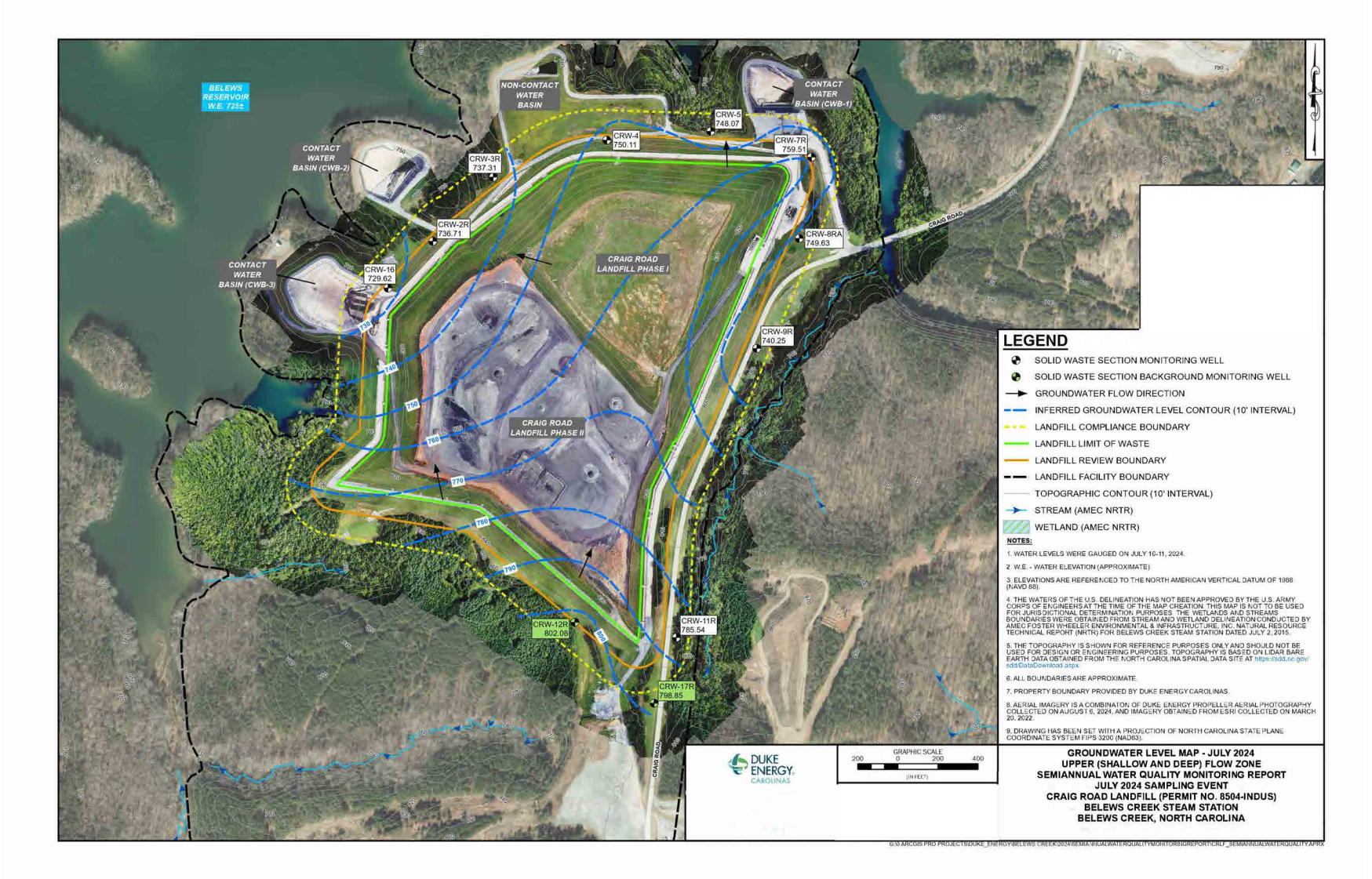


Figure 2.2-26
Flue Gas Desulfurization Landfill Potentiometric Map (May 2024)

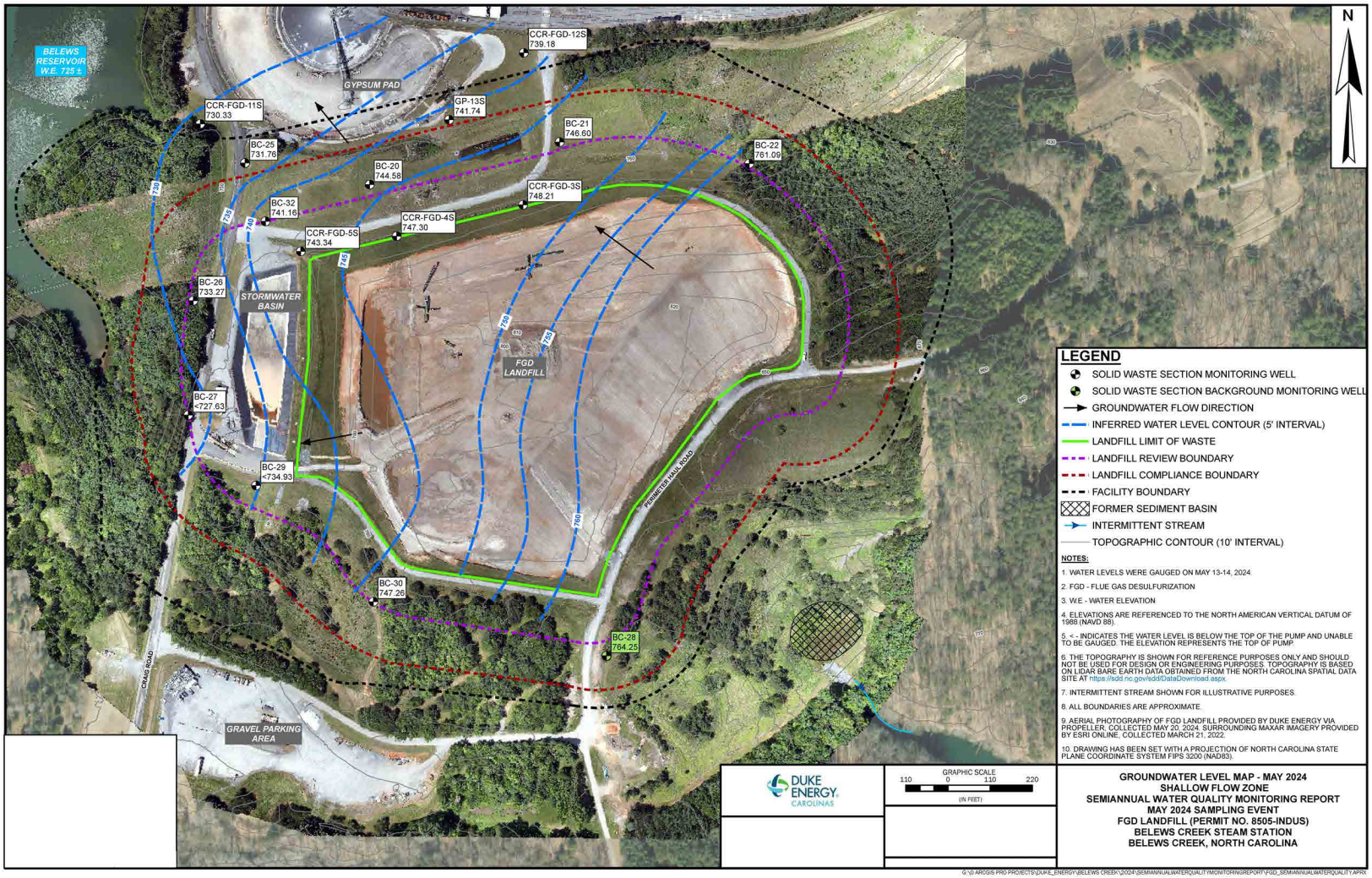
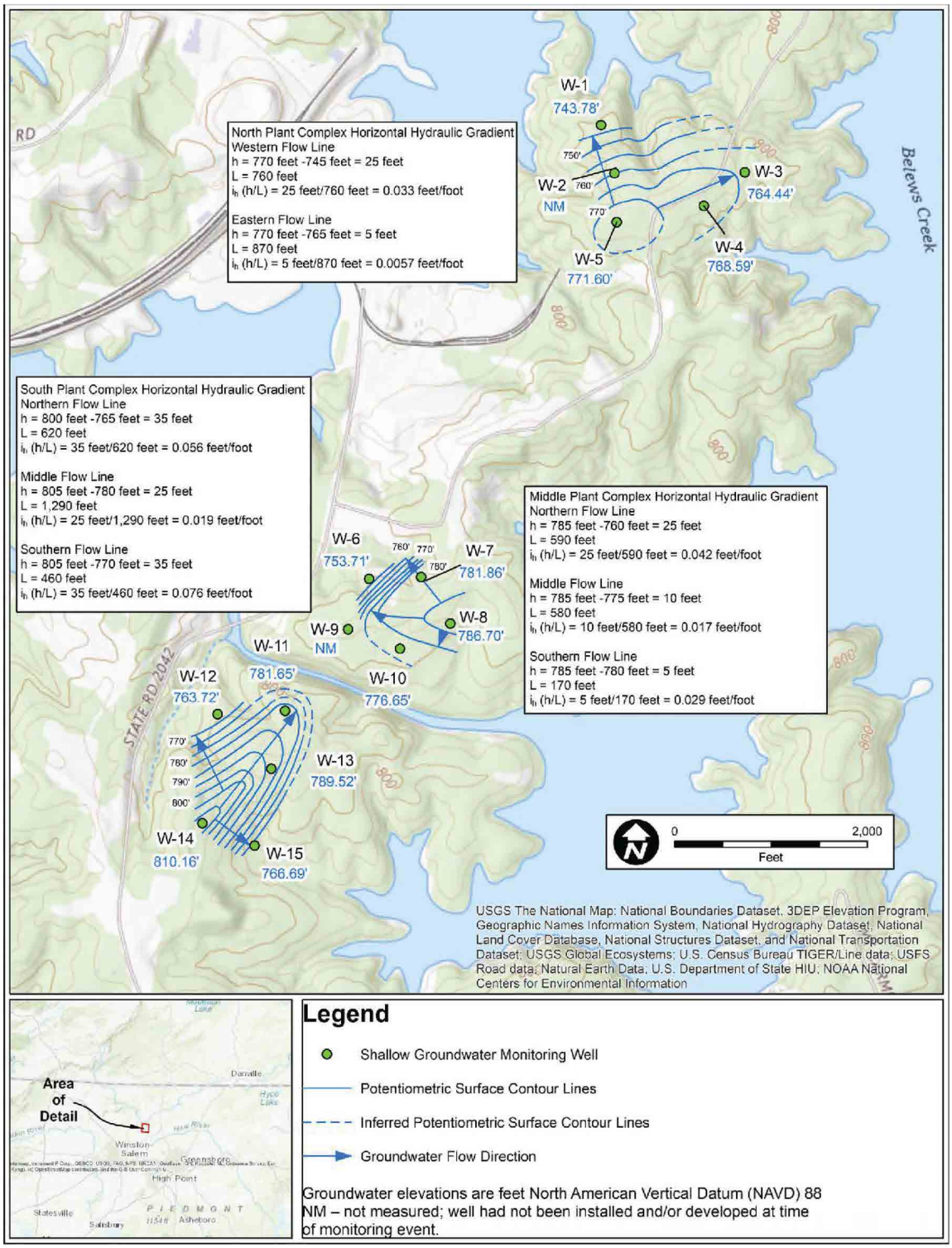
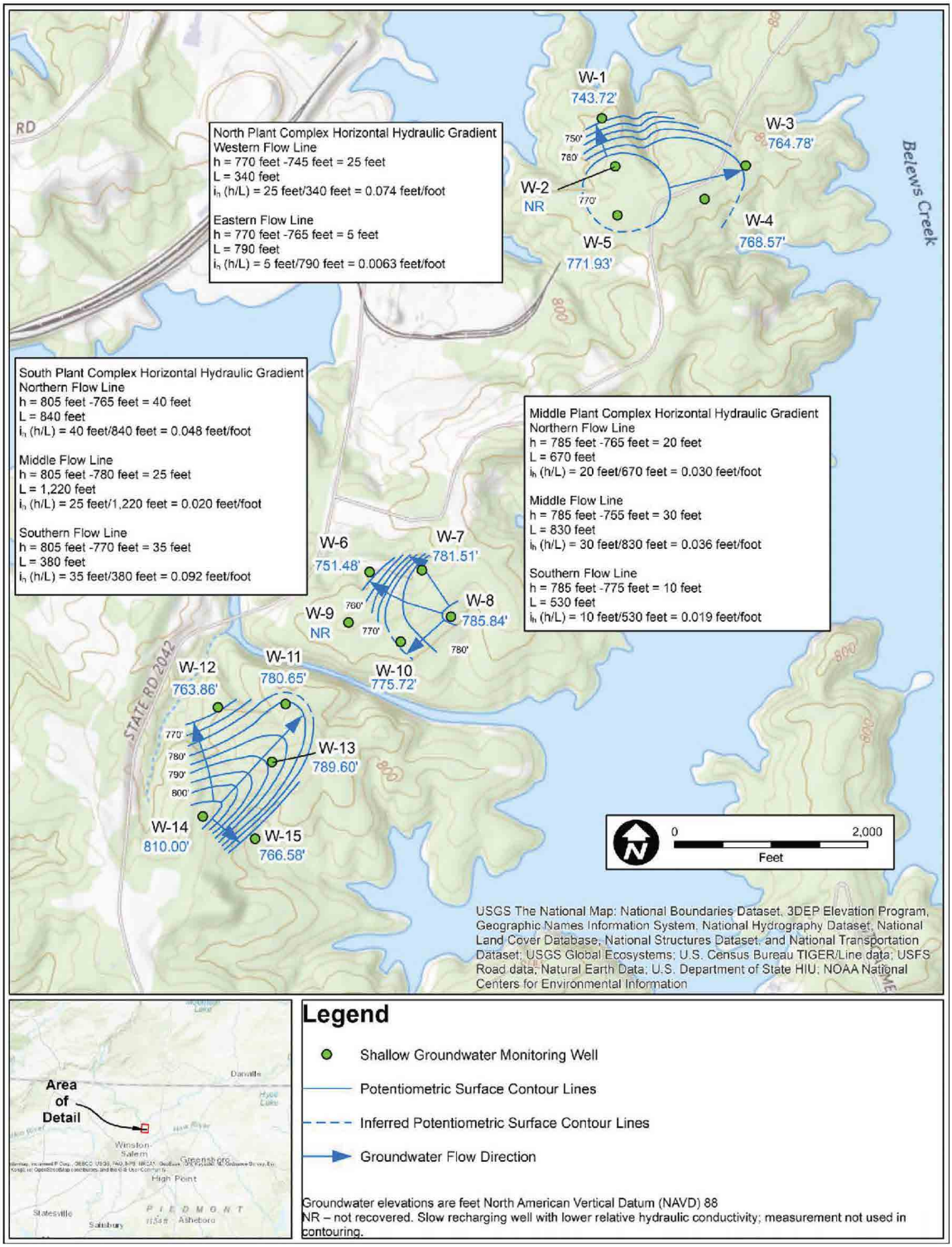


Figure 2.2-27
Project Site Potentiometric Map (July 2024)



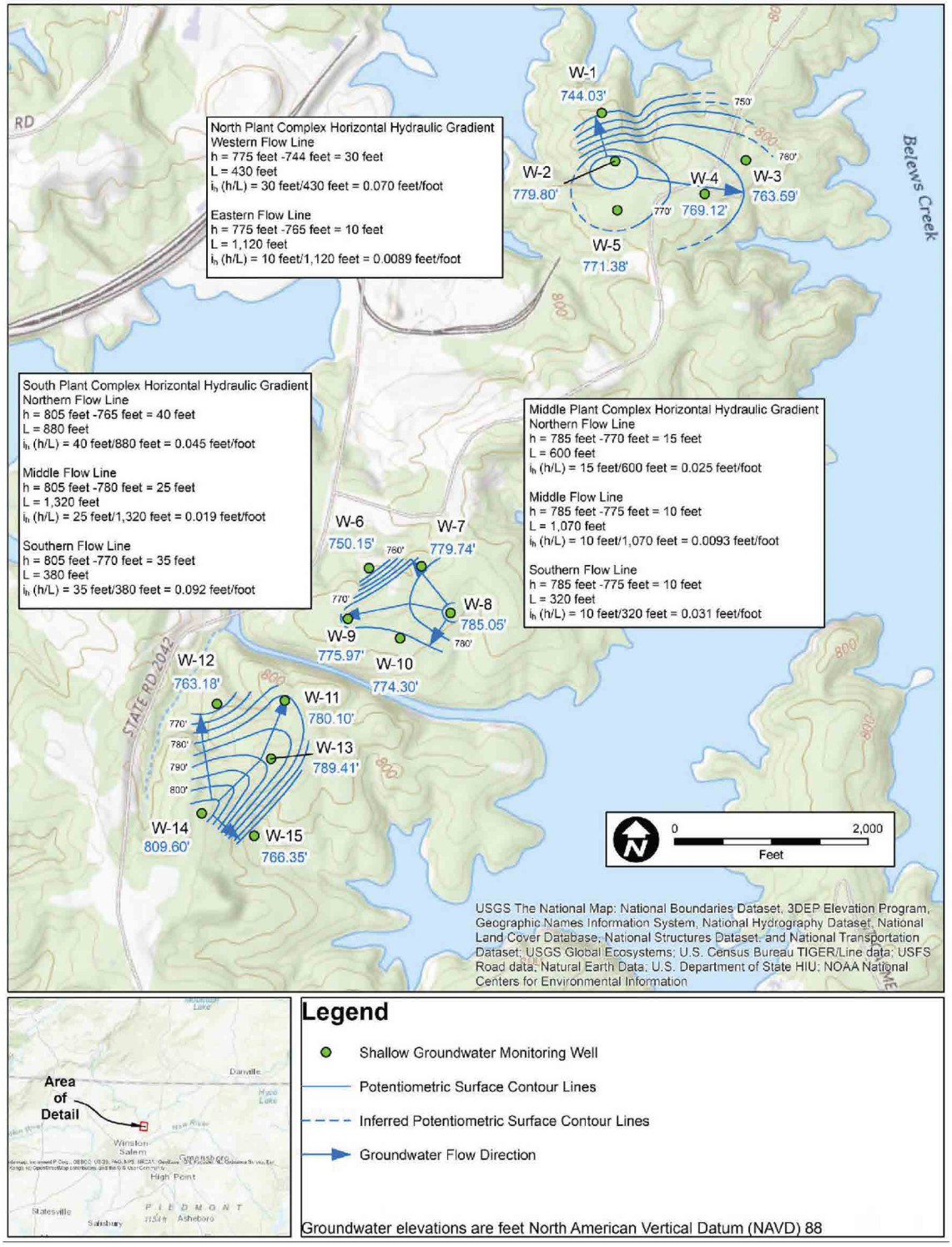
Key: h = height; i_h = horizontal hydraulic gradient; L = length; NAVD = North American Vertical Datum; NM = not measured

Figure 2.2-28
Project Site Potentiometric Map (October 2024)



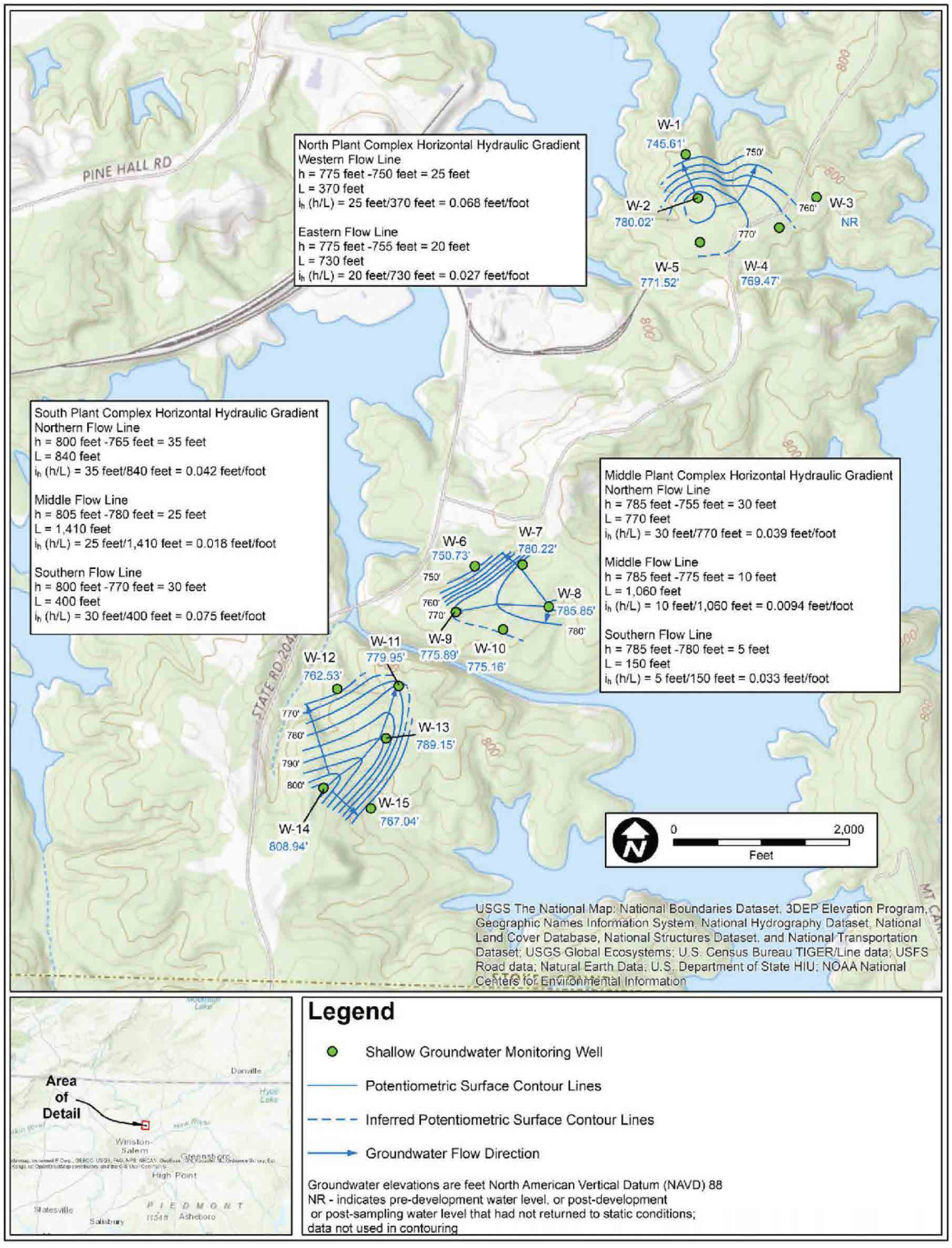
Key: h = height; i_h = horizontal hydraulic gradient; L = length; NAVD = North American Vertical Datum; NR = not recovered

Figure 2.2-29
Project Site Potentiometric Map (January 2025)



Key: h = height; i_h = horizontal hydraulic gradient; L = length; NAVD = North American Vertical Datum

Figure 2.2-30
Project Site Potentiometric Map (April 2025)



Key: h = height; i_h = horizontal hydraulic gradient; L = length; NAVD = North American Vertical Datum

Figure 2.2-31
Surface Water Intakes in the 50-Miles (80-Kilometers) Project Region

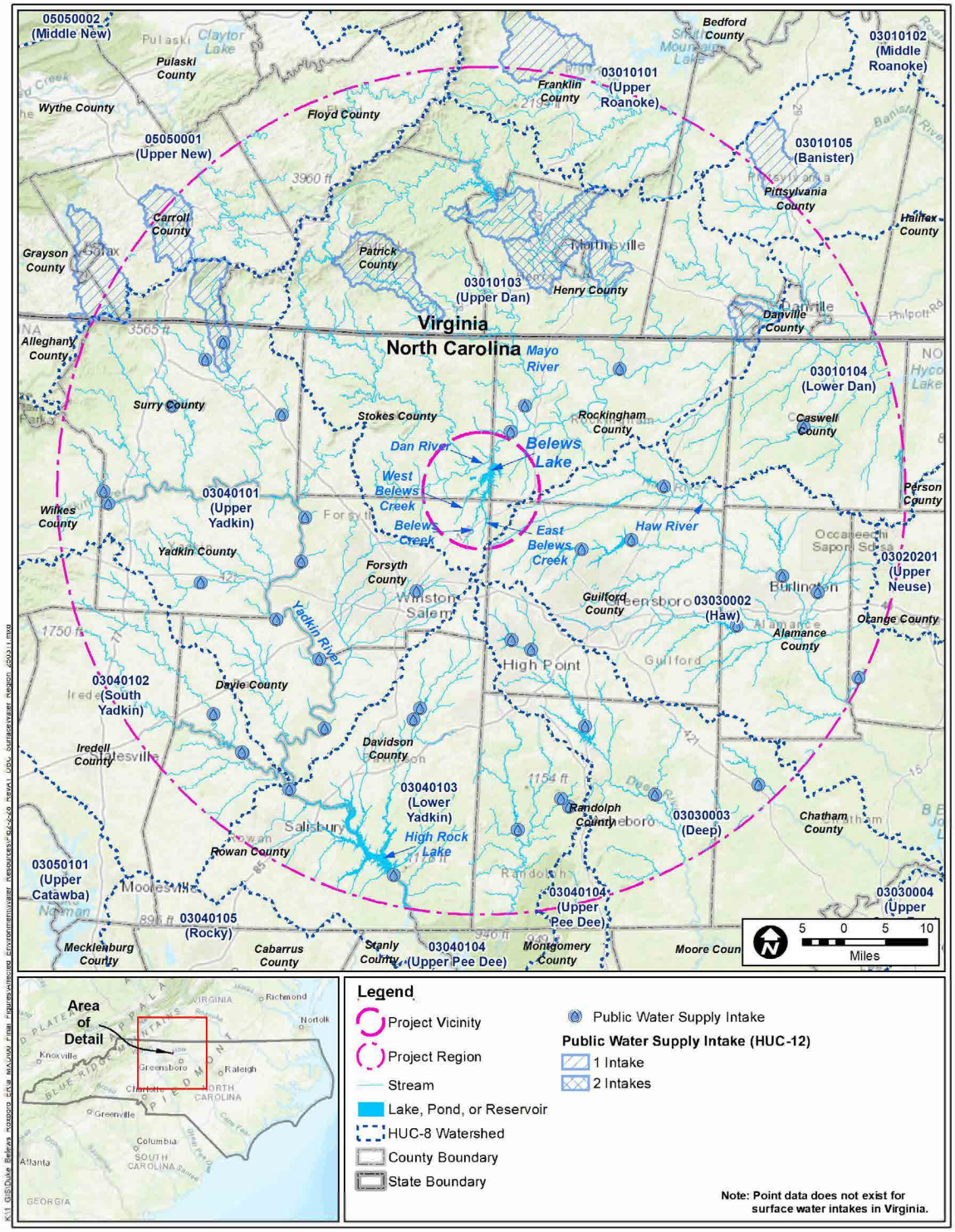


Figure 2.2-32
Vicinity Groundwater Withdrawals by Use

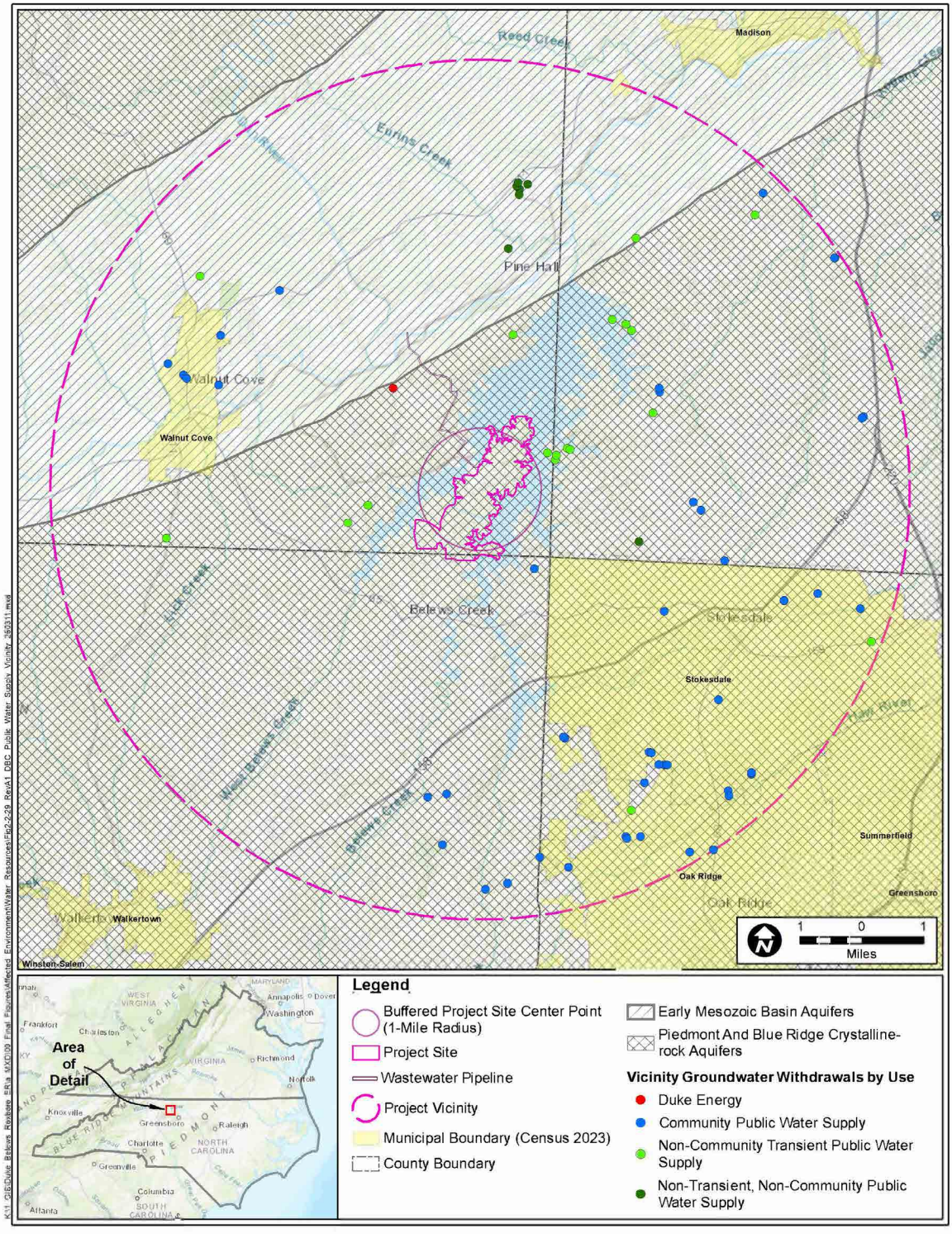


Figure 2.2-33
Dan River, Town Fork Creek, and Belews Lake Waterbody Classifications Map

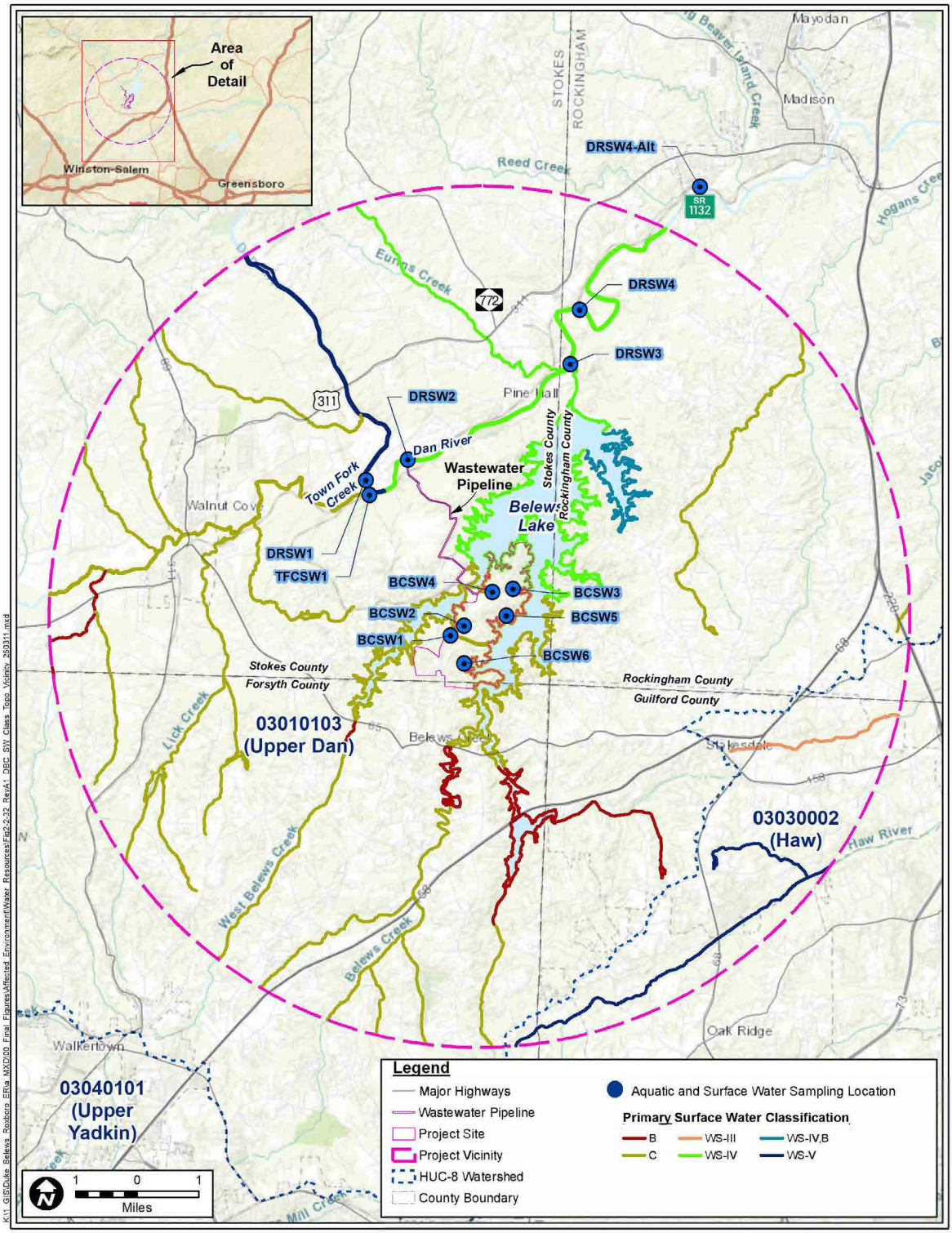


Figure 2.2-34
Duke Energy Existing Surface Water Aquatic and Surface Water Sampling Locations

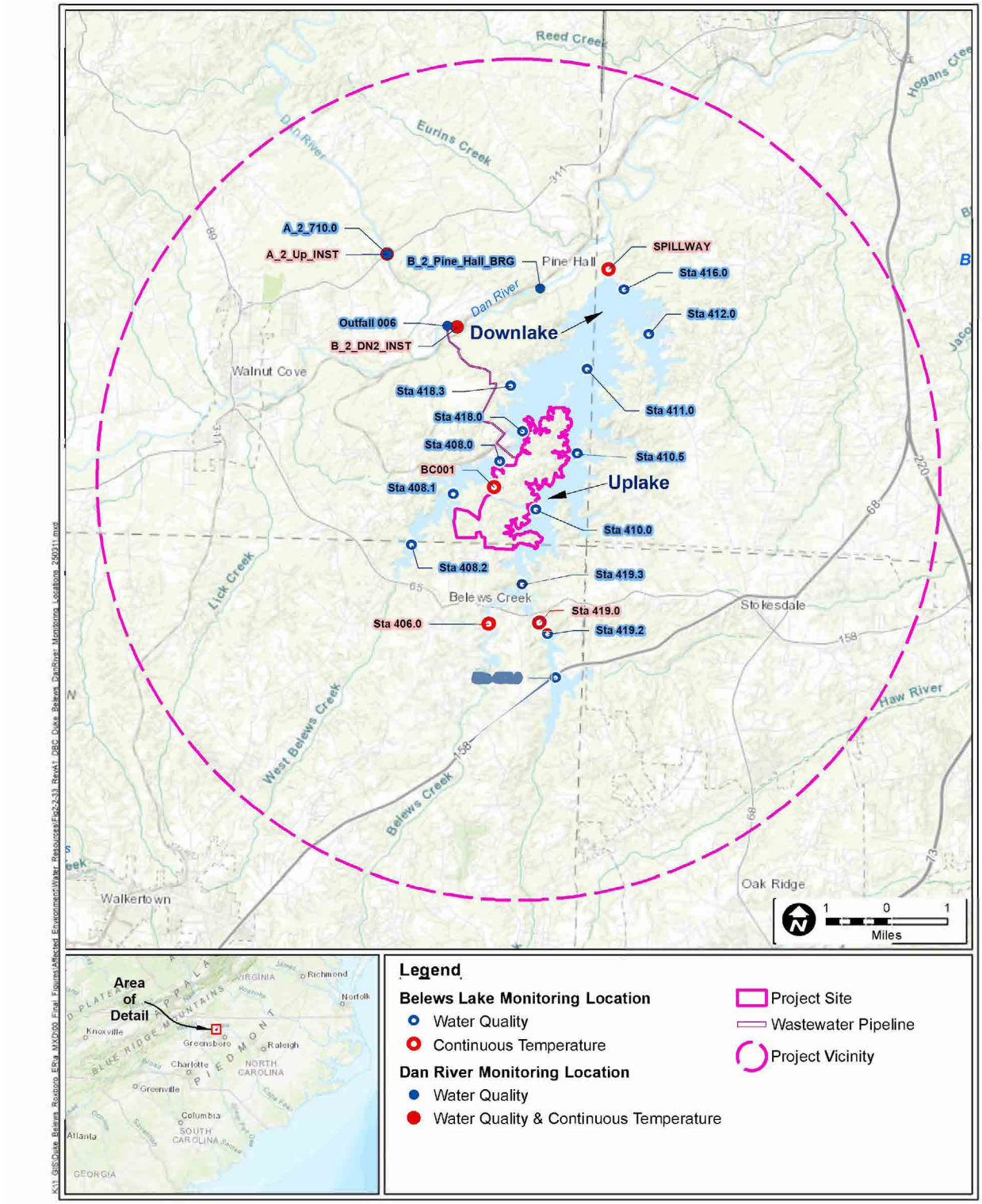


Figure 2.2-35
Duke Energy Surface Water Preapplication Water Quality Monitoring Locations

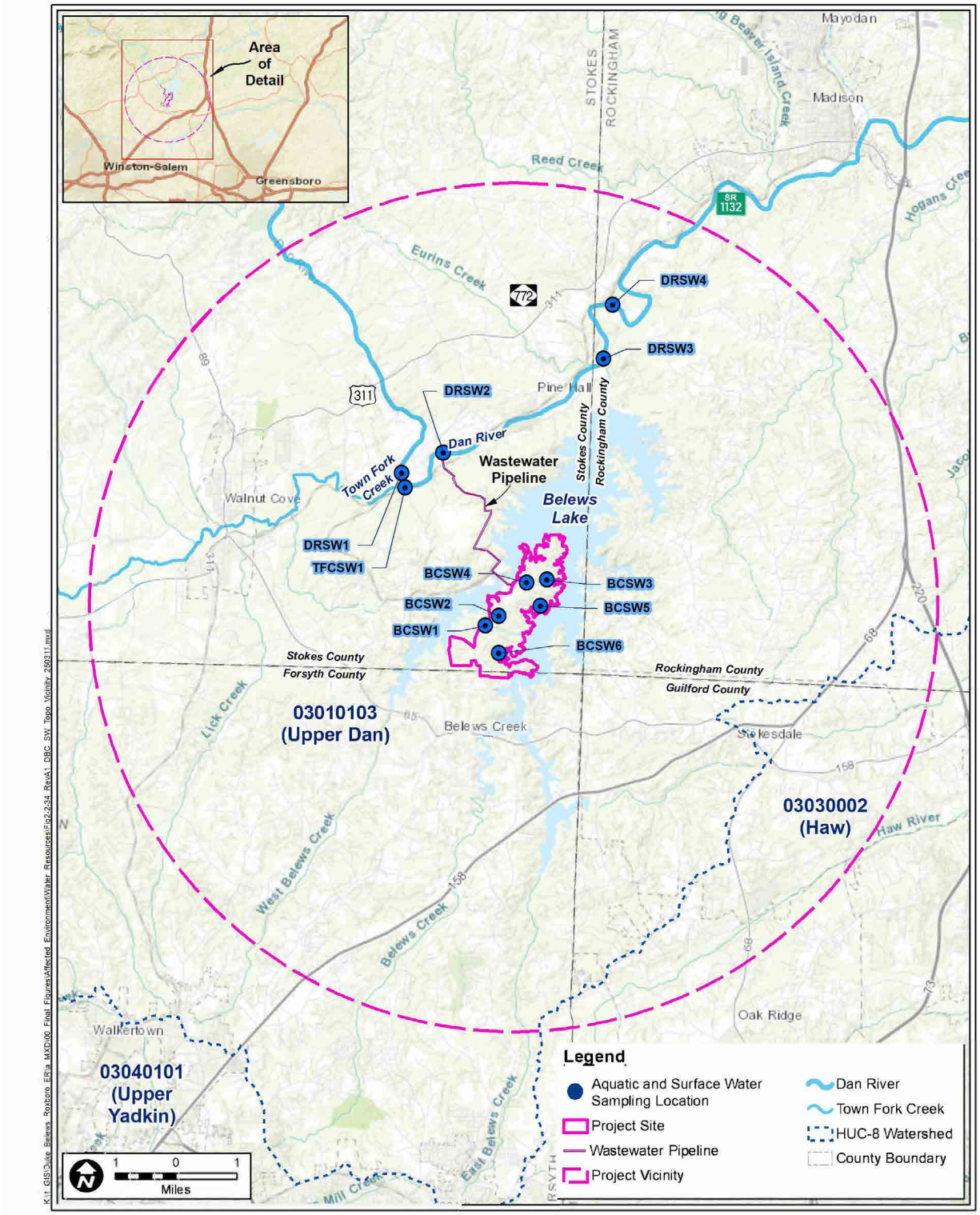


Figure 2.2-36
NCDEQ and USGS Surface Water Aquatic and Surface Water Sampling Locations

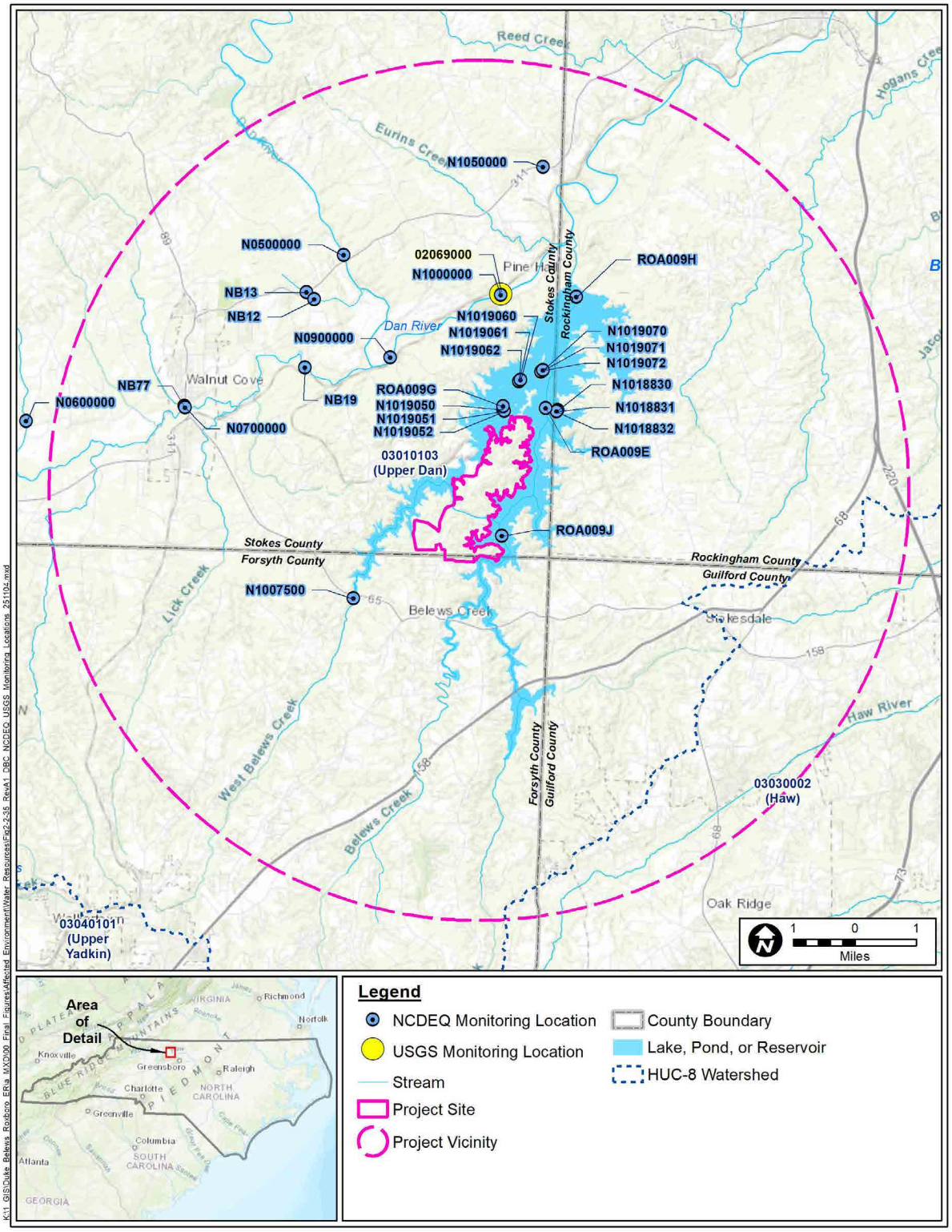


Figure 2.2-37
Belews Creek Water Quality Well Locations

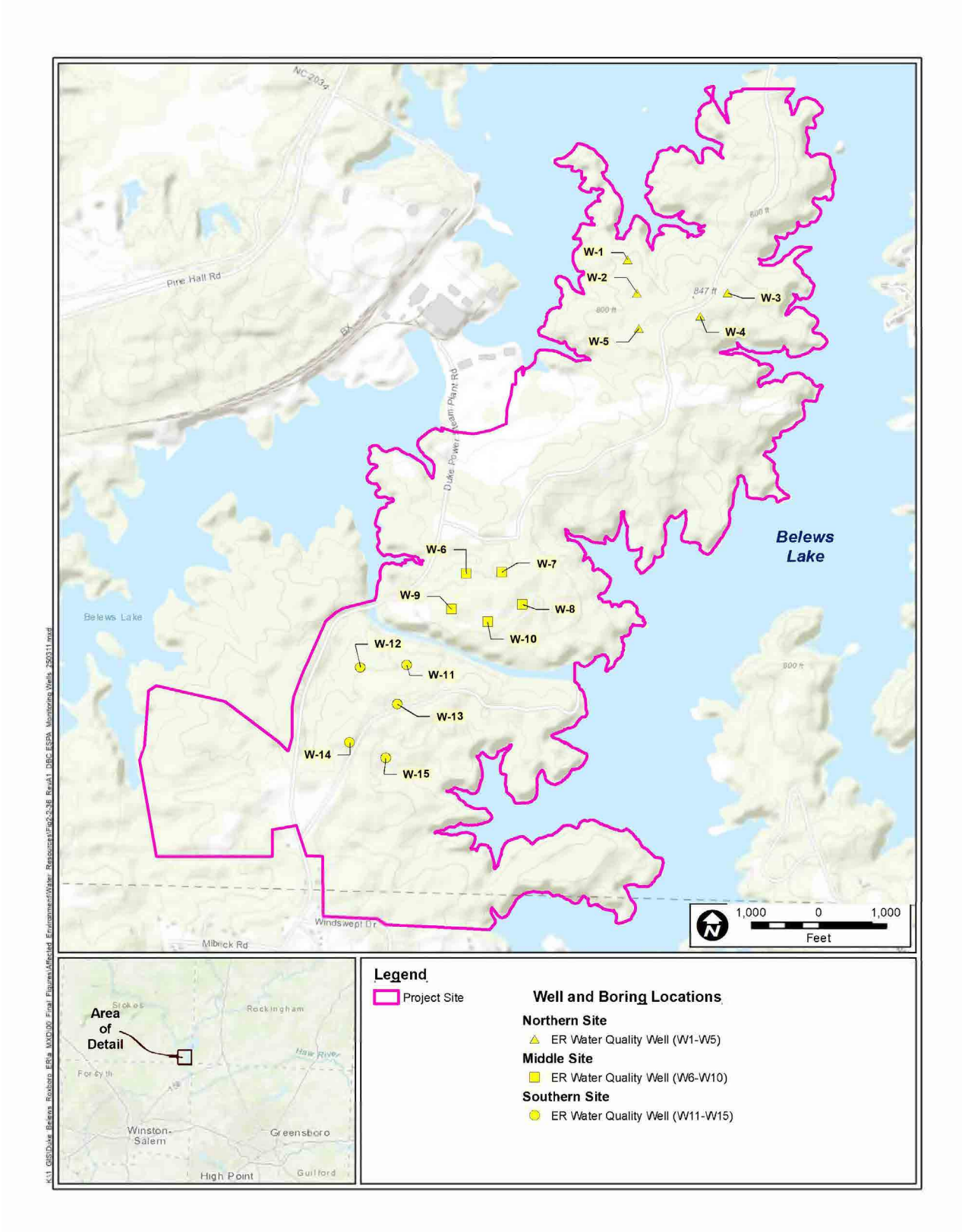


Figure 2.3-1
Ecoregions of the Project Region

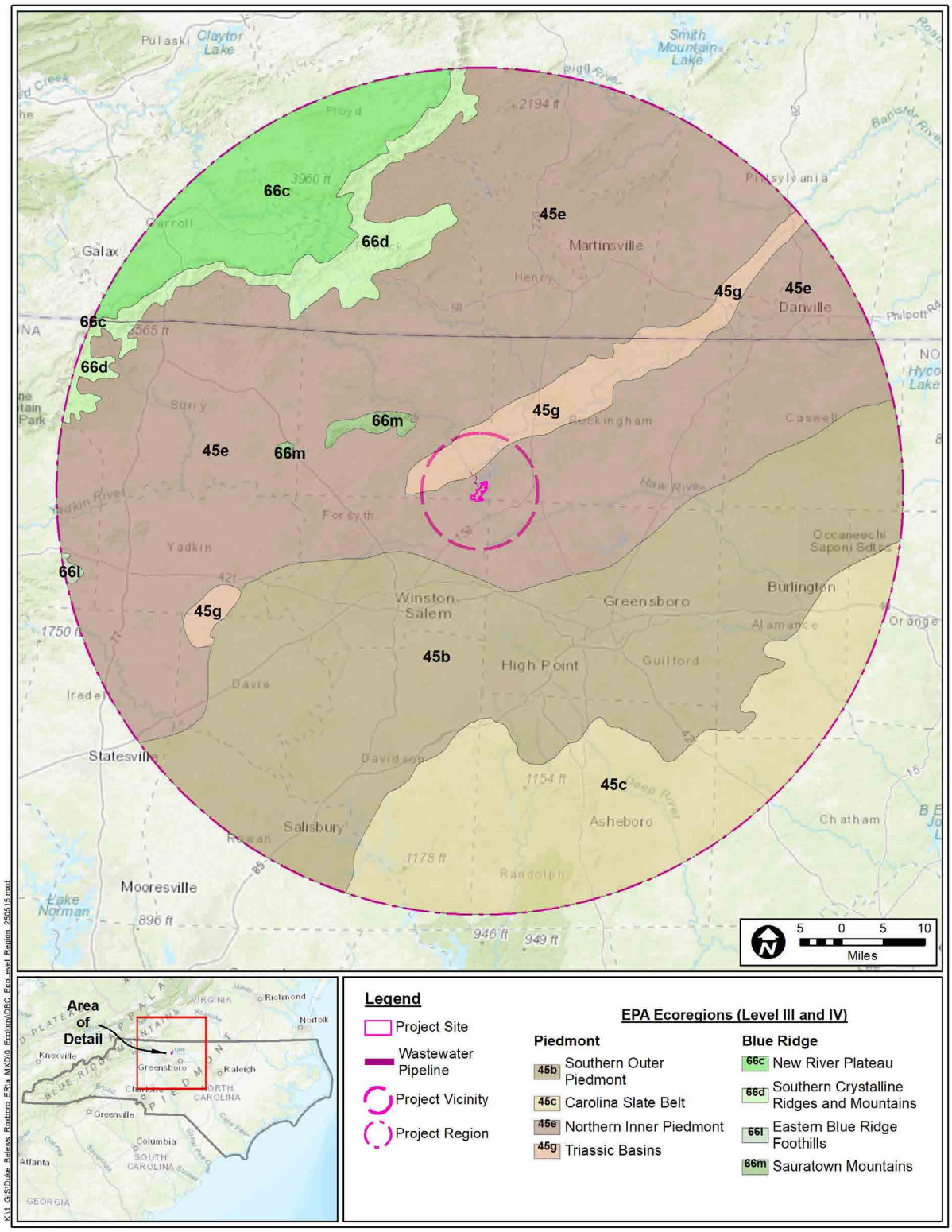


Figure 2.3-2
Land Cover of the Project Site

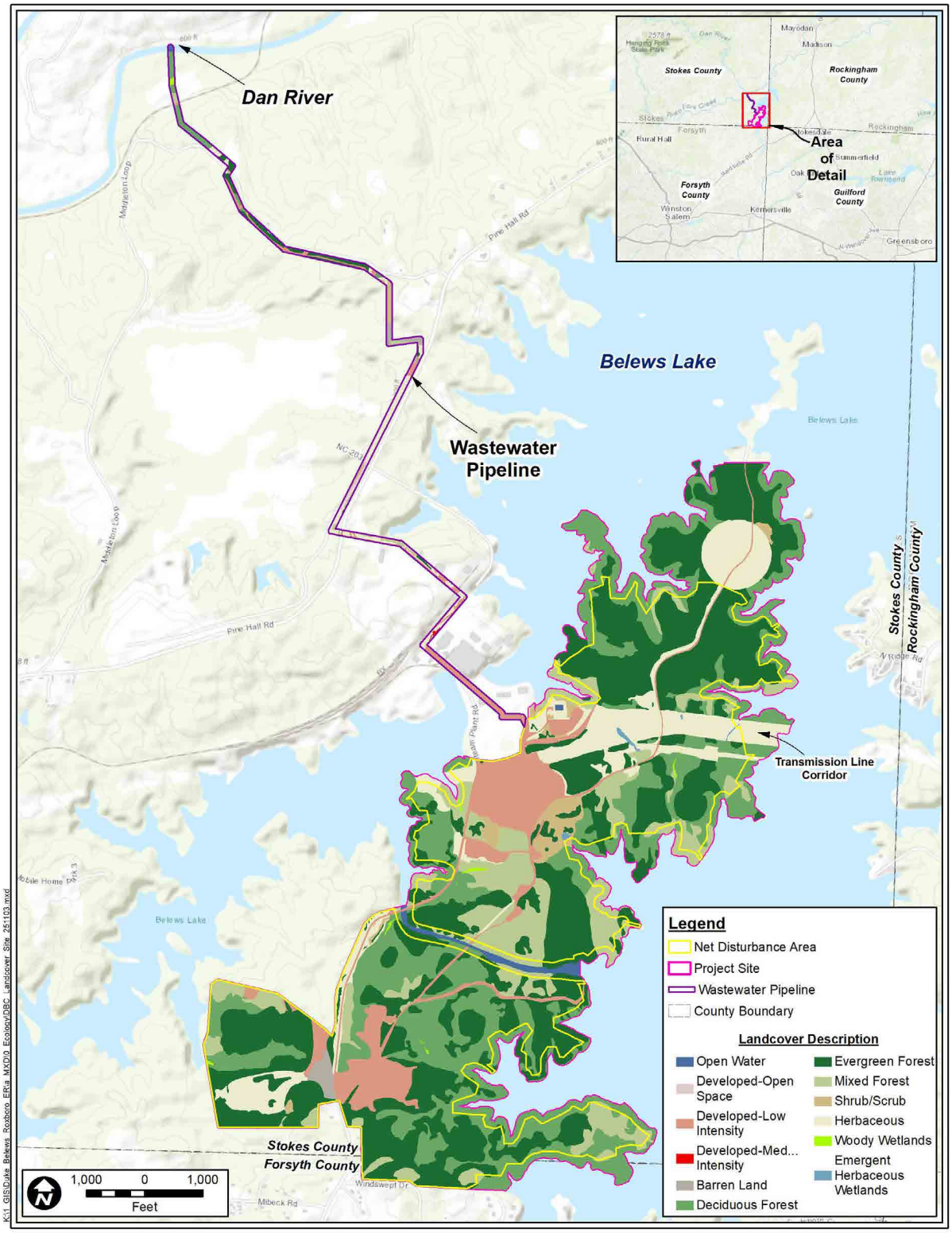


Figure 2.3-3
NWI Features in the Project Vicinity

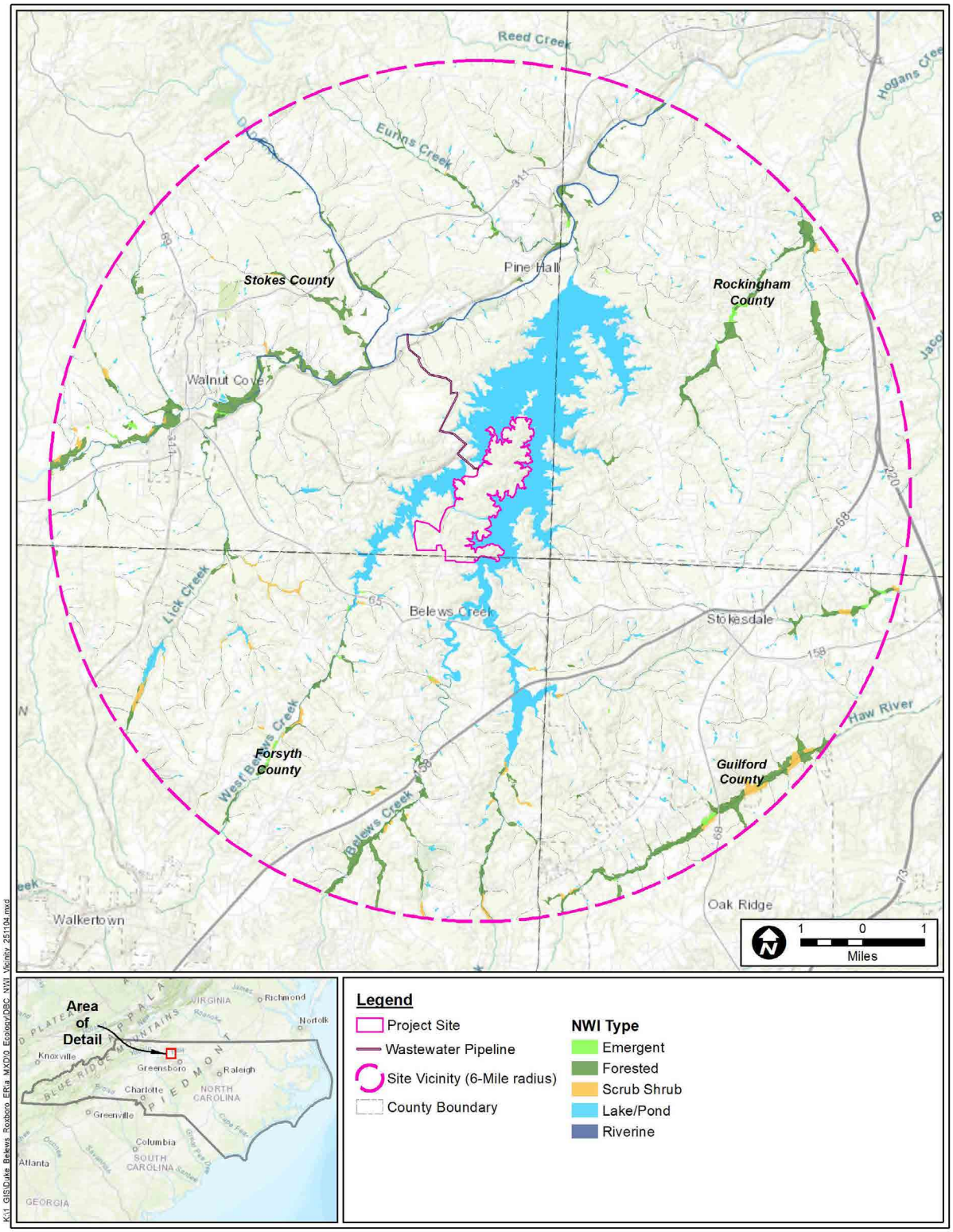


Figure 2.3-4
NWI Features in the Project Site

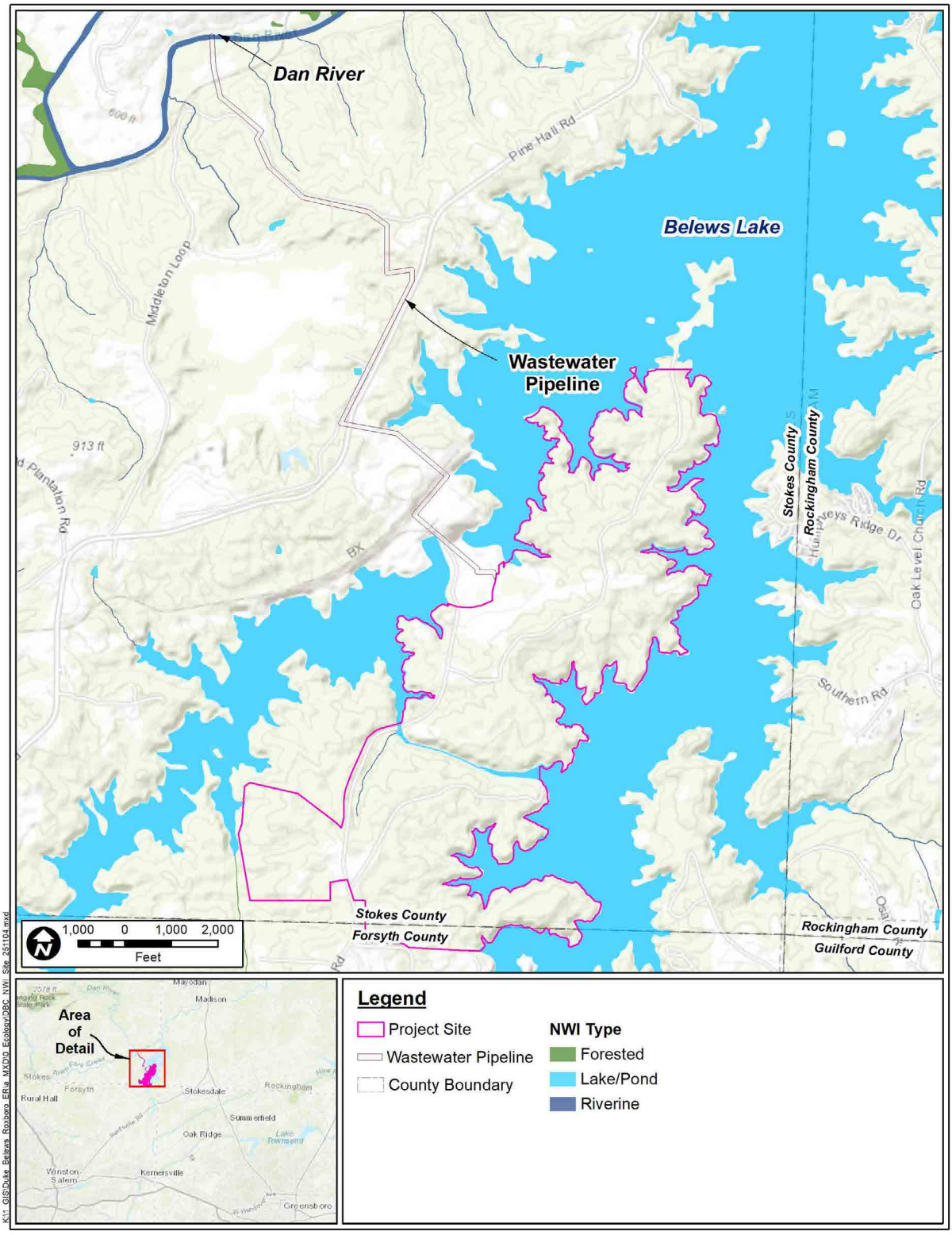


Figure 2.3-5
Potential Waters of the United States in the Project Site
(Sheet 1 of 2)

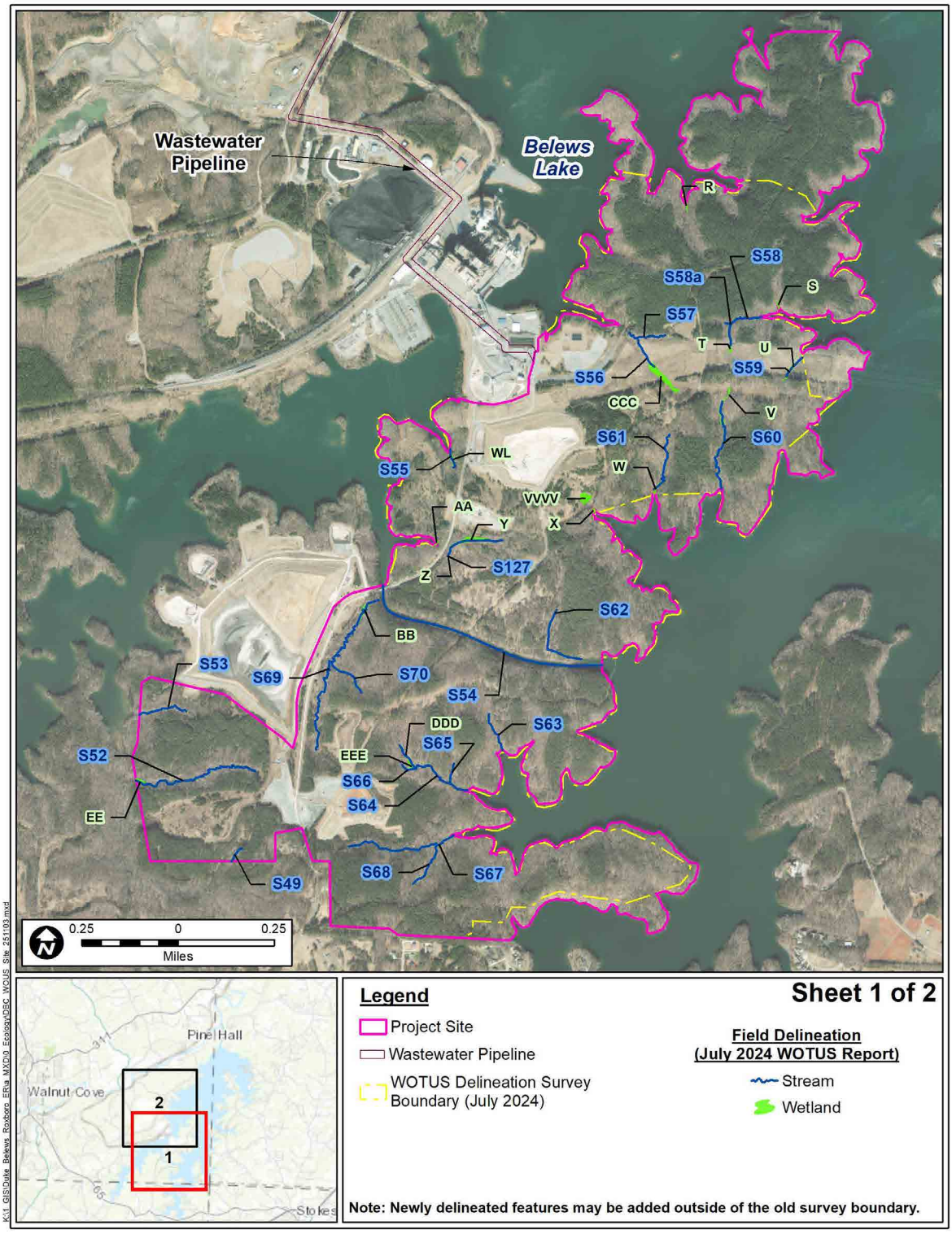


Figure 2.3-5
Potential Waters of the United States in the Project Site
(Sheet 2 of 2)

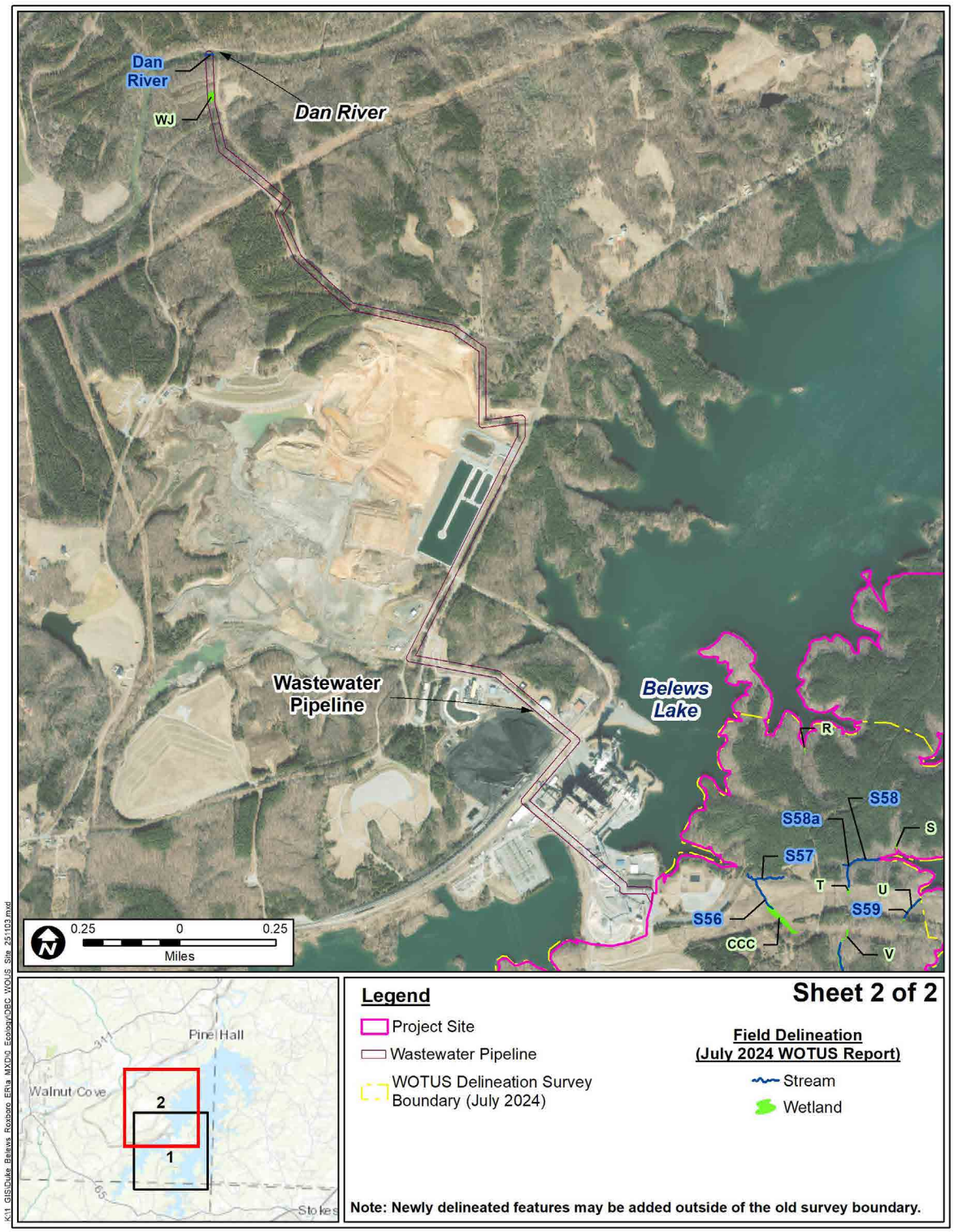


Figure 2.3-6
Ecological Resources Survey Routes

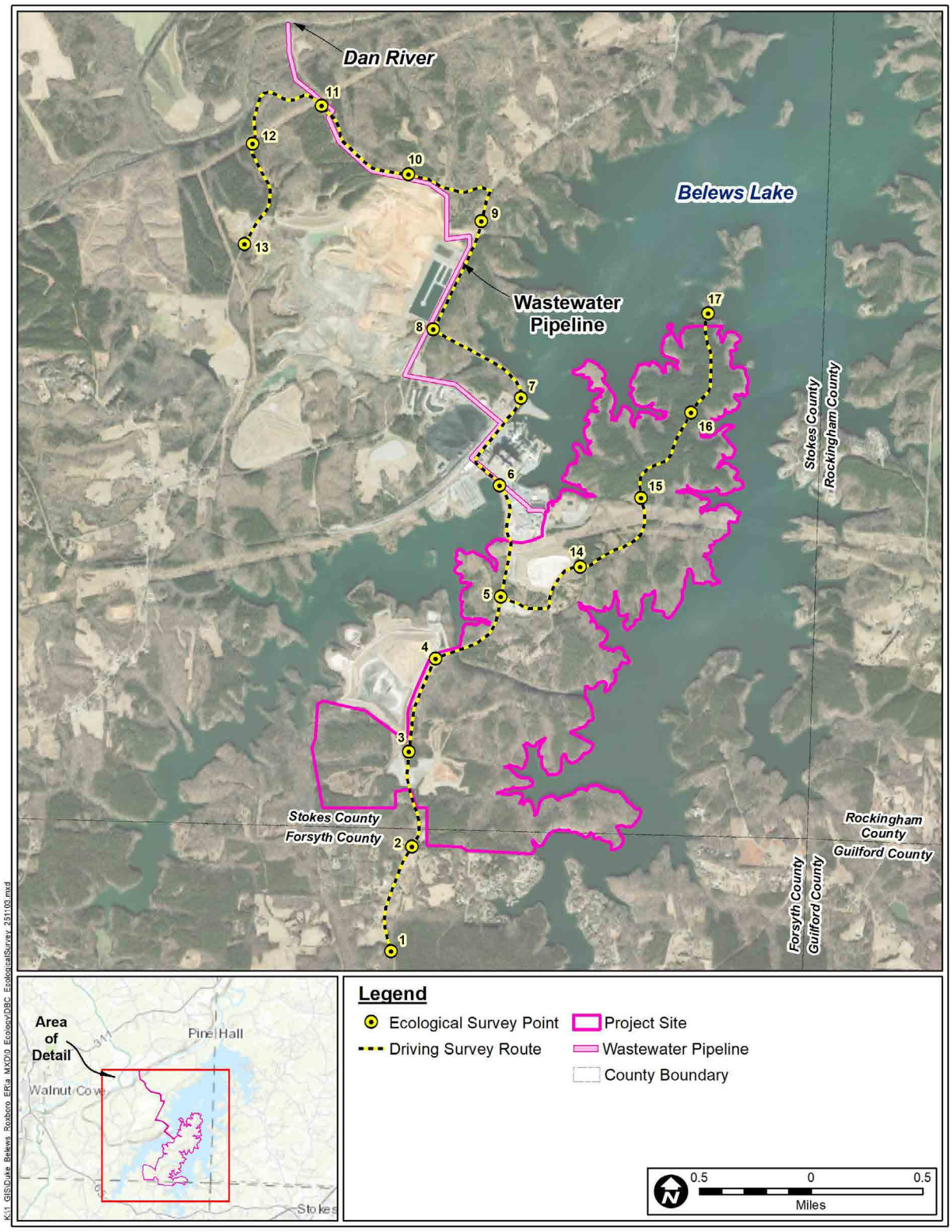


Figure 2.3-7
Raptor Nests within the Project Site and Adjacent Off-site Areas

Figure 2.3-8
Sensitive Species Habitat on the Project Site

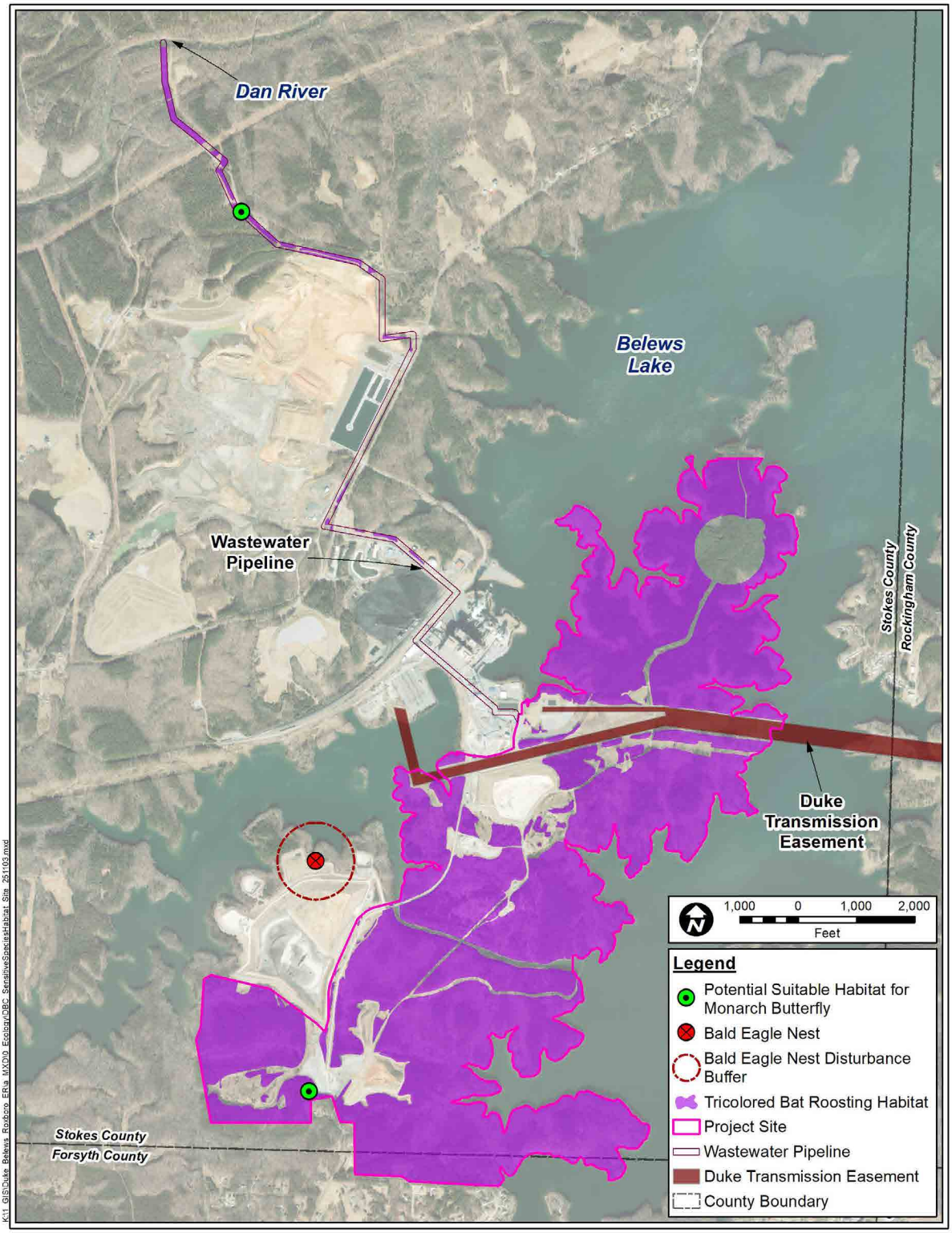


Figure 2.3-9
Previously Burned Areas Within the Project Site

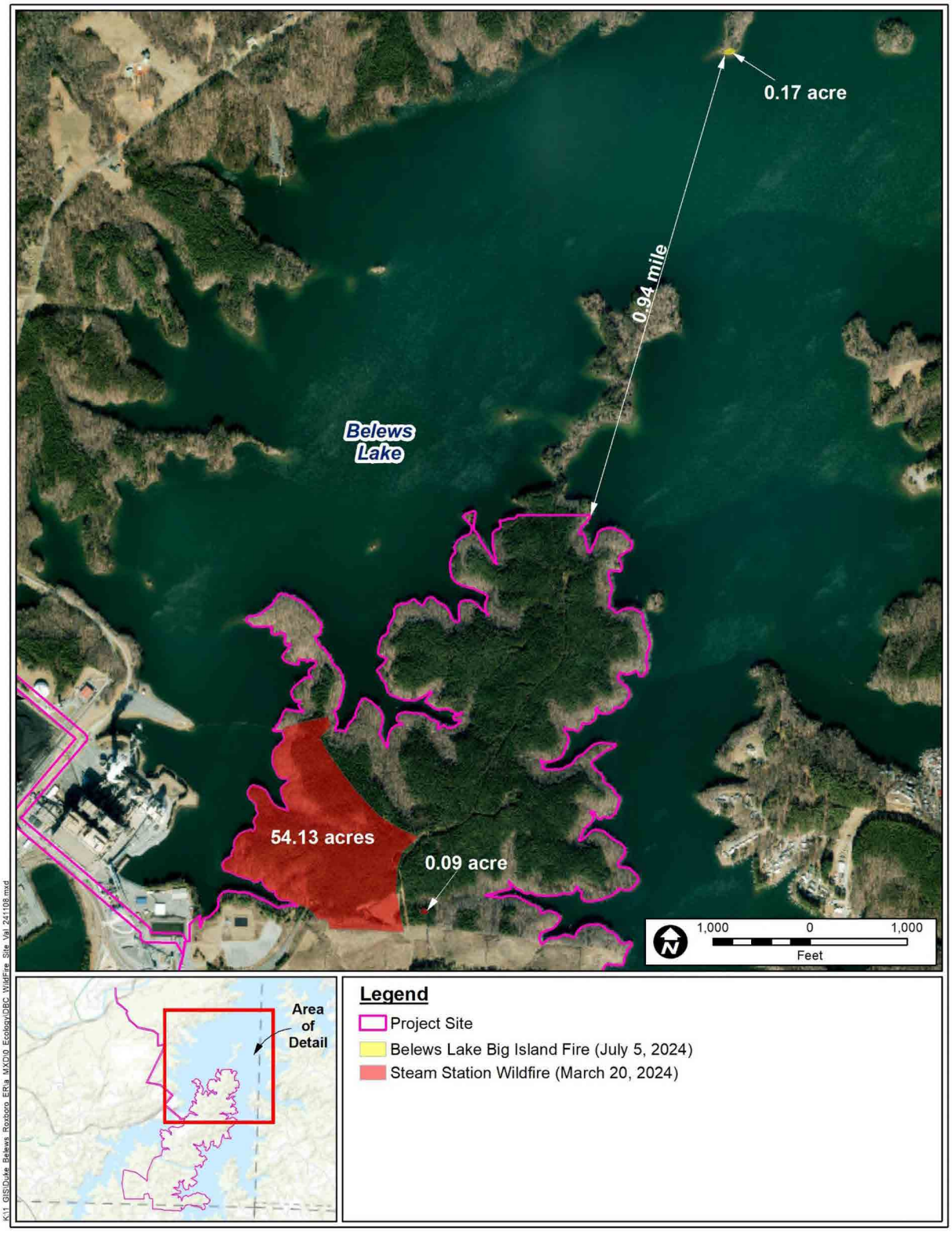


Figure 2.3-10
Quarterly Aquatic Ecology Sampling Locations, 2024

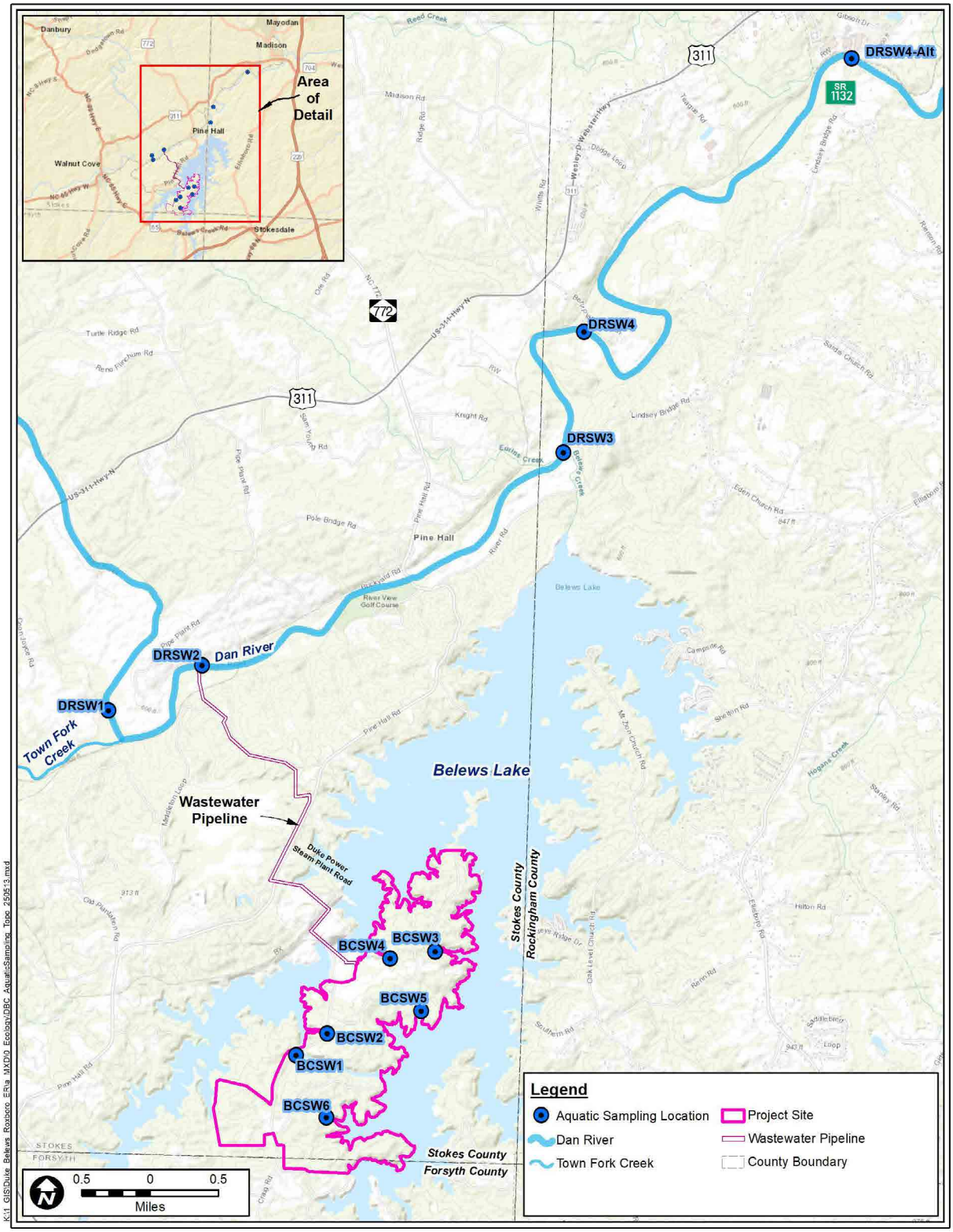
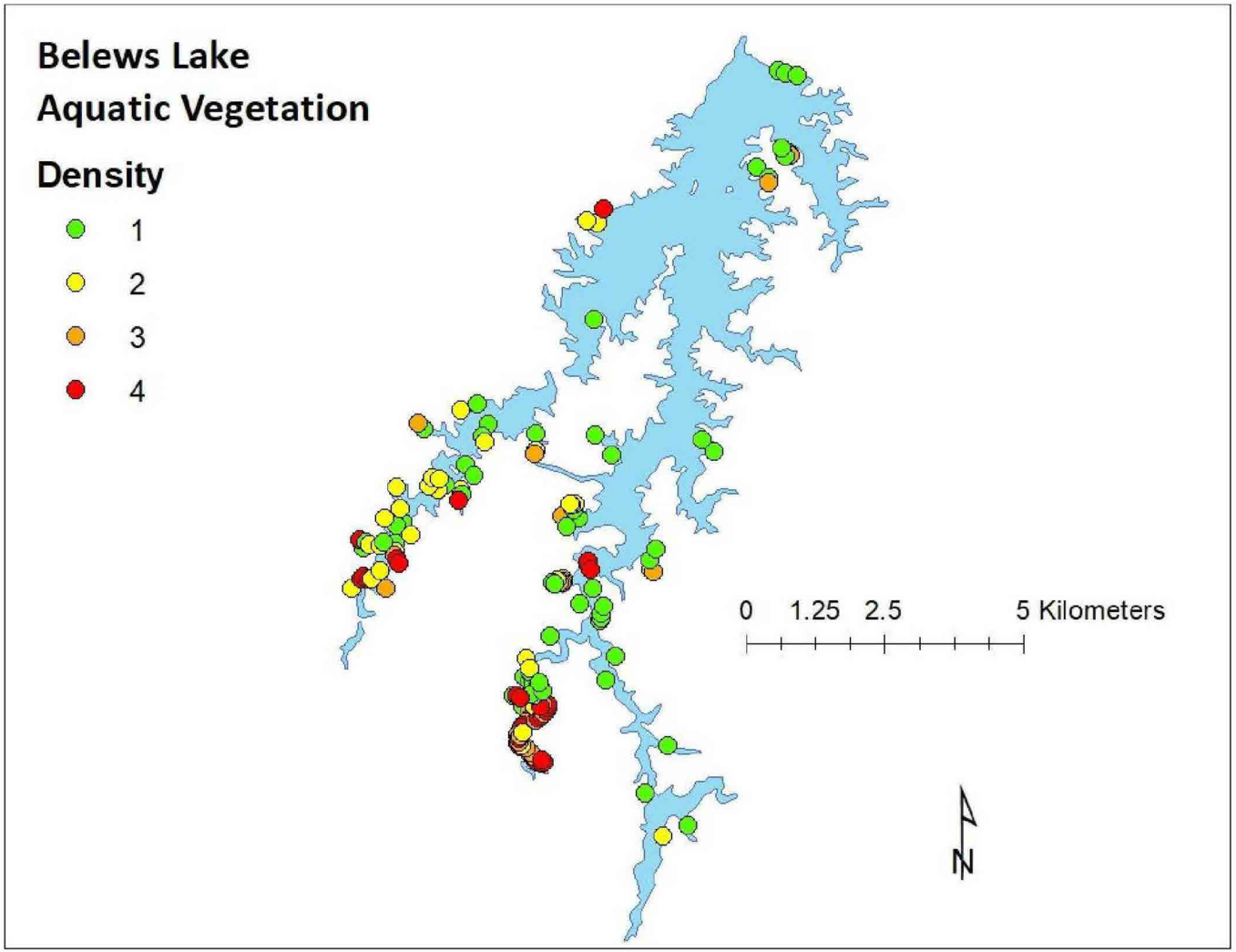


Figure 2.3-11
Aquatic Macrophytes Present in Belews Lake



Duke Energy, 2021

Figure 2.4-1
Population by Sector, 0-20 Miles (0-32 Kilometers)

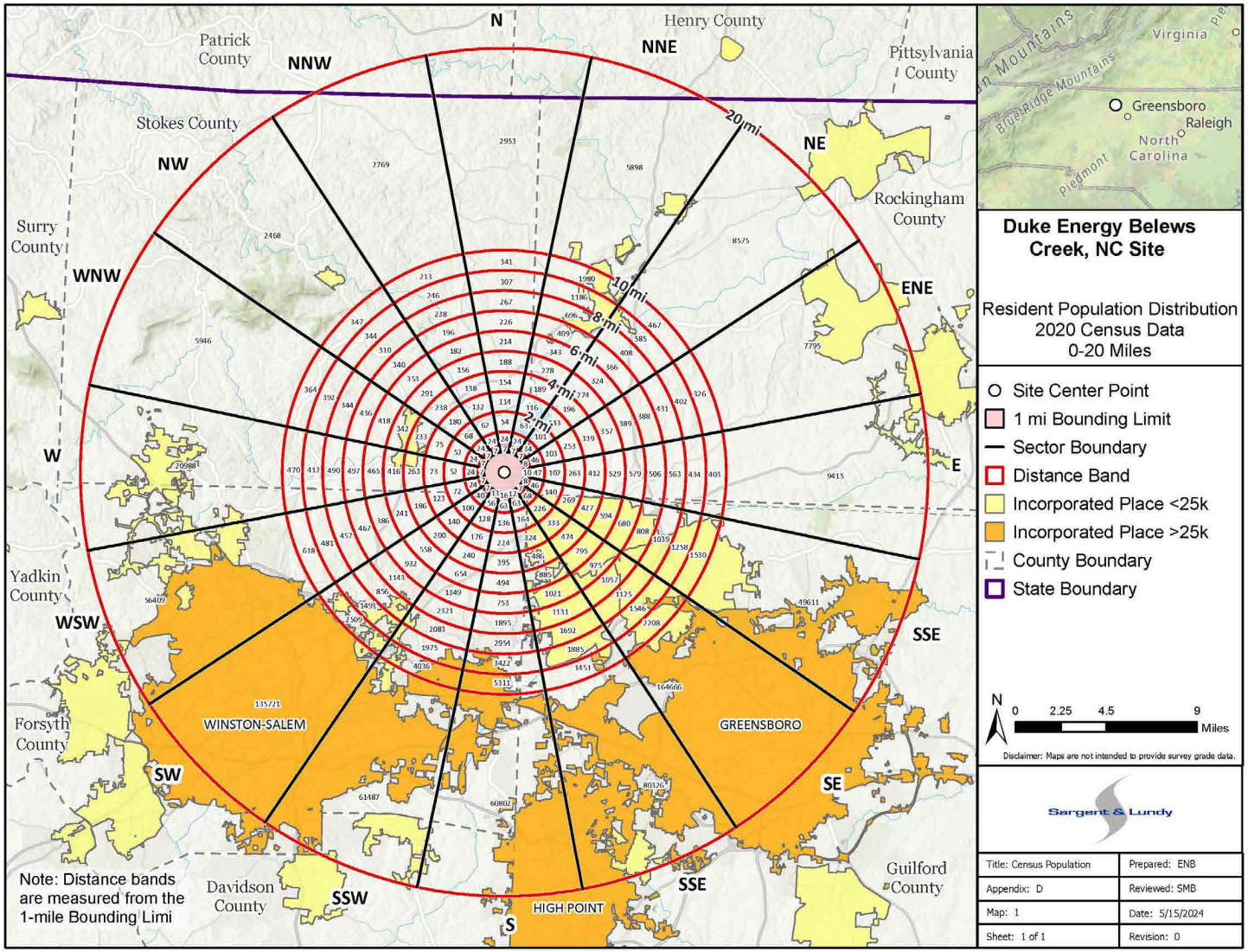
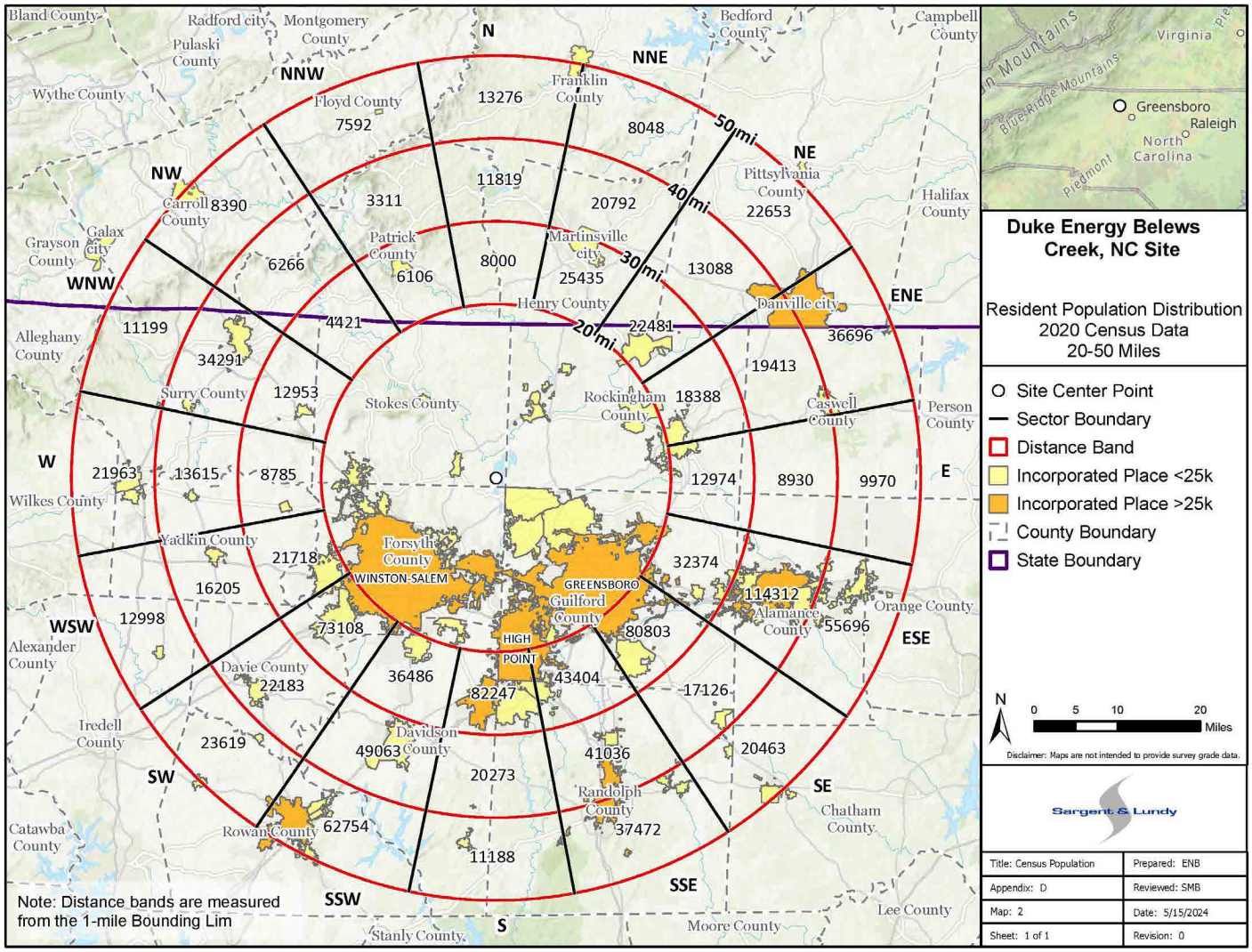


Figure 2.4-2
Population by Sector, 20–50 Miles (32-80 Kilometers)



Key: mi. = mile

Figure 2.4-3
Distance from Municipalities to the Project Site

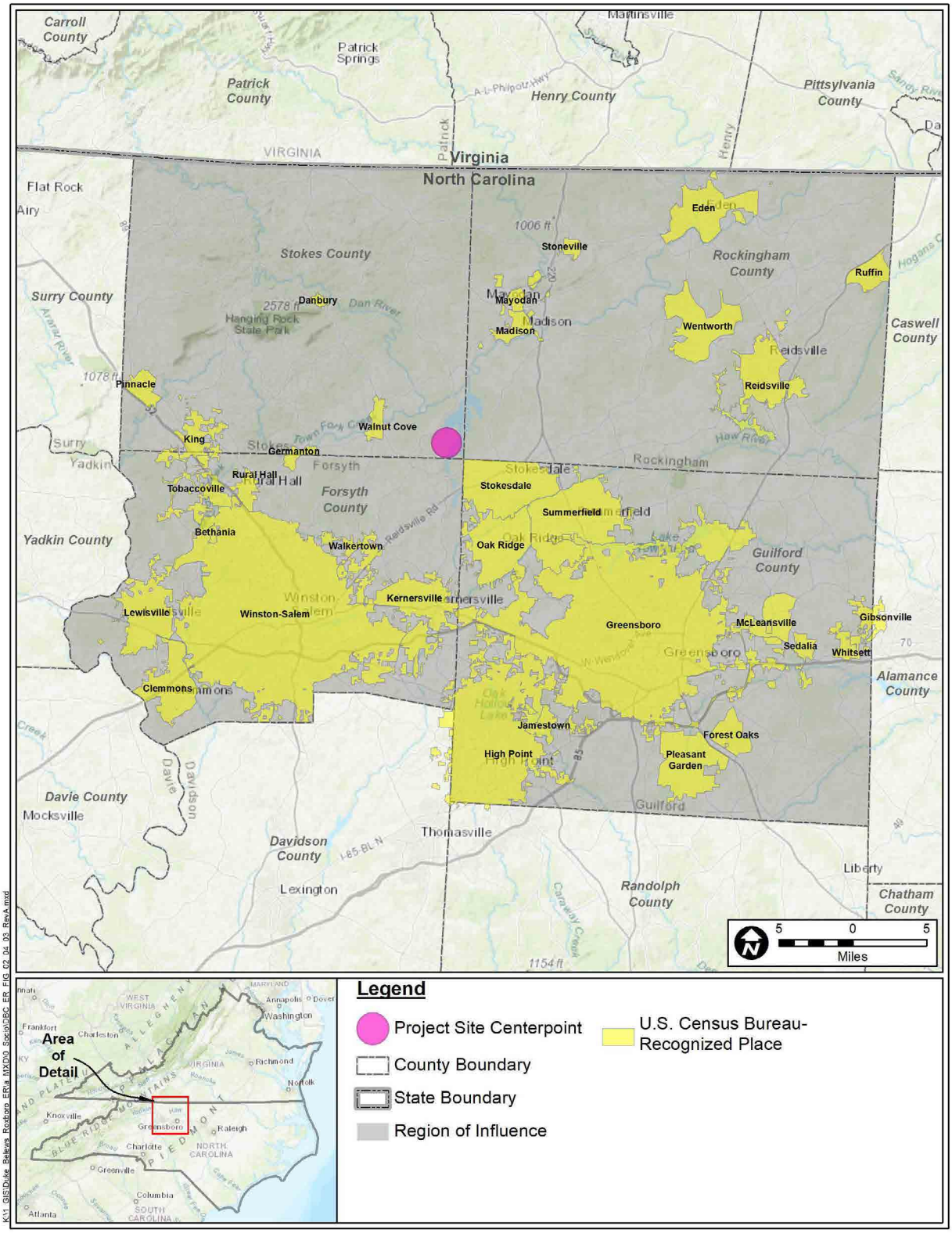


Figure 2.4-4
Transportation Network – Project Vicinity

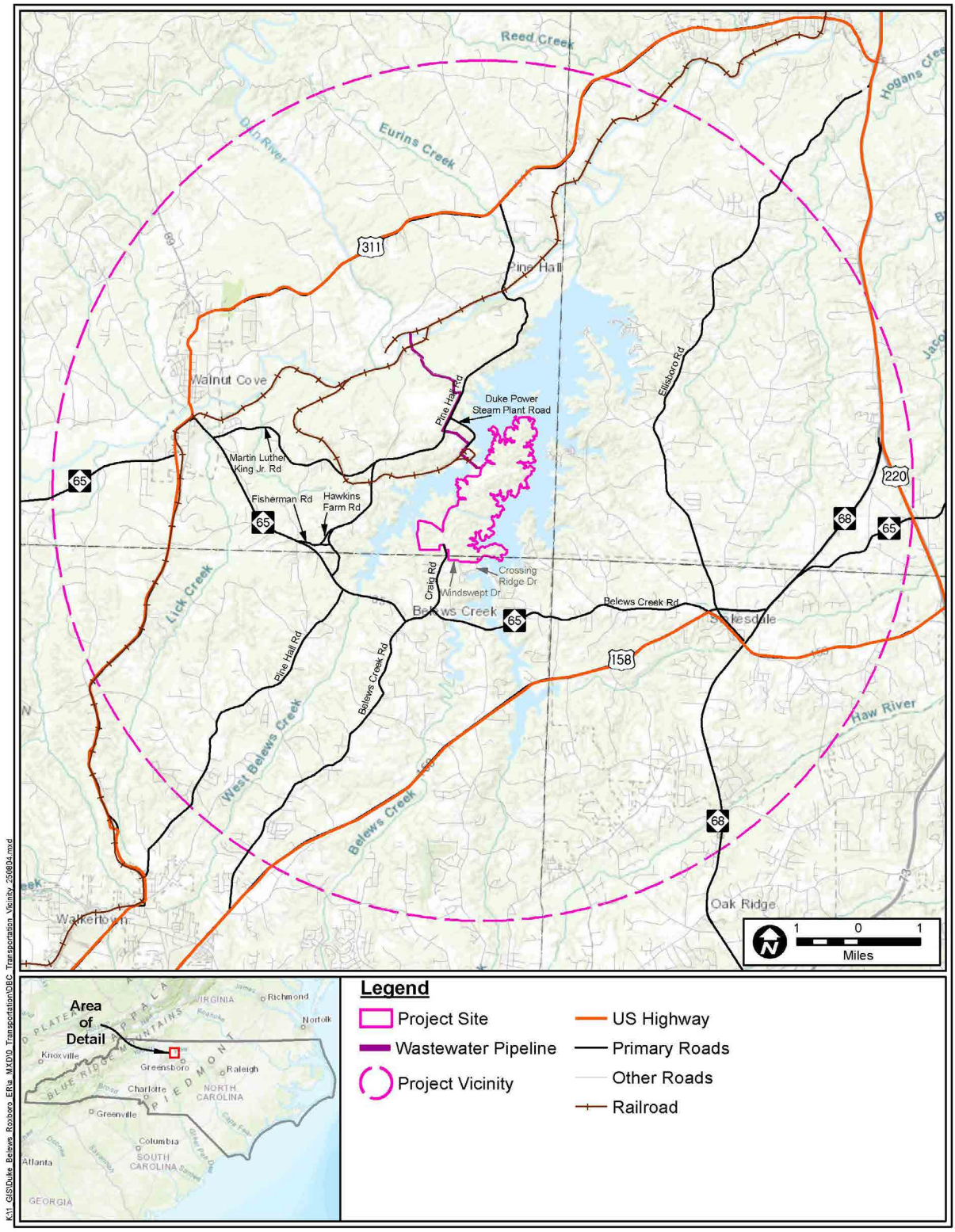


Figure 2.4-5
Recreation Areas – Project Vicinity

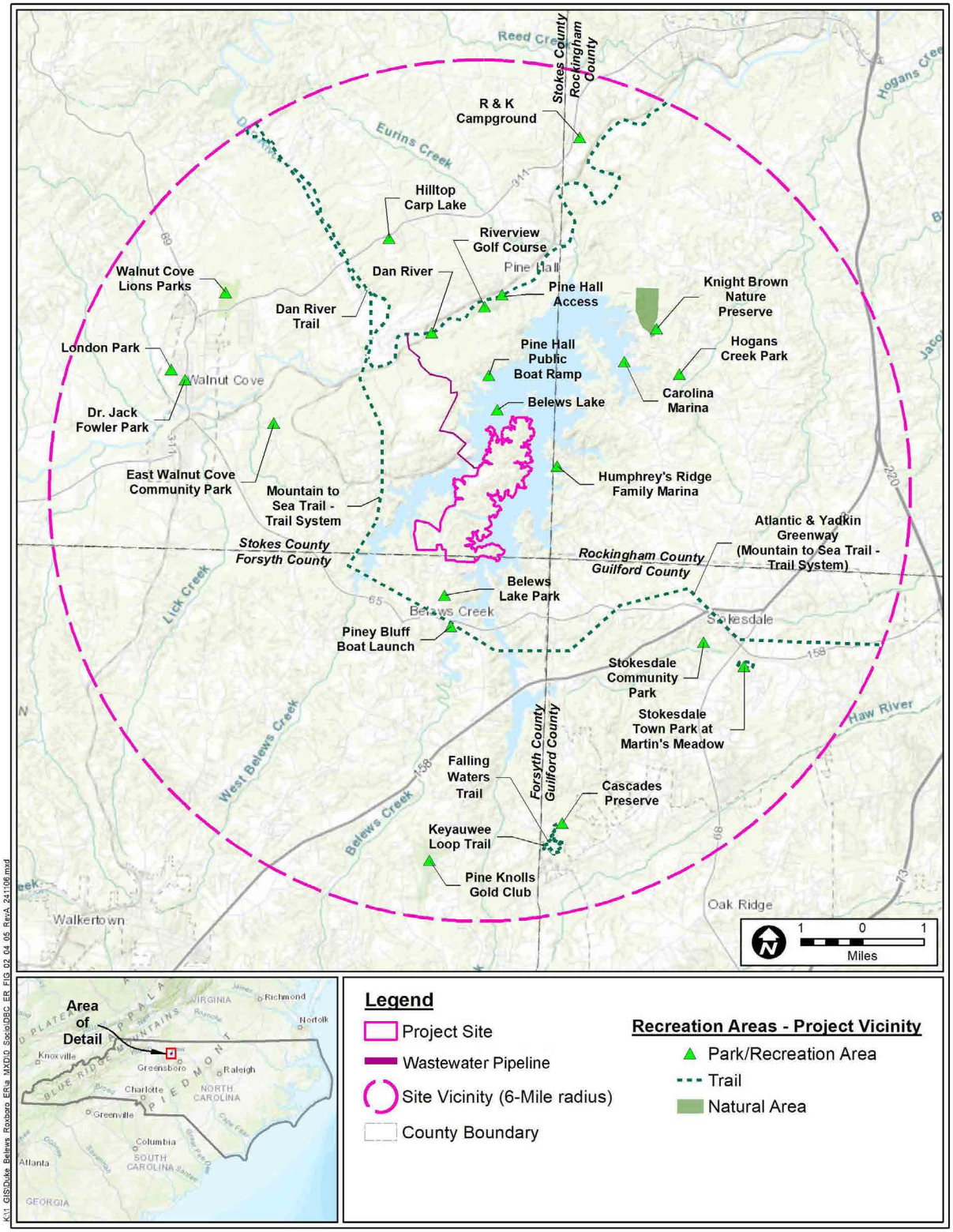
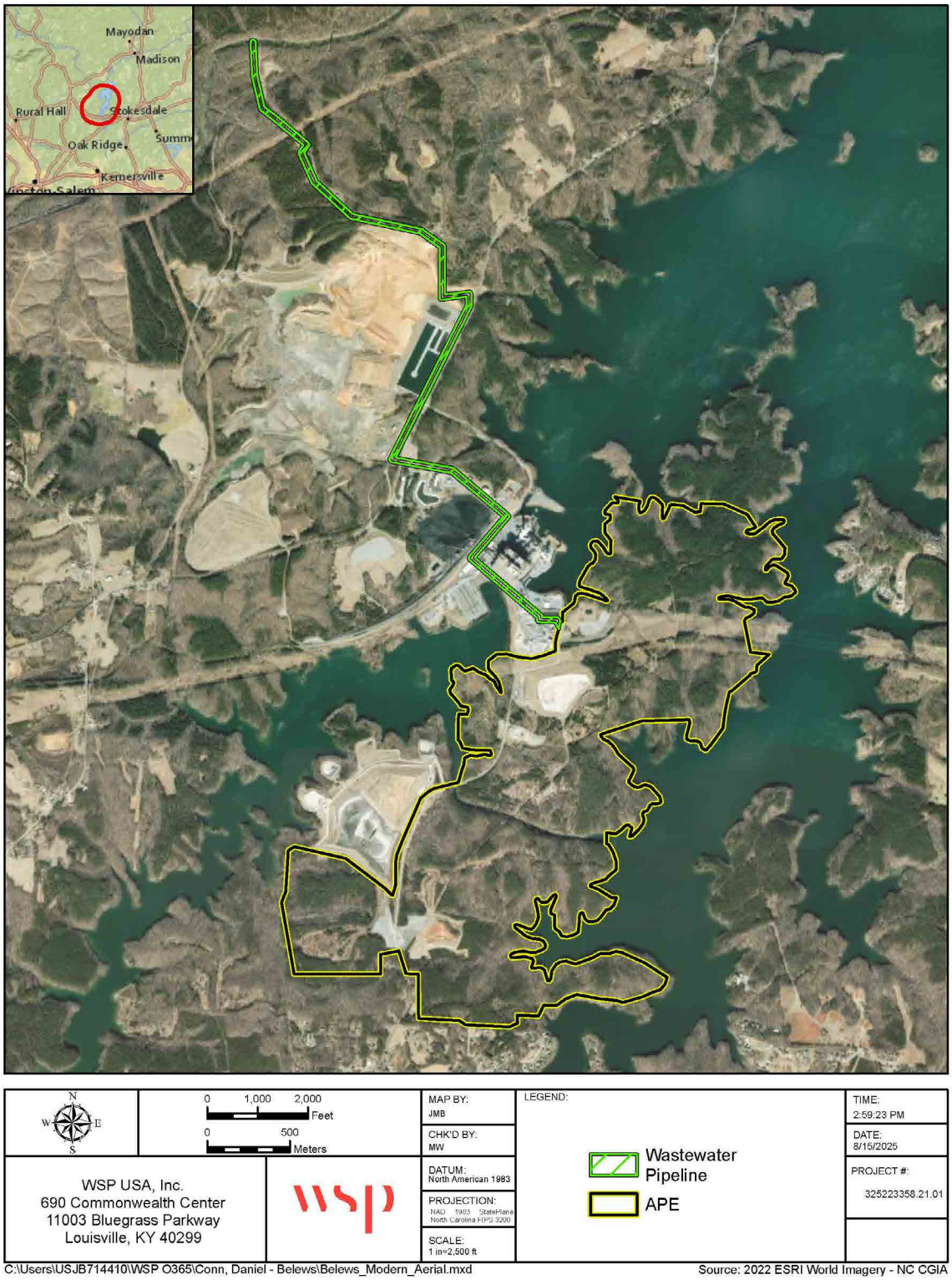


Figure 2.6-1
Direct APE Shown on Modern Aerial Imagery



Key: APE = area of potential effects

Figure 2.6-2
Direct APE Shown on USGS Topographic Mapping

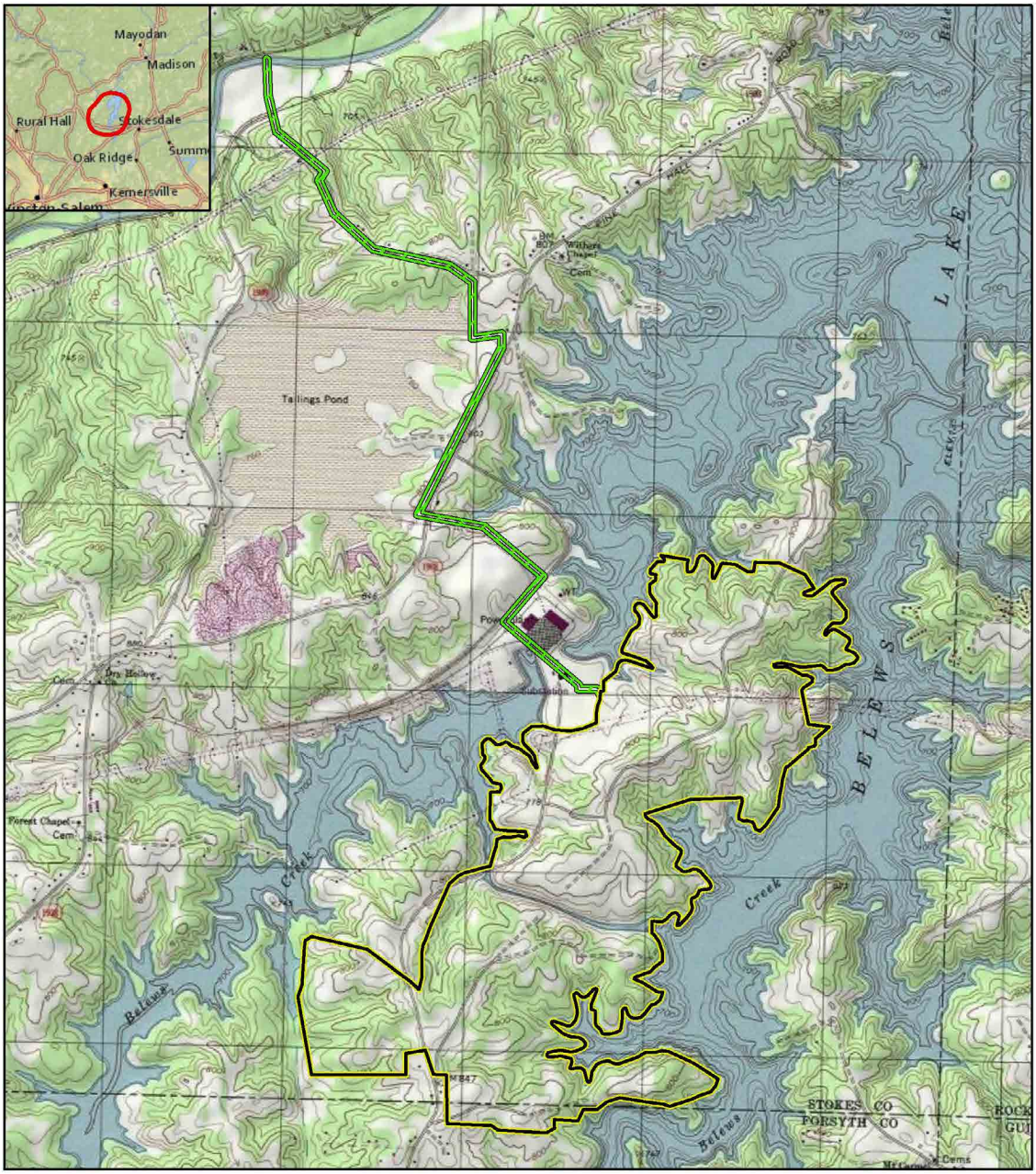
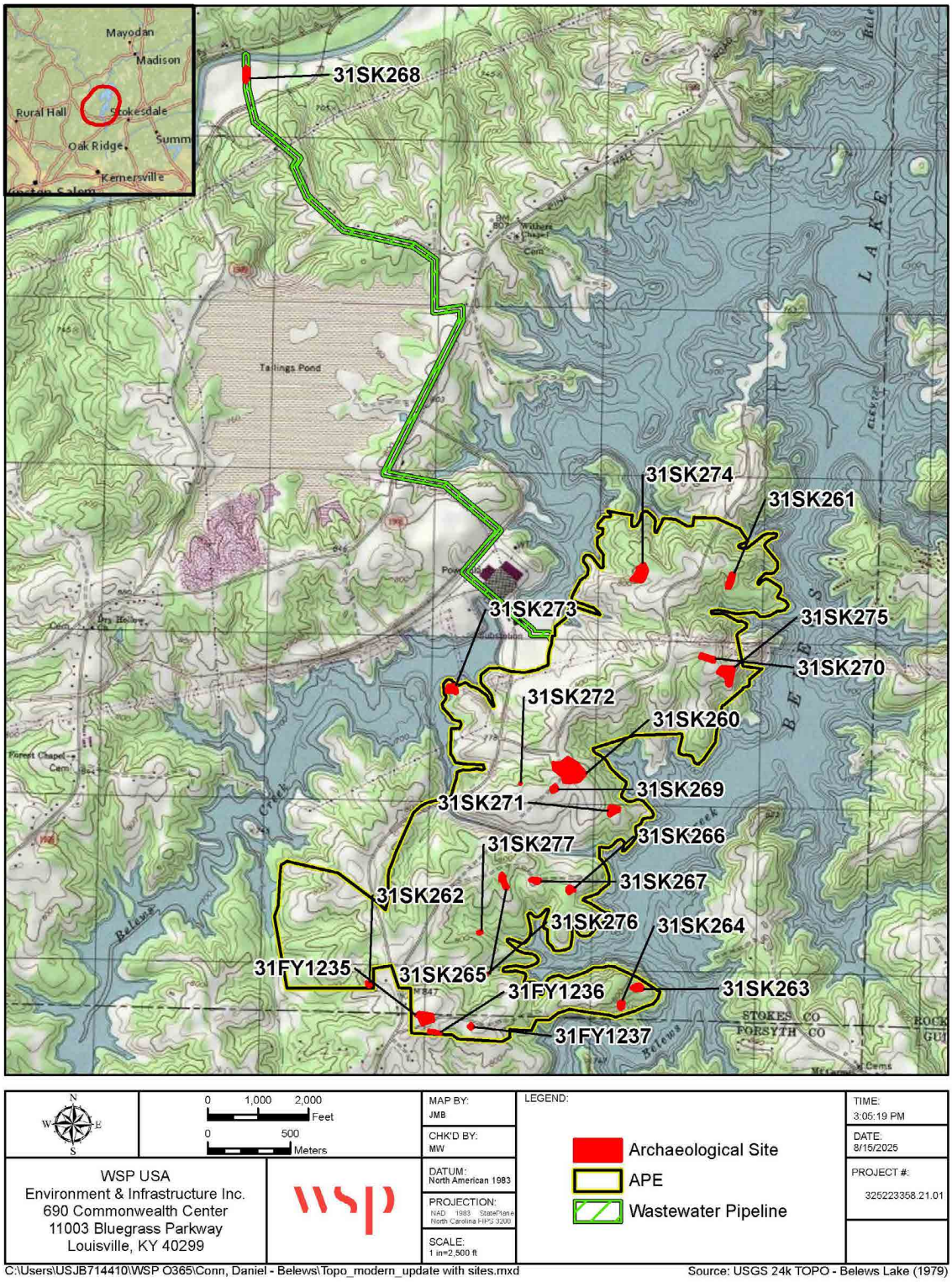


Figure 2.6-3
Newly Recorded Archaeological Sites

[[



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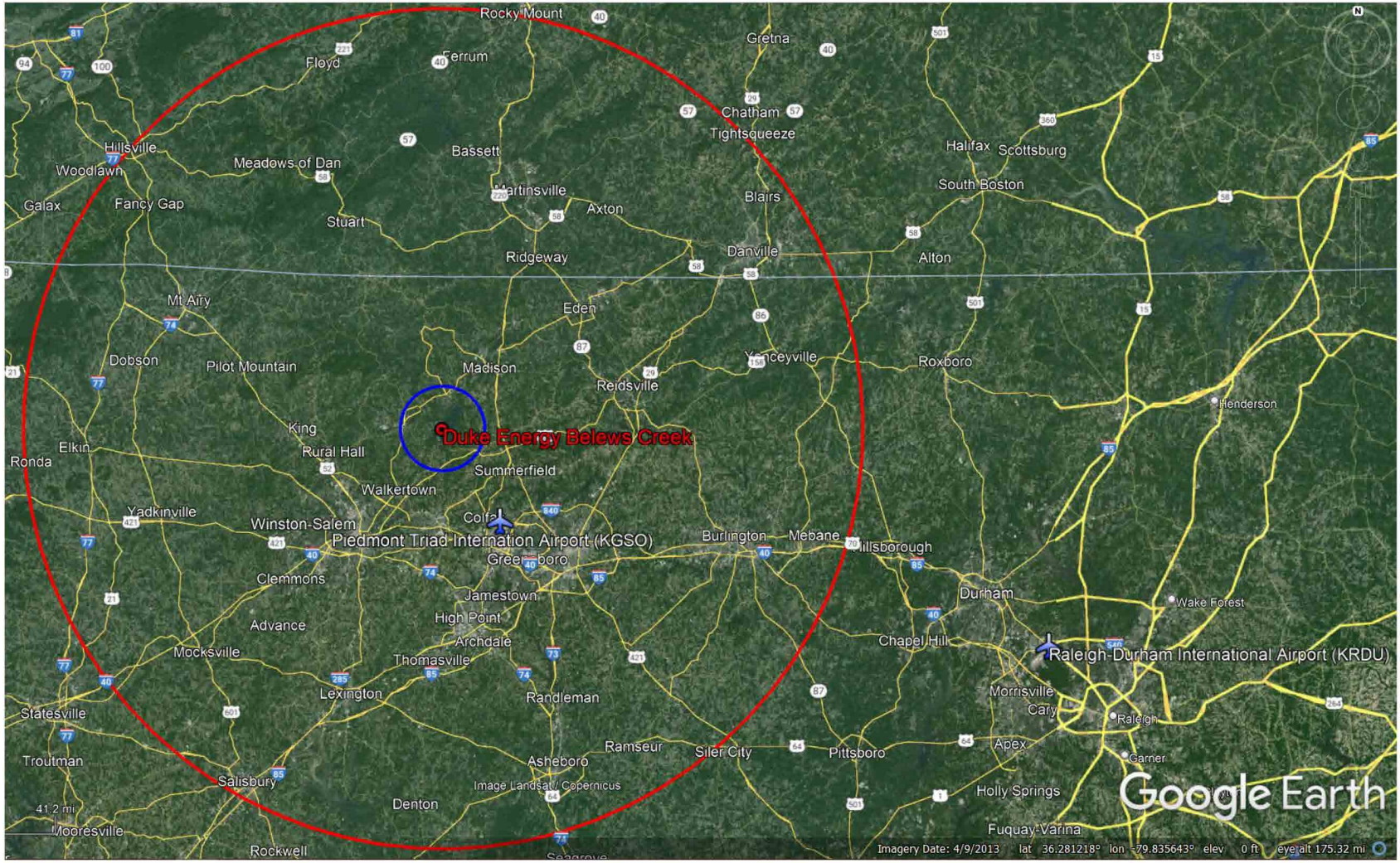
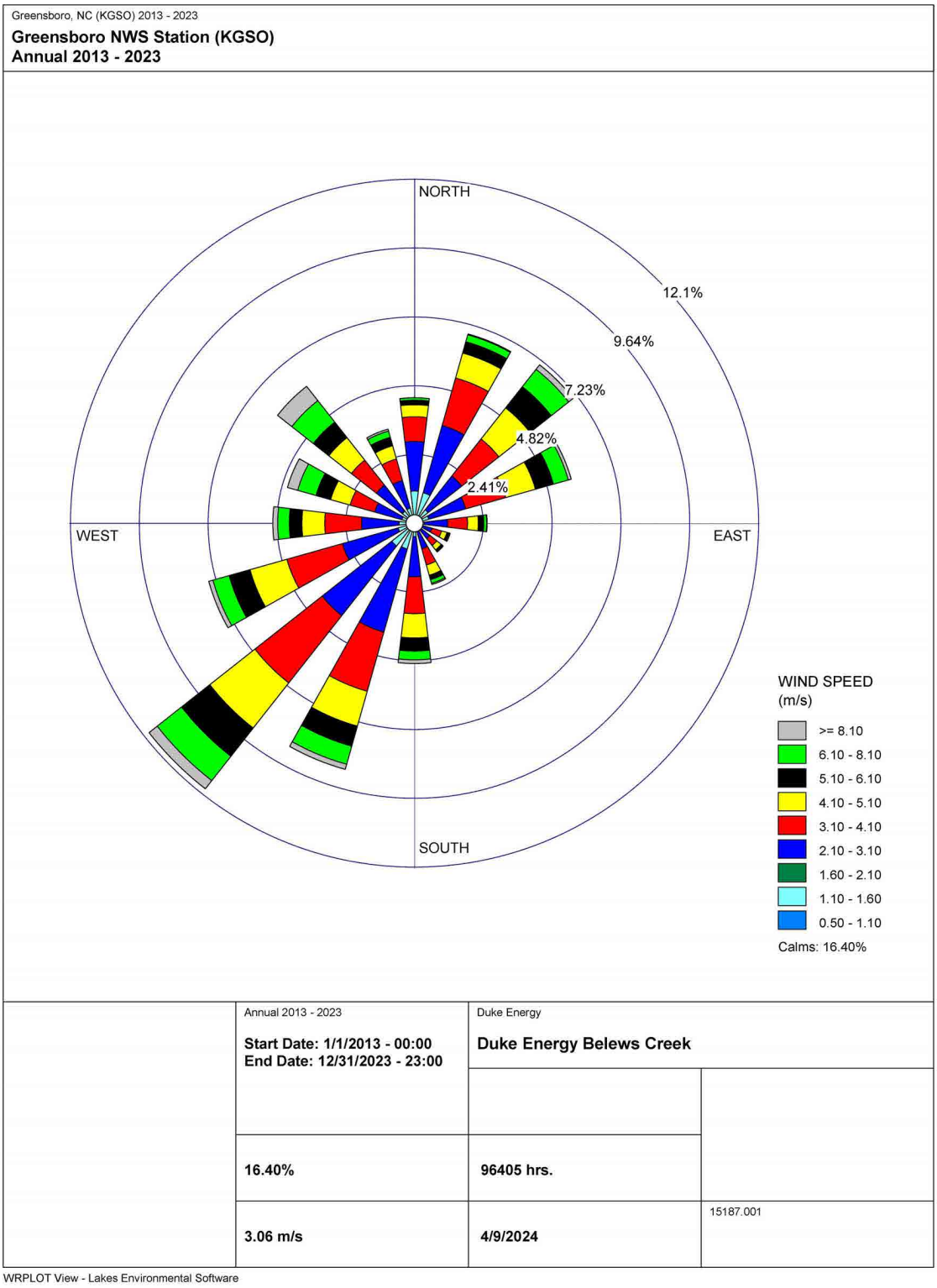
Key: APE = area of potential effects

Figure 2.7-1
Aerial Map of the Project Site and Regional Area



Note: The blue circle delineates a region with a radius of 5 mi. centered on the Project site. The red circle delineates a region with a radius of 50 mi. centered on the Project site.

Figure 2.7-2
Wind Rose KGSO (10 Years) Annual (2013-2023)



Key: hr. = hour; m/s = meters per second

Figure 2.7-3
Wind Rose KGSO (10 Years) January (2013 – 2023)

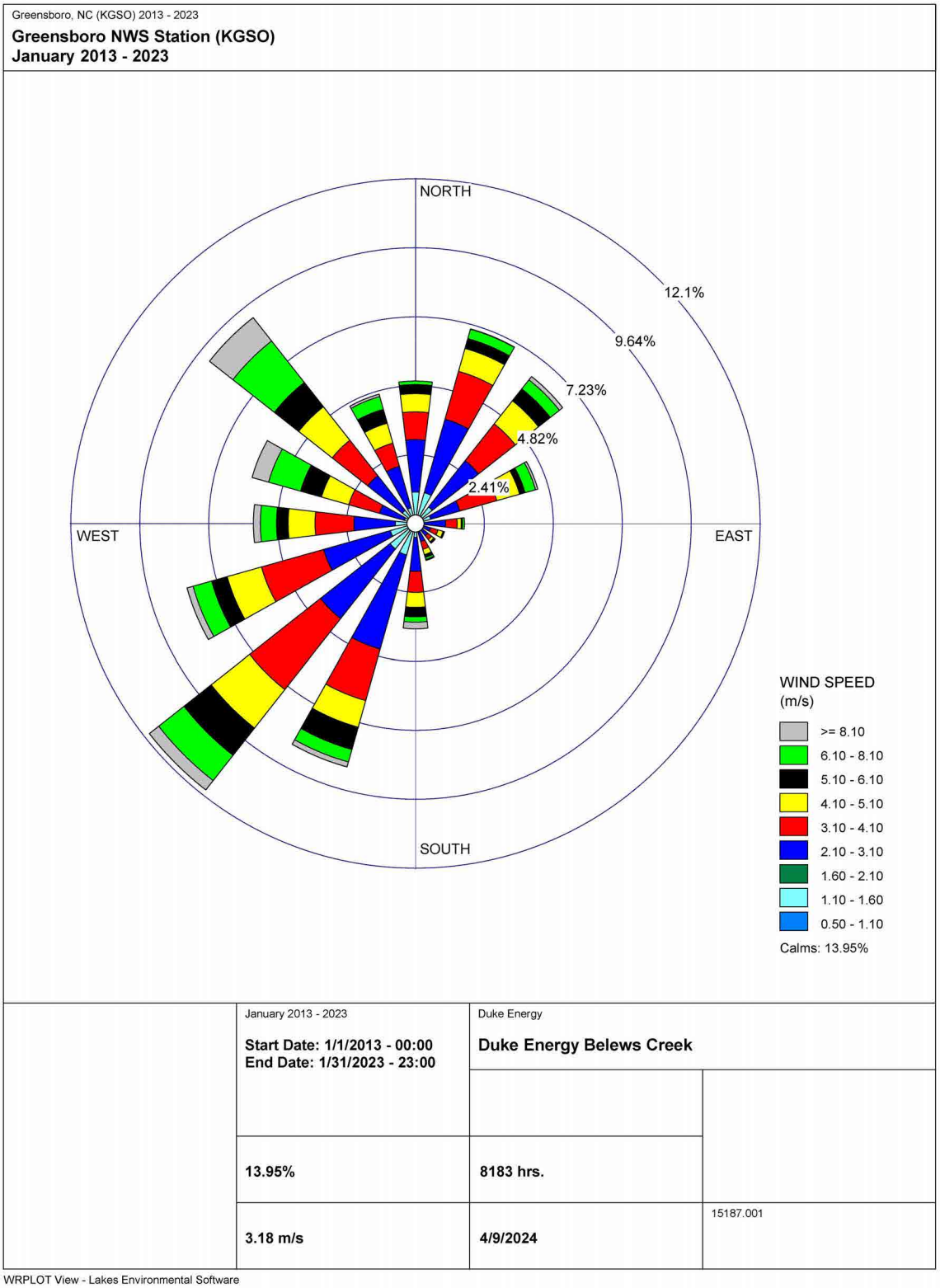


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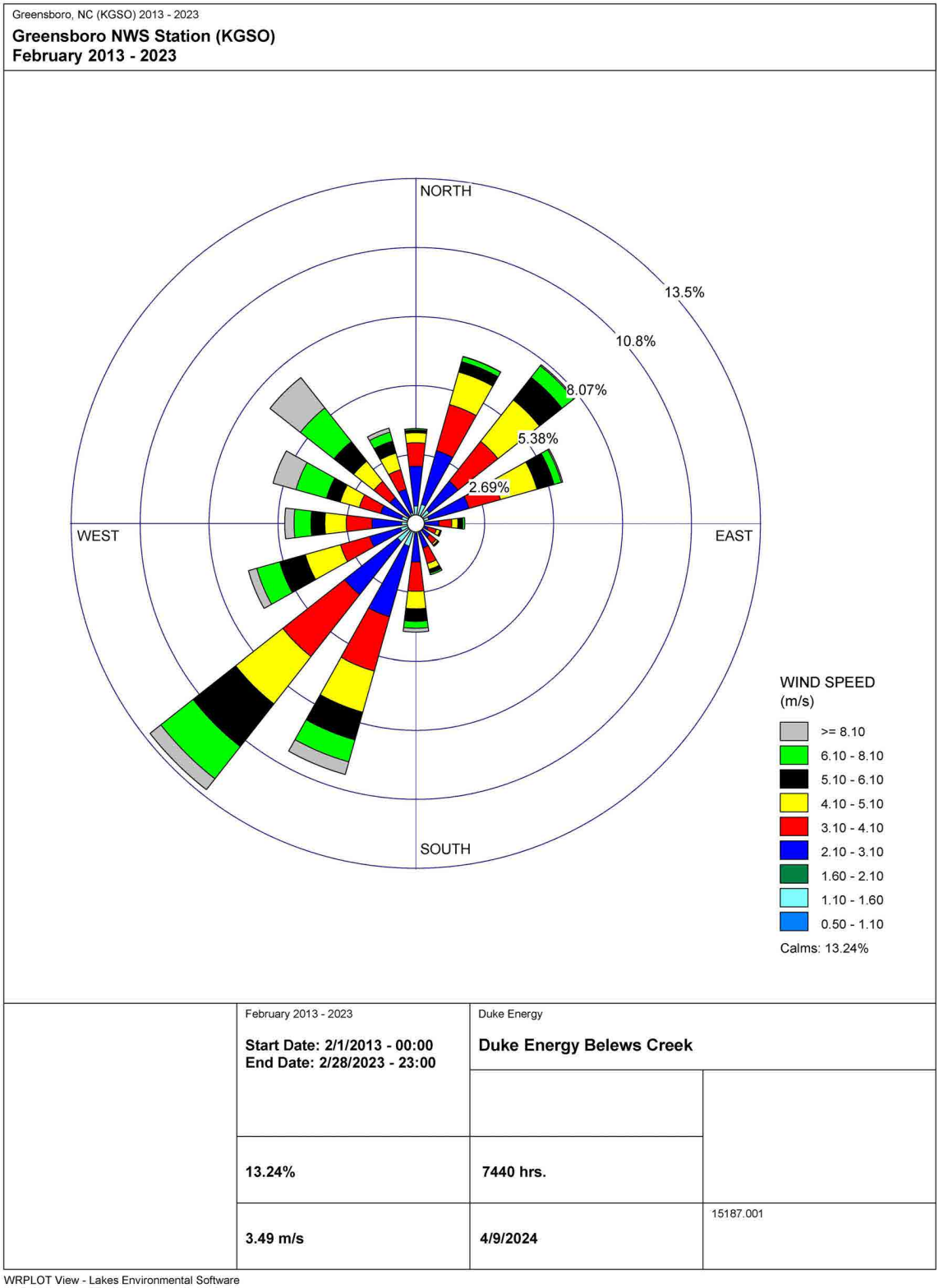
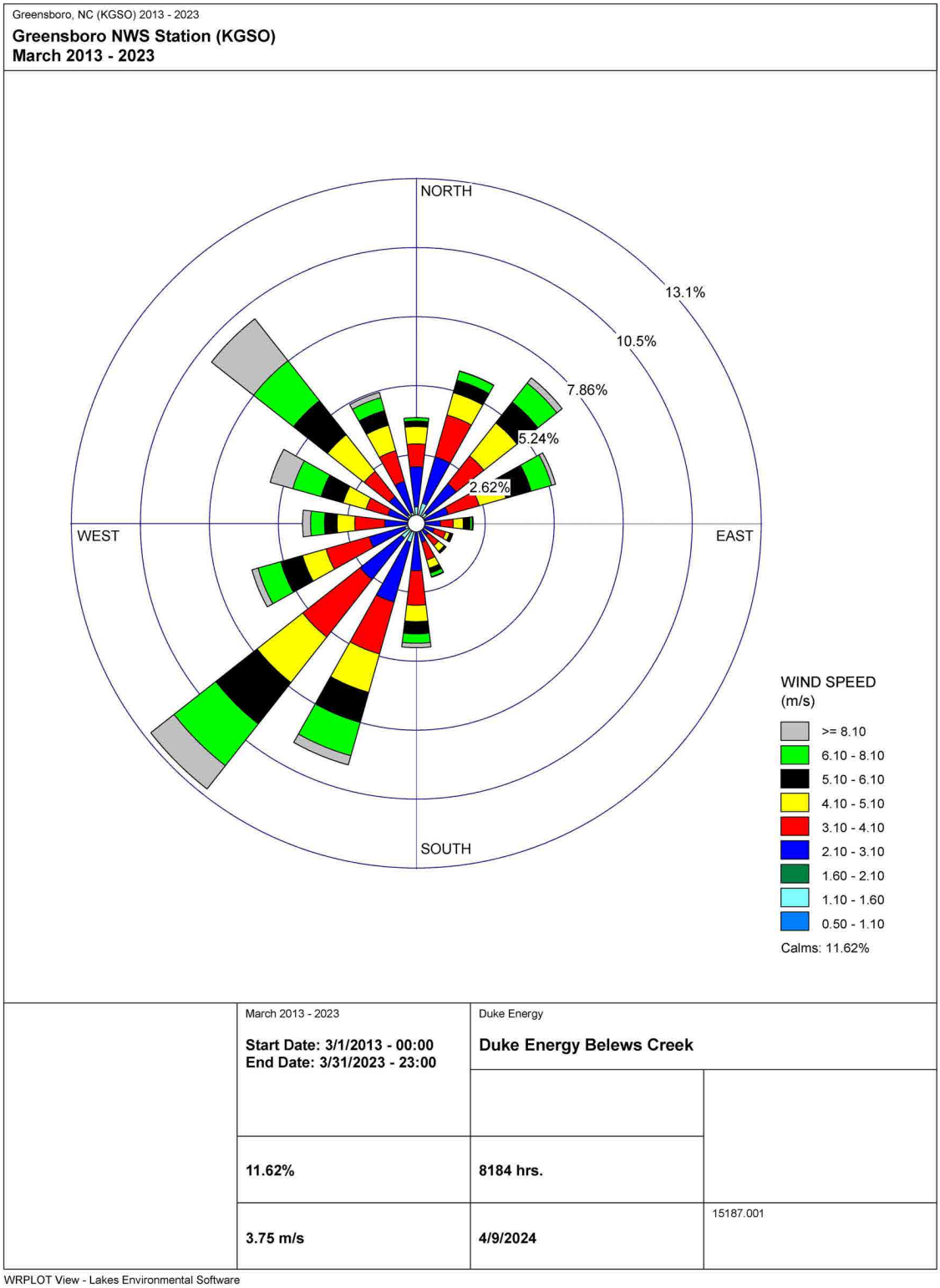
Figure 2.7-4
Wind Rose KGSO (10 Years) February (2013 – 2023)



Key: hr. = hour; m/s = meters per second

Figure 2.7-5
Wind Rose KGSO (10 Years) March (2013 – 2023)



Key: hr. = hour; m/s = meters per second

Figure 2.7-6
Wind Rose KGSO (10 Years) April (2013 – 2023)

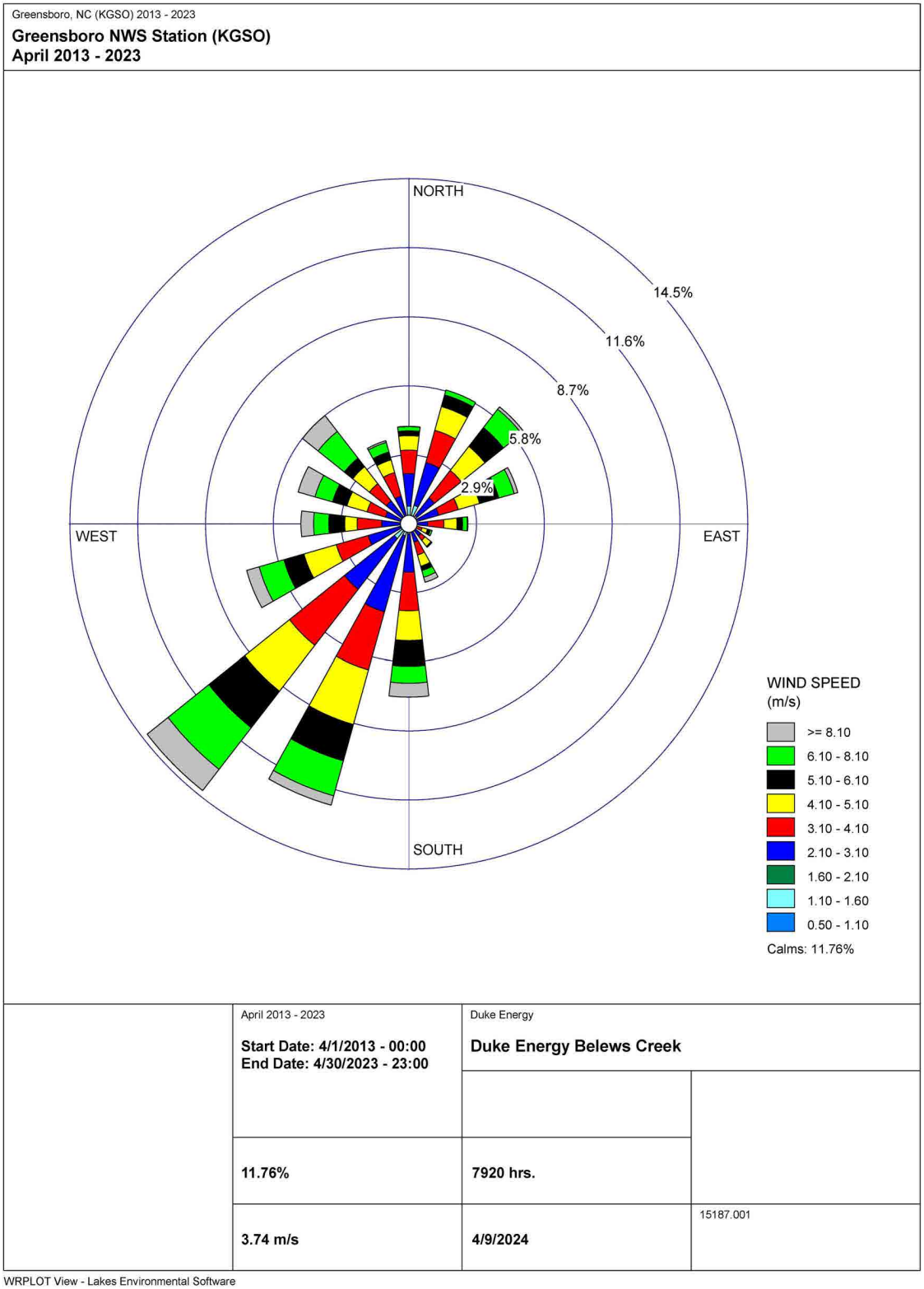


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Figure 2.7-7
Wind Rose KGSO (10 Years) May (2013 – 2023)

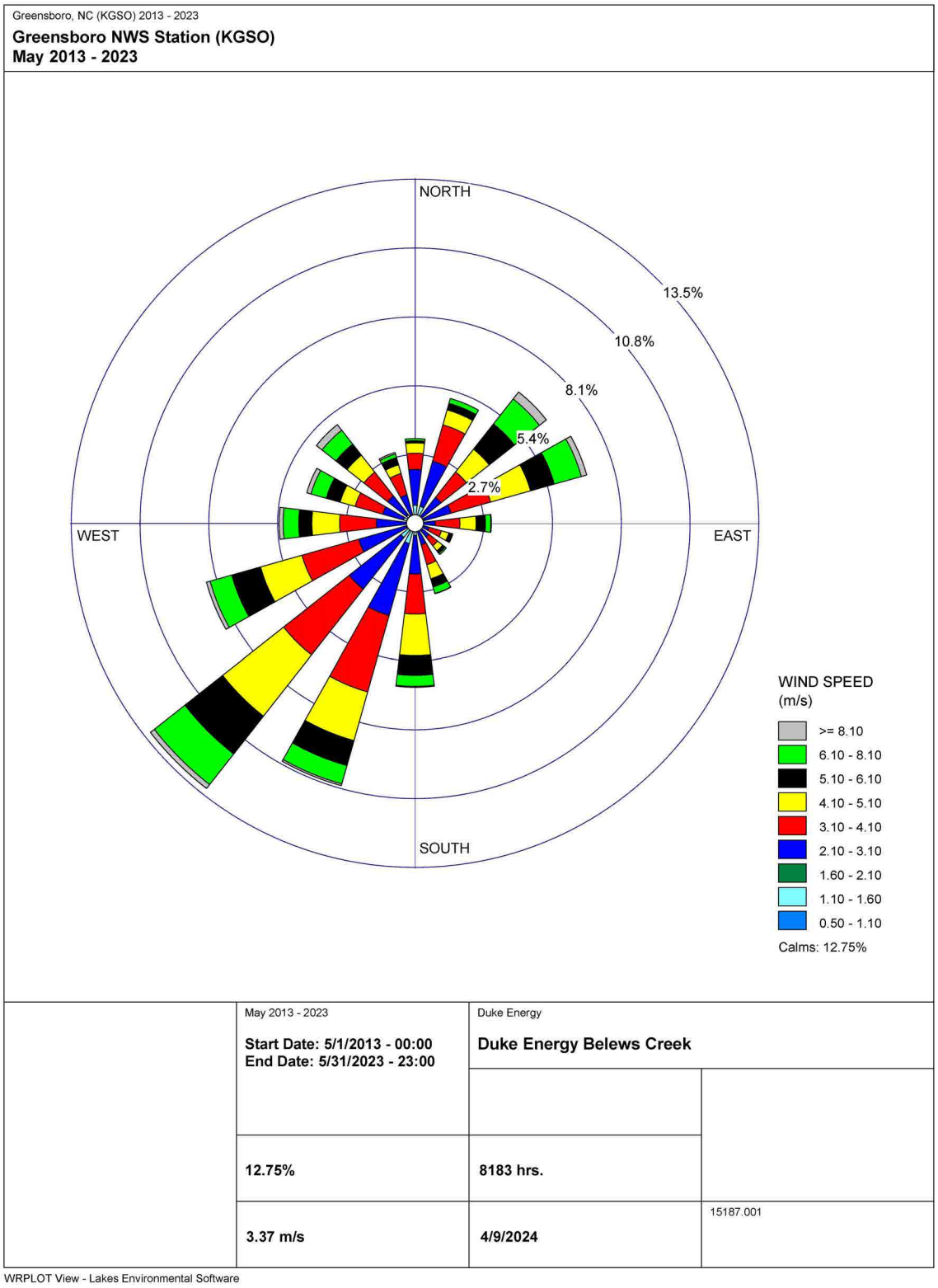

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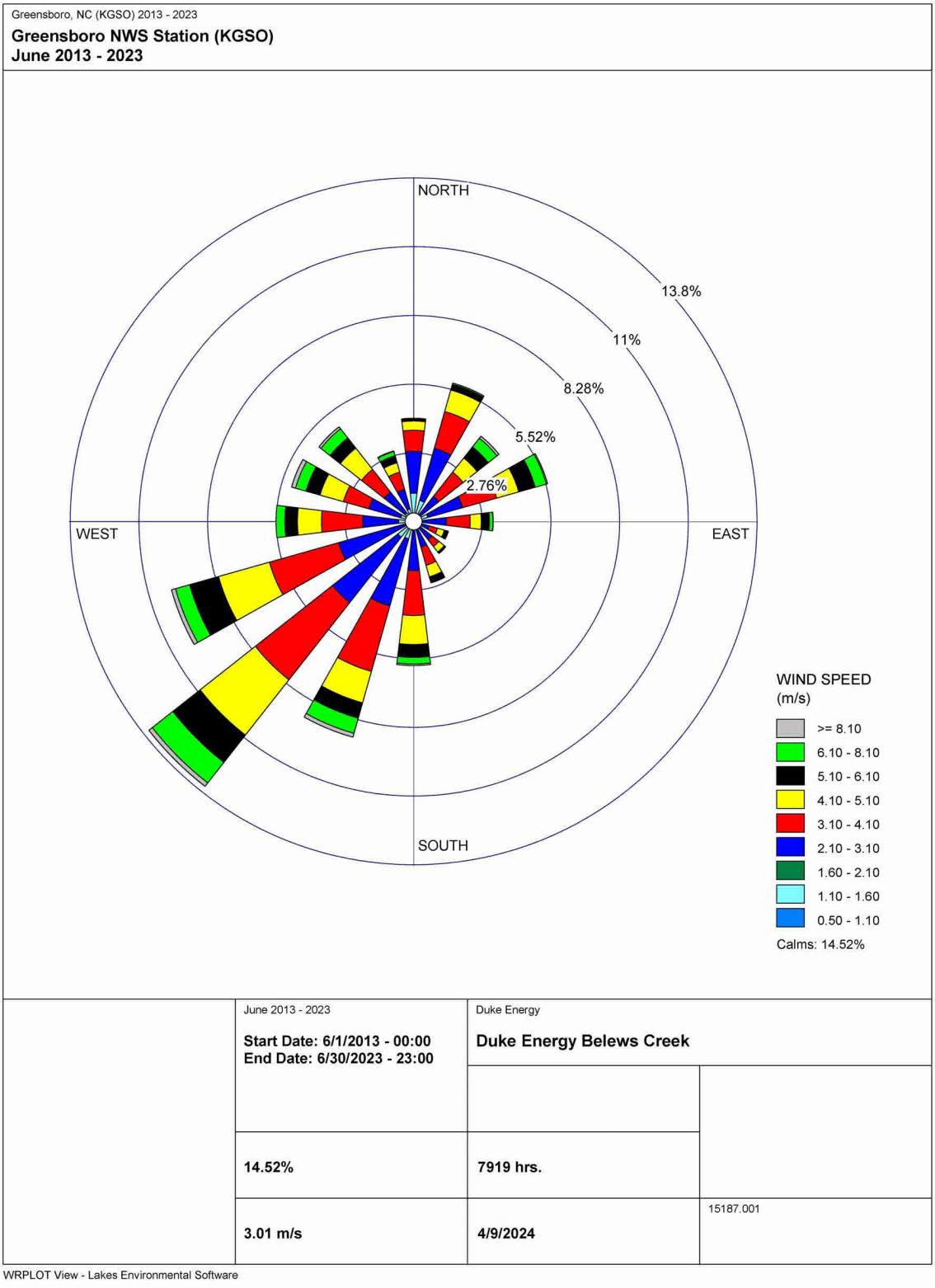
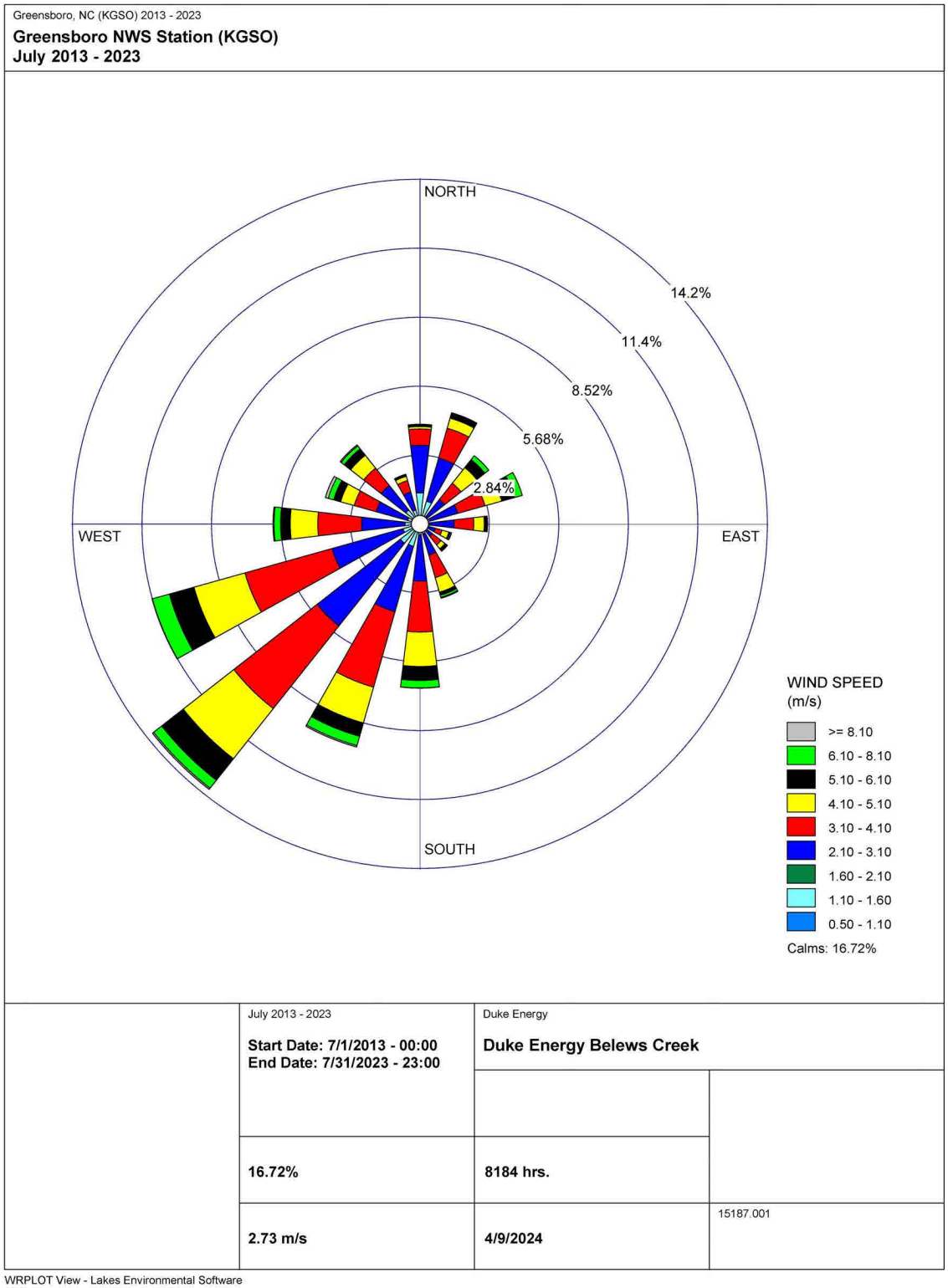
Figure 2.7-8
Wind Rose KGSO (10 Years) June (2013 – 2023)



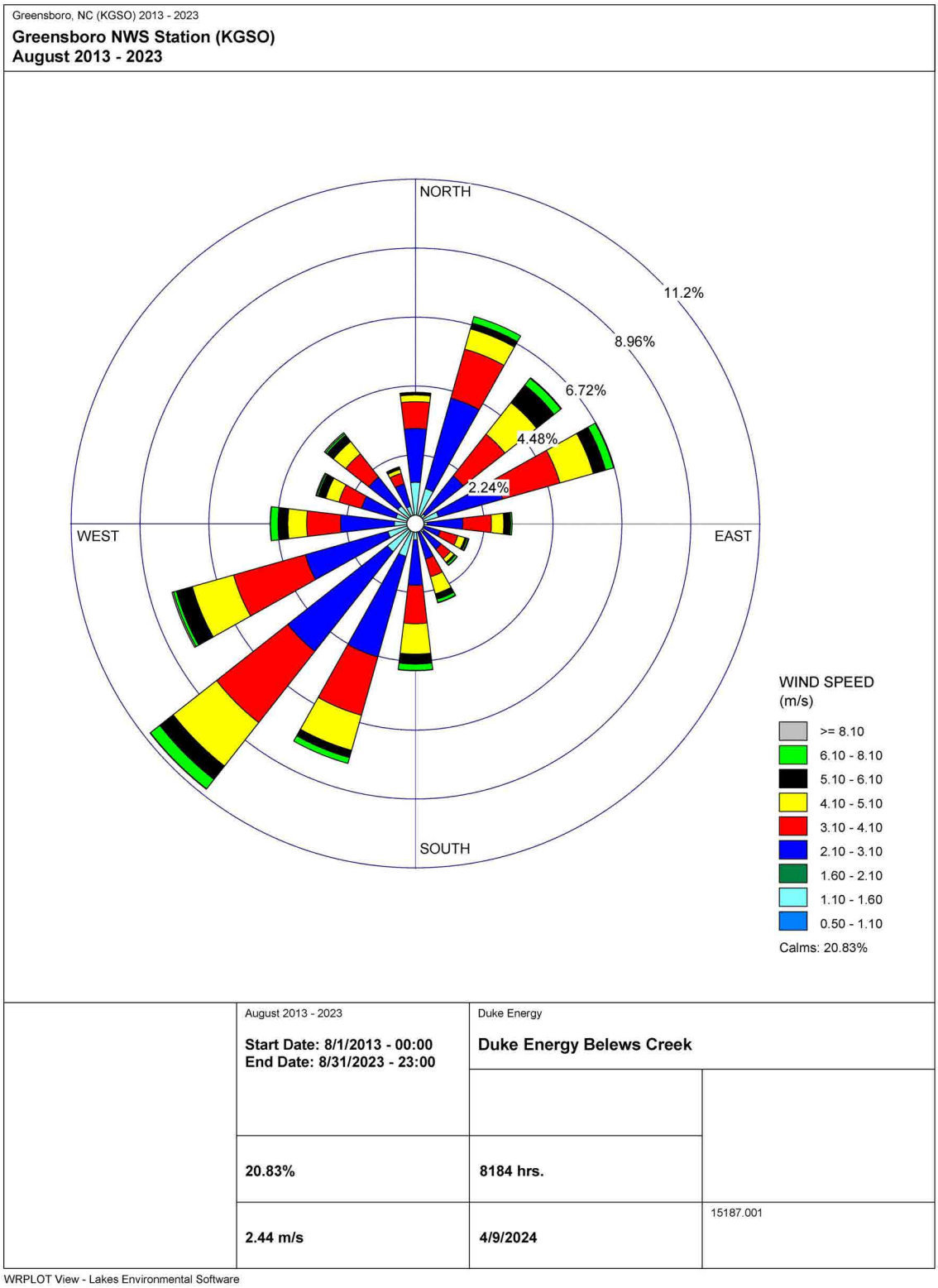
Key: hr. = hour; m/s = meters per second

Figure 2.7-9
Wind Rose KGSO (10 Years) July (2013 – 2023)



Key: hr. = hour; m/s = meters per second

Figure 2.7-10
Wind Rose KGSO (10 Years) August (2013 – 2023)



Key: hr. = hour; m/s = meters per second

Figure 2.7-11
Wind Rose KGSO (10 Years) September (2013 – 2023)

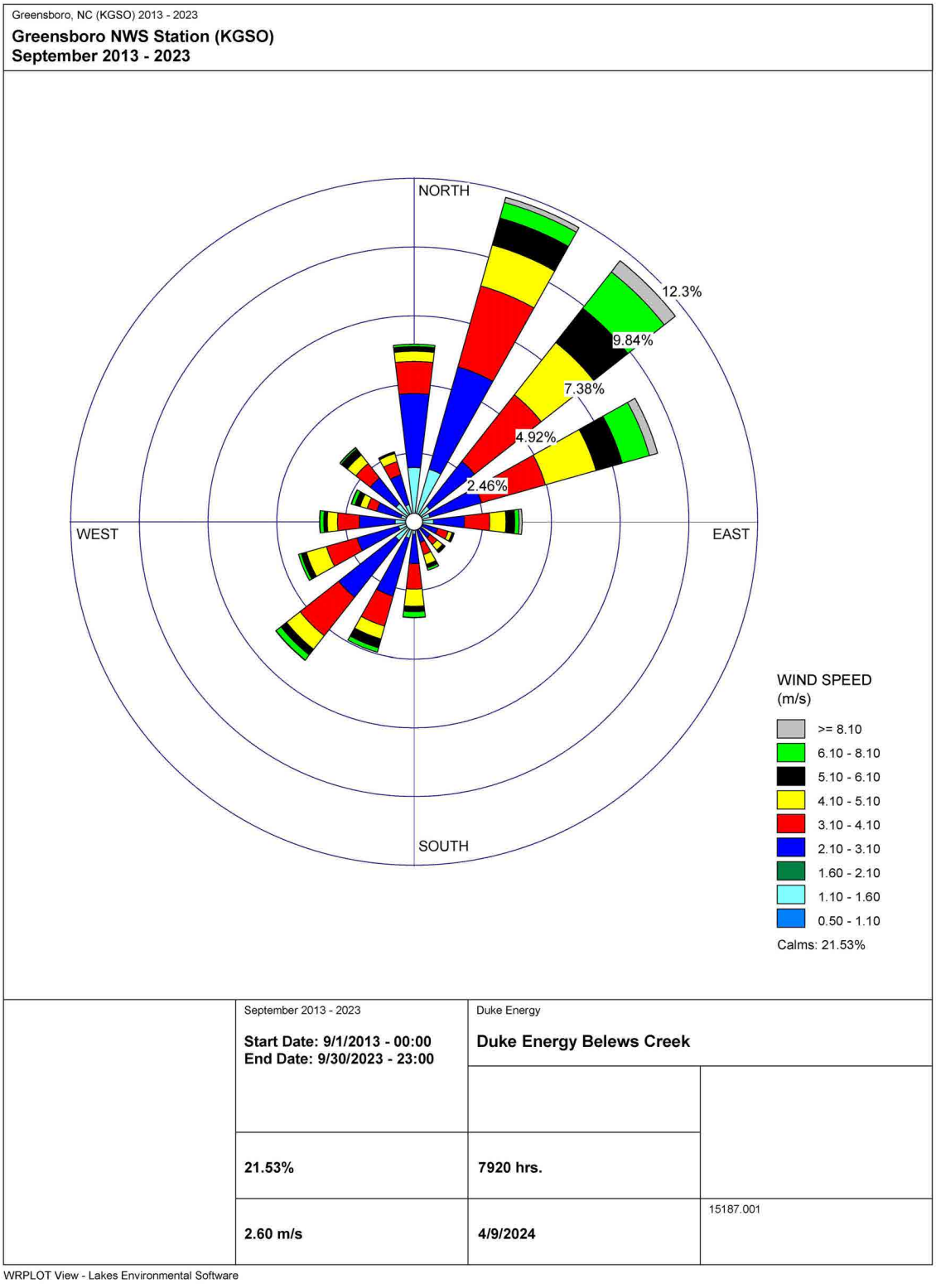


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Figure 2.7-12
Wind Rose KGSO (10 Years) October (2013 – 2023)

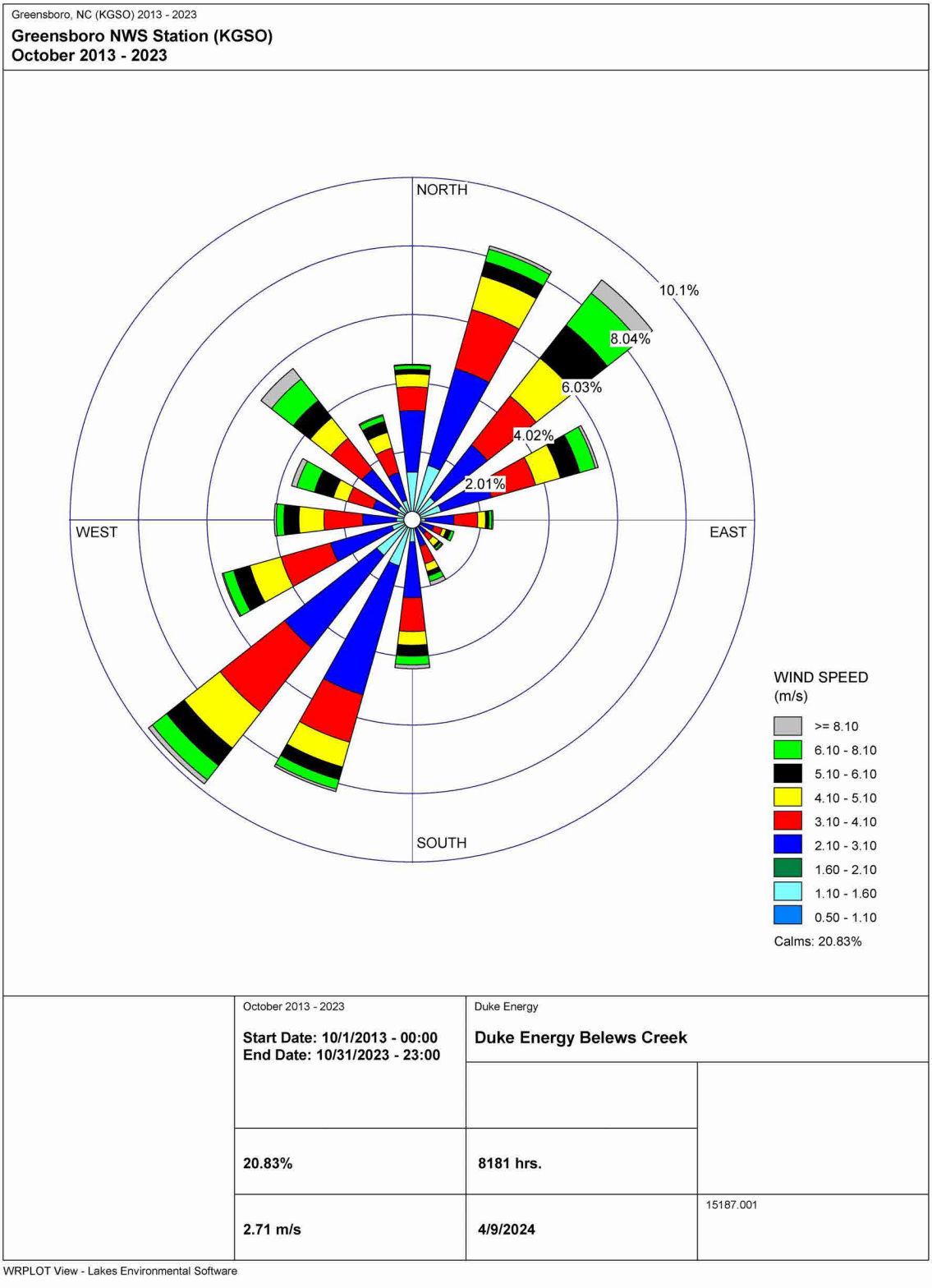

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Figure 2.7-13
Wind Rose KGSO (10 Years) November (2013 – 2023)

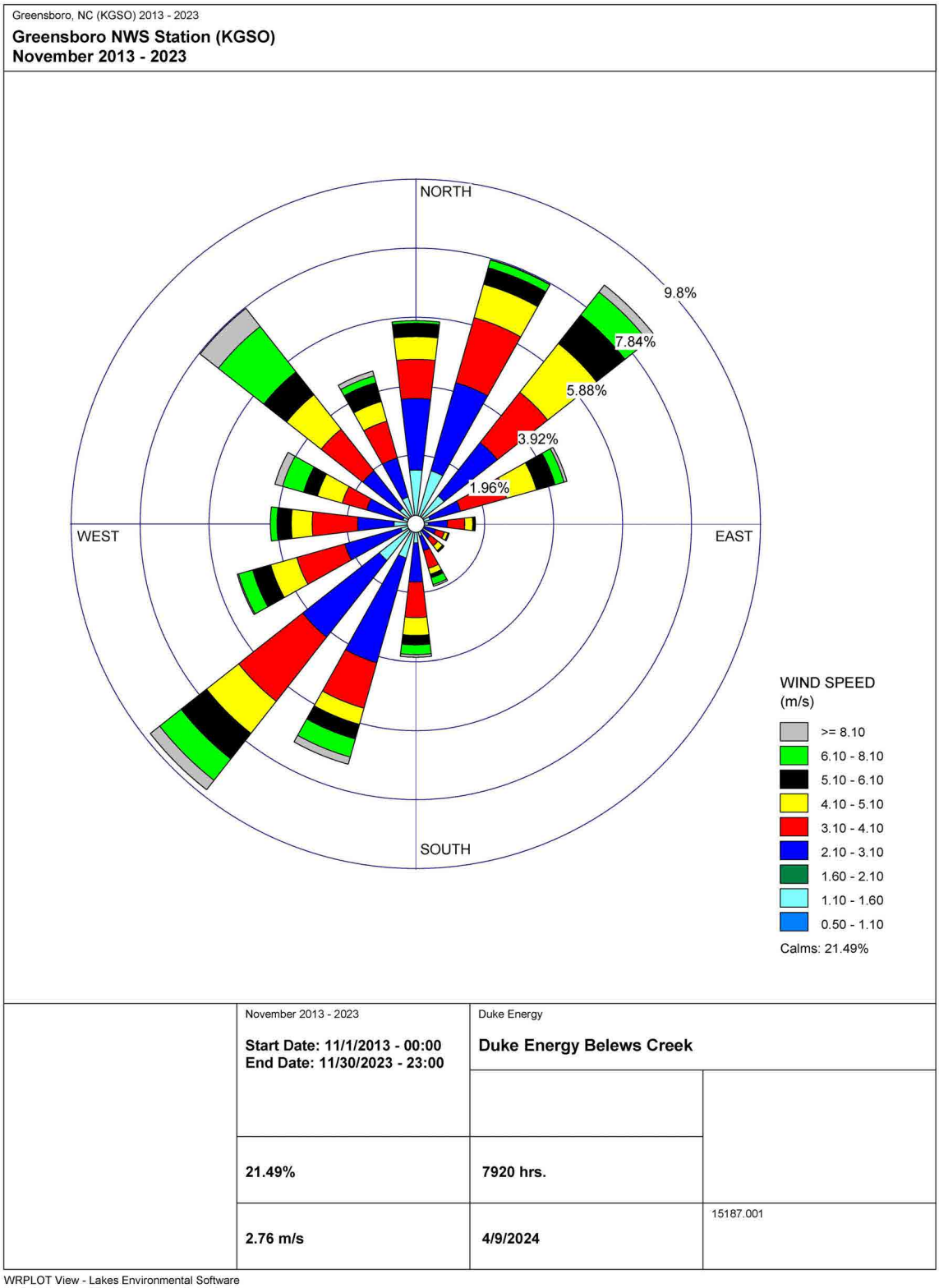

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Figure 2.7-14
Wind Rose KGSO (10 Years) December (2013 – 2023)

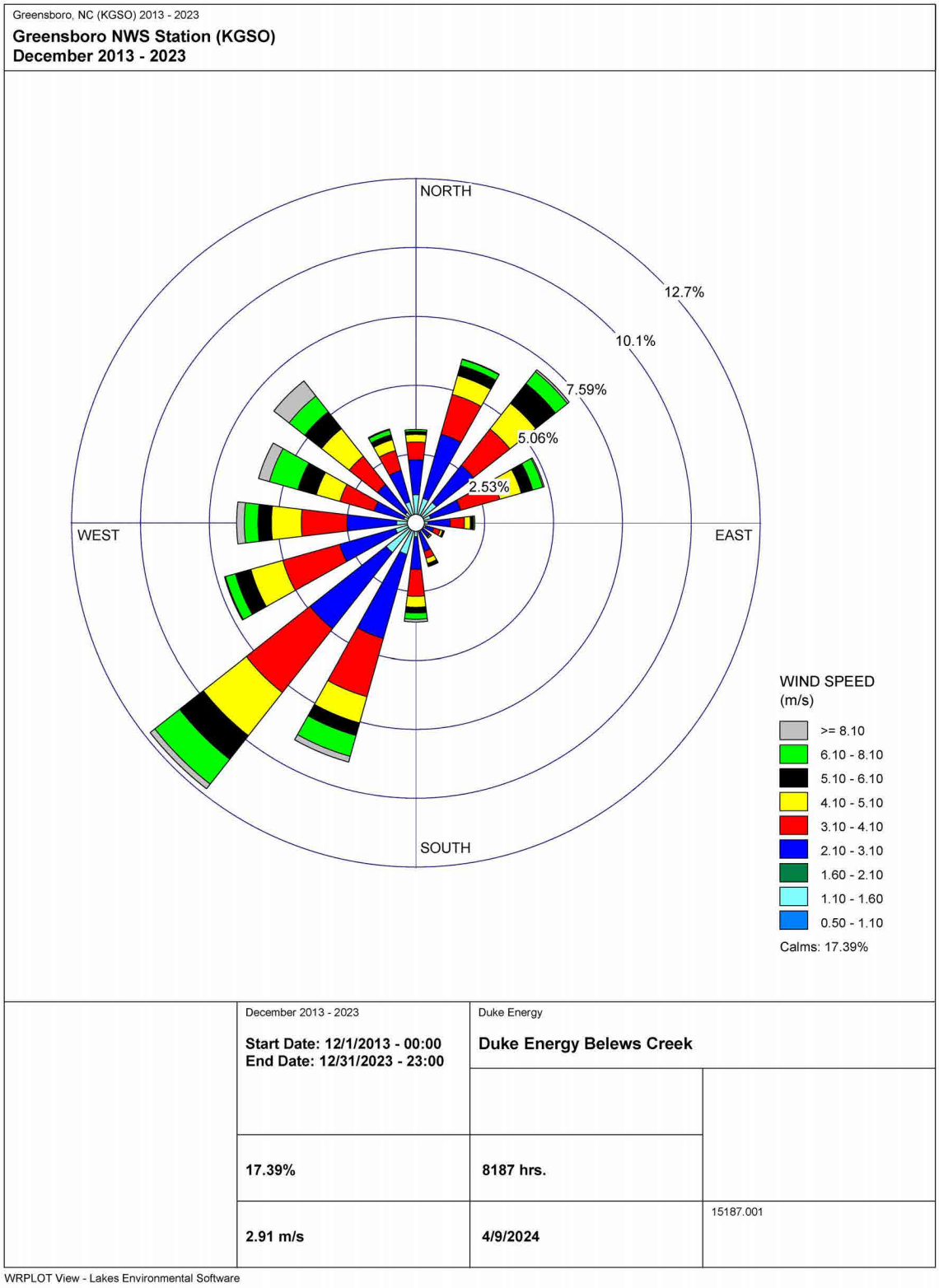

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Figure 2.7-15
Wind Roses for the Project Site (10 meters) Annual All Data

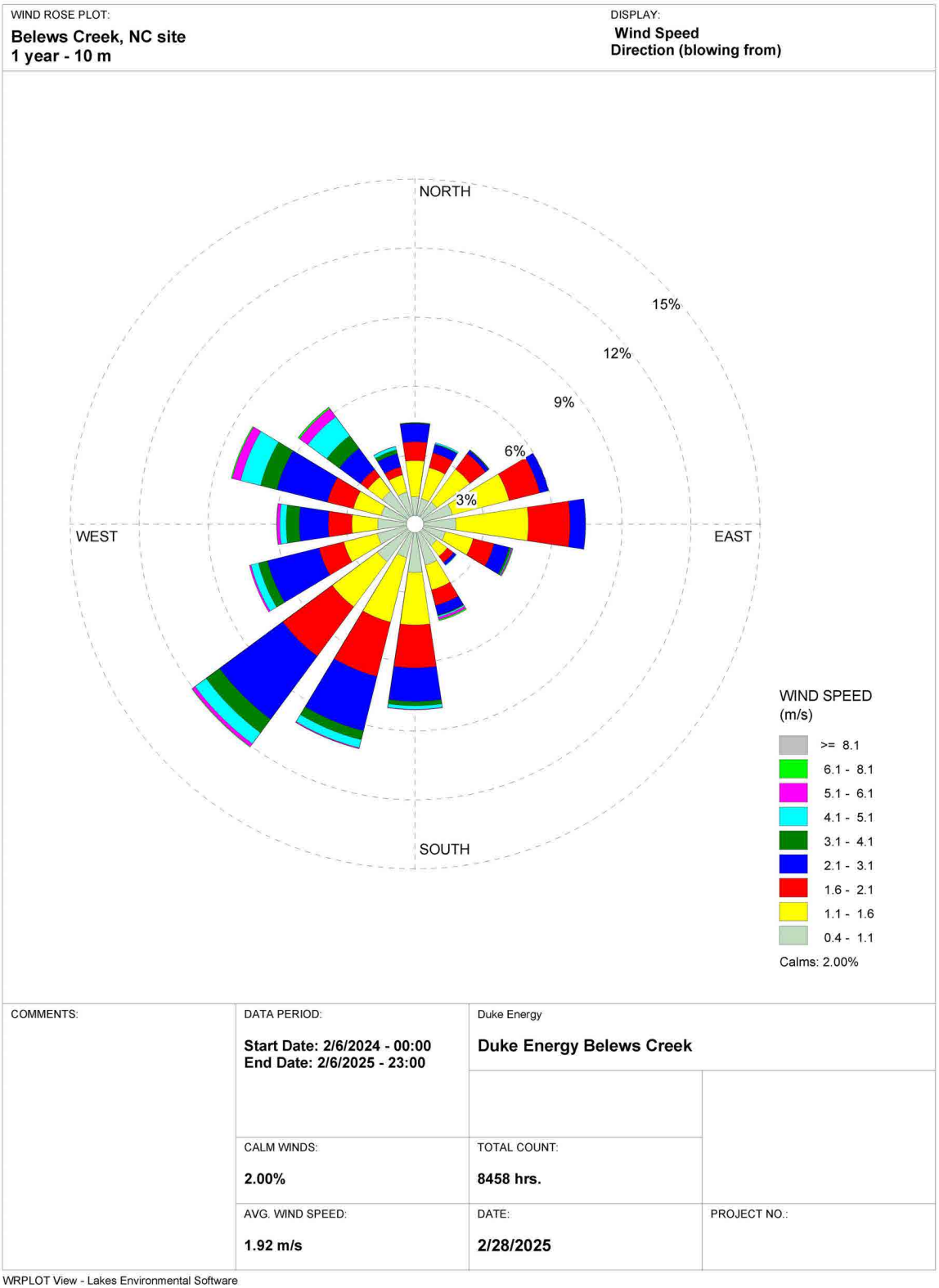

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Figure 2.7-16
Wind Roses for the Project Site (10 meters) February 2024/2025

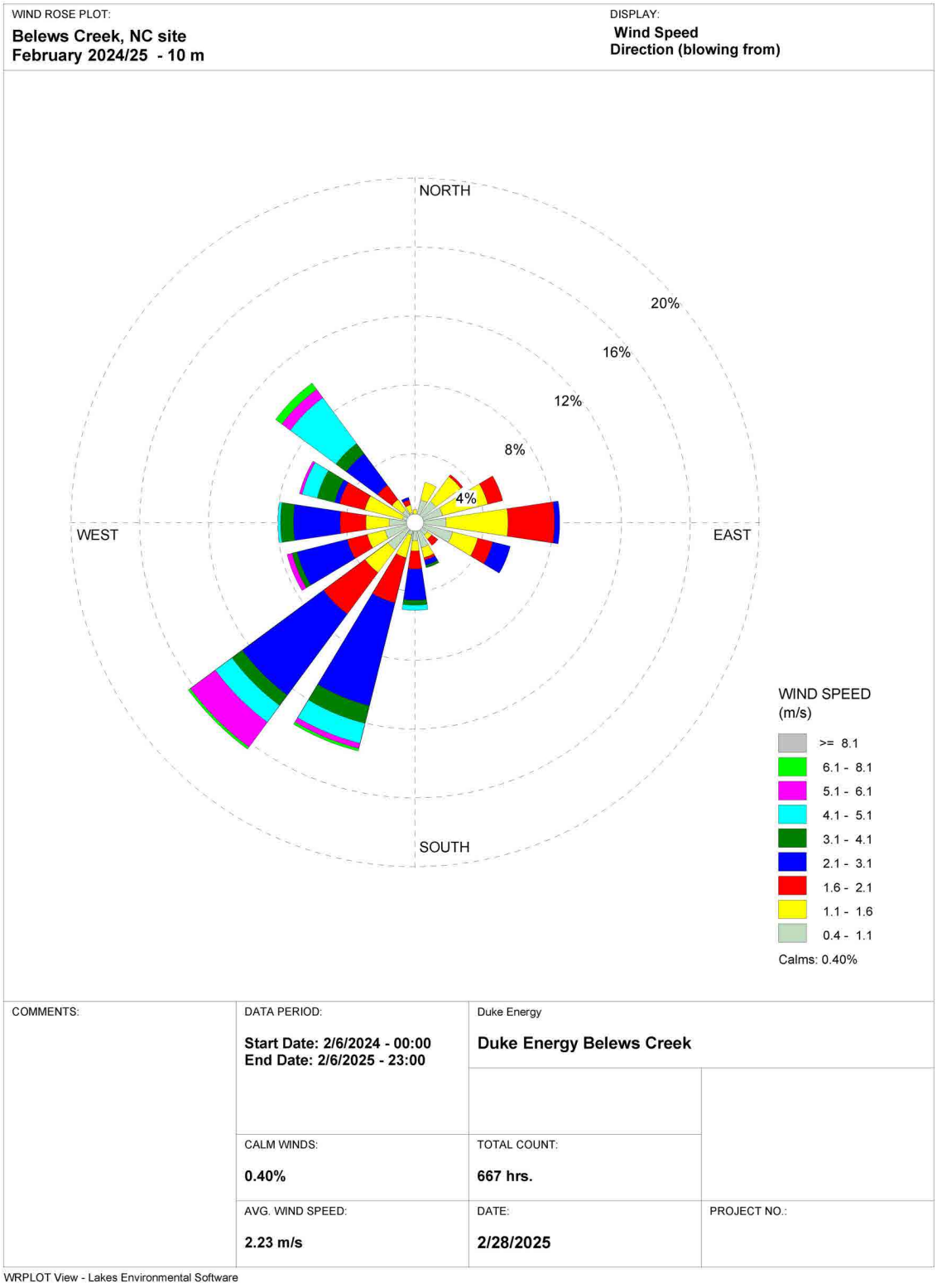

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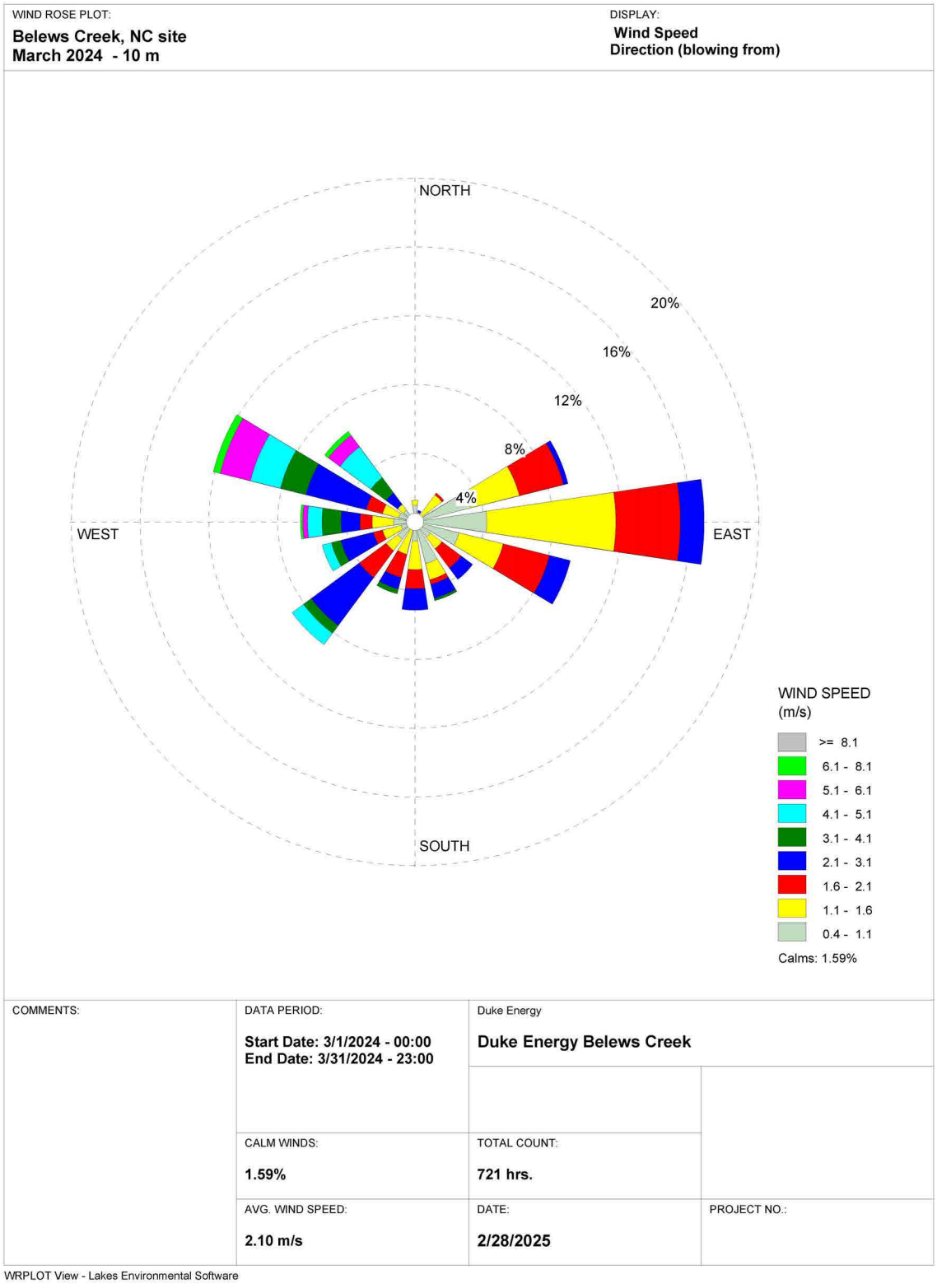
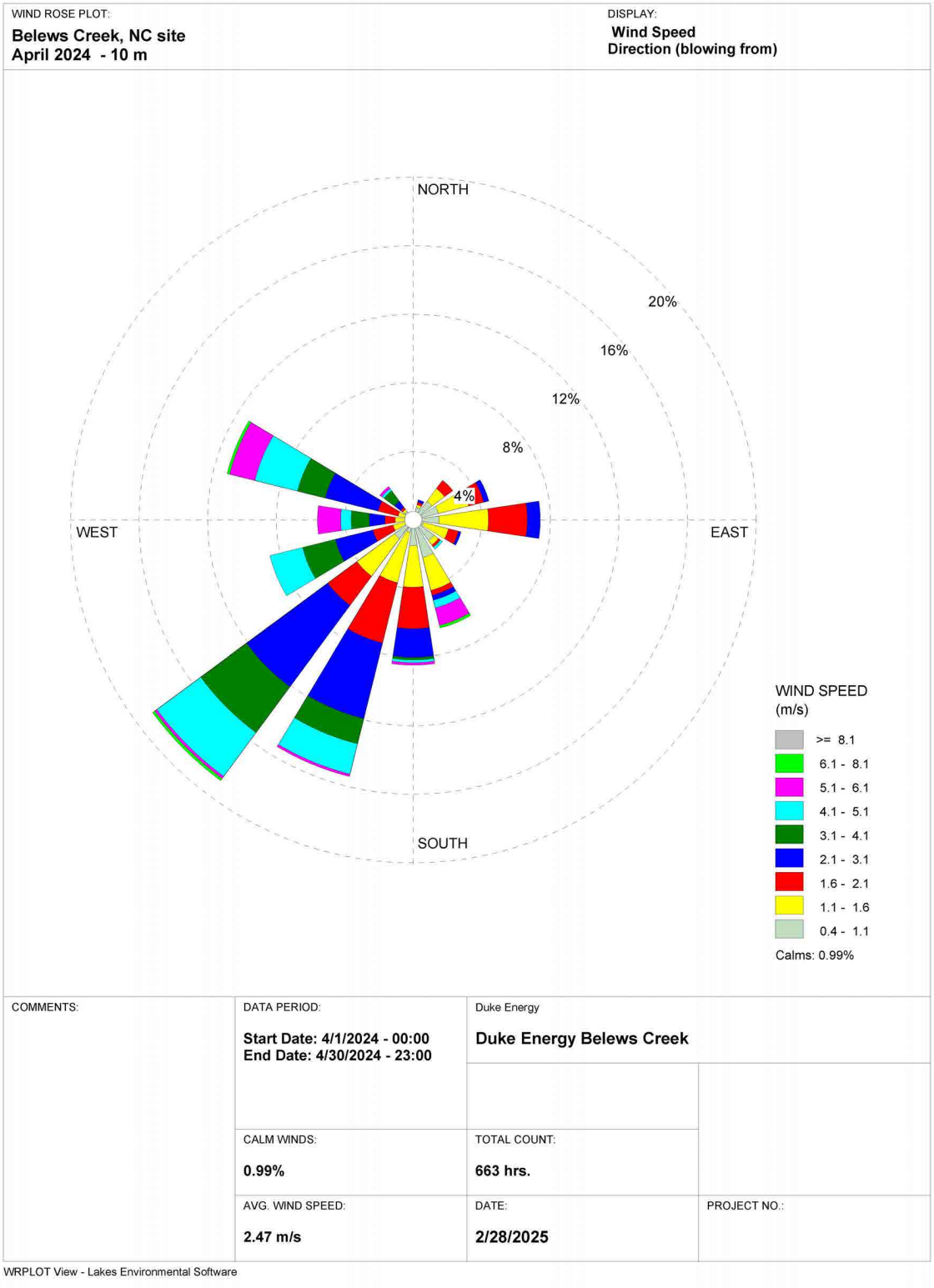
Figure 2.7-17
Wind Roses for the Project Site (10 meters) March 2024



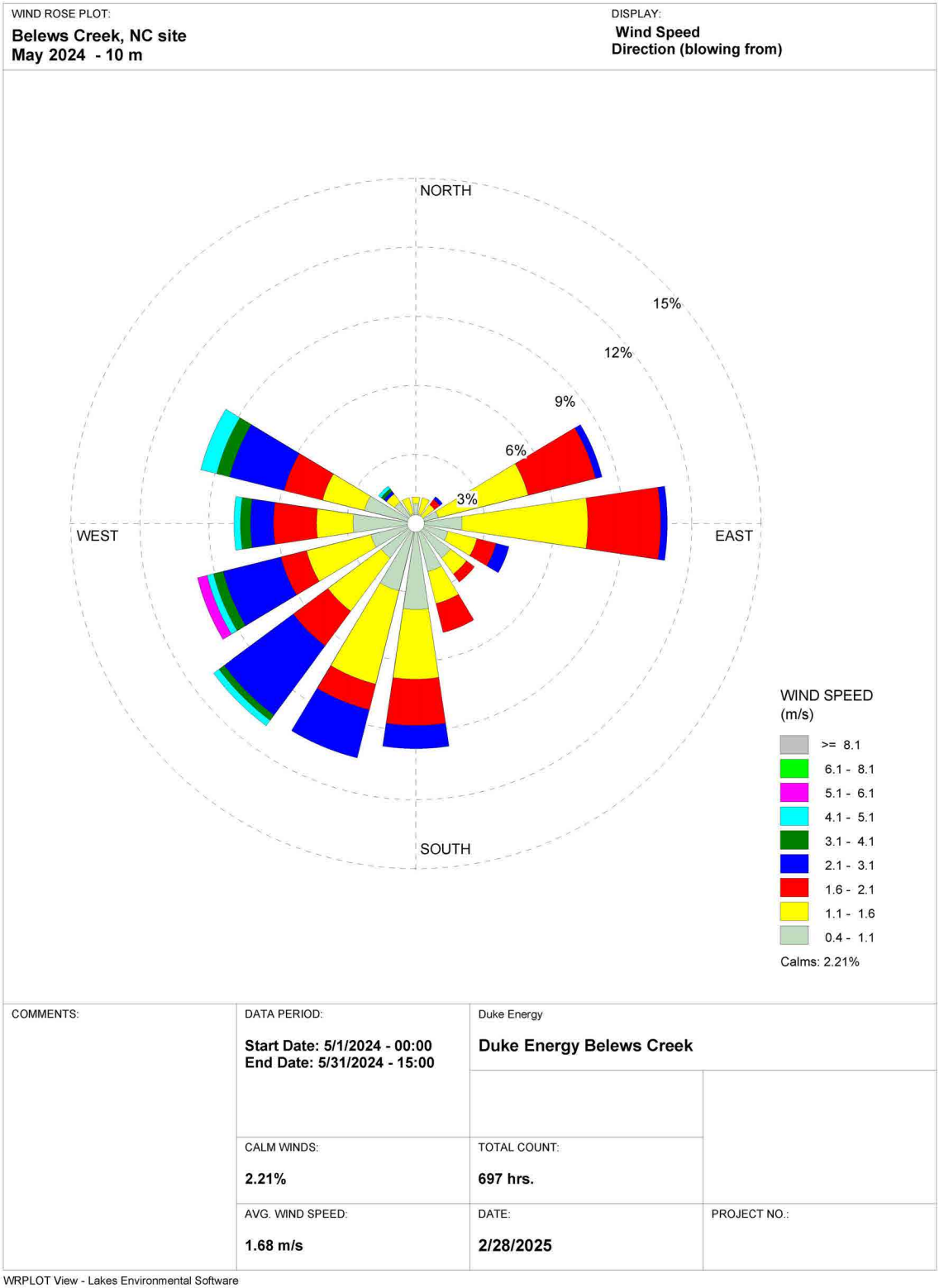
Key: hr. = hour; m/s = meters per second

Figure 2.7-18
Wind Roses for the Project Site (10 meters) April 2024



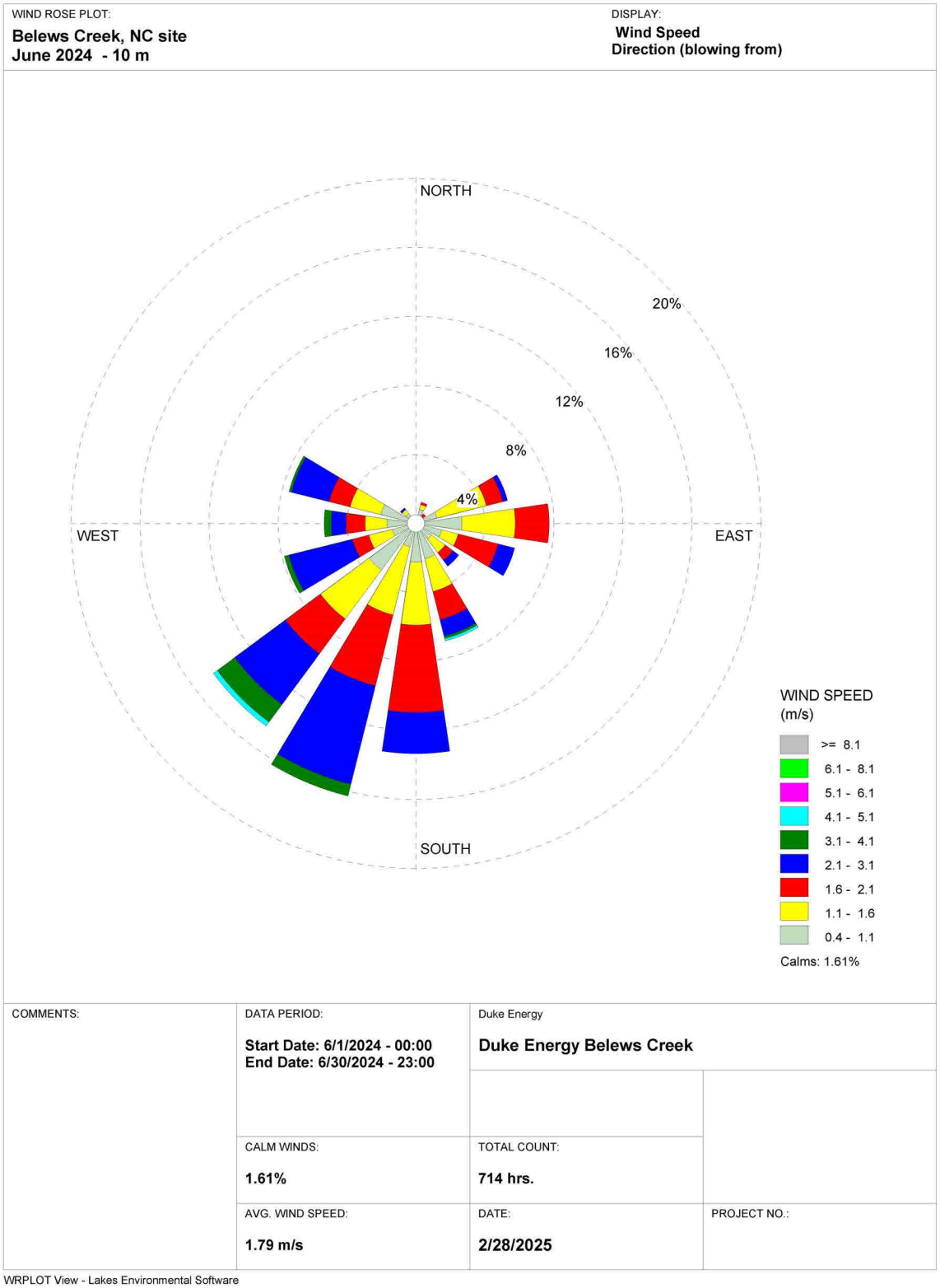
Key: hr. = hour; m/s = meters per second

Figure 2.7-19
Wind Roses for the Project Site (10 meters) May 2024



Key: hr. = hour; m/s = meters per second

Figure 2.7-20
Wind Roses for the Project Site (10 meters) June 2024



Key: hr. = hour; m/s = meters per second

Figure 2.7-21
Wind Roses for the Project Site (10 meters) July 2024

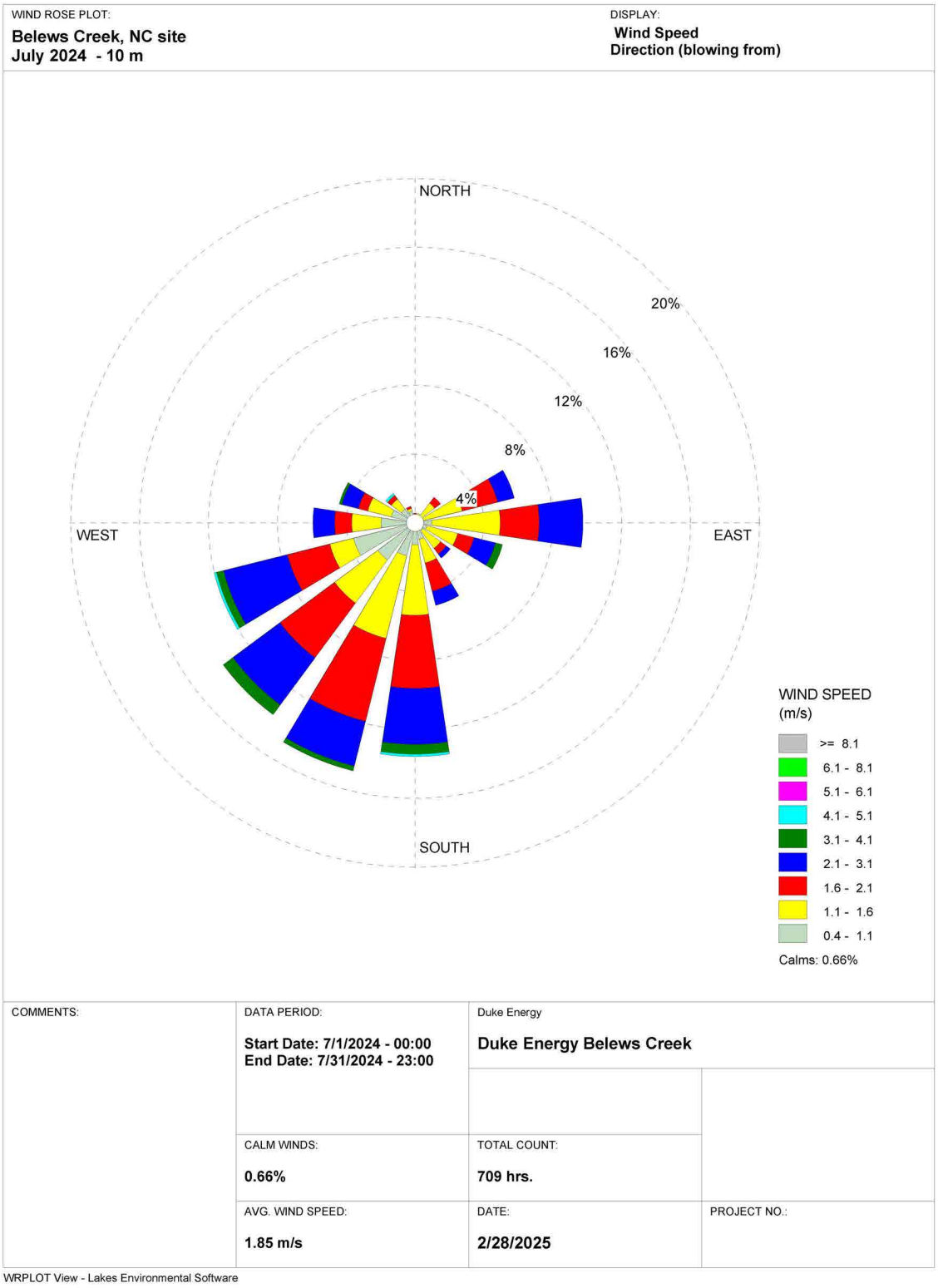


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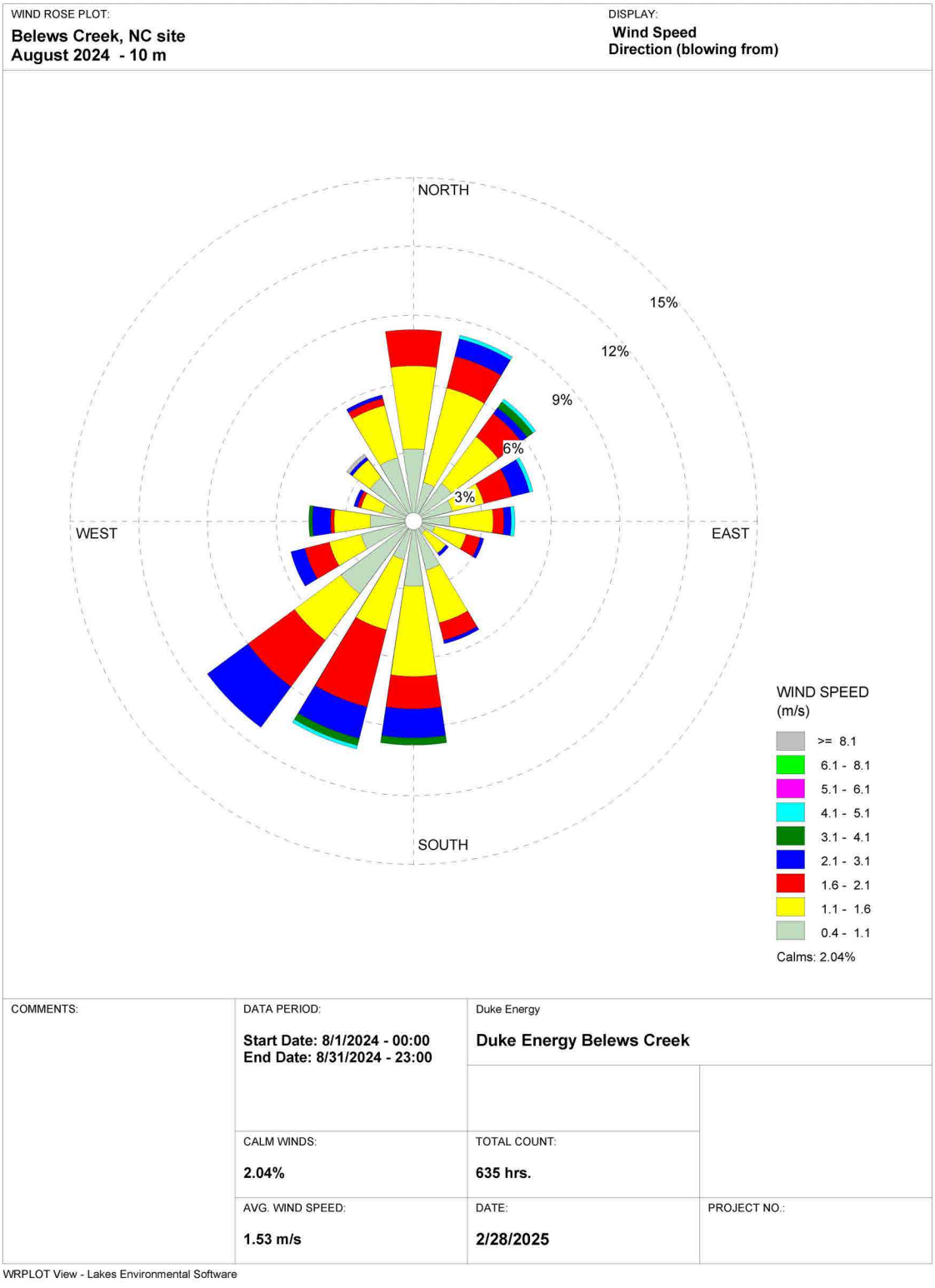
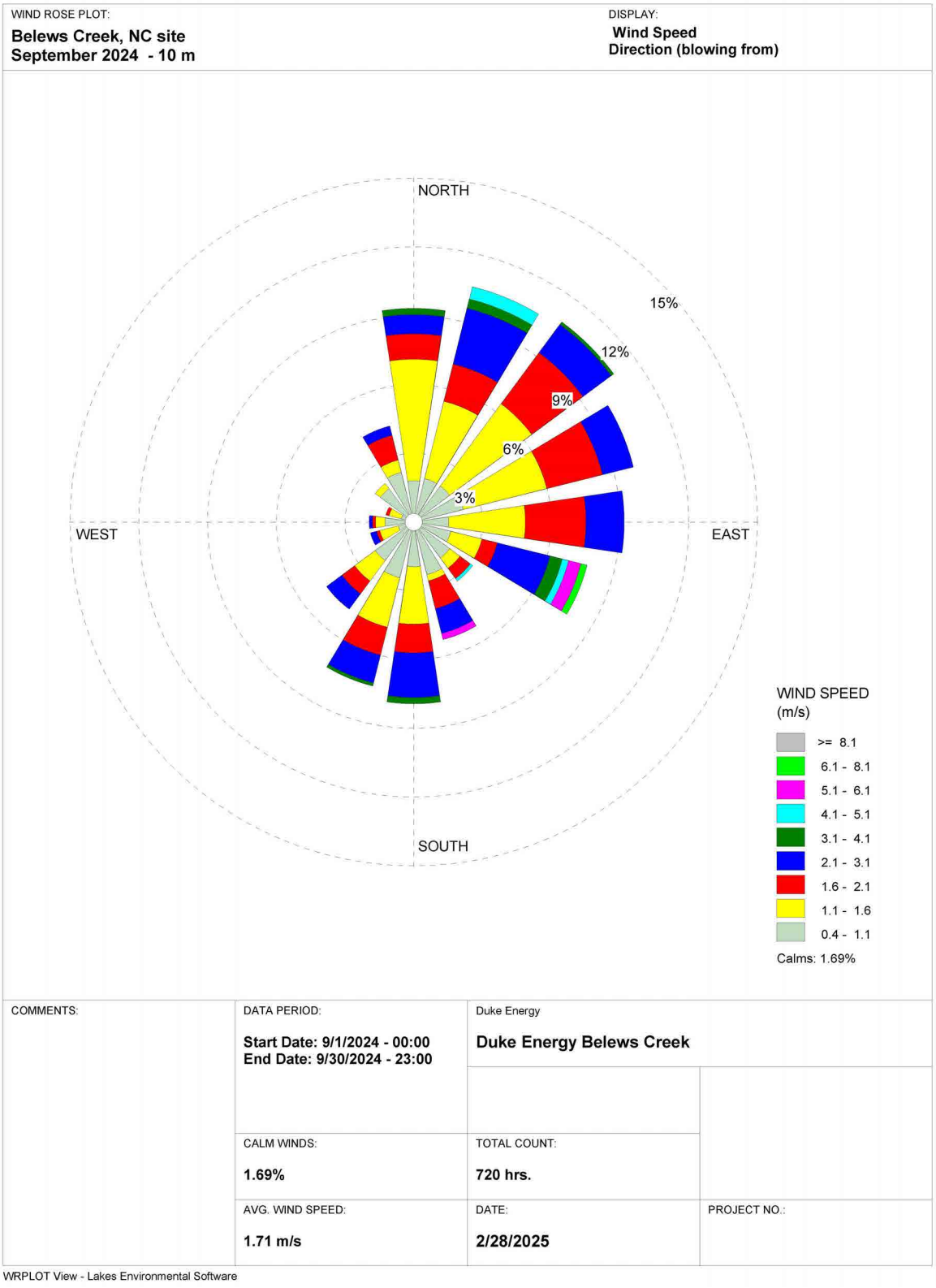
Figure 2.7-22
Wind Roses for the Project Site (10 meters) August 2024



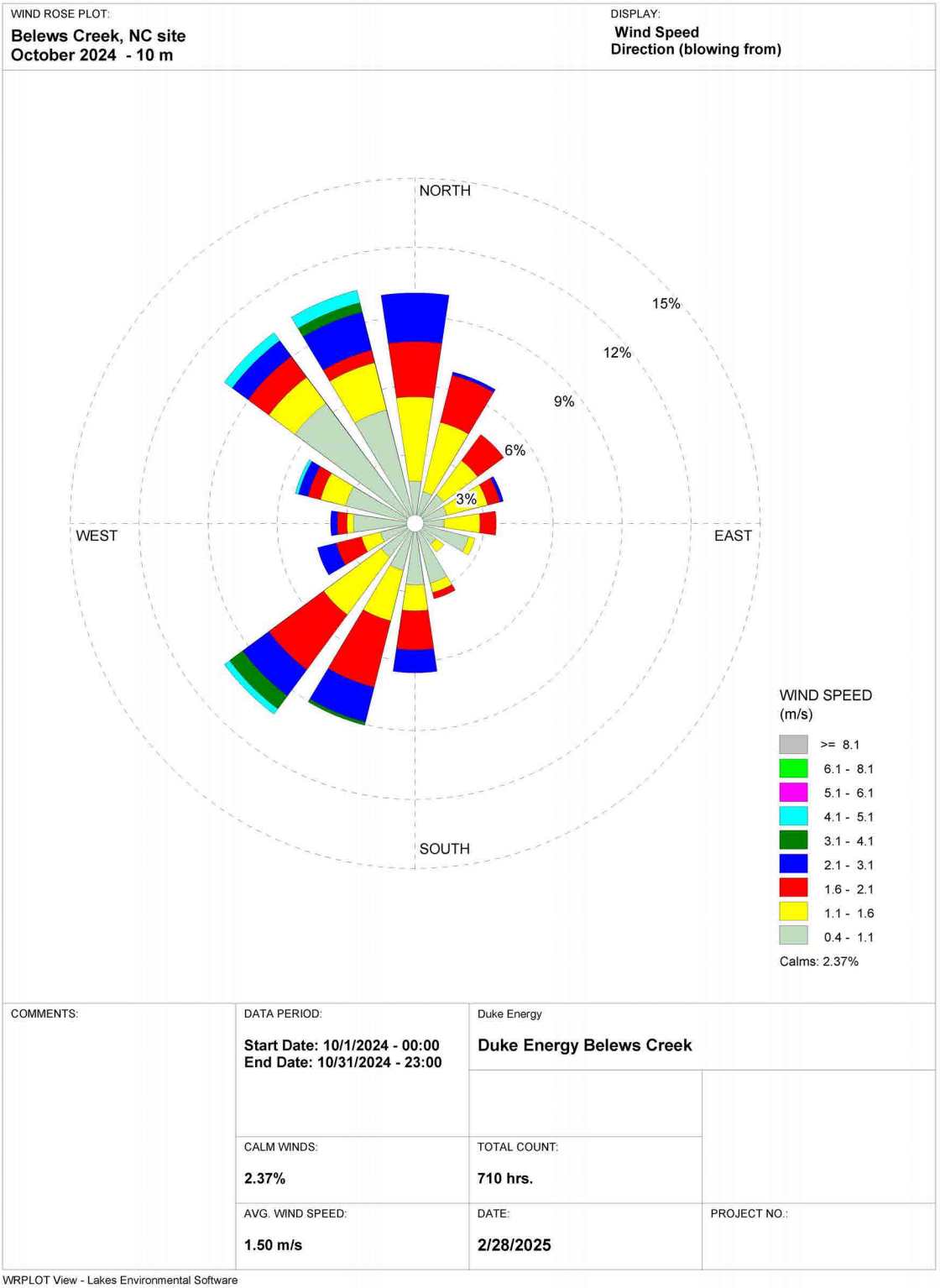
Key: hr. = hour; m/s = meters per second

Figure 2.7-23
Wind Roses for the Project Site (10 meters) September 2024



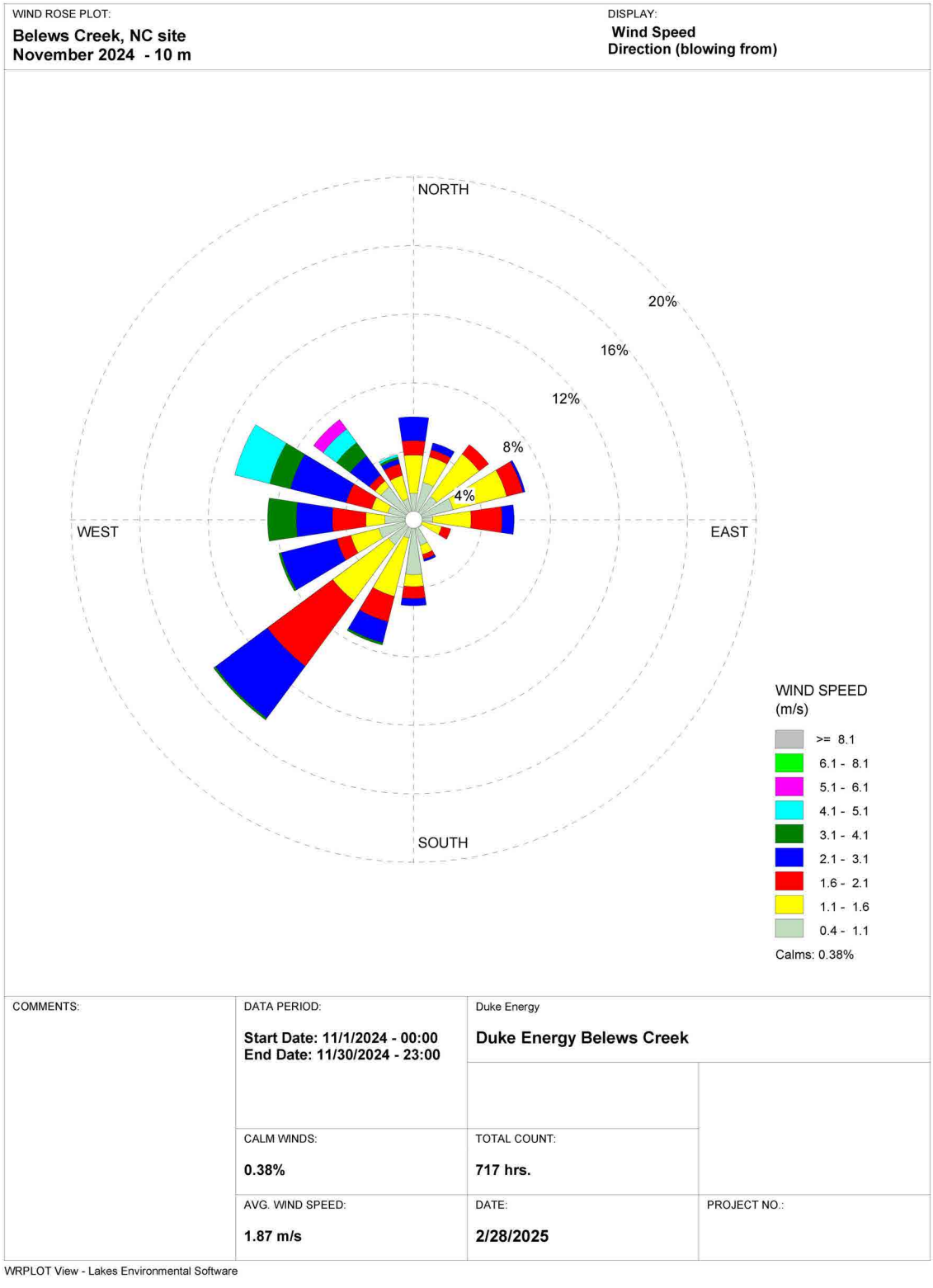
Key: hr. = hour; m/s = meters per second

Figure 2.7-24
Wind Roses for the Project Site (10 meters) October 2024



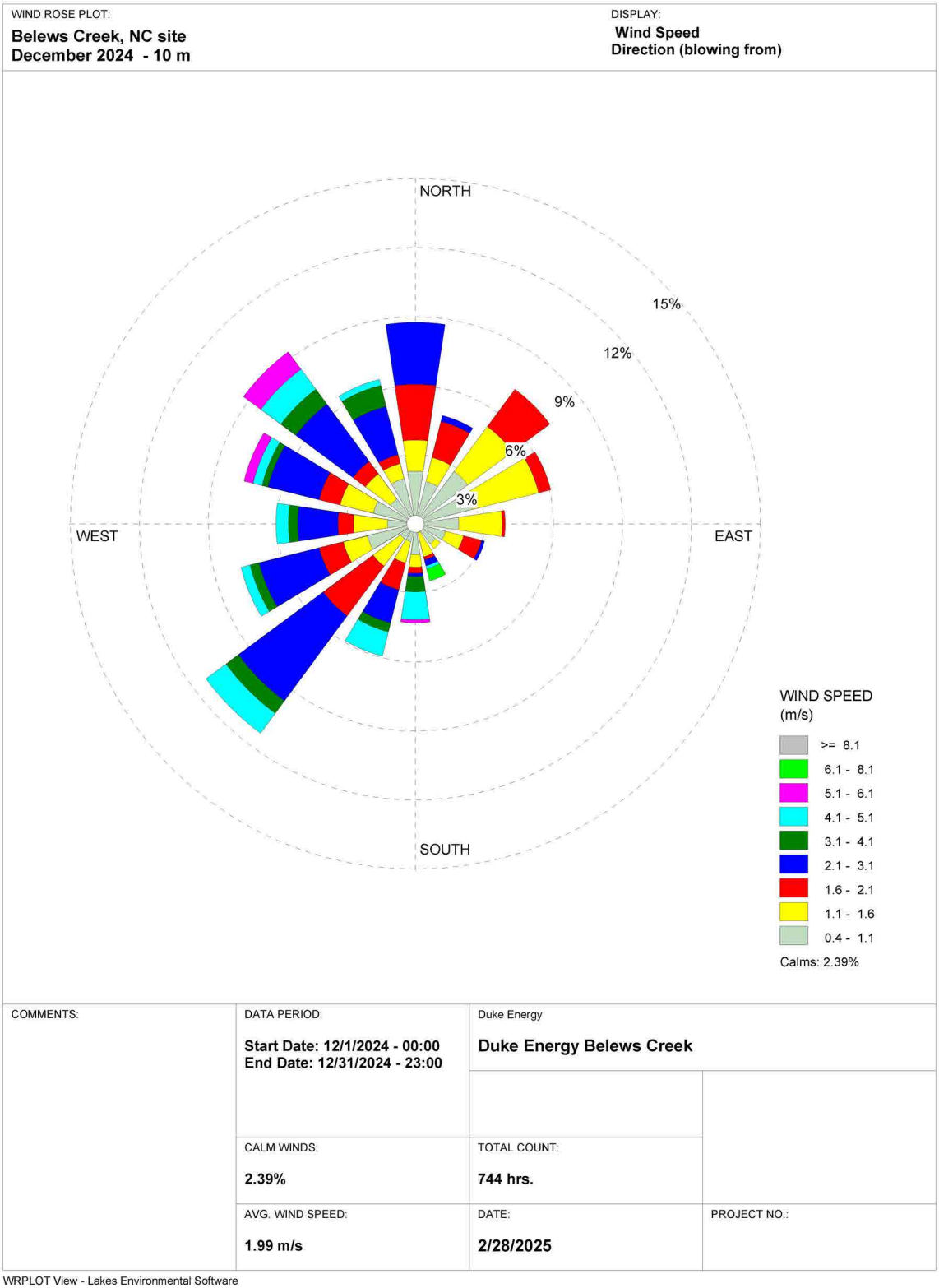
Key: hr. = hour; m/s = meters per second

Figure 2.7-25
Wind Roses for the Project Site (10 meters) November 2024



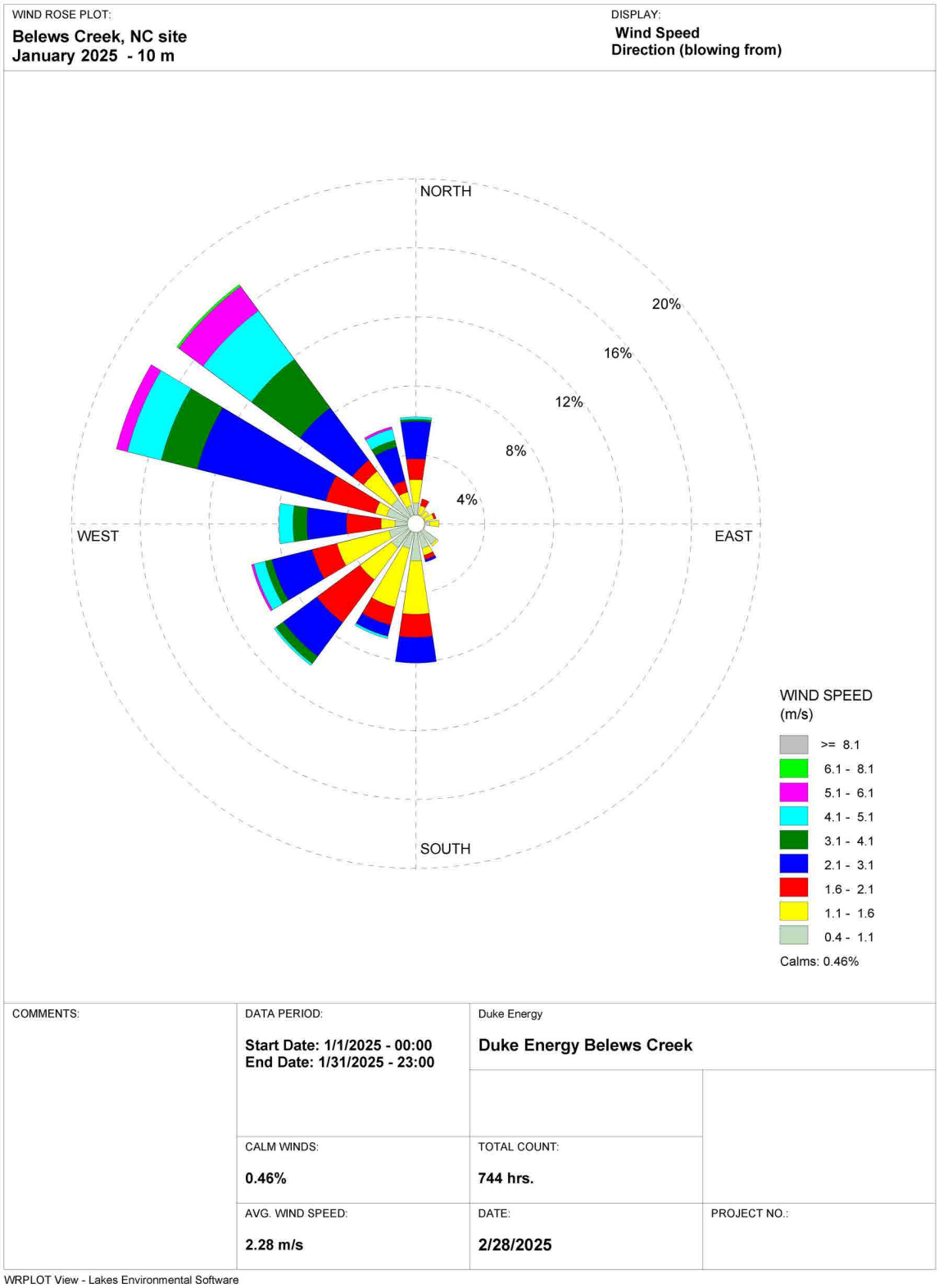
Key: hr. = hour; m/s = meters per second

Figure 2.7-26
Wind Roses for the Project Site (10 meters) December 2024



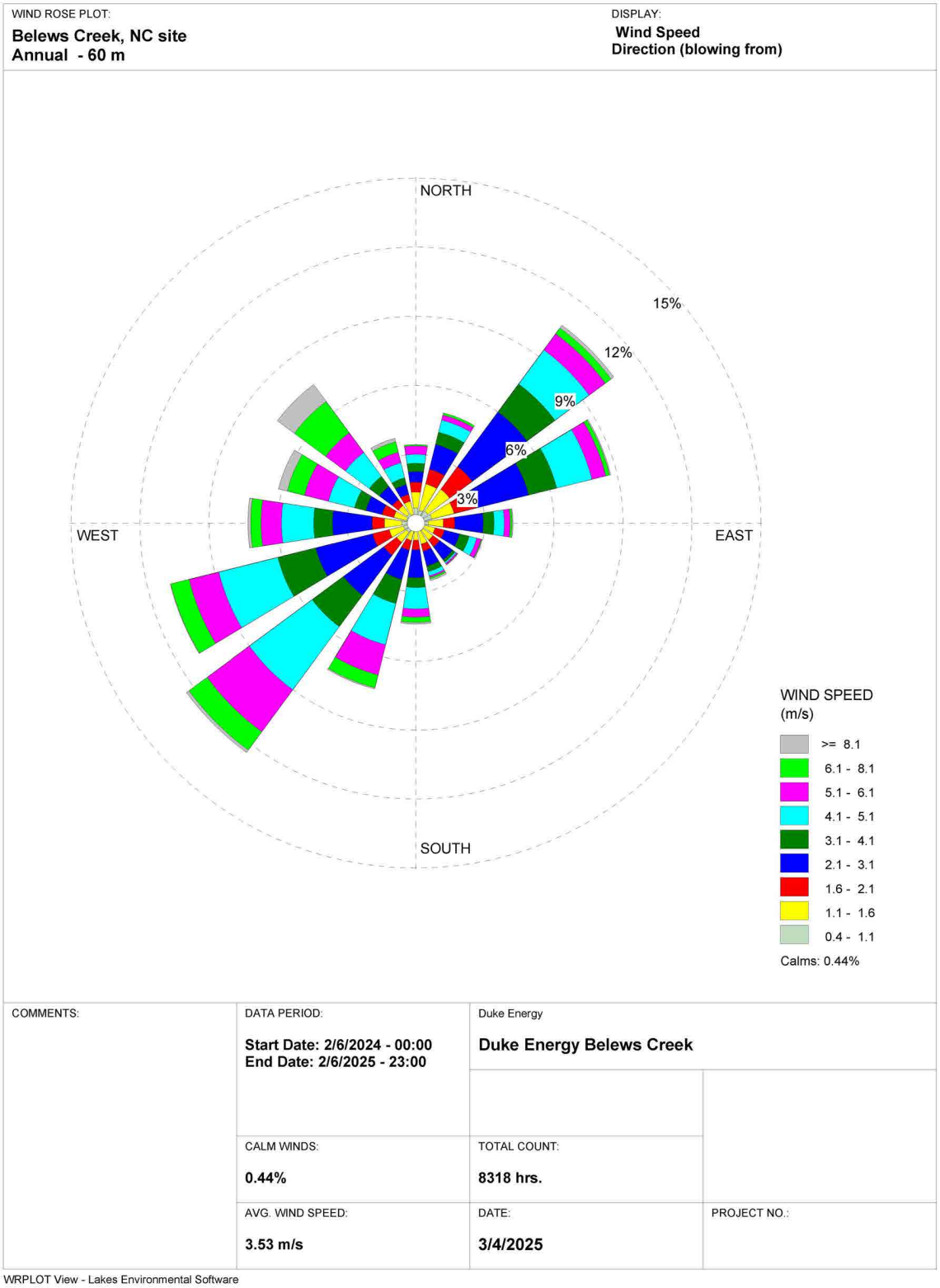
Key: hr. = hour; m/s = meters per second

Figure 2.7-27
Wind Roses for the Project Site (10 meters) January 2025



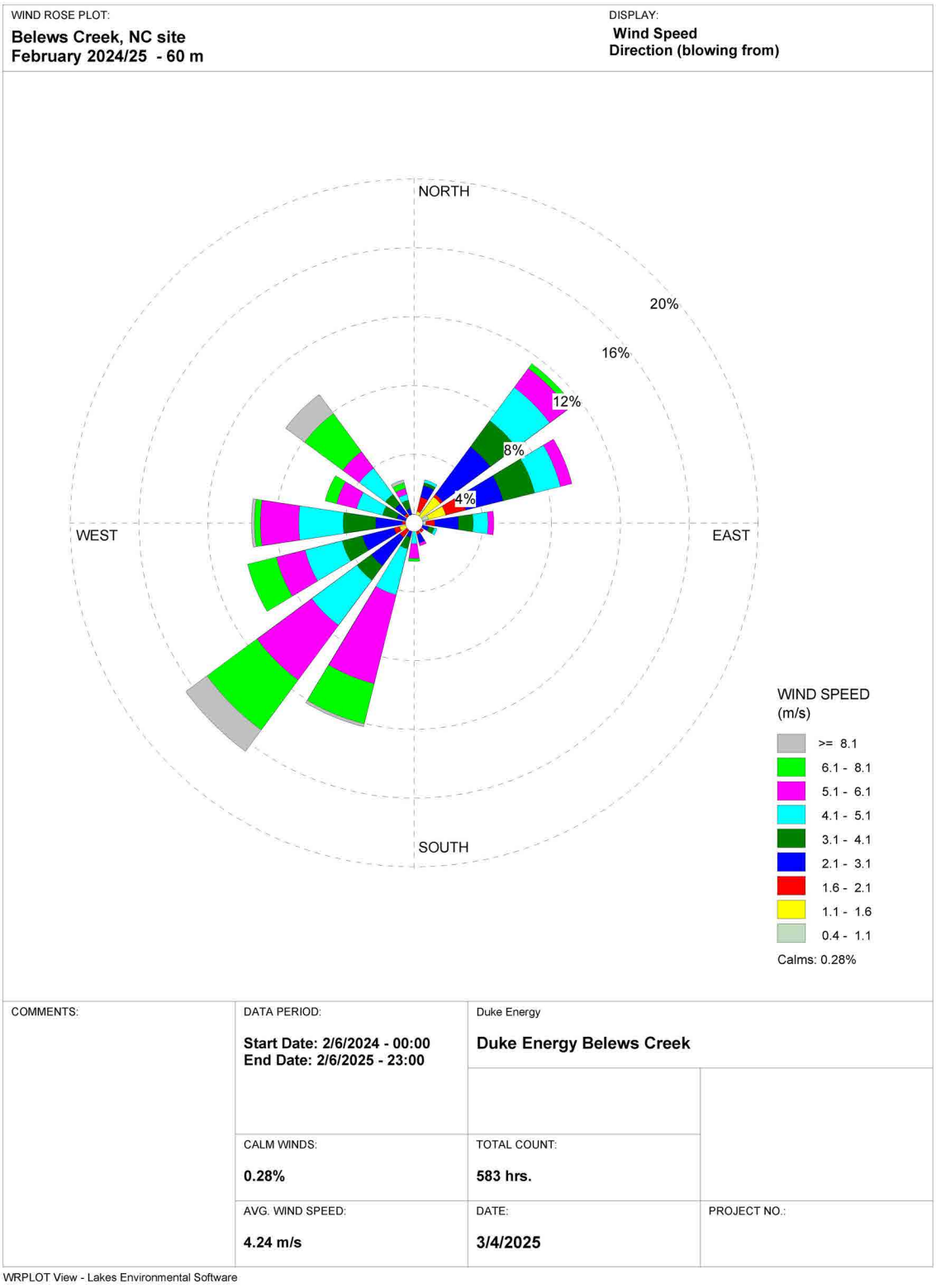
Key: hr. = hour; m/s = meters per second

Figure 2.7-28
Wind Roses for the Project Site (60 meters) Annual All Data



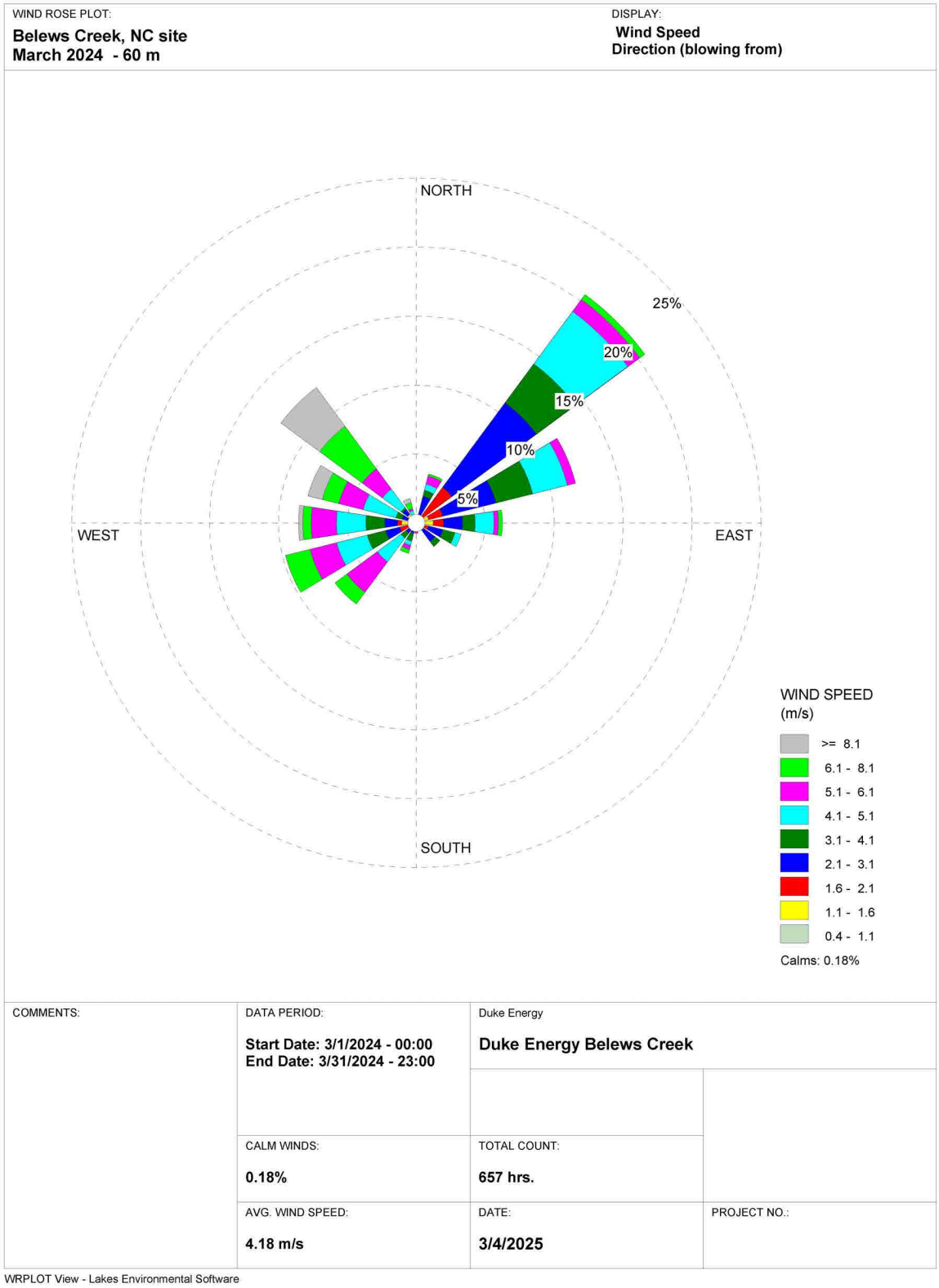
Key: hr. = hour; m/s = meters per second

Figure 2.7-29
Wind Roses for the Project Site (60 meters) February 2024/2025



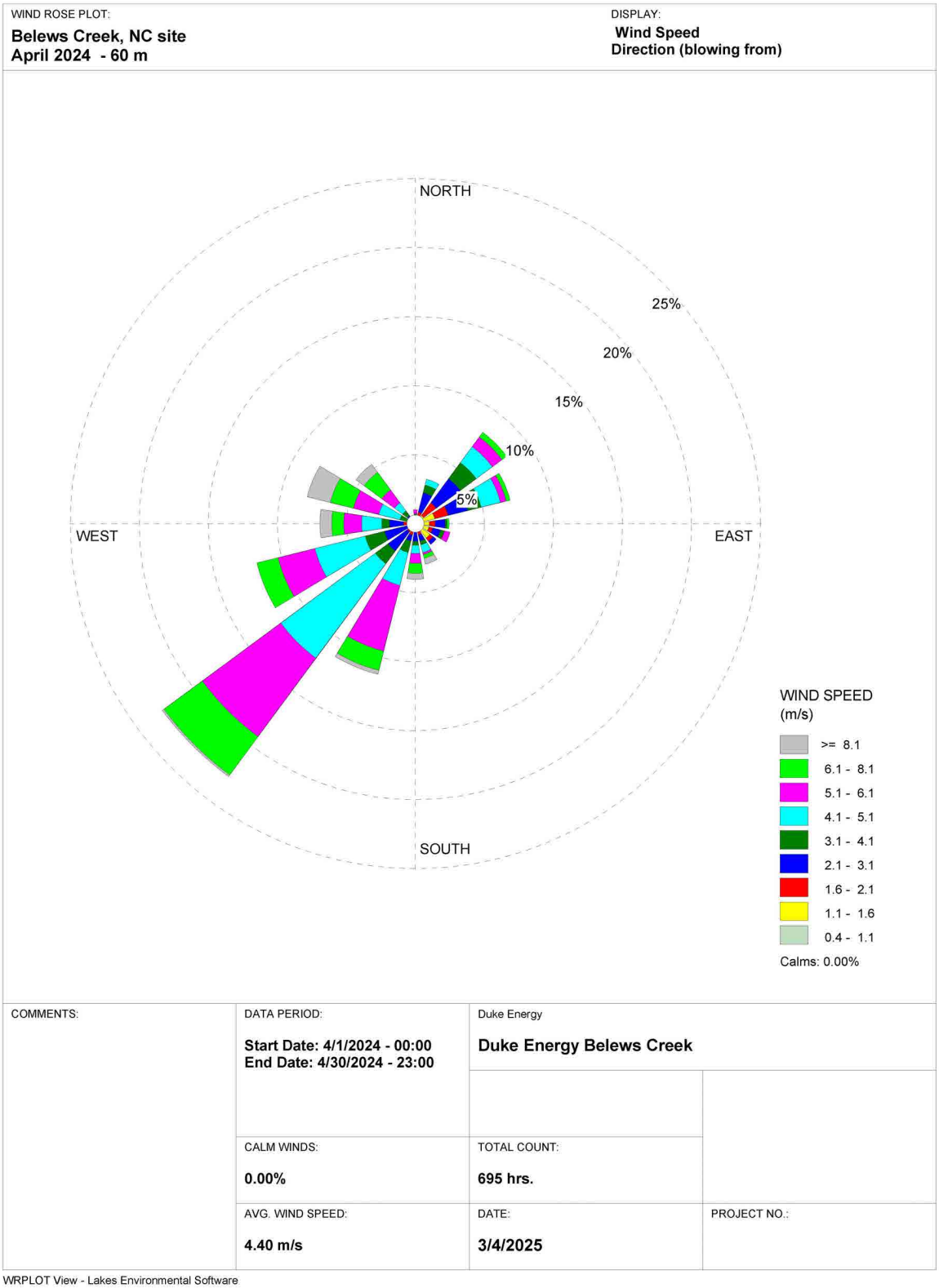
Key: hr. = hour; m/s = meters per second

Figure 2.7-30
Wind Roses for the Project Site (60 meters) March 2024



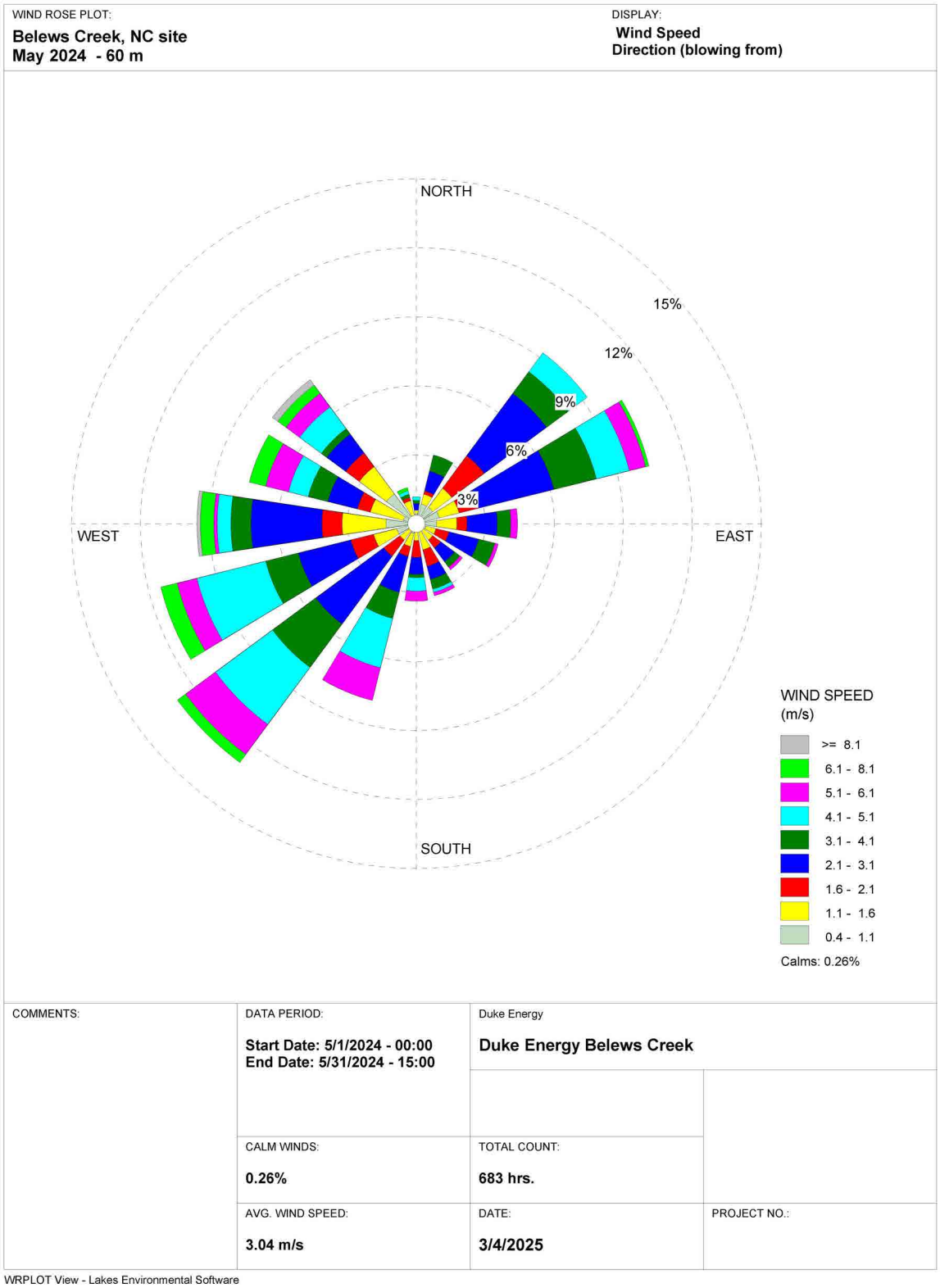
Key: hr. = hour; m/s = meters per second

Figure 2.7-31
Wind Roses for the Project Site (60 meters) April 2024



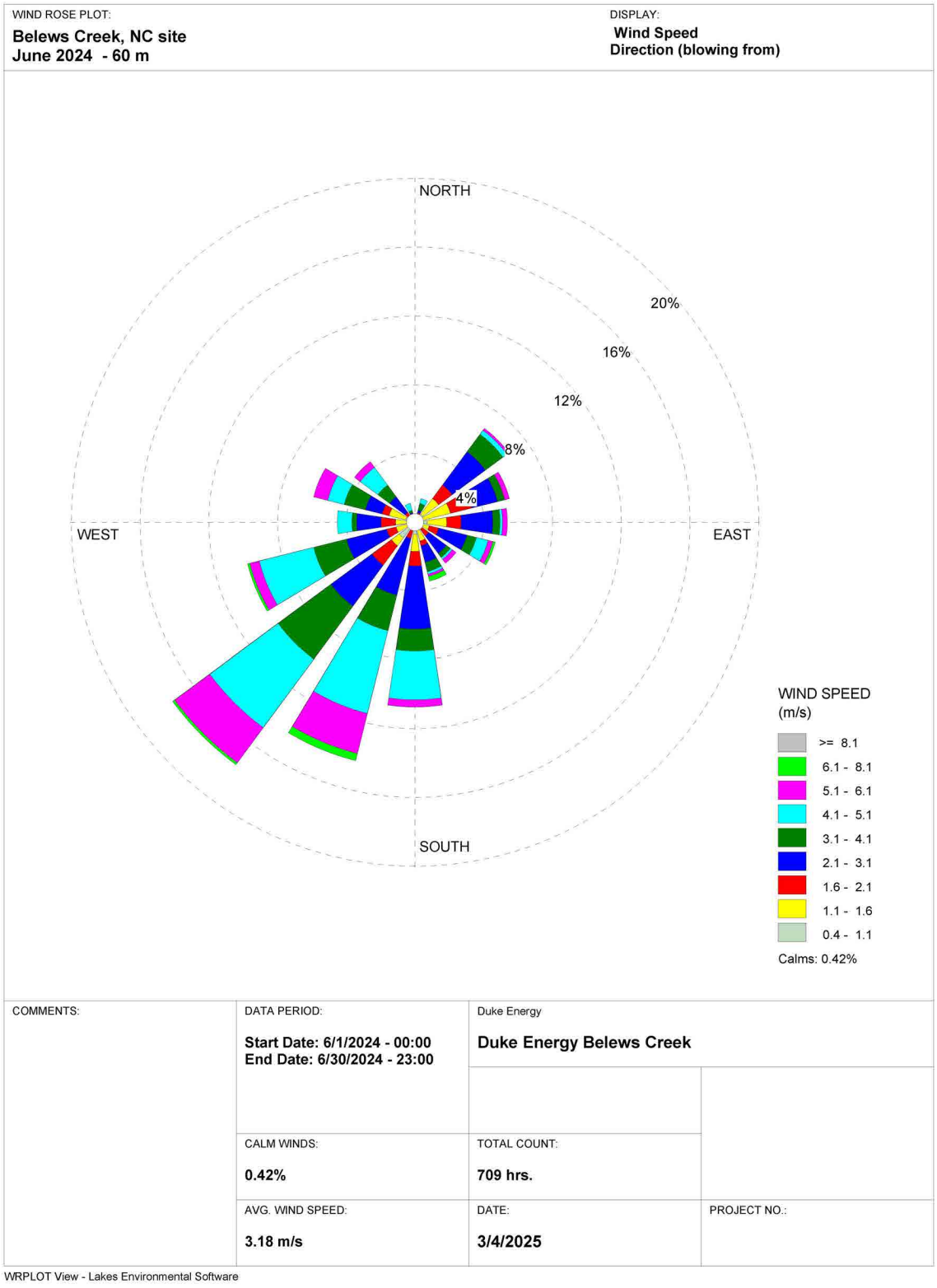
Key: hr. = hour; m/s = meters per second

Figure 2.7-32
Wind Roses for the Project Site (60 meters) May 2024



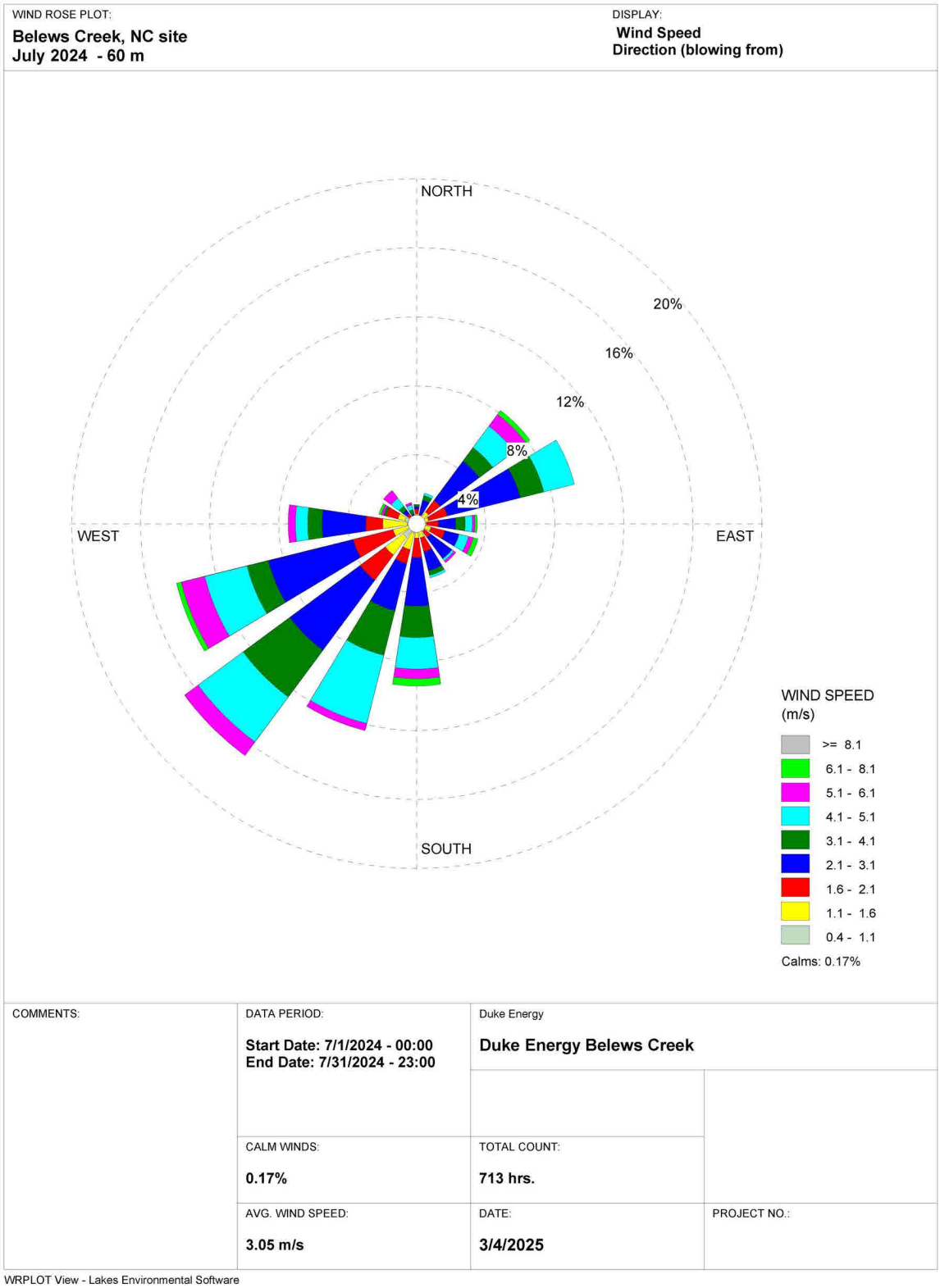
Key: hr. = hour; m/s = meters per second

Figure 2.7-33
Wind Roses for the Project Site (60 meters) June 2024



Key: hr. = hour; m/s = meters per second

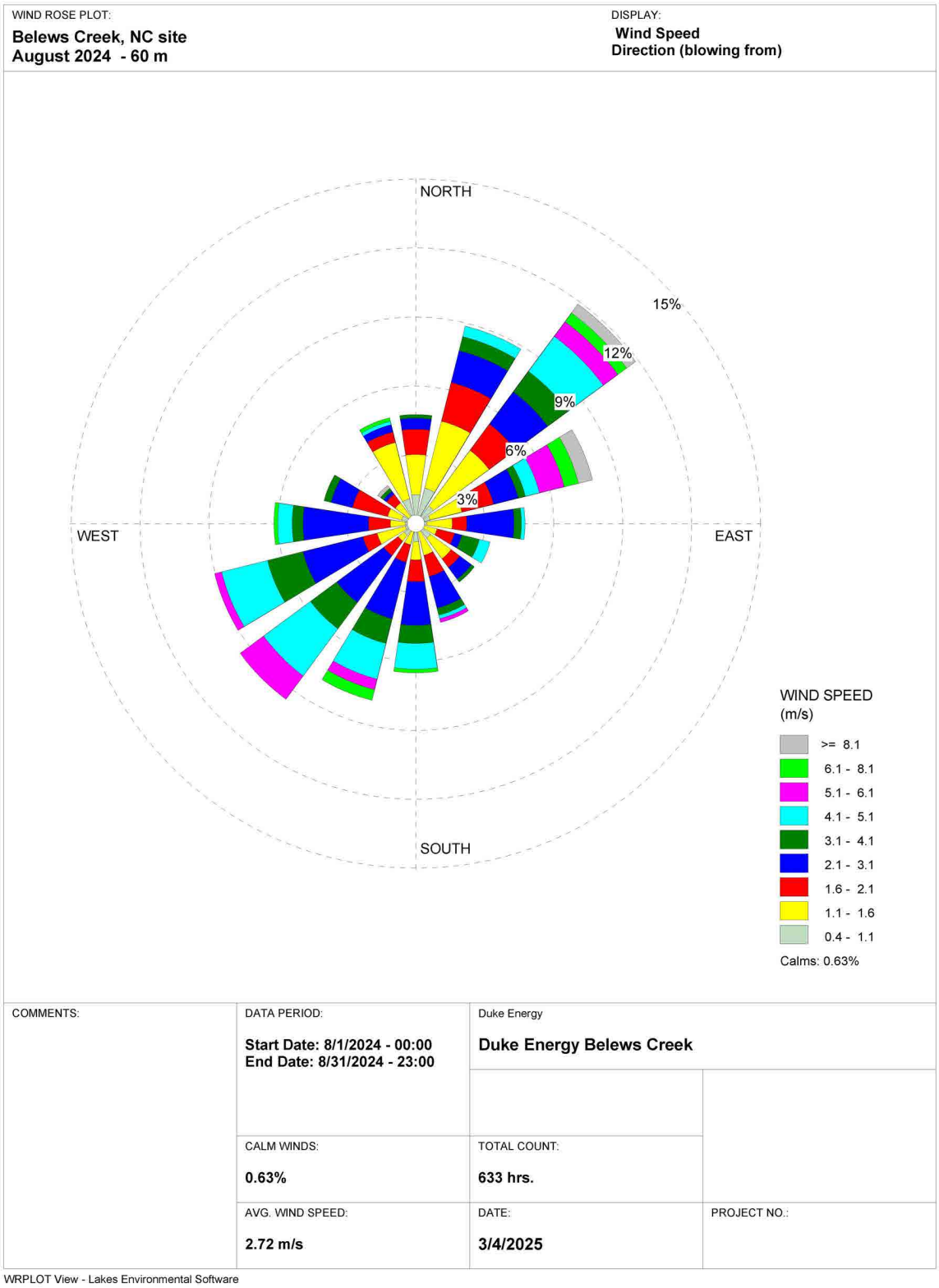
Figure 2.7-34
Wind Roses for the Project Site (60 meters) July 2024



Key: hr. = hour; m/s = meters per second

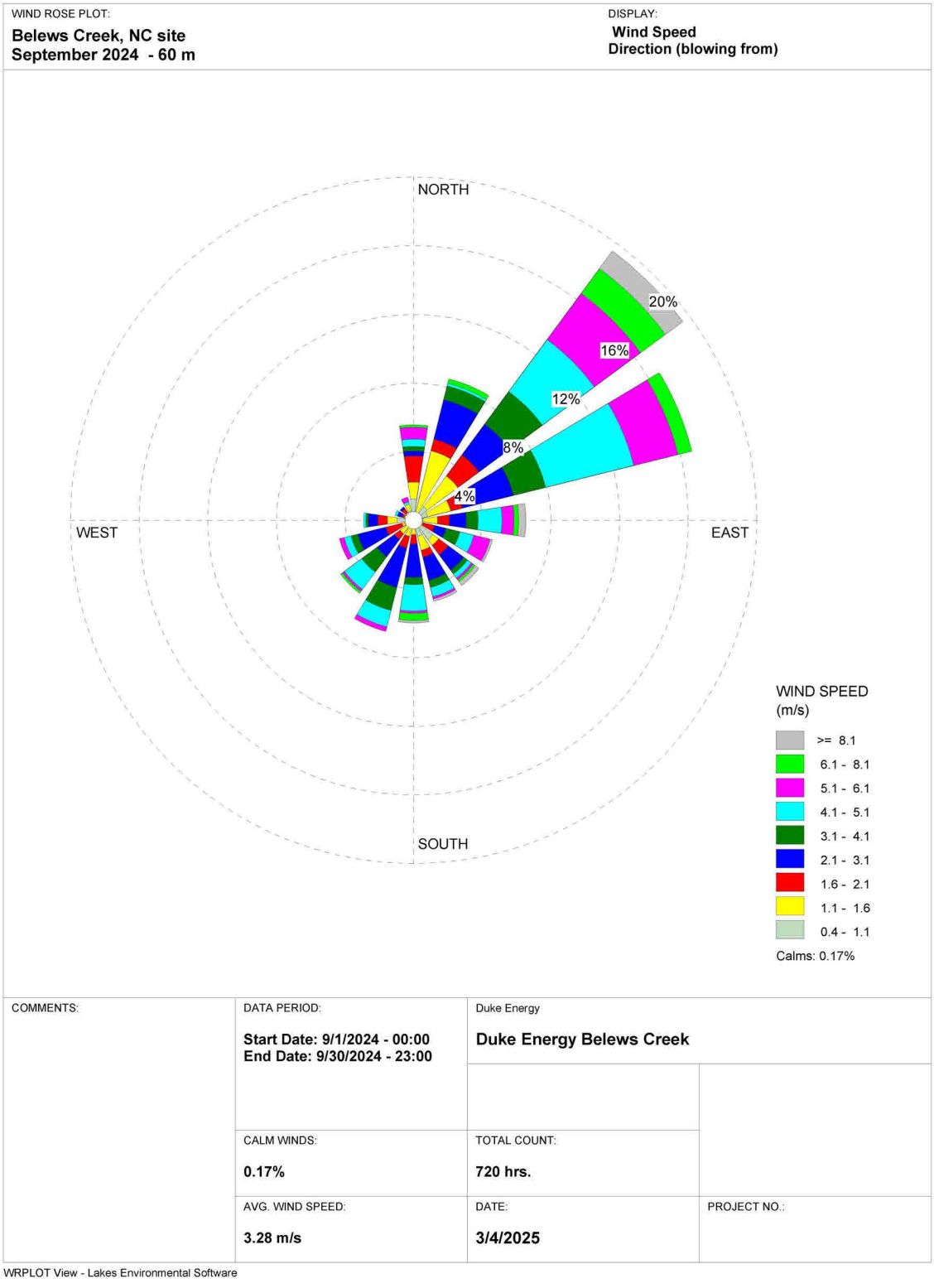
Figure 2.7-35

Wind Roses for the Project Site (60 meters) August 2024



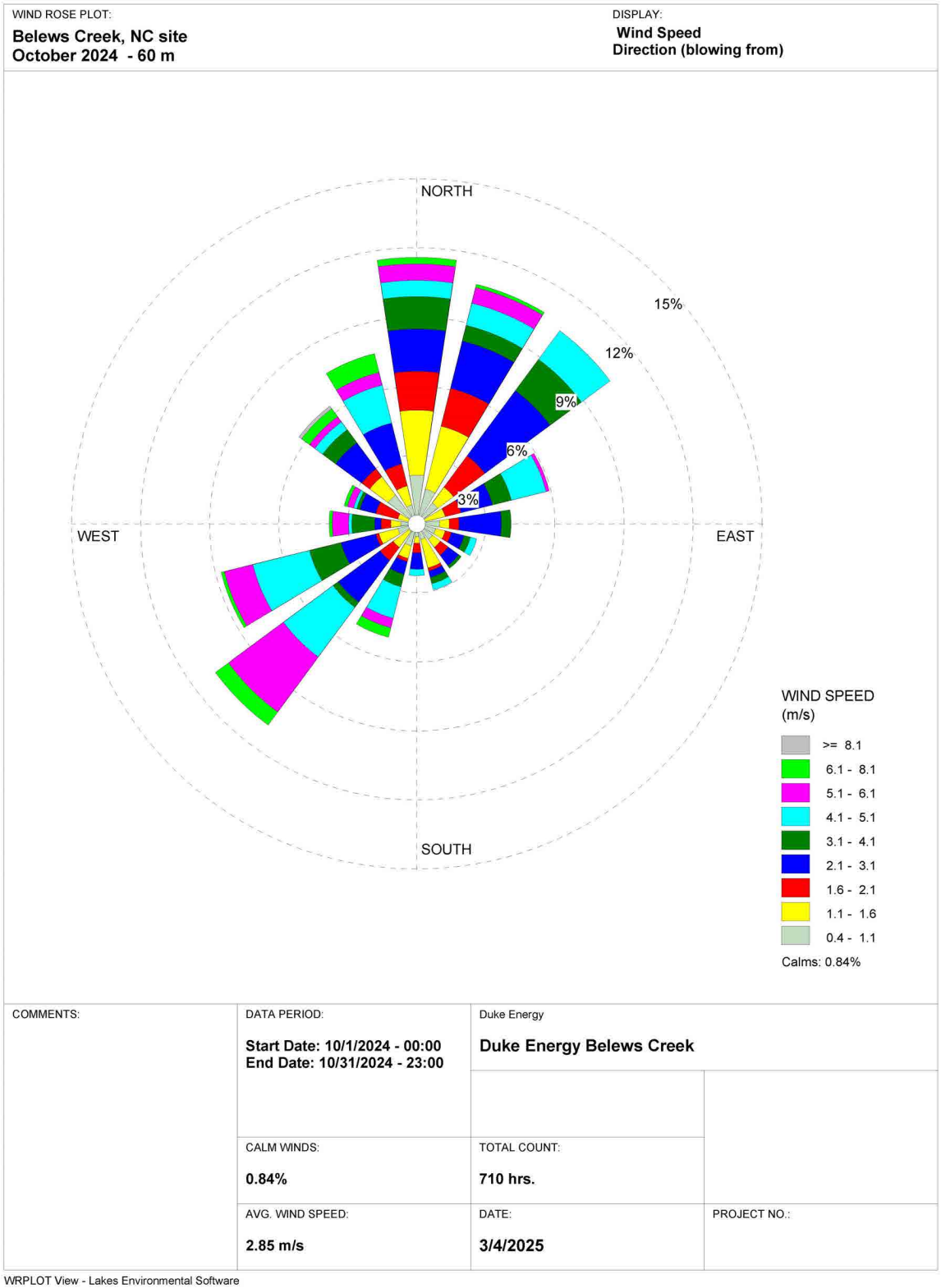
Key: hr. = hour; m/s = meters per second

Figure 2.7-36
Wind Roses for the Project Site (60 meters) September 2024



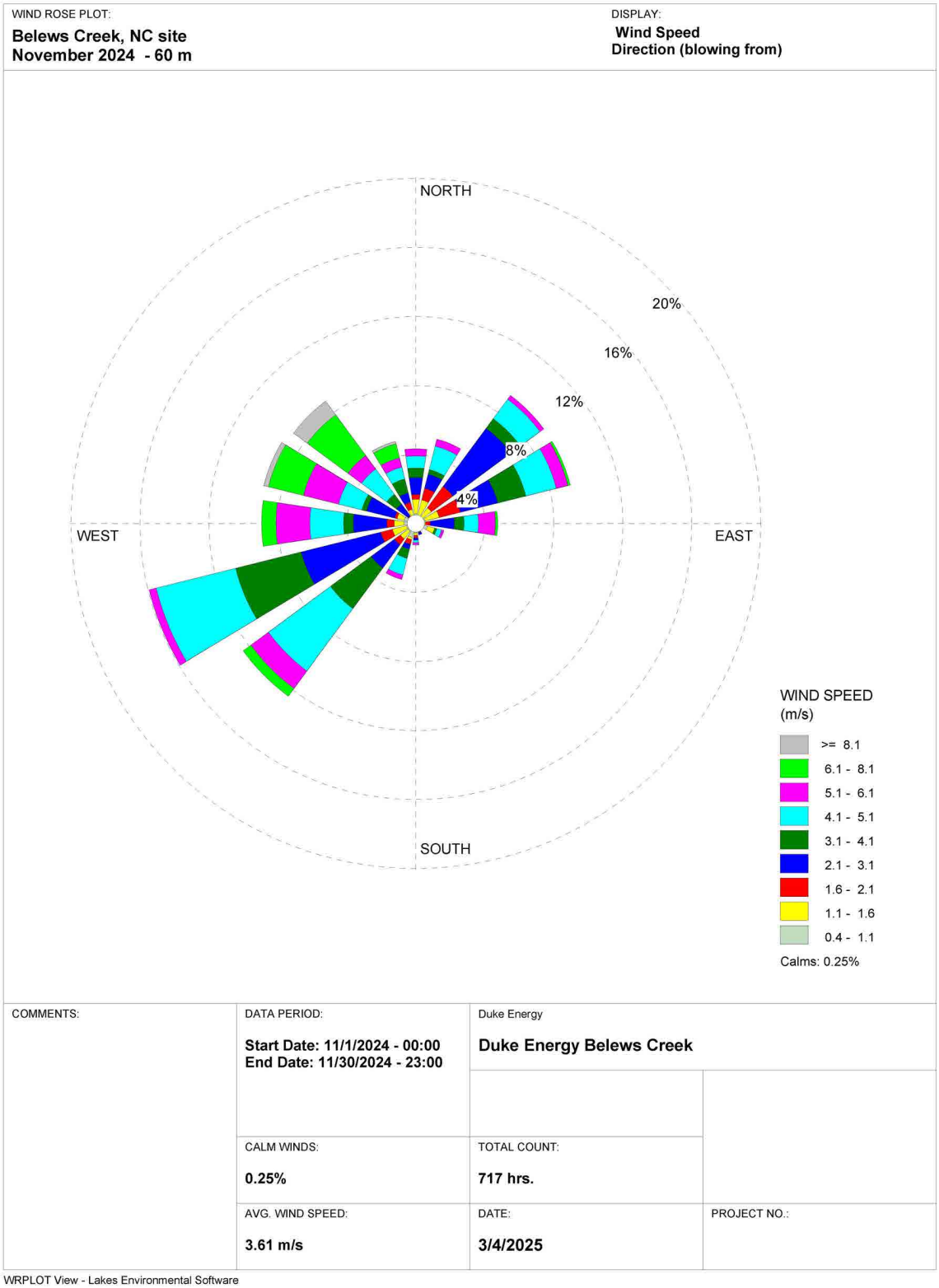
Key: hr. = hour; m/s = meters per second

Figure 2.7-37
Wind Roses for the Project Site (60 meters) October 2024



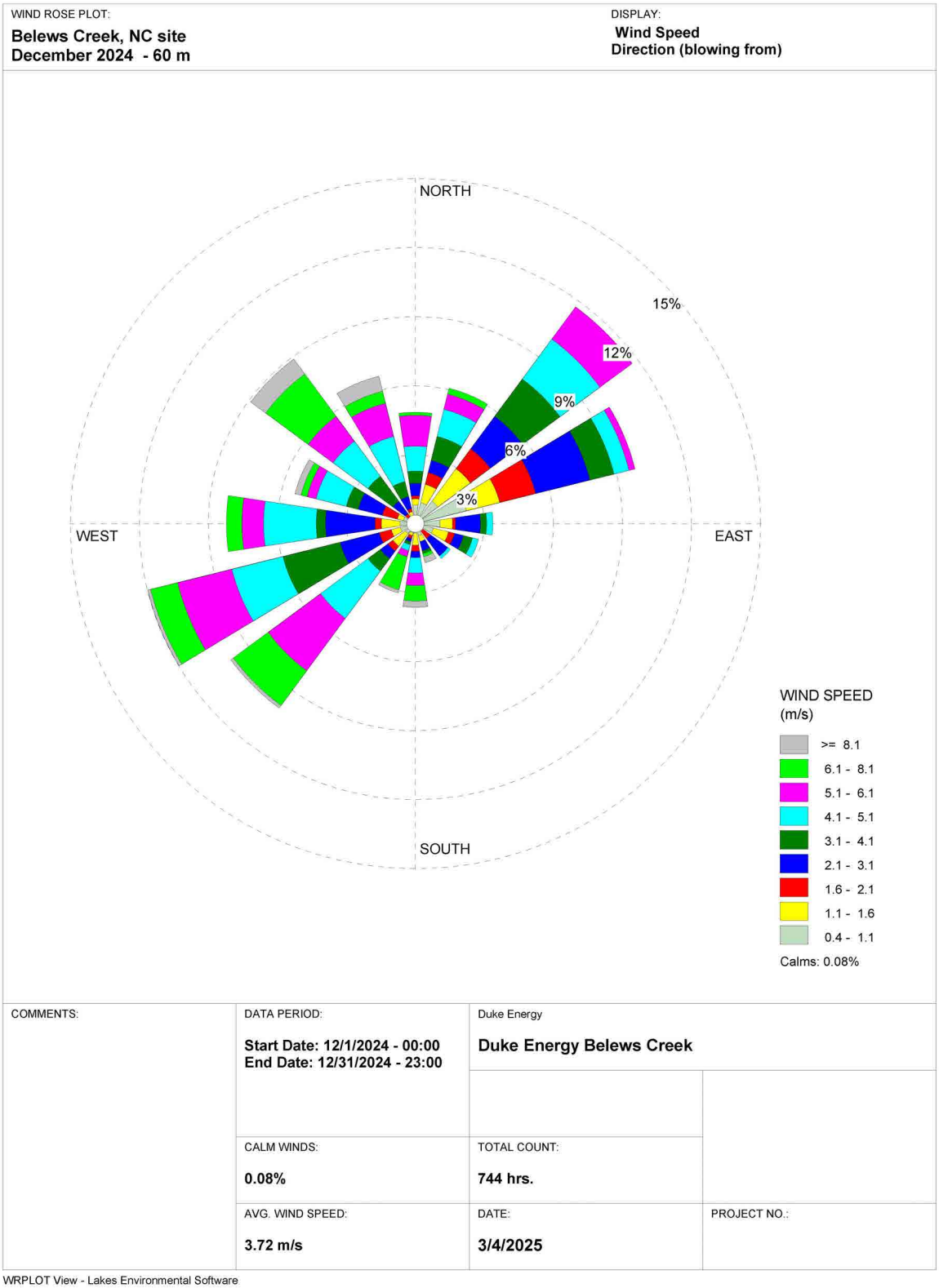
Key: hr. = hour; m/s = meters per second

Figure 2.7-38
Wind Roses for the Project Site (60 meters) November 2024



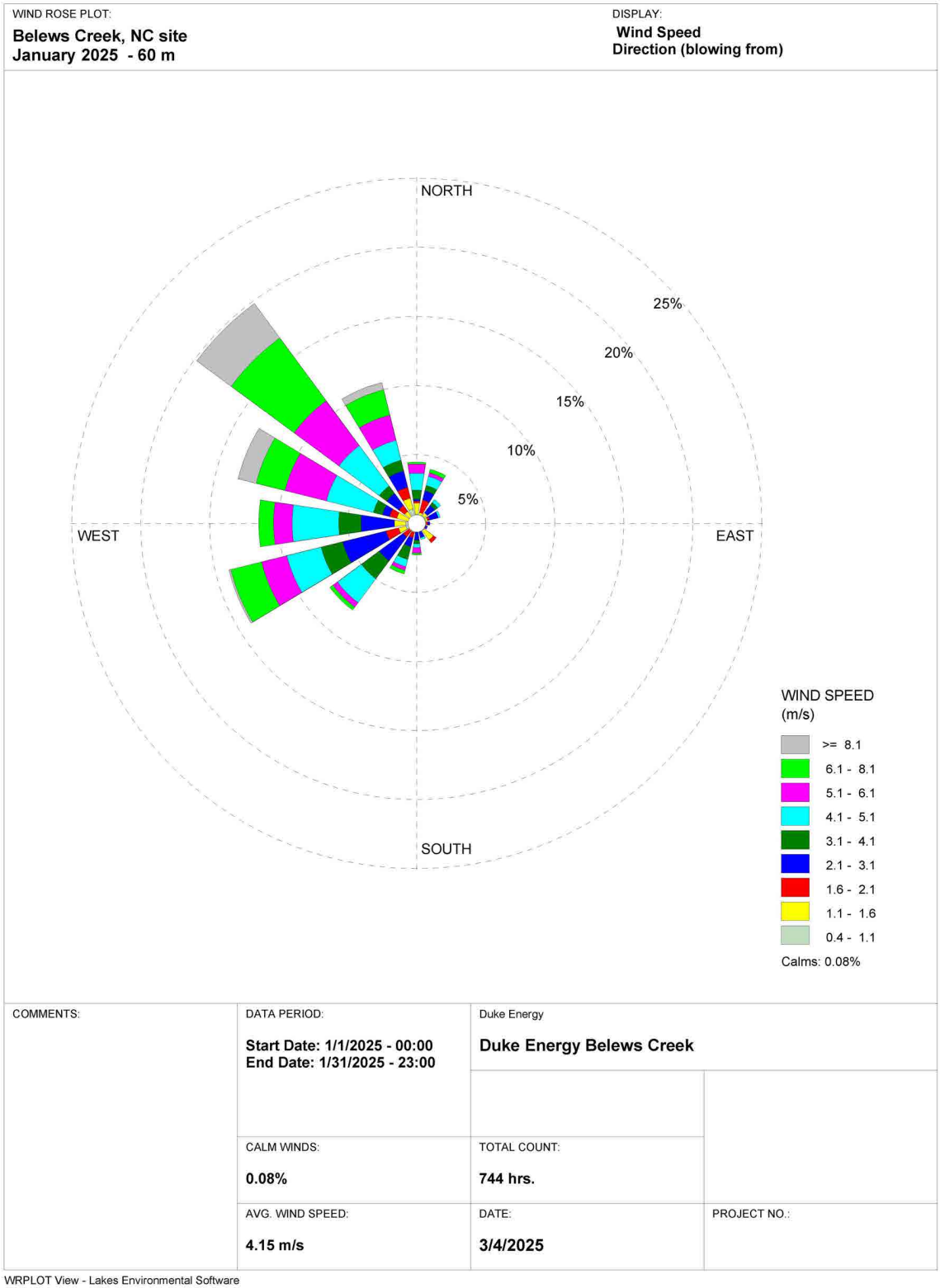
Key: hr. = hour; m/s = meters per second

Figure 2.7-39
Wind Roses for Project Site (60 meters) December 2024



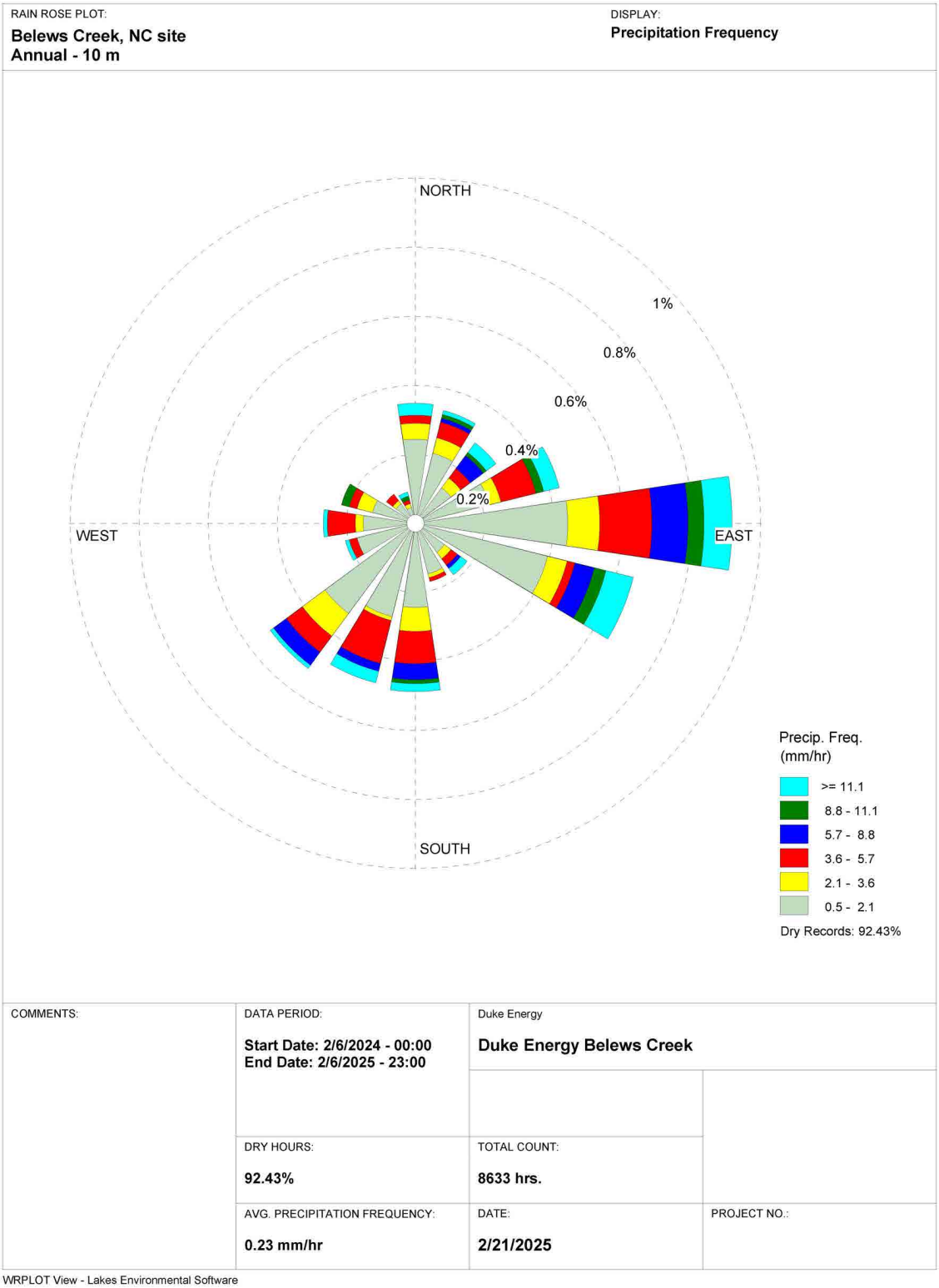
Key: hr. = hour; m/s = meters per second

Figure 2.7-40
Wind Roses for the Project Site (60 meters) January 2025



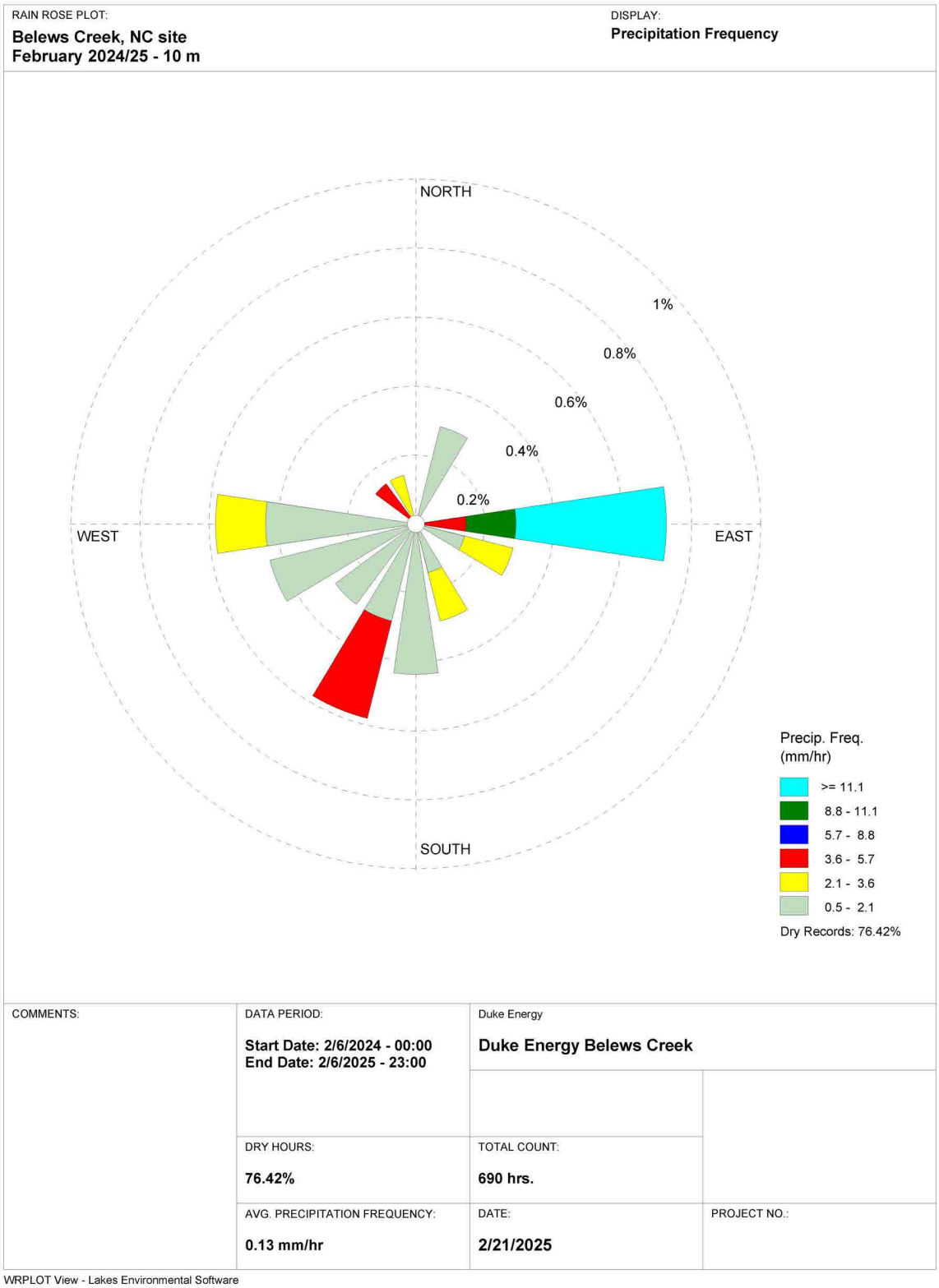
Key: hr. = hour; m/s = meters per second

Figure 2.7-41
Precipitation Frequency Wind Roses for the Project Site (10 meters) Annual All Data



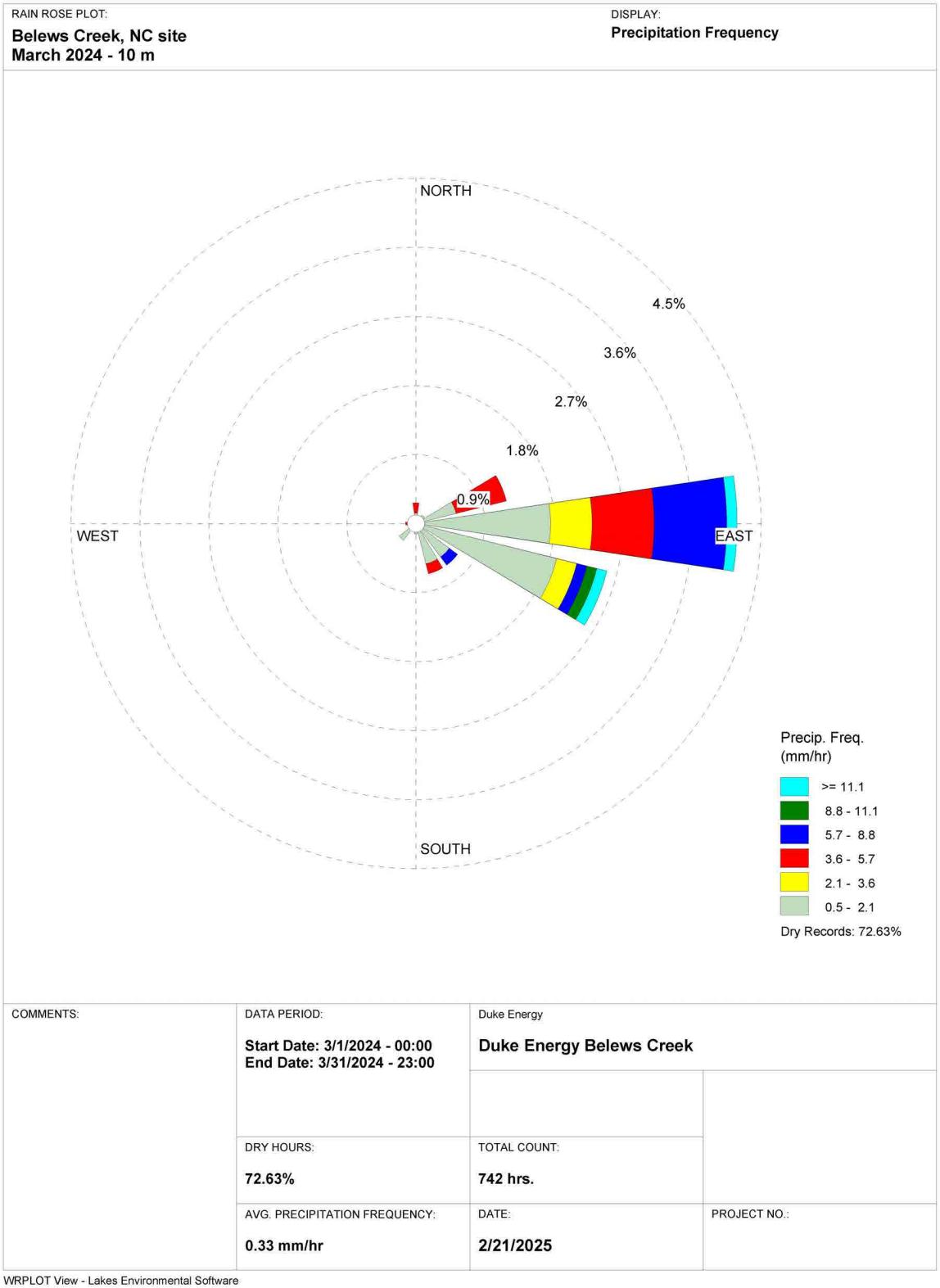
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-42
Precipitation Frequency Wind Roses for the Project Site (10 meters) February 2024/2025



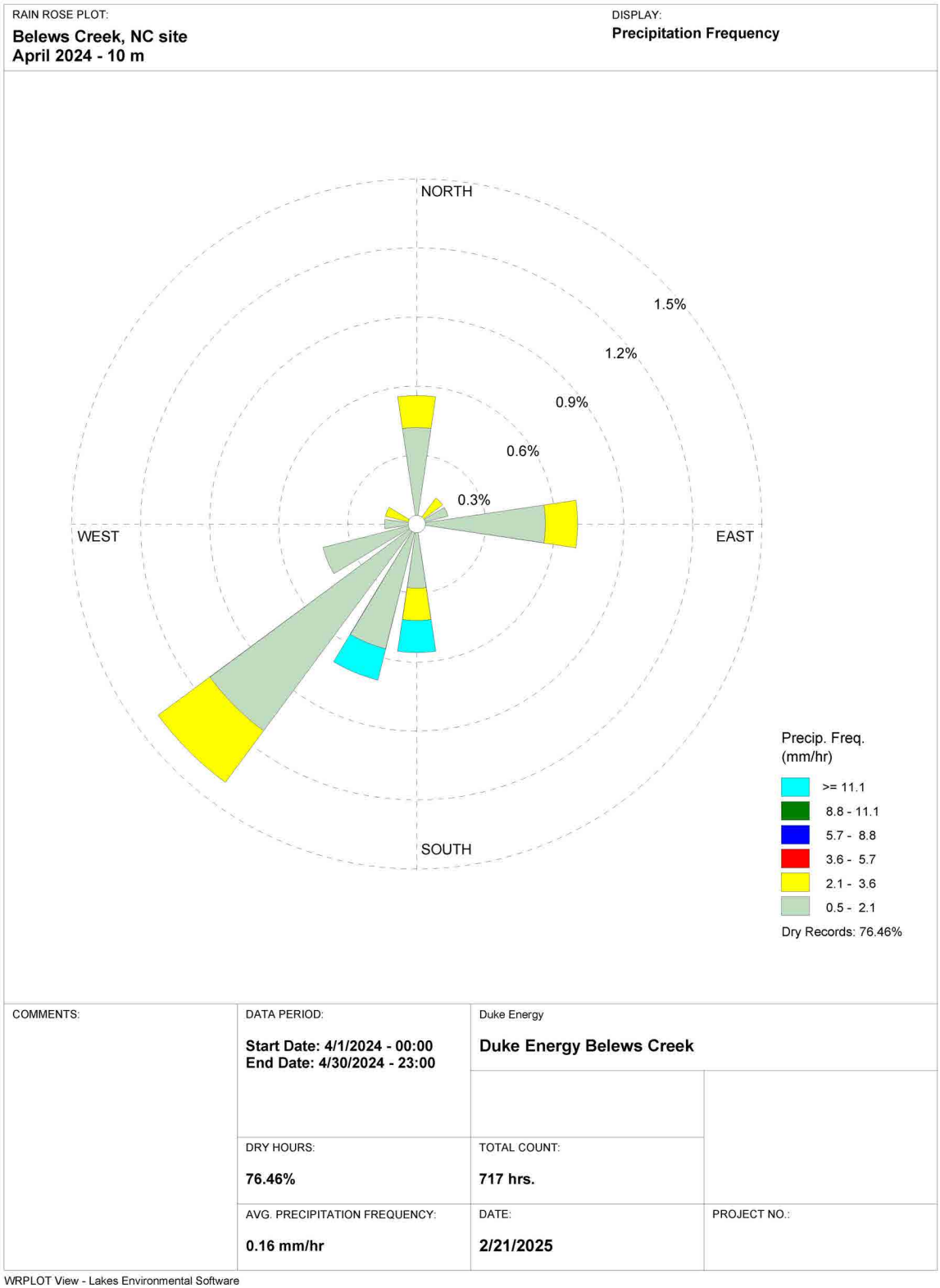
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-43
Precipitation Frequency Wind Roses for the Project Site (10 meters) March 2024



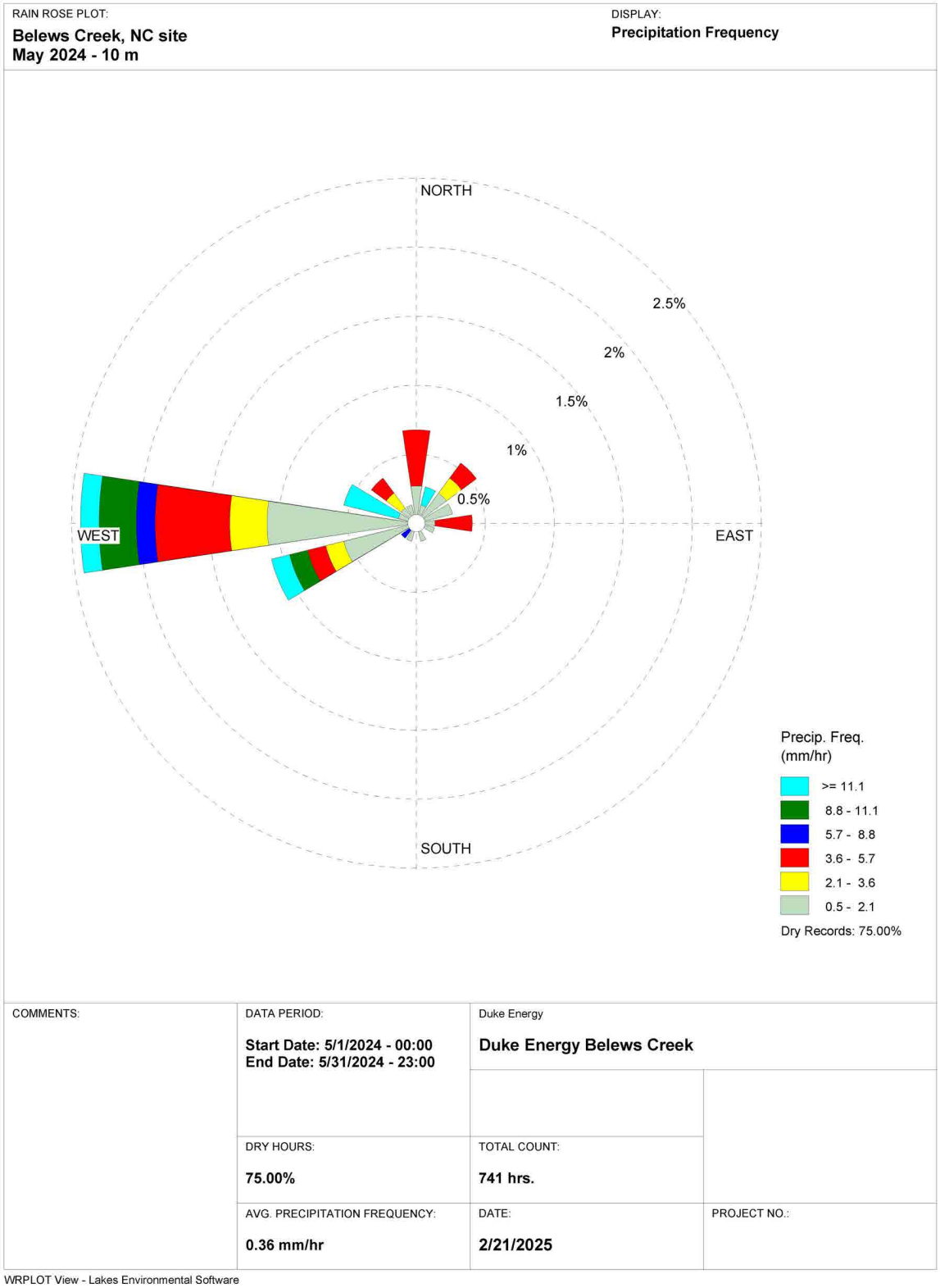
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-44
Precipitation Frequency Wind Roses for the Project Site (10 meters) April 2024



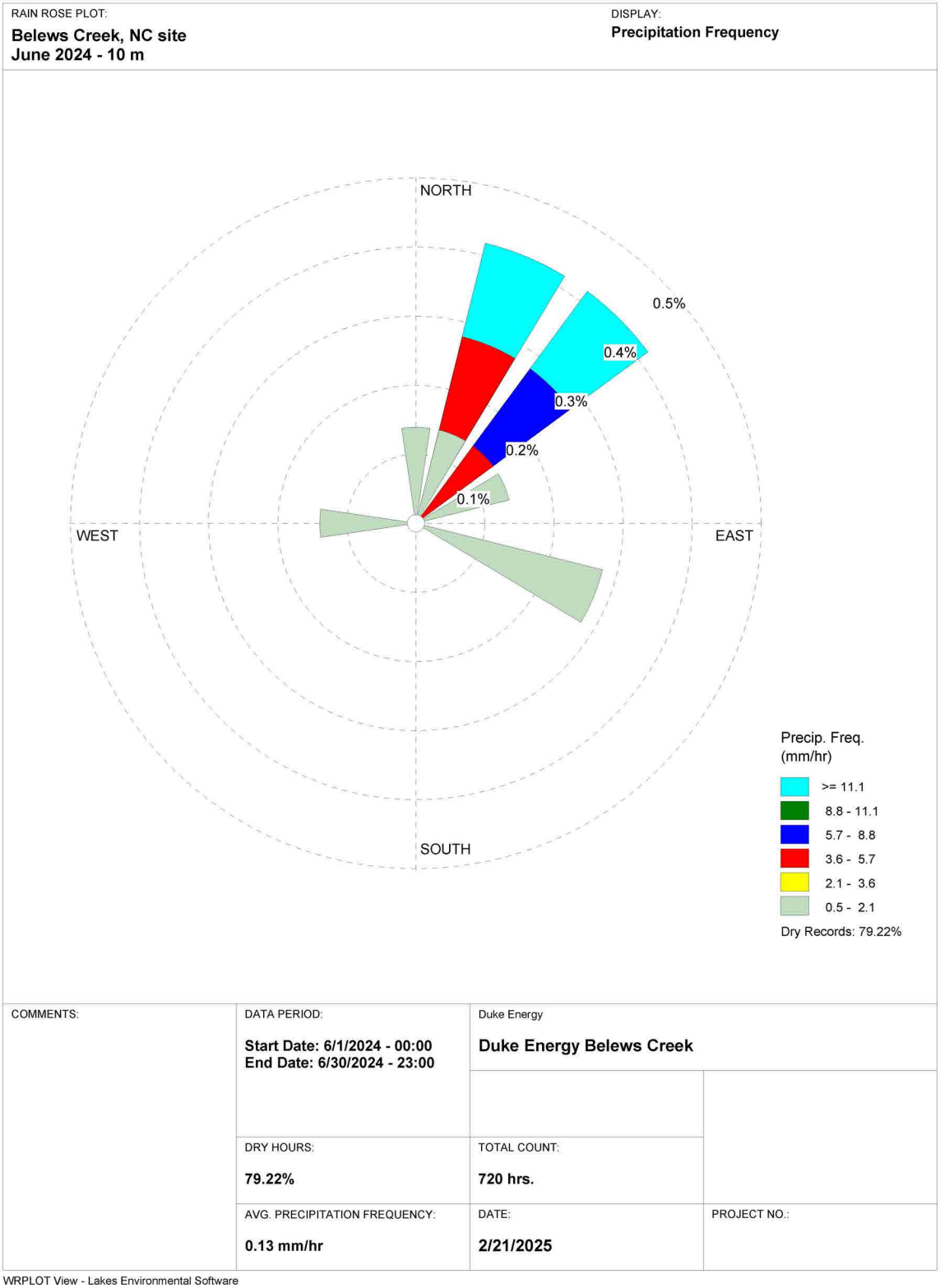
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-45
Precipitation Frequency Wind Roses the Project Site (10 meters) May 2024



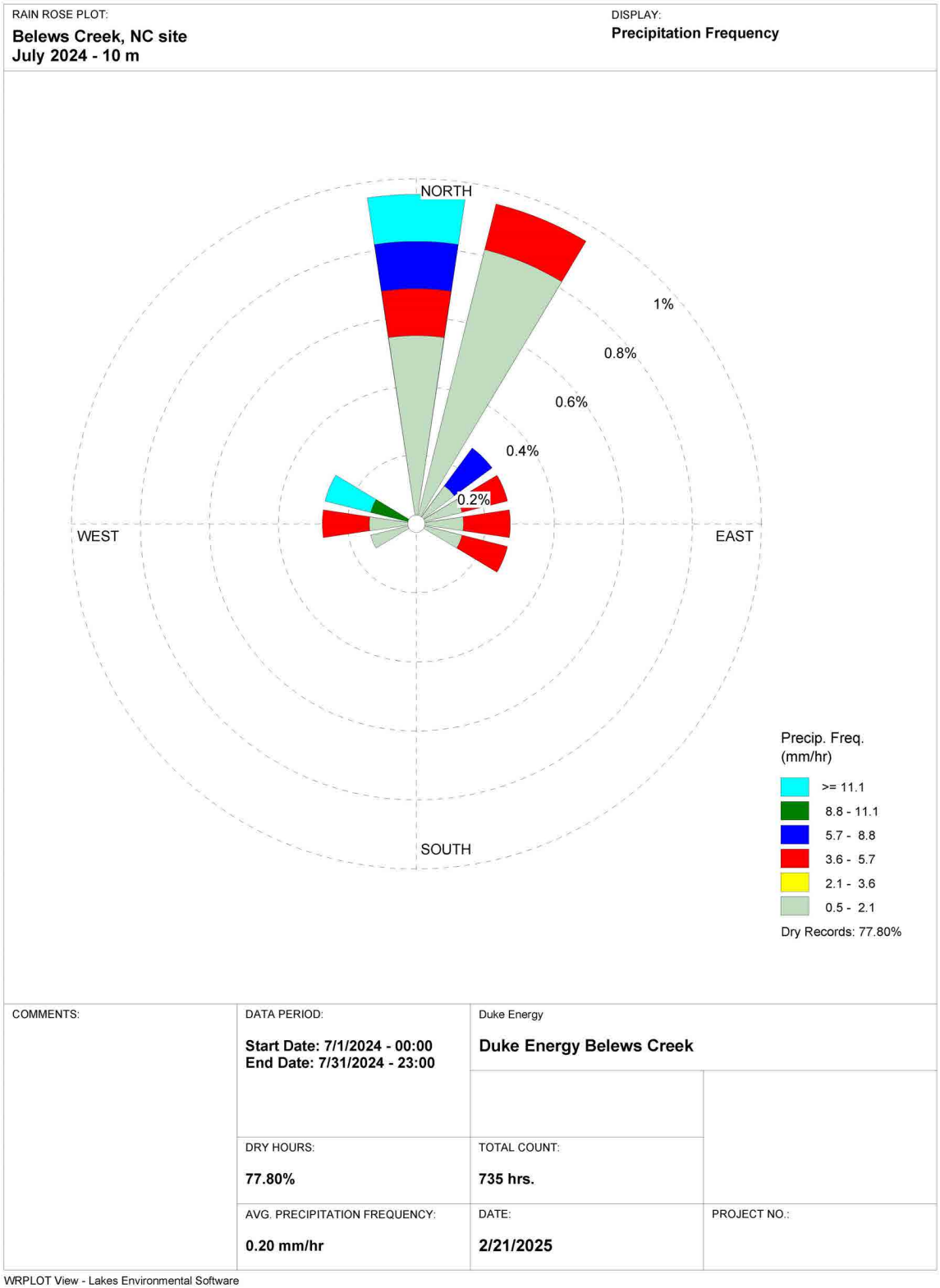
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-46
Precipitation Frequency Wind Roses for the Project Site (10 meters) June 2024



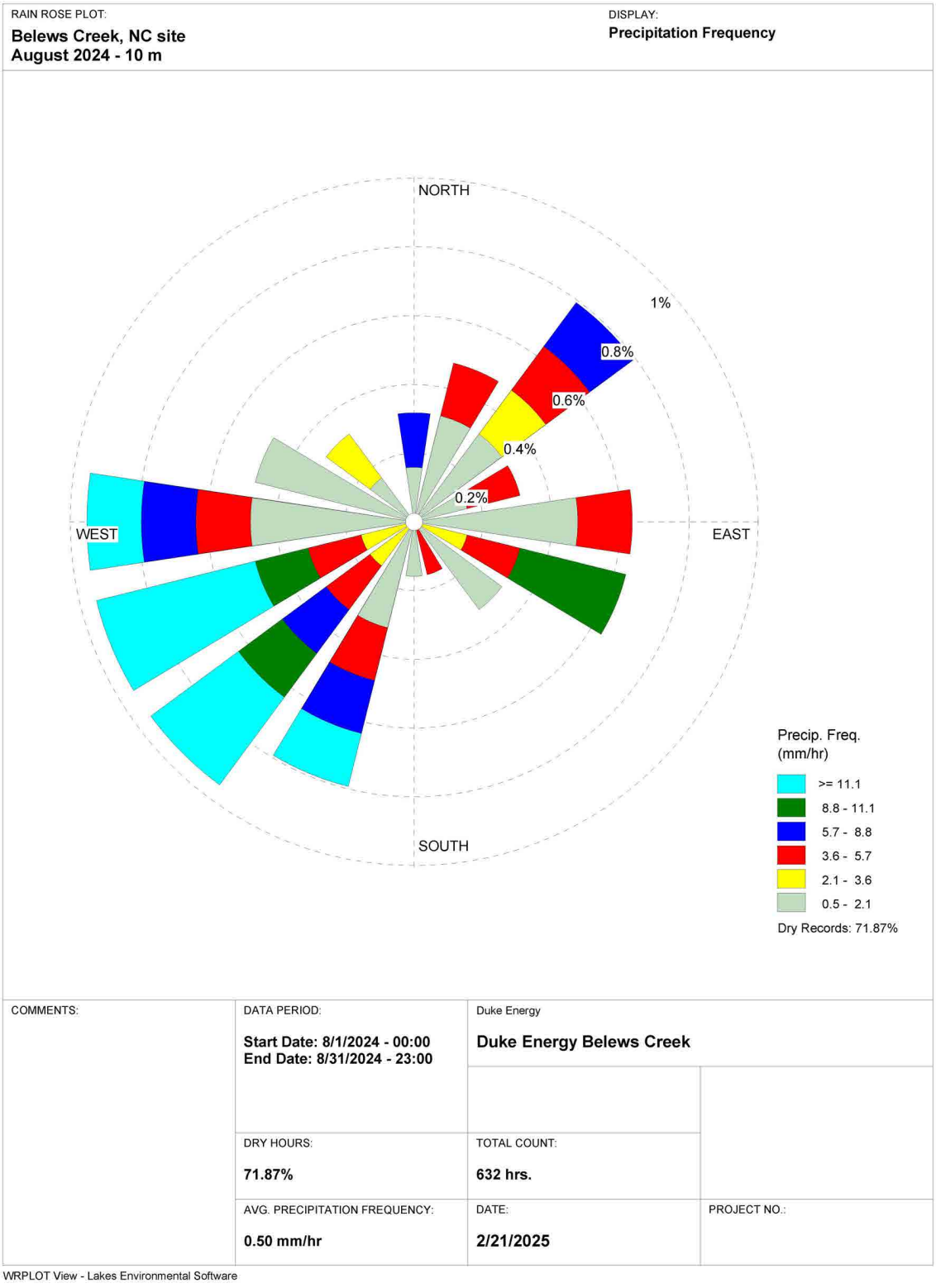
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-47
Precipitation Frequency Wind Roses for the Project Site (10 meters) July 2024



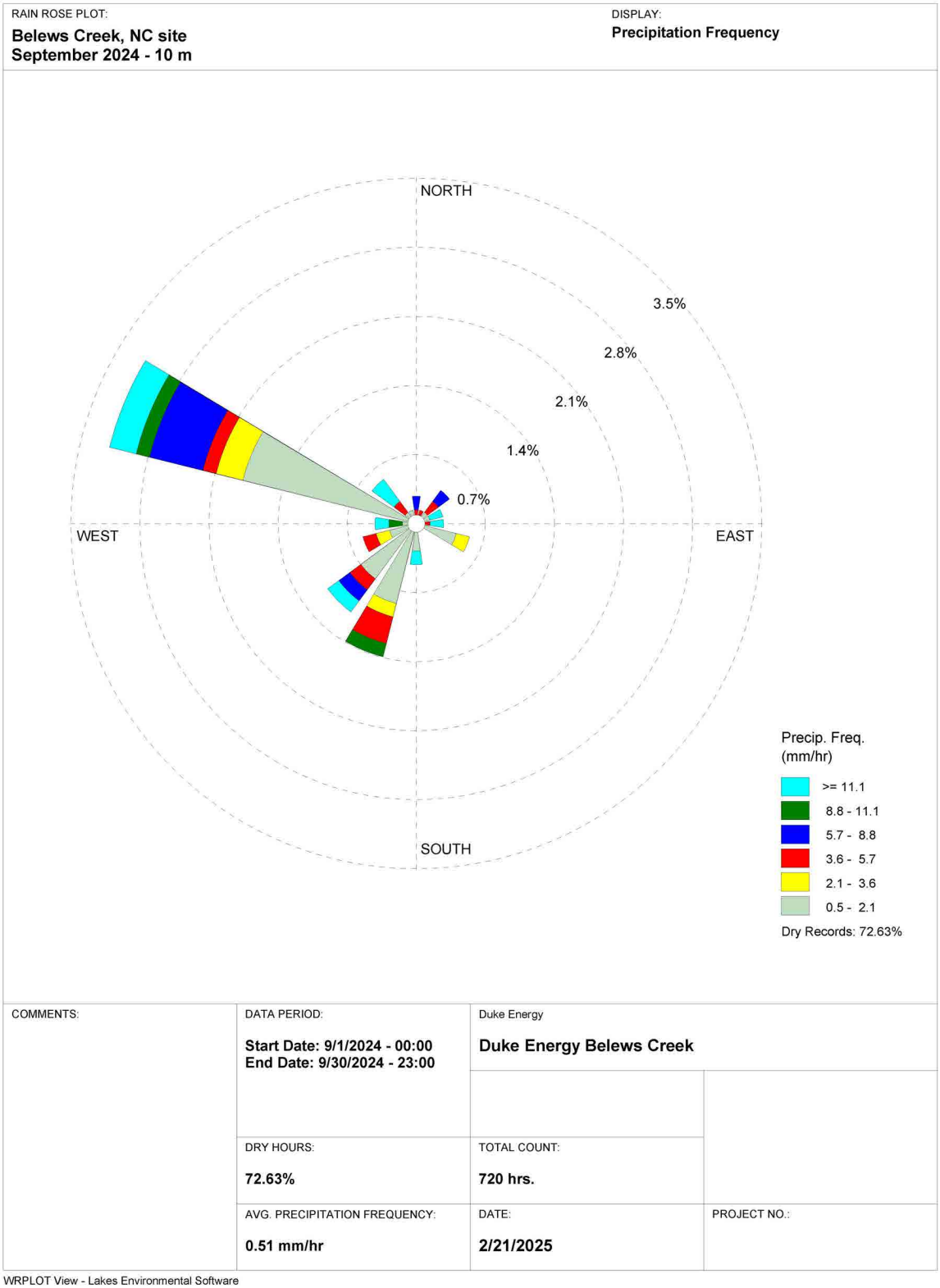
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-48
Precipitation Frequency Wind Roses for the Project Site (10 meters) August 2024



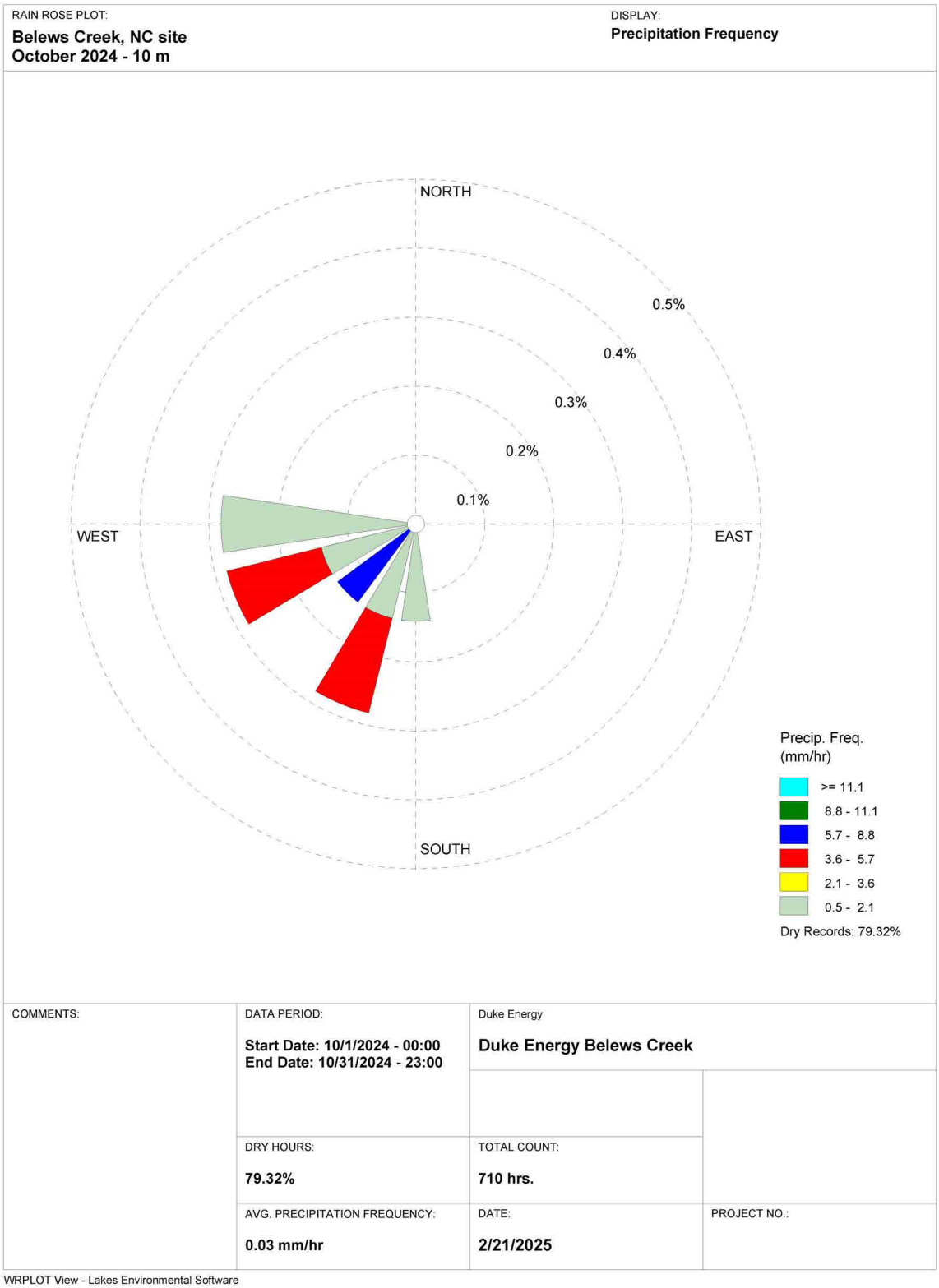
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-49
Precipitation Frequency Wind Roses for the Project Site (10 meters) September 2024



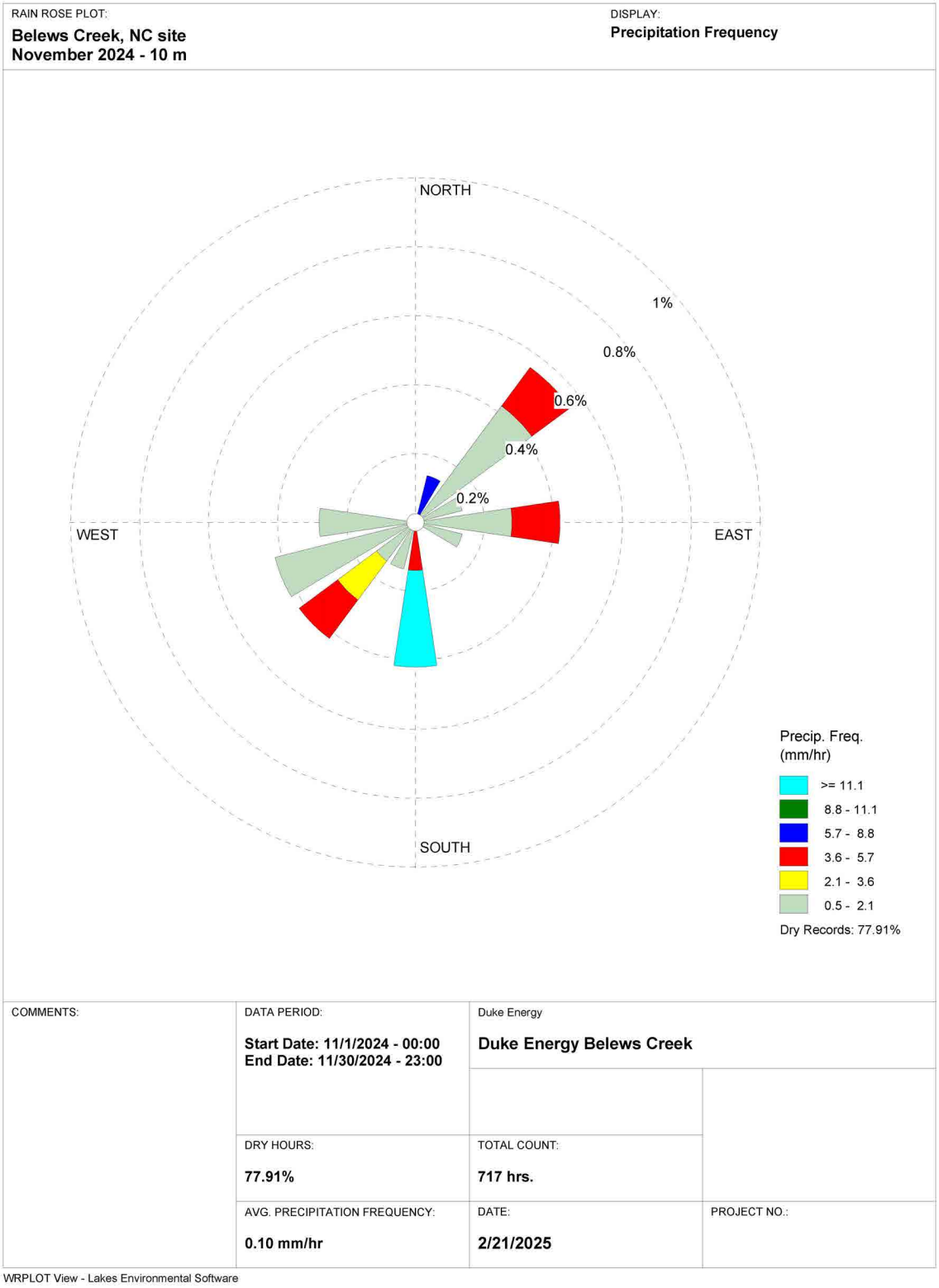
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-50
Precipitation Frequency Wind Roses for the Project Site (10 meters) October 2024



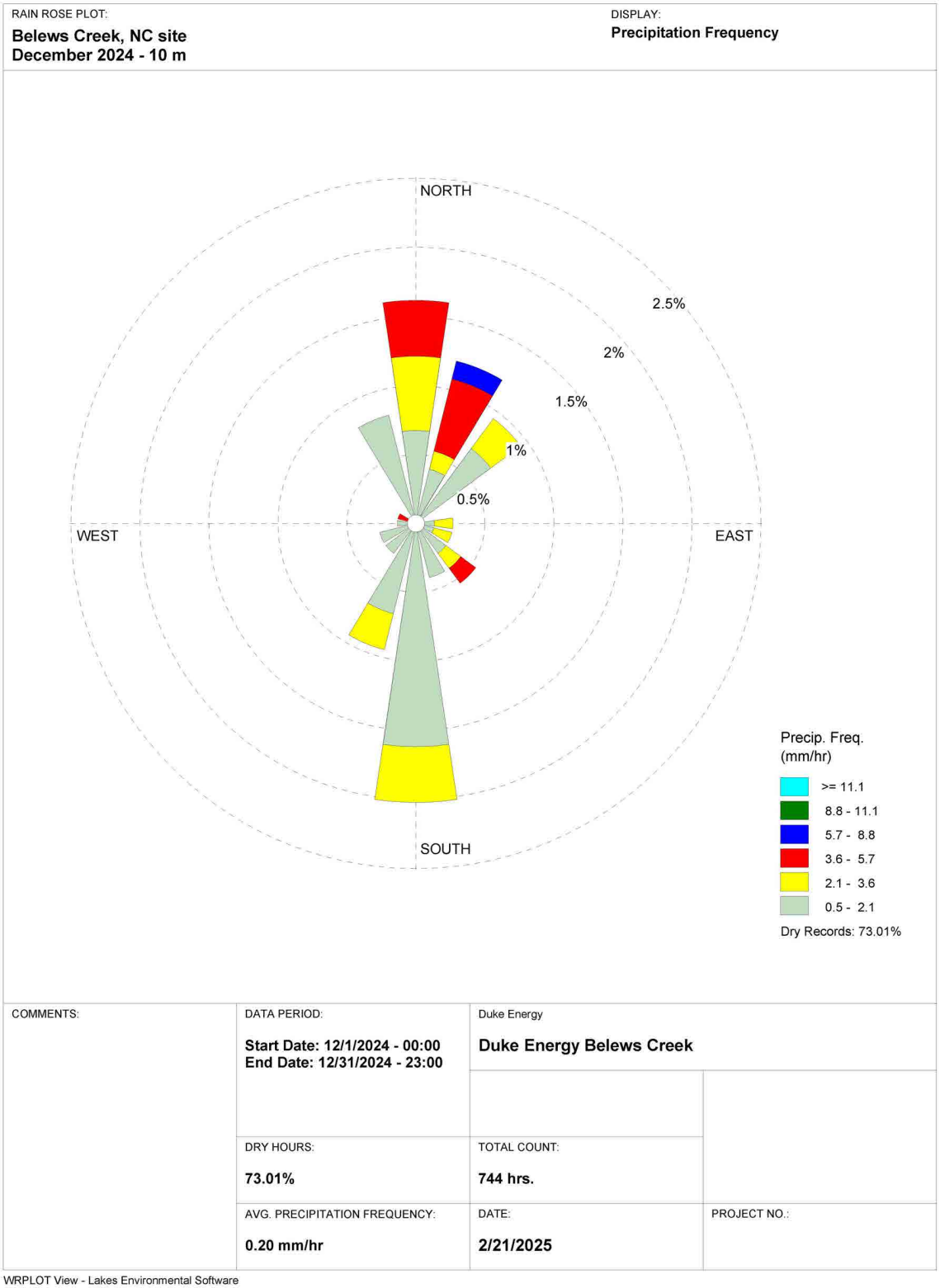
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-51
Precipitation Frequency Wind Roses for the Project Site (10 meters) November 2024



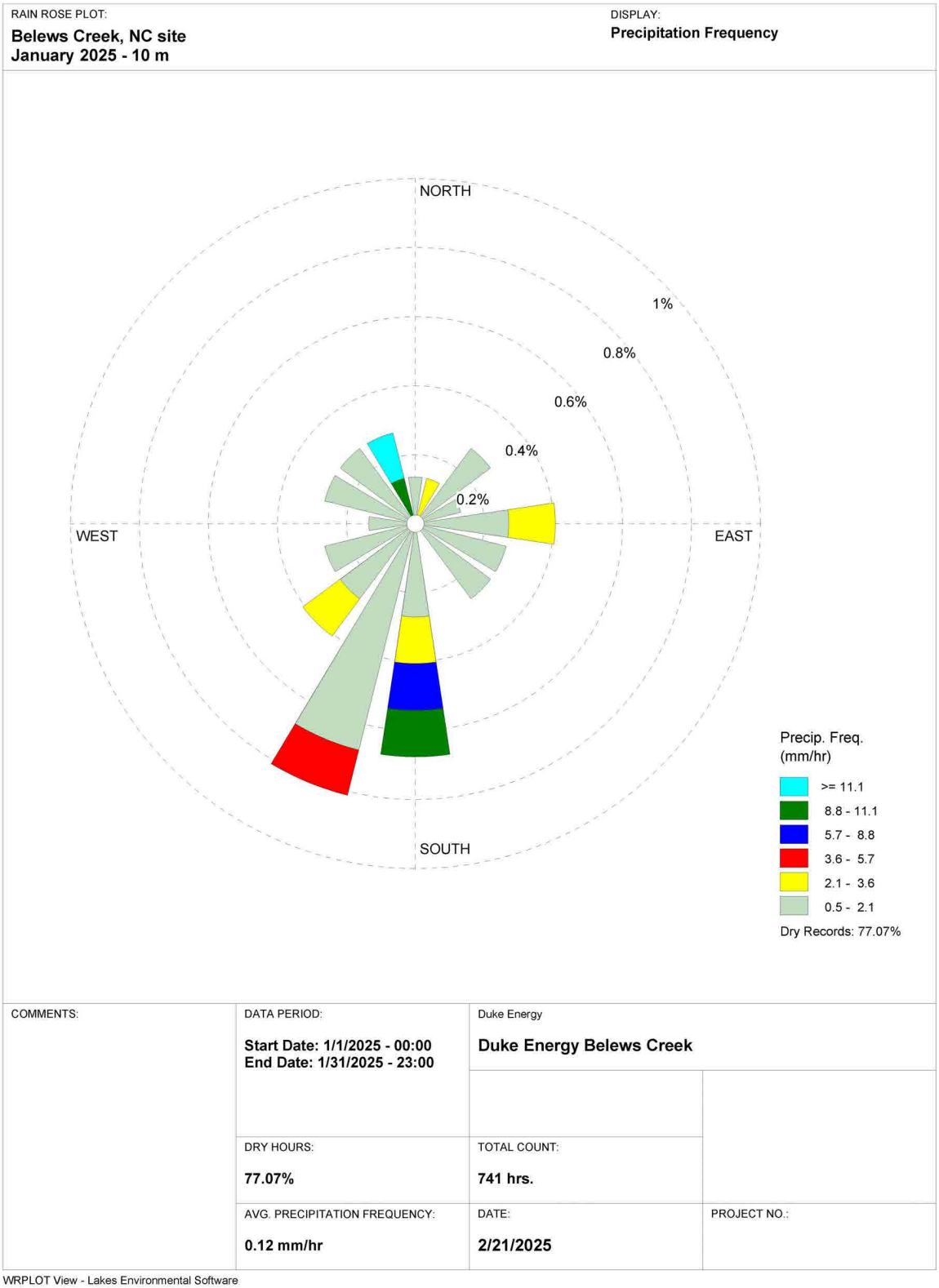
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-52
Precipitation Frequency Wind Roses for the Project Site (10 meters) December 2024



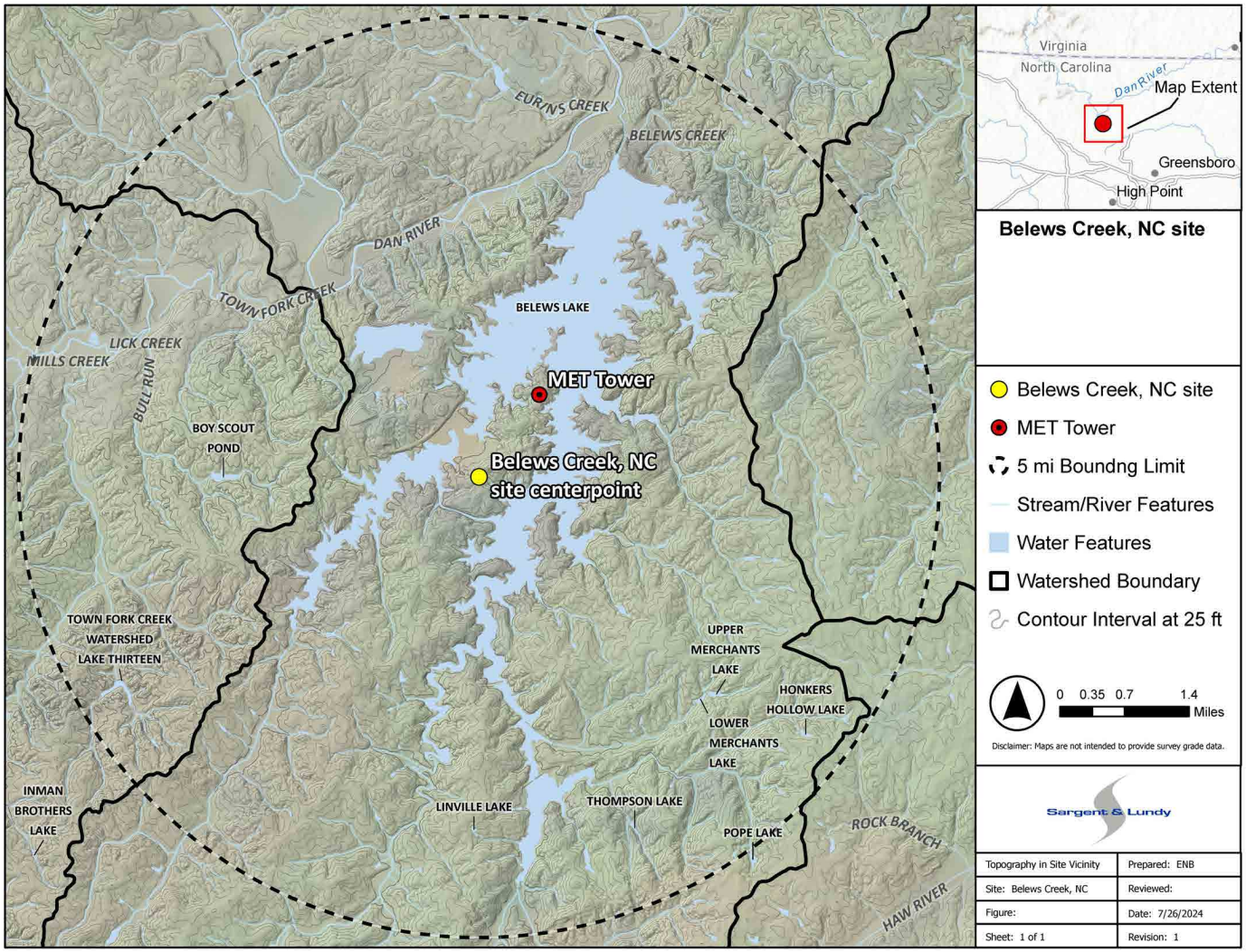
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-53
Precipitation Frequency Wind Roses for the Project Site (10 meters) January 2025



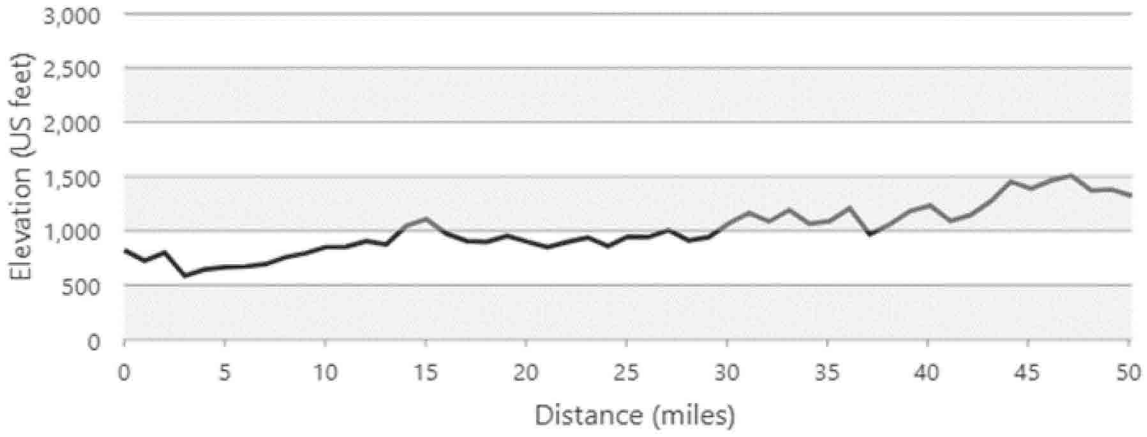
Key: hr. = hour; m = meter; mm/hr = millimeters per hour

Figure 2.7-54
Topography within 5-Mile Radius of the Project Site

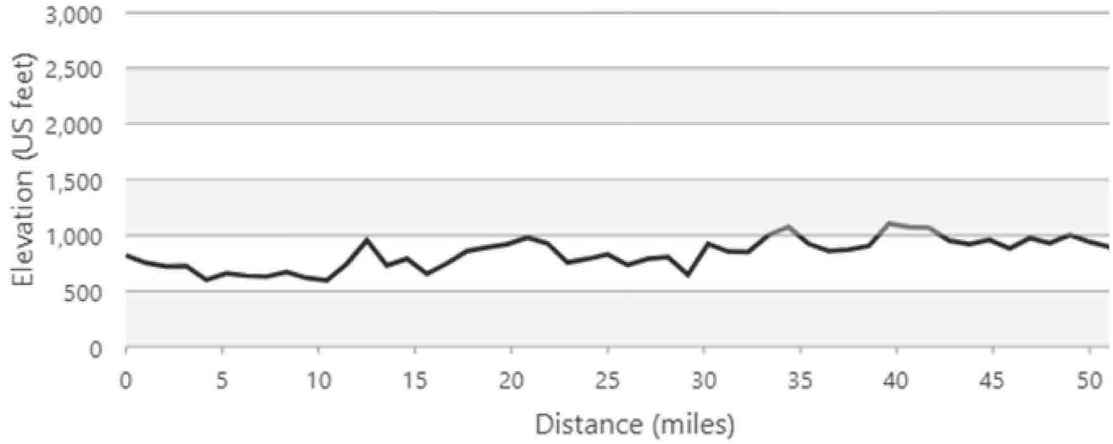


Key: ft = feet; MET = meteorological; NC = North Carolina

Figure 2.7-55
Elevation Profiles 0 to 50-Miles from the Project Site
North and North-Northeast

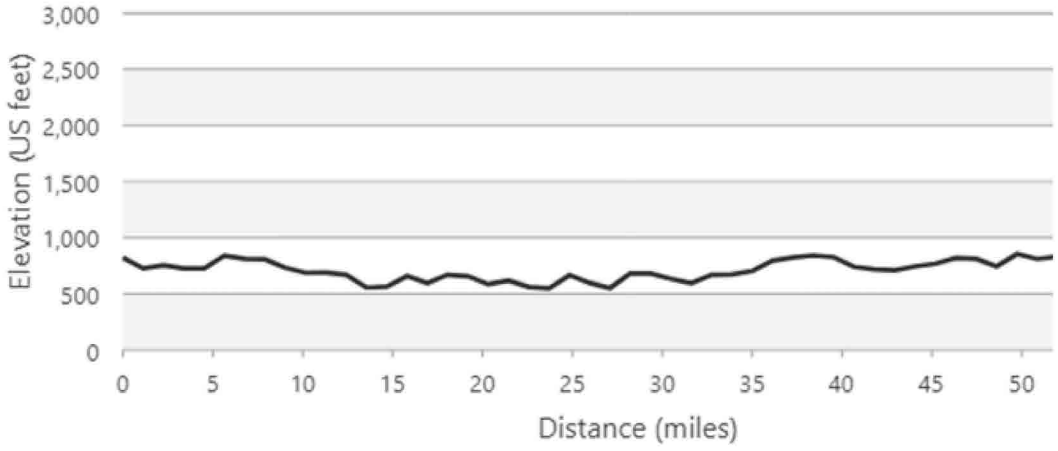


North

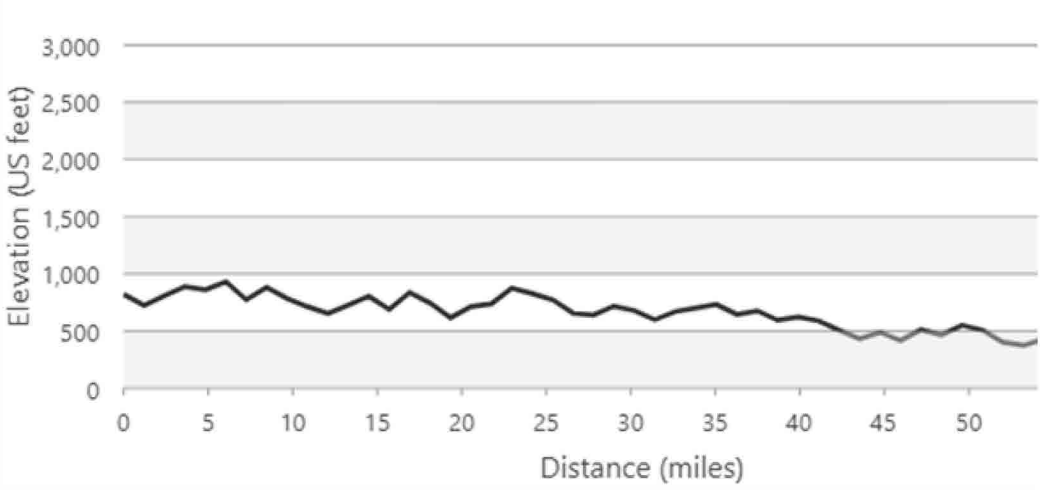


North Northeast

Figure 2.7-56
Elevation Profiles 0 to 50-Miles from the Project Site
Northeast and East-Northeast

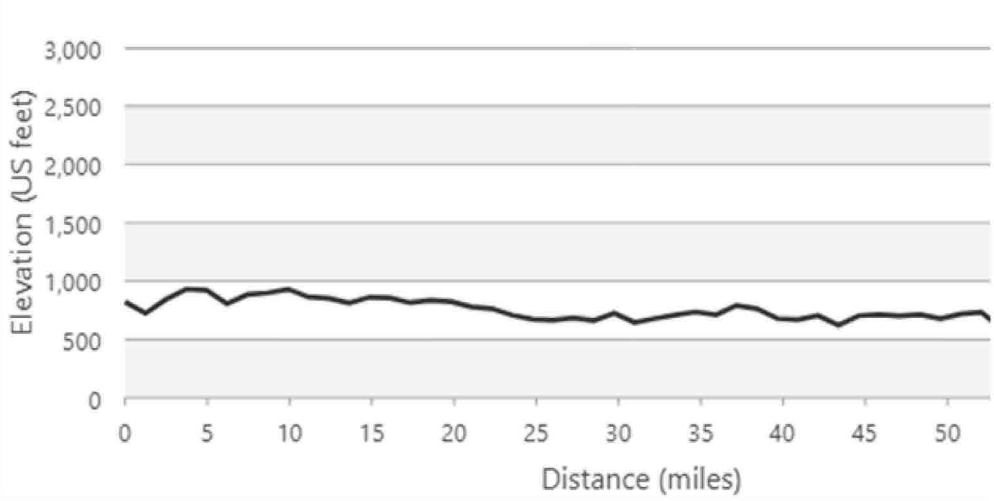


Northeast

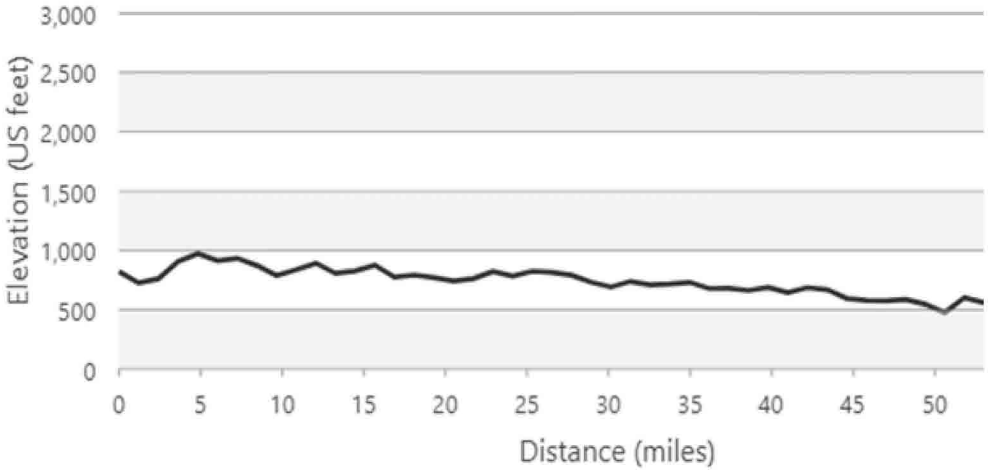


East Northeast

Figure 2.7-57
Elevation Profiles 0 to 50-Miles from the Project Site
East and East-Southeast

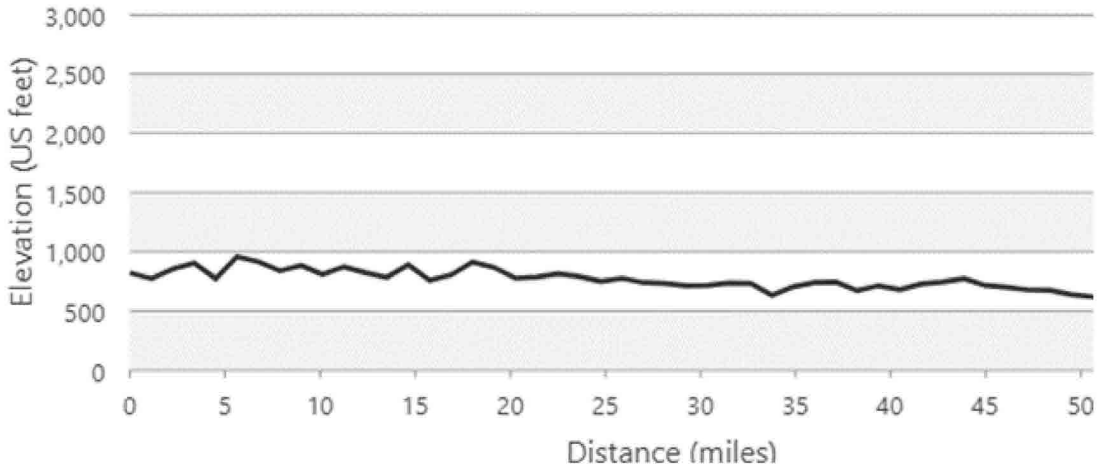


East

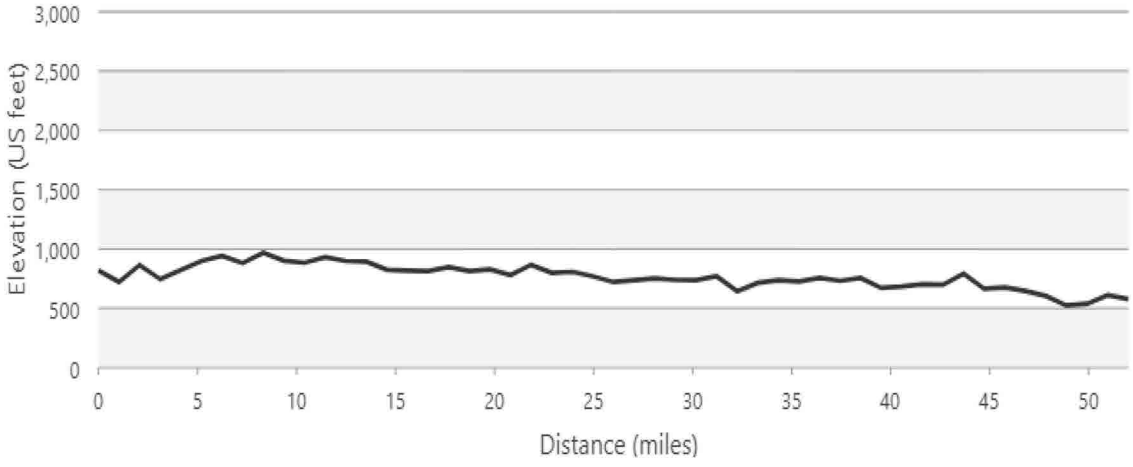


East Southeast

Figure 2.7-58
Elevation Profiles 0 to 50-Miles from the Project Site
Southeast and South-Southeast

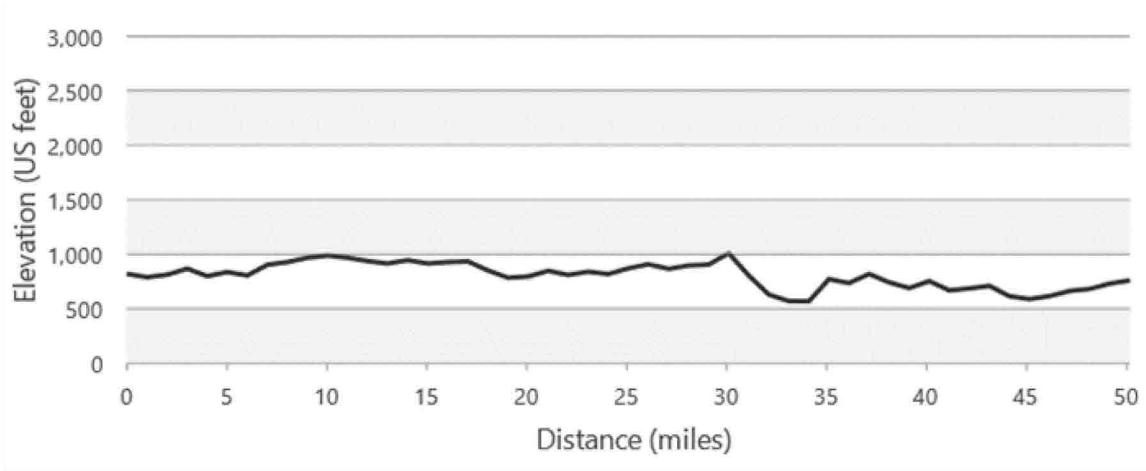


Southeast

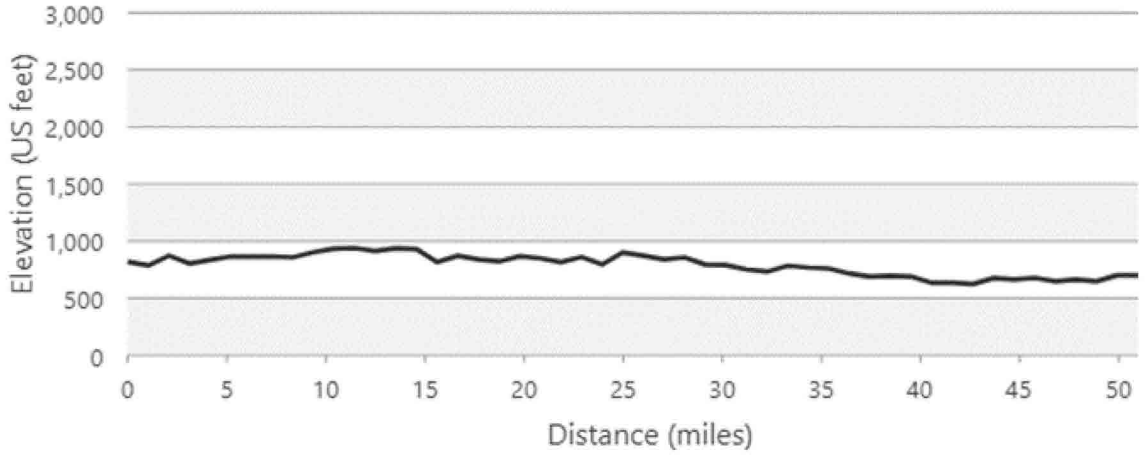


South Southeast

Figure 2.7-59
Elevation Profiles 0 to 50-Miles from the Project Site
South and South-Southwest

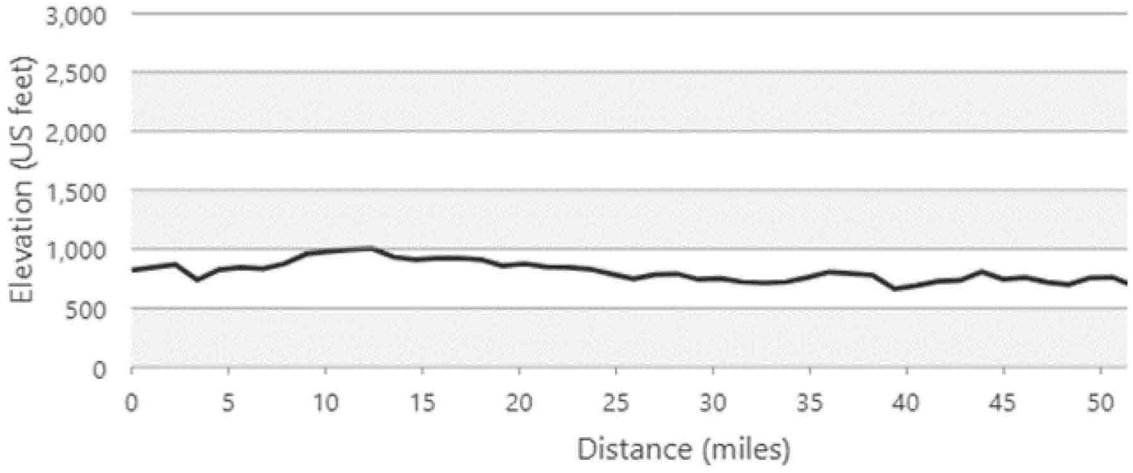


South

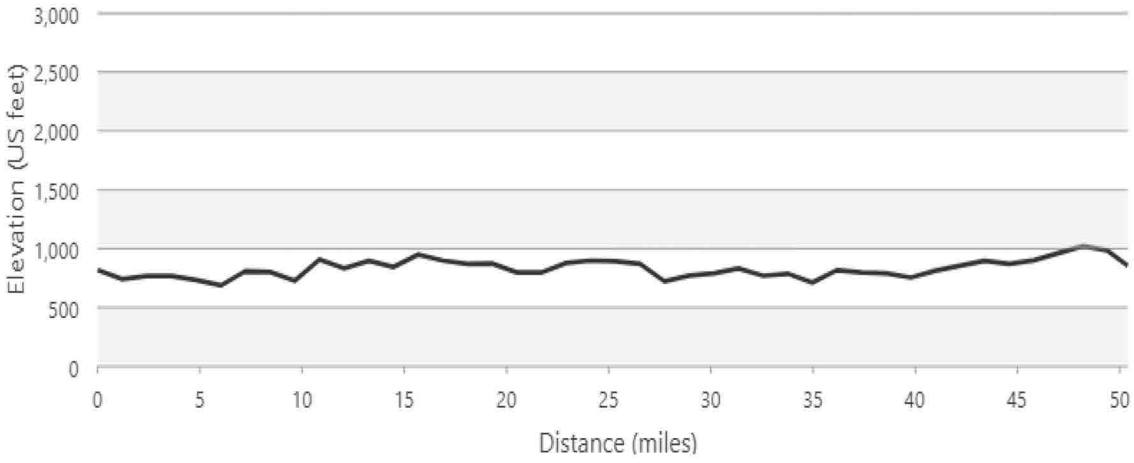


South Southwest

Figure 2.7-60
Elevation Profiles 0 to 50-Miles from the Project Site
Southwest and West-Southwest

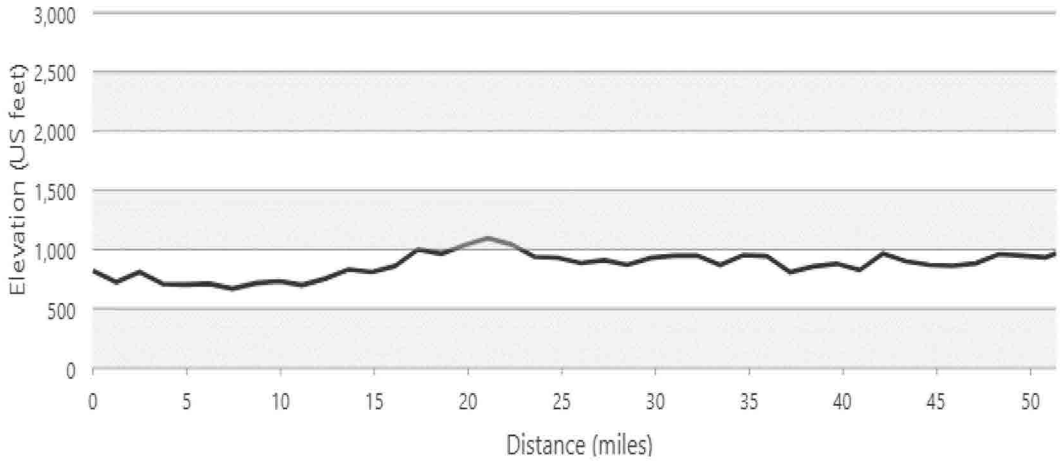


Southwest

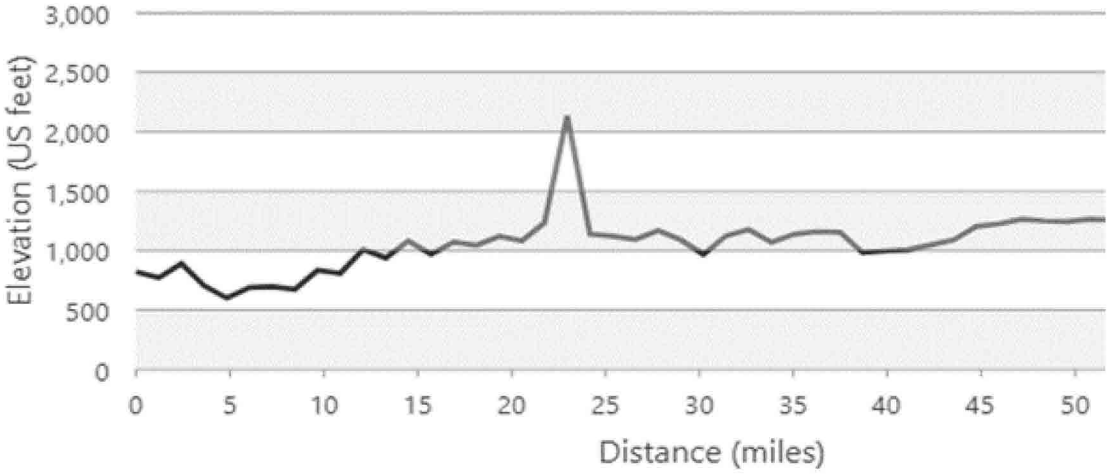


West Southwest

Figure 2.7-61
Elevation Profiles 0 to 50-Miles from the Project Site
West and West-Northwest

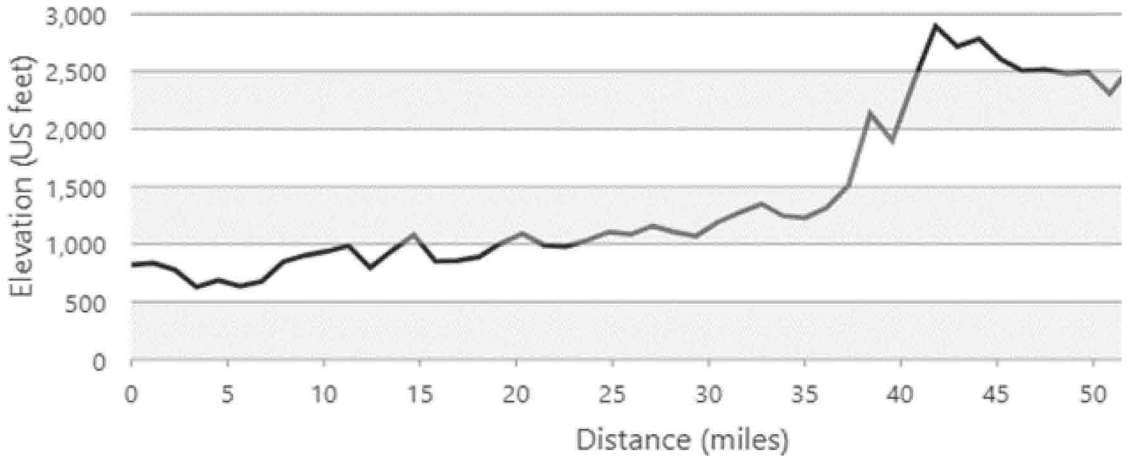


West

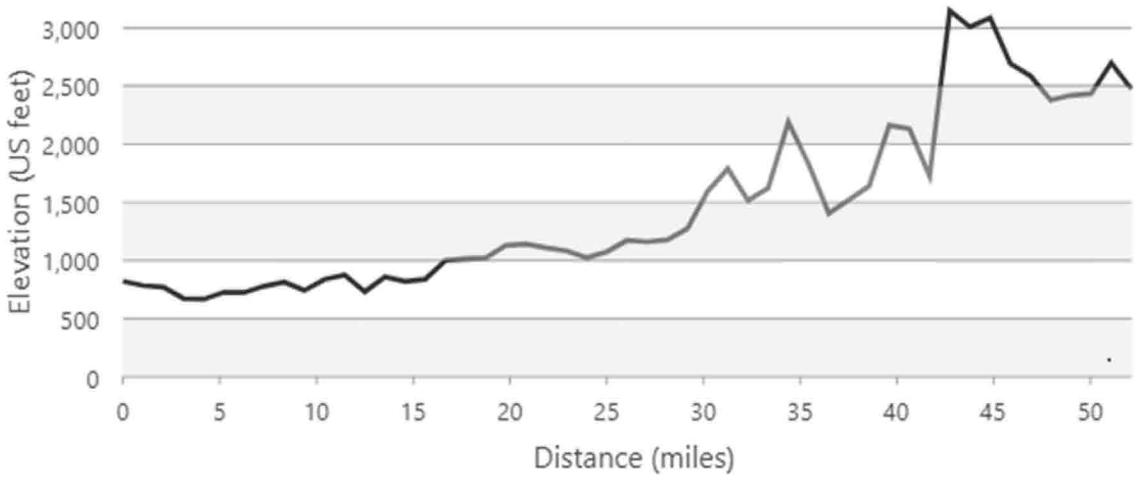


West Northwest

Figure 2.7-62
Elevation Profiles 0 to 50-Miles from the Project Site
Northwest and North-Northwest

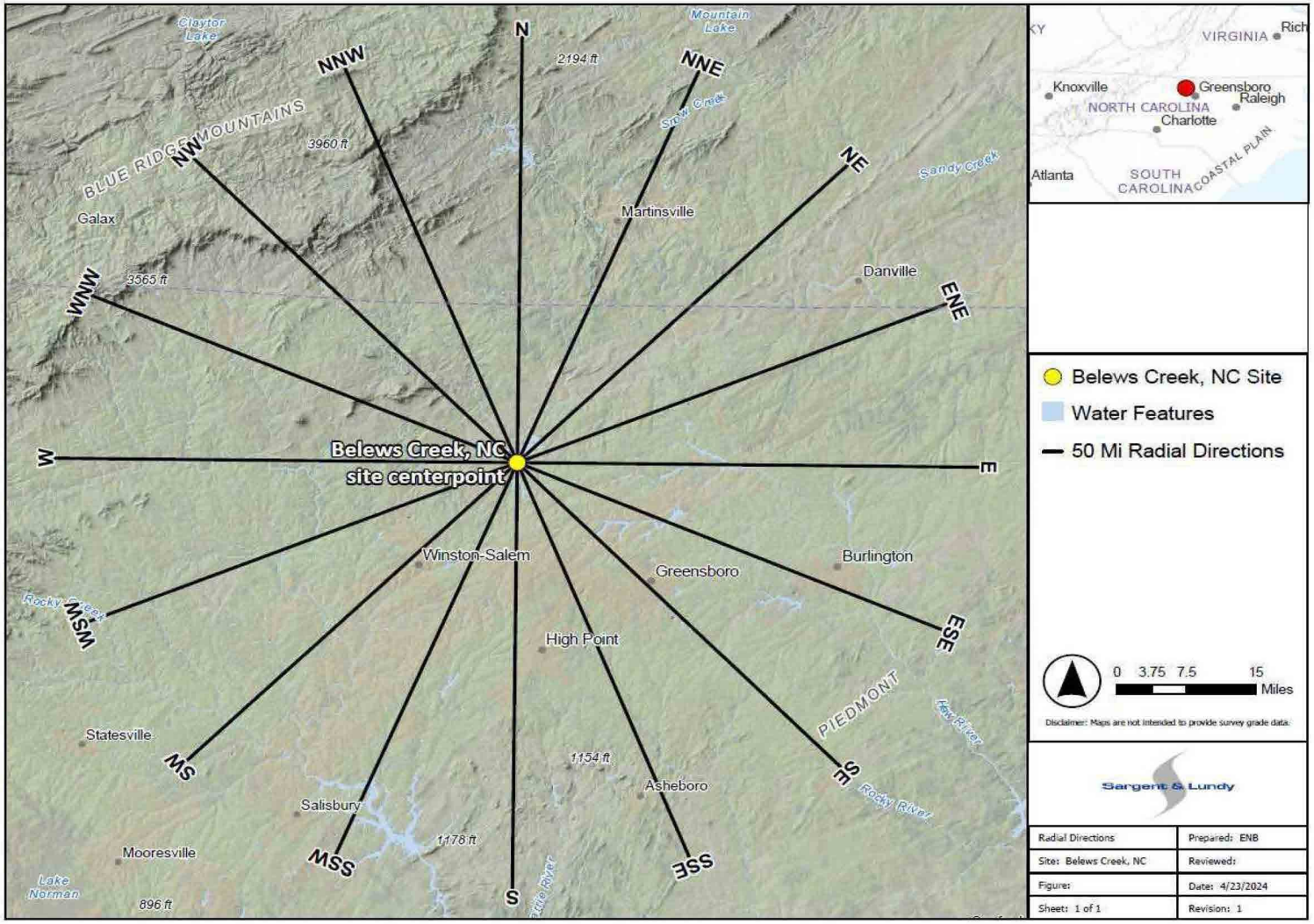


Northwest



North Northwest

Figure 2.7-63
Topographic Map of Elevation Profile Radials



Key: E = east; ENE = east-northeast; ESE = east-southeast; mi= mile; N = north; NC = North Carolina; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest

Figure 2.7-64
Belews Creek North Plant Complex Unrestricted Area Boundary Distances

Figure 2.7-65
Belews Creek Middle Plant Complex Unrestricted Area Boundary Distances

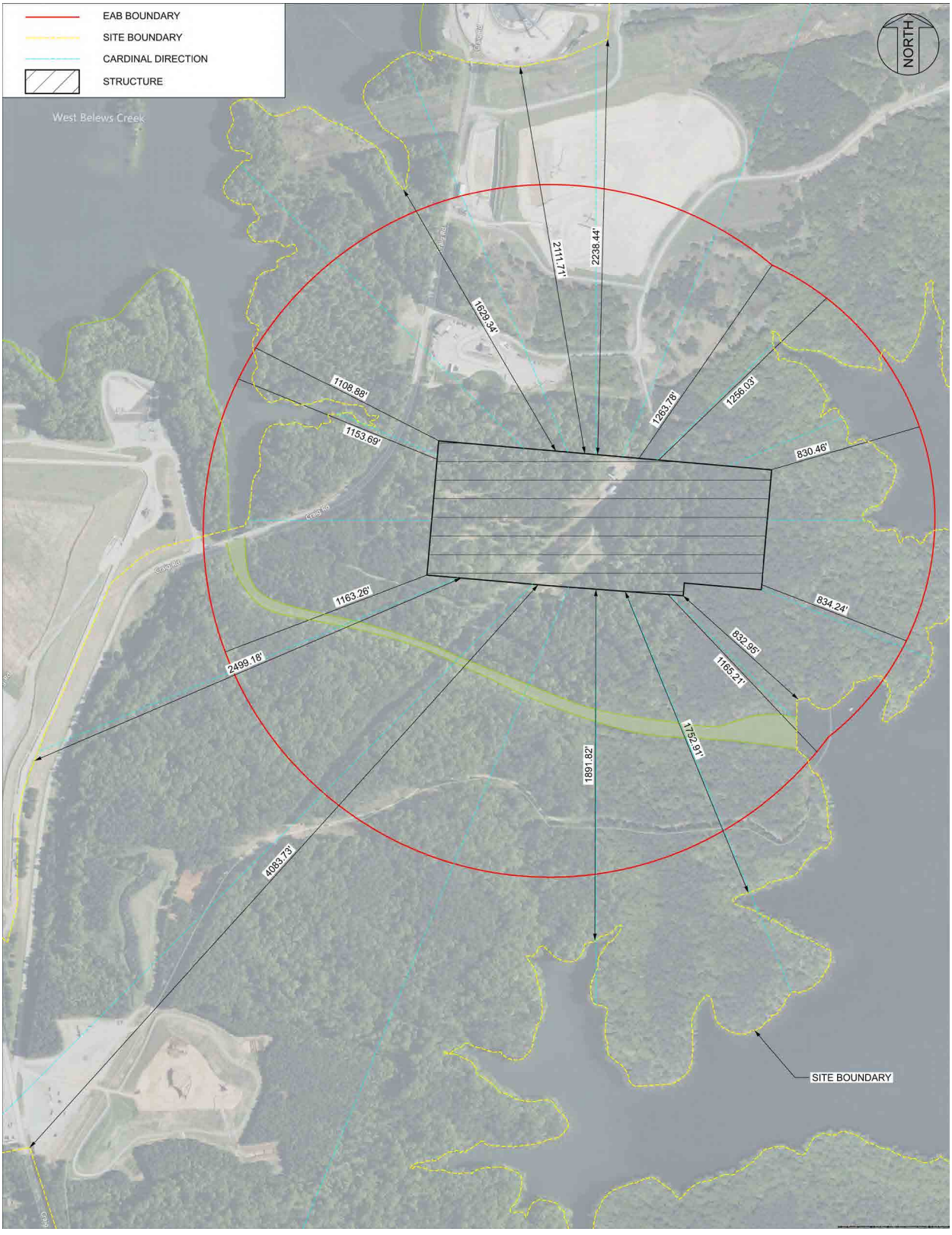


Figure 2.7-66
Belews Creek South Plant Complex Unrestricted Area Boundary Distances

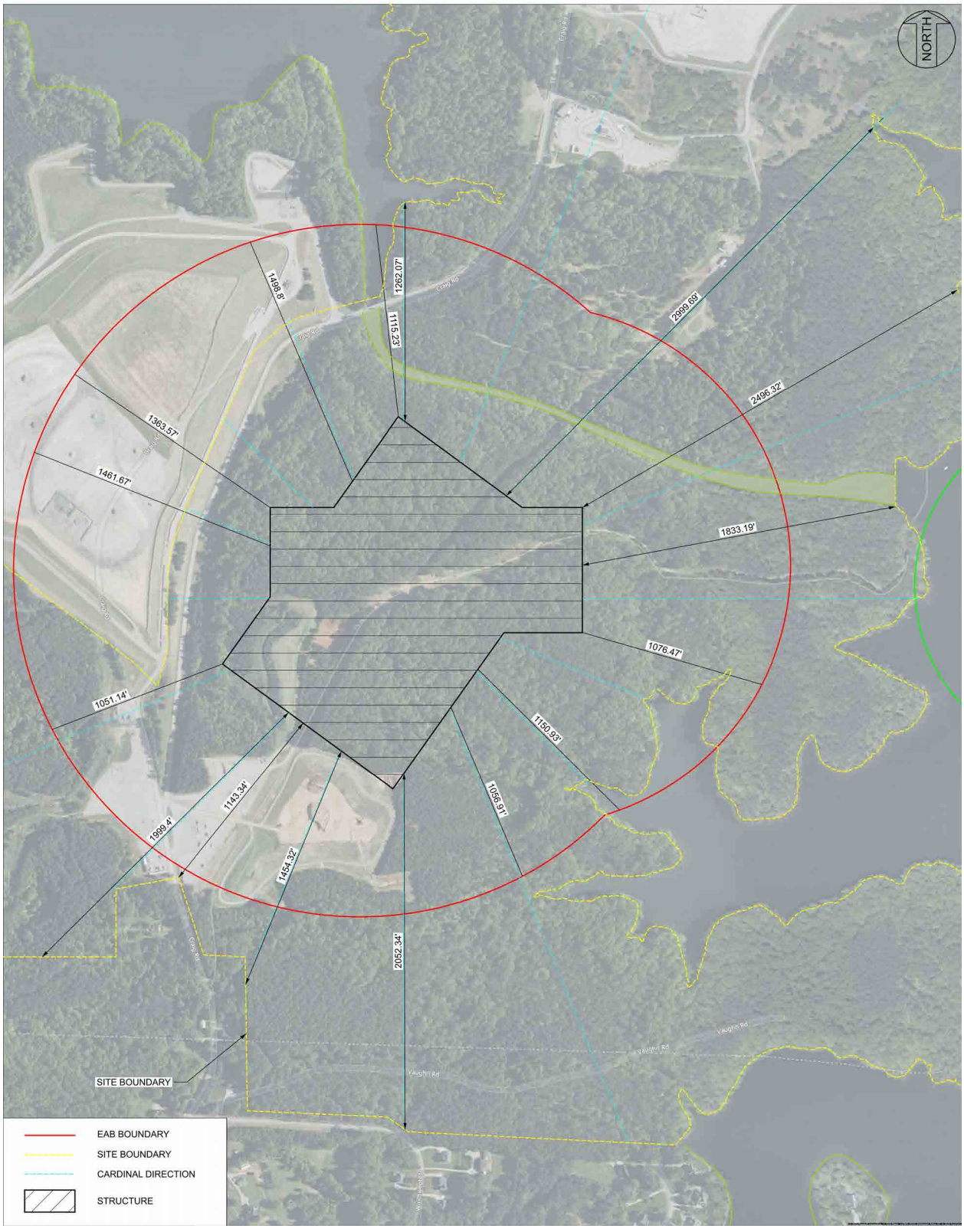
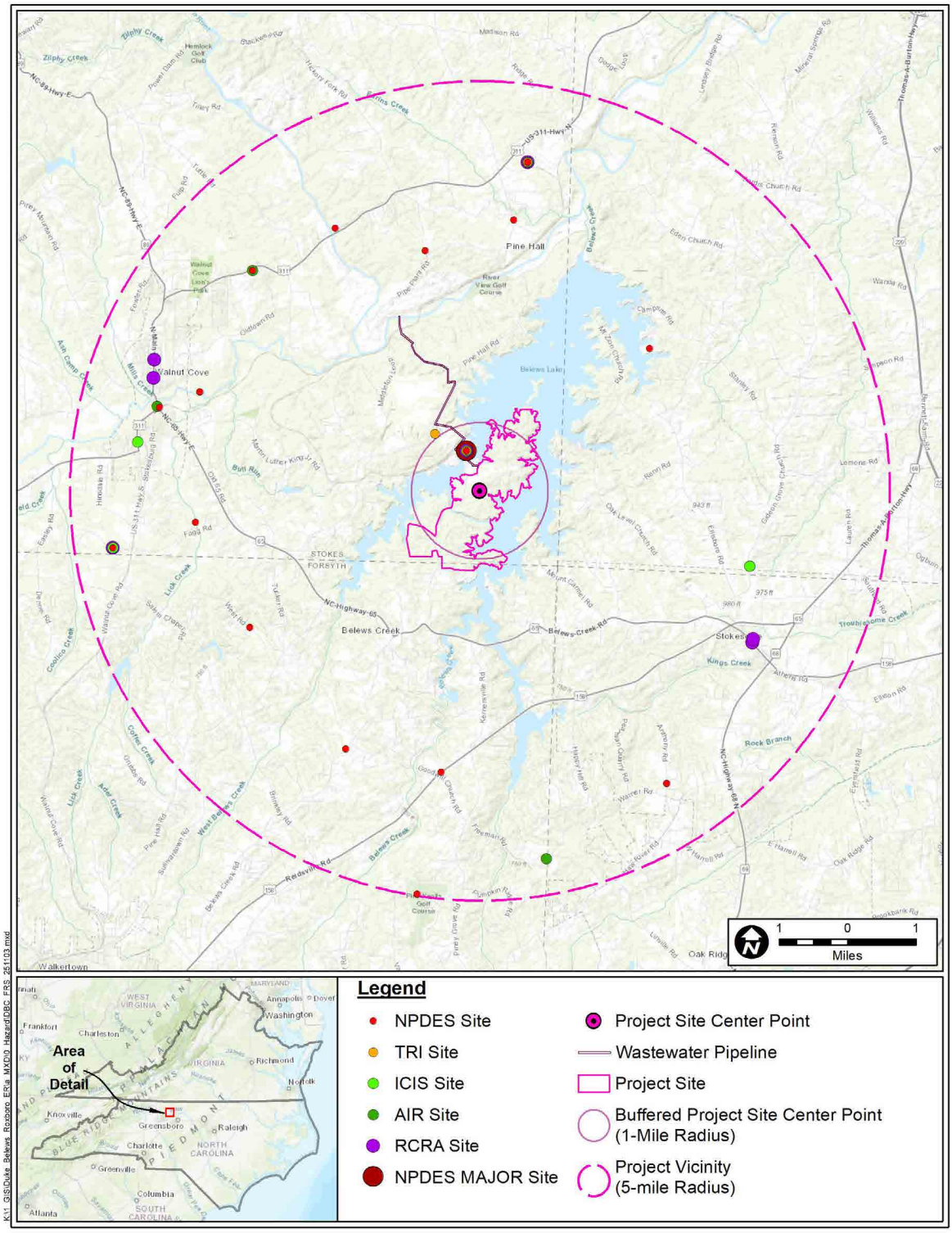
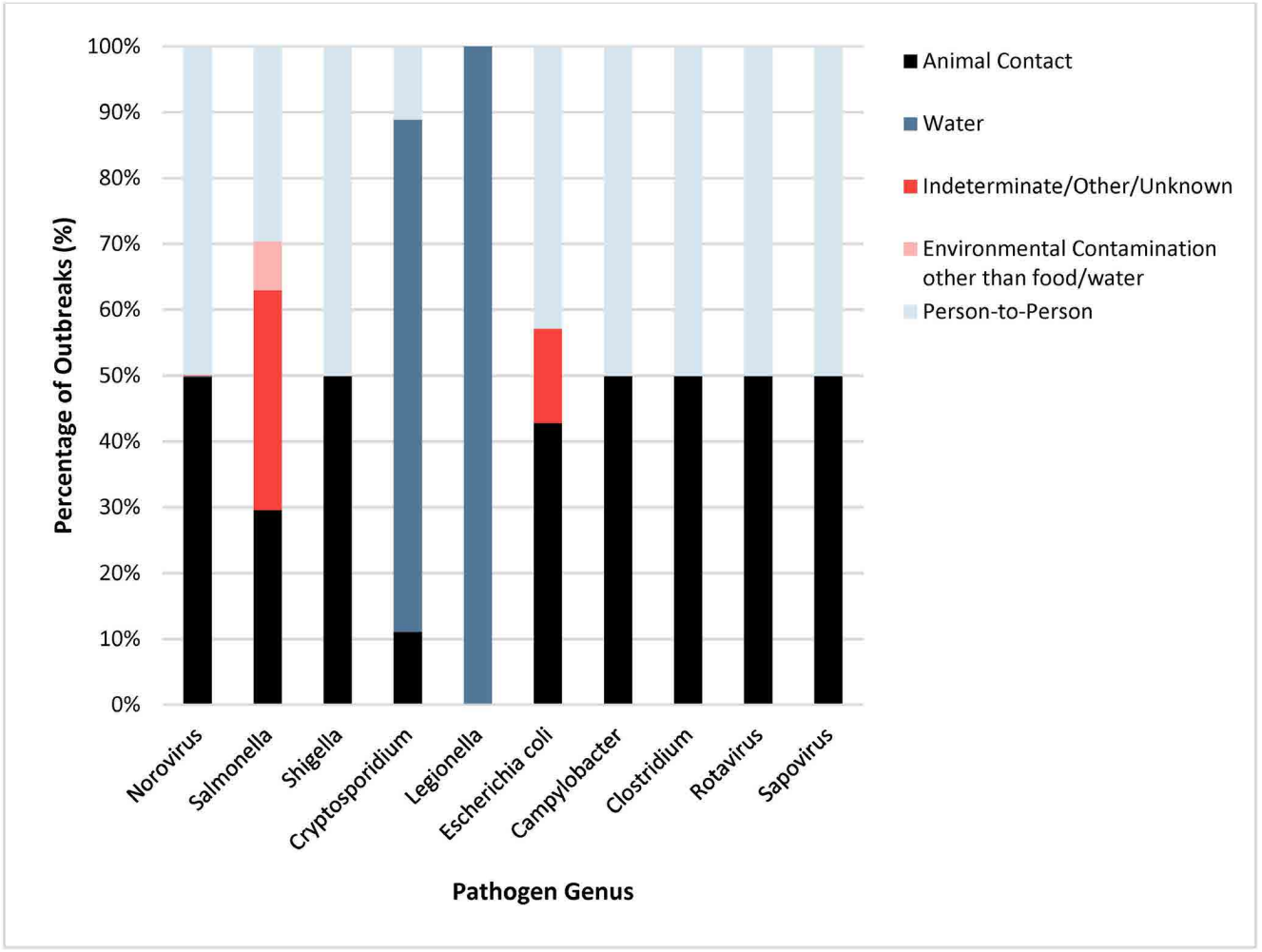


Figure 2.8-1
2021Regulated Pollutant Releases Within the Project Region and Vicinity



Key: AIR = Integrated Compliance Information System for Air; ICIS = Integrated Compliance Information System; NPDES = National Pollutant Discharge Elimination System; RCRA = Resource Conservation and Recovery Act; TRI = Toxics Release Inventory

Figure 2.8-2
Mode of Contamination of Pathogen Outbreaks in North Carolina, from 2011 to 2021



Source: CDC, 2023

Figure 2.8-3
Noise Monitoring Locations

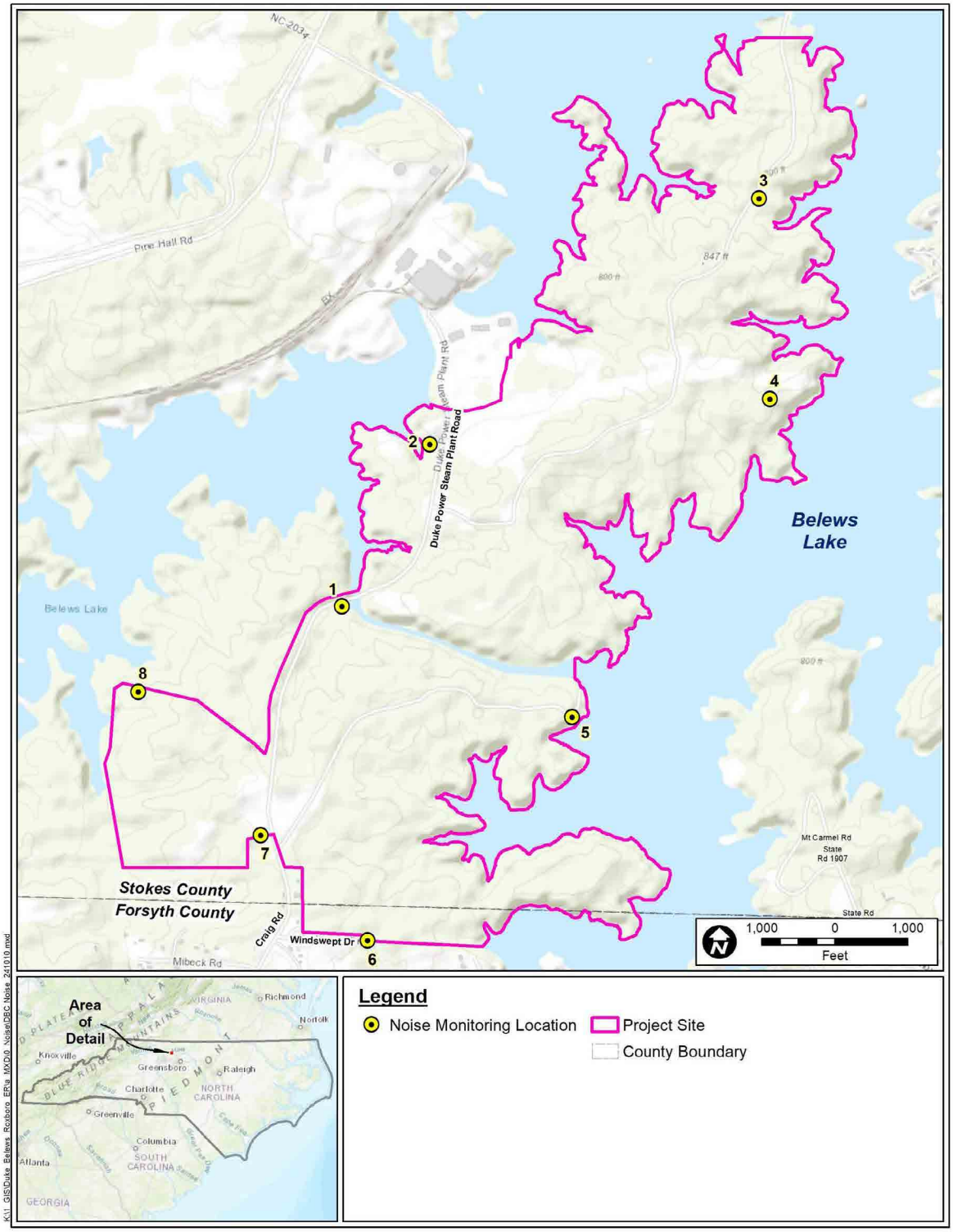


Figure 2.10-1
Physiographic Provinces Within the Project Region

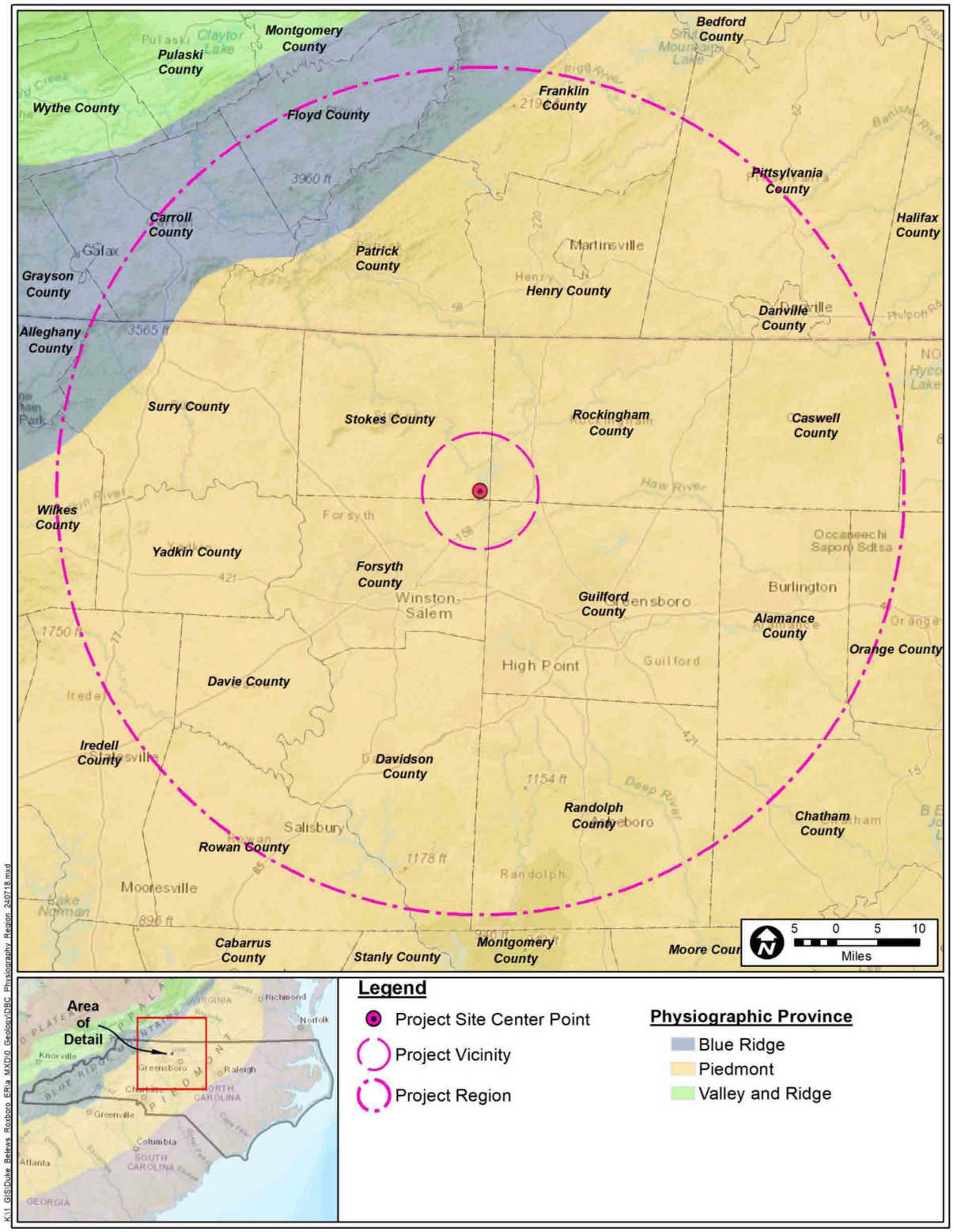


Figure 2.10-2
Project Vicinity Terranes and Major Geological Features

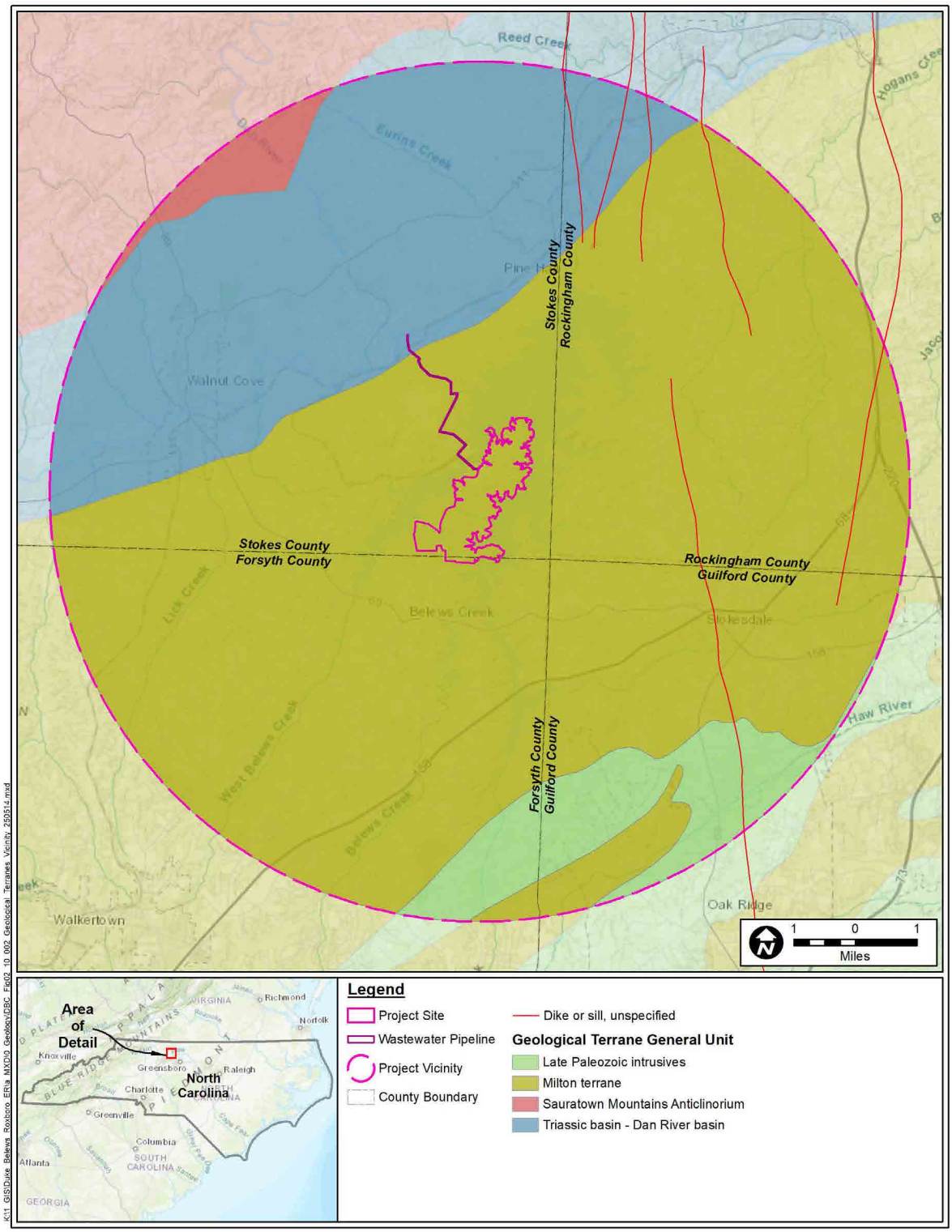


Figure 2.10-3
Geologic Map

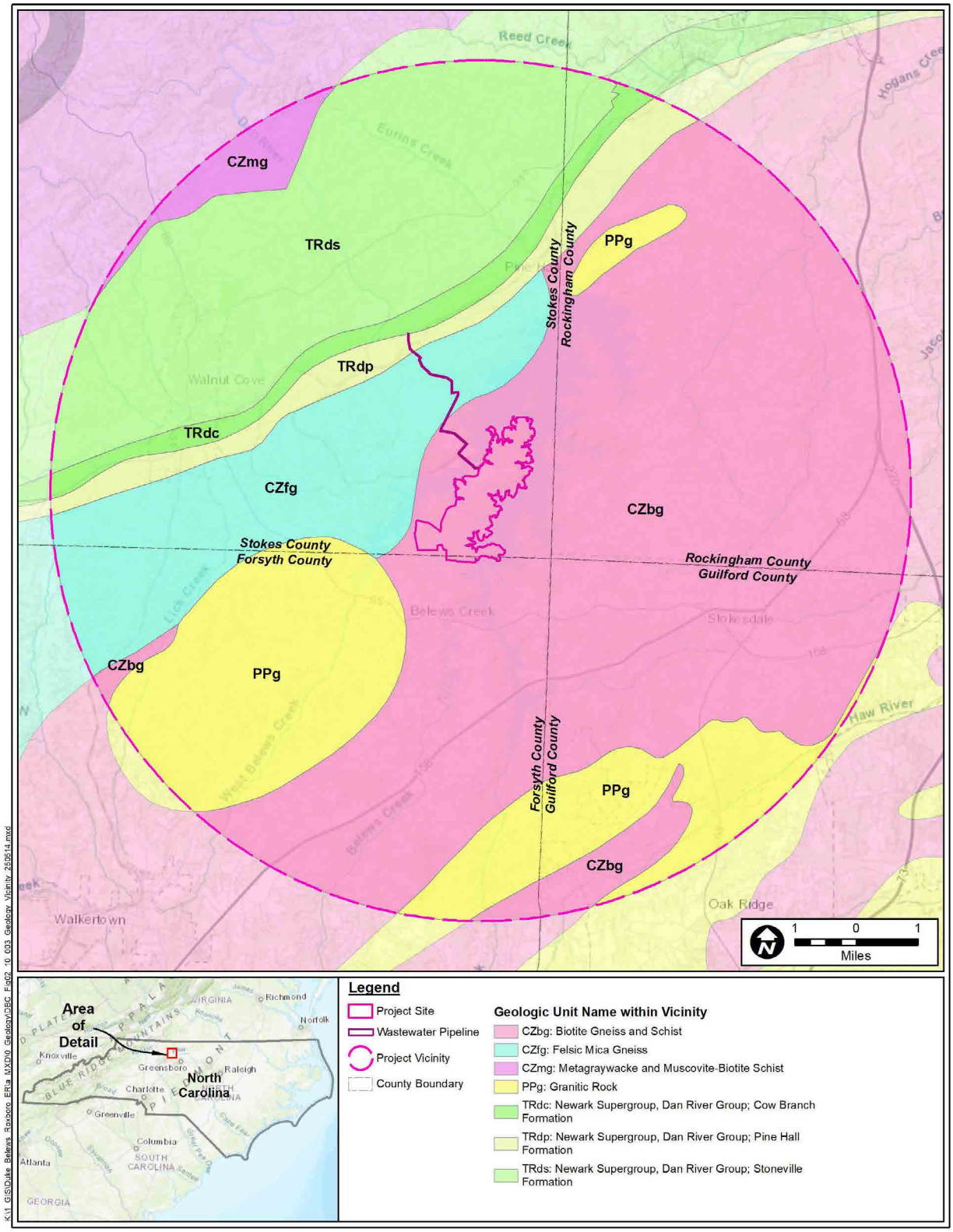
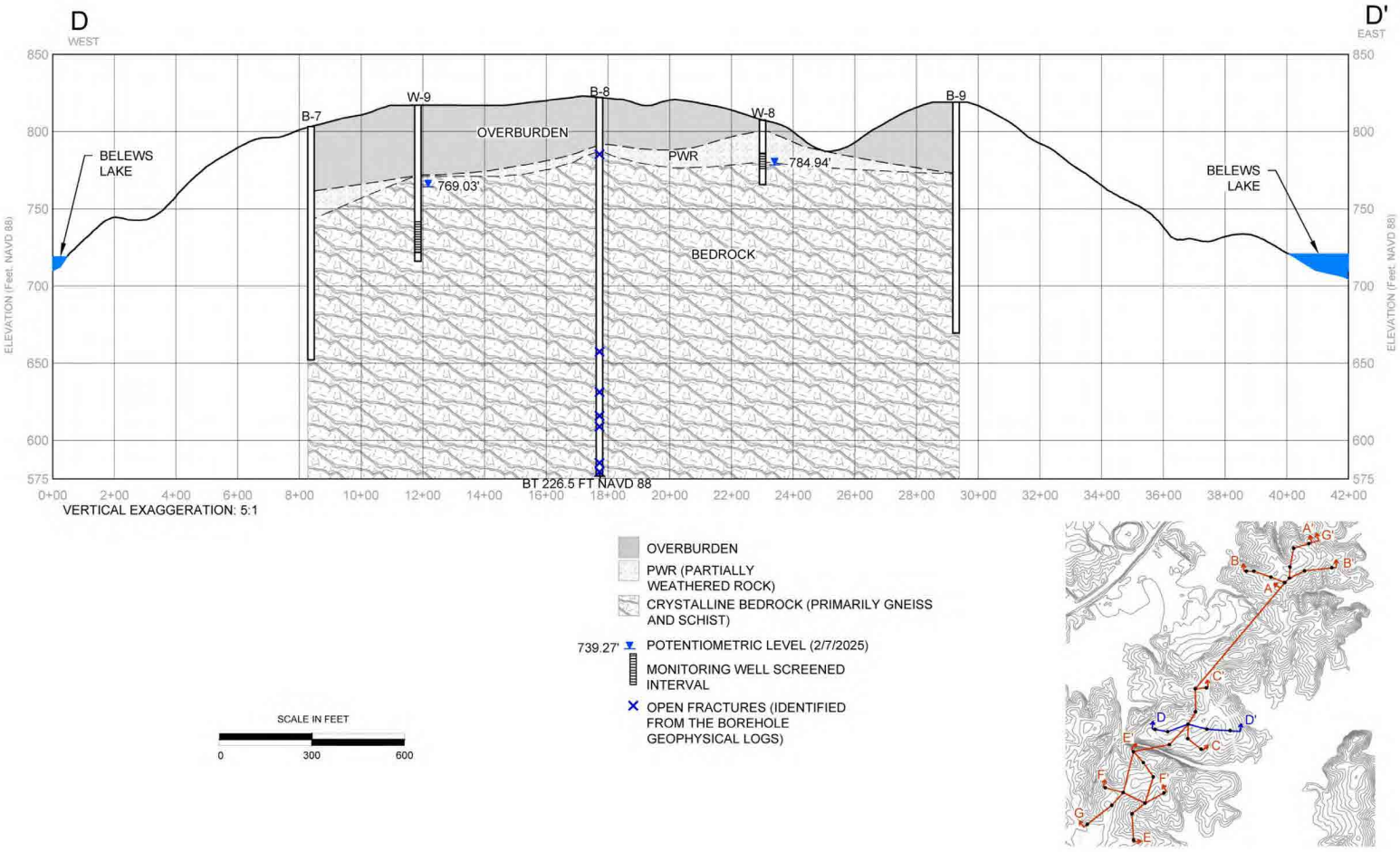


Figure 2.10-4
Project Site Stratigraphy



Key: PWR = partially weathered rock

CHAPTER 3
SITE LAYOUT AND PROJECT DESCRIPTION

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GLOSSARY

Term	Definition
°C	degree Celsius
°F	degree Fahrenheit
ac.	acre
ACSR	aluminum conductor steel reinforced
ALARA	as low as is reasonably achievable
API	American Petroleum Institute
BCSS	Belews Creek Steam Station
BIL	basic insulation level
Btu	British thermal unit
Btu/hr	British thermal unit per hour
B/W	Black and White
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci/yr	Curies per year
COL	Combined License
CP	Construction Permit
CWA	Clean Water Act
CWS	circulating water system

Term	Definition
dBA	A-weighted scale decibel
Duke Energy	Duke Energy Carolinas, LLC
EAB	exclusion area boundary
ESF	engineering safety features
ESP	Early Site Permit
ESPA	Early Site Permit Application
FGD	Flue Gas Desulfurization
ft.	feet
ft/s	feet per second
gpd	gallons per day
gpm	gallons per minute
GVH	GE Vernova Hitachi Nuclear Energy
ha	hectare
HALEU	high-assay, low-enriched uranium
Holtec	Holtec International
hr.	hour
HVAC	heating, ventilation, and air conditioning
ISFSI	independent spent fuel storage installation

Term	Definition
kg	kilogram
km	kilometer
kV	kilovolt
lb.	pound
LHV	lower heating value
LLW	low-level waste
LRB	Lined Retention Basin
m	meter
mm	millimeter
m/s	meter per second
m^3	cubic meter
m^3/min	cubic meter per minute
m^3/s	cubic meter per second
MDCT	mechanical draft cooling towers
mi.	mile
min.	minute
MMBtu	million British thermal units
MMBTU/hr	million British thermal units per hour

Term	Definition
MW	megawatt
MWD/MTU	megawatt days per metric ton of uranium
MWe	megawatts electric
MWIS	Makeup Water Intake Structure
MWt	megawatts thermal
NC	North Carolina
NCAC	North Carolina Administrative Code
NCDEQ	North Carolina Department of Environmental Quality
NDA	net disturbance area
NEI	Nuclear Energy Institute
NESC	National Electrical Safety Code
NS	Norfolk Southern
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NuScale	NuScale Power, LLC
NUREG	NRC Technical Report designation
PPE	plant parameter envelope
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc.

Term	Definition
Project site	Belews Creek, NC site
psig	pound per square inch gauge
RCRA	Resource Conservation and Recovery Act
RG	Regulatory Guide
ROW	right-of-way
SMR	small modular reactor
SQG	Small Quantity Generator
SSCs	structures, systems, and components
TerraPower	TerraPower, LLC
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WEC	Westinghouse Electric Company, LLC
X-energy	X-energy, LLC
yr.	year

Chapter 3 Site Layout and Project Description

3.0 INTRODUCTION

The Belews Creek, North Carolina (NC) site (Project site) proposed plant layout, design, and activities required to build and operate the plant are described in this chapter.

The Project site is located adjacent to the existing Belews Creek Steam Station (BCSS). Because of the proximity to BCSS, the Project site uses some existing infrastructure, including transmission corridors and switchyard, access roads, and water resources. A description of the associated structures and facilities as well as the physical activities involved in building and operating the proposed plant are provided. The chapter is divided into four sections:

- Proposed External Appearance and Plant Layout (Section 3.1)
- Proposed Plant Structures, Systems, and Components (Section 3.2)
- Building Activities (Section 3.3)
- Operational Activities (Section 3.4)

Because the specific reactor technology has not been selected, a plant parameter envelope (PPE) is used to bound key siting-related features. The bounding values and information from the PPE, presented in this chapter, are used as the basis for the evaluation of environmental effects.

3.1 EXTERNAL APPEARANCES AND PLANT LAYOUT

This section describes the overall appearance of the proposed plant layout and all associated facilities. Section 3.1.1 provides an overview of the Project site, while Section 3.1.2 details the PPE. Sections 3.1.3 and 3.1.4 outline the existing units, structures, and facilities, as well as the shared structures and facilities. Section 3.1.5 presents the proposed plant layout and site modifications.

3.1.1 PROJECT SITE

The Project site consists primarily of undeveloped forested land consisting of rolling hills and steep slopes, with surface elevations varying from near the shoreline of Belews Lake to higher ridgetops as described in Section 2.1.1.3. A topographic map of the site is provided in Figure 2.1-10.

Located on a peninsula, the Project site is bordered by Belews Lake to the north, east, and much of the west. It also lies adjacent to the existing BCSS, which is west of the Project site. Section 1.1.2 provides additional details of the site location, while Section 2.1.1 outlines the surrounding region and vicinity.

Belews Lake, described in Section 2.2.1.1.3, serves as a cooling reservoir for the BCSS, a dual-fuel coal and natural gas power generation facility. Duke Energy, Carolinas, LLC (Duke Energy) owns all the land within and immediately adjacent to Belews Lake.

The Project site encompasses approximately 1187 acres (ac.) (480 hectares [ha]) with the general arrangements shown in Figure 3.1-1. It includes the site boundary, Plant Complexes, cooling tower areas, permanently disturbed laydown areas, and other supporting facilities. Space is reserved for a future independent spent fuel storage installation with additional information provided in Section 3.4.2.2.

3.1.2 PLANT PARAMETER ENVELOPE

As described in Chapter 1, Duke Energy is pursuing an Early Site Permit (ESP) to approve the Project site as suitable for deployment of advanced reactors located on up to three nuclear power Plant Complexes (each referred to as “Plant Complex”). The ESP application (ESPA) aims to assess the site’s suitability to accommodate construction and operation of advanced reactors. The ESPA does not specify a specific reactor technology at this stage but rather encompasses several reactor technologies considered that could be deployed on the site. Advanced reactor technologies under consideration are provided in Section 3.2.1.

The PPE was developed using guidance provided in the Nuclear Energy Institute (NEI) document NEI 10-01, Revision 1: *Industry Guideline for Developing a Plant Parameter Envelope in Support of an Early Site Permit*, as well as in Regulatory Guide (RG) 4.27, Revision 0, *Use of Plant Parameter Envelope in Early Site Permit Applications for Nuclear Power Plants*. The bounding value for each parameter identified in NEI 10-01 was determined through a review of vendor supplied information provided for each reactor technology.

The PPE incorporates information from reactor vendors for technologies under consideration to define a bounding surrogate facility. This approach considers all available vendor information to determine the bounding—maximum or minimum—values across parameters. These bounding parameters serve as input for the analyses needed to support the development of the ESPA

(NEI, 2012).

The final reactor technology selected for the Project site will undergo review during the construction permit or license application phase to ensure it falls within the bounds established by the PPE. This approach supports site suitability for a range of reactor technologies without requiring a commitment to a specific design at this stage.

The PPE for the Project site considers the bounding parameters from six different reactor technologies, as listed in Section 3.2.1. The site-related design parameters are provided in Table 3.1-1 and the site characteristics are listed in Table 3.1-2.

3.1.3 EXISTING GENERATION, STRUCTURES, AND FACILITIES

As described in Chapter 1, BCSS began operating in 1974 and is scheduled for retirement in the mid-2030s. Because the Project site is located adjacent to BCSS, existing grid connections and cooling resources will support the Project site. Additionally, there are disturbed areas of the Project site that are used to support BCSS operations. Figure 3.1-2 shows an aerial overlay of the existing generation, structures, and facilities located at and around the Project site.

Belews Lake is a man-made reservoir originally constructed to meet the cooling needs of BCSS as described in Section 2.2.1.1.3. As described in Section 3.4.1.1.2, Duke Energy built the Makeup Water Intake Structure (MWIS) in 2010 at the confluence of the Dan River and Belews Creek, off-site, to function as a lake makeup water system.

The existing wastewater consolidation sump, Lined Retention Basin (LRB), and the associated pipeline corridor extend beyond the Project site. As noted in Section 2.1.2, BCSS uses the wastewater pipeline as a permitted discharge point—referred to as Outfall 006—to discharge into the Dan River under the National Pollutant Discharge Elimination System (NPDES).

An existing 230 kilovolt (kV) switchyard and established transmission corridors currently serve BCSS and will support the Project site. However, a second 230 kV switchyard or multiple smaller 230 kV switchyards are required to fully support the Project. Additional details are provided in Section 3.2.4.

A Duke Energy-owned natural gas pipeline traverses the Project site that provides natural gas to the BCSS, noted in Section 2.1.1.3 and shown on Figure 2.1-1. Three double-circuit 230 kV transmission lines also cross the Project site. Duke Energy owns and operates the lines.

Figure 3.1-2 shows two landfills located on and off the Project site. The off-site Craig Road Landfill is detailed on Figure 2.2-25, while the on-site Flue Gas Desulfurization (FGD) Landfill is depicted on Figure 2.2-26.

The primary access roads into the Project site are already in place with additional smaller on-site and off-site access roads. The primary access to and from the Project site is from the south via Craig Road, as shown on Figure 3.1-3, which connects to State Highway 65 in Forsyth County. Rail lines are also present, which connect to the Norfolk Southern (NS) Railroad (NS, 2025).

3.1.4 SHARED STRUCTURES AND FACILITIES

Figure 3.1-3 provides a graphical representation of the shared structures and facilities listed below.

- 230 kV switchyard (off-site)
- Access roads (on- and off-site)
- Belews Lake (off-site)
- MWIS and associated piping (off-site)
- LRB (off-site)
- Wastewater pipeline to the Dan River (off-site)
- NPDES Outfall 006 (off-site)
- Perimeter security fencing (on- and off-site)
- Rail lines with connection to NS Railroad (on- and off-site)
- Sewage treatment lagoon (on-site)
- Transmission line corridor (on- and off-site)
- Wastewater consolidated sump (off-site)
- Wastewater redirection sump (off-site)

The shared infrastructure limits the overall land use impact and provides economic and beneficial reuse of these structures and facilities.

3.1.5 PROPOSED PLANT LAYOUT

The Project site can accommodate up to three separate, noncontiguous Plant Complexes, each containing multiple advanced reactors depending on the reactor technology selected. Because the layout of the Project site is not finalized, the exact location of the Project site center point and associated boundaries are yet to be determined. The proposed site center point is shown on Figure 3.1-1 and detailed in Table 2.1-8. The Plant site center point incorporates a bounding radius around the Project site such that the radius encompasses all safety-related features as described in Section 2.1.1.3.

The overall Project site layout, including proposed structures, acreages, and EAB is shown on Figure 3.1-1. The Project site spans approximately 1187 ac. (480 ha), with approximately 906 ac. (367 ha) designated for permanent disturbances, such as the power blocks, cooling towers, laydown areas, and switchyards. After completing construction activities, laydown areas used to support construction activities will remain disturbed areas and be used to support operations such as parking lots and related facilities.

The PPE bounding values and parameters for the Project site are listed in Table 3.1-1. The maximum structure height in the power block area, excluding the cooling tower(s) and facility stack(s) is 176 feet (ft.) (53.6 meters [m]) above grade as listed in the PPE. In general, buildings are constructed using standard building materials such as concrete, metal with metal siding, or wood with metal, vinyl, or other acceptable siding. The design and construction of building structures will take into consideration the surroundings to minimize aesthetic impacts.

The circulating water system is anticipated to include mechanical draft cooling towers (MDCT) with makeup water drawn from Belews Lake. The intake, discharge, and circulating water structures and systems are described in Section 3.2.2. Necessary upgrades and modifications to the transmission system noted in Section 3.1.3 are further detailed in Section 3.2.4.

The Project site is located on a primarily forested peninsula and development of this site will alter stormwater flow patterns. As part of site development, engineered stormwater controls are incorporated to manage runoff quantity and quality. Stormwater flow is diverted away from each Plant Complex by an engineered stormwater collection system. It includes a combination of swales, retention and detention basins, pipes, culverts, and sediment and erosion control measures designed to prevent discharge of pollutants to Belews Lake, the Dan River, and its tributaries. The stormwater system will be designed to accommodate site-specific topography, hydrologic conditions, and soil characteristics to ensure compliance with North Carolina Department of Environmental Quality (NCDEQ) NPDES requirements for both construction and post-construction phases.

Access to each Plant Complex is from the south via the existing Craig Road or from the west via Pine Hall Road/Duke Power Steam Plant Road. Duke Energy access roads, shown in Figure 3.1-3, which lead to the existing structures and facilities may require some widening and extending to support the Project site building and operation.

A meteorological tower is located on the northern portion of the peninsula and is further described in Section 2.7.4.

Figures 3.1-4 through 3.1-7 present renderings of the proposed plant layout. The renderings show the proposed Plant Complexes from multiple vantage points within the natural landscape of Belews Creek, NC.

The Project site leverages the use of existing infrastructure and resources to minimize adverse environmental effects. Additional details related to the proposed plant structures, systems, and components are provided in Section 3.2.

Table 3.1-1
Site-Related Design Parameters
(Sheet 1 of 5)

Parameter[(a)]	Definition	PPE Value	ER Section
1. Structures			
1.1 Building Characteristics			
1.1.1 Height	The height from finished grade to the top of the tallest power block structure, excluding cooling towers (excludes stairway towers, elevator, etc.).	176 feet	3.1, 5.4
1.1.2 Foundation Embedment	The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure.	125 feet	3.3
3. Normal Plant Heat Sink			
3.1 Condenser			
3.1.2 Condenser / Heat Exchanger Duty	Design value for the waste heat rejected to the circulating water system across the condensers.	1.32E+10 Btu/hr	3.2, 5.7
3.2 Nonsafety-Related Service Water Systems			
3.2.2 SW Heat Exchanger Duty	The heat transferred to the nonsafety-related service water system for rejection to the environment.	2.05E+08 Btu/hr (normal) 5.86E+08 Btu/hr (max)	3.2
3.2.3 Miscellaneous Plant Water Uses Intake	The maximum, and normal, water intake of the plant neglecting cooling tower makeup, potable/sanitary water users, and liquid radwaste treatment.	1080 gpm (max) 300 gpm (normal)	3.2, 3.4
3.2.4 Miscellaneous Plant Water Uses Discharge	The maximum, and normal, water discharge of the plant neglecting cooling tower makeup, potable/sanitary water users, and liquid radwaste treatment.	360 gpm (max) 102 gpm (normal)	3.2, 3.4
3.3 Mechanical Draft Cooling Towers			
3.3.1 Acreage	The land required for cooling towers, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.	10.8 acres Also see Figure 3.1-1	3.2
3.3.3 Blowdown Constituents and Concentrations	The maximum expected concentrations for anticipated constituents in the cooling water systems blowdown to the receiving water body.	See Table 3.4-3	3.4, 5.2, 5.7
3.3.4 Blowdown Flow Rate	The normal (and maximum) flow rate of the blowdown stream from the cooling water systems to the receiving water body for closed system designs	3852 gpm (normal) 6516 gpm (max)	3.2, 3.4
3.3.5 Blowdown Temperature	The maximum expected blowdown temperature at the point of discharge to the receiving water body.	95°F	3.2, 3.4
3.3.6 Cycles of Concentration	The ratio of total dissolved solids in the cooling water blowdown streams to the total dissolved solids in the make-up water streams.	6 minimum 8-12 normal operating range	3.2, 3.4, 5.7

Table 3.1-1
Site-Related Design Parameters
(Sheet 2 of 5)

Parameter[(a)]	Definition	PPE Value	ER Section
3.3.7 Evaporation Rate	The expected (and maximum) rate at which water is lost by evaporation from the cooling water systems.	26,256 gpm (normal) 32,580 gpm (max)	3.2, 3.4
3.3.8 Height	The vertical height above finished grade of mechanical draft cooling towers associated with the cooling water systems.	50-75 feet	3.2, 5.7
3.3.9 Makeup Flow Rate	The expected (and maximum) rate of removal of water from a natural source to replace water losses from Circulating Water System.	30,109 gpm (normal) 39,117 gpm (max)	3.2, 3.4
3.3.10 Noise	The maximum expected sound level produced by operation of cooling towers, measured at 1000 feet from the noise source.	55.1 dBA	2.8, 4.8, 5.8
3.3.11 Cooling Tower Temperature Range	The temperature difference between the cooling water entering and leaving the towers.	14.8°F - 21.2°F	3.2, 3.4
3.3.12 Cooling Water Flow Rate	The total cooling water flow rate through the condenser/heat exchangers.	676,000 gpm to 1,400,000 gpm	3.2
3.3.14 Maximum Consumption of Raw Water	The expected maximum short-term consumptive use of water by the cooling water systems (evaporation and drift losses).	32,601 gpm	3.2
3.3.16 Stored Water Volume	The quantity of water stored in cooling water system impoundments, basins, tanks and/or ponds.	12,000,000 gallons	3.2
3.3.17 Drift	Rate of water lost from the tower as liquid droplets entrained in the vapor exhaust air stream.	1.2 gpm (normal) 21 gpm (max)	3.2, 3.4
5. Potable Water/Sanitary Waste Systems			
5.1 Discharge to Site Water Bodies			
5.1.1 Flow Rate (Potable/Sanitary Normal)	The expected (normal) effluent flow rate from the potable/sanitary water system to the receiving water body.	11 gpm	3.2
5.1.2 Flow Rate (Potable/Sanitary Maximum)	The maximum effluent flow rate from the potable/sanitary water system to the receiving water body.	19 gpm	3.2
5.2 Raw Water Requirements			
5.2.1 Maximum Use	The maximum short-term rate of withdrawal from the water source for the potable and sanitary wastewater systems.	19 gpm	3.2
5.2.2 Monthly Average Use	The average rate of withdrawal from the water source for the potable and sanitary wastewater systems.	472,500 gallons per month	3.2

Table 3.1-1
Site-Related Design Parameters
(Sheet 3 of 5)

Parameter[(a)]	Definition	PPE Value	ER Section
6. Demineralized Water System			
6.1 Discharge to Site Water Bodies			
6.1.1 Flow Rate	The expected (and maximum) effluent flow rate from the demineralized processing system to the receiving water body.	102 gpm (expected) 360 gpm (max)	3.2, 3.4
6.2 Raw Water Requirements			
6.2.1 Maximum Use	The maximum short-term rate of withdrawal from the water source for the demineralized water system.	1080 gpm	3.2
6.2.2 Monthly Average Use	The average rate of withdrawal from the water source for the demineralized water system.	13,000,000 gallons per month	3.2
7. Fire Protection System			
7.1 Raw Water Requirements			
7.1.1 Maximum Use	The maximum short-term rate of withdrawal from the water source for the fire protection water system (does not include large area fire requirements).	1250 gpm	3.2, 3.4
7.1.2 Monthly Average Use	The average rate of withdrawal from the water source for the fire protection water system.	6 gpm	3.2, 3.4
9. Unit Vent/Airborne Effluent Release Point			
9.4 Source Term			
9.4.1 Gaseous (Normal)	The expected annual activity, by radionuclide, contained in routine plant airborne effluent streams. Provide in Table 7.	See Table 3.4-6	3.4
10. Liquid Radwaste System			
10.2 Release Point			
10.2.1 Flow Rate	The discharge (including minimum dilution flow) flow rate of liquid potentially radioactive effluent streams from plant systems to the receiving water body.	300 - 450 gpm (liquid radwaste discharge flow) 3000 - 9000 gpm (dilution flow)	3.2, 3.4
10.3 Source Term			
10.3.1 Liquid	The annual activity, by radionuclide, contained in routine plant liquid effluent streams, if any.	See Table 3.4-4	3.4
11. Solid Radwaste System			
11.2 Solid Radwaste			
11.2.1 Activity	The annual radionuclide activity contained in solid radioactive wastes generated during routine operations.	See Table 3.4-8	3.4
11.2.2 Volume	The expected volume of solid radioactive wastes generated during routine operations.	38,988 cubic feet per year	6.2

Table 3.1-1
Site-Related Design Parameters
(Sheet 4 of 5)

Parameter[(a)]	Definition	PPE Value	ER Section
13. Auxiliary Boiler System			
13.2 Flue Gas Effluents	The expected combustion products and anticipated quantities released to the environment due to operation of the auxiliary boilers.	See Table 3.4-9	3.4
14. Standby Power System			
14.1 Diesel			
14.1.2 Diesel Exhaust Elevation	The elevation above finished grade of the release point for standby diesel exhaust releases.	9.84 feet	3.4
14.1.3 Diesel Flue Gas Effluents	The expected combustion products and anticipated quantities released to the environment due to operation of the emergency standby diesel generators.	See Table 3.4-10	3.4
15. Plant Layout Considerations			
15.1 Access Routes			
15.1.1 Heavy Haul Routes	The land usage required for permanent heavy haul routes to support normal operations and refueling.	30.12 acres	3.1, 4.1
15.2.1 Acreage to Support Plant Operations	The land area required to provide space for plant facilities.	312.9 acres Also see Figure 3.1-1	3.1, 4.1
16. Plant Operations Considerations			
16.1 Megawatts Thermal	The thermal power generated by one unit (may be the total of several modules). Specify both core thermal power and RCP thermal power (if there are RCPs in the design).	6250 MWt	3.2
16.2 Megawatts Electrical	Best estimate of MWe generator output. Assuming 100% power with 85F circulating water.	2250 MWe	3.2
16.3 Plant Design Life	The operational life for which the plant is designed.	80 years	3.2
16.8 Plant Population			
16.8.1 Operation	The estimated number of total permanent staff to support operations of the plant. Specifically, by responsibility for online operation: Operations Maintenance (including reactor services for online spent fuel work); RP/Health; Physics; Chemistry; Engineering; Security; Training; Other	450	4.4, 4.8, 5.8

Table 3.1-1
Site-Related Design Parameters
(Sheet 5 of 5)

Parameter[(a)]	Definition	PPE Value	ER Section
16.8.2 Refueling/Major Maintenance	The estimated additional number of staff required to conduct refueling and major maintenance activities by responsibility. Operations Maintenance (including reactor services for online spent fuel work); RP/Health; Physics; Chemistry; Engineering; Security.	350	4.4, 4.8, 5.8
17. Construction			
17.2 Acreage			
17.2.1 Laydown Area	The land area required during construction beyond what may be needed for plant operation.	256.2 acres	3.1, 4.1
17.3 Construction			
17.3.1 Noise	The maximum expected sound level due to construction activities, measured at 50 feet from the noise source.	110 dBA	4.8
17.4 Plant Population			
17.4.1 Construction	Maximum number of people on-site during construction.	2096	4.4, 4.8
18. Fuel			
18.1 Maximum Fuel Enrichment	Concentration (weight percent fraction) of U-235 in the fuel uranium.	<5 percent weight (Bounding for LWRs) 15.5 percent weight (Bounding for non-LWRs)	3.2, 6.2
18.4 Maximum Average Assembly Burnup	Maximum assembly average burn-up at end of assembly life.	65,000 (Bounding for LWRs) 169,450 MWD/MTU (Bounding for non-LWRs)	3.2, 6.2
18.8 Peak fuel rod exposure at end of life	Peak fuel rod exposure at end of life	62,000 MWD/MTU (LWRs)	3.2
18.11 Fuel Reload	Mass of uranium in the reload batch.	9.47 MTU/year (Bounding for LWRs) 11.3 MTU/year (Bounding for non-LWRs)	6.1

Notes:
(a) The numbering of the parameters is not intended to be sequential; rather, it reflects the structure of the list developed by industry and refined for this Early Site Permit Application.

Key: °C = degree(s) Celsius; °F = degree Fahrenheit; dBA = A-weighted scale decibels; gpm = gallons per minute; LWR = light-water reactor; MTU/year = metric tons of uranium per year; MWD/MTU = megawatt days per metric ton of uranium; MWe = megawatts electric; MWt = megawatts thermal

Table 3.1-2
Site Characteristics

Parameter[(a)]	Definition	Site Value	ER Section
9. Unit Vent/Airborne Effluent Release Point			
9.1 Atmospheric Dispersion (χ/Q) (Accident)			
9.1.1. 0-2 hour (Exclusion Area Boundary)	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases in the limiting two-hour interval.	2.62E-04 sec/m^3	5.11
9.1.2. 0-8 hour (Low Population Zone)	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases in the first eight hours.	2.55E-04 sec/m^3	5.11
9.1.3. 8-24 hour (Low Population Zone)	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases between hours 8 and 24 after the accident.	2.60E-04 sec/m^3	5.11
9.1.4. 1-4 day (Low Population Zone)	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases between the first day and the fourth day after the accident.	2.71E-04 sec/m^3	5.11
9.1.5. 4-30 day (Low Population Zone)	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases between day four until the end of the first 30 days after the accident.	2.88E-04 sec/m^3	5.11
9.2 Atmospheric Dispersion (χ/Q) (Annual Average)	The atmospheric dispersion coefficients used in the safety analysis for the dose consequences of normal airborne releases.	2.71E-04 sec/m^3 (Summed total of the three plant complexes)	5.9
	North Plant Complex	2.60E-04 sec/m^3	
	Middle Plant Complex	7.20E-06 sec/m^3	
	South Plant Complex	3.40E-06 sec/m^3	

Notes:
(a) The parameter numbering reflects the structure of the list developed by industry and refined for this Early Site Permit Application.
Key: χ/Q= atmospheric dispersion factor; sec/m^3 = seconds per cubic meter

3.2 PROPOSED PLANT STRUCTURES, SYSTEMS AND COMPONENTS

3.2.1 REACTOR POWER CONVERSION SYSTEM

At this time, Duke Energy has not selected a vendor for the reactor(s) to be constructed at the Project site. Because the reactor technology has not been chosen, a PPE has been developed to evaluate potential environmental impacts. The PPE and related guidance used to establish the surrogate plant is described in Section 3.1.2. The following AR technologies are currently under consideration:

- GVH BWRX-300
- NuScale VOYGR
- Holtec SMR-300
- WEC AP300
- TerraPower Natrium
- X-energy Xe-100

The Project site has the capability to support a total electrical output of 2250 megawatts electric (MWe) of new nuclear power generation. In general, steam generated by the nuclear steam supply system of each unit flows through the steam turbine, creating rotational mechanical work, that rotates the electric generator and produces electricity.

3.2.1.1 Reactor Description

Final arrangement of the Plant Complexes on the Project site is dependent on the reactor technology selected and shall be provided during the construction permit or license application phase. The proposed layout of the Plant Complexes, switchyard, and cooling tower areas is provided in Figure 3.1-1. The design life of the proposed plant is 80 years, but it is dependent on the reactor technology selected.

The maximum thermal output per reactor, based on the technologies being considered, is 1000 megawatts thermal (MWt), with a site maximum of 6250 MWt. The site maximum is based on a bounding electrical output of 2250 MWe at an assumed efficiency of 36 percent. Each reactor, along with its associated power conversion equipment, is estimated to have a maximum gross electrical output of 370 MWe, resulting in a total gross output of up to 2250 MWe for all units. The estimated net electrical efficiency ranges from 30 to 36 percent, depending on the reactor technology selected.

Fuel design is specific to the reactor technology, and all the technologies being considered for the Project site use uranium as their fissile material. For light-water reactor technologies, the maximum fuel enrichment of uranium-235 is less than 5 percent, the maximum average burnup is 65,000 megawatt days per metric ton of uranium (MWD/MTU), and the peak fuel rod exposure is 62,000 MWD/MTU. For non-light-water reactor technologies, the maximum fuel enrichment is 19.75 percent or less of uranium-235, the maximum average burnup is 169,450 MWD/MTU.

3.2.1.2 Engineered Safety Features

Engineered safety feature (ESF) systems are included in the designs being considered and include both active and passive ESF systems. In general, active safety systems rely on powered components, such as valve opening, to supply safety injection water and provide core and containment cooling. In the event of a loss of power, backup power sources like a diesel generator or a gas turbine powers the active systems. Alternatively, passive safety systems rely almost exclusively on natural forces, such as differences in density, gravity, or stored energy, to supply safety injection water and to provide core and containment cooling. Specific details about the ESF system for the reactor technology selected are addressed at the construction permit or license application phase.

3.2.1.3 Power Conversion Systems

The designs under consideration each use a steam turbine to convert the heat energy to mechanical energy. Waste heat from the turbine condensers is rejected to one or more MDCT, which serve as the normal heat sink. Specific details about the power conversion system for the reactor technology selected are addressed at the construction permit or license application phase.

3.2.2 COOLING SYSTEM

Cooling system components used for the planned operation at the Project site are described in Section 3.2.2.1. The cooling system operational modes are described in Section 3.4. The advanced reactor technologies considered do not require a safety-related service water system and instead employ passive containment cooling systems to support safety-related cooling functions. As a result, no external water source is required to support safety-related activities and all aspects of the cooling systems described below are considered non-safety-related.

3.2.2.1 System Description

The circulating water systems (CWS) for the facility are planned as closed-cycle cooling with MDCT as the mechanism for cooling the main condenser. The design assumes makeup water for the CWS is obtained from an intake on Belews Lake, pumped into the cooling towers, and circulated in and out of the main condenser. A portion of the water is lost as evaporation and drift from the cooling towers. The remaining water loss in the CWS is due to blowdown from the MDCT. Blowdown will predominately be returned to Belews Lake through a combined discharge structure or three independent discharge structures but can be diverted to the Dan River for short durations to support liquid radioactive waste dilution or to support operational flexibility.

No modifications to the Belews Lake outfall at the main dam to the Dan River are planned or expected to be required. Operation of the main dam and its existing equipment is maintained and appropriately operated to maintain proper lake levels and conditions. Water is pumped from the Dan River to the northern part of the main lake by the MWIS. The MWIS is planned to operate within the existing permitted limits. Refurbishment, replacement, or modifications may be implemented as needed to improve the facility's efficiency, reliability, and overall operation, while ensuring continued compliance with existing permit conditions.

Other closed-cooling water systems provide cooling water to auxiliary components. A detailed description of these cooling systems is dependent on the reactor technology selected and will be provided at the construction permit or license application phase.

3.2.2.2 Heat Generated, Dissipated to the Atmosphere, and Released in Liquid Discharges

During full power operation, heat generated by the plant is transferred to the CWS via the condensers. The majority of this heat is dissipated to the atmosphere through evaporation in the MDCT, while a smaller portion is discharged as liquid waste (blowdown) to Belews Lake or the Dan River.

As captured in Table 3.1-1, the CWS rejects heat at a rate of 13,200 million British thermal units per hour (MMBtu/hr), with a normal blowdown flow of 3852 gallons per minute (gpm) and a maximum flow of 6516 gpm. The peak blowdown temperature is 95 degrees Fahrenheit (˚F) (35 degrees Celsius [˚C]).

Additionally, blowdown is used as liquid radiological waste dilution and routed to the new outfall near the existing Dan River Outfall 006. Administrative and engineering controls are used to meet the thermal discharge limitations outlined in the NPDES permit for this new outfall. Consistent with thermal discharge requirements for the Belews Lake Dam/Spillway (Outfall 001) to the Dan River, these controls are designed to ensure that the river temperature downstream of the mixing zone remains within 5˚F (2.8˚C) of the upstream river temperature and will not exceed 32°C (89.6˚F) as a result of AR operations.

Heat is also dissipated to the atmosphere by the non-safety-related service water heat exchangers at a normal rate of 2.05E+08 Btu/hr (205 MMBtu/hr) and a maximum rate of 5.86E+08 Btu/hr (586 MMBtu/hr) as noted in Table 3.1-1.

The specific quantities of heat generated, dissipated to the atmosphere, and released in liquid discharges depend on the reactor technology selected and are addressed during the construction permit or license application phase.

3.2.2.3 Water Source and Quantities of Water Withdrawn, Consumed, and Discharged

In full power operation mode, the CWS requires withdrawal of makeup water from Belews Lake. A water balance showing the use of water by the entire Project site, including the CWS, is provided in Figure 3.2-4. The total cooling tower makeup water is withdrawn through the intake at a maximum rate of 41,601 gpm, and a normal rate of 30,109 gpm. Cooling tower water is released to the environment through evaporation, drift, and blowdown. Evaporation and drift are consumptive losses because water is not returned to Belews Lake. The maximum evaporation rate is 32,580 gpm, and the maximum rate of drift is 21 gpm. The normal consumptive water use includes 26,256 gpm from evaporation and 1 gpm from drift. The normal blowdown rate, based on eight cycles of concentration, is 3852 gpm. The maximum blowdown rate, based on six cycles of concentration, is 6516 gpm. Cooling tower blowdown can be used to support dilution of liquid radiological waste releases to the Dan River. When operating to support liquid radiological waste dilution, the blowdown flow can be as high as 9000 gpm.

Miscellaneous plant water is withdrawn from Belews Lake at a maximum rate of 1530 gpm and a normal rate of 600 gpm. As shown in Figure 3.2-4, discharges from the liquid radioactive waste treatment system, 300 gpm normal and 450 gpm maximum, are batch discharges directed to the Dan River with dilution flow (3000 gpm normal, 9000 gpm maximum) provided from cooling tower blowdown. Wastewater generated during the production of demineralized water (at a normal flow of 102 gpm and a maximum of 360 gpm) also discharges to the Dan River. An additional source of water, shown in Figure 3.2-4, is municipal water. This water

services the potable water and sanitary waste systems at a normal flow of 11 gpm and maximum of 19 gpm and is treated and discharged to the Dan River at the same rate with no appreciable water loss. Municipal water, or Belews Lake main intake as an alternate source, provides fire protection water supply at a normal rate of 6 gpm and maximum rate of 1250 gpm.

3.2.2.4 Component Descriptions

Layout and description of various proposed plant structures and components for the CWS, including the intake and discharge, are described in Sections 3.2.2.4.1 through 3.2.2.4.4. Other water systems not described below are dependent on the reactor technology selected and details will be available at the construction permit or license application phase.

3.2.2.4.1 Intake System

Two intake locations are being considered and their approximate locations on Belews Lake are shown in Figure 3.1-1. Section and plan views of the conceptual intake design are shown in Figure 3.2-1.

A single intake structure services all new generation facilities on-site. The intake is a wet well-type structure on the banks of the lake with an adequate number of bays with pump/motor sets to supply the selected technology and support redundancy.

Additional support systems, such as debris removal, and maintenance activities are provided to ensure operational reliability. Debris removal is performed by passive technology screens appropriately sized to meet Clean Water Act 316(b) velocity requirements of less than 0.5 feet per second (ft/s) (0.15 meters per second [m/s]). These passive screens are installed at appropriate depths and in adequate size and quantity to support continuous operation. The common intake structure includes the required electrical switchgear to support intake system operations.

Water intake to the facility is at an adequate depth to not affect full rated power generation capabilities of the facilities during analyzed drought conditions. Current analysis supports an intake depth of up to approximately 60 ft. (18.3 m) for both drought tolerance and thermal stability. Additional water intake design details will be available at the construction permit or license application phase.

Makeup to Belews Lake from the Dan River is available through the MWIS maintained under the existing BCSS NPDES Permit. The existing permit will be updated to include activities associated with nuclear generation. However, no changes to existing limitations associated with operation of the MWIS as outlined in the existing NPDES permit are expected.

3.2.2.4.2 Not Used

3.2.2.4.3 Blowdown Discharge

Conceptual discharge designs being considered for Belews Lake are shown in Figure 3.1-1 and Figure 3.2-2. The base discharge design is one separate discharge for each Plant Complex. The blowdown from each Plant Complex is discharged via gravity to Belews Lake. An alternative design includes collecting the blowdown from each Plant Complex and discharging it through a combined discharge located northeast of the most northern Plant Complex. Discharge piping entering the lake is submerged and routed to the appropriate location and depth to mix

with the bulk waters of the lake. Final discharge location(s) will be based on environmental, technical, and regulatory considerations, with additional details provided during the construction permit or license application phase.

While blowdown is predominantly returned to Belews Lake, blowdown flow can be diverted to the Dan River at an outfall location within the existing corridor, adjacent to Outfall 006. When blowdown is diverted to the Dan River outfall, administrative and engineering controls are used to limit temperature impacts to the river such that the river temperature downstream from the mixing zone remains within the limits required to meet NPDES permit limitations. The blowdown discharge to the Dan River is a submerged discharge. A conceptual discharge design is shown in Figure 3.2-3.

All potential discharge designs for Belews Lake maintain an exit velocity less than approximately 10 ft/s (3.05 m/s) to minimize erosion and corrosion aspects. The Dan River discharge is designed to optimize thermal mixing to minimize environmental impacts. The Dan River consists of five ports spaced at approximately 5-ft. (1.5-m) intervals with a total length of approximately 20-ft. (6.1-m) The maximum port discharge velocity is approximately 10.6 ft/s (3.2 m/s) while the minimum velocity is approximately 5.5 ft/s (1.7 m/s). Thermal discharges are designed and constructed to comply with NPDES permit conditions. Additional discharge design details are available at the construction permit or license application phase once a reactor technology is selected.

3.2.2.4.4 Mechanical Draft Cooling Towers

Heat dissipation for the Project site is planned as a closed-cycle cooling type with MDCT as the mechanism for cooling the main condensers of wasted thermal heat.

Cooling towers being considered are MDCT that utilize evaporative cooling for heat dissipation. Makeup water for the cooling water system is from the common intake structure on Belews Lake, pumped to the cooling towers, and circulated through the main condenser. Drift and evaporation cause the loss of cooling water, while a portion is returned to Belews Lake and Dan River as blowdown from the cooling towers through a planned discharge. The locations of the cooling towers are within the plant areas shown in Figure 3.1-1. The cooling tower locations occupy a maximum area of approximately 10.8 ac. (4.4 ha) with a maximum height of 75 ft. (22.86 m) above plant grade. The maximum volume of water stored in the cooling towers is 12,000,000 gallons, with a maximum circulation rate of 1.4E+06 gpm. The planned cooling towers are designed for a maximum blowdown temperature of 95°F (35°C) at the point of discharge to Belews Lake and an approximate temperature differential of 21.2°F (11.8 °C) between the cooling water entering and leaving the towers. Cooling towers are expected to operate at a minimum of six cycles of concentration, with a typical operating range of 8 to12 cycles of concentration under normal conditions.

3.2.3 PLANT WATER USE

Water is required to support the Project site during building activities and operation. Typical water uses for operation include the CWS, potable and sanitary water system, fire protection system, and other auxiliary systems like demineralized water and liquid radioactive waste treatment systems. Belews Lake is the primary water source for plant operations and water is withdrawn via a new common intake structure. Municipal water is used for fire protection, as well as potable and sanitary purposes for building and operational activities.

3.2.3.1 Water Consumption

A water-use diagram for the conceptual facility is provided in Figure 3.2-4. The diagram shows the normal and maximum flow rates for the intake and discharge from the lake, the rates for consumptive uses, and the relationships between the various water flow systems. All flow values are for all Plant Complexes, not a single Plant Complex. The average values are the expected limiting values for normal plant operation with cooling tower operation at eight cycles of concentration, and the maximum values are those for cooling tower operation at six cycles of concentration.

The source of water for facility operations is Belews Lake. Two potential proposed water intake locations are shown in Figure 3.1-1. A single intake withdraws water at a normal flow of approximately 30,709 gpm, and a maximum flow of approximately 43,131 gpm.

Of the total intake, approximately 30,109 gpm (normal) and 41,601 gpm (maximum with radwaste dilution flow) is directed to serve as makeup water for the CWS. The proposed CWS uses MDCT for heat dissipation. MDCT consume water through evaporation and drift. The normal drift rate is estimated to be 1 gpm and the maximum drift rate is estimated to be 21 gpm. The normal and maximum evaporation rate is estimated to be 26,256 gpm and 32,580 gpm, respectively. The blowdown from the cooling towers discharges water back to Belews Lake through a combined discharge or a specific Plant Complex discharge, or to the Dan River for radwaste dilution or operational flexibility. The blowdown rate to Belews Lake is estimated to be a normal flow of 3852 gpm, and a maximum of 6516 gpm. Maximum blowdown during radwaste dilution is approximately 9000 gpm.

The operational modes (e.g., hot standby, startup, normal operation, etc.), for the cooling water system are to be defined once a specific reactor technology is selected.

Of the total intake withdrawal volume, a normal flow of approximately 600 gpm and a maximum of 1530 gpm is directed to the plants and facilities and then distributed for various auxiliary systems. The consumptive uses of water within these systems are normally 198 gpm and maximum of 720 gpm. The specific water volumes distributed to each of these individual uses have not been defined but are to be developed once the reactor technology has been selected. The effluent generated during the production of demineralized water is discharged to the Dan River at a normal flow rate of 102 gpm and maximum flow rate of 360 gpm. Treated liquid radioactive waste effluent is discharged to the Dan River through the proposed discharge in batch releases maintaining a normal flow rate of 300 gpm and maximum flow rate of 450 gpm with an added dilution flow. During batch releases, the dilution flow has a normal flow of 3000 gpm and a maximum of 9000 gpm.

The source of water for the potable and sanitary water systems is to be from the municipal water system. Consumptive uses of this water are expected to be negligible, and the wastewater is to be discharged through the existing Belews Creek sewage treatment facility to the Dan River. The water supply rate for the potable and sanitary water systems is estimated at 11 gpm normal, with a maximum rate of 19 gpm.

3.2.3.2 Water Treatment

Duke Energy uses a common open cooling water chemistry program that covers cooling tower and once-through systems for waste heat condenser applications and some service water cooling applications. Similarly, Duke Energy has common water chemistry programs for primary,

secondary, and closed-cooling water systems. The programs describe the implementation for treatments, maintenance and testing best suited for the site-specific design and environment. Procedures specific to the Project site will be defined at the construction permit or license application phase once reactor technology is selected, water quality studies are completed, and NC NPDES permitting requirements are established. A representative list of chemicals which may be used at each site for water treatment activities is provided in Table 3.2-1. This list may not be all inclusive and will be determined based on the chosen reactor technology.

The demineralized water treatment system is expected to employ reverse osmosis and additional demineralization processes to further remove dissolved solids from filtered water produced by the raw water treatment system. Specific details for the treatment of demineralized water will be available at the construction permit or license application phase.

3.2.4 POWER TRANSMISSION SYSTEM

An existing 230 kilovolt (kV) switchyard, owned and operated by Duke Energy, serves the BCSS and will support the Project site. Established transmission corridors that serve the BCSS will also support the Project site. Figures 3.1-1 and 3.1-2 present the proposed transmission switchyard and the existing transmission system. Details are provided at the construction permit or license application phase once a reactor technology is selected.

3.2.4.1 Transmission System

The interconnection of the existing Belews Creek 230 kV switchyard to the proposed Project site and switchyard consists of the following activities:

- An extra bay is built at the existing Belews Creek 230 kV switchyard.
- The Pleasant Garden Black and White (B/W) 230 kV lines are rerouted into the northside of the existing Belews Creek 230 kV switchyard.
- The Belews Creek 230 kV lines are shifted down four positions (towards the lake) to terminate into the corresponding new and existing breaker positions.
- Capacitor Banks 1 and 2 have been permanently removed from the Belews Creek 230kV switchyard to accommodate new transmission line connections.
- A new switchyard is constructed.
- The proposed nuclear units are connected to the new switchyard on individual bus lines.
- Four bus lines are constructed to connect the new switchyard to the existing Belews Creek 230kV switchyard.
- Backup emergency power (off-site power) is connected to either open taps off the existing transmission lines or the new switchyard. A small substation may be needed to distribute off-site power to each unit. This decision is dependent on the selection of final reactor technology.

To support this configuration, the Bank 1 and Bank 2 capacitors at the existing Belews Creek 230 kV switchyard must be removed. A new switchyard will be constructed to the east of the

existing Belews Creek switchyard and south of the existing transmission corridor to facilitate the interconnection of the proposed nuclear units. Each nuclear unit will be connected to the new switchyard via dedicated bus lines.

Additionally, four bus lines will be built to connect the new switchyard to the existing Belews Creek 230 kV switchyard. Backup (off-site) emergency power is connected to either open taps on the existing transmission lines or via the new switchyard. A small substation may be needed to distribute off-site power to each unit, depending on the final selection of reactor technology.

3.2.4.2 Existing BCSS and Proposed Transmission Line Corridors

Proposed transmission lines from power blocks, switchyard areas, and the existing Belews Creek switchyard are located within the net disturbance area (NDA). Routes are dependent on the final layout of the site. Corridors associated with the construction of tie-ins and the relocation of the 230kV transmission lines are determined based on Duke Energy standard corridor widths per DE-B-06, shown in Figure 3.2-5. These corridor widths support all necessary National Electrical Safety Code (NESC) requirements.

3.2.4.3 230kV Switchyard

The 230kV switchyard may include transformers, breakers, switches, relays, real-time metering, and dual communication paths. Additional equipment would include connecting bus work, a supporting steel superstructure, ground wire towers, switch house, and equipment storage building. No underground utilities are planned for this switchyard.

The parameters involve ensuring adequate voltage and current handling capabilities, system protection and reliability. The system must be designed with appropriate voltage ratings to manage system voltages under normal and fault conditions, such as Basic Insulation Level (BIL) to withstand surges, current ratings for switchyard equipment to accommodate anticipated load flows and short circuit current to handle fault currents within their allowable ranges. Critical design considerations include clearance requirements to ensure there is sufficient phase to phase and phase to ground distances to prevent flashover and maintain operational safety.

Capacitor Banks 1 and 2 have been removed from the existing Belews Creek 230 kV switchyard to accommodate new transmission connections. Additional details are provided as part of the construction permit or license application phase once final reactor technology has been selected.

3.2.4.4 230kV Structures and Conductors

The proposed 230kV transmission line connections use self-supporting, lattice steel towers. The configuration for the electrical conductors (the cables that carry the electrical current) is yet to be determined, but the existing configuration is single 2156 aluminum conductor steel reinforced (ACSR). Two single ground wires are placed on the two highest points of the structures to provide lightning protection. In some cases, these ground wires may carry fiber optic or other communication circuits. Tower height may vary depending on final grade and land use but normally ranges between 80 and 120 ft. (24.4 and 36.6 m) with standard span lengths typically between 600-800 ft. (182.9-243.8 m). Tower foundations are normally laced-steel grillages, one per leg, buried in the earth. Some towers where the line turns at an angle require foundations of reinforced concrete. Figure 3.2-6 is a sketch of a typical structure with no underbuilt

transmission lines.

3.2.4.5 General Methods of Construction Switchyard

A construction assembly area, referred to as a laydown area, is required for worker assembly, vehicle parking, and material storage during construction. Laydown areas are located within the Project site as shown on Figure 3.1-1. Selection criteria used for locating the potential laydown area include:

- Relatively flat.
- Well drained.
- Previously cleared.
- Preferably graveled and fenced.
- Preferably wide access points with appropriate culverts.
- Sufficiently distant from streams, wetlands, or sensitive environmental features.
- Located adjacent to an existing paved road near the transmission line.

In general, the site is leveled using a cut-and-fill process. Areas of the site that are too high (sloped) or too low are leveled to achieve a consistent elevation. Any fill required is obtained from an approved or permitted borrow area. All activities are conducted in accordance with Duke Energy's Site Clearing and Grading Specifications. Construction activities are conducted in accordance with Duke Energy Transmission Construction Guidelines Near Streams, Duke Energy Quality Protection for Transmission, Substation or Communications Construction, and Duke Energy Substation Lighting Guidelines.

Trailers used for material storage and office space are parked in the laydown area. Following completion of construction activities, trailers, unused materials, and construction debris are removed from the Project site. Additional building activity details are provided in Section 3.3.

3.2.4.6 Transmission Line Tie-Ins

A laydown area is required for assembly, vehicle parking, and material storage during construction. The laydown area within the Project site used for associated transmission line structures is approximately 5 ac. (2.0 ha). Selection criteria described in Section 3.2.4.5 are the same as for the switchyard and substation laydown area. Additional building activity details are provided in Section 3.3.

The transmission structure is the most visible element of the electric transmission system, and functions to keep an adequate distance between the high-voltage conductors and the surrounding area. The transmission line structure type depends on the line voltage, terrain, and whether the line is single circuit or double circuit. Transmission structure heights vary depending on final grade and land use but normally range from 80 to 120 ft. (24.4 to 36.6 m). The Federal Aviation Administration provides guidance for marking and lighting of structures that may affect navigable airspace. The guidance applies to structures that exceed an overall height of 200 ft.

(61 m) above ground level or are located within 3 nautical miles of an airport.

Equipment used during the construction phase may include trucks, truck-mounted augers, drills, tracked cranes, and bulldozers. Low ground-pressure-type equipment is used in specified locations (such as areas with soft ground) to reduce the potential for environmental impacts.

Reels of conductor and ground wire are delivered to various staging areas along the corridor. A small rope is used from structure to structure, connected to the conductor and ground wire, and used to pull them down line through pulleys suspended from insulators. A bulldozer and specialized tensioning equipment are used to pull conductors and ground wires to the proper tension. Crews clamp wires to the insulators and remove the pulleys.

Activities associated with the transmission line tie-ins and relocation are conducted in accordance with Duke Energy procedures.

3.2.4.7 Predicted Noise Levels from Transmission System Operations

High-voltage transmission lines can emit noise when the electric field strength surrounding the lines is greater than the breakdown threshold of the encapsulating air, creating an energy discharge. This discharge is known as corona discharge and is affected by ambient weather conditions such as wind, precipitation, air density, humidity, and energized surface irregularities. Corona results in audible noise, radio, and television interference, energy losses, and the production of ozone and oxides of nitrogen. The sound created from corona discharge can result in a noise that can be heard near the base of the transmission lines. According to NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, noise from corona discharge along a transmission line is low, well below the 65 dBA threshold for perceptible noise.

Table 3.2-1
Representative Water Treatment Chemicals

Chemical use	Chemical
Water treatment (Clarifier)	60% Ferric Sulfate/Ferralyte 8130
Water treatment (Clarifier)	25% Sodium Hydroxide
Water treatment (Clarifier)	12.5% Sodium Hypochlorite
Water treatment (Clarifier and Thickener Tank)	Nalclear 7768
Water treatment (Clarifier and Thickener Tank)	Ferralyte 8130 Ferric Sulfate
Water treatment (Polymer Pumps)	PolyClean 7
Cooling Tower (shared with Chiller Tower)	3D Trasar 3DT187
Cooling Tower (shared with Chiller Tower)	12.5% Sodium Hypochlorite
Cooling Tower (shared with Chiller Tower)	Trasar 3DT199
Cooling Tower	Nalco 7468
Chiller System	DOWFROST HD (propylene glycol)
Chiller System	Dupont SUVA 123
Chiller System	NalPrep IV
Closed Water Cooling	33% Propylene Glycol
Closed Water Cooling	Nalco C-4710
Demineralizer Building (RO and Cooling Tower Blow down)	38% Sodium bisulfite
Demineralizer Building (RO system)	25% Sodium hydroxide
Demineralizer Building (UF system)	50% Citric acid
Demineralizer Building (UF system)	12.5% sodium hypochlorite
Demineralizer Building (RO system)	Antiscalant PC-191T
Demineralizer Building (RO cleaning biocide)	RoCide DB20
Demineralizer Building (RO cleaning)	RoClean P303
Demineralizer Building (RO cleaning)	RoCide IS2
Demineralizer Building (RO cleaning)	RoClean P111
Aux Boiler Building (HRSG Water)	19% Aqueous Ammonia
Aux Boiler Building (HRSG Water)	Eliminox

3.3 BUILDING ACTIVITIES

3.3.1 INTRODUCTION

This section describes the site development activities that form the basis for evaluating environmental impacts and distinguishes between preconstruction and construction activities at the Project site, which can accommodate up to three separate Plant Complexes (each referred to as a Plant Complex).

Construction activities generally involve safety-related structures, systems, and components (SSCs) that require authorization by the United States (U.S.) Nuclear Regulatory Commission (NRC) through a formal review process defined in Title 10 of the Code of Federal Regulations (CFR) Part 50.10(a)(1) (10 CFR 50.10(a)(1)). In contrast, preconstruction activities are non-safety-related and may be performed without NRC authorization.

Because Duke Energy has not yet selected an advanced reactor technology, a PPE, as described in Section 3.1.2, has been developed to evaluate the potential environmental impacts.

As described in Section 3.1.1, the Project site encompasses approximately 1187 ac. (480 ha) with the general arrangements shown in Figure 3.1-1. It includes the site boundary, Plant Complexes with approximate elevations, cooling tower areas, permanently disturbed laydown areas, and other supporting facilities.

Additionally, an aerial view showing the site boundary and the NDA is provided in Figure 3.3-1. The NDA encompasses approximately 906 ac. (367 ha) and includes a vegetative buffer zone along the shoreline. Space is also reserved for a future independent spent fuel storage installation with additional information provided in Section 3.4.2.2.

3.3.2 PRECONSTRUCTION ACTIVITIES

Preconstruction and site preparation activities may proceed without prior NRC approval, provided that the necessary regulatory authorizations for land-disturbing activities, building and infrastructure development, and environmental protection have been obtained from federal, state, and local agencies. These regulatory requirements may include, but are not limited to, stormwater management permits, water quality certifications, and construction-related environmental controls. The Project complies with applicable federal, state, and local regulations governing grading, filling, earthwork, and stormwater discharges. A comprehensive list of anticipated permits and authorizations applicable to the Project is provided in Table 1.4-2.

Site preparation and building activities require the placement of earthen fill, which is sourced primarily from the Project site within the NDA. Land-disturbing activities, including excavation and fill placement, are conducted in accordance with applicable state erosion and sediment control requirements. An approved Erosion and Sedimentation Control Plan (ESCP) is required, and coverage under the applicable state stormwater general permit is obtained from the NCDEQ or local delegation prior to initiating building activities as indicated in Table 1.4-2.

Pursuant to the North Carolina Sediment Pollution Control Act of 1973, any potential fill material needed from an off-site borrow site will be obtained from an approved NCDEQ source. Fill material reused on-site is placed only after determination of its geotechnical suitability for the intended use. Final quantities of fill are determined during detailed design and reflect a balanced cut-and-fill approach planned for the Project. Material not suitable for backfill will either be

reused on-site for ground-maintenance purposes or disposed of in accordance with state or local requirements.

To prevent off-site sedimentation and manage stormwater runoff during building activities, the Project implements a range of best management practices (BMPs) during all phases of building activities. These may include silt fencing, filter socks, stabilized construction entrances (potentially with wheel wash systems), sediment basins, floating turbidity barriers, and similar systems used for managing stormwater during construction activities. Additional environmental protection measures may include containment and spill response kits and systems for construction materials such as oils, paints, and chemicals.

The following is a summary of anticipated preconstruction activities that may be performed in advance of an NRC issued Construction Permit (CP) or Combined License (COL):

- Construction of new roads within the site construction areas to facilitate access to parking and storage areas, and new access roads to remote areas of development such as the cooling and makeup water intake and process wastewater discharge structure locations.

- Construction of rail unloading areas with heavy haul roads and bridges leading from the unloading areas to the construction storage and staging areas.

- Improvements of existing site roads and bridges to accommodate anticipated construction and operational vehicle traffic and to handle anticipated oversized or heavy haul vehicles.

- Site preparation of each Plant Complex, which are eventually enclosed by a Protected Area fence in accordance with 10 CFR Part 73.

    - Site preparation for each Plant Complex includes clearing and grubbing of trees and dense vegetation, topsoil stripping, grading and installation of stormwater management systems. Some areas may be temporarily stabilized with crushed stone for accessibility; however, temporary and permanent stabilization are most likely to be sequenced with the substructure installations comprised of non-safety-related foundations and buried utilities.

    - As presented in Table 3.3-1, the Plant Complexes are planned to be constructed sequentially. It is anticipated that each Plant Complex will be graded to balance earthwork cut-and-fill quantities to the greatest extent practical. Adjacent laydown areas may be adjusted to grade elevations that are different than the power block and permanent plant equipment grades to facilitate a balanced earthwork design. Specialized off-site material, such as crushed stone, will be brought to the site from an approved off-site source.

    - The potable water source for use during building activities may be with a connection to existing water lines that currently serve existing BCSS operations, landfills or material management areas, or a new water line connection to the municipal system located immediately outside of Duke Energy's existing south gate at Craig Road.

  - Water to be used for building activities could be obtained from a municipal city water connection that serve existing plant facilities or obtained from new groundwater production wells or from Belews Lake.

- Site preparation of construction parking and laydown areas, as well as construction trailer locations and other temporary construction facility areas, along with associated utilities and supporting infrastructure.

  - Site preparation includes clearing and grubbing of trees and dense vegetation, topsoil stripping, mass earthwork and grading, installation of stormwater management systems, and stabilizing the completed surfaces with crushed stone, asphalt pavement, or concrete paving. Graded slopes may be surfaced with grass seeded topsoil.

- Site preparation of switchyard and cooling tower areas.

  - Site preparation includes clearing and grubbing of trees and dense vegetation, topsoil stripping, mass earthwork and grading, installation of stormwater management systems and stabilizing the surface with crushed stone.

- Construction of cooling and makeup water intake and discharge systems along the Belews Lake shoreline.

  - The type of disturbance will vary based on the structure types selected; however, it is anticipated that excavation and lakebed dredging will occur to prepare the site for structure construction, and cofferdams may be temporarily installed to perform work in a dry environment. Cooling and makeup water intake and process wastewater discharge piping and electrical power and control cables will comprise utility corridors that will extend from each Plant Complex to their respective intake and discharge structures located along the lake shoreline.

- Installation of preconstruction site security features that include perimeter and interior vehicle and personnel access control points, fencing, site access gates, lighting, physical barriers, and guard houses.

- Installation of utility systems for construction use that would support the entire construction site and associated activities.

  - The utilities and systems may be installed below grade or above grade as needed and may include electrical power, potable and fire protection water, sanitary, and wastewater.

- Installation of permanent, non-safety-related utility systems.

  - The non-safety-related utility systems may be installed below grade or above grade as needed and may include electrical power and communications, potable and fire protection water, sanitary, wastewater, and other balance of plant systems.

- Erection and installation of construction-use facilities such as:

  - Offices, warehouses, equipment storage sheds, fuel and lubricant storage areas, bathrooms and change rooms, first aid and dining trailers, assembly and training areas, and personnel access facilities.
  - Concrete batch plant.
  - Concrete pads for construction cranes and crane assembly.
  - Construction fencing.

- Erection and installation of the switchyard foundation, equipment, and transmission towers.
- Erection and installation of the non-safety-related cooling and makeup water intake and process wastewater discharge structures and ancillary equipment and utilities, including site access roads for inspection and maintenance of these systems. Any work within, along, or near shorelines is typically provided with erosion control measures such as floating turbidity barriers to limit aquatic impacts.
- Erection and installation of the non-safety-related cooling tower system, including makeup water supply and blowdown water discharge pipelines and supporting electrical infrastructure.
- Soil and rock excavation for foundations within the Protected Area, including the power block and other support SSCs. Excavation may require permanent installation of construction aids, such as dewatering equipment. Rock excavation activities will most likely require controlled rock blasting. As captured in PPE Table 3.1-1, the Reactor Building excavation extends to a maximum depth of 125 ft. (38.1 m) below finished grade elevation.
- Transportation of backfill material from off-site sources and on-site stockpiles for backfilling foundations inside the Protected Area, including the power block and other support SSCs. Activities related to installation of safety-related structural backfill for safety-related SSCs are performed as part of the construction phase.
- Procurement or fabrication of components, or portions of the proposed advanced reactors, occurring at other than the final, in-place location, may also be performed. This work includes assembly of the components into complete modules on-site. However, the setting of completed modules does not occur until after the receipt of a CP or a COL and is considered a construction activity.

3.3.3 CONSTRUCTION ACTIVITIES

Activities constituting construction, as defined in 10 CFR 50.10(a)(1), are the driving of piles, subsurface preparation, placement of backfill, concrete, or permanent retaining walls within an excavation, installation of foundations, or in-place assembly, erection, fabrication, or testing, which are for:

(i) Safety-related SSCs of a facility, as defined in 10 CFR 50.2;

(ii) SSCs relied upon to mitigate accidents or transients or used in plant emergency

operating procedures;

(iii) SSCs whose failure could prevent safety-related SSCs from fulfilling their safety-related function;

(iv) SSCs whose failure could cause a reactor scram or actuation of a safety-related system;

(v) SSCs necessary to comply with 10 CFR Part 73;

(vi) SSCs necessary to comply with 10 CFR 50.48 and criterion 3 of 10 CFR Part 50, appendix A; and

(vii) On-site emergency facilities necessary to comply with either § 50.160 or § 50.47 and appendix E to this part, as applicable.

3.3.3.1 Overview of Construction Activities

Construction activities may begin after the NRC issues a CP or a COL. The safety-related SSCs facility types, arrangements, and layout will vary among the reactor technology vendors; however, the nuclear island and power block will generally include the items listed in the subsequent paragraphs that are patterned after the typical SSC facilities that comprise a pressurized water reactor.

As part of each SSC installation, supporting infrastructure includes the installation of mechanical piping and process systems, such as fire protection and heating, ventilation, air conditioning (HVAC) systems. Electrical installations begin at lower elevations and continue progressively to above grade as structures are completed.

3.3.3.2 Reactor Building Construction

The Reactor Building is the central safety-related structure housing the reactor vessel and related components. This heavily reinforced concrete structure includes the following key construction activities:

- Placement of reinforcing steel and concrete for the mat foundation that supports the containment structure. This includes the installation of mudmats, vapor barriers, basemat rebar/dowels, permanent commodities embedded in the basemat (e.g., pipe, conduit), and permanently installed construction aids within the basemat.
- Construction of the containment structure, which includes a steel plate lining system that seals the containment vessel, and structurally reinforced concrete walls and dome.
- Placement of the reactor pressure vessel within the containment structure.
- Construction of internal structures such as interior walls, slabs, platforms, and supports for mechanical and electrical systems.
- Installation of associated piping, valves, and mechanical and electrical equipment.
- Installation of containment structure cranes, including jib and bridge cranes.

- Completion of the reactor containment roof structure.

Outside the reactor containment structure, additional activities include:

- Construction of exterior walls, slabs, and platforms.
- Installation of major mechanical and electrical equipment.
- Installation of refueling machine and diesel equipment.
- Placement of gantry and bridge cranes.

3.3.3.3 Turbine Generator Building Construction

The Turbine Generator Building supports the steam turbine and generator systems and includes the following construction scope:

- Formation and placement of heavily reinforced structural concrete mat foundation and pedestal system to support off-site fabricated turbine and generator units.
- Erection of a multi-story steel frame enclosure with walls constructed of precast concrete panels or steel siding, and a structural roof system.
- Installation of an overhead crane to facilitate turbine and generator erection and future maintenance.

3.3.3.4 Radiological Waste Building Construction

The Radiological Waste Building is designed to process and manage radioactive solid and liquid waste removed from the Reactor Building. Key construction elements include:

- A single story, steel-framed structure with heavily reinforced concrete mat foundation.
- Construction of concrete walls and a concrete roof system lined with steel shielding for radiological protection.
- Installation of internal tanks, process equipment, and waste handling systems required for interim processing and storage prior to final disposal.

3.3.3.5 Additional Safety-Related and Support Facilities

Other key plant facilities anticipated for construction or installation include:

- Auxiliary Building
- Annex Building
- Security Building and Sally Ports
- Control Building

- Water Treatment Building
- Wastewater Treatment Building
- Emergency Diesel Generator Building
- Fire Protection Safety Building and Water Storage Tanks
- Bulk Gas Storage Facilities
- Process Water Storage Tanks
- Vehicle Maintenance and Warehouse Buildings

The common yard area construction spans the full construction duration beginning at the start of site preparation. The necessary permits and authorizations are obtained to ensure compliance with all applicable rules and regulations.

Civil installations include backfill of safety-related foundations and safety-related utilities, concrete formwork and structural modules, concrete foundations with reinforcing steel and steel embedments, structural steel, concrete pipe, and coatings.

Mechanical and HVAC installations include equipment such as vessels, pumps, compressors, tanks, heat exchangers, turbine generators, condensers, cooling towers, HVAC systems, process equipment, process system piping, and valves.

Electrical installations include transformers, electrical panels and instruments, switchgear, cable trays, conduit with cables encased in duct banks or direct buried, control instruments, and instrument trays.

3.3.4 CONSTRUCTION EQUIPMENT

The following construction equipment is anticipated to be used throughout the construction of the Project, categorized by major construction activities.

Clearing and grubbing operations: expected equipment includes excavators, bulldozers, backhoes, small tracked cranes, dump trucks, woodchippers and mulchers, and skid steer loaders.

Mass earthwork activities (excavation, grading, and fill placement): anticipated equipment includes bulldozers, scrapers, backhoes, end loaders, trenching machines, dump trucks, water trucks, graders, roller compactors, and vibratory plate compactors.

Substructure and equipment erection (foundations, utilities, and buried commodities): expected equipment includes backhoes, end loaders, trenching machines, dump trucks, skid steer loaders, wheel-mounted and tracked cranes, concrete trucks, pumper trucks, graders, asphalt pavers, roller compactors, and vibratory plate compactors.

Marine construction work (cooling and makeup water intake, process wastewater discharge structures, and related systems): depending on the selected technology, equipment may include pile drivers, vibratory hammers, hydraulic dredgers, excavators, backhoes, end loaders, dump

trucks, skid steers loaders, forklifts, wheel-mounted and tracked cranes, concrete trucks, pumper trucks, and other specialized equipment required for pump structure erection.

3.3.5 Construction Sequencing

The anticipated sequencing of construction is that the South Plant Complex will be constructed initially, followed by construction on the Middle Plant Complex, and lastly the North Plant Complex.

The timeline/duration for preconstruction and construction activities has not been established; however, a major activities schedule has been used as a basis for sequencing the construction activities presented in Table 3.3-1.

The construction sequence for all Plant Complexes has not been finalized. Nevertheless, concurrent construction of multiple units or multiple site areas remains a possibility, depending on the technology selected. This is especially true for the technologies that have multiple units in each Plant Complex, but less likely where one plant design houses multiple reactors, such as the Holtec dual-unit plant and the NuScale VOYGR.

Table 3.3-1
Conceptual Preconstruction and Construction Activities Schedule

Plant Complex	Preconstruction Activity Duration	Construction Activity Duration	Preconstruction Activity Start Date	Construction Completion Date Unit Online
South	24 months	36 to 42-month duration for Unit 1 Unit 2 starts 12 months after the start of Unit 1	Q3 2028	Q2 2034 Q2 2035
Middle	Starts 24 months after South Plant Complex	Unit 3 starts 12 months after the start of Unit 2 Unit 4 starts 12 months after the start of Unit 3	Q3 2030	Q1 2036 Q1 2037
North	Starts 24 months after the Middle Plant Complex	Unit 5 starts 12 months after the start of Unit 4 Unit 6 starts 12 months after the start of Unit 5	Q3 2032	Q1 2038 Q1 2039

3.4 OPERATIONAL ACTIVITIES

3.4.1 PLANT-ENVIRONMENTAL INTERFACES DURING OPERATION

The Project site will utilize advanced reactors with MDCT for primary heat dissipation at the plant. Bounding values provided throughout this section are for the entire site, not a single unit. Sections 3.4.1.1, 3.4.1.2 and 3.4.1.3 describe the water, land, and air interfaces, respectively. The operational modes of the cooling system such as hot standby, startup, and normal operation are defined upon the selection of a specific reactor technology and addressed during the construction permit or license phase.

3.4.1.1 Water Interfaces

The environmental interfaces with the Project site water systems include the plant intake and discharge structures, the cooling towers, and the sanitary and radwaste systems. Figure 3.2-4 shows normal operational flow rates to and from the various water systems, the source water for each system, and the receiving body of water for liquid discharges. Table 3.4-1 summarizes the normal and maximum operational flow rates that include withdrawals, consumptive uses, and liquid discharges.

3.4.1.1.1 Common Intake Structure

A common intake structure is planned on Belews Lake to serve all Plant Complexes at the Project site. Two potential locations are under consideration for the common intake structure and shown on Figure 3.1-1. Option 1 is located generally north of the canal on the eastern bank of the Project site, in between the North and Middle Plant Complexes. Option 2 is located on the western bank near the proposed North Plant Complex and east of the existing BCSS.

The conceptual design of the common intake structure is shown in Figure 3.2-1. The intake design will include debris screening capabilities, with passive screening technology as the preferred option. The passive screen will be designed and installed at the appropriate depth to ensure continuous operation. The design will include debris removal systems to maintain clean surface areas, ensure low velocity of less than 0.5 ft/s (0.15 m/s) through the screens, and comply with impingement and entrainment requirements of Section 316(b) of the Clean Water Act (CWA).

3.4.1.1.2 Makeup Water Intake Structure

In 2010, Duke Energy built the MWIS to support BCSS operation. It withdraws water from the Dan River and Belews Creek and routes it directly to Belews Lake. The MWIS is designed and permitted to include two 50 cubic feet per second (cfs) (1.42 cubic meters per second [m^3/s]) velocity caps, a permanent settling pond with approximately 6000 square feet of surface area, a four-pump pumping station with a capacity not to exceed 100 cfs, (2.83 m^3/s), force main, an electrical substation with an access road, and a diffuser in Belews Lake.

The MWIS is located north of the Project site at the confluence of the Dan River and Belews Creek as shown on Figure 3.1-3. It is authorized under the existing BCSS NPDES Permit NC0024406 issued by the NCDEQ. The total pumping capacity of the MWIS is defined by the conditions in the NPDES permit and adhered to as follows:

- Pumping will not lower flow in the Dan River below 110 cfs (3.12 m^3/s).

- Pump intakes are positioned above the river bottom with a velocity less than or equal to 0.5 ft/s (0.15 m/s) at the inlet of the velocity caps with a 2 millimeter (mm) fine mesh traveling screen.
- Water withdrawal location is near the confluence of the spillway channel below Belews Lake Dam and the Dan River.
- Semi-annual lake monitoring to assess limnological conditions in Belews Lake.
- Pumping may occur to a maximum water elevation in Belews Lake of 724.5 ft. (220.8 m) Mean Surface Level.
- No pumping will occur between April 1 and June 30 in order to avoid the fish spawning period.
- At least 80 percent of ambient flow will be bypassed, meaning withdrawals will not exceed 20 percent of the river flow.

Routine inspection and cleaning in and around the velocity caps, including the removal of silt, sediment, and debris, ensures reliable makeup water to Belews Lake from the MWIS is maintained.

3.4.1.1.3 Cooling Tower Blowdown

The normal cooling tower blowdown flow rate, based on eight cycles of concentration, is 3852 gpm (14.6 cubic meters per minute [m^3/min]). The maximum blowdown flow rate, based on six cycles of concentration, is 6516 gpm (24.7 m^3/min). The cooling tower temperature range, which is the difference between the cooling water entering and leaving the cooling towers, is 21.2°F (11.8°C). The maximum blowdown temperature at the point of discharge to Belews Lake is 95°F (35°C). Blowdown constituents and concentration in the wastewater at discharge are shown in Table 3.4-3.

The range of water quality including peak constituent concentrations in Belews Lake is detailed in Section 2.2.3 and summarized in Tables 2.2-27 and 2.2-28. This bounds any seasonal variations in water quality for Belews Lake. The blowdown constituents at the discharge are estimated based on the peak Belews Lake constituent concentrations at the intake, assuming the cooling towers operate at the maximum of 12 cycles of concentration. This conservative estimate bounds any seasonal variation and different plant operating modes. Impacts associated with cooling tower blowdown are described in Section 5.2.

Based on the bounding values in the PPE, described in Section 3.1.2, the normal water evaporation rate from the cooling system is 26,256 gpm (99.4 m^3/min), with a maximum evaporation rate of 32,580 gpm (123.3 m^3/min). Drift losses occur at a normal rate of 1 gpm (0.0038 m^3/min), with the maximum drift rate of 21 gpm (0.08 m^3/min). Table 3.2-1 contains a representative list of chemicals that may be used at each Plant Complex for water treatment activities. The specific chemicals and storage quantities are determined by the results of water quality studies and systems required for the chosen reactor technology.

3.4.1.1.4 Discharge Design

The discharge design is dependent upon the reactor technology selected but is designed to ensure compliance with environmental and regulatory standards. The cooling tower blowdown will be directed to multiple discharge points based on operational needs, allowing for flexibility and optimization of water retention and water quality strategies.

The primary discharge route will return the blowdown to Belews Lake, supporting water retention strategies to preserve lake levels and ecosystem health. Alternatively, the blowdown may be diverted to the Dan River outfall, located within the existing corridor adjacent to Outfall 006. This option supports water quality strategies that help manage the constituents returning to Belews Lake and ensure effective contaminant control.

Additionally, the blowdown flow will be used as a dilution flow for treated liquid radioactive waste, which will be directed to a new Dan River outfall adjacent to Outfall 006. Blowdown diversion to the Dan River occurs in short durations. When blowdown is diverted to the Dan River outfall, administrative and engineering controls are used to limit temperature impacts to the river such that the increase in river temperature downstream from the mixing zone does not exceed NPDES permit limitations.

The final configuration will depend on the reactor technology selected. Specific details regarding specific flows, temperature changes, losses, and associated procedures will be addressed in the construction permit or license application phase. Conceptual discharge designs are shown in Figure 3.2-2 and Figure 3.2-3.

3.4.1.2 Land Interfaces

Routine maintenance of the Project site and associated infrastructure is necessary for ensuring its continued operation and upkeep.

3.4.1.2.1 General Site Maintenance

Domestic waste and trash are regularly removed to ensure waste and debris do not impact the environment, facility, personnel, or operational activities. Groundskeeping is performed routinely to maintain the areas surrounding facilities and associated infrastructure, corridors, and parking areas.

3.4.1.2.2 Paved Area Maintenance

Road and paved area maintenance depends on the material used. Asphalt paved roads and parking areas are maintained by filling stress-related cracks with a bitumen sealer on a periodic basis. Asphalt roads generally last ten to twenty years, and surface rehabilitation can be performed to extend the lifespan. Crushed stone surfaced roads and parking areas generally need annual grading. Concrete pavement maintenance includes resealing joints or cracks and replacing sections of pavement with excessive cracking, uplift, or degradation. Changes in road surfaces may occur as site operations evolve potentially affecting grade, runoff, and future maintenance requirements.

3.4.1.2.3 Rail Line Maintenance

Rail line maintenance is infrequent and may include replacing ties in cases of excessive deterioration or failure, as well as reballasting to address track settlement. Switch components will require periodic lubrication and occasional replacement of parts or components.

3.4.1.2.4 Transmission Line Operation and Maintenance

Modifications to the existing Belews Creek 230 kV switchyard, the installation of a new switchyard, the reroute and expansion of the Pleasant Garden B/W 230 kV and Belews Creek

B/W 230 kV lines, and the installation of new individual bus lines to interconnect the existing facilities to each Plant Complex is required.

Additional details on the transmission system and design parameters are described in Section 3.2.4. Impacts to land resources due to the transmission system are addressed in Section 5.1.

3.4.1.2.5 Transmission Corridor Maintenance

Vegetation is cleared to at least the full width of the transmission corridor. Additional clearing is required beyond the corridor for trees that have the potential to fall on the transmission lines. Periodic vegetation maintenance may be required to ensure the reliability of the transmission system.

3.4.1.3 Air Interfaces

Various stacks and vents associated with gaseous effluent release and diesel emissions are used. The MDCT height ranges from 50 to 75 ft. (15 to 22.9 m) above finished grade, and the release point for the standby diesel exhaust is at least 9.84 ft. (3 m) above grade. Location and elevation of other plant vents and exhausts for systems such as the auxiliary boiler system, if needed, are conservatively assumed to exhaust at grade.

3.4.1.4 Summary of Plant-Environmental Interfaces During Operation

A summary of environmental interfaces during operation is provided in Table 3.4-2, which includes section, table, and figure reference numbers where this information is discussed in more detail.

3.4.2 RADIOACTIVE WASTE MANAGEMENT

Radioactive waste is generated through several processes associated with the normal operation and maintenance of nuclear reactors. Radioactive waste contains or emits radioactive particles and can be in a liquid, gas, or solid form (NRC, 2024). This section describes the liquid, gaseous, and solid radioactive waste management systems proposed to be used at the Project site.

3.4.2.1 Radioactive Waste Generation Process

Fission products, from the nuclear reactor process, may enter the reactor coolant by diffusing from the nuclear fuel through fuel cladding leaks. Nonradioactive materials such as metals in the reactor core or primary cooling system can be activated by the neutrons in the reactor core as corrosion products. Contaminated reactor coolant is treated through filtration systems that produce radioactive solid and liquid waste. Gaseous byproducts are generated through fission or released from the reactor coolant. Radioactive waste results from a combination of fission products, activated materials, treatment processes, and contaminated materials used to perform routine maintenance and general repairs. Duke Energy's existing nuclear fleet operates under various administrative procedures to ensure the safe handling and management of radioactive wastes.

3.4.2.2 Independent Spent Fuel Storage Installation

According to 10 CFR Part 72, an independent spent fuel storage installation (ISFSI) is a facility

designed to safely store spent nuclear fuel, which is used fuel that remains after it has been removed from a nuclear reactor. As noted in Section 3.1, an ISFSI is anticipated for the Project site, with its size and design to be determined based on the selected reactor technology. Details of the ISFSI including its layout, capacity, and operational characteristics will be determined during the construction permit or license application phase. The ISFSI will meet the requirements set forth in 10 CFR Part 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste*.

3.4.2.3 Regulatory Compliance and Safety Standards

The radioactive waste management systems are designed to minimize releases from reactor operations to values as low as is reasonably achievable (ALARA). The systems are designed and maintained to meet the requirements of 10 CFR Part 20, *Standards for the Protection Against Radiation* and 10 CFR Part 50, Appendix I, *Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion As Low as is Reasonably Achievable for Radioactive Material in Light-Water Cooled Nuclear Power Reactor Effluents*. Radiation dose impacts from normal operation of the Project site are provided in Section 5.9.

3.4.2.4 Liquid Radioactive Waste Management

Nuclear reactors produce liquid radioactive waste during normal operations. Sources of liquid radioactive waste include leakage from systems, processing systems, and maintenance activities. The liquid radioactive waste system controls, collects, processes, handles, stores, and disposes of liquid radioactive waste generated during normal operation.

The sources and potential sources of liquid radioactive waste are determined following the reactor technology selection and are provided during the construction permit or license application phase. The collection and processing systems are designed to remove the radioactivity to the extent that the system recycles or discharges the processed liquid in accordance with the requirements of 10 CFR Part 20 and the ALARA principles of 10 CFR Part 50, Appendix I.

After treating liquid radioactive waste, it is diluted with cooling tower blowdown water through independent piping from each Plant Complex routed to a common liquid radioactive waste line directed toward the Dan River outfall, adjacent to Outfall 006 shown on Figure 3.1-3 and Figure 3.2-3. The common liquid radioactive waste line is located within the existing corridor, adjacent to the Outfall 006 piping. The discharge is controlled and monitored to ensure compliance with environmental regulations and safety standards. Liquid radioactive waste processing systems are designed to keep radiation exposures of plant personnel ALARA and ensure that discharges to the Dan River stay within the limits set by the NRC and other applicable regulations, which protect public health and the environment from radiological impacts.

The bounding annual release of radioactivity in liquid effluents from the proposed Project site is provided in Table 3.4-4, and the bounding annual liquid effluent release of radioactivity from a single reactor is shown in Table 3.4-5.

3.4.2.5 Gaseous Radioactive Waste Management

Nuclear reactors generate gaseous radioisotopes during normal operation, which may include radioactive aerosols, noble gases, radioiodine, and tritium. Common gaseous radioactive waste

comes from collection tank and processing equipment vents, and non-condensable gases in steam systems.

The processing system collects, processes, and stores gases from multiple sources, to decrease the radioactivity content to a level that allows them to be released to the environment through a controlled and monitored release point (e.g., plant vent). Radioactive gases are usually held for radioactive decay for the purpose of minimizing radioactivity released to the environment. Retention methods may include storage in pressurized tanks, long delay lines, and holdup through adsorption on activated charcoal. Radioactive gases from plant system leakage to the building atmosphere are detected by area radiation monitors. Ventilation systems process these gases through filtration, if needed, and direct releases through the monitored building ventilation system release points.

Gaseous radioactive waste discharges are controlled pursuant to 10 CFR Part 20 and the ALARA principles of 10 CFR Part 50, Appendix I. Gaseous radioactive waste system equipment is designed to ensure occupational exposure to plant personnel are ALARA. Additionally, system safeguards and operational practices ensure radiation doses to members of the public and releases are below established regulatory limits. The bounding annual release of radioactivity in gaseous waste from the Project site is provided in Table 3.4-6, and Table 3.4-7 provides the bounding annual release of radioactivity from a single reactor.

3.4.2.6 Solid Radioactive Waste Management

Nuclear reactors generate various types and quantities of solid (wet or dry) radioactive waste as a byproduct of processing contaminated liquid and gaseous effluent, and through incidental and designed contact with radioactive materials during routine operations. These wastes result from routine operations and maintenance activities within radiologically controlled areas, and from processes that involve direct contact with radioactive materials. Details for the management of high-level waste will be presented in the construction permit or license application phase.

Low-level waste (LLW) consists of items contaminated with radioactive material or made radioactive by exposure to neutron radiation. This waste typically includes protective clothing, shoe covers, wiping rags, mops, filters, reactor water treatment residues, and various tools and equipment. The radioactivity of LLW ranges from levels slightly above natural background radiation to much higher levels on parts from inside the reactor. LLW is stored on-site in a radwaste building, either until it decays and can be disposed of with solid waste, or until the quantity is large enough to ship to a licensed LLW disposal site in compliant containers (NRC, 2024).

The solid radioactive waste management system collects, monitors, segregates, processes, and prepares solid radioactive waste prior to shipment or on-site storage. This system ensures the handling, processing, and storage of solid radioactive waste in a manner that minimizes exposure to plant personnel and the public, in accordance with 10 CFR Part 20. Wastes are packaged to meet the U.S. Department of Transportation (49 CFR Part 173 and 178) and NRC (10 CFR Part 71) regulations for transportation of radioactive materials. Packaged radioactive waste is transported to either a licensed waste processing facility or a licensed low-level radioactive waste disposal facility.

The bounding volume of solid radioactive waste generated at the Project site is listed in Table 3.1-1. The bounding annual radioactivity of solid radioactive waste from the Project site is provided in Table 3.4-8.

3.4.3 NONRADIOACTIVE WASTE MANAGEMENT

Solid and hazardous waste is generated during the construction and operation of advanced reactors on the Project site. This section provides a general discussion of typical nonradioactive solid, liquid, and gaseous waste streams generated on-site. Nonradioactive waste from nuclear power plants includes both hazardous and nonhazardous wastes.

Common waste streams include cooling water that may contain water treatment chemicals or biocides, waste from floor and equipment drains, water treatment residuals, sanitary effluents, stormwater runoff, gaseous effluents, used oils, universal waste, and hazardous waste.

Duke Energy's existing waste management programs comply with federal, state, and local regulations.

3.4.3.1 Effluents Containing Chemicals or Biocides

Biocides and other chemicals are used to treat cooling and process waters to avoid scaling or fouling. Effluents from the plant water systems, described in Section 3.2.3, are processed to minimize the release of these treatments, but may still contain some low-level chemicals or biocides. Chemical concentrations are controlled through engineering, operational, and administrative controls to comply with the conditions in NPDES permit.

Specific chemicals and biocides used depend upon the characteristics of the water to be treated and the design requirements of the reactor technology selected. Duke Energy's nuclear operating fleet uses an established water chemistry program that covers cooling tower and once-through systems for waste heat condenser applications and some service water cooling applications. The program utilizes several administrative procedures to ensure compliance and describes the implementation for treatments, maintenance, and testing best suited for the site-specific design and environment. Table 3.2-1 summarizes representative chemicals that may be used for water treatment at the Project site.

After the reactor technology is selected, site-specific procedures are developed during the construction permit or license application phase, including any necessary revisions to the NPDES permit requirements. The constituents and their concentrations are controlled in accordance with the limits outlined in the NPDES permit and limitations set by federal, state, or local regulatory agencies.

3.4.3.2 Sanitary System Effluents

Sanitary waste is generated during building and operational activities. The Project site is subject to the NPDES program for wastewater discharges (NCDEQ, 2024a). As shown on Figure 3.2-4, sanitary waste from the Project site is pumped to the existing BCSS domestic wastewater treatment plant for treatment prior to discharge.

The BCSS domestic wastewater treatment plant is authorized to treat and discharge under NPDES Permit No. NC0024406. In accordance with the permit, liquid waste from the domestic wastewater treatment plant is discharged via internal Outfall 009. Effluent is subsequently released to the Dan River via Outfall 006.

Under the proposed Project, sanitary effluent limits for internal Outfall 009 will remain in effect as specified in the existing permit. The maximum effluent flow rate from the domestic

wastewater plant is 19 gpm (0.07145 m^3/min) or approximately 27,305 gpd (0.10 m^3/day) as noted on Table 3.4-1 and shown on Figure 3.2-4.

The NPDES permit defines discharge limits for flow volume and water quality to protect receiving surface waters, and the Project site will continue to operate in compliance with these requirements.

3.4.3.3 Other Effluents

Nonradioactive waste streams, separate from the liquid process and sanitary waste systems described above, are described in this section. The following waste streams are included in this section:

- Solid waste management.
- Hazardous and mixed waste management.
- Liquid effluents.
- Gaseous effluents.

3.4.3.3.1 Solid Waste Management

Solid waste consists of hazardous and nonhazardous nonradioactive waste streams and are generated during construction and operation of advanced reactor technologies at the Project site. Solid waste is managed in accordance with existing Duke Energy waste management programs designed to comply with federal, state, and local regulations.

Broadly, Duke Energy Environmental Programs maintain administrative policies and procedures to ensure all employees and contractors properly manage waste. Procedures are tailored to meet site-specific obligations and regulations to ensure compliance. Duke Energy also maintains regional waste subject matter experts as a resource.

To ensure safe handling and minimize environmental impacts, all nonradioactive waste will be segregated based on waste type and its potential hazards and stored in appropriate containers. Waste segregation will occur at the point of generation, and waste will be labeled accordingly to facilitate proper disposal. Duke Energy maintains an approved waste vendor list to ensure waste is recycled or disposed of through an approved facility. Additional details are provided in Section 5.10.

3.4.3.3.2 Hazardous and Mixed Waste Management

3.4.3.3.2.1 Hazardous Waste

Hazardous waste in NC is regulated by the U.S. Environmental Protection Agency (USEPA) and the NCDEQ, Division of Waste Management (NCDEQ, 2024b). The existing BCSS is a Small Quantity Generator (SQG) of hazardous waste issued EPA ID Number NCD000856591 (USEPA, 2024a), and Duke Energy anticipates no change to generator status at the Project site.

A SQG Is a facility that generates more than 100 kg (220 lbs.) but no more than 1000 kg (2200 lbs.) per month of hazardous waste, and less than 1 kg (2.2 lbs.) per month of an acute hazardous waste (USEPA, 2024b). SQGs are subject to enforcement and oversight under the

Resource Conservation and Recovery Act (RCRA) Subtitle C, codified in 40 CFR Part 260 through 280 (USEPA, 2024b), as well as North Carolina Administrative Code (NCAC), Subchapter 13A – Hazardous Waste Management, which adopts RCRA (NCDEQ, 2024b).

SQGs must manage and dispose of hazardous waste in accordance with Subtitle C of RCRA that include requirements for manifesting, labeling, storage limits, hazardous waste determinations, recordkeeping and reporting, employee training, waste minimization, and emergency preparedness.

3.4.3.3.2.2 Mixed Waste

Mixed waste contains both radioactive and hazardous wastes and are generally accumulated in designated areas on-site and then shipped off-site for treatment and disposal. This waste is regulated by both the USEPA through RCRA and by the NRC under the Atomic Energy Act.

Duke Energy maintains procedures for management of hazardous and mixed waste at their facilities. While there is potential for mixed waste generation, all effort to abate this waste stream is implemented through engineering controls and administrative procedures.

Hazardous and mixed waste generated at the Project site are managed in accordance with relevant federal and state regulations. Additional details on hazardous and mixed waste and associated impacts are described in Section 5.10.1.

3.4.3.3.3 Liquid Effluents

The CWA, 33 U.S. Code 1251 establishes the basic structure for regulating discharges into U.S. waters and sets quality standards for surface waters (USEPA, 2024c). Section 402 of the CWA (40 CFR Part 122) authorizes the NPDES program, which requires permits to control point source discharges (USEPA, 2024d). The EPA has delegated permitting authority to the state, administered through the NCDEQ, Division of Water Resources (NCDEQ, 2024c).

Nonradioactive liquid effluents from the Project site include cooling tower blowdown, stormwater discharges, and other conventional liquid discharge streams (e.g., turbine building sumps, groundwater sumps, water treatment discharges), which are authorized and controlled by the Project site NPDES permit.

3.4.3.3.3.1 Cooling Tower Blowdown

Cooling tower blowdown, water that is routinely released from the cooling system to remove impurities and sediment that may degrade performance, is typically discharged to Belews Lake but can be discharged to the Dan River. As described in Section 3.4.1.1.4, blowdown flow is also used for water quality purposes to dilute treated liquid radioactive effluent prior to discharge into the Dan River. Normal and maximum operational flow rates are listed in Table 3.4-1. Section 3.4.1.1 describes the water interfaces, while Section 3.4.1.1.3 details cooling tower blowdown. This effluent contains constituents normally present in Belews Lake but at a higher concentration based on the cycles of concentration assumed for the cooling towers. As described in Section 3.4.3.1, biocides or other chemicals may also be used to prevent biological growth and prevent scaling. A list of blowdown constituents and concentrations is provided in Table 3.4-3.

3.4.3.3.3.2 Stormwater Management System

As described in Section 3.4.3.3.3, the NCDEQ administers the NPDES program. Accordingly, the stormwater management system for the Project site will be designed and permitted in compliance with the requirements set by the state of NC. The system is engineered to meet NCDEQ design standards and will collect and manage stormwater runoff from each Plant Complex through a dedicated stormwater collection and conveyance system.

This system includes drainage swales and trapezoidal ditches in open areas such as construction laydown and use zones, with culverts at road crossings. In the power block and equipment areas, drainage inlets, manholes, and interconnected drainpipes collect and direct runoff. The system channels runoff to Belews Lake when permissible, and to stormwater ponds designed to meet retention requirements and attenuate peak flows to predevelopment conditions, as required.

The stormwater system is designed to comply with relevant federal, states, and local stormwater regulations.

3.4.3.3.3.3 Other Liquid Effluent Sources

The remaining nonradioactive liquid waste discharges (e.g., turbine building sumps, groundwater sumps, and water treatment discharges) are routed to the consolidated sump, where they undergo treatment before discharging to the Dan River Outfall 006. Section 3.4.1.1.4 provides information on the discharge to Outfall 006.

Liquid effluent discharges are managed in accordance with the Project site issued NPDES permit.

3.4.3.3.4 Gaseous Effluents

Operation of a nuclear power reactor emits gaseous effluents during normal operation. This section describes the gas effluents associated with the operation of a nuclear plant utilizing advanced reactor technology. Cooling towers, auxiliary boilers, and fossil fuel-powered equipment, such as generators, pumps, boilers, and compressors are the primary sources of effluents. These effluents commonly include carbon monoxide, hydrocarbons, nitrogen oxides, particulates, and sulfur oxides.

Only one reactor technology being considered includes a fossil fuel-powered auxiliary boiler, with emissions listed in Table 3.4-9. For air modeling purposes, the exhaust elevation is conservatively modeled at grade elevation. The exhaust elevation is to be included in the construction permit or license application phase, if selected. Diesel generators and diesel-driven fire water pumps are used intermittently and for brief durations. The standby diesel generators' exhaust is at a bounding minimum elevation of 9.84 ft. (3 m) above grade, and estimated emissions are provided in Table 3.4-10.

Air emissions from the Project site will comply with applicable federal, state, and local air emission standards.

Table 3.4-1
Normal and Maximum Operational Flow Rates

Withdrawal	**Normal Operational Flow (gpm)**	**Maximum Flow (gpm)**
Intake from Belews Lake (circulating makeup water and miscellaneous plant water uses)	30,709	43,131
Municipal Water for Potable/Sanitary and Fire Protection	17	1269
Consumptive Use	**Normal Operational Flow (gpm)**	**Maximum Flow (gpm)**
Cooling Tower Evaporation	26,256	32,580
Cooling Tower Drift	1	21
Demineralized Water Losses	198	720
Fire Protection	6	1250
Liquid Discharges	**Normal Operational Flow (gpm)**	**Maximum Flow (gpm)**
Treated/Diluted Radwaste (to Dan River)	3300	9450
Treated Domestic (Sanitary) Waste (to Dan River)	11	19
Miscellaneous Plant Water Uses (to Dan River)	102	360
Cooling Tower Blowdown (to Belews Lake)	3852	6516

Key: gpm = gallons per minute

Table 3.4-2
Summary of Plant-Environmental Interfaces During Operations

Resource Type	Operational Interface Point Description	Reference Section Number	Table Number	Figure Number
Water	Normal operational flow rates and maximum flow rates.	Section 3.2.2.3 Section 3.4.1.1	Table 3.4-1	Figure 3.2-4
	Description of intake operation, water intake systems.	Section 3.2.2.4.1 Section 3.4.1.1.1		Figure 3.2-1
	Plant discharge outfall to Belews Lake.	Section 3.2.2.4.3 Section 3.4.1.1.4		Figure 3.2-2
	Plant discharge to the Dan River.	Section 3.4.1.1.4		Figure 3.2-3
	Stormwater discharge.	Section 3.4.3.3.3.2		
	Cooling tower blowdown volume, flow rates, temperature range, number of cycles of concentration assumed for operations.	Section 3.2.2.4.4 Section 3.2.3.1 Section 3.4.1.1.3		Figure 3.2-4
	Description of chemicals for intake and discharge treatment, including temperature and chemical constituent concentration in wastewater at the plant discharge outfall location.	Section 3.2.3.2 Section 3.4.1.1.3 Section 3.4.3.1	Table 3.2-1, Table 3.4-3	
Land	General site maintenance.	Section 3.4.1.2.1		
	Roadway and paved surface maintenance.	Section 3.4.1.2.2		
	Rail line maintenance.	Section 3.4.1.2.3		
	Transmission system and transmission line corridor.	Section 3.2.4.1 Section 3.2.4.2		Figure 3.2-5 Figure 3.2-6
	Transmission voltage, number of transmission facilities, proposed modifications to existing corridors and new transmission lines.	Section 3.2.4.1.1 Section 3.4.1.2.1		Figure 3.1-1 Figure 3.1-2 Figure 3.1-3
	Transmission maintenance procedures and frequency for transmission corridors, switchyards, roads, and other associated infrastructure.	Section 3.2.4.2 Section 3.4.1.2 Section 3.4.1.2.2		
Air	Cooling Tower Emissions.	Section 3.4.1.3		
	Gaseous Effluent Release.	Section 3.4.1.3 Section 3.4.3.3.4	Table 3.4-9	
	Standby Diesel Generator Exhaust.	Section 3.4.1.3 Section 3.4.3.3.4	Table 3.4-10	

Table 3.4-3
Bounding Blowdown Constituents and Concentrations

Constituent	Maximum Potential Concentration parts per million (ppm)[(a)(b)]
Alkalinity	330
Aluminum	11
Ammonia	1.2
Arsenic	0.0065
Barium	0.23
Boron	0.54
Cadmium	0.0012
Calcium	69
Hardness (as CaCO3)	310
Total Organic Carbon (TOC)	36
Chloride	73
Chromium	0.0073
Copper	0.014
Iron	5.5
Lead	0.0041
Magnesium	32
Manganese	0.35
Mercury	N/A
Nickel	0.012
Nitrite plus Nitrate	2.4
Nitrogen, Total Kjeldahl (TKN)	6.7
pH range	6 – 9
Phosphate, Ortho (as PO4)	0.60
Phosphorus, P	0.60
Potassium, K	34
Selenium	0.012
Silicon, Si	78
Sodium	61
Sulfate	78
Total dissolved solids	940
Total suspended solids	24
Zinc	0.039
Thallium	0.0024
Vanadium, (and Compounds)	0.018

Notes:
(a) Values are calculated based on water quality data from the nearest upstream sample location to the potential intake location option 1 or Sample Location 410, as described in Section 3.4.1.1.1.
(b) The concentration at discharge is based on the assumption of the maximum normal operating value of 12 Cycles of Concentration.

Table 3.4-4
Bounding Normal Liquid Radioactive Release

Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)
Ag-110	1.20E-04	I-132	9.00E-04	Sb-124	6.00E-05
Ag-110m	9.00E-04	I-133	1.14E-02	Sb-125	6.00E-05
Am-241	6.00E-05	I-134	6.00E-05	Sb-127	5.84E-09
As-76	6.00E-05	I-135	5.16E-03	Sb-129	2.12E-07
Ba-137m	7.20E-04	La-140	1.20E-03	Se-75	6.00E-05
Ba-139	1.32E-03	La-141	1.26E-21	Sr-89	3.00E-04
Ba-140	2.94E-02	La-142	1.08E-03	Sr-90	6.00E-05
Br-82	1.57E-07	Mn-54	3.90E-02	Sr-91	1.20E-02
Br-83	4.02E-03	Mn-56	1.20E-03	Sr-92	2.88E-03
Br-84	6.00E-05	Mo-99	1.68E-02	Tc-99	1.16E-08
Br-85	1.41E-05	Mo-101	1.62E-04	Tc-99m	1.68E-02
C-14	6.00E-05	Na-24	1.14E-02	Te-123m	6.00E-05
Ce-141	1.98E-03	Nb-95	7.20E-03	Te-125m	8.38E-07
Ce-143	9.60E-04	Nb-98	6.00E-05	Te-127	3.30E-06
Ce-144	2.82E-03	Nd-147	2.40E-04	Te-127m	3.38E-06
Cm-242	6.00E-05	Ni-63	1.86E-02	Te-129	1.80E-04
Cm-244	6.00E-05	Ni-65	2.40E-04	Te-129m	3.00E-03
Co-57	6.00E-05	Np-239	1.26E-02	Te-131	1.26E-03
Co-58	2.04E-02	P-32	2.82E-03	Te-131m	1.20E-04
Co-60	3.96E-02	Pr-143	3.54E-03	Te-132	4.20E-04
Cr-51	7.20E-02	Pr-144	2.82E-03	Te-133m	1.50E-04
Cs-132	5.16E-06	Pu-238	6.00E-05	Te-134	2.07E-04
Cs-134	1.38E-02	Pu-239	6.00E-05	W-187	4.44E-03
Cs-135m	7.20E-07	Pu-240	6.00E-05	Y-90	3.00E-07
Cs-136	7.80E-03	Pu-241	6.00E-05	Y-91	4.02E-03
Cs-137	2.10E-02	Rb-86	5.76E-04	Y-91m	6.00E-05
Cs-138	1.78E-03	Rb-86m	5.66E-09	Y-92	9.00E-03
Cu-64	4.44E-02	Rb-88	6.00E-05	Y-93	9.60E-04
Fe-55	8.40E-02	Rb-89	2.44E-04	Zn-65	1.62E-02
Fe-59	2.10E-02	Rh-103m	4.62E-03	Zn-69m	2.52E-02
H-3	1.62E+03	Rh-105	6.30E-09	Zr-95	6.60E-03
Hf-181	6.00E-05	Rh-106	1.50E-03	Zr-97	1.20E-04
I-129	1.25E-10	Ru-103	4.62E-03		
I-130	1.76E-09	Ru-105	4.74E-03	**Total**	**1.62E+03**
I-131	6.60E-03	Ru-106	2.88E-03		

Key: Ci/yr = Curies per year

Table 3.4-5
Bounding Liquid Effluent Activities Per Reactor

Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)
Ag-110	2.00E-05	I-132	1.50E-04	Sb-124	1.00E-05
Ag-110m	1.50E-04	I-133	1.90E-03	Sb-125	1.00E-05
Am-241	1.00E-05	I-134	1.00E-05	Sb-127	2.92E-09
As-76	1.00E-05	I-135	8.60E-04	Sb-129	3.54E-08
Ba-137m	1.20E-04	La-140	2.00E-04	Se-75	1.00E-05
Ba-139	2.20E-04	La-141	6.29E-22	Sr-89	5.00E-05
Ba-140	4.90E-03	La-142	1.80E-04	Sr-90	1.00E-05
Br-82	7.86E-08	Mn-54	6.50E-03	Sr-91	2.00E-03
Br-83	6.70E-04	Mn-56	2.00E-04	Sr-92	4.80E-04
Br-84	1.00E-05	Mo-99	2.80E-03	Tc-99	5.80E-09
Br-85	2.35E-06	Mo-101	2.70E-05	Tc-99m	2.80E-03
C-14	1.00E-05	Na-24	1.90E-03	Te-123m	1.00E-05
Ce-141	3.30E-04	Nb-95	1.20E-03	Te-125m	4.19E-07
Ce-143	1.60E-04	Nb-98	1.00E-05	Te-127	1.65E-06
Ce-144	4.70E-04	Nd-147	4.00E-05	Te-127m	1.69E-06
Cm-242	1.00E-05	Ni-63	3.10E-03	Te-129	3.00E-05
Cm-244	1.00E-05	Ni-65	4.00E-05	Te-129m	5.00E-04
Co-57	1.00E-05	Np-239	2.10E-03	Te-131	2.10E-04
Co-58	3.40E-03	P-32	4.70E-04	Te-131m	2.00E-05
Co-60	6.60E-03	Pr-143	5.90E-04	Te-132	7.00E-05
Cr-51	1.20E-02	Pr-144	4.70E-04	Te-133m	2.50E-05
Cs-132	2.58E-06	Pu-238	1.00E-05	Te-134	3.45E-05
Cs-134	2.30E-03	Pu-239	1.00E-05	W-187	7.40E-04
Cs-135m	1.20E-07	Pu-240	1.00E-05	Y-90	1.50E-07
Cs-136	1.30E-03	Pu-241	1.00E-05	Y-91	6.70E-04
Cs-137	3.50E-03	Rb-86	2.88E-04	Y-91m	1.00E-05
Cs-138	2.96E-04	Rb-86m	9.43E-10	Y-92	1.50E-03
Cu-64	7.40E-03	Rb-88	1.00E-05	Y-93	1.60E-04
Fe-55	1.40E-02	Rb-89	4.07E-05	Zn-65	2.70E-03
Fe-59	3.50E-03	Rh-103m	7.70E-04	Zn-69m	4.20E-03
H-3	2.70E+02	Rh-105	3.15E-09	Zr-95	1.10E-03
Hf-181	1.00E-05	Rh-106	2.50E-04	Zr-97	2.00E-05
I-129	6.26E-11	Ru-103	7.70E-04		
I-130	8.80E-10	Ru-105	7.90E-04	**Total**	**2.70E+02**
I-131	1.10E-03	Ru-106	4.80E-04		

Key: Ci/yr = Curies per year

Table 3.4-6
Bounding Normal Gaseous Radioactive Release

Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)
Ag-110	8.02E-05	I-135	7.52E-01	Sb-129	7.38E-09
Ag-110m	6.00E-05	Kr-83m	4.87E+01	Se-75	6.00E-05
Am-241	6.00E-05	Kr-85	3.62E+02	Sr-89	5.64E-05
Ar-41	2.04E+02	Kr-85m	5.37E+00	Sr-90	2.22E-05
As-76	6.00E-05	Kr-87	1.65E+01	Sr-91	2.73E-04
Ba-137m	4.98E-05	Kr-88	1.80E+01	Sr-92	1.66E-04
Ba-139	1.01E-07	Kr-89	7.71E+01	Tc-99	2.48E-09
Ba-140	1.15E-03	La-140	2.66E-04	Tc-99m	3.64E-05
Br-82	4.16E-06	La-141	3.12E-08	Te-125m	2.02E-07
Br-83	2.38E-05	La-142	1.49E-08	Te-127	2.70E-05
Br-84	1.10E-05	Mn-54	1.89E-03	Te-127m	7.70E-07
Br-85	1.32E-06	Mn-56	7.32E-05	Te-129	2.86E-06
C-14	6.51E+01	Mo-99	4.22E-04	Te-129m	1.36E-04
Ce-141	7.35E-05	Mo-101	4.22E-06	Te-131	3.08E-06
Ce-143	6.72E-08	Na-24	2.32E-04	Te-131m	2.44E-05
Ce-144	6.00E-05	Nb-95	2.89E-04	Te-132	6.00E-05
Co-57	4.92E-07	Ni-63	3.98E-06	Te-133m	3.82E-06
Co-58	8.46E-04	Np-239	2.86E-04	Te-134	5.42E-06
Co-60	1.77E-03	P-32	1.12E-04	W-187	8.53E-05
Cr-51	3.19E-03	Pr-143	8.72E-08	Xe-131m	5.40E+01
Cs-132	8.66E-08	Pr-144	1.36E-08	Xe-133	2.57E+02
Cs-134	1.07E-04	Pu-238	6.00E-05	Xe-133m	1.86E-01
Cs-135m	3.52E-07	Pu-239	6.00E-05	Xe-135	2.00E+02
Cs-136	5.95E-05	Rb-86	4.60E-06	Xe-135m	9.75E+01
Cs-137	1.67E-04	Rb-86m	4.90E-10	Xe-137	1.88E+01
Cs-138	1.79E-05	Rb-88	5.00E-04	Xe-138	1.91E+02
Cu-64	9.37E-04	Rb-89	7.17E-06	Y-90	1.43E-07
Fe-55	3.96E-03	Rh-103m	3.01E-07	Y-91	1.45E-04
Fe-59	9.39E-04	Rh-105	7.66E-08	Y-91m	1.04E-07
H-3	1.57E+02	Rh-106	1.67E-06	Y-92	6.70E-05
I-129	6.00E-05	Ru-103	7.31E-05	Y-93	2.12E-05
I-130	3.38E-05	Ru-105	3.52E-08	Zn-65	8.01E-04
I-131	8.48E-02	Ru-106	6.00E-05	Zr-95	3.05E-04
I-132	5.00E-01	Sb-124	6.00E-05	Zr-97	6.30E-08
I-133	3.92E-01	Sb-125	6.00E-05	**Total**	**1.77E+03**
I-134	1.41E+00	Sb-127	6.70E-09		

Key: Ci/yr = Curies per year

Table 3.4-7
Bounding Gaseous Effluent Activities Per Reactor

Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)
Ag-110	4.01E-05	I-135	1.25E-01	Sb-129	3.69E-09
Ag-110m	1.00E-05	Kr-83m	8.11E+00	Se-75	1.00E-05
Am-241	1.00E-05	Kr-85	6.03E+01	Sr-89	9.40E-06
Ar-41	3.40E+01	Kr-85m	8.95E-01	Sr-90	3.70E-06
As-76	1.00E-05	Kr-87	2.76E+00	Sr-91	4.56E-05
Ba-137m	8.30E-06	Kr-88	3.00E+00	Sr-92	2.77E-05
Ba-139	5.06E-08	Kr-89	1.29E+01	Tc-99	1.24E-09
Ba-140	1.92E-04	La-140	4.44E-05	Tc-99m	6.07E-06
Br-82	2.08E-06	La-141	1.56E-08	Te-125m	1.01E-07
Br-83	1.19E-05	La-142	7.47E-09	Te-127	1.35E-05
Br-84	5.52E-06	Mn-54	3.14E-04	Te-127m	3.85E-07
Br-85	6.58E-07	Mn-56	1.22E-05	Te-129	1.43E-06
C-14	1.09E+01	Mo-99	7.03E-05	Te-129m	2.26E-05
Ce-141	1.23E-05	Mo-101	2.11E-06	Te-131	1.54E-06
Ce-143	3.36E-08	Na-24	3.87E-05	Te-131m	4.07E-06
Ce-144	1.00E-05	Nb-95	4.82E-05	Te-132	1.00E-05
Co-57	8.20E-08	Ni-63	6.63E-07	Te-133m	1.91E-06
Co-58	1.41E-04	Np-239	4.76E-05	Te-134	2.71E-06
Co-60	2.95E-04	P-32	1.86E-05	W-187	1.42E-05
Cr-51	5.31E-04	Pr-143	4.36E-08	Xe-131m	9.00E+00
Cs-132	4.33E-08	Pr-144	2.27E-09	Xe-133	4.28E+01
Cs-134	1.79E-05	Pu-238	1.00E-05	Xe-133m	3.10E-02
Cs-135m	1.76E-07	Pu-239	1.00E-05	Xe-135	3.33E+01
Cs-136	9.92E-06	Rb-86	2.30E-06	Xe-135m	1.63E+01
Cs-137	2.78E-05	Rb-86m	2.45E-10	Xe-137	3.13E+00
Cs-138	2.99E-06	Rb-88	2.50E-04	Xe-138	3.18E+01
Cu-64	1.56E-04	Rb-89	1.19E-06	Y-90	2.38E-08
Fe-55	6.59E-04	Rh-103m	5.01E-08	Y-91	2.41E-05
Fe-59	1.56E-04	Rh-105	3.83E-08	Y-91m	5.20E-08
H-3	2.61E+01	Rh-106	2.79E-07	Y-92	1.12E-05
I-129	1.00E-05	Ru-103	1.22E-05	Y-93	3.53E-06
I-130	1.69E-05	Ru-105	1.76E-08	Zn-65	1.34E-04
I-131	1.41E-02	Ru-106	1.00E-05	Zr-95	5.09E-05
I-132	8.33E-02	Sb-124	1.00E-05	Zr-97	3.15E-08
I-133	6.54E-02	Sb-125	1.00E-05	**Total**	**2.96E+02**
I-134	2.35E-01	Sb-127	3.35E-09		

Key: Ci/yr = Curies per year

Table 3.4-8
Bounding Radionuclides in Solid Radioactive Waste

Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)	Radionuclide	Release (Ci/yr)
Ag-110	1.84E+00	I-133	2.46E+03	Sb-125	3.80E-02
Ag-110m	3.19E+01	I-134	1.75E+02	Sb-127	1.32E-05
Ba-137m	7.32E+02	I-135	1.05E+03	Sb-129	3.00E-08
Ba-139	1.28E-07	La-140	8.60E+01	Sr-89	8.12E+02
Ba-140	5.54E+02	La-141	1.13E-07	Sr-90	1.87E+00
Br-82	4.10E-04	La-142	2.08E-08	Sr-91	1.53E+02
Br-83	1.71E-05	Mn-54	1.24E+03	Sr-92	9.85E+01
Br-84	3.27E-01	Mn-56	2.34E+02	Tc-99	1.09E-01
Br-85	1.94E-08	Mo-99	5.62E+02	Tc-99m	4.97E+01
Ce-141	1.88E+02	Mo-101	9.38E-07	Te-125m	1.22E-01
Ce-143	1.12E-05	Na-24	1.26E+02	Te-127	1.50E+00
Ce-144	9.93E+01	Nb-95	3.88E+01	Te-127m	1.53E+00
Co-57	6.66E-07	Ni-63	1.39E+02	Te-129	2.60E-01
Co-58	1.35E+03	Np-239	1.92E+03	Te-129m	1.94E+02
Co-60	1.04E+04	P-32	3.14E-07	Te-131	1.73E-04
Cr-51	1.61E+04	Pr-143	2.78E-03	Te-131m	1.25E+01
Cs-132	4.40E-04	Pr-144	3.51E-03	Te-132	3.31E+00
Cs-134	1.22E+03	Rb-86	1.73E-01	Te-133m	3.20E-06
Cs-135m	2.64E-06	Rb-86m	7.24E-11	Te-134	3.44E-06
Cs-136	1.68E+01	Rb-88	1.60E+00	W-187	3.27E+01
Cs-137	4.13E+03	Rb-89	2.69E+00	Y-90	2.88E+00
Cs-138	5.84E+00	Rh-103m	7.81E-02	Y-91	4.50E+02
Cu-64	1.57E+02	Rh-105	1.62E-05	Y-91m	8.18E-07
Fe-55	1.72E+02	Rh-106	1.04E+00	Y-92	7.88E+01
Fe-59	2.59E+02	Ro-106	7.09E-05	Y-93	1.64E+02
I-129	1.80E-03	Ru-103	1.56E+02	Zn-65	3.13E+04
I-130	1.91E-04	Ru-105	1.45E-07	Zr-95	9.96E+01
I-131	4.28E+03	Ru-106	1.05E-01	Zr-97	1.87E-06
I-132	2.95E+02	Sb-124	1.15E-04	**Total**	**8.16E+04**

Key: Ci/yr = Curies per year

Table 3.4-9
Bounding Emissions from Auxiliary Boilers

Pollutant	Bounding Value (lb/yr)
Carbon monoxide	5930
Hydrocarbons	465
Nitrogen oxides	33,875
Particulates	7700
Sulfur oxides	41,575

Notes:
The emissions are based on the following inputs:

- Auxiliary boiler operation during each startup: 36 days per year; 864 hours per year.
- Auxiliary boiler size: 75,000 lb/hr at 150 psig, saturation temperature 89.1 MMBtu/hr.
- Quantity one auxiliary boiler operating at 100 percent load.
- Auxiliary boiler without "low NOx" burners.

Key: lb/yr = pound(s) per year; MMBtu/hr = million British thermal units per hour; NOx = nitrogen oxides; psig = pounds per square inch gauge; yr = year

Table 3.4-10
Bounding Emissions from Standby Diesel Generators

Pollutant	Emissions (lb/yr)
Carbon monoxide	18,744
Hydrocarbons	9000
Nitrogen oxides	233,898
Particulates	4830
Sulfur oxides	14,580

Notes:
The bounding emissions are based on inputs as follows:

- Fuel used is Number 2 diesel oil with 35° API and LHV of 18,390 Btu/lb.
- Standby diesel generators operating at 100 percent load.
- Emissions are based on each generator operating fours per month.

Key: ° = degree; API = American Petroleum Institute; Btu/lb = British thermal units per pound; lb/yr = pound(s) per year; LHV = lower heating value

3.5 REFERENCES

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Figure 3.1-1
General Arrangements

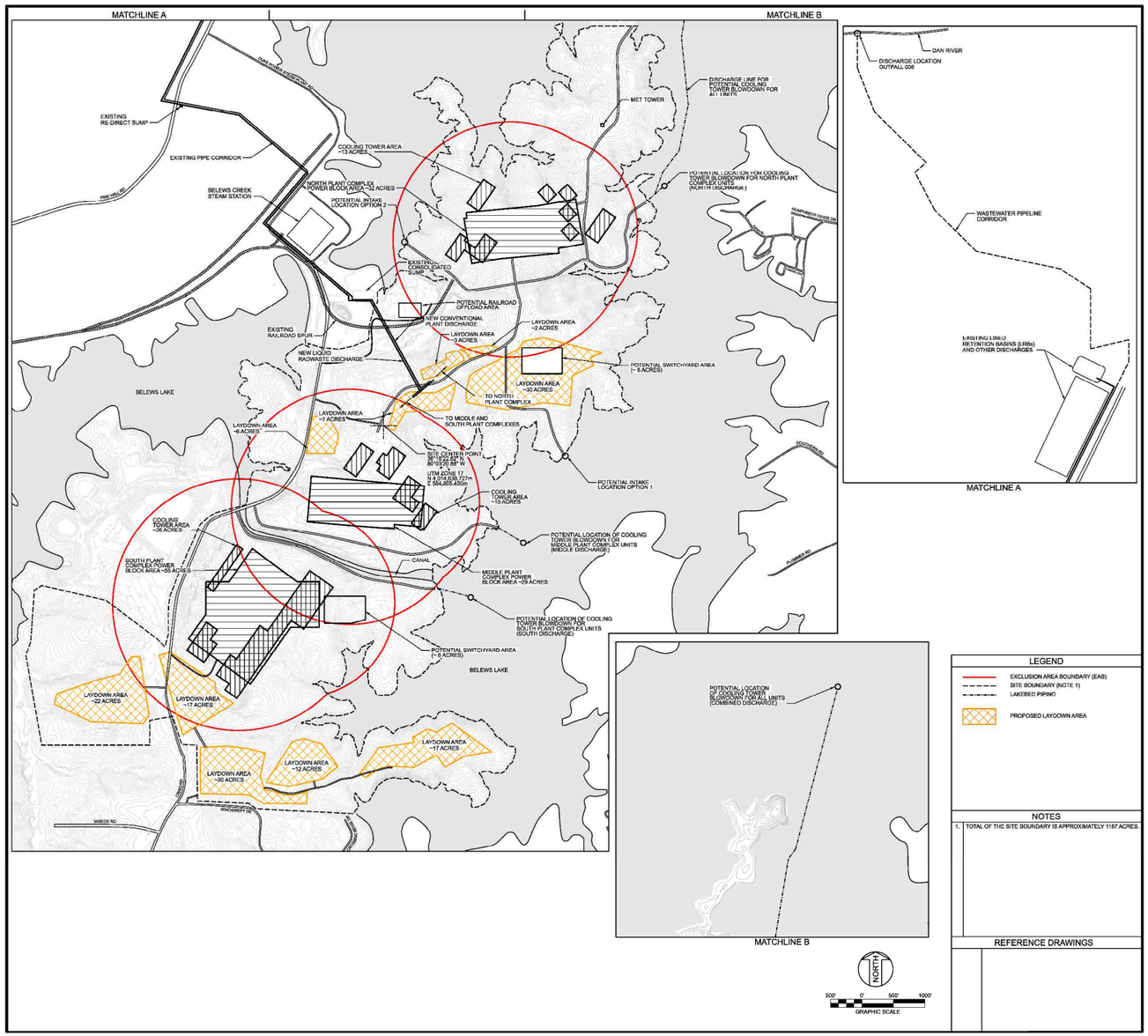


Figure 3.1-2
Existing Units, Structures, and Facilities

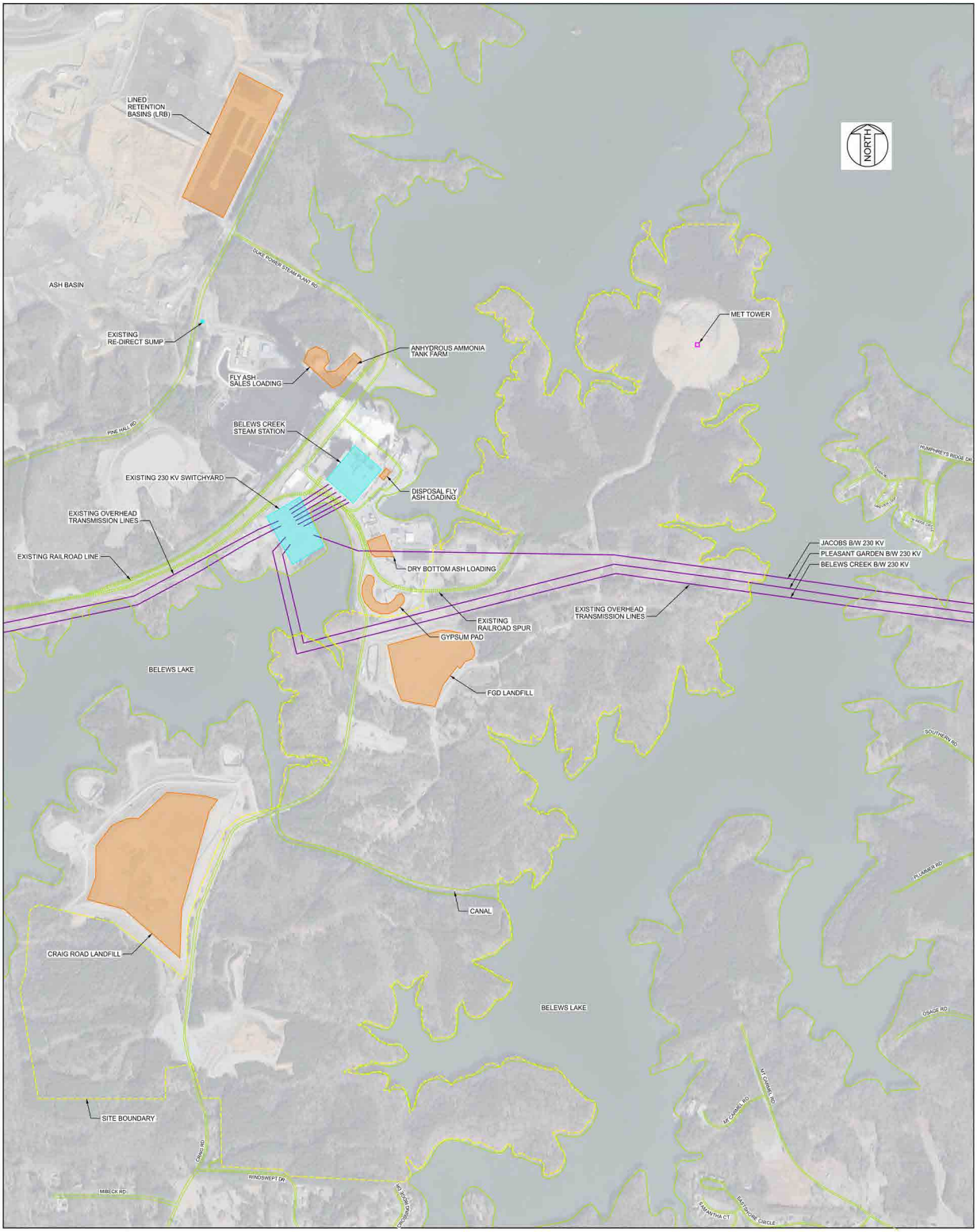


Figure 3.1-3
Shared Structures and Facilities

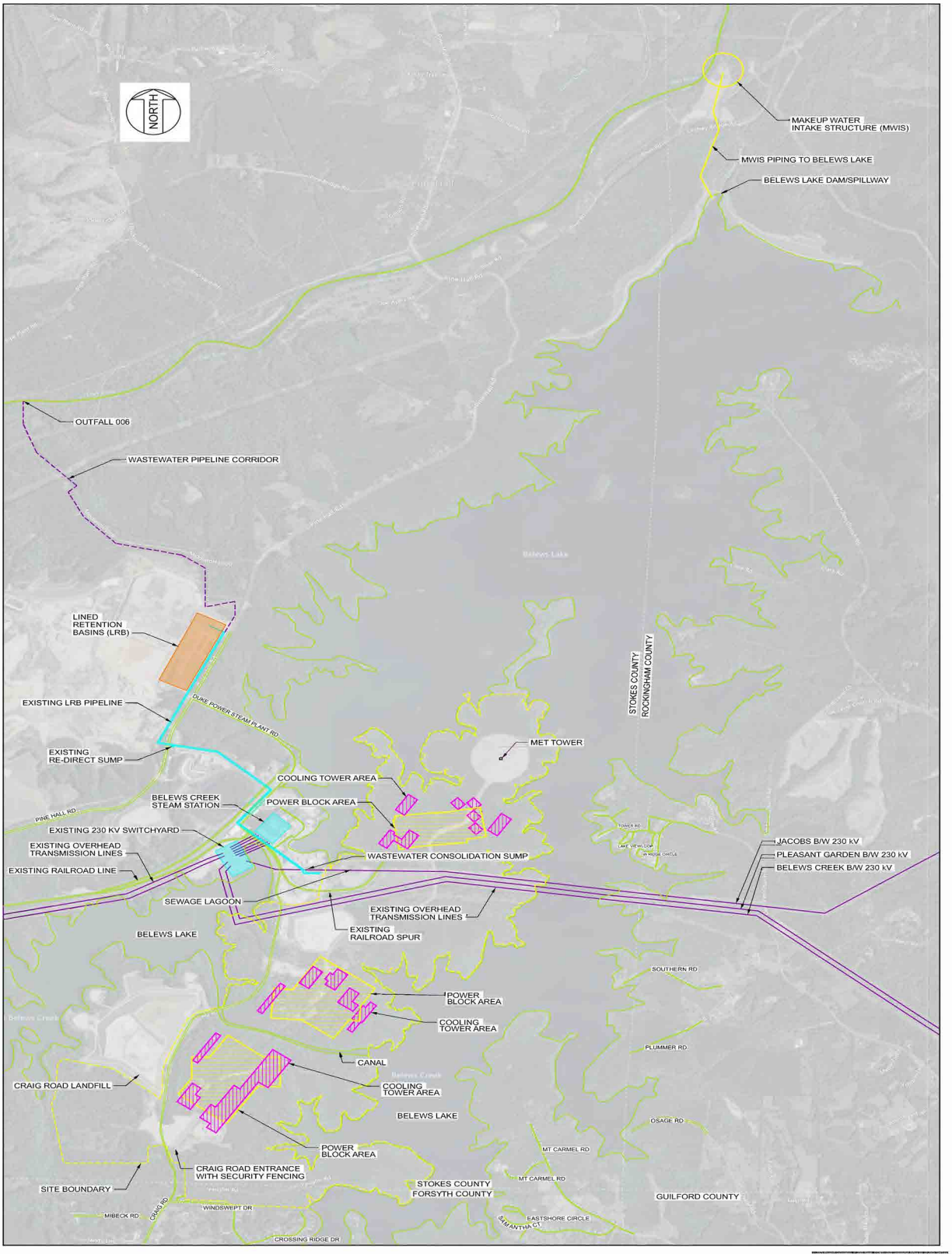


Figure 3.1-4
Proposed Plant Rendering – View Looking Northeast from the South Plant Complex

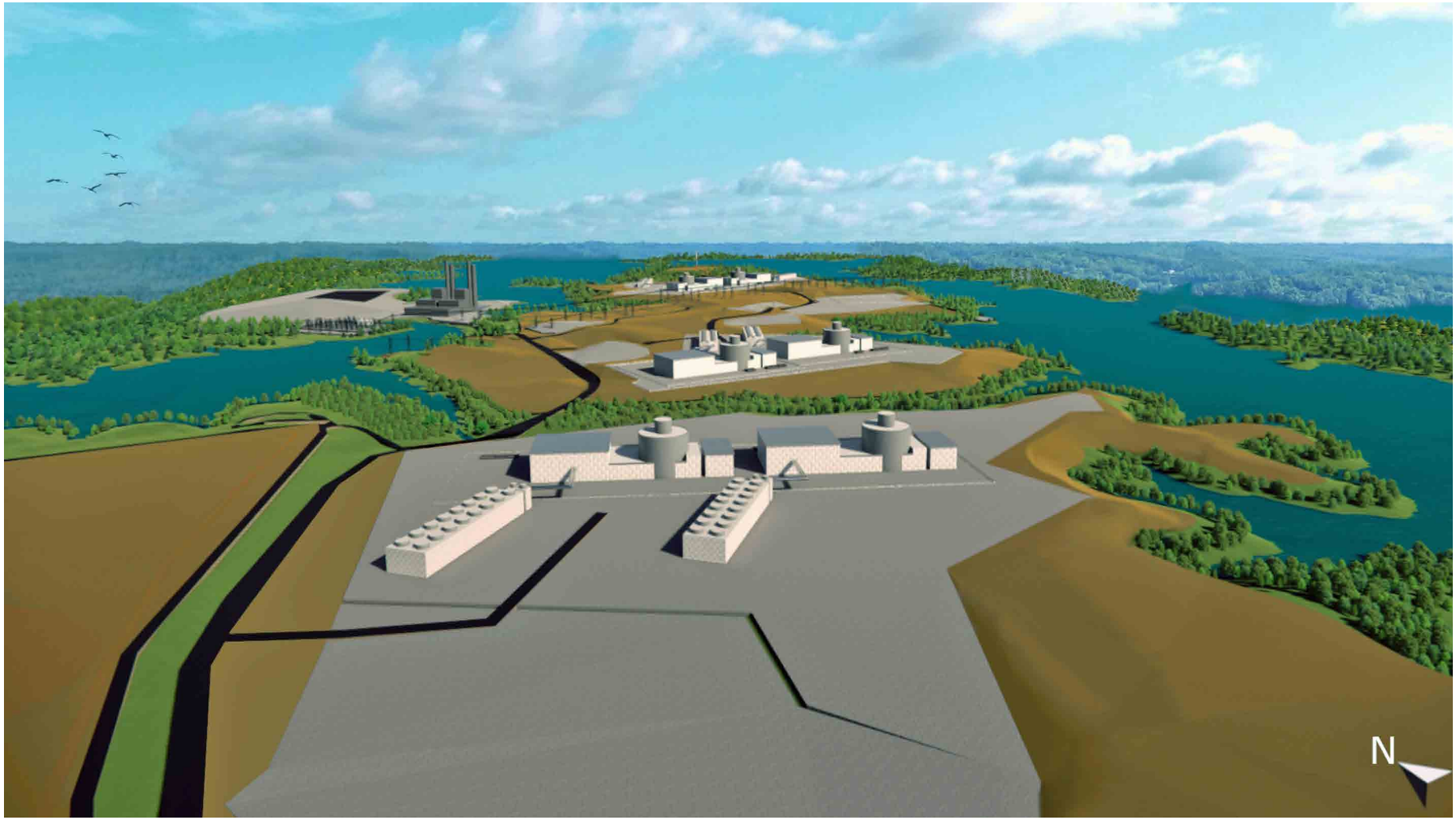


Figure 3.1-5
Proposed Plant Rendering – View Looking Southeast from the Middle Plant Complex

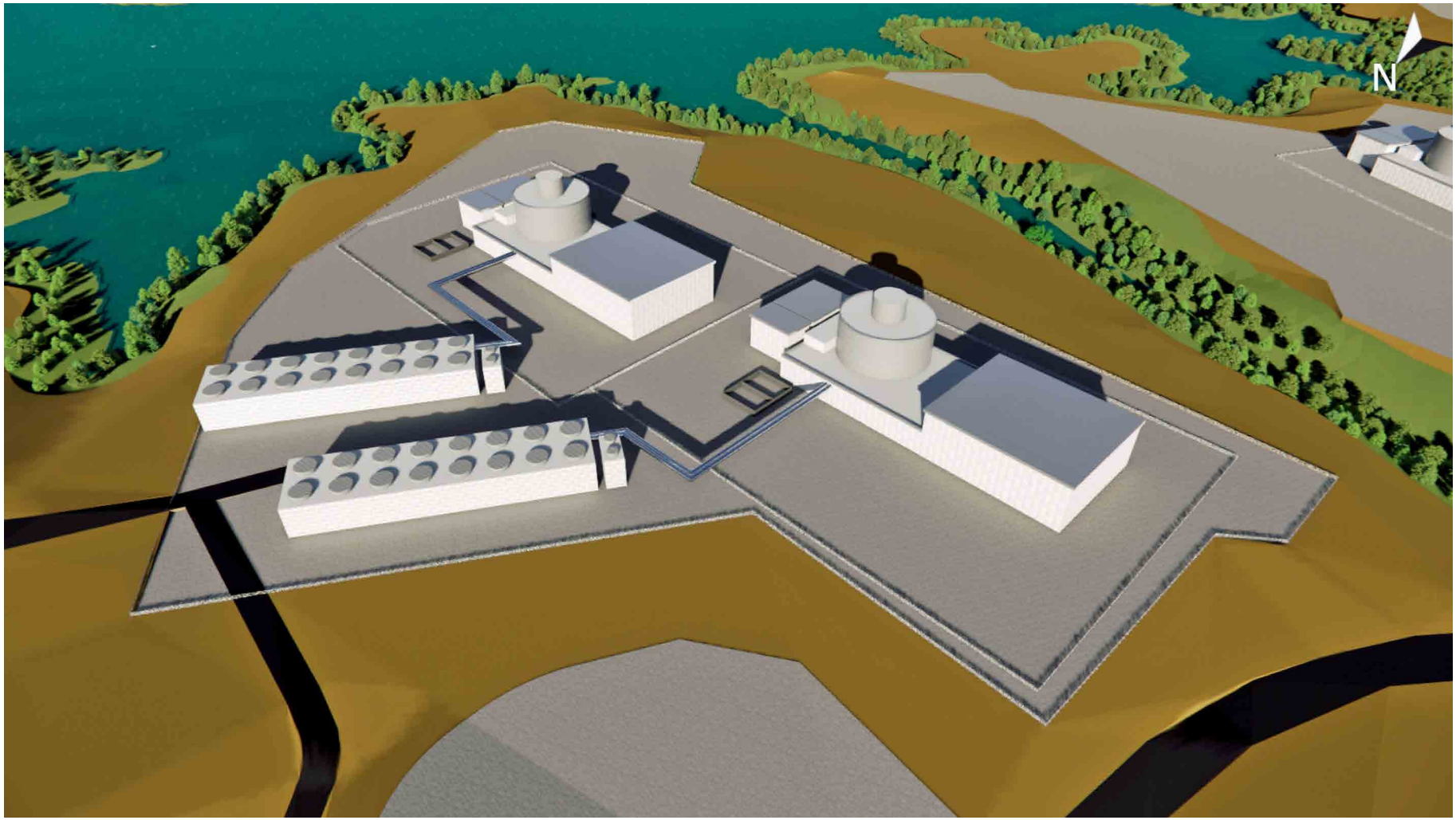


Figure 3.1-6
Proposed Plant Rendering – View Looking Southwest from the North Plant Complex

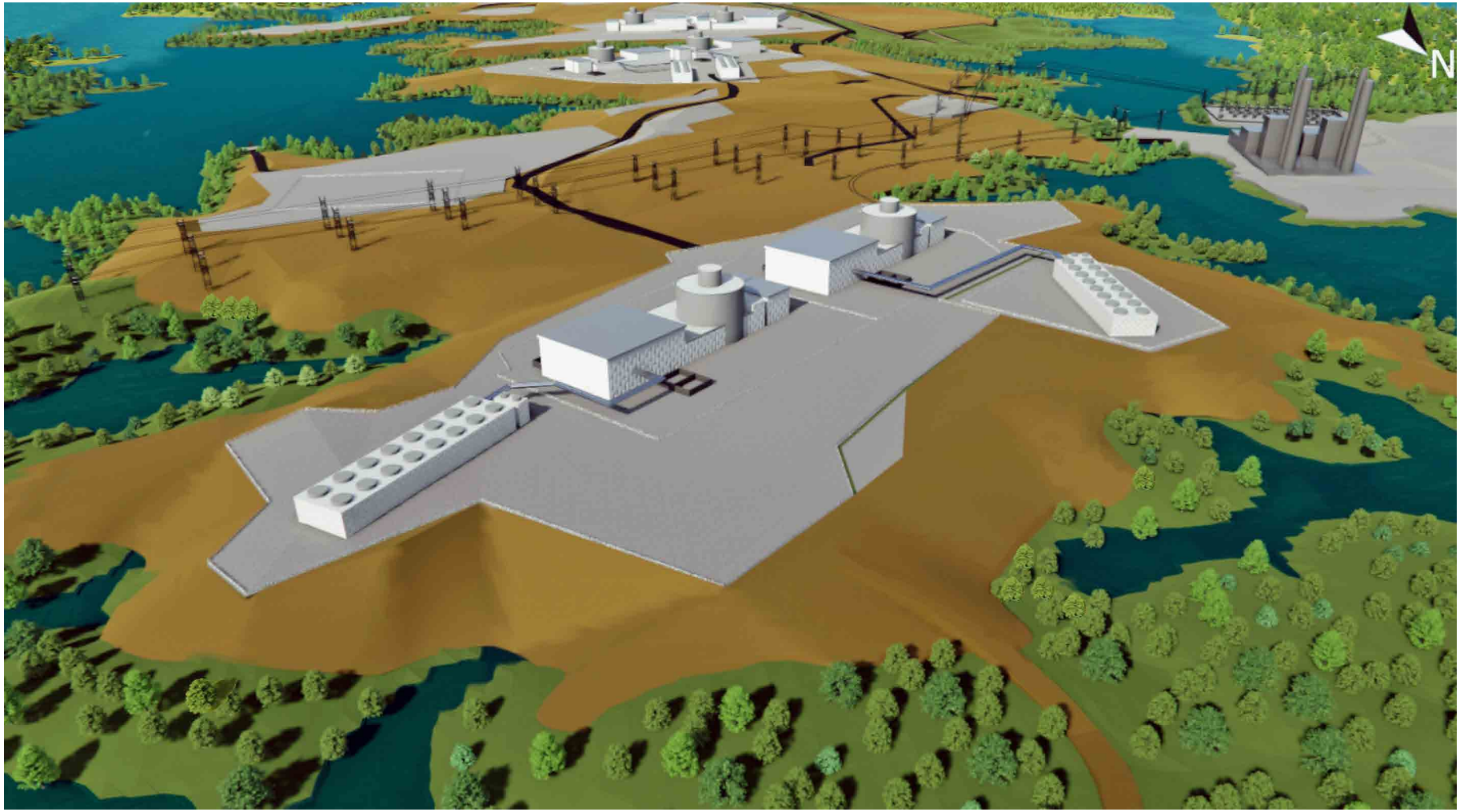


Figure 3.1-7
Proposed Plant Rendering – Plan View

Figure 3.2-1
Conceptual Design of Common Intake Structure
(Sheet 1 of 2)

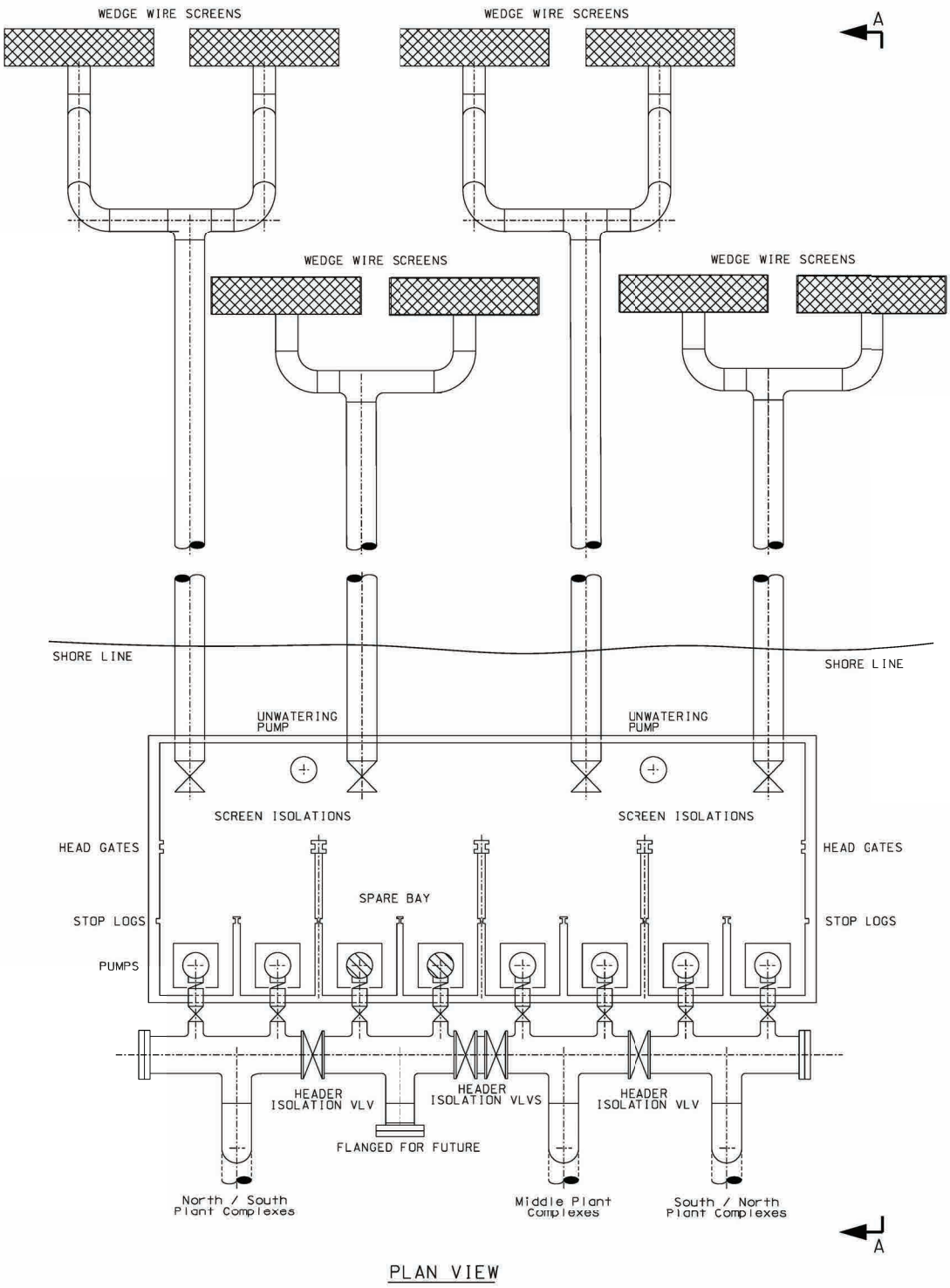


Figure 3.2-1
Conceptual Design of Common Intake Structure
(Sheet 2 of 2)

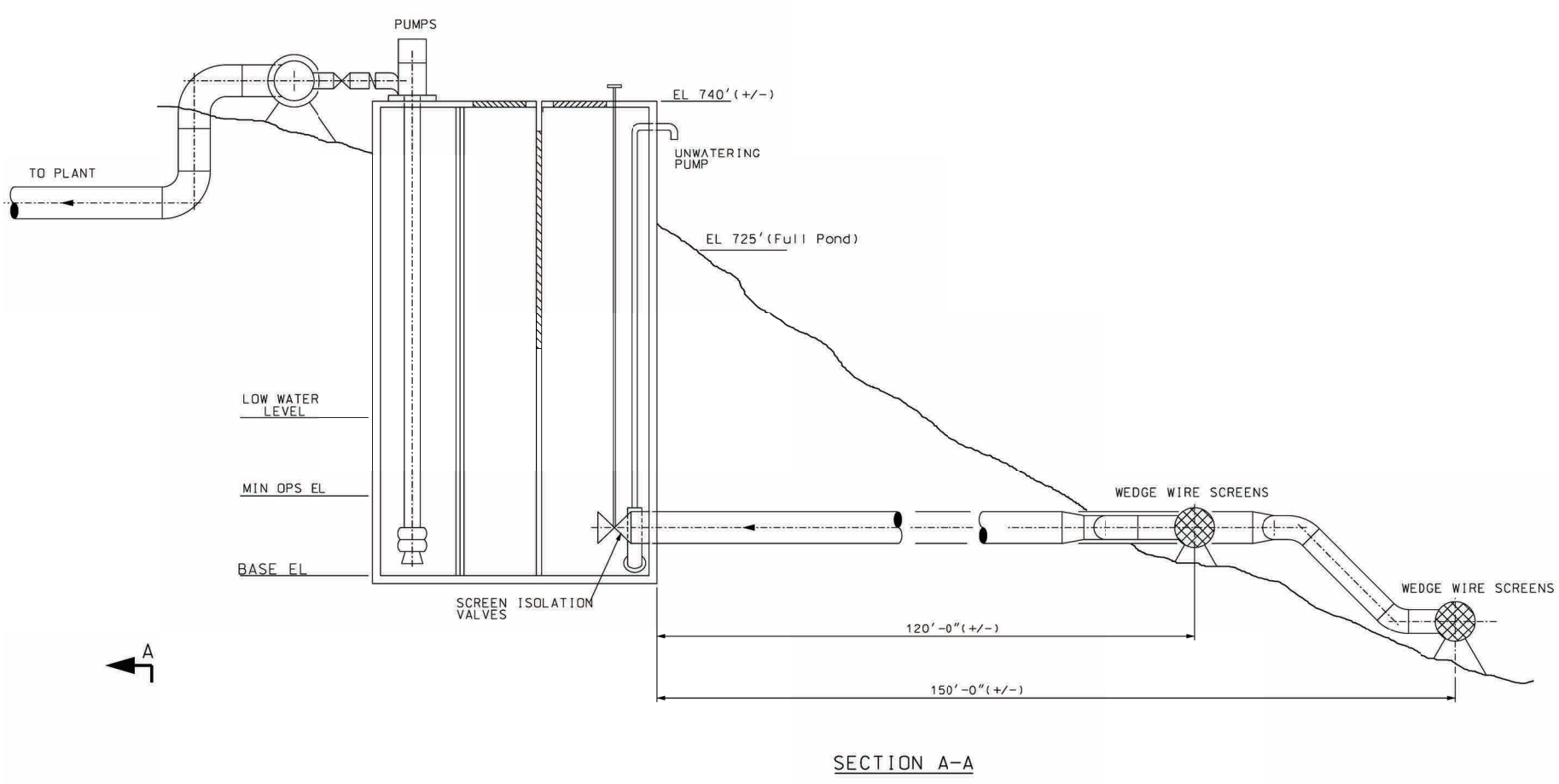
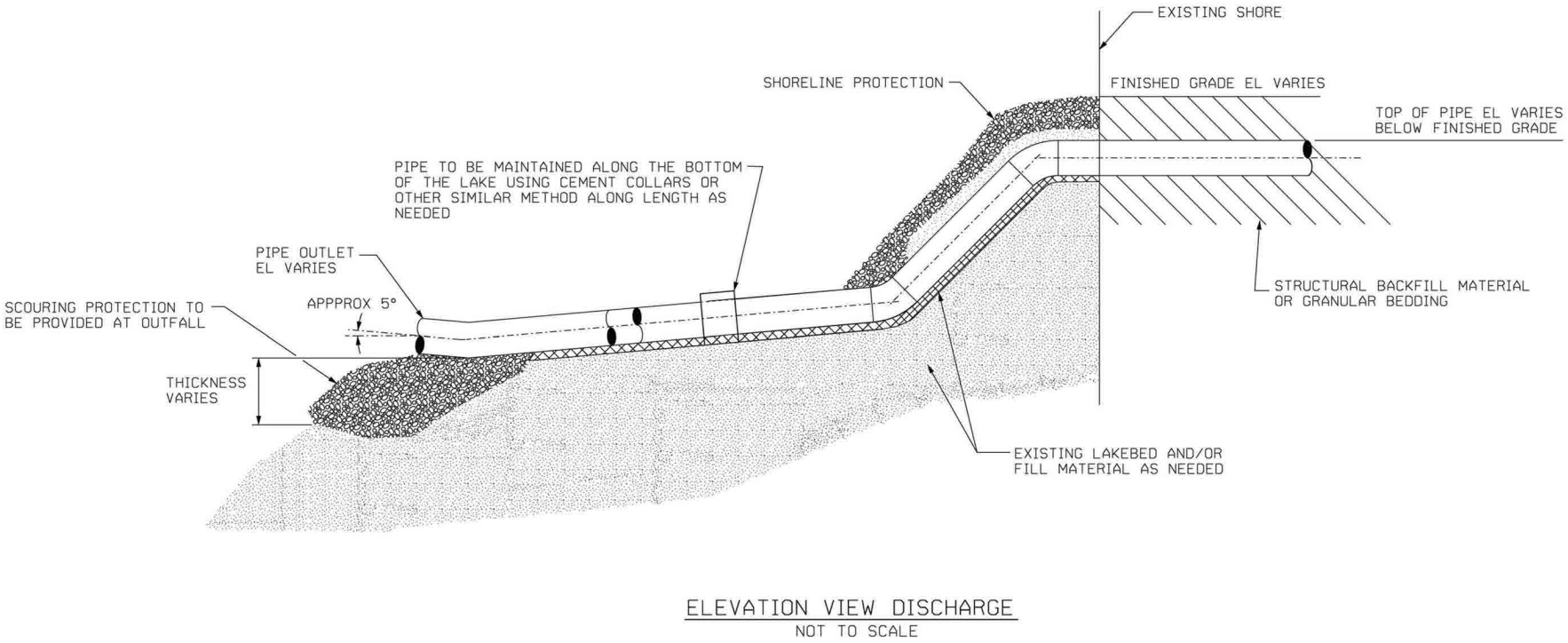


Figure 3.2-2
Conceptual Design of Belews Lake Discharge



ELEVATION VIEW DISCHARGE
NOT TO SCALE

Figure 3.2-3
Conceptual Design of Dan River Discharge

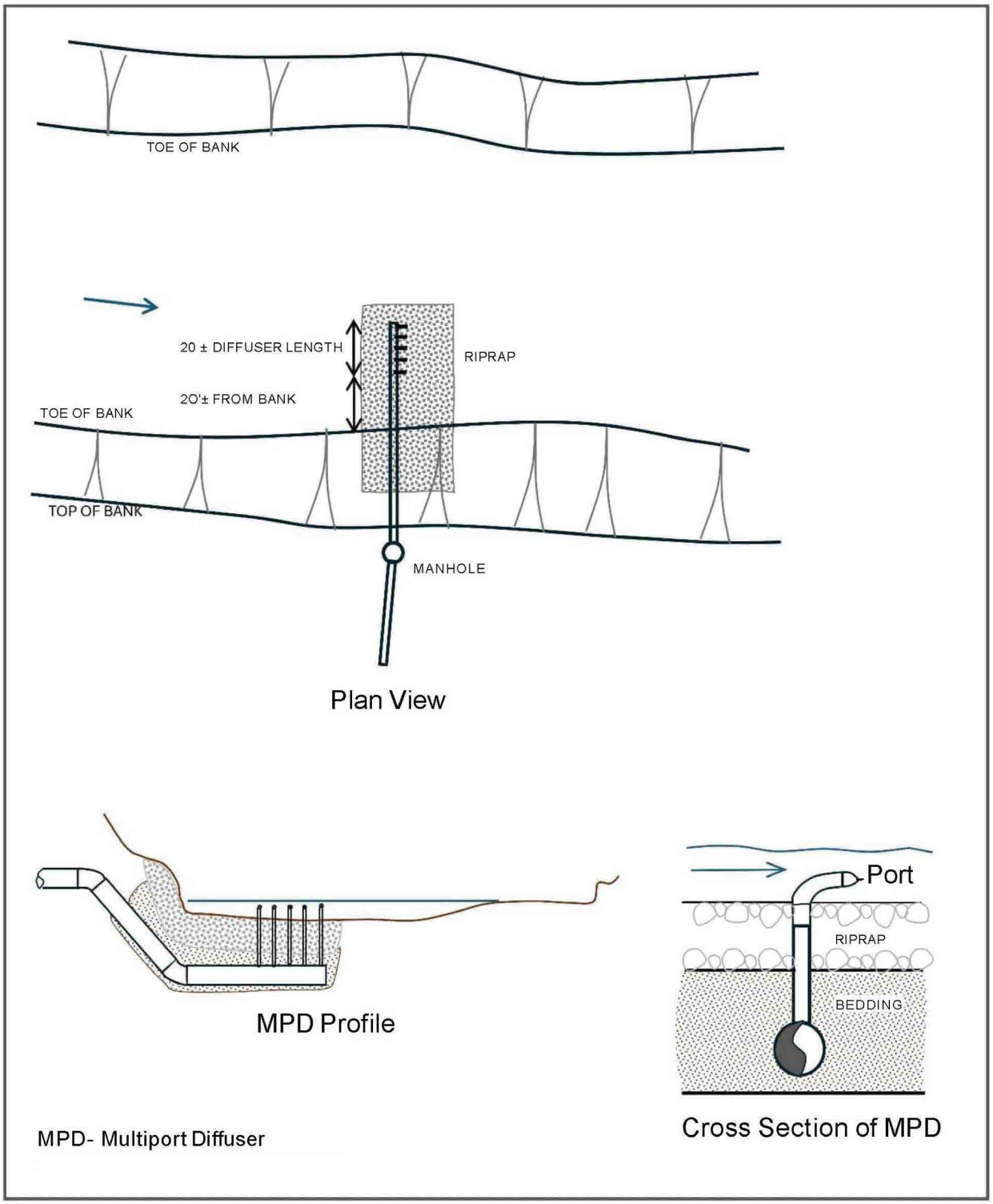
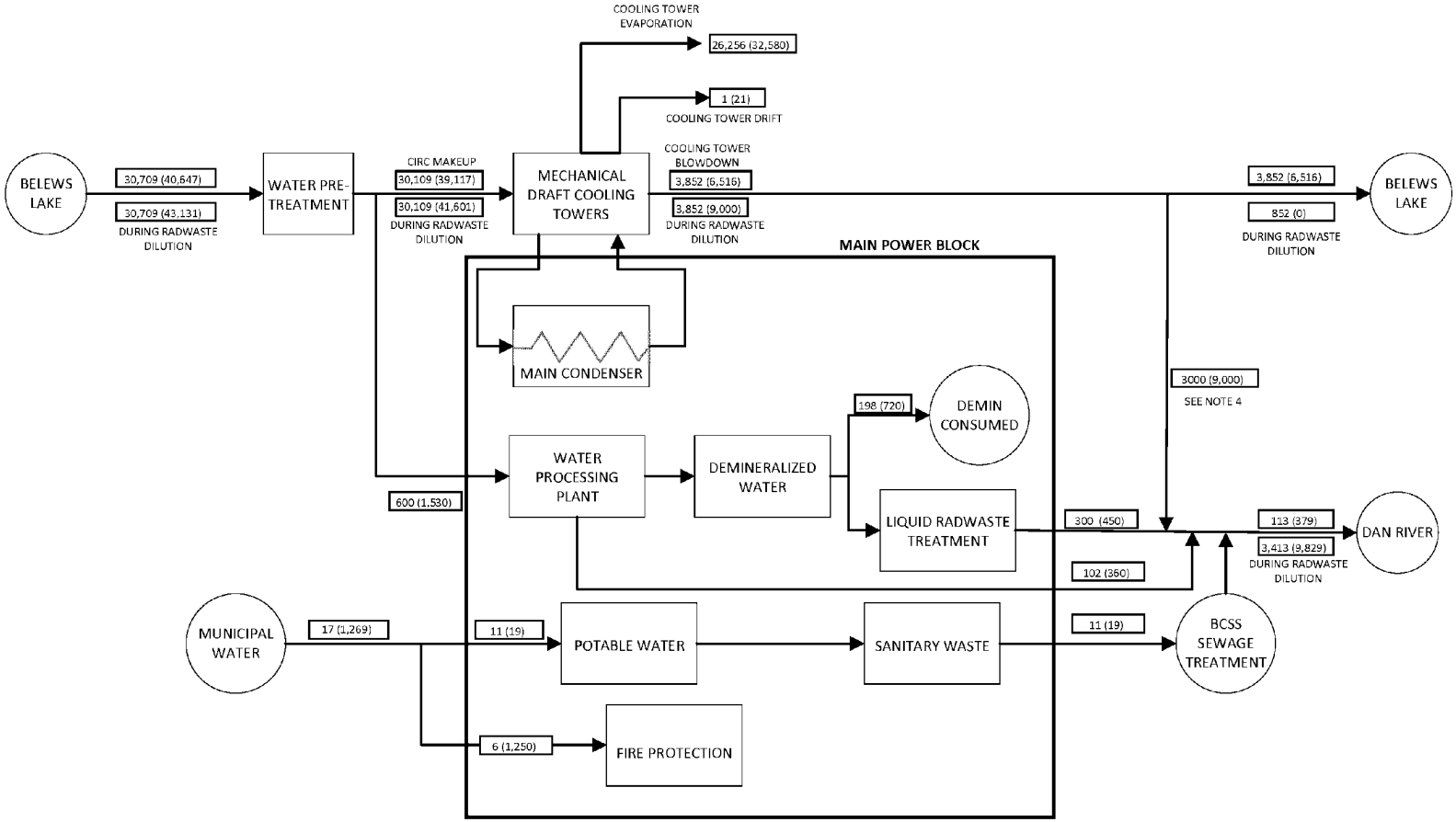


Figure 3.2-4
Site Water-Use Diagram



NOTES:
1. ALL FLOW VALUES ARE SHOWN IN GPM
2. FLOW VALUES ARE SHOWN AS NORMAL FLOW (MAXIMUM FLOW)
3. ALL FLOW VALUES ARE FOR THE ENTIRE FACILITY, NOT A SINGLE REACTOR.
4. LIQUID RADWASTE AND DILUTION FLOW IS TO BE PERFORMED AS A BATCH PROCESS. FOR MODELING LONG-TERM WATER USE, A 10% REDUCTION IN NORMAL BLOWDOWN FLOW CAN BE ASSUMED.

Figure 3.2-5
Duke Energy Right-of-Way Standard Widths for Transmission Lines

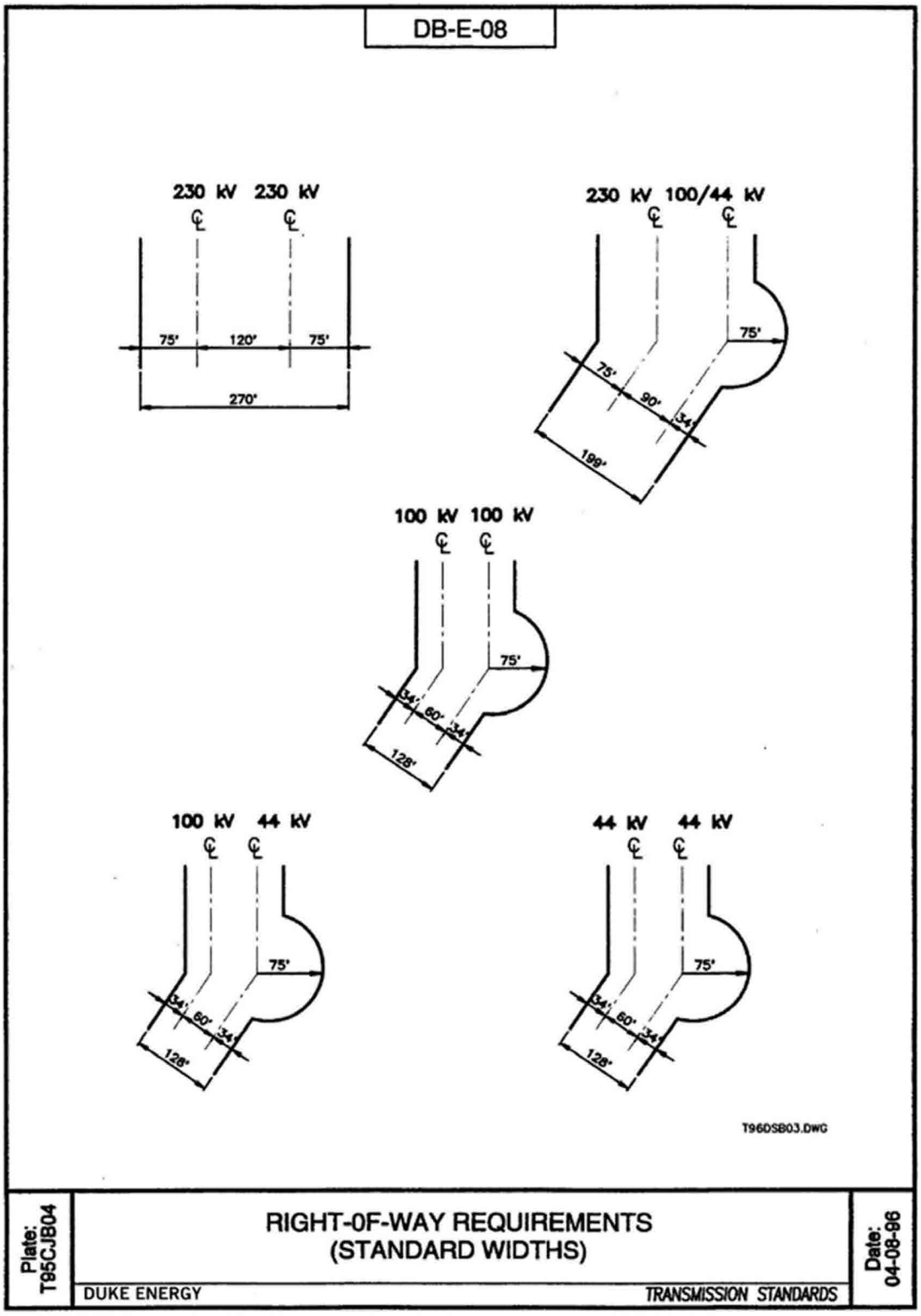


Figure 3.2-6
Duke Energy 2F Series 230kV Standard

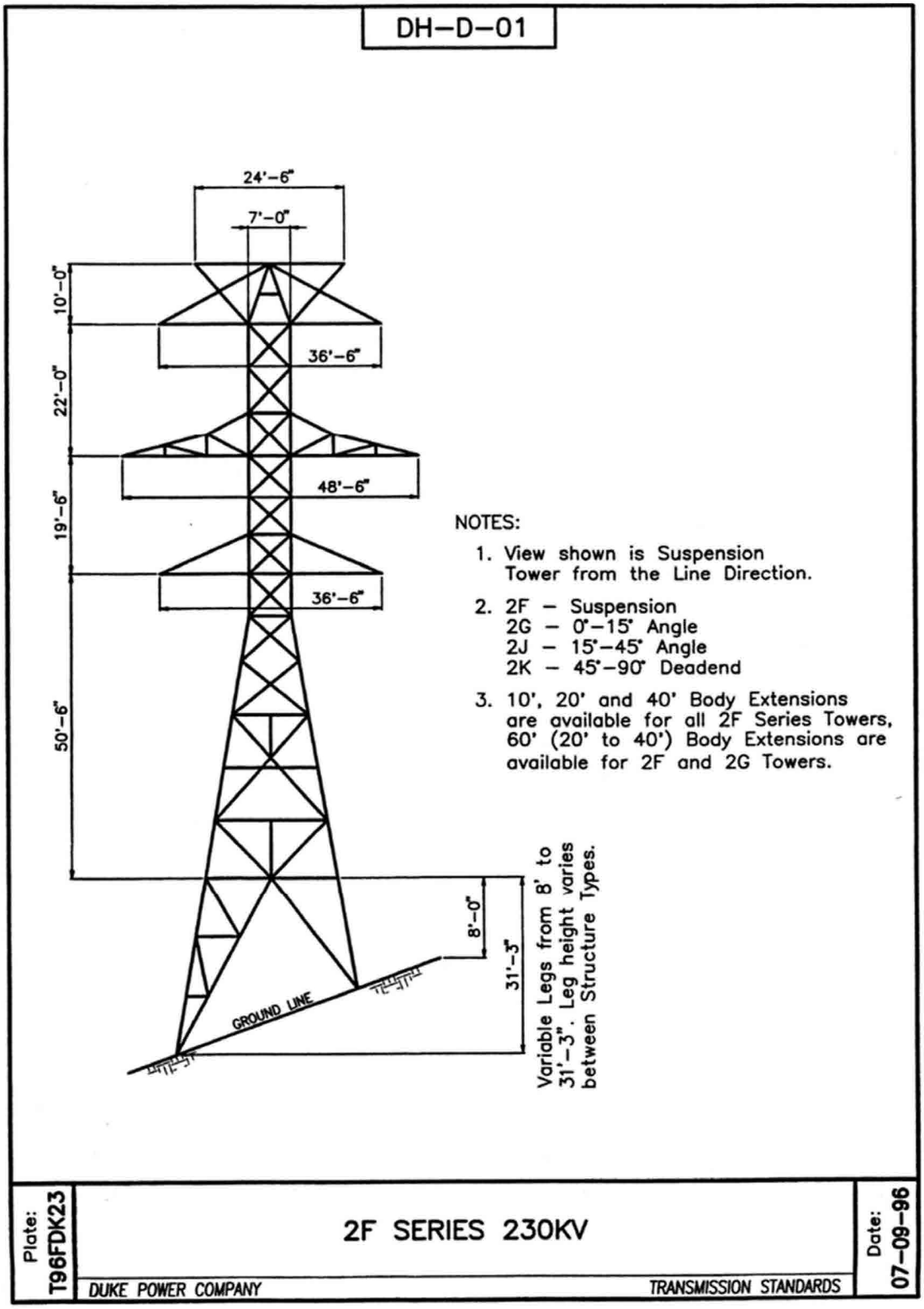


Figure 3.3-1
Site Layout and Net Disturbance Area

CHAPTER 4
ENVIRONMENTAL IMPACTS FROM CONSTRUCTION OF THE PROPOSED PROJECT

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GLOSSARY

Term	Definition
AADT	average annual daily traffic
ac.	acre
APE	area of potential effect
AQMD	Air Quality Management District
BCSS	Belews Creek Steam Station
BEA	Bureau of Economic Analysis
BLS	U.S. Bureau of Labor Statistics
BMP	best management practice
CAA	Clean Air Act
CFR	Code of Federal Regulations
CCW	condenser cooling water
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CWA	Clean Water Act
dBA	A-weighted scale decibel
EB	eastbound

Term	Definition
ER	Environmental Report
ft.	feet
ft^2	square foot
ft^3	cubic foot
FGD	flue gas desulfurization
FTE	full-time equivalent employee
GHG	greenhouse gases
gpd	gallons per day
ha	hectare
HCS	Highway Capacity Software
HC	hydrocarbon
KGSO	Piedmont Triad International Airport NWS Station, Winston-Salem, NC
km	kilometer
LOS	level of service
lpd	liters per day
m	meter
m^2	square meter
m^3	cubic meter

Term	Definition
m/s	meters per second
mgd	million gallons per day
mi.	mile
MMT	million metric tons
MRLC	Multi-Resolution Land Characteristics
MWe	megawatt electric
NAAQS	National Ambient Air Quality Standards
NAVD 88	North American Vertical Datum of 1988
NB	northbound
NC	North Carolina
NCDEQ	North Carolina Department of Environmental Quality
NCNHP	North Carolina Natural Heritage Program
NCOSA	North Carolina Office of State Archaeology
NCSHPO	North Carolina State Historic Preservation Office
NCWRC	North Carolina Wildlife Resources Commission
NDA	net disturbance area
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System

Term	Definition
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NUREG	NRC Technical Report designation
NWS	National Weather Service
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter of 2.5 microns or less
PM_{10}	particulate matter with a diameter of 10 microns or less
PPE	plant parameter envelope
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc.
Project Region	The area encompassed within a 50-mile (80-kilometer) radius of the Belews Creek, NC site bounding limit unless otherwise specified for a particular resource
Project site	Belews Creek, NC site
Project Vicinity	The area encompassed with a 6-mile (10-kilometer) radius of the Plant site center point unless otherwise specified for a particular resource
rev.	revision
RG	Regulatory Guide
RIMS	Regional Input-Output Modeling System

Term	Definition
ROI	region of influence
RV	recreational vehicle
s/m^3	seconds per cubic meters
SB	southbound
SO_x	sulfur oxides
SPCC	spill prevention, control, and countermeasure
SR	State Road
SSCs	structures, systems, and components
SWPPP	stormwater pollution prevention plan
TEDE	total effective dose equivalent
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCB	U.S. Census Bureau
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VdB	vibration decibels
WB	westbound

Term	Definition
χ/Q	atmospheric dispersion factor

Chapter 4 Environmental Impacts from Construction of the Proposed Project

As described in Section 3.3, construction activities are generally comprised of safety-related structures, systems, and components (SSCs) that require authorization by the United States (U.S.) Nuclear Regulatory Commission (NRC) under an established review process, as defined in 10 Code of Federal Regulations (CFR) 50.10(a)(1). 10 CFR Part 51 contains a substantially similar definition of "construction" at 10 CFR 51.4 (definition of "construction," item (1)(i)). Other building activities that do not require NRC approval may occur before, during, or after NRC-authorized construction activities. These other activities include those explicitly excluded from the definition of construction in 10 CFR 50.10(a)(2). 10 CFR Part 51 contains a substantially similar list of exclusions from the definition of "construction" at 10 CFR 51.4 (definition of "construction," item (1)(ii)) and which are termed "preconstruction" in 10 CFR 51.45(c). As noted in 10 CFR 51.45, an Environmental Report (ER) prepared at the early site permit stage must also include a description of impacts from both "construction" and "preconstruction" activities. Together, these are referred to as "building" activities, which include the preconstruction and construction-related activities that form the basis for analyses in Chapter 4 – Environmental Impacts from Construction of the Proposed Project.

As described in Regulatory Guide (RG) 4.2, Rev. 3, *Preparation of Environmental Reports for Nuclear Power Stations,* assessing the significance of environmental impacts for new reactor applications, the NRC uses the following definitions of significance levels as codified in the footnotes to Table B-1 in Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51:

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purpose of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are small.

MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The Project site spans approximately 1187 ac. (480 ha) with a net disturbance area (NDA) of approximately 906 ac. (367 ha), as shown on Figure 3.3-1. Impacts from building are assessed within the NDA, which designates up to 906 ac. (367 ha) for permanent disturbances. The NDA excludes an approximate 100-foot (ft.) (31-meter [m]) vegetative buffer along the shoreline of Belews Lake, except in areas where shoreline access is required for building activities. To ensure future impacts are adequately bounded by this application, the entire NDA is defined as the expected area of permanent disturbance for the purposes of impact assessment. Additionally, the associated off-site area of approximately 40 ac. (16 ha), including the portion of the wastewater pipeline that extends outside of the Project site, is designated as permanent disturbance. The impacts presented in this chapter are based on the Plant Parameter Envelope (PPE) that is used to bound key siting-related features, as discussed in Section 3.1.2. Duke Energy Carolinas, LLC (Duke Energy) will consider and implement avoidance, minimization, and other mitigation measures, as appropriate. Subject to future licenses and designs, permanent impacts within the NDA may be reduced.

4.1 LAND USE IMPACTS

This section assesses impacts to land use and land cover at the Belews Creek, North Carolina (NC) site (Project site) and the Project Vicinity (6 miles [mi.] [10 kilometers {km}]) associated with building the Project. The impacts of building the wastewater pipeline at an associated off-site area are discussed in Section 4.1.2. The Project site is not located near a Superfund site.

4.1.1 ON-SITE IMPACTS

As stated in Section 2.1.1.3, the Project site consists of approximately 1187 acres (ac.) (480 hectare [ha]) located adjacent to the Belews Creek Steam Station (BCSS) on a peninsula surrounded by Belews Lake to the north, east, and west. As described in Section 2.1.1.3, the Project site is primarily undeveloped forested land. Approximately 7 percent of the land cover within the Project site is classified as developed land (high, medium, or low intensity, or open space). These areas represent various land uses necessary to support operation of the BCSS, including the Flue Gas Desulfurization (FGD) Landfill, which will be closed through excavation in accordance with state regulations, thereby eliminating the landfill.

Impacts to land use occur within the NDA shown on Figure 3.3-1. Initial building activities described in Section 3.3 include clearing and grubbing of trees and dense vegetation, site grading, and excavation. Figure 4.1-1 illustrates the land area by land cover type that is disturbed by building activities associated with the Project. Table 4.1-1 presents the approximate acreage of each land cover type impacted within the NDA. Of the 906 ac. (367 ha) disturbed, approximately 696 ac. (282 ha) are forested, representing 77 percent of the NDA.

Each Plant Complex is graded to balance earthwork cut and fill quantities to the greatest extent practical. As stated in Section 4.10.1, material generated from clearing, grubbing, and grading activities is stockpiled in a remote location on-site or transported off-site as needed. In addition to earthwork material, building activities generate general waste, metal waste, and equipment waste, which are disposed in accordance with federal, state, and local regulatory requirements. As stated in Section 4.10.1.5, adequate landfill capacity is available to meet the projected demand for waste disposal needs during the building phase.

As detailed in Section 2.1.1.3, most of the Project site is located in Stokes County and is zoned as “M-1 Light Manufacturing District.” The principal use in this zoning district is light manufacturing and warehousing uses on large tracts of land. Electrical power generation facilities including coal, gas, hydroelectric, solar, nuclear, and wind are permitted as conditional zoning uses within this district. All three nuclear power Plant Complexes on the Project site are located in Stokes County. Each complex may contain multiple advanced reactors. Therefore, using the Project site for nuclear power generation complies with the Stokes County zoning regulations. A small portion of the southern end of the Project site located in Forsyth County is zoned “AG-Agricultural.” This portion of the site is used for laydown areas during building activities which is consistent with permitted uses in the AG zoning district. Duke Energy will obtain all county approvals for zoning and development of the Project site, as appropriate.

As discussed in Section 2.1.1.2, Stokes and Forsyth counties have adopted county-wide comprehensive plans. The *Stokes County 2035 Vision Plan: Moving Together* designates most of the county, including an area in the southeastern corner of the county where the Project site is located, as “(O-2) Open Space: Rural Community” for land use planning purposes. The purpose of this designation is to preserve low-density development as it includes many of the rural areas in Stokes County. The Project conforms to existing zoning and is adjacent to the

BCSS and would not preclude preservation of other rural areas in the county included within the O-2 land use planning area. The small portion of the Project site located within Forsyth County is within the county's designated Growth Management Area 5 / Rural Area. Land uses in this designation are intended to remain very low-density residential and agricultural in character. The use of the Forsyth County portion of the site as laydown areas is consistent with low-density development.

As indicated in Section 2.1.1.3, the Project site includes prime farmland, and approximately 67 percent of the land in the Project Vicinity is considered prime farmland (Table 2.1-7). In accordance with the Farmland Protection Policy Act, Duke Energy coordinated with the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) regarding impacts to prime and unique farmlands. A Farmland Conversion Impact Rating (Form AD-1006) was completed in consultation with the NRCS to evaluate the potential impacts to prime and unique farmland by county. The impact rating score considers the acreage of converted prime farmland, the relative abundance of prime farmland in the surrounding county, and other criteria such as distance from urban support services and built-up areas, potential effects of conversion on the local agricultural economy, and compatibility with existing agricultural use. Sites with an impact rating score of 160 or greater have the potential to adversely affect prime farmland. The impact rating score developed for the Project site is 99.69 points for the portion of the Project site located in Stokes County (1153 ac. [467 ha]) and 100.51 points for the Forsyth County portion (33.7 ac. [14 ha]). Because the impact rating scores for Stokes and Forsyth counties are less than 160, impacts to prime and unique farmlands are expected to be minor and no further consultation with the NRCS is required.

As stated in Section 2.2.1.1.5, floodplains at the Project site are mostly concentrated along the shorelines and tributaries to Belews Lake. Clearing and grading activities necessary for building the proposed intake and blowdown structures would result in a minor intrusion into the floodplain of Belews Lake. Section 4.2.1.1.6 further discusses impacts on floodplains. Impacts to wetlands on the Project site during construction are described in Section 4.3.1.2. Of the 17 wetlands (totaling 2.68 ac. [1.08 ha]) on the Project site, 14 are completely or partially within the NDA. An additional wetland (0.26 ac. [0.11 ha]) is located in the associated off-site area (wastewater pipeline). To minimize wetland impacts, Duke Energy will implement appropriate avoidance and minimization measures. Where impacts are unavoidable, Duke Energy will obtain the necessary permits for impacts.

As stated in Section 4.4.4.2, hunting leases on the Project site are expected to be discontinued. As shown in Figure 2.4-5, recreational lake facilities such as the Pine Hall Public Boat Ramp, Piney Bluff Boat Launch, and commercial marinas are situated at a considerable distance from the Project site or across Belews Lake. Therefore, building activities do not impact access to these facilities.

Site development disturbs approximately 906 ac. (367 ha), transforming a primarily naturally vegetated and forested area into developed industrial land. This change noticeably alters but does not destabilize land use on and around the Project site. All site preparation and building activities are conducted in accordance with applicable federal, state, and local regulations. Environmental controls, including a site-specific stormwater pollution prevention plan (SWPPP), which is discussed in Section 4.2.3, are implemented to minimize impacts of building activities.

4.1.2 OFF-SITE IMPACTS

As stated in Section 2.1.2, no new off-site transmission line corridors are needed for the Project;

therefore, there are no corresponding changes to off-site land use from transmission line development.

As discussed in Section 2.1.2, portions of the existing associated off-site wastewater pipeline corridor extend outside the Project site. Land cover within the existing associated off-site wastewater pipeline corridor, which is approximately 40 ac. (16 ha), is mostly developed land and forested land (Table 4.1-1). As described in Section 3.3.2, building activities within this corridor are similar to those for the Project site and consist of land clearing and grubbing, grading, trenching, and backfilling. Although building activities within the corridor disturb existing land cover, the overall use of the corridor for the pipeline does not change. As such, impacts to land use in the associated off-site wastewater pipeline corridor are minor.

Impacts to floodplains within the wastewater pipeline corridor are discussed in Section 4.2.1.1.6 and are minor. Impacts to wetlands associated with building activities within the wastewater pipeline corridor are discussed in Section 4.3.1.2. Based on anticipated avoidance and minimization of wetland impacts, landscape perspective of total wetland habitats, adherence to mitigative requirements, and the use of best management practices (BMPs), impacts on wetlands are minor.

4.1.3 SUMMARY OF LAND USE IMPACTS

Overall, noticeable land use impacts from building activities are primarily due to the conversion of up to approximately 696 ac. (282 ha) of forested land within the Project site to developed land for industrial use. Development of the Project site would be compatible with BCSS on the adjacent property and complies with current zoning in Stokes and Forsyth counties. Based on the acreage of land that is converted from forest to industrial use, impacts from building activities on the Project site noticeably alter, but do not destabilize, land use. Therefore, on-site impacts to land use from building activities are MODERATE. Off-site impacts to land use in the associated off-site wastewater pipeline corridor are minor and, therefore, SMALL.

Table 4.1-1
Land Cover Types Disturbed by Building Activities on the Project Site and Associated Off-Site Area

	On-Site Area		Associated Off-Site Area (Wastewater Pipeline)		Total Area in the NDA[(a)]
Land Cover Type	**Ac.**	**Percent**	**Ac.**	**Percent**	**Ac.**
Barren Land	14.0	1.5	1.4	3.5	15.4
Deciduous Forest	270.3	29.8	4.8	12.0	275.1
Developed, Low Intensity	10.8	1.2	4.3	10.6	15.0
Developed, Medium Intensity	19.0	2.1	7.7	19.2	26.7
Developed, High Intensity	11.3	1.2	3.5	8.6	14.8
Developed, Open Space	33.0	3.6	6.2	15.4	39.1
Emergent Herbaceous Wetlands	3.7	0.4	–	–	3.7
Evergreen Forest	335.3	37.0	6.0	15.0	341.4
Hay/Pasture	16.2	1.8	0.2	0.5	16.4
Herbaceous	37.9	4.2	2.7	6.6	40.6
Mixed Forest	90.7	10.0	2.1	5.3	92.8
Open Water	1.2	0.1	0.2	0.5	1.3
Shrub/Scrub	62.3	6.9	1.1	2.8	63.5
Total[(b)]	**905.8**	**100**	**40.1**	**100**	**945.9**

Source: MRLC Consortium, 2021
Notes:
(a) The NDA is assumed to be permanently disturbed to ensure future impacts are adequately bounded by this application.
(b) Column total may not equal sum of individual values due to rounding.

4.2 WATER RESOURCES

This section describes water-related impacts that could result from building activities associated with the development of advanced reactors on the Project site. Section 4.2.1 addresses hydrologic alterations. Sections 4.2.2 and 4.2.3 address water-use impacts and water quality impacts, and Section 4.2.4 discusses water monitoring, respectively.

Potential water-related impacts include:

- Direct physical alteration of Belews Lake, streams, rivers, and wetlands.
- Indirect physical alteration of receiving surface water bodies, especially streams, due to changes in runoff volumes and rates.
- Changes in groundwater flow patterns from dewatering and soil retention management practices.
- Alteration of surface water quality as a result of erosion and sedimentation or inadvertent discharges of pollutants.
- Down-gradient groundwater quality changes from inadvertent or accidental spills of fuels and lubricants.

A detailed description of building activities, methods, and durations is provided in Section 1.3 and Section 3.3. Table 1.4-2 provides a list of consultations and permits that may be required prior to initiating building activities.

The following sections describe the building-related effects on both surface water and groundwater resources.

4.2.1 HYDROLOGIC ALTERATIONS

This section identifies and describes hydrologic alterations that result from building activities on surface water and groundwater hydrology. Activities that may produce hydrologic alterations are described in Sections 3.3.2 and 3.3.3 and could include:

- Clearing land and installing infrastructure such as roads and stormwater management systems.
- Altering the surface grade and runoff patterns.
- Building new structures (e.g., reactor containment structure, turbine building, cooling towers, electrical substation, sub-grade piping and systems), roads, rails, and parking lots.
- Building transmission towers.
- Building cooling water intake and discharge structures within Belews Lake and the Dan River.
- Potential changes in surface water and/or groundwater use during building.

4.2.1.1 Surface Water

This section evaluates the potential direct and indirect impacts of building activities on the surface waters present on the Project site and associated off-site areas. Surface water resources potentially affected by building activities are described in detail in Section 2.2.1 and include on-site streams, watershed runoff characteristics, Belews Lake, the Dan River, and floodplains. Potential impacts to on-site wetlands are described in Section 4.3.1.

As described at the beginning of this chapter, impacts from building activities are assessed within the NDA and the associated off-site wastewater pipeline that extends outside the NDA. Surface waters within the NDA and the associated off-site wastewater pipeline area directly impacted by building activities are shown on Figure 4.2-1. As the design progresses, Duke Energy is considering appropriate avoidance, minimization, and mitigation measures to reduce total impacts. Impacts are also being permitted in accordance with applicable regulations.

4.2.1.1.1 Project Site Streams

Jurisdictional streams are described in Section 2.2.1.1.4 and include 22 on-site and one off-site jurisdictional streams (i.e., six intermittent, seven perennial, and ten intermittent streams that transition to perennial) that were verified by the U.S. Army Corps of Engineers (USACE). Section 2.2.1.1.4.2 identifies the lengths of stream channels, which range from 80 ft. (24.4 m) to more than 3440 ft. (1048.5 m).

On-site streams drain into Belews Lake (Figure 4.2-1). Drainage slopes are typically steep, while channel widths are narrow. Project site streams are subject to direct and indirect impacts of building activities. Building activities include site preparation (e.g., clearing, site grading, and installation of stormwater management systems), as described in Section 3.3.2.

Of the 22 Project site streams, all are within or partially within the NDA, with the exception of the Condenser Cooling Water (CCW) Canal (S54). Eleven streams are entirely within the NDA, 10 are partially within the NDA, and the CCW Canal (S54) is outside the NDA. The CCW Canal (S54) is discussed in Section 4.2.1.1.3. Up to approximately 16,875 linear ft. (5144 linear m) of Project site streams are potentially impacted by building activities that result from fill activities, resulting in the loss of surface streams and associated functions. The impacted streams are primarily first order, relatively small streams which are mostly intermittent in nature and do not demonstrate high quality habitat.

An additional approximately 1256 linear ft. (383 linear m) of Project site streams are indirectly impacted. As shown on Figure 4.2-1, the indirect effects are to the portions of the streams that extend outside of the NDA to the confluence with Belews Lake. The remnant portions of these streams are indirectly affected due to the reduction in size, which can affect their degree of functionality. These remnant streams are indirectly impacted by building activities that result in flow alteration and disruption, stream bed and bank erosion, increased sedimentation, and decreased water quality (Figure 4.2-1 and Table 4.2-1). Increased sedimentation alters the flow of water and reduces water depth (MARC, 2025). Water quality impacts are further discussed in Section 4.2.3.1.

BMPs specific to the extent and type of building activity are implemented and maintained at appropriate time intervals throughout building activities. These BMPs stabilize soils, control the off-site movement of sediments, control stormwater flows, and remove construction debris to minimize indirect impacts to streams outside the NDA. Disturbed areas are stabilized in

accordance with design specifications employing good engineering and construction practices. Soil stabilization and sediment control BMPs are further discussed in Section 4.2.3. In addition, the Project is subject to an Erosion and Sediment Control permit that is issued by the NC Department of Environmental Quality (NCDEQ) that ensures protection for affected surface water bodies. Stormwater controls include retention ponds to control rate and volume of overland flow into receiving streams, as described in Section 3.2. Stormwater BMPs are further discussed in Section 4.2.1.1.2. Additionally, as described in Section 3.2, construction debris is properly disposed of to avoid affecting Project site streams.

Unavoidable direct and indirect impacts to jurisdictional streams are subject to regulatory authority of the USACE and NCDEQ pursuant to Sections 404, 401, and 402 of the Clean Water Act (CWA). The USACE issues Section 404 permits, and the NCDEQ manages Section 401 Water Quality Certifications and Section 402 National Pollutant Discharge Elimination System (NPDES) permits through its Division of Water Resources. The USACE requires demonstration of specific avoidance and minimization measures and implementation of specific compensatory mitigation measures in accordance with 33 CFR Part 332 “Compensatory Mitigation for Losses of Aquatic Resources.” Because impacts to Project site streams are mitigated, impacts of building activities are minor.

4.2.1.1.2 Stormwater

As Section 2.1.1.3 describes, the Project site consists of rolling hills and steep slopes, with surface elevations ranging from 725 ft. (219.5 m) North American Vertical Datum of 1988 (NAVD 88) near the shoreline of Belews Lake to 890 ft. (271 m) NAVD 88 along the ridgetops. Extensive grading and earthwork during site preparation results in grading and leveling much of the Project site within the NDA to accommodate a nominal base elevation (Figure 3.1-1). Each of the sequentially built Plant Complexes that are planned as presented in Table 3.3-1 is graded to balance earthwork cut and fill quantities to the greatest extent practical. Adjacent laydown areas may be adjusted to grade elevations that are different from the power block and permanent plant equipment grades to facilitate a balanced earthwork design. Site preparation includes clearing and grubbing of trees and dense vegetation, topsoil stripping, grading and installation of stormwater management systems, and mass earthwork and grading (Section 3.3.2).

In conjunction with grading and leveling activities, stormwater runoff patterns across the NDA are affected as drainage subbasins are recontoured. Additionally, runoff rates are affected due to the change in land cover from a substantially undeveloped and heavily forested landscape to one dominated by developed land surfaces. In accordance with the NPDES construction general permit for stormwater discharge (Section 1.4), a SWPPP is developed for stormwater management and erosion and sediment control within the disturbance area. Stormwater flow is diverted away from the Plant Complexes by an engineered stormwater collection system and may include a combination of swales, retention and detention basins, pipes, culverts, and sediment and erosion control measures designed to prevent discharge of pollutants to Belews Lake, Dan River, and associated tributaries. Sedimentation basins are one component of a system to control sediment discharge from larger disturbed areas. Sedimentation basins may be converted to detention or retention facilities for the permanent stormwater management system. Other building-phase stormwater facilities may be temporary or converted to permanent stormwater management facilities. The total ground area disturbed at any given time is minimized to the extent practicable. Temporary or permanent stabilization is used when areas are not disturbed for an extended time (Table 3.3-1).

The overall Project site runoff potential is coordinated with Belews Lake spillway operations to account for increased storm runoff volume and more rapid timing of runoff (more rapid than the existing condition) and resulting impacts on lake level control.

In summary, structural and non-structural BMPs are implemented throughout the building phase to control and manage stormwater runoff. Phasing during the building process minimizes the extent of ground surface that is disturbed at any given time. With a comprehensive plan to manage stormwater using BMPs, detention basins, and engineered stormwater conveyances, impacts from stormwater are minor.

4.2.1.1.3 Belews Lake

Building activities that directly impact Belews Lake include installation of the Project intake and discharge structures and associated in-lake pipelines. Indirect impacts include an increase in stormwater runoff rates and volumes from the cleared Project site to Belews Lake.

Belews Lake shoreline and the CCW Canal (S54) are depicted on Figure 4.2-1. An approximate 100-ft. (30-m) vegetated buffer extends along the shoreline of Belews Lake and the edges of the CCW Canal. The NCDEQ Erosion and Sediment Control program prohibits land disturbance during building unless a buffer zone is provided along the margin of the watercourse of sufficient width to confine visible siltation within the 25 percent of the buffer zone nearest the land-disturbing activity. This prohibition shall not apply to a land-disturbing activity in connection with building activities located on, over, or under a lake or natural watercourse. Application of this buffer zone guidance is applicable to minimize potential effects to both Belews Lake and the CCW Canal from building activities in the NDA (Figure 4.2-1). The appropriate buffer width can vary depending on-site conditions, soils, topography, and hydrology. Zones of undisturbed vegetation may be used to ensure compliance with this requirement even in the event of failure of other erosion and sedimentation control measures and practices. The NC Erosion and Sedimentation Control Planning Design Manual provides guidance for determining the necessary width of undisturbed vegetation required for compliance (NCDEQ, 2013). Because the NDA is limited by a buffer zone along both Belews Lake and the CCW Canal, effects of erosion and deposition within Belews Lake are minimized.

Section 3.2.2 describes the cooling system that includes intake and discharges. Building activities related to the intake structure include excavation and lakebed dredging to prepare the Project site for building activities. Cofferdams may be temporarily installed to perform work in a dewatered environment. Two optional locations are identified for the intake structure; however, only a single structure is developed for the Project. Cooling tower blowdown discharge options are described in Section 3.2.2.4.3 and include either one common discharge structure for all advanced reactor Plant Complexes or a separate discharge structure for each advanced reactor Plant Complex (Figure 3.1-1). Discharge structure piping extends from the shoreline to the submerged discharge structure(s) in Belews Lake, as described in Section 3.2.2.4.3.

Localized and short-term increases in turbidity and sediment deposition from building activities may occur in the immediate vicinity of both the intake and discharge structures as well as the lakebed piping areas. As described in Section 4.2.3.1, the intake structure is built within an approximate 5000-square-foot (ft^2) (464.5-square-meter [m^2]) area on the shoreline. Dredging for the discharge structure occurs in an approximate 20-ft. (6-m) x 20-ft. (6-m) area to a depth of approximately 3 ft. (0.9 m) for the installation of scour protection. For the discharge conveyance from the Project site elevation to the shoreline, an approximately 45-degree-angle bore hole is required to place the piping directly into Belews Lake. Dredging may be required at the outlet of

the discharge piping to install scour protection. If dredging is required, approximately 1200 cubic feet (ft^3) (111 cubic meters [m^3]) of soil and sediment is disposed of within either an approved upland location that may include a location on-site or at an off-site landfill. Temporary and localized impacts on Belews Lake hydrology are possible adjacent to and downstream of the activities if disturbed sediment extends beyond the immediate area. Within Belews Lake the dredged material is replaced with crushed rock. No significant losses occur to the lake surface area and storage volume as a result of intake and discharge structures installation. As described in Section 3.3.2, cofferdams are temporarily installed as the principal mitigative BMP to contain and control sedimentation as well as allowing dewatering for construction.

Impacts to Belews Lake are limited to the locations of the intake and discharge structures and associated pipelines within the lake. Temporary and localized impacts affect relatively small areas of the lake and are minimized through the use of other BMPs in addition to cofferdams that may include turbidity curtains, shoreline erosion control measures or other measures. Dredging activity is minimized as much as possible, and dredged material is replaced with crushed rock to avoid any changes in hydrology as a result of sediment displacement. Overall direct impacts to water resources of Belews Lake from building activities are localized to the footprint of the intake and discharge structures and associated pipelines within the lake. Impacts are further minimized by incorporating the approximate 100-ft. (30-m) vegetated buffer outside of the NDA. Therefore, impacts from building activities on water resources within Belews Lake are localized and minor.

4.2.1.1.4 Dan River

Project nonradioactive discharges are routed through the existing Outfall 006. Liquid radioactive wastes are routed through a new discharge in a corridor adjacent to existing Outfall 006 and are diluted with cooling tower blowdown discharge. The only anticipated building activity on the Dan River is within the new discharge in the associated off-site corridor that includes the wastewater pipeline located at Outfall 006. While the wastewater pipeline is located within an approximate 100-ft. (30.5-m) wide corridor, building-related disturbances within the Dan River are more localized. As described in Section 3.2.2.4.3, the discharge structure within the Dan River consists of a pipeline buried within the river bottom. In-river excavation is conducted to install the discharge pipeline and results in localized sediment disturbance and localized hydraulic alterations. Riprap is placed in conjunction with the discharge to minimize scour and erosion of the riverbed.

Adherence to federal, state, and local permit conditions reduces direct and indirect impacts to the Dan River. Excavation and fill (e.g., riprap) activities within the Dan River are regulated under Section 404 of the CWA via a permit from the USACE. As indicated in Section 1.4, an NPDES construction general permit authorization for building is required. This permit includes provisions for a site-specific SWPPP and appropriate strategies to reduce erosion and control sedimentation at the Project site. For example, structural and non-structural BMPs in the SWPPP minimize direct and indirect impacts to the Dan River. Therefore, hydrologic alteration impacts from building the discharge in the Dan River are minor.

4.2.1.1.5 Wetlands

Direct and indirect impacts to wetlands within the Project site and the associated off-site wastewater pipeline corridor are presented in Section 4.3.1.2.

4.2.1.1.6 Floodplains

The Federal Emergency Management Agency 100-year floodplains are mostly concentrated along Project site shorelines and tributaries to Belews Lake and along the associated off-site wastewater pipeline corridor at the Dan River, as discussed in Section 2.2.1.1.5 (Figure 4.2-2). Building activity necessitates the use of heavy equipment and increases impervious surfaces. BMPs to mitigate the impacts to floodplains are outlined in the SWPPP and Section 4.2.1.1.2.

Building activity within the Project site directly impacts approximately 6.4 ac. (2.59 ha) of floodplains within the NDA. Impacts on floodplains within the NDA are minor and are mitigated by BMPs and compliance with permits. Floodplains within the Project site represent a minority of floodplains within the 6-mi. (10-km) Project Vicinity (Figure 2.2-22). Therefore, building activities do not destabilize the function of floodplains along the shoreline and tributaries to Belews Lake.

Installing a new discharge outlet and the associated off-site wastewater pipeline within the Dan River directly affects approximately 2.14 ac. (0.87 ha) of floodplain (see Figure 4.2-2).

As described in Section 3.2.2, the discharge structure within the Dan River consists of a pipeline buried below-grade within the river bottom (Figure 3.2-2). In-river excavation is conducted to install the discharge pipeline. BMPs minimize the temporary impacts to floodplains of the Dan River from heavy equipment and ensure the floodplain is not destabilized. Areas impacted during building may be revegetated or rehabilitated after installing the wastewater pipeline to mitigate the localized and temporary impacts on floodplain function and value. The Dan River has approximately 4507 ac. (123 ha.) of floodplains within the Project Vicinity. As there are substantially greater floodplain resources within the Project Vicinity, localized impacts from the wastewater pipeline do not destabilize the overall function of flood storage. Temporary impacts to floodplain areas along the Dan River are minimized by use of BMPs and by the restoration of the disturbed corridor following building activities. Therefore, impacts to floodplains are minor.

4.2.1.1.7 Transmission Corridors

As discussed in Section 1.1.5, additional transmission lines that extend outside of the existing Project site boundary are not required. As described in Section 3.3, transmission improvements within the existing Project site include a second 230-kilovolt switchyard and other transmission line improvements. These improvements are located within the Project site and within the NDA. Accordingly, analysis of impacts on surface waters within transmission corridors is integrated in the preceding sections of Section 4.2.1.1.

4.2.1.1.8 Summary of Hydrologic Alteration Impacts to Surface Waters

Building activities result in potential direct impacts of up to approximately 16,875 linear ft. (5144 linear m) of streams within the NDA and approximately 100 linear ft. (30.5 m) within the associated off-site wastewater pipeline. An additional approximately 1256 linear ft. (383 linear m) of streams on the Project site are indirectly impacted by building activities. Impacts within Belews Lake are localized to the intake, discharge, and associated lakebed piping structures. In conjunction with grading and leveling activities, stormwater runoff patterns across the NDA are affected, resulting in changes in stormwater runoff rates across the Project site. As described in Section 4.2.1.1.2, structural and non-structural BMPs are implemented throughout the building phase to control and manage stormwater runoff and retain sediment.

Impacts to on-site aquatic habitats are mitigated in accordance with Sections 404, 401, and 402

of the CWA and permitted by the USACE and the NCDEQ. Implementation of design measures and BMPs, coupled with adherence to federal, state, and local permit conditions related to Sections 404, 401, and 402 of the CWA, reduce direct and indirect impacts from building activities on stormwater runoff rates, Belews Lake, and the Dan River. For impacts that result from activities subject to permitting under Section 404 of the CWA and cannot be reduced, Duke Energy implements specific compensatory mitigation measures in accordance with 33 CFR Part 332 “Compensatory Mitigation for Losses of Aquatic Resources.” As indicated in Section 1.4, an NPDES construction general permit authorization with site-specific SWPPP is required and includes strategies to reduce erosion and control sedimentation at the Project site.

As discussed above, the overall impacts of hydrologic alterations to surface waters are mitigated and are, therefore, SMALL.

4.2.1.2 Groundwater

This section identifies and describes hydrologic alterations that result from building activities on groundwater hydrology. Groundwater resources potentially affected by building activities are described in detail in Section 2.2.2. Physical characteristics of the groundwater system within the Project site and surrounding area are identified in Section 2.2.1.2.

Potential hydrologic alterations to groundwater that may result from building activities include those associated with dewatering and building of impervious surfaces such as buildings and concrete. As referenced in Section 3.3.2, dewatering may be required to maintain a dry excavation for building structural foundations, including the power block and other support SSCs. Duke Energy has not identified the specific reactor technology to be used on the Project site. Depending on the technology, the building excavation depth of safety-related structures will vary. As detailed in Section 3.3, the deepest building excavation will be 125 ft. (38 m) below finished grade elevation.

Bounding dewatering impacts were evaluated using the deepest excavation depth of 125 ft. (38 m) below finished grade elevation. Dewatering is accomplished by pumping from sumps located around the base perimeter of the excavation area. The radius of influence of the drawdown cone surrounding the foundation excavation is estimated using site-specific aquifer coefficients. The maximum extent of the drawdown cone, based on conservative calculations, is predicted to extend up to 4000 ft (1219 m) during peak dewatering operations. The actual drawdown is expected to be controlled and restricted by recharge and boundary conditions from Belews Lake. Groundwater users within the area are not expected to experience adverse effects from dewatering. Localized changes (decreases) in groundwater elevations may occur during dewatering. Dewatering flows are discharged pursuant to the appropriate regulatory guidelines. Once building activities are completed, dewatering is no longer needed, and the water table is returned to the static baseline conditions described in Section 2.2.1. Groundwater flow patterns may be affected during building and grading activities; however, effects are minor. Structure foundation development does not result in long-term impacts on groundwater availability or flow patterns.

The building activities result in the development of permanent use areas within the NDA. While specific details of site layout within the NDA have not yet been fully designed, it is expected that the permanent use areas consist of land uses that are impervious to groundwater infiltration, such as power blocks, cooling towers, laydown areas, and switchyards. Impervious surfaces from the development of these areas result in reduced infiltration and groundwater recharge in the immediate area of these structures. Other lands within the NDA are expected to allow for

varying degrees of groundwater infiltration and recharge. Surface water that does not infiltrate to groundwater is managed as stormwater runoff and ultimately discharged to Belews Lake. In locations where groundwater recharge is affected, corresponding effects (reductions) in groundwater levels may occur. Overall impacts on groundwater levels are expected to be minor. Therefore, impacts of hydrologic alteration of groundwater during building activities are SMALL.

4.2.2 WATER-USE IMPACTS

Water used for building activities is obtained from a municipal city water connection or from Belews Lake, as described in Section 3.3.2. The potential impacts of water use during building activities are described in this section.

4.2.2.1 Surface Water

Section 2.2.2 describes current surface water usage. Section 3.3 describes the water required to support the Project site during building activities. The impacts from surface water alteration and building activities to recreation are discussed in Section 4.4.4.2.

Water for dust suppression and concrete batch plant operation is withdrawn from Belews Lake. The maximum daily water usage from Belews Lake during building activities is 500,000 gpd (1,892,706 lpd). The current volume of Belews Lake is discussed in Sections 2.2.1.1 and 2.2.2.1 and the effects of water use from Belews Lake are negligible.

As described in Section 2.2.2.1.3, there are no public water supply facilities that withdraw water from surface water resources within the Project Vicinity. The only two self-supplied surface water withdrawal locations in the Project Vicinity are associated with the BCSS. These include the CCW intake structure on Belews Lake, and the existing Dan River make-up water intake structure (Figure 2.2-2). No building-phase water use is obtained from the Dan River.

As described in Section 3.3.2, potable water for building is obtained from either an existing water line connection or a new water line connection with Winston-Salem/Forsyth County Utilities. The maximum expected daily potable water usage is 61,622 gpd (233,264 lpd). The total permitted capacity of Winston-Salem/Forsyth County Utilities is 91 million gallons per day (mgd) (344.5 million liters per day [MLD]), with a maximum daily use during the 2024 annual period of 61.1 mgd (277.8 MLD). Because this supply has excess capacity, the effects of potable water usage are minor.

In summary, the impacts from surface water use during the building phase are SMALL.

4.2.2.2 Groundwater

Groundwater is not used as a source of water for building activities. Therefore, the impacts from groundwater use are SMALL.

4.2.3 WATER QUALITY IMPACTS

Various impacts on water quality may occur because of building activities. Potential impacts include those related to changes in stormwater flow and runoff that result in increased soil erosion or sediment transport, accidental discharges of construction-related chemicals such as fuel, oil, or grease, and changes in water quality parameters. Existing water quality of surface water and groundwater at the Project site is presented in Section 2.3.3. The following sections

discuss the potential impacts of building activities on surface water and groundwater quality.

Compliance with federal, state, and local requirements minimizes potential impacts of construction activities on surface water resources. For example, a site-specific SWPPP outlines guidance as part of the NPDES permit compliance program for managing stormwater and minimizes pollutant loading within receiving waterbodies. Duke Energy will also coordinate with the USACE and NCDEQ regarding compliance with applicable Section 401/404 permits for jurisdictional waters.

4.2.3.1 Surface Water

Direct physical alteration of surface waters from building activities resulting in the filling of streams, results in adverse impacts to surface water quality. Activities such as erosion and sedimentation, accidental spills, or releases of stormwater can result in indirect impacts on surface water quality. Section 4.2.1.1 evaluates the site preparation and building activities that could affect surface water quality. The total area affected by building activities within the Project site and the proposed intake and discharge structures are summarized in Table 4.1-1 and Section 4.1.1. Section 4.10 discusses the anticipated water quality impacts from nonradiological waste releases to surface water resources.

Surface water impacts are regulated by the USACE and the NCDEQ. Ground-disturbing activities that have the potential to affect surface water quality are permitted in accordance with applicable federal, state, and local regulations. On-site streams are subject to regulatory authority pursuant to Sections 404, 401, and 402 of the CWA. Duke Energy will obtain appropriate USACE and NCDEQ permits for impacts on streams and will adhere to USACE and NCDEQ guidelines and mitigative requirements, as applicable to control and minimize impacts on water quality. Requirements that address water quality include but are not limited to an NPDES general construction permit and a site-specific SWPPP that mitigates the impact of building activities on stormwater.

To minimize the impacts of building activities on surface water quality, BMPs are used to control erosion and limit the amount of soil and sediment entering surface waters. These controls include silt fencing, mulching, geotextiles, sod stabilization, flow diversion, buffer strips, detention ponds, and establishment of temporary or permanent vegetation as outlined in the NC Erosion and Sediment Control Planning and Design Manual (NCDEQ, 2013).

To control the discharge of oil spills and limit their effects on surface water, Duke Energy will implement a spill prevention, control, and countermeasure (SPCC) plan pursuant to 40 CFR Part 112 at the Project site. An SPCC plan includes BMP actions such as proper vehicle and equipment maintenance, containment for fuel or oil storage tanks, and the maintenance of spill response equipment and materials. With adherence to permit conditions and implementation of mitigation measures including the use of BMPs, SPCC plan and the SWPPP, impacts of Project building activities on surface water quality are minor.

4.2.3.1.1 On-Site Streams and Stormwater

As described in Section 4.2.1.1.1, building activities result in direct impacts of up to approximately 16,875 linear ft. (5144 linear m) of streams within the NDA and approximately 100 linear ft. (30.5 m) within the associated off-site wastewater pipeline. An additional approximately 1,256 linear ft. (383 linear m) of streams on the Project site are indirectly impacted by building activities. In conjunction with grading and leveling activities, stormwater

runoff patterns across the NDA are noticeably altered resulting in changes in stormwater runoff rates across the Project site. Each of these activities results in water quality alteration in conjunction with erosion, sedimentation, pollutant transport, and potential accidental spills and releases of contaminants during building activities.

Duke Energy has a site-specific SWPPP to mitigate the impact of building activities on off-site stream water quality caused by the permanent impact to streams within the NDA, as discussed in Section 4.2.1.1.1. As described in Section 4.2.1.1.2, structural and non-structural BMPs are implemented throughout the building phase to control and manage stormwater runoff and minimize downstream water quality degradation in Belews Lake. An SPCC plan minimizes and controls the effects of accidental oil-related releases from construction equipment during the building phase.

The on-site streams are not used for either consumptive or recreational purposes, as described in Section 2.2.2.1. Therefore, water quality impacts do not affect water users of on-site streams. Mitigation measures implemented as part of a site-specific SWPPP and SPCC plan minimize impacts of building activities on off-site water quality, specifically within receiving waters.

4.2.3.1.2 Belews Lake

Building activities within Belews Lake entail the development of intake and discharge structures and associated pipelines as part of the cooling system (Section 3.2.2). Impacts within Belews Lake are temporary and localized to the intake and discharge structures on the Project site. Installation of these structures and any associated underwater excavation are compliant with USACE and NCDEQ requirements, including Section 404 permits. As described in Section 4.2.1, dredging activities are minimized through the use of a cofferdam. The intake structure or structures are expected to be within an approximate 5000 ft^2 (464.5 m^2) area on the shoreline. From the site elevation to the shoreline, a 45-degree angled bore hole is required to lay the piping directly into Belews Lake. Dredging may be required at the discharge pipeline outlet to install scouring protection. It is estimated that, if required, approximately 1200 ft^3 (111 m^3) of soil and sediment are dredged. Material dredged in conjunction with building the intake and discharge are stockpiled in an approved upland location and tested for potential constituents of concern. Based on sample analytical results, materials are disposed of within either an approved upland location on the Project site or at an off-site landfill. The dredged material would be replaced with crushed rock. As described in Section 3.3.2, cofferdams may be temporarily installed to perform work in a dewatered environment as the principal BMP to contain and control sedimentation. Sediment disturbed during excavation results in a short-term localized impact on water quality consisting of increased turbidity and suspended solids in the vicinity of the building activity. Section 4.2.4.1.2 describes a sediment monitoring program to monitor potential constituents of concern that may remobilize from sediment disturbed during dredging. Program results will determine whether additional BMPs, engineering controls, or alternative methods are required to maintain water quality and aquatic habitat.

Water quality may be impacted by building activities associated with the intake and discharge structure and discharge pipeline(s). These building activities may result in erosion and sedimentation, accidental spills, releases of stormwater, or changes in runoff volumes resulting in direct and indirect impacts on surface water quality. However, permitting requirements including the implementation of appropriate BMPs and control measures minimize impacts such that impacts to the water quality of Belews Lake are localized and temporary. Additionally, an implemented SPCC plan minimizes and controls the effects of accidental releases from construction equipment during the building phase. Therefore, impacts to Belews Lake are minor.

4.2.3.1.3 Dan River

As described in Section 4.2.1.1.4, project nonradioactive discharges are routed through the existing Outfall 006. Liquid radioactive wastes are routed through a new discharge in a corridor adjacent to existing Outfall 006 and are diluted with cooling tower blowdown discharge. The only anticipated building activity on the Dan River is within the new discharge in the associated off-site corridor that includes the wastewater pipeline located at Outfall 006. While the wastewater pipeline is located within an approximate 100-ft. (30.5-m) wide corridor, building-related disturbances within the Dan River are more localized. As described in Section 3.2.2, the discharge structure within the Dan River consists of a pipeline buried within the river bottom. In-river excavation is conducted to install the discharge pipeline and results in localized sediment disturbance and localized water quality alterations related to turbidity and suspended solids. Riprap is placed in conjunction with the discharge to minimize scour and erosion of the riverbed. Disturbance of riparian vegetation by construction equipment operations within the wastewater pipeline corridor can also indirectly reduce the water quality of the Dan River due to erosion, associated sedimentation, and potential accidental releases from spills.

Adherence to federal, state, and local permit conditions reduce direct and indirect impacts to the Dan River. Placement of fill material (e.g., riprap) below the ordinary high-water mark is regulated by the USACE under Section 404 of the CWA. As indicated in Section 1.4, a NPDES general construction permit with a site-specific SWPPP is required and includes strategies to reduce erosion and sediment at the construction site. BMPs in the SWPPP will be used to minimize direct and indirect impacts to the Dan River. Additionally, an SPCC plan will be implemented to minimize and control the effects of accidental oil-related releases from building equipment during the building phase. Water quality impacts from building the wastewater discharge pipeline to the Dan River are localized and short-term. Therefore, water quality effects on the Dan River are minor.

4.2.3.1.4 Summary of Water Quality Impacts to Surface Water

As a result of mitigative measures and engineering controls (e.g., BMPs, SWPPP, and SPCC) regulated by the NCDEQ and the USACE that are implemented during building activities, impacts to surface water quality are controlled, localized, and temporary. Therefore, the impacts on surface water quality are SMALL.

4.2.3.2 Groundwater

Baseline water quality data for groundwater are provided in Section 2.2.3.2. Dewatering of the power block areas usually occurs within a limited area during the duration of the building of the below-grade nuclear island structures and foundations. Drainage sumps at the bottom of the excavation area discharge water that may have entered the excavation area into surface waters pursuant to permitting conditions and applicable regulations. Dewatering is managed in accordance with BMP procedures and construction stormwater permit.

During building activities, gasoline, diesel fuel, hydraulic lubricants, and other similar products are used for building equipment. Accidental releases or spills of these fluids have the potential to affect groundwater. Pursuant to 40 CFR Part 112, an SPCC plan will be prepared and implemented at the Project site, which would include the use of BMPs to minimize the occurrence of spills and limit their effects on groundwater. These BMPs include actions such as proper vehicle and equipment maintenance, containment for fuel or oil storage tanks, and the maintenance of spill response equipment and materials. BMPs are also used during building

activities to minimize potential discharges to the environment.

In the unlikely event small amounts of oil-related substances are released into the environment, they would have a small, localized, temporary impact on the groundwater. Because engineering controls, as described above, prevent or minimize the release of harmful effluents, and effluent concentrations are maintained at levels below permitted threshold limits that are established to be protective of water quality, impacts to groundwater quality are SMALL.

4.2.4 WATER MONITORING

This section describes the monitoring programs Duke Energy uses to provide protection of waterbodies that may be affected by building activities and to obtain timely and accurate information so that actions can be taken to limit building impacts. This section discusses the thermal and chemical monitoring programs, as applicable, for surface water and groundwater at the Project site, Belews Lake, and the Dan River. Building monitoring programs are compared to baseline conditions to identify potential concerns and take appropriate actions toward limiting the impact on both surface water and groundwater resources.

4.2.4.1 Surface Water

4.2.4.1.1 Preapplication Monitoring Program

Duke Energy's preapplication surface water monitoring program includes surface water quality sampling and analyses, as described in Section 2.2.4.1 and shown on Figure 2.2-35. The preapplication monitoring program consists of six on-site streams within the Project site, four sample locations along the Dan River, and one sample location in Town Fork Creek. These surface water sample locations were selected to establish baseline surface water conditions at each of the proposed advanced reactor locations at the North, Middle, and South Plant Complex areas. The preapplication locations supplement Duke Energy's existing monitoring sampling locations described in Section 2.2.4.1.1 and shown on Figure 2.2-34. The preapplication monitoring sample locations were each sampled once quarterly from April 2024 to January 2025. As described in Section 2.2.3.1, samples were analyzed for standard water quality parameters (temperature, pH, conventional pollutants), metals, and select radionuclides following the guidance of NUREG-1555.

4.2.4.1.2 Building Monitoring Program

Duke Energy will monitor existing locations as described in Section 2.2.4.1.1 throughout the building period outlined in Section 3.3.5. Surface water locations monitored during building may include additional monitoring locations following technology selection and final design. Details of the building monitoring program are defined following technology selection and will include thermal and chemical monitoring as needed. As part of the program, a monitoring plan will be developed to specify locations, sampling frequencies, sampling protocols, and quality assurance procedures for sampling and analysis.

Water discharges to Belews Lake and on-site streams during building activities are monitored in accordance with applicable NPDES permit requirements and NCDEQ water quality requirements (Table 1.4-2). Typical requirements of an NPDES permit include monitoring of stormwater and dewatering discharges. A SWPPP is required as part of the NPDES permit and identifies required inspection methods and BMPs used to detect and limit erosion and provide effective sediment control. Discharges of water during building activities are subject to

monitoring which may include temperature and water quality monitoring. A full radiological monitoring program is not planned to be performed during building activities due to the lack of radiological gaseous emission, liquid effluents, or direct radiation during the building phase.

Through a sediment monitoring program, Duke Energy will monitor potential constituents of concern that may remobilize from sediment disturbed during dredging. Sediment monitoring will occur both before and during building activities. The program results will determine whether additional BMPs, engineering controls, or alternative methods are required.

Requirements for monitoring on-site streams, Belews Lake and the Dan River during building of the intake structure, the discharge pipeline and potential diffuser are specified as part of the USACE Section 404 permit, and the Section 401 water quality certification issued by NCDEQ.

As shown in Table 3.3-1, the advanced reactors are brought online in a phased approach. As such, building monitoring programs described in this section occur in conjunction with operating monitoring programs described in Sections 5.2.4.1.2 and 5.9.

4.2.4.2 Groundwater

4.2.4.2.1 Preapplication Monitoring Program

Duke Energy's preapplication groundwater monitoring program includes groundwater quality sampling and analyses, as described in Section 2.2.4.2. The preapplication monitoring program consists of 15 groundwater observation wells. Groundwater sample locations establish baseline groundwater conditions at each of the proposed advanced reactor locations at the North, Middle, and South Plant Complex areas. These sample locations were each sampled once quarterly from June 2024 to April 2025. Samples were analyzed for standard water quality parameters (temperature, pH, conventional pollutants), metals, and selected radionuclides following the guidance of NUREG-1555 as described in Section 2.2.3.2. Water levels were obtained from each groundwater observation well on a monthly basis.

4.2.4.2.2 Building Monitoring Program

The groundwater wells to be monitored during building are a subset of the wells that exist from the preapplication monitoring program as described in Section 2.2.4.2. The building monitoring program is not defined until a technology is selected and will include water level and chemical monitoring. As part of the program, a monitoring plan is developed to specific locations, sampling frequencies, sampling protocols, and quality assurance procedures for sampling and analysis. The monitoring program will include both water quality sampling and water level monitoring.

A full radiological monitoring program is not planned to be performed during building activities due to the lack of radiological gaseous emission, liquid effluents, or direct radiation during the building phase. Testing of radionuclides is included to compare with the baseline established in the preapplication monitoring program to monitor during building.

As shown in Table 3.3-1, the advanced reactors are brought online in a phased approach. As such, building monitoring programs described in this section occur in conjunction with operating monitoring programs described in Sections 5.2.4.2.2 and 5.9.

Table 4.2-1
Project Site Stream Impacts
(Sheet 1 of 2)

Feature ID	Designation	Total Stream Linear ft. within the Project Site	Direct Impact (linear ft.)	Indirect Impact (linear ft.)
S49	Perennial	255	255	-
S52	Perennial	2017	2017	-
S53	Intermittent/Perennial	716	716	-
S54 (canal)	Perennial	3440	-	-
S55	Intermittent/Perennial	286	148	138
S56	Intermittent/Perennial	641	641	-
S57	Intermittent	432	432	-
S58	Perennial	768	661	107
S58a	Intermittent	80	80	-
S59	Intermittent/Perennial	343	268	75
S60	Perennial	1387	1289	98
S61	Intermittent/Perennial	924	811	113
S62	Intermittent	1062	810	252
S63	Intermittent/Perennial	558	446	112
S64	Perennial	1358	1199	159
S65	Intermittent	286	286	-
S66	Intermittent	225	225	-
S67	Intermittent/Perennial	1597	1464	133
S68	Intermittent/Perennial	706	706	-
S69	Intermittent/Perennial	2992	2923	69

Table 4.2-1
Project Site Stream Impacts
(Sheet 2 of 2)

Feature ID	Designation	Total Stream Linear ft. within the Project Site	Direct Impact (linear ft.)	Indirect Impact (linear ft.)
S70	Intermittent	633	633	-
S127	Intermittent/Perennial	865	865	-
	Summary of Impacts by Stream Type			
	Intermittent/Perennial	9628	8988	640
	Intermittent	2718	2466	252
	Perennial	9225	5421	364
	Total	21,571	16,875	1256

Key: ft.= feet; S = Stream

4.3 ECOLOGICAL RESOURCES

This section describes the potential effects on terrestrial, wetland, and aquatic ecological resources from building activities associated with the Project.

Building activities associated with the Project could affect terrestrial, wetland, and aquatic ecosystems occurring on and adjacent to the Project site. Potentially affected resources include the habitats and associated ecological communities of upland terrestrial habitats, wetlands, and aquatic habitats. Preconstruction activities, including site preparation (such as land clearing, grading, excavation, and filling), have the greatest potential to result in effects on ecosystems.

Section 1.4 discusses the status of required consultations with federal, state, tribal, and local agencies. Consultations with the U.S. Fish and Wildlife Service (USFWS), USACE, NCDEQ, NC Wildlife Resources Commission (NCWRC), and NC Natural Heritage Program (NCNHP) were initiated to acquire information regarding ecological resources within and near the Project site (Section 2.3). Consultation was used to obtain agency input regarding threatened and endangered species, sensitive habitats, commercial and recreational species, and other ecological characteristics for the Project site and Project Vicinity. For more details on dates and responses from agencies, see Section 2.3.1.5 and Appendix A in Chapter 1. Input from these agencies is included in the sections below, as applicable.

4.3.1 TERRESTRIAL AND WETLAND IMPACTS

As stated in Section 2.1.1.3, the Project site consists of approximately 1187 ac. (480 hectares [ha]) located adjacent to the BCSS on a peninsula surrounded by Belews Lake to the north, east, and west. Section 2.3.1 describes the terrestrial ecosystems of the Project site and includes upland and wetland habitats, associated ecological communities, and important species. Section 2.3.1 also briefly describes these features for the potentially affected areas in proximity to the Project site. This section evaluates the potential effects of building activities on the terrestrial ecosystems that occur on the Project site and associated off-site areas. Additionally, measures to mitigate adverse environmental impacts are proposed, where necessary.

As described at the beginning of this chapter, impacts from building activities are assessed within the NDA and the associated off-site wastewater pipeline that extends outside the NDA. As the design progresses, Duke Energy is considering appropriate avoidance, minimization, and mitigation measures to reduce total impacts.

4.3.1.1 Terrestrial Habitats

The Project site spans approximately 1187 ac. (480 ha), with approximately 906 ac. (367 ha) designated for permanent disturbances such as the power blocks, cooling towers, laydown areas, and switchyards. After completing construction activities, laydown areas used to support construction activities will remain disturbed areas and be used to support operations such as parking lots and related facilities. As described in the Chapter 4 introduction, the 906 ac. (367 ha) represents the NDA, which excludes an approximate 100-ft. (31-m]) vegetative buffer along the shoreline of Belews Lake, except in areas where shoreline access is required for building activities. Additionally, the associated off-site wastewater pipeline corridor results in the conversion of up to an additional 40 ac. (16 ha) to permanent uses. These areas are cleared of vegetation for building activities (Table 4.1-1). Although facilities will not occupy the entire acreages, there are no plans to revegetate or restore disturbed areas such as laydown areas.

Land clearing, grubbing, grading, excavation, and other typical site preparation activities result in the loss of existing vegetation. The types of habitats present at the Project site are shown in Figure 4.3-1, with the affected habitats summarized in Table 4.3-1.

Building on the Project site and associated off-site wastewater pipeline corridor results in the combined conversion of approximately 946 ac. (383 ha) to permanent uses, most of which (approximately 906 ac. [367 ha]) occurs within the NDA. The predominant habitat types impacted by building activities on the Project site are evergreen forest (31.9 percent), deciduous forest (17.0 percent), and mixed forest (9.8 percent). Approximately 85.6 ac. (34.6 ha) of herbaceous lands and 16.4 ac. (6.6 ha) of scrub shrub are also converted by building activities to developed uses. Land cover impacts to wetland areas include both woody (1.2 ac. [ha]) and emergent herbaceous (1.3 ac. [0.5 ha]) wetlands. Section 4.3.1.2 discusses wetland impacts.

Building on the associated off-site wastewater pipeline corridor results in the conversion of approximately 40.1 ac. (16.2 ha) to permanent uses. Impacts on the associated off-site wastewater pipeline corridor primarily affect developed, low-intensity land (11.4 ac. [4.6 ha]), herbaceous land (10.0 ac. [4.0 ha]), evergreen forest (5.5 ac. [2.2 ha]), and deciduous forest (4.3 ac. [1.7 ha]). Permanent uses on the Project site include those associated with power-generating facilities, switchyard, cooling towers, utility systems, and other construction use facilities. More details on the Project site layout and description can be found in Section 3.1.

As discussed in Section 2.3.1.4, plant communities on the Project site are common and well represented throughout the local region. Many of these communities are successional and contain substantial populations of non-native plant species, indicating the effects of past anthropogenic disturbance and disruption to natural disturbance patterns. Approximately 76 percent of the Project site and 100 percent of the associated off-site wastewater pipeline corridor are impacted by building activities (Table 4.3-1). However, most of this land was previously disturbed and generally low-quality, marginal evergreen, herbaceous, and scrub shrub habitat. Other land cover types impacted include developed and barren lands that provided minimal habitat to plant communities and wildlife on the Project site. Deciduous forests on the Project site and associated off-site wastewater pipeline corridor represent higher-quality habitat impacts. Based on the amount of deciduous forest within the on-site and associated off-site areas, as shown in Table 4.3-1, 61.8 percent of on-site deciduous forest is directly impacted, and 100 percent is permanently impacted in the associated off-site area. Although there is a similar habitat within the Project Vicinity (Table 4.3-1), a large amount of forested habitat is lost on the Project site and associated off-site wastewater pipeline corridor due to building activities. Therefore, direct impacts on habitat on the Project site and associated off-site wastewater pipeline corridor are noticeable but not destabilizing.

Habitats outside of the NDA are subject to potential indirect effects from the building activities occurring within the adjacent NDA. Some indirect effects may include encroachment of invasive species and erosion and sedimentation impacts. As discussed in Section 2.3.1.7.2, substantial populations of invasive plant species are present within certain areas on the Project site. Disturbance associated with building activities, such as earth-moving and excavation, creates conditions for opportunistic invasive species to become more widespread and established across the Project site and in habitats adjacent to the NDA. Establishment of invasive species from building activities is minimized by periodic monitoring and control measures, as feasible.

BMPs for erosion and sedimentation control, specific to the extent and type of construction, are developed and installed prior to building activities and are maintained throughout construction.

Based on the area affected, overall impacts on terrestrial habitats are noticeable. However, because of the availability of similar land cover types within the Project Vicinity, the prevalence of low-quality plant communities, and reduced quality of the existing habitats on the Project site and associated off-site area, potential impacts on terrestrial land cover are noticeable but not destabilizing.

4.3.1.2 Wetlands

Wetland communities on the Project site are described in Section 2.3.1.2 and mapped in Figure 2.3-5. Figure 4.3-2 depicts wetlands affected by building activities. Of the 17 wetlands (totaling 2.68 ac. [1.08 ha]) in the Project site, 14 are completely or partially within the NDA. An additional wetland (0.26 ac. [0.11 ha]) is located in the associated off-site area (wastewater pipeline). The total for these wetland areas subject to direct impacts is 2.45 ac. (0.99 ha) within the Project site and 0.26 ac. [0.11 ha] within the associated off-site wastewater pipeline area. As discussed in Section 2.3.1.2.1, based on USFWS National Wetlands Inventory data, approximately 88 ac. (35 ha) of freshwater emergent wetlands, 1855 ac. (751 ha) of freshwater forested wetlands, and 312 ac. (126 ha) of freshwater scrub shrub wetlands (totaling 2255 ac. [913 ha] of wetlands) are mapped within the Project Vicinity. Table 4.3-2 provides a breakdown of Project site direct and indirect wetland impacts by system and also by Cowardin classification. Direct wetland impacts within the associated off-site area are to wetland WJ, a palustrine (freshwater) forested wetland. As summarized in Table 2.3-2, wetlands identified were determined to have functional ratings of low to high. Impacts from filling wetlands result in the permanent loss of all functions within the area affected for each wetland.

Project site wetlands outside of the NDA are subject to indirect effects of building activities. Wetlands AA, R, and X are located entirely outside of the NDA while wetlands S, U, W, and WL are bisected by the NDA (Table 4.3-2). The remnant portions of wetlands S, U, W, and WL are indirectly affected due to the reduction in size which can affect their degree of functionality. Wetlands U, WL, and W are associated with on-site impacted streams. The removal of these associated stream systems results in indirect effects on the hydrology of these systems. Wetlands AA, R, and X are also subject to indirect effects associated with changes in hydrologic inputs due to grading, excavation, or the introduction of impervious surfaces occurring within the NDA. Changes to their hydrologic inputs can impact the function of these wetlands. Wetland systems outside of the NDA are subject to potential indirect effects from the land-clearing and other preconstruction and building activities occurring within the adjacent NDA, such as edge-effect encroachment of invasive species or changes to the shading of remaining wetlands, which could affect the habitat function of these features. Remaining wetland resources retain some landscape connectivity via the forested buffer along the lake edge, thereby sustaining corridors that can support wildlife movement. Wetlands not directly subject to impacts risk indirect erosion and sedimentation impacts from preconstruction and building activities; however, these impacts are mitigated to the extent practicable by the use of BMPs to prevent erosion and the transport of sediment to wetlands via stormwater. Erosion controls can include mulching, geotextiles, sod stabilization, and buffer strips, while sediment control can include silt fences or vegetative buffer strips. These BMPs are designed, installed, and operated to meet all requirements and be acceptable for approval and issuance of both erosion and sediment plans/NPDES permit NCG010000 and post-construction categorical industrial stormwater coverage as required for steam electric generation sites. Building activities comply with federal and state BMPs for erosion control and stormwater management, thereby minimizing the potential for those processes to directly disturb or indirectly impact nearby wetland communities outside the Project site and associated off-site areas.

As Section 2.3.1.2.2 notes, wetlands are subject to regulatory authority pursuant to Sections 401 and 404 of the CWA. The USACE performed a site visit in December 2024 to field verify the streams and wetland delineation, followed by issuance of a Jurisdictional Delineation Concurrence letter in January 2025 confirming the delineation is a sufficiently accurate representation of the geographic boundaries of the aquatic resources located on the site within the delineation survey area. Appropriate NCDEQ (Section 401) and USACE (Section 404) permitting applications for wetlands will be submitted based upon final design, and NCDEQ and USACE guidelines and mitigative requirements will be followed.

Any required mitigation by USACE will comply with the requirements of 33 CFR Part 332 "Compensatory Mitigation for Losses of Aquatic Resources," which promotes the national goal of "no net loss" of wetland acreage and functions as described in the Final Rule. Potential stream and wetland mitigation will be evaluated during later design and permitting phases for any unavoidable impacts to waters of U.S., including wetlands, using a watershed-based approach in the selection of mitigation sites. Mitigation sites will be evaluated and prioritized consistent with the Final Rule's mitigation preference hierarchy: 1) credits from approved mitigation banks, 2) credits from approved in-lieu fee programs, and 3) permittee-responsible mitigation. During the permitting phase, if a mitigation bank is not available within the approved service area for the Project watershed, compensatory mitigation will be coordinated through the NCDEQ's In-Lieu Fee Program administered by the Division of Mitigation Services. Other options will be evaluated if banks or in-lieu fee options are not available. Therefore, impacts on waters of the U.S., including wetlands, will be fully mitigated.

In summary, all wetlands within the Project site are directly or indirectly impacted by building activities, while the associated off-site wetland is directly impacted. Of the approximately 2.94 ac. (1.19 ha) of on-site and off-site total wetland area (approximately 2.68 on-site and approximately 0.26 off-site), approximately 92 percent (2.71 ac. [1.1 ha]) will be directly impacted. The remaining approximately 0.23 ac. (0.09 ha) of on-site wetlands are subject to indirect effects to hydrology, vegetative cover composition, and habitat value from construction activities. However, there are substantially greater wetland resources within the Project Vicinity approximately 2255 ac. (913 ha). Total direct and indirect impacts constitute a negligible impact on total wetland habitats in the Project Vicinity, such that overall impacts on wetlands are not destabilizing.

As the design and permitting processes progress, Duke Energy will consider and implement appropriate avoidance and minimization measures. For impacts that cannot be avoided, Duke Energy will coordinate with the USACE and the NCDEQ to ensure the appropriate mitigation credits will be generated or acquired following the watershed approach and "no net loss" principle. Based on anticipated avoidance and minimization of wetland impacts, landscape perspective of total wetland habitats, NCDEQ and USACE guidelines and mitigative requirements, and the use of BMPs, impacts on wetlands are minor.

4.3.1.3 Wildlife

As described in Section 2.3.1.3, wildlife communities within the Project site and the associated off-site wastewater pipeline corridor are common, well represented, and reflect the composition of associated wildlife communities (Section 2.3.1.4). Wildlife communities using evergreen, herbaceous, or shrub scrub habitat within the Project site and associated off-site wastewater

pipeline corridor are generally characterized as having low diversity and are dominated by common species. However, deciduous forest and associated stream valley habitats provide higher-quality wildlife habitat on the Project site. Impacts on streams are discussed below in Section 4.3.2.1.1. Section 4.3.1.4 provides a discussion of impacts on species of concern and important terrestrial species.

Building activities result in disturbance, displacement, and loss of wildlife because heavy equipment is used for clearing, grading, and excavation. Mobile animals, such as birds and larger mammals, avoid disturbance areas and may relocate to safer areas. However, smaller, less mobile species, such as small mammals, reptiles, and amphibians, are displaced or may suffer mortality during building activities. Based upon the conversion of habitats to developed areas described in Section 4.3.1.1, the overall abundance and composition of wildlife within the Project site is altered from wildlife communities that are characteristic of undeveloped habitats, to those communities that are naturalized or tolerant of developed habitats. Wildlife displaced by building activities can find refuge in undisturbed habitats within the Belews Lake shoreline buffer or within similar habitats within the Project Vicinity. While the shoreline buffer is retained and serves as a refuge area for wildlife and a corridor for wildlife movement during building activities, the narrowness of this shoreline buffer limits the overall capacity to support wildlife diversity. Movement of species through the Project site to Belews Lake in search of water may be similarly impacted by this habitat fragmentation. However, the loss of individuals from these localized impacts is not anticipated to affect regional species populations.

Riparian zones are valued habitats that are used by wildlife. A forested riparian zone of approximately 100 ft. (30 m) within the Project site is retained along most of Belews Lake shoreline, except in the areas where shoreline access is needed. Similar riparian habitat for wildlife is available along Belews Lake and other water bodies in the 50-mi. (80-km) Project Region, and the loss of small segments at the intake and discharge structures does not affect populations of wildlife that use riparian habitats.

As described in Section 2.3.1.8, the Project site and associated off-site wastewater pipeline corridor are located within the Atlantic Flyway migration route. One osprey (*Pandion haliaetus)* nest on a man-made nesting platform was documented on the Project site within the NDA (Figure 4.3-3) and is impacted by building activities. A known bald eagle (*Haliaeetus leucocephalus*) nest is outside the NDA and is not impacted by building activities. Additional discussion on bald eagle impacts is included below in Section 4.3.1.4.1. BMPs to minimize impacts on migrating bird species include minimizing or avoiding tree clearing during nesting season from April to July. If building activities occur during this window, Duke Energy compliance recommendations are in place to reduce effects to nesting migratory birds. These include surveying for active nest sites and establishing avoidance buffers as needed.

Birds flying through the Project site may collide with tall construction equipment or structures that include cranes and transmission lines. During final design, Duke Energy will consider placing new transmission lines in locations that will minimize potential impacts to birds utilizing methods such as those outlined by the Avian Power Line Interaction Committee. NUREG-1437, *The Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* concludes that bird collisions with cooling towers, other nuclear power plant structures, and transmission lines occur at rates that are unlikely to affect local or migratory bird populations (NRC, 2013).

If artificial lighting is used to support nighttime building activities, birds and nocturnal pollinators are subject to impacts. Bird collisions may be more frequent during migration because some

bird species are attracted to artificial lights during migration (Gauthreaux and Belser, 2006). Recent studies have shown that artificial lighting disrupts the natural reproduction and feeding patterns of nocturnal pollinators, such as beetles and moths. As a result, pollination rates in plants and the health and diversity of nocturnal pollinators may be correspondingly reduced. Mitigation measures such as minimizing the number of light structures, installing fully shielded lights that direct light downward, avoiding landscape lighting features for trees or building facades, and using only low-pressure sodium, high-pressure sodium, or light-emitting diode light sources help minimize potential adverse effects of outdoor lighting to wildlife. Therefore, impacts of collisions and effects from artificial lighting on species during building activities are minor.

Section 4.8.2 describes noise that can result from building activities and factors that influence noise effects, such as frequency, intensity, duration, location, and timing. As summarized in Table 4.8-1, noise emissions from most of the construction equipment used on the Project site attenuate to 85 A-weighted scale decibels (dBA) or less at 50 ft. (15 m) from the noise source. The exception is pile-driving activities, which can reach up to 110 dBA at 50 ft. (15 m) from the source. As discussed in Section 4.8.2, pile-driving activities occur periodically within the power block areas and may occur as part of the intake and discharge structure installation. Additionally, as described in Section 3.3.2, rock excavation activities likely require controlled rock blasting, which may produce noise levels of up to 126 dBA. However, the noise emissions of these isolated explosive events are equivalent to a thunderclap at the source and are temporary and short-term. The noise level at which birds and small mammals are startled or frightened is 80 to 85 dBA (Golden et al., 1980). Thus, wildlife within 50 ft. (15 m) during most building activities on the Project site may be startled, move away from the building activities, and avoid feeding or sheltering in nearby habitats. Displacement of small mammals and birds is expected within areas affected by building activities.

While many wildlife communities on the Project site have low diversity and are dominated by common species, there are some higher-quality habitats on the Project site, such as deciduous forest and associated stream valley habitats. All habitat on the Project site within the NDA is permanently converted to developed use which alters the composition of wildlife species. BMPs minimize impacts on common wildlife species, and individual losses of species as a result of building activities do not noticeably affect species populations within the Project Vicinity or Region. Thus, overall impacts on general wildlife as a result of building activities are noticeable but not destabilizing.

4.3.1.4 Important Terrestrial Species and Habitats

4.3.1.4.1 Important Terrestrial Species

As discussed in Section 2.3.1.5, there are important terrestrial species and habitats within or near the Project site. Table 2.3-9 identifies the important terrestrial species that may be impacted by building activities on the Project site. Species that are federally listed as endangered, or species proposed to be listed as endangered, include Schweinitz's sunflower (*Helianthus schweinitzii*), tricolored bat (*Perimyotis subflavus*), bog turtle (*Glyptemys muhlenbergii*), monarch butterfly (*Danaus plexippus*), and gray bat (*Myotis grisescens)*.

As discussed in Section 2.3.1.5.1, the Project site contains suitable habitat for Schweinitz's sunflower in the form of open roadsides, the transmission corridor, and within natural forest openings near the Belews Lake shoreline. However, this species was not documented during vegetation surveys of the Project site in April, July, or October 2024. Surveys during the October event were conducted during the optimal flowering period for this species. While specific habitat

for the sunflower was identified, no specimens were observed, as discussed in Section 2.3.1.5.1. On-site suitable habitat for this species is disturbed by periodic mowing and other general maintenance occurring along transmission lines and roadsides. Further, dense vegetation within the transmission corridor limits growth of this species, which needs partial to full sun. Affected habitats that are suitable for Schweinitz's sunflower include approximately 85.6 ac. (34.6 ha) on the Project site, and 10.0 ac. (4.0 ha) within the associated off-site wastewater pipeline corridor. Impacts on Schweinitz's sunflower are minor because the species was not observed, and suitable habitat is limited on the Project site.

Tricolored bat is proposed for federal listing as endangered, and this species was documented on-site through acoustic surveys in 2023 as detailed in Section 2.3.1.5.1. Roosting and foraging habitat is present on the Project site and is impacted by building activities. Impacts on foraging habitat are limited because habitat types affected, such as forests and open water, are common in the Project Vicinity (Table 4.3-1), and bats are highly mobile and capable of using other, similar foraging habitats nearby. The greatest direct threat to tricolored bats during building activities is associated with the clearing of roost trees within forested habitat on the Project site; however, the forests in the Project Vicinity provide potential roost trees that tricolored bats could use as alternatives to roost trees removed from the Project site. Approximately 698.0 ac. (282.5 ha) of roosting habitat (deciduous forest, evergreen forest, mixed forest, and woody wetlands) is within the NDA, whereas 12.1 ac. (4.9 ha) of roosting habitat is within the associated off-site wastewater pipeline corridor (Figure 4.3-4). To minimize potential effects to tricolored bats, mitigative measures that include tree-clearing restrictions and culvert surveys are used. Clearing trees during the winter when bats are hibernating and not using trees during summer roosting also limit direct impacts on roosting bats. Prior to construction, Duke Energy will consult with the USFWS and adhere to conservation measures, such as tree-clearing time frames and conducting surveys to avoid impacts on roost trees and associated bats, as appropriate. Tricolored bats may also roost in culverts. Culverts greater than 3 ft. (1 m) wide and bridges within or adjacent to the Project are surveyed for bats within 15 days of construction. Based on the limited dependence of tricolored bats on the Project site for foraging habitat and the ability to avoid direct effects on bats in occupied roosting trees if present, the potential for construction impacts on tricolored bats is minor.

Potentially suitable habitat for the bog turtle is present on the Project site, but the species has not been documented in surveys. Furthermore, as noted in Section 2.3.1.2.2, there are only four palustrine emergent wetlands, and one forested and emergent vegetated wetland delineated on the Project site. These are located in a relict stormwater management pond or in the transmission corridor and are therefore in maintained areas that are periodically disturbed. These wetlands are within the NDA (Figure 4.3-2), but suitability for bog turtles within these areas is considered low due to the recurring disturbance. Therefore, impacts on the bog turtle are minor.

Monarch butterfly is a species proposed for federal listing as threatened and is reliant on milkweed species for breeding. USFWS has occurrence records of this species around the Project site. During 2024 surveys, the monarch butterfly was not documented on-site, and its breeding habitat is limited on the Project site. Milkweed was limited to rare in its occurrence during surveys in the southwest portion of the Project site and along the associated off-site wastewater pipeline corridor, as discussed in Section 2.3.1.5.1 and shown in Figure 4.3-4. Suitable foraging habitat exists on the Project site in the form of herbaceous areas, especially the grassland found just south of the transmission line corridor bordering the lake on the east side of the Project site. This area hosts native wildflowers (not including milkweed), while other herbaceous areas are dominated by invasive species. As Figure 4.3-1 shows, the herbaceous

area just south of the transmission line corridor is also within the NDA. Within the Project site, 85.6 ac. (34.6 ha) of herbaceous foraging habitat is impacted by building activities. However, this herbaceous foraging habitat is not unique on the Project site (Table 4.3-1), and transmission corridors established as part of building activities may provide suitable herbaceous foraging habitat within other areas of the Project site for use by this species. Duke Energy will consult with USFWS regarding this species as appropriate if the monarch butterfly becomes federally listed. Based on limited breeding habitat and the presence of other suitable foraging habitat in the Project Vicinity, impacts on monarch butterfly are minor.

As discussed in Section 2.3.1.5, federally endangered gray bats are not expected on the Project site. Gray bats were not documented during 2023 acoustic monitoring and no suitable roosting habitat is present on the Project site; therefore, impacts on these bats are limited. Suitable foraging habitat may be present on the Project site in the form of stream corridors, but bats are highly mobile and capable of using other, similar habitat nearby.

Bald eagles are protected under the Bald and Golden Eagle Protection Act and are state-listed as a threatened species. As discussed in Section 2.3.1.5.2, there is a bald eagle nest at the BCSS adjacent to the Craig Road landfill and approximately 0.23 mi. (0.37 km) west of the Project site. As Section 2.3.1.5.2 describes, Duke Energy has developed a Bald Eagle Nest Management Plan for the BCSS, which details general bald eagle nest disturbance guidelines, activity guidelines during vegetation management, activity guidelines during utility structure or electrical maintenance, and guidelines for removal and beneficiation of coal ash (Duke Energy, 2023a). Protective buffers help shield bald eagle nests from activities that may result in detrimental impacts on breeding and successful production of chicks. The standard buffer distance for bald eagle nests during the nesting season is a 660-ft. (201-m) radius measured from the base of the nest as discussed in the Bald Eagle Nest Management Plan (Duke Energy, 2023a). This buffer is outside of any on-site and off-site disturbance areas, as shown in Figure 4.3-4. Duke Energy will coordinate with the USFWS prior to construction to obtain required permits and implement conservation measures, as appropriate. Based on avoidance of the nest area and implementation of appropriate conservation measures, impacts on bald eagles are minor.

Section 2.3.1.5.3 describes state-listed species with the potential to be present on the Project site including, rusty blackbird (*Euphagus carolinus*), coppery emerald (*Somatochlora georgiana*), and marsh St. John's-wort (*Triadenum tubulosum*). Rusty blackbird, a species state-listed as threatened, was not observed on-site but has the potential to occur due to the species' preferred hardwood forest habitat along the shoreline of Belews Lake. Furthermore, rusty blackbirds do not breed in the Piedmont Ecoregion and are only expected during the winter months. As previously discussed, an approximate 100-ft. (30-m) vegetative buffer around the lake is retained and not impacted by building activities. Rusty blackbirds are highly mobile and hardwood forests by the lake are not unique to the Project Vicinity. Therefore, the impacts on the rusty blackbird are minor.

The coppery emerald is a species designated by NCNHP as significantly rare, and it may occur on the Project site. However, as noted in Section 2.3.1.5.3, habitat for this species is limited due to the small size of on-site streams. Therefore, even though impacts on streams would occur, as discussed in Section 4.3.2.1.1, impacts on this species are minor.

Marsh St. John's-wort is a species designated by NCNHP as significantly rare, and suitable habitat occurs within coves and along low, wetland shorelines of Belews Lake. This species has not been observed on-site. An approximate 100-ft. (30-m) buffer around the lake is retained.

Shoreline impacts are also limited to relatively isolated intake/discharge areas along Belews Lake. Therefore, impacts on marsh St. John's-wort are minor.

As Section 2.3.1.5.4 discusses, species of commercial or recreational value on the Project site include game species (such as gray squirrel [*Sciurus carolinensis*], white-tailed deer [*Odocoileus virginianus*], and wood duck [*Aix sponsa*]), non-game species (coyotes [*Canis latrans]*), and furbearers (such as raccoon [*Procyon lotor*] and opossum [*Didelphis virginiana*]). These species are common in the area and within the Project Vicinity. Therefore, impacts on these species are minor.

Overall, impacts on important terrestrial species are limited because of the low probability of occurrence for the species, the presence of extensive habitat characterized by low-quality plant communities, and the abundance of similar suitable habitat within the Project Vicinity. In addition, Duke Energy will consult as appropriate regarding potential effects to tricolored bat and bald eagle and incorporate relevant conservation measures to minimize effects to these species. Therefore, impacts on important terrestrial species are minor.

4.3.1.4.2 Important Terrestrial Habitats

As Section 2.3.1.6 discusses, the Project site does not include any designated or proposed critical habitat for terrestrial species. Important terrestrial habitats on the Project site or in the Project Vicinity include wetlands, Belews Lake Park, Knight Brown Nature Preserve, and the Dan River Educational State Forest. Building activities do not impact Belews Lake Park, Knight Brown Nature Preserve, or the Dan River Educational State Forest, as these features are outside the Project site NDA and the off-site wastewater pipeline area.

Impacts on wetlands from building activities are described in Section 4.3.1.2. Based on the limited extent of wetlands on the Project site, the impact on wetlands from building activities is minor. Therefore, the overall impact on important terrestrial habitats because of building activities is minor.

4.3.1.5 Transmission Corridors

As discussed in Section 1.1.5, additional transmission lines that extend outside of the existing Project site boundary are not required. Transmission improvements within the existing Project site include a second 230-kilovolt switchyard and other transmission line improvements. These improvements are located within the Project site and substantially within the NDA. Accordingly, analysis of impacts on habitats and species within transmission corridors is integrated in the preceding sections of Section 4.3.1.

4.3.1.6 Summary of Impacts on Terrestrial Ecology

As previously discussed, impacts on plant communities and habitats are noticeable based on the size of the area affected. Much of the habitat on-site is low quality and there is suitable habitat within the Project Vicinity. However, higher-quality habitats on-site are also permanently impacted, and composition of wildlife within the Project site is altered to naturalized communities. Impacts on wildlife are limited because of mitigation measures, BMPs, and the short duration of building activities. The only important habitat on the Project site consists of wetlands, as defined by U.S. NRC guidance and discussed in Section 2.3.1.6. Impacts on these habitats are mitigated by BMPs and required federal or state mitigation. Impacts on important terrestrial species are mostly limited because many of these species are not found on the

Project site or there is limited impact on habitats and populations found within the Project Vicinity and Project Region. Consultation with USFWS and implementing appropriate conservation measures and other mitigative measures reduces impacts on important terrestrial species found on the Project site or in adjacent areas. Overall, the impacts on terrestrial ecology from building activities are MODERATE.

4.3.2 AQUATIC IMPACTS

The aquatic ecosystems and aquatic resources of the Project site are described in detail in Section 2.3.2. Aquatic habitats on the Project site, associated off-site areas, and in the Project Vicinity include on-site streams, Belews Lake, Belews Creek, and the Dan River. Impacts on surface water resources as a result of building activities are described in Section 4.2.1. Building activities that can affect aquatic ecosystems include development of the features and structures associated with the cooling water systems on Belews Lake and the Dan River and on-site grading and land preparation. Indirect impacts, such as degradation of water quality from sedimentation and potential accidental spills, can reduce quality of aquatic habitats.

Additionally, accidental discharges of construction-related chemicals such as fuel, oil, or grease can occur during building activities. Compliance with federal, state, and local requirements minimizes potential impacts of building activities on aquatic ecosystems. A site-specific SWPPP as part of the NPDES permit compliance manages stormwater and minimizes pollutant loading within receiving water bodies. In addition, compliance with the terms of applicable Section 404 permits, and coordination with the USACE are required.

4.3.2.1 Aquatic Habitats and Biota

4.3.2.1.1 On-Site Streams

On-site streams are characterized as primarily first order streams and are described in Section 2.3.2. Building activities include site preparation, which includes clearing, site grading, and installation of stormwater management systems, as described in Section 3.3.2. Building activities directly impact approximately 16,875 linear ft. (5144 linear m) of on-site streams. Direct impacts on aquatic biota result in mortality associated with the placement of fill material within aquatic habitats. However, as indicated in Section 2.3.2.2, due to the intermittent availability of surface water, most on-site streams lack unique biological communities and provide minimal habitat for aquatic biota. Additionally, as described in Section 4.2.1, the remaining approximately 1256 linear ft. (323 linear m) of streams outside of the NDA and above the confluence of each of the streams with Belews Lake are indirectly impacted by flow alteration and increased sedimentation and turbidity from building activities.

As described in Section 4.2.1.1, impacts on streams are subject to USACE regulatory authority pursuant to Sections 401 and 404 of the CWA. As appropriate, permitting applications for streams are submitted in accordance with NCDEQ and USACE guidelines and mitigative requirements will be followed. Any required mitigation by USACE would comply with 33 CFR Part 332 “Compensatory Mitigation for Losses of Aquatic Resources.”

Erosion and sedimentation occur as part of the building process. To minimize impacts from the building process on aquatic ecosystems, BMPs are used to control erosion and limit the amount of soil and sediment entering surface waters. BMPs specific to the extent and type of construction are implemented prior to building activities and maintained throughout building activities to protect aquatic ecosystems. These controls may include mulching, geotextiles, sod

stabilization, flow diversion, buffer strips, and establishment of temporary or permanent vegetation. Sediment control measures established at the edges of the NDA can include silt fences, wattles, vegetative buffer strips, and sediment basins. To minimize stream disturbance, personnel and equipment only enter riparian areas when essential to complete work. Land disturbance in riparian areas is, to the extent practicable, limited to what can be stabilized quickly. A SWPPP prescribes methods for collection, mitigation, and control of stormwater runoff from building activities in accordance with state and federal regulations and permit requirements. Stormwater retention ponds are used to decrease sedimentation, and erosion impacts on on-site streams and Belews Lake.

Potential impacts related to accidental spills of petroleum products or industrial chemicals necessary for building activities may result in adverse effects on aquatic ecosystems. As described in Section 4.8, potential impacts are mitigated by designating storage areas for fuel and lubricants on the Project site that are equipped with appropriate spill containment measures in accordance with SPCC plans.

In summary, up to approximately 16,875 linear ft. (5144 linear m) of on-site streams are directly impacted by building activities, and approximately 1256 linear ft. (323 linear m) are impacted indirectly. The impacted streams are primarily first order, relatively small streams which are mostly intermittent in nature and do not demonstrate high-quality habitat. Impacts to on-site aquatic habitats including streams and wetlands are mitigated in accordance with Sections 404 and 401 of the federal CWA and Section 404 permitted by the NCDEQ and the USACE, respectively (see Section 4.2.1). Per Section 4.3.1.2, unavoidable impacts to on-site aquatic habitat, streams and wetlands will be mitigated in accordance with 33 CFR Part 332. Therefore, impacts on aquatic ecosystems within on-site streams are minor.

4.3.2.1.2 Belews Lake

Building activities that affect the aquatic community in Belews Lake include installation of the intake and discharge structures and associated pipelines. Section 3.2.2 describes the cooling system that includes intake and discharges. As described in Section 3.3.2, building activities related to the intake structure include excavation and lakebed dredging to prepare the Project site for building activities and temporary installation of cofferdams so that work can be performed in a dry environment. Two optional locations are included for the intake structure. Discharge options include one common discharge structure for all advanced reactors or a distinct discharge structure for each advanced reactor development area (Figure 3.1-1). Piping for each discharge structure extends from the shoreline to the submerged discharge structure.

In the immediate vicinity of the intake and discharge, increases in turbidity and sediment deposition may occur during development of these structures. Dredging is expected to occur in a 20-ft. (6-m) x 20-ft. (6-m) area to a depth of 3 ft. (0.9 m) for the installation of scour protection. From the site elevation to the shoreline, a 45-degree angled borehole is required to place the piping directly into Belews Lake. Dredging may be required at the outlet of the discharge piping to install scouring protection. It is estimated that, if required, approximately 1200 ft^3 (111 [m^3]) of soil and sediment can be dredged and disposed of within either an approved on-site or off-site landfill. The dredged material would be replaced with crushed rock. As described in Section 4.2.3.1, the intake structure or structures are expected to be within a 5000-ft^2 (464.5-m^2) area on the shoreline. As described in Section 3.3.2, cofferdams may be temporarily installed to perform work in a dewatered environment as the principal BMP to contain and control sedimentation. As Section 4.2.4.1.2 describes, a sediment monitoring program monitors potential constituents of concern that may remobilize from sediment disturbed during dredging.

Program results will determine whether additional BMPs or engineering controls are required to maintain water quality and aquatic habitat.

These temporary and localized impacts affect relatively small areas of aquatic habitats within Belews Lake, and effects are minimized through the use of BMPs, such as silt curtains or wattles. Mobile aquatic species, such as fish, avoid the building area, thereby reducing mortality. By comparison, less mobile or sessile benthic organisms (e.g., macroinvertebrates, mollusks, aquatic plants) are directly impacted. Benthic aquatic biota of Belews Lake are not rare and recolonize following the completion of building activities. Localized, indirect, adverse effects on aquatic organisms from sedimentation are also possible adjacent to direct disturbance areas. Additionally, potential impacts on aquatic organisms may occur as a result of spills of fuel, lubricants, solvents, or other liquids. As described in Section 4.2.3.1, such impacts are minimized because of BMPs that prevent and control spills in accordance with the SWPPP and SPCC plan.

Disturbances of habitats related to the building of the intake structure and discharge pipeline are temporary. The size of the area impacted by building activities is relatively small in relation to the area of Belews Lake. Additionally, the loss of aquatic habitat and resultant effects on aquatic biota is minor, relative to available aquatic habitats within Belews Lake.

Potential indirect impacts on the aquatic ecosystems of Belews Lake may also result from upland building activities. Building activities on the Project site may increase erosion, resulting in downstream sedimentation that may impact adjacent areas in Belews Lake. Sedimentation may result in reductions in quality habitat and smothering of sessile species in the localized vicinity of the impact. BMPs are used during building activities to minimize sedimentation in Project site water bodies. An approximate 100-ft. (30.5-m) buffer near water bodies minimizes potential sedimentation in Belews Lake.

Overall, the impacts on aquatic habitats and associated biota within Belews Lake as a result of building activities are localized and temporary. Impacts on aquatic habitats are limited to the location of the intake and discharge structures and associated pipelines within the lake and are minimized by implementation of BMPs to prevent and control spills in accordance with the SWPPP and SPCC plan. Therefore, impacts from building activities on aquatic habitats and biota within Belews Lake are minor.

4.3.2.1.3 Dan River

The only anticipated building activity on the Dan River is within the associated off-site area that includes the wastewater pipeline located at Outfall 006. While the wastewater pipeline is located within an approximate 100-ft. (30.5-m) wide corridor, building-related disturbances within the Dan River are more localized. As described in Section 3.2.2, the discharge structure within the Dan River consists of a pipeline buried within the river bottom. In-river excavation is conducted to install the discharge pipeline. This building activity occurs after the appropriate NCDEQ (Section 401) and USACE Wilmington District (Section 404) permits for waters of the U.S. are submitted and approved based upon final design. In addition, NCDEQ and USACE guidelines and mitigative requirements will be followed. Use of BMPs and adherence to permit conditions minimize impacts on aquatic communities within the Dan River. Temporary loss of aquatic habitats occurs in the footprint of building activities. Avoidance of the building area by mobile species decreases mortality and nonlethal adverse impacts on those individuals. Any required mitigation by the USACE will comply with 33 CFR Part 332 “Compensatory Mitigation for Losses of Aquatic Resources”, which adheres to the “no net loss” principle and the associated Final

Rule. This rule emphasizes a watershed approach in the selection of mitigation locations, generally ensuring that impacts are mitigated within the same watershed area. Habitat for more immobile organisms (benthic macroinvertebrates and mollusks) is temporarily lost but reestablished over time. Coordination with NCWRC will occur regarding the results of mussel surveys and the potential for mussel relocation prior to in-stream building activities.

Potential indirect impacts on Dan River habitat may occur through erosion, sedimentation, and accidental spills or chemical releases during the building period. Implementing BMPs to prevent and control spills in accordance with the SWPPP and SPCC plans minimizes potential impacts. Therefore, impacts from building activities on the aquatic ecosystems of the Dan River are minor.

4.3.2.2 Important Aquatic Species and Habitats

4.3.2.2.1 Important Aquatic Species

Important aquatic species that may be present in the Project site and associated off-site areas are described in Section 2.3.2.3. Impacts of building activities occur primarily in on-site streams and within Belews Lake. No federally listed or state-listed freshwater mollusk species or fish species have been documented in Belews Lake or in on-site streams. Therefore, no direct impacts on federally or state-listed species are expected to occur in Belews Lake as a result of building activities.

Within the Dan River, building activities directly impact 100 ft. (30.5 m) of the shoreline along the right descending bank at the location of the wastewater pipeline. Federal- and state-listed aquatic species present in the Dan River are described in Section 2.3.2.3. As building activities within the Dan River are localized to the immediate location of the wastewater pipeline, impacts are localized and temporary. Localized, indirect, adverse effects on aquatic organisms from sedimentation are also possible adjacent to direct disturbance areas. Additionally, potential impacts on aquatic organisms may occur as a result of spills of fuel, lubricants, solvents, or other liquids. As described in Section 4.2.3.1 such impacts are minimized because of BMPs that prevent and control spills in accordance with the SWPPP and SPCC plan. Avoidance of building activities by mobile species, coupled with the use of BMPs that Section 4.3.2.1.3 describes, minimizes potential adverse impacts. As described in Section 2.3.2.3, the state-endangered Roanoke Logperch (*Percina rex*) has been observed at the location of the wastewater pipeline. Duke Energy will consult with USFWS and NCWRC regarding avoidance, minimization, and appropriate conservation measures to limit potential effects on proposed critical habitats within the Dan River.

Sedimentation may result in reductions in quality habitat and smothering of sessile species in the localized vicinity of the impact. State-endangered and federally proposed threatened freshwater mussel Green Floater (*Lasmigona subviridis*) and federally endangered James Spinymussel (*Parvaspina collina*) are present in the Dan River. As Section 2.3.2.2 describes the location of the wastewater pipeline in the Dan River provides poor habitat for the Green Floater, and no live individuals of either species were observed in the immediate vicinity of the wastewater pipeline.

Within Belews Lake, building activities are limited to installation of the intake structure and discharge structure(s). As discussed in Section 2.3, recreationally valuable fish have been documented within Belews Lake. Each of these fish species is highly mobile and expected to avoid the areas where excavation and other building activities are performed. These activities

create short-term disturbances and noise that cause fish to avoid the immediate area. However, these activities are temporary and localized, and fish can readily avoid the source of disturbance. The use of BMPs, such as turbidity curtains, minimize impacts on aquatic habitats within Belews Lake, thereby reducing impacts on recreationally important aquatic species in Belews Lake during building activities.

Invasive aquatic species are documented to be present within Belews Lake (Section 2.3). The use of BMPs during building activities prevents the spread of aquatic invasive species, decreasing their impact on native species. Protective measures, such as shoreline stabilization and buffer zones are protective of native vegetation species and can assist in decreasing the spread of invasive vegetation. Localized disturbances are also minimized through the use of BMPs that decrease the colonization of non-native species.

Direct impacts on important aquatic species are localized and temporary. Indirect impacts on the important aquatic species are minimized through the use of BMPs during building activities, and coordination with NCWRC will occur regarding the results of mussel surveys and the potential for mussel relocation prior to instream building activities. Therefore, the impacts of building activities on important aquatic species are minor.

4.3.2.2.2 Important Aquatic Habitats

Important aquatic habitats on the Project site, associated off-site areas, and in the Project Vicinity are described in Section 2.3.2.4. Proposed critical habitat for state-endangered species and federally proposed threatened freshwater mussel Green Floater is present in the Dan River. As Section 2.3.2.2 describes the location of the wastewater pipeline in the Dan River provides poor habitat for the Green Floater, and no live individuals were observed in the immediate vicinity. Localized, short-term, indirect impacts on Dan River proposed critical habitat may occur through erosion, sedimentation, and incidental spills or chemical releases during construction of the discharge outlet in the Dan River.

As described in Section 4.2.3.1, surface water impacts are regulated by NCDEQ and the USACE. Ground-disturbing activities that have the potential to affect surface water quality will be permitted by applicable federal, state, and local regulations and guided by an approved SWPPP. The SWPPP will also contain a plan for the building activities. To minimize the impacts of building activities on surface water quality, BMPs are used to control erosion and limit the amount of soil and sediment entering surface waters. These controls may include silt fencing, mulching, geotextiles, sod stabilization, flow diversion, buffer strips, and establishment of temporary or permanent vegetation as outlined in the NC Erosion and Sediment Control Planning and Design Manual (NCDNR, 2013).

To control the discharge of oil spills and limit their effects on surface water, Duke Energy will implement an SPCC plan pursuant to 40 CFR Part 112 at the Project site. An SPCC plan includes BMP actions such as proper vehicle and equipment maintenance, containment for fuel or oil storage tanks, and the maintenance of spill response equipment and materials.

Duke Energy will consult with USFWS and NCWRC regarding avoidance, minimization, and appropriate conservation measures to limit potential effects on proposed critical habitats within the Dan River. Therefore, the impacts of building activities on important aquatic habitats are minor.

4.3.2.3 Transmission Corridors

As discussed in Section 1.1.5, additional transmission lines extending outside the Project site boundary is not required. Transmission improvements within the existing site boundary include a second 230-kilovolt switchyard and other transmission line improvements. Because these improvements are located within the overall Project site NDA, analysis of impacts on habitats and species within transmission corridors are captured within the preceding sections of Section 4.3.2.

4.3.2.4 Summary of Impacts on Aquatic Ecosystems

Building activities result in direct impacts on approximately 16,875 linear ft. (5144 linear m) of streams within the NDA and 100 linear ft. (30.5 m) within the associated off-site wastewater pipeline. An additional 1256 linear ft. (323 linear m) of streams on the Project site are indirectly impacted by building activities. The impacted streams are primarily first order, relatively small streams which are mostly intermittent in nature and do not demonstrate high-quality habitat. In Belews Lake, impacts on aquatic habitats are minor based on the lack of high quality or unique habitats in the locations in which building activities are to occur in Belews Lake. Impacts on most streams or other aquatic ecosystems are mitigated in accordance with permitting requirements. Impacts within Belews Lake and the Dan River are temporary and localized to the intake and discharge structures on the Project site.

There are no direct impacts on important aquatic habitats (e.g., natural areas, managed areas, or other designated areas) from construction and preconstruction activities within the NDA. Indirect impacts on aquatic communities from sedimentation, erosion, and incidental releases as a result of building activities are minimized under permitting and SWPPP requirements and through the use of BMPs. In addition, Duke Energy will consult with USFWS and the state of NC regarding avoidance, minimization, and appropriate conservation measures to limit potential effects on proposed critical habitats within the Dan River. The overall impacts of building activities on aquatic resources are therefore SMALL.

Table 4.3-1
Habitat Types Disturbed by Building Activities on the Project Site

Habitat Types	Area within Vicinity (6-mi.) (ac.)	On-Site Area				Associated Off-site Area (Wastewater Pipeline)			
		Total Habitat (ac.)	Approximate Habitat Affected (NDA) (ac.)	Affected Habitat as a Percent (%) of Total On-Site Habitat	Affected Habitat as a Percent (%) of Total Project Vicinity Area	Total Habitat (ac.)	Approximate Habitat Affected (ac.)	Affected Habitat as a Percent (%) of Total Associated Off-Site Habitat	Affected Habitat as a Percent (%) of Total Project Vicinity Area
Open Water	4115.8	7.4	0.3	<0.1	<0.1	0.3	0.3	0.7	<0.1
Developed, Open Space	7747.0	0	0	0	0	1.8	1.8	4.4	<0.1
Developed, Low Intensity	3339.4	101.3	99.4	8.4	0.1	11.4	11.4	28.4	<0.1
Developed, Medium Intensity	743.2	0	0	0	0	0.2	0.2	0.5	<0.1
Developed, High Intensity	304.6	0	0	0	0	0	0	0	0
Barren Land	372.8	4.9	4.9	0.4	<0.1	2.0	2.0	5.0	<0.1
Deciduous Forest	36,003.3	325.7	201.2	17.0	0.2	4.3	4.3	10.6	<0.1
Evergreen Forest	9578.0	457.8	379.0	31.9	0.4	5.5	5.5	13.6	<0.1
Mixed Forest	8497.1	148.7	116.6	9.8	0.1	2.1	2.1	5.2	<0.1
Scrub Shrub	2386.8	18.4	16.4	1.4	<0.1	2.4	2.4	5.9	<0.1
Herbaceous	2916.8	120.0	85.6	7.2	0.1	10.0	10.0	25.0	<0.1
Hay/Pasture	17,088.2	0	0	0	0	0	0	0	0
Cultivated Crops	3097.7	0	0	0	0	0	0	0	0
Woody Wetlands	2178.5	1.4	1.2	0.1	<0.1	0.3	0.3	0.6	<0.1
Emergent Herbaceous Wetlands	146.1	1.3	1.3	0.1	<0.1	0	0	0	0
Total	**98,515.1**	**1186.7**	**905.8**	**76.3**	**0.9**	**40.1**	**40.1**	**100.0**	**<0.1**

Key: ac. = acre; mi. = mile; NDA = net disturbance area

Table 4.3-2
Project Site (On-Site) Wetland Impacts by Classification

Feature ID	Cowardin Wetland Type[(a)]	Total Wetland Acreage within the Project Site	Direct Impact (ac.)	Indirect Impact (ac.)
AA	PFO	0.04	-	0.04
BB	PFO	0.20	0.20	-
CCC	PEM	0.71	0.71	-
DDD	PFO	0.03	0.03	-
EE	PFO	0.12	0.12	-
EEE	PFO	0.08	0.08	-
R	PFO	0.03	-	0.03
S	PFO	0.03	0.01	0.02
T	PEM	0.06	0.06	-
U	PEM	0.16	0.14	0.02
V	PEM/PFO	0.22	0.22	-
VVVV	PEM	0.34	0.34	-
W	PFO	0.06	0.01	0.05
WL	PFO	0.14	0.08	0.06
X	PFO	0.01	-	0.01
Y	PFO	0.44	0.44	-
Z	PFO	0.01	0.01	-
Summary of Impacts by Wetland Type				
	PEM/PFO	0.22	0.22	-
	PEM	1.27	1.25	0.02
	PFO	1.19	0.98	0.21
	Total	2.68	2.45	0.23

Note:
(a) Note that PFO wetlands are considered Woody Wetlands, and PEM are considered Emergent Herbaceous Wetlands. Wetland V is partially PFO and partially PEM and is therefore a split designation. It was designated as Woody Wetlands for the purpose of land cover analysis (Section 4.3.1.1 and Table 4.3-1).

Key: ac. = acre; PEM = palustrine (freshwater) emergent; PFO = palustrine (freshwater) forested

4.4 SOCIOECONOMIC IMPACTS

This section describes the potential socioeconomic impacts associated with building activities for the Project site. As described in Section 2.4, the region of influence (ROI) for the socioeconomic analysis is defined as the areas where the building and operations workforce and their families reside, spend their income, and use their benefits thereby affecting the economic conditions of the region. Because of expected commuter patterns, the distribution of residential communities in the area, and the likely socioeconomic impacts, the ROI is composed of the four counties nearest to the site—Rockingham, Stokes, Forsyth, and Guilford counties. These counties serve as the basis for the assessment of social and economic impacts from the Project.

The discussion is divided into five sections. Section 4.4.1 describes the physical impacts of building activities on the community. Section 4.4.2 provides a description of demographic impacts. Section 4.4.3 describes the economic impacts, including the impacts on the local and state economy and tax revenues. Section 4.4.4 describes impacts on infrastructure and community services and Section 4.4.1.5 provides a summary of physical impacts.

4.4.1 PHYSICAL IMPACTS

This section provides an analysis of physical impacts due to construction of the Project that may affect people, buildings, and roads in nearby communities. People living near or working at or near construction sites may be subject to the physical impacts of building activities. These include potential impacts associated with noise and vibration, odors, dust and air pollution, transportation, and aesthetics. The magnitude of these potential impacts is typically related to the specific building activities that occur at a given site, the nature and effectiveness of implemented environmental controls, and the proximity of the site to populated areas. This section addresses how these potential impacts may affect people, buildings, transportation routes, and the aesthetics of the area surrounding the Project site. Duke Energy is committed to meeting applicable environmental requirements and following construction BMPs to minimize physical impacts.

4.4.1.1 Noise and Vibration

Building activities at the Project site have the potential to result in elevated noise and vibrations beyond ambient levels. The potential impacts of noise and vibration from building activities on sensitive receptors including residences and surrounding recreational facilities and parklands are provided in Section 4.8.2. Therefore, this section assesses the physical impacts to buildings and structures associated with vibration from building activities.

Building activities, including the operation of heavy machinery, construction vehicles, and blasting, can create ground vibration. Ground vibration and ground noise can disturb people who live or work nearby. If the vibration amplitudes are high enough, physical, and cosmetic damage to structures may occur, as well as interference with the functioning of sensitive machinery. The length of time and strength of vibration varies with the equipment used. For example, the vibration from blasting has a high amplitude and a short duration, whereas vibration from grading or highway traffic have a lower amplitude but longer in duration, like a continuous gentle rumble (Caltrans, 2020). Typical levels of ground-borne vibration and the associated human and structural response are shown on Figure 4.4-1. As noted in Section 2.8.2, the nearest noise-sensitive receptor is located approximately 44 ft. (13.4 m) south of the

Project site at its closest point.

According to the Federal Transit Administration, the threshold of human perception to vibration is approximately 65 vibration decibels (VdB) at 50 feet (ft.) (15 m) from the source, and annoyance begins at a vibration level of 70 VdB. Cosmetic damage to structures, also at 50 ft. (15 m) from the source, can occur at 100 VdB for one-time activities such as blasting operations (FTA, 2018). As noted in Section 3.3.2, rock excavation activities within the power block areas (shown on Figure 3.3-1) most likely require controlled rock blasting. However, there are no residences or privately owned structures located within 50 ft. (15 m) of the power block areas that may be subject to vibration-related effects from blasting. For example, as stated in Section 2.8.2, the residence nearest to any power block area that may be subject to blasting is west of Craig Road near the southern gate entrance to BCSS, approximately 1456 ft. (444 m) from the southern power block area. Therefore, blasting results in minor vibration-related impacts on nearby residences.

Typical sources of vibration include machinery and vehicles needed to support clearing and grubbing, mass earthwork activities, substructure and equipment erection work, and marine construction work. As illustrated on Figure 4.4-1, bulldozers and other heavy-tracked construction equipment may generate vibration levels of approximately 95 VdB at locations 50 ft. (15 m) from the source. Heavy equipment use near any one specific location along the southern Project site boundary is relatively short-term and intermittent (not continuous). As vibration levels of 95 VdB are below the threshold for risk of minor cosmetic damage to fragile buildings (Figure 4.4-1), the vibratory effects of heavy construction equipment (other than blasting) near the closest residence at the southern Project site boundary are also minor.

Based on the above analysis, vibration effects to off-site residences and structures from building-related blasting and equipment use are minor.

4.4.1.2 Odors, Dust, and Air Pollution

Building activities generate temporary air emissions of both gaseous and particulate pollutants. Potential sources of emissions during building include emissions from the use of construction vehicles and engine-driven equipment (e.g., generators and compressors), emissions from motor vehicles used for material and equipment deliveries to the Project site, and from the daily commute of workers. Section 4.7.1.2 provides the analysis of building-phase impacts from heavy equipment emissions. Fugitive dust and fine particulate matter are generated during earthmoving activities, concrete batch plant operation, and movement of vehicular traffic over recently disturbed or cleared areas or unpaved roads. Painting, coating, and similar operations produce emissions of volatile organic compounds. However, such emissions are localized and do not affect off-site receptors. Localized odors from such materials dissipate and are not detectable by off-site receptors.

Because air emissions from on-site building activities are generally released from near ground-level sources, impacts are potentially greatest at the nearest off-site receptors. As stated in Section 4.7.1.2, the nearest sensitive receptors include recreators on Belews Lake, residences just south of the Project site boundary, and residences to the east of the North Plant Complex, across Belews Lake. To minimize temporary air and dust emissions, the following measures may be implemented during building activities at the Project site, as appropriate:

- Scheduling building activities to minimize vehicle idling time.

- Phasing activities and equipment use.
- Ensuring heavy equipment is in good condition, is properly maintained, and complies with applicable regulations.
- Ensuring all machinery is maintained and operated in accordance with the manufacturer's specifications.
- Maintaining low vehicle speeds on dirt roads and exposed areas to minimize dust generation.
- Implementing dust control measures by watering roadways and exposed areas.
- Minimizing the extent of soil storage piles that may be the source of fugitive dust.

Additionally, building activities are subject to air permits under state and federal laws that address the impact of air emissions on sensitive receptors. These permits are further discussed in Section 4.7.

Physical impacts of air emissions from building activities are minor because emissions are controlled using minimization measures and by maintaining established regulatory limits.

4.4.1.3 Transportation

This section discusses the physical impacts on off-site roadways resulting from increased traffic during building activities. The primary access roads to the Project site are identified in Table 2.4-13 and Figure 2.4-4. Traffic-related impacts are discussed in Section 4.4.4.1.

Project-related traffic, including project deliveries and construction, refueling, and maintenance workers, is expected to access the Project site via Craig Road during the building and operation phases. Consequently, the increased Project-related traffic accelerates the deterioration of Craig Road relative to other roads within the surrounding transportation network that provide access to Craig Road. Roadway repairs and improvements on Craig Road and other roadways in the Project Vicinity inadvertently affected by Project-related vehicles, may be necessary to reduce safety risks and restore pavement conditions. Any damage to public roads, markings, or signs caused by building activities is repaired to preexisting conditions or better in accordance with state and local requirements. Therefore, physical impacts from building activities on the transportation network in the Project Vicinity are minor.

4.4.1.4 Aesthetics

Visual and aesthetic effects result from the introduction of structures and facilities that are not consistent with the existing landscape or visual resources. The visual resources immediately surrounding the Project site includes Belews Lake, forested lands, the BCSS, and the rural/low-density residential lands to the south and east (Section 2.4.2.6). The BCSS is a large-scale industrial site with structures that are visible within the Project Vicinity. Visibility of existing BCSS structures from off-site receptors varies with terrain, the presence of existing forest lands and distance from BCSS. Potential receptors that may be affected by changes in the viewshed include recreators on Belews Lake, users of parklands (Belews Lake Park), residents along the southern Project site boundary and along the shoreline of Belews Lake opposite the Project site boundary, and motorists along adjacent roadways.

Aesthetic impacts of building activities result when landscapes or viewsheds are altered. Such impacts vary with receptor location, proximity, or presence of the BCSS within the viewshed, buffer characteristics, and permanence of effect. For example, in areas in which the BCSS is currently visible, the presence of the BCSS facility minimizes the aesthetic impacts associated with building activities, and the development of new structures represents a visual feature consistent with the existing developed viewshed of the BCSS facility. By comparison, modification of existing landscapes that lack the presence of developed structures or view of the existing BCSS industrial setting, is subject to potentially greater visual intrusions and aesthetic effects.

Building activities that may affect visual resources and overall aesthetics include general tree clearing, land surface grading, the use of heavy lift cranes (Section 3.3.3) and the building of vertical structures. Project site building activities are likely most visible to motorists along Pine Hall Road and Craig Road, surrounding residents, and recreators on Belews Lake. Building activities, such as the transport of large materials or components to the Project site, are also visible to residents and recreators within the Project Vicinity. Lighting may be used during building at night and for security purposes, which is visible from receptors in the surrounding area.

The aesthetic effects of building activities on residents near the southern boundary, specifically those along Craig Road and in neighborhoods along Windswept Drive and Crossing Ridge Drive, are noticeable and long-term given proximity to the NDA. By comparison, receptors on Belews Lake and the developed areas along the shoreline opposite the Project site experience aesthetic effects that are variable, based on distance from the Project site, visibility of BCSS, the condition and characteristics of the intervening vegetated buffer, the presence of other land masses and terrain. For receptors in close proximity to the Project site, aesthetic effects are considered to be noticeable, whereas those at greater distances effects are minor. Comparatively, motorists on surrounding roadways, including those on Craig Road and Pine Hall Road, may at times also have an unobstructed view of the Project site. For such receptors aesthetic effects are intermittent based upon the variability of terrain, visibility of BCSS, and the short duration of their exposure to altered viewsheds.

As noted in Section 4.4.1.3, all Project-related traffic, including project deliveries and construction, refueling, and maintenance workers, is expected to access the Project site via Craig Road during the building and operation phases. As a result, the increase in vehicular traffic due to building activities causes aesthetic impacts for sensitive receptors along this road. Traffic from the construction workforce primarily occurs during shift start and shift end. Increased traffic from on-site trucking of building materials is intermittent through normal working hours.

Potential effects of building activities are mitigated by the presence of natural existing buffers. A vegetated buffer along the edge of the Project site (Figure 3.3-1) further screens sensitive receptors from views of the Project site. This buffer zone is predominantly forested and is approximately 100 ft. (30.5 m) wide. As described in Section 2.1, forested land dominates land cover in the Project Vicinity (Table 2.1-2). The surrounding rolling hills and steep, forested slopes naturally screen the visibility of the Project site. Additionally, light shielding will be implemented to the extent practicable.

Therefore, based on the variable factors that may contribute to aesthetic effects and the existence of buffers and other mitigative measures during building activities, the overall aesthetic impacts are therefore variable and noticeable, but not destabilizing. Aesthetic impacts

to recreation are further discussed in Section 4.4.4.2.

4.4.1.5 Summary of Physical Impacts

Physical impacts of building-related noise and vibration on off-site structures is minimal because of the distance separating the nearest structure (residence) from the areas in which vibration-related activities occur. The nearest residence may be disrupted from the use of heavy machinery and vehicles; however, the use of this mobile equipment is intermittent. Emissions from building-related activities are controlled using minimization measures and by maintaining established regulatory limits; therefore, impacts associated with air emissions are minor. Any damage to public roads, markings, or signs caused by building activities are repaired to preexisting conditions or better, in accordance with state and local requirements. Therefore, physical impacts to transportation infrastructure are minor. Impacts to aesthetics from building activities are noticeable but not destabilizing because building activities may impact viewsheds for nearby residents and recreators of Belews Lake through the introduction of new structures, use of equipment, and increased traffic in the Project Vicinity. Therefore, physical impacts of building activities are SMALL for most factors, but MODERATE for aesthetics.

4.4.2 DEMOGRAPHIC IMPACTS

The following evaluation assesses potential impacts associated with building-related activities and the size of the construction workforce on the ROI population. The evaluation is focused on impacts within the ROI identified in Section 2.4 as the area where the workforce and their families reside, spend their income, and use their benefits thereby affecting the economic conditions of the region. The ROI for the Project is defined as encompassing Forsyth, Guilford, Rockingham, and Stokes counties. The analysis is based on the maximum number of workers required for the Project during the building phase. The analysis also applies the distribution of the existing workforce of BCSS as a predictive indicator of the distribution of the workforce and their families during the building phase. Actual workforce distribution and associated impacts on demography is variable based on the selected places of residency (temporary or permanent) of the workforce employees during the building phase.

4.4.2.1 Workforce Distribution

As described in Section 3.2, Duke Energy is considering various reactor technologies and has developed a PPE that encompasses several advanced reactor parameters that bound the attributes used for evaluating the environmental impacts of the Project (see Section 3.1.2). The most conservative scenario includes building up to six advanced reactors to be brought online sequentially. Assuming up to two units are constructed at a time, there is a peak employment period during which the last two units are being constructed while four units operate. Thus, based on the conservative scenario developed in the PPE, peak employment occurs when there is an overlap of both building and operations and consists of the maximum construction workforce plus the operations workforce for four advanced reactor units. The analysis of impacts to population is based on the peak employment that is determined for the building phase and operational phase as follows:

- Building Phase workforce for two advanced reactor units: 2096 workers.
- Operations Phase workforce for four advanced reactor units: 580 workers.

As a result, the total peak workforce (building plus operations) is 2676 workers.

Refueling and major maintenance is also required for approximately 22 to 32 days every maintenance cycle. Refueling and major maintenance of the operating units may also occur while the final units are under construction, contributing to the local employment. However, because refueling and major maintenance activities are infrequent and short-term, workers are assumed to relocate to the area temporarily without their families and use temporary housing such as hotels, motels, or short-term rentals. Therefore, these employees do not notably affect local demographics or community services and are not included in the peak employment calculation.

The direct impact to population during the building phase is contingent upon how many of the 2676 employees are sourced from within the ROI. For example, if all construction and operation workers reside in the ROI, there is no change in the ROI's total population resulting from the Project. Conversely, should workers relocate to the ROI from areas outside of Forsyth, Guilford, Rockingham, or Stokes counties, there are potential demographic impacts to the ROI in conjunction with the in-migration of the supporting workforce and their families.

4.4.2.2 Impacts on Demography

A construction workforce consists of two components: field craft labor and field non-manual labor. Field craft labor is the largest component of the workforce (typically 70 percent in conventional nuclear plant construction) and comprises civil, electrical, mechanical, piping, and instrumentation personnel. Field non-manual staff makes up the balance of the workforce (approximately 30 percent) and comprises field management, field supervision, field engineers, quality assurance/quality control, safety, and administrative staff. Approximately 70 percent, or 1467 of the 2096 construction workers needed during peak employment, are field craft laborers. Construction-sector occupational employment data for the metropolitan and nonmetropolitan areas that include the ROI counties, Greensboro-High Point and Winston-Salem, are published annually by the U.S. Bureau of Labor Statistics (BLS) (BLS, 2022a, 2022b). Based on the BLS data, approximately 50 percent of the field craft labor positions could be filled from the ROI's available labor force. Thus, approximately 50 percent, or an estimated 734 field craft laborers, come from outside the ROI to support building activities. The remaining 30 percent of the 2096 workers, or 629 workers, are field non-manual laborers who are assumed to be sourced from outside the ROI due to the specialized nature of these administrative and supervisory roles. Additionally, due to the total duration of consecutive building activities (Table 3.3-1), it is assumed that in-migrating construction workers seek long-term housing in the ROI and bring their families.

This analysis assumes that peak employment occurs during the building phase in which four units are operating while two additional units remain in the building phase. Operation of four units requires a workforce of 580 employees. Due to the specialized nature of many of the operational positions, it is conservatively assumed that all operations employees are sourced from outside the ROI. Based on this analysis, a total of 1943 workers (734 field craft laborers, 629 non-manual laborers, and 580 occupational workers) are sourced from outside the ROI and in-migrate to support the Project.

The residential distribution of the in-migrating workforce is assumed to be the same as the residential distribution of the current workforce for the BCSS. Twenty-five percent of the existing BCSS workforce commutes to the facility from outside the ROI. Consistent with these commuting patterns, 25 percent, or 486 of the 1943 in-migrating workforce reside in counties outside the ROI and commute to the Project site. Accordingly, the remaining 1457 in-migrating workers would relocate to the ROI and are assumed to bring a family. The average household

size in NC is 2.48 (USCB, 2022a). Therefore, an in-migrating workforce of 1457 and their families increases the ROI's population by approximately 3614 people. The distribution of this new population within the ROI is estimated based on the residential distribution of the BCSS workforce and is shown in Table 4.4-1. The estimated population increases have the greatest impact in Rockingham and Stokes counties, where new residents increase the population by approximately 1.5 percent and 2.6 percent, respectively (based on 2030 projections). Forsyth and Guilford counties each experience population increases of approximately 0.1 percent, while the ROI experiences a population increase of approximately 0.3 percent.

4.4.2.3 Summary of Demographic Impacts

The population increases associated with the in-migration of workers and their families account for less than 1 percent of the ROI's projected total population in 2030 (Table 4.4-1). Therefore, impacts to demographics associated with building activities are SMALL.

4.4.3 ECONOMIC IMPACTS TO THE COMMUNITY

This section describes the projected economic and tax revenue impacts of constructing the Project on the ROI. As described in Section 3.2, Duke Energy is considering various reactor technologies and has developed a PPE to evaluate the potential for building impacts from multiple advanced reactors. Economic impacts of large capital projects within a project setting are generally considered to be positive (beneficial) and are based on the amount of capital costs expended. Furthermore, because economic impacts are generally positive, the bounding economic condition is the configuration or option that results in the lower economic benefit. For this project, multiple advanced reactors are considered for development over three Plant Complexes. Therefore, the development of a single Plant Complex (two reactor units) represents a conservative economic scenario. As such, a single Plant Complex deployment is the bounding condition for this analysis as this would result in lower capital costs and a lower economic benefit as compared to building multiple Plant Complexes. The deployment of additional units would have a substantially greater impact on the ROI and Project Region.

Economic impacts of building activities are expressed both within the ROI and the Project Region. Counties within the ROI are the most affected because they are near the building activities and receive the largest influx of in-migrating workers. Other counties in the Project Region also experience economic impacts, but these impacts are widespread and dispersed across the larger geographic area.

4.4.3.1 Economy

4.4.3.1.1 Economic Input-Output Model

Economic effects from building are linked to both direct and indirect expenditures. Direct expenditures include costs for materials, equipment, and labor. Indirect effects arise from the spending and purchases of goods and services by the workforce. Through the multiplier effect, each dollar spent by workers and businesses circulates through the economy, creating more jobs, income, and economic activity in the ROI and Project Region. Regional input-output multipliers are economic tools that provide a way to estimate the total impact that an initial change in economic activity has on an economy.

The economic multiplier model used in this analysis is the Regional Input-Output Modeling System (RIMS) II developed by the U.S. Department of Commerce, Bureau of Economic

Analysis (BEA), Economics and Statistics Division. The model calculates economic multipliers for various industries and earnings within a specific region (BEA, 2024). The BEA RIMS II multipliers obtained for the ROI are used to evaluate impacts on employment and economic output based on total employment and total expenditure for a single Plant Complex.

4.4.3.1.2 Economic Model Predictions

The RIMS II direct effect employment multiplier for construction jobs is 1.69. Thus, for every newly created construction job, an estimated additional 0.69 jobs are created in the ROI. The change in indirect employment in the ROI during the building phase is estimated by applying the RIMS II direct effect employment multiplier to the total workforce during the building phase. Based on the workforce needed for a single Plant Complex (2096 workers), building the Project results in the creation of approximately 1437 indirect jobs within the ROI. Most indirect jobs are service-related, and those jobs are filled by the existing workforce in the ROI. Some of these indirect jobs could benefit unemployed or underemployed workers in the ROI. Overall, based on BLS labor force data, the combined approximately 3533 jobs (direct and indirect employment) represent 0.7 percent of the total labor force in the ROI.

The RIMS II multipliers are also used to estimate the economic impact resulting from building expenditures. The RIMS II multiplier for construction industry output is 1.83. Thus, for every dollar spent on building, an estimated $0.83 is added to the economy of the ROI. Total building expenditures for the single Plant Complex are estimated to be approximately $5 billion. Applying the RIMS II multiplier for construction industry output to building expenditures results in a total economic output of approximately $9.3 billion across local industries. This includes goods and services produced in the ROI during the building phase and indirect effects related to worker spending. However, as nuclear power plants are highly specialized in nature, certain building materials and equipment may be obtained from outside the Project Region. For such materials, there would be no economic benefit from the purchase of those goods in the ROI or Project Region. However, building of the Project requires generic construction materials and supplies (concrete, piping, and electrical components) which can be procured locally, if available. The purchase of those materials and supplies has a beneficial economic effect on the ROI. Because details regarding the breakdown of geographic origin of purchased materials and equipment are not available, this analysis assumes that all materials are obtained within the ROI. Therefore, the estimated economic output is higher than is likely to be realized in the ROI and Project Region.

In addition to expenditures by the building workforce, the in-migrating families of the workforce are also expected to spend payroll on goods and services within the ROI. While this spending cannot be precisely quantified, the expenditures associated with the increase of the additional in-migrating population (workers and their families) into the ROI during the building phase result in a beneficial impact on the local economy.

Building activities on the Project site introduce billions of dollars into the economy and indirectly create jobs that help reduce unemployment and provide opportunities for service-related industries. The economic impacts during building are conservatively analyzed based on a single Plant Complex (two advanced reactor units). However, Duke Energy is evaluating reactor technologies that could lead to deploying multiple reactor units across three Plant Complexes, which would result in substantially greater economic effects within the ROI and Project Region. While specialized nuclear materials are likely to be sourced from outside the Project Region, portions of the generic building material expenditures can be obtained in the ROI. These expenditures are primarily realized within the ROI, making the economic impact of construction

beneficial and noticeable.

4.4.3.2 Taxes

Building-related activities, purchases, and labor force expenditures generate tax revenues from individual income taxes, franchise taxes, tax on electricity, sales and use taxes, and property taxes.

4.4.3.2.1 Individual Income Tax

As noted in Section 2.4.2.3, the individual income tax assessed in NC is 4.75 percent for tax year 2023 and is gradually lowering to 3.99 percent by tax year 2026.

As shown on Table 2.4-9, in 2022, more than 500,000 individuals were employed in the ROI; therefore, the addition of the in-migrating workforce (for one Plant Complex) of 1363 is a minor increase in the total employed population in the ROI. According to BLS data, the mean salary of a construction laborer in NC is $40,830 per year (BLS, 2023a). Based on the 2026 tax rate, the additional in-migrating workers for one Plant Complex, at an estimated salary of $40,830 per year according to Section 4.4.3.2.4, are anticipated to generate approximately $2.2 million in income tax revenues for the state of NC (BLS, 2023a). This estimated increase in income tax revenue represents 0.01 percent of total income tax revenue of the state of NC in fiscal year 2023. The in-migrating workforce subsequently generates a minor increase in income tax revenue compared to the revenue from the existing employed population in the ROI. Therefore, there is a minor but beneficial increase in individual income tax revenue within the state of NC and the ROI associated with indirect jobs as a result of building activities.

4.4.3.2.2 Corporate Income Tax and Franchise Tax

For tax year 2023, the state of NC imposed a 2.5 percent income tax on corporations; however, by 2030, this tax will be reduced to zero percent (Section 2.4.2.3). During the building phase, no corporate income taxes are assessed as no revenue is generated from the Project site during this time.

As stated in Section 4.4.3, building activities have a multiplier effect on spending within the ROI that may result in new business developments. Therefore, there may be a minor increase in franchise taxes due to the indirect spending during the building phase. Additionally, existing businesses are likely to experience a minor increase in revenue from increased spending within the ROI, resulting in increased franchise taxes. Because Duke Energy does not pay franchise tax during building activities, the increase in franchise taxes paid by other businesses in the ROI are limited and minor.

4.4.3.2.3 Sale of Electricity

The state of NC imposes a 7 percent tax from the sale of electricity (Section 2.4.2.3). Building activities at the Project site are not anticipated to change the current state of Duke Energy's power assets, and it is anticipated that the sale of electricity remains unchanged. Therefore, no impacts to the sale of electricity tax revenues are anticipated.

4.4.3.2.4 Sales and Use Taxes

Taxable goods and services purchased in NC are subject to the state sales tax at a rate of 4.25

percent and an additional 2.0 to 2.75 percent from local taxing jurisdictions (Section 2.4.2.3). According to BLS data, the mean salary of a construction laborer in NC is $40,830 per year (BLS, 2023a). These workers are likely to spend most of their salaries on housing, goods, and services. Expenditures by the in-migrating workers and their families on items subject to sales and use taxes leads to increases in sales tax revenues in the ROI. Due to the small size of the in-migrating workforce for the deployment of one Plant Complex (two reactor units), the additional expenditures resulting from this population increase have a beneficial but minor impact on sales and use tax revenues in the ROI.

Sales tax revenues may also result from sales taxes collected from the purchase of building-related materials, equipment, and services. The distribution of these taxes depends on businesses located throughout the Project Region. However, estimates of regional expenditures expected during the duration of the building phase are unavailable.

4.4.3.2.5 Property Tax

As described in Section 2.4.2.3, Duke Energy paid Stokes County $6.8 million in property taxes in 2024. At this time, Duke Energy has not entered into or negotiated any special property tax abatements or agreements with Stokes County (Section 2.4.2.3) for the building phase.

If in-migrating workers purchase existing homes in the ROI, as opposed to renting, they continue to pay property taxes on those homes. Because there is sufficient housing available in the ROI (Section 4.4.4.3), it is not anticipated that in-migrating workers would build new housing. Therefore, there is no discernible change in property tax revenues in the ROI.

4.4.3.3 Summary of Economic Impacts

Building activities associated with the Project introduce millions of dollars into the economy and creates both direct and indirect jobs. These positive economic impacts are primarily realized within the ROI. Minor tax revenue impacts on local jurisdictions are accrued through increases in individual income tax, sale of electricity tax, and sales and use taxes. Therefore, the economic impacts are MODERATE and beneficial.

4.4.4 COMMUNITY INFRASTRUCTURE IMPACTS

This section provides the estimated impacts on infrastructure and community services, including transportation, recreation, housing, and public services. As described in Section 4.4.2, this analysis applies the distribution of the existing workforce of BCSS as a predictive indicator of the distribution of the workforce and their families during building activities. Actual workforce distribution and associated impacts on community infrastructure are variable based on the selected places of residency (temporary or permanent) of the workforce employees during the building period.

4.4.4.1 Transportation

This section evaluates the impacts on infrastructure from traffic generated by building activities. Section 4.8.3 discusses accident-related consequences of additional traffic from building activities.

4.4.4.1.1 Traffic

Impacts of the construction workforce on traffic are generally dependent on five factors:

- Number of workers during the building phase.
- Distribution of the workforce within the ROI and related commuting patterns.
- Number of truck deliveries to the Project site.
- Projected population growth rate in the ROI.
- Capacity of the potentially affected roadways.

As stated in Section 4.4.2, there is a peak employment period during which two advanced reactor units are being constructed while four advanced reactor units are operating. The assessment of impacts on traffic is based on this bounding condition. The potential traffic effects of the commuting workforce are determined by predicted commuting patterns which take into account the distribution of the workforce and roadway type. Traffic effects during other phases of the building process are reduced from those of the bounding condition.

The building-phase workforce (2096 workers) (Section 4.4.2) work during the daytime, arriving at 7:00 am and departing at 5:00 pm. During the peak employment period, the total number of workers accessing the Project site also includes an operational workforce of 450. These operational workers are divided into two 12-hour shifts. The day shift begins between 5:00 am and 7:00 am and ends between 5:00 pm and 7:00 pm. During the morning shift 400 operations workers enter for the day shift when 50 operations workers leave after the night shift. Between 5:00 pm and 7:00 pm, 400 workers leave after the day shift and 50 workers arrive for the night shift. As noted in Section 4.4.1.3, Project-related traffic is assumed to access the Project site via Craig Road (Figure 4.4-2).

A common practice for construction workers is to carpool or use employer-provided shared transportation to the construction site. However, this traffic analysis conservatively assumes one worker per vehicle because shared transportation information cannot be determined. This equates to a total of 2546 vehicles that enter and leave the construction site at the same times during peak employment. Additionally, it is conservatively assumed that 90 construction truck deliveries are made daily to the Project site. To reduce congestion, deliveries are not scheduled to arrive or depart at the same time as the construction workforce. Delivery traffic is evenly distributed throughout the work hours of the day and avoids peak traffic hours.

As shown on Table 2.4-3, the population in the ROI is projected to grow at a rate of approximately 0.7 percent annually throughout the building phase. Therefore, any increase in traffic due to population growth is minimal and is not further considered in this analysis.

As described in Section 2.4.2.2.3, the average annual daily traffic (AADT) is the average daily volume of motorized vehicle traffic on a highway or roadway segment. The estimated traffic generated by building activities is based on the assumptions listed above regarding peak employment and on the NC Department of Transportation AADT values shown in Table 2.4-13. Traffic operations for existing conditions and conditions during the building phase were analyzed using the Highway Capacity Software (HCS), which uses methodology from the Highway Capacity Manual Seventh Edition (NASEM, 2022).

Level of service (LOS) is a qualitative measure of operational conditions at a roadway segment or intersection. LOS is given a letter designation ranging from A to F (free flow to heavily congested). As described in Section 2.4.2.2.3, the primary roadways in the Project Vicinity currently operate at an acceptable LOS C or better except for U.S. 158 (east of NC Highway 68) and U.S.158 (between Belews Creek Road and NC Highway 68) which are operating at a LOS D. Roadways described in Section 2.4.2.2.3 and evaluated in this section are the roadways in the Project Vicinity that workforce commuters and other Project-related traffic utilize to access the Project site.

Peak traffic on primary roadways to the Project site in the evening, or "PM peak hour", was analyzed for impacts to LOS during peak employment as PM peak traffic is generally heavier than morning traffic, or "AM peak hour" traffic. This is due to additional activities like school pickups, errands, extracurricular activities, and social events that may occur during the afternoon. LOS during the building phase is shown on Figure 4.4-2 and presented in Table 4.4-2.

LOS along Pine Hall Road (south of NC Highway 65), Belews Creek Road (west of NC Highway 65), Fisherman Road, Hawkins Farm Road, Martin Luther King Jr. Road, and U.S. 220 (south of U.S. 158) does not change during the building phase. The LOS on U.S. 311 (south of NC Highway 65) changes from an A to B during the building phase. LOS on U.S. 311 (north of NC Highway 65), and Pine Hall Road (north of NC Highway 65) changes from A to C during the building phase. Under LOS C conditions, speeds are noticeably reduced on two-way highways. The LOS on U.S. 158 (south of Belews Creek Road), U.S. 220 (north of NC Highway 68), NC Highway 68 (south of U.S. 158), and NC Highway 65 (between Pine Hall North and U.S. 311) changes from C and B to D during the building phase. Under LOS D conditions, vehicles become more closely spaced, with volumes near capacity, on two-way highways.

In comparison, congestion and unstable operating conditions during the building phase cause LOS on other roadways to degrade to a failing LOS (LOS E/F). For example, the LOS on NC Highway 68 (north of U.S. 158), U.S. 158 (between Belews Creek Road and NC Highway 68), and U.S. 158 (east of NC Highway 68) changes from C/D to E/F; whereas the LOS on the remaining roads analyzed (NC Highway 65 [between Belews Creek Road and Pine Hall South], Belews Creek Road [between Craig Road, and NC Highway 65], Belews Creek Road [east of Craig Road], Craig Road, and NC Highway 65 [between Pine Hall South and Pine Hall North]) all experience a degradation of LOS from A/B to E/F during peak employment.

Because of the focused traffic at the intersections providing primary access to the Project site, four intersection locations were also reviewed to further analyze traffic impacts during the building phase. These intersections include Belews Creek Road at Craig Road, NC Highway 65 at Belews Creek Road (to the south), NC Highway 65 at Pine Hall Road (to the south), and NC Highway 65 at Pine Hall Road (to the north). Table 4.4-3 summarizes the results of the analysis for these unsignalized intersections during both existing conditions and during the building phase in the PM peak hour. Increased traffic at these intersections results in a decrease in LOS from LOS C or D to LOS F for at least one of the traffic movements at each intersection. This results in unstable traffic conditions characterized by low speeds, volumes exceeding capacity, and long delays with stop-and-go traffic.

The overall impacts on traffic due to the construction workforce are minor within the broader transportation network. However, impacts on local roads and intersections providing primary access to the Project site are potentially destabilizing (LOS changes from A to C, LOS A/B to

E/F, and LOS C/D to F). Traffic impacts along Craig Road are the most evident as it is expected that Project-related traffic accesses the Project site from the south via Craig Road. The most noticeable traffic impacts occur during the beginning and end of the shift and occur for less than two hours a day. These impacts are most evident to local residents closest to the Project site that access Craig Road. Impacts to roadway capacity are minor during other times of the day.

Duke Energy has identified several planned traffic management measures to minimize congestion and unstable traffic conditions including the following:

- Posting signs near construction entrances and exits to make the public aware of areas with high construction traffic.
- Development of a traffic control mitigation plan.
- Using staggered shift start and end times.
- Using carpooling.
- Enforcing the scheduling of deliveries to avoid peak traffic periods.

With the incorporation of traffic management measures during daily short durations of increased traffic in the immediate area near the Project site, impacts to traffic are noticeable, but not destabilizing.

4.4.4.1.2 Railroads

Some items such as heavy lift crane modules and large components are delivered by rail. Deliveries made by rail enter the Project site via an existing Norfolk Southern spur that branches off to connect to the BCSS as shown on Figure 2.4-4. The use of this rail spur does not impact other transportation systems used by the local communities, and the impact on railroads are minor.

4.4.4.1.3 Waterways

As described in Section 2.4.2.2.7, the waterways located within the Project Vicinity are not used for transportation-related purposes. Therefore, there are no building-related activities on the waterways that affect the transportation system.

4.4.4.1.4 Public Transportation

Public transportation services in the ROI are identified in Section 2.4.2.2.9; however, there are no transit services that provide direct access to the Project site. Therefore, there is no impact on public transportation.

4.4.4.2 Recreation

Recreational resources within the Project Vicinity are potentially affected by building activities at the Project site. Impacts may include (1) disruption of recreational experience from building activities including the cooling water intake and discharge structures within Belews Lake and the Dan River, (2) impaired recreational experience associated with the views of the building activities, (3) increased user demand associated with the projected increase in population as a

result of the in-migrating workforce and their families, and (4) possible access delays associated with increased traffic on local roadways.

Building activities change the recreational experience of hunters and recreators on Belews Lake. While specific restrictions on recreational activities have not been determined at this stage, it is expected that hunting on the Project site will be discontinued. Additionally, fishing tournaments that occur on Belews Lake and require the use of docks, landings, and launch ramps that are owned by Duke Energy may be affected during building activities.

As stated in Section 3.3.4, building the cooling water intake and discharge structures requires working within Belews Lake and the Dan River. This work may impact recreators; however, these activities only occur within a small portion of the lake and river during the overall building phase. Once construction of the cooling water intake and discharge structures is complete, it will no longer hinder recreators. However, if building activities associated with installation of intake or discharge structures impede the use of Belews Lake or associated facilities, including marinas, Duke Energy will coordinate with the NCWRC, as appropriate. Recreators on the Dan River as described in Section 2.4.2.6.2 may also be affected by building activities. For example, the discharge of the wastewater to the Dan River (see Section 3.2.3) may either use the existing discharge structure or be released from a new structure. Building a new structure may temporarily restrict recreational use in proximity to the structure installation area. Such effects, however, are temporary and minor.

Recreation users of Belews Lake may experience visual intrusions during building activities due to the presence of large equipment and construction lighting. Although these building activities alter the undeveloped nature of the Project site, the BCSS and associated infrastructure currently exist within the viewshed of recreators on Belews Lake. However, Duke Energy will maintain the existing natural buffer and implement light shielding, to the extent practicable, to screen views of the Project site. See Section 4.8.2 for noise-related impacts during building on recreators. As stated in Section 2.4.2.6.2, Belews Lake Park is currently in development south of the Project site. Phase one of the multiple construction phase schedule has been completed, and the park is open to visitors. Visitors may experience delays accessing the park's main entrance because of increased traffic on Craig Road due to building activities. These access delays are likely to occur primarily during the start and end of construction shifts.

Recreational areas within the Project Vicinity are also impacted by the increase in population associated with the in-migrating workers and their families. Workers who relocate to the ROI are expected to use recreational areas and outdoor activities at the same rates as the existing permanent population of the ROI. As noted in Section 4.4.2, the in-migrating workforce and their families increase population in the ROI by approximately 0.3 percent. Although the in-migrating population increases usage of recreational areas within the Project Vicinity, the increase is small compared to the existing population and is not anticipated to impede or disrupt current usage of recreational areas.

During the building phase, recreators may experience increased noise levels and aesthetic impacts from building at the Project site. The increased noise levels and aesthetic impacts may be noticeable to individual recreators on Belews Lake in areas adjacent to and north of the Project site; however, it does not reflect an impact that is more broadly evident within the larger reaches of Belews Lake and does not destabilize the overall recreational experience. Building activities are most noticeable to recreators on the lake while the intake and discharge structures are being built. Due to the small increase in in-migrating population, use of recreational facilities in the ROI is anticipated to be similar to existing conditions. Users of the Belews Lake Park may

experience delays associated with workforce and construction traffic on Craig Road; however, effects are more pronounced during work shift changes. Because recreators of Belews Lake are mobile, and the construction time frame is limited, impacts to recreation from building activities are minor.

Overall effects of building activities on recreational activities and resources, including those related to potentially impaired recreational experience associated with the views of the building activities, increased user demand associated with the projected increase in population as a result of the in-migrating workforce and their families, and possible access delays associated with increased traffic on local roadways are minor and short-term.

4.4.4.3 Housing

Section 2.4.2.7 describes the existing housing stock in the ROI. The number of vacant housing units in the ROI in 2022 is shown in Table 2.4-18. As described in Section 4.4.2.2, during peak employment, 1457 workers are housed within the ROI.

The in-migrating workforce demand on current available vacant housing, which is defined as housing units listed as for rent and for sale, is shown on Table 4.4-4. With an in-migration workforce of 1457, approximately 9.8 percent of the available vacant housing in the ROI is used to accommodate in-migrating households. Based on the assumed distribution of the in-migrating workforce within the ROI counties, Forsyth and Guilford counties have ample housing supply, while available vacant housing in Stokes County is deficient with demand exceeding supply. In Rockingham County, approximately 80 percent of available vacant housing is used to accommodate the in-migrating population. Adequate housing is available within the ROI, specifically in Forsyth, Guilford, and Rockingham counties, to accommodate the in-migrating population.

Workers on short-term outage and maintenance assignments may use temporary housing in the form of hotels, seasonal homes (for long-term rentals), and recreational vehicle (RV) parks and campgrounds. As described in Section 2.4.2.7, within Greensboro (Guilford County) and Winston-Salem (Forsyth County), there are 163 hotels, 25 bed and breakfasts, and 28 camping and RV sites. Additionally, within the ROI, there were 3908 seasonal, recreational, or occasional use housing units available in 2022 (Table 2.4-18).

Overall, sufficient housing is available within the ROI to accommodate both in-migrating and temporary short-term workers. Therefore, impacts on housing are minor.

4.4.4.4 Public Services

This section discusses the impacts on the existing water supply, wastewater treatment, police, fire protection, healthcare services, and education in the ROI during building. The impact on public services is primarily driven by the population increase associated with the Project, specifically, in-migrating construction workers and their families. As shown in Table 4.4-1, the estimated population increase associated with construction of the Project is 3614.

4.4.4.4.1 Water Supply and Wastewater Treatment

Table 2.4-21 details the current municipal water suppliers within the ROI and their capacities and utilization rates. All of the counties within the ROI have excess water capacity. The impact to local water supply systems from in-migrating workers and their families is estimated by

calculating the amount of water that is used by the total population increase. The average person in the U.S. uses about 82 gallons of water per day (USEPA, 2023a). The in-migrating workforce and their families account for an approximately 3614-person increase in the ROI, which increases the used capacity by less than 1 percent (Table 4.4-5). Therefore, the impact of the in-migrating workforce and their families on water supply systems is minor.

Current wastewater systems in the ROI and their treatment capacities are detailed in Table 2.4-22. All of the counties within the ROI have excess wastewater treatment capacity. The impact to wastewater treatment systems is calculated by assuming that 100 percent of the water used by the in-migrating population (82 gallons of water per person per day) is disposed of through existing wastewater treatment facilities. While the increase in population from the in-migrating workforce and their families increases use of wastewater treatment facilities within counties of the ROI, as identified in Table 4.4-6, each of the counties has sufficient excess capacity to accommodate the increased demand. Therefore, the relatively small increase in use from the in-migrating workforce and their families has a minor impact on wastewater systems.

4.4.4.4.2 Police and Fire Protection Services

Police services within the ROI are summarized in Table 2.4-23 which shows that the number of police officers per resident (i.e., 1 officer per 445 residents) falls slightly below the nationwide ratio of 2.4 officers per 1000 residents (1 officer per 417 residents) (Section 2.4.2.8). As discussed in Section 4.4.2, approximately 3614 people are migrating into the ROI during the building phase. Table 4.4-7 details the distribution of the in-migrating population and its associated impact on police services within the ROI. The in-migrating population increases the demand on police services by increasing the number of persons per police officer. However, the overall increase in population in the ROI is minimal (0.3 percent increase) (Table 4.4-1), resulting in a change in police services from 445-residents-per-officer to 447-residents-per-officer. Although the service level continues to exceed the nationwide ratio, the net increase in police service needs in the ROI is minor.

Table 2.4-24 details the existing fire protection services within the ROI which shows that the number of firefighters per resident in Forsyth and Guilford counties (i.e., 1 firefighter per 340 and 368 residents, respectively) exceeds the nationwide ratio of one firefighter for every 318 residents (Section 2.4.2.8.) Table 4.4-8 details the distribution of the in-migrating population and its associated impact on fire protection services within the ROI. The in-migrating population increases the demand for fire protection services by increasing the number of persons per firefighter. However, as detailed in Table 4.4-1, the overall increase in population of 3614 people is minimal (0.3 percent increase in population). The increase in population changes the service level in the ROI from the existing condition of 300 residents per firefighter to 301 residents per firefighter. Although the service level in Forsyth and Guilford counties continues to exceed the nationwide ratio, the remaining two counties in the ROI and the ROI overall remain below the nationwide ratio. As such, the limited increase in fire protection service needs is minor.

4.4.4.4.3 Medical Services

Hospitals in the ROI are shown on Table 2.4-25. As discussed in Section 4.4.2, approximately 3614 people are migrating into the ROI during the building phase. Table 4.4-9 details the distribution of the in-migrating population and its associated impact on the availability of hospital beds in the ROI. The in-migrating population increases the demand for hospital beds. However, the population increase is minimal (0.3 percent) and the associated increase in demand for hospital beds is minimal, increasing from 298 residents per hospital bed to 299 residents per

hospital bed. Therefore, the slight increase in number of residents per hospital bed in the ROI is minor.

Physicians and dentists located in the ROI are detailed in Table 2.4-27. Table 4.4-10 details the distribution of the in-migrating population and its associated impact on the availability of physicians and dentists in the ROI. The in-migrating population affects physicians and dental services by increasing the number of patients each provider must care for. However, as detailed in Table 4.4-1, the in-migrating population increases total population in the ROI by 0.3 percent, changing the number of patients per provider from 1169 residents per physician to 1173 residents per physician and 1702 residents per dentist to 1708 resident per dentist. Therefore, the limited increase in number of patients per physician and dentists in the ROI is minor.

4.4.4.4.4 Education

Schools and existing student enrollment are discussed in Section 2.4.2.9. According to 2022 U.S. Census Bureau (USCB) American Community Survey data, 19 percent of the population in NC is between 5 to 19 years old (i.e., school age). Using this percentage and applying it to the total in-migrating population of 3614 persons, approximately 688 persons are of school age. The increase in student enrollment within the ROI is detailed in Table 4.4-11. Assuming that all in-migrating school aged children attend public school, the increase in student enrollment within the ROI ranges from 92 (Guilford County) to 266 (Rockingham County). However, the increase due to the in-migrating school aged children does not change the student -to- teacher ratios within each of the ROI counties or within the ROI (Table 4.4-11). Additionally, the student-to-teacher ratios within the ROI counties and the ROI as a whole remain below the thresholds outlined in Section 2.4.2.9. Therefore, impacts of the in-migrating population on education services are minor.

4.4.4.5 Summary of Community Infrastructure Impacts

Building-related impacts on all infrastructure and community services are SMALL within the ROI, with the exception of traffic impacts. Impacts to transportation due to workforce traffic are SMALL within the broader transportation network, but MODERATE on two-lane segments and intersections that provide access to the Project site due to the short duration of daily peak traffic and implementation of planned traffic management measures to reduce congestion and unstable conditions.

Table 4.4-1
Population Increases in ROI Associated with the Peak Workforce

	Percentage of Existing BCSS Workforce by Place of Residence	Distribution of Workers Needed from Outside ROI	Total Number of New Residents	Baseline Population (2030 Projections)[a]	Percent Increase in Population
Within ROI	75.0%	1457[b]	3614[b]	1,132,724	0.3%
Forsyth County	11.0%	214	530	416,948	0.1%
Guilford County	10.0%	194	482	577,037	0.1%
Rockingham County	29.0%	563	1397	91,571	1.5%
Stokes County	25.0%	486	1205	47,168	2.6%
Outside ROI	25.0%	486[c]	N/A	NA	N/A
Total	**100.0%**	**1943**	**–**	**–**	**–**

Notes:

(a) Source: NCOSBM, 2023

(b) Expected to relocate to the ROI; estimates are rounded to the nearest whole number, accounting for potential discrepancies between the ROI total and the sum of the four ROI counties.

(c) Expected to commute from counties outside the ROI; workers and families continue to reside outside of the ROI and do not impact the ROI population.

Key: BCSS = Belews Creek Steam Station; ROI = region of influence

Table 4.4-2
Existing and Building Phase PM Peak Hour LOS for Primary Roads Used to Access the Project Site
(Sheet 1 of 2)

Segment Number[a]	Road Name	Existing LOS			Building Phase LOS				
		Inbound Existing Volumes	Outbound Existing Volumes	LOS	Inbound Volume Added	Outbound Volume Added	Inbound Total Volumes	Outbound Total Volumes	LOS
1	U.S. 158 (South of Belews Creek Road)	555	555	C	41	99	596	654	D
2	U.S. 311 (South of NC Highway 65)	255	255	A	41	99	296	354	B
3	U.S. 311 (North of NC Highway 65)	255	255	A	114	274	369	529	C
4	NC Highway 65 (Between Belews Creek Road and Pine Hall Road South)	300	300	B	311	746	611	1046	E
5	Pine Hall Road (South of NC Highway 65)	105	105	A	41	99	146	204	A
6	Pine Hall Road (North of NC Highway 65)	128	128	A	114	274	242	402	C
7	Belews Creek Road (West of NC Highway 65)	128	128	A	43	103	171	231	A
8	Belews Creek Road (Between Craig Road and NC Highway 65)	128	128	A	354	850	482	977	E
9	Belews Creek Road (East of Craig Road)	285	285	A	395	948	680	1233	E
10	Fisherman Road	90	90	A	0	0	90	90	A

Table 4.4-2
Existing and Building Phase PM Peak Hour LOS for Primary Roads Used to Access the Project Site
(Sheet 2 of 2)

Segment Number[(a)]	Road Name	Existing			Building Phase				
		Inbound Existing Volumes	Outbound Existing Volumes	LOS	Inbound Volume Added	Outbound Volume Added	Inbound Total Volumes	Outbound Total Volumes	LOS
11	Hawkins Farm Road	90	90	A	0	0	90	90	A
12	Martin Luther King Jr. Road	60	60	A	0	0	60	60	A
13	Craig Road	68	68	A	749	1797	817	1865	F
14	NC Highway 68 (North of U.S. 158)	480	480	C	238	571	718	1051	E
15	U.S. 220 (North of NC Highway 68)	2025	2025	C	238	571	2263	2596	D
16	U.S. 220 (South of U.S. 158)	2025	2025	C	58	139	2083	2164	C
17	NC Highway 68 (South of U.S. 158)	480	480	C	58	139	538	619	D
18	U.S. 158 (Between Belews Creek Road and NC Highway 68)	728	728	D	354	849	1081	1577	F
19	U.S. 158 (East of NC Highway 68)	728	728	D	58	139	786	867	E
20	NC Highway 65 (Between Pine Hall South and Pine Hall North)	300	300	B	270	647	570	947	E
21	NC Highway 65 (Between Pine Hall North and U.S. 311)	300	300	B	156	373	456	673	D

Notes: All analysis performed with HCS 7 Two-Lane Version 7.9.6.
(a) Refer to Figure 4.4-2.
Key: pm = afternoon and evening timeframe; HCS = Highway Capacity Software; Inbound = vehicles entering Project site; LOS = Level of Service; Outbound = vehicles leaving Project site

Table 4.4-3
Existing and Building Phase PM Peak Hour LOS for Unsignalized Intersections

Intersection	Approach	Existing Conditions	Building Phase
		LOS	LOS
Belews Creek Road at Craig Road	SB	C	F
	EB	A	B
NC Highway 65 at Belews Creek Road (to the south)	SB	D	F
	EB	A	B
NC Highway 65 at Pine Hall Road (to the south)	NB	A	A
	EB	C	F
NC Highway 65 at Pine Hall Road (to the north)	SB	A	B
	WB	C	F

Note: HCS software requires the yield control for Craig Road at the Belews Creek Road intersection; therefore, the analysis assumed a stop control for Craig Road.

Key: EB = eastbound; HCS = Highway Capacity Software; NB = northbound; SB = southbound; WB = westbound; LOS = Level of Service; PM = afternoon and evening timeframe

Table 4.4-4
Housing Demand in the ROI Associated with the Peak Workforce

County	Number of Workers Relocating to ROI[a]	Available Vacant Housing Units - For Rent (2022)[b]	Available Vacant Housing Units – For Sale (2022)[b]	Total Available Vacant Housing Units for Rent or Sale (2022)	Projected Net Vacant Housing Unit Supply /Deficit
Forsyth	214	5531	1401	6932	6718
Guilford	194	5405	1404	6809	6615
Rockingham	563	443	251	694	131
Stokes	486	76	351	427	-59
ROI	**1457**	**11,455**	**3407**	**14,862**	**13,405**

Notes:

(a) Represents individual households.

(b) See Table 2.4-18.

Key: ROI = region of influence

Table 4.4-5
Public Water Supply Systems Demand in the ROI During Building Phase

	Existing Conditions				Building-Phase Demand			
Water Systems	**Total Available Supply (mgd)**	**Service Area Demand (mgd)**	**Utilized Capacity (%)**	**Excess Capacity**	**Increased Average Daily Usage (mgd)**	**Utilized Capacity (%)**	**Excess Capacity (mgd)**	**Change in Capacity**
Forsyth County	133.0	36.7	27.6%	72.4%	36.7	27.6%	72.4%	0.0%
Guilford County	91.8	49.9	54.3%	45.7%	49.9	54.4%	45.6%	0.0%
Rockingham County	69.3	7.7	11.1%	88.9%	7.8	11.3%	88.7%	-0.2%
Stokes County	50.5	2.0	4.0%	96.0%	2.1	4.2%	95.8%	-0.2%
ROI	**344.5**	**96.3**	**27.9%**	**72.1%**	**96.5**	**28.0%**	**72.0%**	**-0.1%**

Sources: USEPA, 2023b; NCDEQ, 2023
Key: mgd =million gallons per day; ROI = region of influence

Table 4.4-6
Public Wastewater Treatment Facility Demand in the ROI During Building Phase

		Existing Conditions			Building-Phase Demand		
Water Systems	**Total Design Flow (mgd)**	**Total Flow (mgd)**	**Flow as Percent of Design**	**Excess Capacity (%)**	**Total Flow (mgd)**	**Flow as Percent of Design**	**Excess Capacity (%)**
Forsyth County	51.0	37.9	74.2%	25.8%	37.9	74.3%	25.7%
Guilford County	82.0	44.4	54.2%	45.8%	44.5	54.2%	45.8%
Rockingham County	25.5	11.6	45.4%	54.6%	11.7	45.8%	54.2%
Stokes County	0.6	0.1	16.7%	83.3%	0.2	33.1%	66.9%
ROI	**159.1**	**94.0**	**59.1%**	**40.9%**	**94.2**	**59.2%**	**40.8%**

Source: USEPA, 2012

Key: mgd = million gallons per day; ROI = region of influence

Table 4.4-7
Police Protection in the ROI During Building Phase

Counties in the ROI	Total Population in 2020	Additional Population Due to New Facility Construction[a]	Total Population	Number of Sworn Law Enforcement Officers[b]	Current Officer-to-Resident Ratio[b]	Officer-to-Resident Ratio with Additional Population	Percent Increase from Current Officer-to-Resident Ratio
Forsyth	382,590	530	383,120	805	1:475	1:476	0.2
Guilford	541,299	482	541,711	1276	1:424	1:425	0.2
Rockingham	91,096	1397	92,493	225	1:405	1:411	1.5
Stokes	44,520	1205	45,725	73	1:610	1:626	2.6
ROI	**1,059,505**	**3614**	**1,063,119**	**2379**	**1:445**	**1:447**	**0.4**

Source: USCB, 2020

Notes:

(a) See Table 4.4-1.

(b) See Table 2.4-23.

Key: ROI = region of influence

Table 4.4-8
Fire Protection in the ROI During Building Phase

Counties	Total Population in 2020	Additional Population Due to New Facility Construction[a]	Total with Additional Population	Number of Firefighters (Full-time and Volunteer)[b]	Current Firefighter-to-Resident Ratio[b]	Firefighter-to-Resident Ratio with Additional Population	Percent Increase from Current Firefighter-to-Resident Ratio
Forsyth	382,590	530	383,120	1125	1:340	1:341	0.3
Guilford	541,299	482	541,781	1470	1:368	1:369	0.3
Rockingham	91,096	1397	92,493	580	1:157	1:159	1.3
Stokes	44,520	1205	45,725	361	1:123	1:127	3.3
ROI	**1,059,505**	**3614**	**1,063,119**	**3536**	**1:300**	**1:301**	**0.3**

Source: USCB, 2020

Notes:

(a) See Table 4.4-1.

(b) See Table 2.4-24.

Key: ROI = region of influence

Table 4.4-9
Available Hospital Beds in the ROI During Building Phase

Counties	2024 Population	Additional Population Due to New Facility Construction[a]	Total with Additional Population	Current Number of Hospital Beds[b]	Current Ratio of Hospital Beds-to-Residents[b]	New Ratio of Hospital Beds-to-Residents	Percent Increase
Forsyth	389,157	530	389,687	1940	1:201	1:201	0.1
Guilford	546,101	482	546,583	1365	1:400	1:400	0.1
Rockingham	91,957	1397	93,354	231	1:398	1:404	1.5
Stokes	45,175	1205	46,380	59	1:766	1:786	2.7
ROI	**1,072,390**	**3614**	**1,076,004**	**3595**	**1:298**	**1:299**	**0.3**

Source: County Health Rankings, 2024

Notes:

(a) See Table 4.4-1.

(b) See Table 2.4-25.

Key: ROI = region of influence

Table 4.4-10
Physicians and Dentists in the ROI During Building Phase

Counties	2024 Population	Additional Population Due to New Facility Construction[a]	Total with Additional Population	Current Number of Physicians[b]	Current Ratio of Physicians-to-Residents[b]	New Ratio of Physicians-to-Residents	% Increase	Current Number of Dentists[b]	Current Ratio of Dentists-to-Residents[b]	New Ratio of Dentists-to-Residents	% Increase
Forsyth	389,157	530	389,687	439	1:886	1:888	0.2	255	1:1526	1:1528	0.1
Guilford	546,101	482	546,583	438	1:1247	1:1248	0.1	333	1:1640	1:1641	0.1
Rockingham	91,957	1397	93,354	28	1:3284	1:3334	1.5	35	1:2627	1:2667	1.5
Stokes	45,175	1205	46,380	12	1:3765	1:3865	2.7	7	1:6454	1:6626	2.7
ROI	**1,072,390**	**3614**	**1,076,004**	**917**	**1:1169**	**1:1173**	**0.3**	**630**	**1:1702**	**1:1708**	**0.4**

Source: County Health Rankings, 2024

Notes:

(a) See Table 4.4-1.

(b) See Table 2.4-27.

Key: ROI = region of influence

Table 4.4-11
Education Impacts in the ROI During Building Phase

Counties	Number of Workers Relocating	Total Number of New Residents[a]	New School Aged Children[b]	Baseline Student Enrollment (K–12, 2022–2023)[c]	New Student Enrollment	Percent Increase over Baseline Enrollment	Teachers (FTE)[c],[d]	Current Student-to-Teacher Ratio[c]	New Student-to-Teacher Ratio
Forsyth	214	530	101	56,563	56,664	0.2%	3747.7	15:1	15:1
Guilford	194	482	92	78,961	79,053	0.1%	4977.1	16:1	16:1
Rockingham	563	1397	266	12,177	12,443	2.2%	786.3	16:1	16:1
Stokes	486	1205	230	5606	5836	4.1%	378.6	15:1	15:1
ROI	**1457**	**3614**	**688**	**153,307**	**153,995**	**0.4%**	**9889.7**	**16:1**	**16:1**

Source: USCB, 2022b

Notes

(a) See Table 4.4-1.

(b) Based on percentage of North Carolina population of school age children.

(c) See Table 2.4-28.

(d) "FTE" includes part-time workers who are reported as a fraction of one full-time worker.

Key: FTE = full-time equivalent employee; ROI = region of influence

4.5 NOT USED

Deleted (Executive Order, 2025a, 2025b).

4.6 HISTORIC AND CULTURAL RESOURCES

The purpose of this section is to evaluate potential impacts of building the Project on historic or cultural resources within the Area of Potential Effects (APE). As described in Section 2.6, the APE is based on the potential for direct and indirect effects and was determined to be the approximately 1080 ac. (437.06 hectares [ha]) contiguous area where Project impacts may occur, and a wastewater discharge pipeline corridor to the Dan River (Figure 2.6-1).

Building impacts, as well as operational impacts of the Project, determine whether the Project results in an adverse effect on historic properties, as defined in 36 CFR 800.5.

As a federal project requesting a permit from a federal agency, this Project is subject to review and consultation under Section 106 of the National Historic Preservation Act (16 U.S. Code [USC] § 470 et seq.) and its implementing regulations (36 CFR Part 800). Additionally, this Project is subject to the Native American Graves Protection and Repatriation Act (25 USC. 3001 et seq.), the Archaeological Resources Protection Act (16 USC 470aa-mm), the American Indian Religious Freedom Act (42 USC 1996), and the Archaeological and Historic Preservation Act (16 USC 469).

4.6.1 HISTORIC ARCHITECTURE RESOURCES

As noted in Section 2.6.3.1, the NC State Historic Preservation Office (NCSHPO) determined that the Project would not have an effect on historic structures in the Project Vicinity. Therefore, there are no impacts to historic structures from building.

4.6.2 ARCHAEOLOGICAL RESOURCES

Archaeological sites eligible for listing on the National Register of Historic Places (NRHP) may be affected by building the Project. Effects to archaeological sites within the APE and any required mitigation are dependent on the eligibility of each site for listing on the NRHP. Duke Energy conducted a Phase II investigation to assess the significance and eligibility for inclusion of archaeological sites in the APE for eligibility on the NRHP. As described in Section 2.6 and listed in Table 2.6-2, five sites within the APE were recommended as ineligible for listing on the NRHP and received NCSHPO concurrence. The remaining four sites remain in consultation with NCSHPO. Duke Energy has committed to avoidance or mitigation of these sites if they are deemed eligible. If any site is deemed eligible and avoidance is not possible, archaeological mitigation including Phase III data recovery will be required to resolve adverse effects. The results of all data recovery investigations are summarized as a technical report that is reviewed and approved by the NCSHPO.

The results of all data recovery investigations are summarized as a technical report that is reviewed and approved by the NCSHPO.

Ground-disturbing activities during the building phase include land clearing, grading, excavating, road work and facility construction and may have the potential to discover previously unknown archaeological resources or human remains. The Catawba Indian Nation, the only federally recognized tribe with interest in the Project area, requested to be notified if Native American artifacts or human remains are discovered. Consistent with Duke Energy Cultural Resources Procedures, if an inadvertent discovery of a cultural resource (e.g., graves or grave sites, archaeological sites, historical artifacts, etc.) is made during the building phase, then appropriate mitigative measures to address potential effects to these previously unknown

cultural resources will be developed in consultation with the tribes, NCSHPO, and NC Office of State Archaeology (NCOSA). Such measures may include the following:

- Ground-disturbing work will stop within a 50-ft. (15 m) radius of the discovery.
- Should previously unknown archaeological resources be discovered, sites will be protected and stabilized to prevent any further disturbance.
- Consultation will be initiated with the NCSHPO and federally recognized Native American tribes that attach religious and cultural significance to the property affected by the undertaking.
- A discovery plan will be developed and implemented to make an informed NRHP eligibility determination.

In the event of discovery of human remains during building activities, Duke Energy will implement the following measures:

- Ensure that the treatment of any human remains complies with all state and federal laws concerning archaeological sites and treatment of human remains.
- Immediately cease all ground-disturbing activities within a 10-ft. (3 m) radius of the burial.
- Notify the appropriate county coroner and the NCSHPO within 24 hours.

In summary, there were nine sites within the NDA that required further study. The NCSHPO concurred with five sites as being ineligible. The remaining four sites remain in consultation with the NCSHPO. Duke Energy has committed to avoidance or mitigation of any eligible archaeological site. As such, impacts of building activities are SMALL. However, if site avoidance is not possible, Duke Energy will conduct Phase III data recovery investigations in consultation with the NCSHPO. If eligible archaeological sites are not avoidable, impacts of building activities are MODERATE. Additionally, because of the potential for affecting undiscovered resources, mitigative measures developed in consultation with NCSHPO and NCOSA are proposed for addressing unavoidable archaeological sites and previously undiscovered resources.

4.6.3 CEMETERIES

The previously surveyed Branson Cemetery, shown as site [[ ]]^{CRI} on Figure 2.6-3, was visually inspected as part of the Phase I archaeological survey for the Project. The cemetery was determined ineligible for inclusion to the NRHP. However, cemeteries are protected under NC General Statutes Chapter 14-148 and 14-149 and are afforded consideration under Chapter 65. Therefore, the cemetery was recommended for avoidance. Duke Energy has undertaken work to conduct archival research with respect to the cemetery, including its history and associated records. The proposed development plan identified in Figure 3.1-1 assumes that the area within the NDA is permanently disturbed. Branson Cemetery is located within the NDA near the center of the Project site. Therefore, it is determined that avoidance of the Branson Cemetery is not possible. Accordingly, the provisions regarding exhumation and repatriation provided by NC General Statute Chapter 65-106 Removal of Graves will be followed as appropriate. Duke Energy plans to remove all graves in Branson Cemetery and relocate them to

a new burial ground in accordance with an approved cemetery relocation plan that includes delineation of the cemetery boundaries, generation of cemetery maps, and completion of historical and genealogical research. The plan will be developed in consultation with NCSHPO and in accordance with NC General Statute 65-106**.**

4.6.4 SUMMARY OF IMPACTS ON HISTORIC AND CULTURAL RESOURCES

Impacts to any NRHP-eligible archaeological site is minimized through avoidance and mitigated where site avoidance is not possible. Avoidance of the Branson Cemetery is not possible; however, Duke Energy will relocate all graves in accordance with an approved cemetery relocation plan. Therefore, impacts on historic and cultural resources are SMALL to MODERATE.

4.7 AIR RESOURCES

Section 2.7 discusses the meteorological characteristics and air quality at and around the Project site, while Section 4.7 contains a summary of potential cumulative environmental impacts to these resources that are associated with construction activities. The primary impacts on local meteorology and air quality of constructing a new nuclear power plant at the Project site would be from dust generated by land-clearing and building activities, emissions from heavy equipment and machinery, concrete batch plant operations, and emissions from vehicles used to transport workers and deliver materials to and from the site. Air-quality impacts directly associated with these building activities are described below in Section 4.7.1. Air-quality impacts associated with workforce transportation emissions are addressed in Section 4.7.2.

4.7.1 PRECONSTRUCTION AND CONSTRUCTION ACTIVITIES

Preconstruction and construction activities (sometimes referred to jointly as building activities) at the Project site would result in temporary impacts on local air quality. Potential air emission activities include:

- Land clearing and material processing, handling, and removal
- Material placement (e.g., subsurface preparation and concrete pouring and paving)
- Driving piles and erecting structures
- Machinery operation and maintenance
- Truck deliveries of supplies and materials
- Soil transport and temporary stockpiling
- Workforce commute (discussed in Section 4.7.2).

According to NUREG-1555, Section 4.4.1, “Physical impacts to a community from construction of a nuclear plant are not markedly different from any other large heavy construction project.”

4.7.1.1 Air Quality

The Clean Air Act (CAA) regulates air emissions from stationary and mobile sources. It authorizes the U.S. Environmental Protection Agency (USEPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants. Compliance with the applicable regulatory limits defined by the NAAQS (40 CFR Part 50) and National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61) involves implementation of emissions-specific strategies and measures. The Project site is located in the Northern Piedmont Intrastate Air Quality Control Region as set out in 40 CFR 81.150. Additionally, building activities are subject to air permits under state and federal laws that address the impact of air emissions on sensitive receptors.

NAAQS are established by the USEPA in Title 40 CFR Part 50 (Sections 50.4 - 50.13 and 50.15 - 50.18) for defined criteria pollutants which are sulfur dioxide, carbon monoxide (CO), nitrogen dioxide, particulate matter with a diameter less than 10 microns (PM_{10}), particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$), lead, and ozone.

In addition, the USEPA has classified areas of the U.S. where the NAAQS are met (attainment areas), locations that sufficient data are not available for setting a classification (unclassifiable or undesignated), and locations that do not meet the NAAQS (nonattainment areas). These areas are designated on a pollutant-by-pollutant basis. NC reached full attainment with all NAAQS across all counties in 2015 (NCDEQ, 2024a, USEPA, 2024b). The pollutant needed to be redesignated to meet attainment was ozone and on July 28, 2015, the USEPA redesignated the NC portion of the Charlotte-Rock Hill, NC-SC, nonattainment area for the 2008 8-hour ozone NAAQS, effective August 27, 2015 (FR, 2016).

As discussed in Section 2.7, wind speeds at the Project site during 2024-2025 were light with an average 10-m speed of 4.3 mph and a prevailing wind direction from the WSW. Regional mean wind speeds recorded at Piedmont Triad International Airport (KGSO) for the 39-year period from 1983-2022 were moderate with an average annual mean speed of 7.1 mph and a prevailing wind direction from the SW. The wind data for KGSO and the Project site show a consistent pattern of wind directions predominant from the SW, with moderate seasonal variation. Based on the combination of uniformly light to moderate wind speeds and surrounding terrain, there will often be little transport of fugitive dust and other air pollutants away from the site. The impact on the air quality related to construction activities would be temporary and minimal.

4.7.1.2 Heavy Equipment Emissions

Equipment and vehicle emissions from preconstruction and construction activities would contain CO, oxides of nitrogen, volatile organic compounds, and oxides of sulfur to a lesser extent. Fugitive emissions of dust particles (including PM_{10} and $PM_{2.5}$) would be generated during windy periods, earth-moving, and movement of vehicular traffic over recently disturbed or cleared areas. Emissions of fugitive dust and construction equipment engine exhaust are generally limited in duration, infrequent, and localized to the Project area. Additionally, the emissions are intermittent, temporary, and transient (i.e., do not encompass the entire Project site at all times). Because emissions are localized to the Project site, there would be no impact to off-site sensitive receptors and recreation areas from dust and air pollution. As discussed above, the state of NC is in attainment for all criteria pollutants.

Preconstruction and construction activities associated with motor vehicle operation and engines produce temporary gaseous pollutant and particulate matter (PM) emissions. The numbers and types of equipment on-site during the preconstruction and construction phase have not yet been determined. Preliminary emissions estimates are provided in Table 4.7-1.

Authorizations for preconstruction, construction, and operation activities are discussed in Section 1.2. Air permits under NC and federal laws will address the impact of air emissions on sensitive receptors located in the vicinity of the Project site.

Emissions from preconstruction and construction are typically near ground level; therefore, air-quality impacts are greatest at the receptors nearest these activities. Figure 2.3-8 shows the location of the receptors. Emissions are expected to be minor and will be addressed under the NCDEQ and USEPA requirements.

Sensitive receptors, which are potentially affected by the Project, include recreators on Belews Lake, residences just south of the Project site boundary, and residences to the east of the Project site across Belews Lake. Additional sensitive receptors include visitors to the recreation areas within the Project Vicinity and residences and facilities located along access roads to the

Project site. Primary roadways in the Project Vicinity are shown on Figure 2.4-4. Because the surrounding topography consists of rolling hills and steep slopes with forested land, there is visual screening for the Project site from area roadways. The recreation areas within the Project Vicinity are shown on Figure 2.4-5.

There will be a concrete batch plant in operation at the Project site during construction (Section 3.3). PM emissions consisting primarily of cement and pozzolan dust, including some aggregate and sand dust emissions, is the primary pollutant of concern. In addition, there are emissions of some metals that are associated with this PM. The fugitive sources include the transfer of materials, truck loading, mixer loading, vehicle traffic, and wind erosion from storage piles (USEPA, 2011). Types of controls may include water sprays, enclosures, hoods, curtains, shrouds, and movable and telescoping chutes.

Emissions from the concrete batch plants are expected to be minor and will meet the requirements of the NCDEQ General Air Permit for Concrete Batch Plants.

Additionally, Duke Energy plans to implement an emissions mitigation plan. Section 4.4 of the ER lists air emissions mitigation measures that may be used, including the following:

- Phasing activities and equipment use
- Minimizing the idling time of vehicles
- Using properly maintained equipment in compliance with applicable regulations minimizing speeds on unpaved roads
- Watering roads and exposed areas
- Minimizing soil storage piles
- Locating stationary equipment (e.g., generators and compressors) away from sensitive receptors
- Minimizing dust-generating activities during high winds.

4.7.1.3 Greenhouse Gas Emissions

Preconstruction and construction activities, such as operation of on-road construction vehicles, commuter vehicles, nonroad construction equipment, and marine engines, would also result in greenhouse gas (GHG) emissions, principally carbon dioxide (CO_2). GHG emissions for preconstruction and construction equipment are derived from NRC Interim Staff Guidance COL/ESP-ISG-026, Interim Staff Guidance on Environmental Issues Associated with New Reactors (NRC, 2014). This guidance estimates GHG emissions of 39,000 MT CO_2 equivalent (CO_2e) for a reference 1000-megawatt electric (MWe) reactor with a 7-year preconstruction and construction duration (Table A-3. Nuclear Power Plant Lifetime GHG Footprint NRC, 2014). The estimates from the 1000 MW(e) reference reactor is expected to be conservative relative to the Project site, based on the duration of activities and the utilization of advanced reactors. This GHG emission mass in COL/ESP-ISG-026 translates to an emission rate of about 5570 MT CO_2e per unit (33,420 MT CO_2e for six units) annually, averaged over the 7-year period of preconstruction/construction, which amounts to about 0.004 percent per unit (0.0024 percent for six units) of the total estimated GHG emissions in NC (139.45 million metric tons (MMT) of gross) in 2020 (NCDEQ 2024b). This also equates to about 0.00009 percent per unit (0.00054 percent for six units) of the total U.S. annual emission rate of 6.3 billion MT CO_2e in 2022 (USEPA, 2024c). Based on the assessment of the relatively small construction equipment GHG

footprint compared to total NC and U.S. annual GHG emissions, the atmospheric impacts of GHGs from preconstruction and construction activities would be minimal and additional mitigation would not be warranted.

In general, emissions from preconstruction and construction activities, including GHG emissions, would vary based on the level and duration of a specific activity, but the overall impact is expected to be temporary and limited in magnitude. It is stated in Section 4.4.1.2 that emission-specific strategies and measures would be developed and implemented to ensure compliance with the applicable regulatory limits defined by the NAAQS (40 CFR Part 50). Additionally, a dust control program would likely be implemented by the Project site. Based on the applicant's stated intent to develop and implement strategies to reduce emissions to ensure compliance with federal, State, and local regulations, the impacts on air quality from Project site preconstruction and construction activities would not be noticeable and appropriate mitigation measures would be adopted.

4.7.2 TRAFFIC (EMISSIONS)

During building activities, additional commuter vehicles, trucks, and other construction vehicles would pass daily through Pine Hall Road or Craig Road, leading into the Project site (see Figure 2.4-4 for primary roadways). This traffic would include the passenger cars and light-duty trucks of the preconstruction and construction workforce and truck traffic for delivery of construction materials and heavy equipment used to support development (e.g., excavators, bulldozers, heavy-haul trucks, cranes). Increases in emission levels are expected to be temporary and would have a minimal impact on air quality from criteria pollutants.

The overall impact caused by increased traffic volume and congestion would be localized and temporary. The ER identifies mitigation measures that would be developed before building activities begin. These traffic mitigation measures would reduce the impact of increased traffic on air quality. Potential mitigation measures involve additional traffic ramps and changes to intersections to reduce congestion. Workers may carpool to the site to minimize the effect of added vehicle traffic.

Workforce transportation would also result in GHG emissions, principally CO_2. Assuming a 7-year period for preconstruction and construction activities and a typical workforce size, it is estimated that the total workforce GHG emission footprint for building a new 1000 MW(e) nuclear power plant at the Project site would be on the order of 43,000 MT CO_2e. The assumptions, factors, and other information used in any site-specific analysis will be described in sufficient detail to allow an independent evaluation and assessment of the resulting GHG emissions estimate per NRC COL/ESP-ISG-26 (Environmental Issues Associated with New Reactors Interim Staff Guidance).

Workforce transportation emissions from the Project site during the construction period amounts to about 0.09 percent of the total estimated GHG emissions from transportation in NC (50.35 MMT of gross CO_2e) in 2020 (NCDEQ, 2024b) and about 0.002 percent of the total estimated gross CO_2e U.S. transportation emissions (1810.4 MMT [USEPA, 2024a]).

Based on the relatively small preconstruction and construction workforce GHG footprint compared to the NC and U.S. annual GHG emissions, atmospheric impacts of GHGs from workforce transportation would not be noticeable, and additional mitigation would not be warranted. Based on the limited increase in local vehicle traffic and Duke Energy's stated intent to develop mitigation measures listed in the ER, the impact on the air quality related to

preconstruction and construction activities, including the effect of GHG emissions, would be temporary and not noticeable.

4.7.3 SUMMARY

An evaluation of potential impacts on air quality associated with criteria pollutants and GHG emissions during the Project site building activities is outlined above. It is determined that the impacts are minimal. On this basis, it can be concluded that the impacts on air quality from emissions of criteria pollutants and GHGs during Project site preconstruction and construction would be SMALL and that no further mitigation would be warranted beyond the mitigation strategies discussed for air emissions in Section 4.4.1.2.

Table 4.7-1
Typical Emissions from Construction Equipment and Light-Duty Vehicles Used in Major Construction Projects

Equipment Type	Emissions (lb/hr)					
	CO	NO_X	SO_X	PM	CO_2	CH_4
Cement and Mortar Mixers	0.0414	0.0534	0.0001	0.0021	7.2	0.0008
Concrete/Industrial Saws	0.3706	0.2471	0.0007	0.0093	58.5	0.0030
Cranes	0.3738	0.4223	0.0014	0.0143	129	0.0061
Crawler Tractors	0.5065	0.4492	0.0013	0.0227	114	0.0071
Excavators	0.5086	0.2269	0.0013	0.0086	120	0.0050
Generator Sets	0.2667	0.2329	0.0007	0.0081	61.0	0.0026
Graders	0.5696	0.3314	0.0015	0.0147	133	0.0061
Off-Highway Tractors	0.6101	0.7291	0.0017	0.0331	151	0.0102
Off-Highway Trucks	0.5385	0.4769	0.0027	0.0142	260	0.0103
Other Construction Equipment	0.3474	0.2021	0.0013	0.0069	123	0.0040
Other Material Handling Equipment	0.4355	0.3844	0.0015	0.0124	141	0.0063
Pressure Washers	0.0531	0.0561	0.0001	0.0019	9.4	0.0006
Rollers	0.3763	0.2501	0.0008	0.0122	67.0	0.0037
Rubber Tired Dozers	0.6620	1.0824	0.0025	0.0419	239	0.0151
Rubber Tired Loaders	0.4311	0.2835	0.0012	0.0121	109	0.0050
Scrapers	0.7187	0.8387	0.0027	0.0335	262	0.0135
Skid Steer Loaders	0.2104	0.1354	0.0004	0.0019	30.3	0.0017
Tractors/Loaders/Backhoes	0.3586	0.1857	0.0008	0.0059	66.8	0.0030
Trenchers	0.4085	0.3481	0.0007	0.0215	58.7	0.0061
	Emissions (grams/mi.)					
	HC	CO	NO_x	CO_2		
Light-Duty Vehicles[(a)]	2.8-3.5	20.9-27.7	1.39-1.81	416-522		

Sources: AQMD, 2024, South Coast Air Quality Management District for construction emissions and USEPA, 2000 for vehicles.

Key: CO = Carbon Monoxide, NOx = Nitrogen Oxide, Sox = Sulfur Oxide, PM = Particulate Matter, CO_2 = Carbon Dioxide, CH_4 = Methane, HC = Hydrocarbon

4.8 NONRADIOLOGICAL HEALTH

Nonradiological health impacts on the public and workers from building activities at the Project site are described in this section. It includes the impacts on public and occupational health (Section 4.8.1), the impacts of noise and vibration (Section 4.8.2), and the impacts of transporting building materials and personnel to and from the Project site (Section 4.8.3). Nonradiological health impacts are summarized in Section 4.8.4.

4.8.1 PUBLIC AND OCCUPATIONAL HEALTH

Members of the public may be subject to health impacts from building activities at the Project site. Section 4.4.1 discusses health impacts to the public from building activities associated with noise and vibration, fugitive dust and odors, and air emissions from building equipment and vehicles. Section 4.4.1 notes that these impacts are minor due to the distance of the receptors from the Project site and the localized nature of the hazards.

Building activities involve risks to workers and on-site personnel from occupational accidents, injuries, and illnesses. These risks can result from exposure to airborne contaminants during close contact with solvents, exhaust, and other building-related chemicals; exposure to biological hazards, such as naturally occurring toxins in vegetation and insects; exposure to physical hazards, including slips, trips, and falls; heat or cold stress, burns, frostbite, noise; electric shock; and repetitive motion injuries. Section 2.8.1.1 describes that construction workers and on-site personnel receive training and use personal protective equipment to minimize the risk of potential harm (Duke Energy, 2023b). Regular health and safety monitoring is conducted during building activities as required.

Duke Energy facilities implement a range of control measures to minimize fugitive dust emissions. These measures include watering roads, covering truck loads, stabilizing material stockpiles, minimizing material handling, and limiting vehicle speeds. Worker health risks from engine exhaust are minimized by maintaining equipment in good mechanical condition. Fuel, oils, lubricants, and other fluids such as antifreeze are properly stored and handled to reduce risk to workers. Procedures for SPCC are used to prevent and mitigate adverse impacts to the public.

The BLS publishes statistics on incidence rates of occupational illnesses, injuries, and fatalities for all U.S. companies. As presented in Tables 2.8-1 and 2.8-2, in 2022 the construction industry incidence rate for nonfatal occupational injuries and illness was 2.4 per 100 full-time workers and the rate of fatal work injuries was 9.6 per 100,000 full-time equivalent workers (BLS, 2023b, c).

The incidence of nonfatal injuries and illnesses during the building phase has been calculated as the incidence rate times the number of workers. Using the construction workforce of 2096 (as provided in Section 4.4.2), recordable nonfatal injuries and illnesses during the building phase is estimated at 50 incidents. Based on the 2022 fatal occupational injury incidence rate from BLS and the construction workforce of 2096, fatal occupational injuries during construction would be less than one (0.2 incidents).

To protect workers and the public, mitigation measures outlined in the Duke Energy Environmental, Health, and Safety handbook are used to control fugitive dust emissions and minimize exposure to chemical spills and leaks. Chemical, biological, and physical occupational hazards are reduced by adhering to Occupational Safety and Health Administration, NC, and

Duke Energy safety standards and procedures. Safety training and the use of personal protective equipment further mitigate risks to workers.

Given the impacts associated with building activities that affect public health are minor, and the Project complies with all federal and state regulations, impacts on workers and the public from building activities are minor.

4.8.2 NOISE AND VIBRATION

Increased noise levels from building-related activities and traffic at the Project site may impact nearby sensitive receptors, which include residents and recreation users. Some activities that generate noise are also vibration-inducing activities; therefore, vibration impacts were analyzed in conjunction with the noise impacts.

4.8.2.1 Noise

Section 2.8.2 provides information and data related to background noise levels at the Project site. As Section 2.8.2.2 describes, there are no municipal, county, or state-level regulations that establish quantitative noise level limits applicable to the Project site. The USEPA guidelines recommend that outdoor noise levels do not exceed a day-night average community noise level of 55 dBA. However, this level is not a regulatory goal and is intentionally conservative to protect the most sensitive portion of the population with an additional margin of safety. The Department of Housing and Urban Development uses day-night average sound levels recommended by USEPA as guidelines for outdoors in residential areas. Noise levels are acceptable and allowable if the day-night average sound level outside a residence is less than or equal to 65 decibels. Therefore, this threshold provides the basis for impact determination in this analysis.

During building activities at the Project site, noise levels increase relative to background noise levels because of the operation of vehicles and machinery and building-related traffic. Building activities require the use of heavy equipment for clearing, excavating, grading, and building the facilities. Table 4.8-1 identifies building equipment that may be used during building activities and the attenuated noise levels for each piece of equipment at various distances.

Sound levels from operating most standard building equipment listed in Table 4.8-1 are 85 dBA or less at 50 ft. (15 m) from the source. An exception is the pile driver, which can reach up to 110 dBA at 50 ft. (15 m) from the source. Pile-driving activities are expected to occur periodically within the power block areas and may also occur as part of the intake and discharge structure installation. During building activities, temporary cofferdams may be used for shoreline or marine-based installations. Cofferdams are generally constructed of driven sheet piles, which are removed after the structure is built. Additionally, as described in Section 3.3.2 excavation for foundations including the power block and other support systems (see Figure 3.3-1), will likely require controlled rock blasting. Periodic blasting activities may produce noise levels that reach 126 dBA at 50 ft. (15 m) from the source (WSDOT, 2020). Noise from an isolated explosive blast event may be equivalent to a thunderclap at the source, or approximately 97 dBA at the nearest residence, and would be temporary and short-term.

Section 2.8.2 describes the nearest off-site noise-sensitive receptor to the Project site. This receptor is a residence located along Craig Road, approximately 44 ft. (13.4 m) south of the Project site boundary at its closest point. Notably, several other residents along Windswept Drive are also close to the Project site boundary but at greater distances than the nearest

residence along Craig Road. The loudest noise emissions during building activities that may affect this receptor are from building equipment that operates near the southern boundary of the Project site. Pile driving and rock blasting emit greater noise but would not occur at the southern boundary of the Project site.

Estimates of sound levels are calculated using straight-line noise attenuation which assumes sound travels in a straight line and attenuates based on distance. Based on straight-line attenuation, noise levels from the most standard operating equipment attenuate to 65 dBA or less at a distance of 500 ft. (152 m). However, for residents within this distance, noise levels remain at about the 65 dBA threshold. Environmental conditions that affect sound propagation such as vegetation, topography, and water are not factored into the calculation. Assuming straight-line noise attenuation, the loudest piece of equipment used during building (excluding pile driving and rock blasting, which would not occur at the southern boundary of the Project site) produces a sound level of 85 dBA measured at 50 ft. (15 m) from the source (Table 4.8-1). This equates to approximately 86 dBA at the nearest residence. Although the modeled 86 dBA at this receptor is notably greater than the average ambient noise levels for this area (Table 2.8-5), it represents a worst-case modeling assumption in which the loudest piece of equipment (excluding pile driving and rock blasting) is operated at the boundary of the NDA closest to the receptor. However, it is noted that portions of the Project site nearest to sensitive noise receptors are designated as laydown areas, and as such, they experience only occasional noise due to intermittent use and limited construction activity. In contrast, areas of the Project site located more than 500 ft. from the southern site boundary are subject to more frequent and elevated noise levels. These levels are expected to diminish to below 65 dBA at the site boundary. As a result, the overall impact of building-related noise on sensitive receptors is minimal.

Building equipment used for site preparation is not stationary but mobilizes across the Project site. As this equipment moves, the location of the noise source shifts, and the distance between the source and any given receptor increases, resulting in lower noise levels at that receptor over time. For example, as shown in Table 4.8-1, noise from equipment that attenuates to 85 dBA or less at 50 ft. (15 m) from the source attenuates to 67 dBA at 394 ft. (120 m) from the source. Most building activities occur well within the Project site boundary, and similar attenuation demonstrated in Table 4.8-1 indicates noise levels at residential receptors will remain below 65 dBA. As such, exposure to high noise levels for any particular receptor at or along the Project site boundary is variable and short-term during the building phase.

The nearest recreational area is Belews Lake, which is located immediately adjacent to the Project site boundary (Figure 2.4-5). Belews Lake is used for recreational boating and fishing. Residential areas are located along the shoreline of Belews Lake opposite the Project site. Most building activities at the Project site use typical equipment that produces noise levels of 85 dBA or less at 50 ft. (15 m) from the source (Table 4.8-1). These building activities do not occur directly at the Project site boundary along Belews Lake because of an approximate 100 ft. (30 m) vegetative buffer zone along the shoreline. Based on similar noise attenuation distances demonstrated in Table 4.8-1, the typical equipment used attenuates to 79 dBA at 98 ft. (30 m) near the site boundary. As described above, while this is greater than the 65-dBA threshold, it represents a conservative scenario in which the loudest piece of equipment is operated at the boundary of the NDA closest to the shoreline. As recreational areas of Belews Lake extend over large distances away from the Project site and shoreline residences are located across the lake (shown in Figure 3.1-2), noise levels from building activities attenuate to below 65 dBA for most lake users and residents. However, noise levels from the most standard operating equipment may be greater than 65 dBA only for recreators and residences within 500 ft. (152 m) of the

NDA. Additionally, building activities that involve pile driving or rock blasting may temporarily impact recreators. For example, pile driving during the installation of the intake and discharge structures near the Project site boundary generates noise exceeding 65 dBA on localized portions of Belews Lake. However, these building activities are short-term and temporary.

In addition to dispersed recreation occurring on Belews Lake, the closest developed recreational area is J. Dudley Watts Jr. Park (Belews Lake Park), which is approximately 1181 ft. (360 m) from the Project site boundary and approximately 3668 ft. (1118 m) from the southern power block. Assuming straight-line noise attenuation, the noise produced by the loudest piece of equipment (pile driver) operated at the closest power block area, attenuates to approximately 73 dBA at the park boundary. However, pile driving would be completed within a limited time frame, minimizing noise impacts to recreators in the park. Noise levels from other typical building equipment operated at the Project site boundary for much of the building period attenuate to approximately 58 dBA, which is less than the NRC threshold of 65 dBA.

The increase in traffic associated with workers commuting to the Project site and the delivery of construction materials also results in the generation of noise on roadways providing access to the Project site. Noise levels may increase on roadways based on vehicle, type, speed, and terrain. Noise would attenuate with distance to nearby residential receptors along the roadway network. These effects are more pronounced at residential receptors located close to Craig Road as it is expected that all Project-related traffic accesses the Project site from the south via this road. Noise impacts related to this increased traffic are most apparent during the morning and evening shift changes, when the volume of vehicles entering and exiting the site is at its peak. Such noise levels effects are short-term and temporary.

As stated, the maximum noise levels are higher than 65 dBA at each of the nearest sensitive receptors during building activities. However, as noise-producing equipment mobilizes across the Project site, the noise levels at any given point fluctuate, minimizing the overall noise impact by preventing prolonged exposure to high noise levels at the receptors closest to the Project site boundary. Noise is also minimized in areas where a vegetative buffer is retained along the perimeter of the Project site. Therefore, noise impacts from building activities are minor and further minimized through the use of common practices to mitigate noise, which include:

- Using noise-reduction devices on heavy equipment (e.g., mufflers).
- Limiting driving speeds, use of “Jake brakes,” and tail-gate slamming.
- Constructing earthen berms.
- Placing foliage or ground cover between the noise sources and receptors.

4.8.2.2 Vibration

Section 4.4.1.1 discusses vibration from the operation of heavy machinery, building-related vehicles, and blasting during building activities. As shown in Figure 4.4-1, residential annoyance begins at a level of 80 VdB at 50 ft. (15 m) from the source for infrequent events. The use of bulldozers and other heavy-tracked building equipment at 50 ft. (15 m) from the source may generate vibration levels of 95 VdB, which can be disruptive and may make concentrating on tasks such as reading a computer screen difficult. As noted in Section 4.8.2.1, the nearest residence is located along Craig Road, approximately 44 ft. (13 m) south of the Project site at its closest point; therefore, the nearest residents may be temporarily disrupted by vibration from building equipment. However, the use of mobile-heavy equipment near any one specific location

along the southern Project site boundary is relatively short-term and intermittent (not continuous). Thus, the impact of building-related vibration on public health is minor.

4.8.3 EFFECTS OF TRANSPORTATION OF CONSTRUCTION MATERIALS AND PERSONNEL TO AND FROM THE PROJECT SITE

This section analyzes how potential impacts related to increased traffic on roadways near the Project site during the building phase could increase the number of vehicle accidents involving injuries and fatalities. The analysis estimated new vehicle trips and additional traffic crashes including injuries and fatalities based on the peak employment period, which as described in Section 4.4.4.1, includes 2096 construction workers and 450 operations workers. In addition, as stated in Section 4.4.4.1, it is conservatively assumed that 90 construction truck deliveries per day are made to the construction site. Although building-related deliveries do not occur when workers arrive and depart the Project site, for this analysis, these deliveries are accounted for in the building-phase AADT along the roadways providing access to the Project site.

The crash rates (number of crashes per mi. per year) for the Project were estimated using the University of Florida Transportation Institute Highway Safety Software (HSS) (UTFI, 2025). The crash rates are estimated by considering the increase in AADT due to building-phase traffic on the primary roadways that provide access to the Project site. The predicted increase in traffic volume is used to estimate potential changes in crash rates consistent with the methodologies outlined in the Highway Safety Manual (AASHTO, 2024). Crash rates (predicted crashes per mi. per year) were developed for the existing condition (2024) to provide a baseline and the building phase for the roadway segments that commuters and delivery trucks use to access the Project site. In addition, predicted crash rates for the existing condition and building phase were developed at four intersections along these roadways: Belews Creek Road at Craig Road; Belews Creek Road at NC Highway 65; NC Highway 65 at Pine Hall Road (to the south); and NC Highway 65 at Pine Hall Road (to the north).

The HSS crash rate estimates predict average crash rates as a function of traffic volumes, roadway type (e.g., controlled-access), roadway characteristics (e.g., roadway geometry, number of lanes, lane width, shoulder type) and road segment length. The predicted crash rate associated with the increase in AADT during building for surrounding roadway segments identified in Figure 4.4-2 is shown in Table 4.8-2. These crash rates are variable. For example, the highest crash rates are predicted for U.S. 220, which is a high volume (AADT greater than 25,000), controlled-access freeway. By comparison crash rates are lowest on small local roads having a low AADT such as Craig Road, Fisherman Road, and Hawkins Farm Road. Crash rates for most roadway segments analyzed are predicted to be slightly higher for the building phase relative to the existing condition. The increase for Craig Road was greater than any other roadway segment (0.11 to 0.73). While notable, this increase is relatively minor. Overall, predicted crashes along the roadway network serving the Project site during the building phase are minor and do not destabilize traffic safety.

Table 4.8-3 presents predicted crashes at the four intersections that provide access to the Project site. The HSS estimates the number of predicted crashes based on factors including traffic volume, intersection geometry, and control. The number of predicted crashes at most intersections analyzed increase marginally during the building phase. The increase in predicted crashes (both injury and fatality) at the intersection of Belews Creek Road and Craig Road is slightly higher than as predicted at the other intersections analyzed. Overall, the effects of predicted increases in crash rates at intersections during the building phase on human health are minor.

The addition of vehicles associated with building-phase traffic results in a minor increase relative to the current traffic accident injury risk on the surrounding roadway network used by commuters to access the Project site. This minor increase is minimized through implementation of the traffic management measures identified in Section 4.4.4.1.

4.8.4 SUMMARY OF IMPACTS TO NONRADIOLOGICAL HEALTH

Impacts on nonradiological health and safety of workers and the public are minimized through compliance with all applicable state and federal regulations. Based on the most conservative application of analyses, noise levels at residences closest to the Project site are higher than the 65 dBA during building activities; however, because noise levels attenuate rapidly with distance, the sources of noise emission will also vary as equipment is mobilized across the Project site. Additionally, exposure to high noise levels for any particular receptor at or along the Project site boundary is short-term and temporary. As such, noise impacts are minor. The impact of building-related vibration on public health is minor. The addition of vehicles during the building phase on local roads accessing the Project site results in a minor increase in crashes. Based on these impact determinations, the nonradiological health impacts of building activities are SMALL.

Table 4.8-1
Noise Levels Expected for Operation of Representative Building Equipment

Source	Attenuated Noise Levels (dBA)			
	50 ft. [a] (15 m)	98 ft. [b] (30 m)	197 ft. [b] (60 m)	394 ft. [b] (120 m)
Backhoe	80	74	68	62
Compactor	80	74	68	62
Concrete Truck Mixer	85	79	73	67
Crane	85	79	73	67
Dozer	85	79	73	67
Dump Truck	84	78	72	66
Excavator	85	79	73	67
Flat Bed Truck	84	78	72	66
Front End Loader	80	74	68	62
Grader	85	79	73	67
Roller	85	79	73	67
Scraper	85	79	73	67
Tractor	84	78	72	66
Pile Driver	110	104	98	92
All Other Equipment >5 Horsepower	85	79	73	67

Source: FHWA, 2017

Notes:

(a) The attenuated noise levels are calculated based on straight-line noise attenuation of sound level at a given distance.

Distances shown are distances from the noise source.

Key: dBA = A-weighted decibels, ft. = feet, m = meter

Table 4.8-2
Predicted Building Phase Crash Rates on Roadways in the Project Vicinity

	Roadway Segments	Segment Length (mi)	AADT		Predicted Crash Rate (crashes / mi. / year)	
			Existing Condition	Building Phase	Existing Condition	Building Phase
1	U.S. 158 (S of Belews Creek Rd)	5.00	7400	7680	0.91	0.9696
2	U.S. 311 (S of NC Highway 65)	5.00	3400	3681	0.44	0.47
3	U.S. 311 (N of NC Highway 65)	5.00	3400	4177	0.59	0.70
4	NC 65 (between Belews Creek Rd and Pine Hall Rd S)	1.20	4000	6115	0.44	0.68
5	Pine Hall Rd (S of NC 65)	5.00	1400	1680	0.23	0.28
6	Pine Hall Rd (N of NC 65)	5.00	1700	2477	0.22	0.33
7	Belews Creek Rd (W of NC 65)	5.00	1700	1993	0.30	0.36
8	Belews Creek Rd (between Craig Rd and NC 65)	0.15	1700	4107	0.35	0.75
9	Belews Creek Rd (E of Craig Rd)	4.75	3800	6486	0.50	0.82
10	Fisherman Rd	0.50	1200	1200	0.13	0.13
11	Hawkins Farm Rd	0.40	1200	1200	0.13	0.13
12	Martin Luther King Jr Rd	3.15	800	800	0.14	0.14
13	Craig Rd	2.75	900	5993	0.11	0.73
14	NC 68 (N of US 158)	3.20	6400	8017	0.76	0.94
15	U.S. 220 Hwy (N of NC 68)	5.00	27,000	28,617	2.95	3.12
16	U.S. 220 Hwy (S of NC 65)	1.00	27,000	27,395	2.55	2.59
17	NC 68 (S of US 158)	5.00	6400	6795	0.89	0.94
18	U.S. 158 (between Belews Creek Rd and NC 68)	1.30	9700	12,106	1.21	1.47
19	U.S. 158 (E of NC 68)	3.50	9700	10,095	1.17	1.21
20	NC 65 (between Pine Hall Rd S and Pine Hall Rd N)	0.30	4000	5835	0.73	0.98
21	NC 65 (between Pine Hall Rd N and U.S. 311)	3.60	4000	5058	0.53	0.65

Key: AADT = Annual Average Daily Traffic; E = east; mi = mile; N = north; Rd = Road; S = south

Table 4.8-3
Predicted Crashes During the Building Phase at Intersections Near the Project Site

Unsignalized Intersection	AADT		Predicted Number of Crashes (per year)	
	Existing	Building Phase	Existing	Building Phase
Belews Creek Rd at Craig Rd	1300	5050	0.22	1.10
NC Highway 65 at Belews Creek Rd (to the south)	2850	5111	0.58	0.81
NC Highway 65 at Pine Hall Rd (to the south)	2700	3897	0.53	0.81
NC Highway 65 at Pine Hall Rd (to the north)	2850	4156	0.58	0.94

Key: AADT = Annual Average Daily Traffic; Rd = Road

4.9 RADIOLOGICAL HEALTH

The purpose of this section is to estimate the annual radiation doses to construction workers at the Project site. As determined in the discussion below, construction workers are classified as members of the public and are not subject to radiation monitoring. Section 3.3.5 states that multiple units are anticipated to be sequentially constructed at the Project site.

As stated in Section 3.1, the Project site contains three separate disconnected advanced reactor areas classified as the Middle, North, and South Plant Complexes. These locations are shown in Figure 3.1-1.

The proposed construction schedule, contained in Table 3.3-1, shows that construction of the next unit or set of units would be complete one year after the previously completed unit(s) until the last scheduled unit has completed construction at the North Plant Complex at the Project site. Using this construction schedule, the construction worker analysis conservatively analyzes the dose to workers, with all but one unit constructed and operating. However, the analysis is performed at the Middle Plant Complex due to location conservatisms, despite the construction schedule indicating the final unit(s) constructed will be located at the North Plant Complex. Because the number of units vary based on the advanced reactor technology, and the advanced reactor technology has not been selected, the detailed construction worker dose analysis conservatively utilizes the bounding radionuclide release activity in Section 3.4.

Additionally, because construction workers will not be at a fixed location on the Project nor a constant distance from the operating units throughout the duration of their time on the Project site, the analysis bases the location (and therefore the assumed distance from an operating unit) of the workers with respect to the center of the assumed location of the last reactor building under construction.

4.9.1 DIRECT RADIATION EXPOSURES

4.9.1.1 Radiation Sources

Construction workers may be exposed to direct radiation sources from plant buildings and facilities of operating units (e.g., radioactive waste handling facilities, low-level waste storage facilities, condensate storage tanks) while subsequent units are under construction.

4.9.1.2 Calculated Dose Rates

Because an advanced reactor technology has not been selected, data available for larger operating pressurized-water reactors is considered in the construction worker dose analysis to provide a good indication (even compared to different technologies) that the potential direct radiation doses to construction workers next to operational reactors would be SMALL. Based on measurements previously used to estimate the construction worker dose for the construction of Vogtle Electric Generating Plant Units 3 and 4, and adjusting for changes in exposure time, distance, and power generation, the annual dose to an individual construction worker from direct shine of operating units is calculated to be 2.68E+01 mrem. This corresponds to an annual dose to the total construction workforce to be 5.63E+01 person-rem.

4.9.2 RADIATION EXPOSURES FROM GASEOUS EFFLUENTS

4.9.2.1 Radiation Sources

As stated in Section 3.4.2.5, radioactive gaseous effluents are released to the environment through a controlled and monitored release point (e.g., plant vent). Additionally, radioactive gases from plant system leakage to the building atmosphere will travel through ventilation systems, passing through filtration, and is released through monitored building ventilation system release points. The expected exposure pathways considered for construction workers include:

- External exposure to airborne radioactivity (Air Submersion)
- Inhalation of airborne radioactivity

Ground shine dose is assumed to be negligible in this evaluation. The annual dose due to ground shine from normal operation at the Project site boundary is significantly less than the air submersion plume dose from normal operation at the Project site boundary The construction worker is located within the Project site boundary and therefore closer to the release point, meaning that the construction worker ground shine dose is even smaller than the dose at the Project site boundary and the air submersion dose is larger.

The ingestion component that is due to eating and drinking food is not included in this section for determining dose due to exposures from gaseous effluents because it is assumed the food and drink ingested on the Project site will be sourced from beyond the Project site.

Additionally, as stated in Section 2.9, any gaseous effluents released from the McGuire Nuclear Station and the Shearon Harris Nuclear Power Plant is expected to be negligible. Therefore, gaseous effluents from McGuire Nuclear Station and Shearon Harris Nuclear Power Plant are not included in the analysis as a contributable radiation source.

4.9.2.2 Calculated Dose Rates

The methodology for estimating the annual dose to the construction workforce at the Project site uses a bounding atmospheric relative concentration value (i.e., atmospheric dispersion factor [χ/Q]) for the Plant Complexes containing operating reactors, bounding release activities, appropriate dose conversion factors, estimated total number of construction workers, and the estimated number of hours construction workers are expected to be on-site.

A χ/Q representing similar or bounding distance and wind direction for Plant Complexes containing operating reactors is utilized from the analysis performed to provide χ/Q values in Section 2.7. The χ/Q is determined using the XOQDOQ computer code, which implements RG 1.111 methodology.

The bounding χ/Q for Plant Complexes containing operating units are determined in an analysis using the constant mean wind direction model from RG 1.111. The distance from the release point is assumed to be 100 m (328.0 ft.) from the unit under construction based on analysis in which the construction worker is assumed to be in the middle of the Middle Plant Complex and the units (the operating unit and the unit under construction) evenly spaced from the other unit on the Middle Plant Complex and the eastern or western edges of the power block on the Middle Plant Complex boundary, respectively. Additionally, construction workers are conservatively assumed to be standing at the center of the gaseous effluent plume. The

bounding χ/Q for the Plant Complexes containing operating units is 1.10E-03 seconds per cubic meters (s/m^3).

Construction workers are assumed to be present at the Project site for 2400 hours per year (i.e., 40 hours per week for 50 weeks, with an overtime factor of 1.2), and the maximum number of workers during any period while construction of the subsequent unit is 2096. The analysis conservatively utilizes the projected bounding release activities from a single reactor, located in Table 3.4-7. The release activities in Table 3.4-7 are multiplied by the respective number of units operating at each Plant Complex (e.g., two operating units at both the South and North Plant Complexes and one operating unit at the Middle Plant Complex).

The dose received by construction workers due to inhalation are scaled using ICRP Publication 68 and is calculated to be 1.48E-02 rem annually. This corresponds to an annual dose to the total construction workforce to be 3.11E+01 person-rem.

The dose received by construction workers due to air submersion are scaled using ICRP Publication 144 and is calculated to be 3.93E-02 rem annually. This corresponds to an annual dose to the total construction workforce to be 8.24E+01 person-rem.

4.9.3 RADIATION EXPOSURES FROM LIQUID EFFLUENTS

4.9.3.1 Radiation Sources

As stated in Section 3.4.2.1, small quantities of radioactive effluents may be released to the environment at designated release points, typically in the cooling water discharge stream. While it is expected that the Project site cooling water discharge stream releases radioactive liquid effluent into the Dan River, it is not expected that construction workers will ingest any food, be submerged in liquid sources, or be located near the shoreline exposed to radioactive liquid effluent release pathways from operating units. Additionally, construction workers are not expected to ingest any drinking water exposed to radioactive liquid effluent pathways as the construction site has access to potable water lines that can be tied into for construction purposes. Therefore, construction workers are not expected to be exposed to radioactive liquid effluent pathways.

4.9.3.2 Calculated Dose Rates

Construction workers are not expected to be exposed to radioactive liquid effluent pathways, therefore no dose is received from any radioactive liquid effluent pathways from the Project site. Doses from liquid effluent pathways to members of the public, including construction workers when not on the job, are evaluated in Section 5.9 and are included in the dose contribution assumed to be received by the construction workers as members of the general public in Section 4.9.4.

4.9.4 TOTAL DOSE TO CONSTRUCTION WORKERS

As noted in Sections 4.9.1 through 4.9.3, the exposure pathways calculated for the Project site construction workers are from both direct shine and gaseous effluents of operating units during subsequent construction This includes external exposure to workers in the form of air submersion and inhalation. The sum of the doses to construction workers calculated in Sections 4.9.1 through 4.9.3 is the Total Effective Dose Equivalent (TEDE) of the estimated individual and collective construction worker dose results. These results are presented in Table 4.9-1 for

the individual construction worker and Table 4.9-2 for the collective construction workforce. The TEDE to an individual construction worker is determined to be 8.11E-02 rem to the individual and 1.70E+02 person-rem to the collective workforce of 2096 persons.

The dose limits for individual members of the public are found in 10 CFR 20.1301 and 10 CFR 20.1302. Table 4.9-3 lists the dose limits from 10 CFR 20.1301 and 10 CFR 20.1302 and compares against the values determined for the construction worker dose analysis. Based on the analysis presented in this section, the dose to construction workers is within the limits from 10 CFR 20.1301 and 10 CFR 20.1302, As such, construction workers are classified as members of the public and do not require additional monitoring. Therefore, impacts to construction workers from radiation exposure would be SMALL.

Table 4.9-1
Total Annual Construction Worker Doses

Exposure Type	Exposure (rem)
Dose Equivalent from Direct Shine	2.68E-02
Dose Equivalent from Gaseous Effluents	5.41E-02
Total Effective Dose Equivalent (TEDE)	8.10E-02

Table 4.9-2
Collective Construction Worker Doses

Parameter	Value
Total Individual Construction Worker TEDE (rem)	8.10E-02
Assumed Worker Population (persons)	2096
Total Collective TEDE (person-rem)	1.70E+02

Table 4.9-3
Comparison of Construction Worker Dose to Dose Limits

Exposure Type	Exposure	10 CFR 20.1301 and 10 CFR 20.1302 Limits	Percent of Limit
Annual Construction Worker TEDE (mrem/yr)	81.0	1.00E+02	81.0%
Dose from External Sources to Construction Worker in 1 Hour (mrem/hr)	9.25E-03	2	0.462%

4.10 NONRADIOACTIVE WASTE MANAGEMENT

Potential environmental impacts may result from the generation, handling, and disposal of nonradioactive waste during building activities at the Project site. Types of nonradioactive wastes generated, handled, and disposed of include cleared vegetation, building material debris, spoils, stormwater runoff, municipal and sanitary waste, dust, other air emissions, used oils and lubricants from heavy equipment maintenance, and other hazardous chemicals. The following sections present an assessment of potential impacts resulting from these types of wastes.

4.10.1 IMPACTS TO LAND

Impacts to land include waste generated by building and equipment maintenance activities, workforce activities, and storage and disposal of cleared vegetation, soil, rock, and other debris. Building activities generate vegetation and other earthworks waste, general waste, metal waste, and equipment waste within the Project Vicinity and Project site. As stated in Section 3.4.3.3.1, Duke Energy's Environmental Programs maintain policies and procedures to ensure waste is properly managed to ensure safe handling and to minimize environmental impacts. All nonradioactive waste will be segregated based on waste type and its potential hazards and stored in appropriate containers. Waste segregation will occur at the point of generation, and waste will be labeled accordingly to facilitate proper disposal. Impacts to land use from building activities are presented in Section 4.1.

As stated in Section 3.4.3, Duke Energy's existing waste management programs, which comply with federal, state, and local regulations, are followed to manage wastes generated during operation. It is expected that impacts to land from nonradioactive wastes generated during building would be minimal and that no further mitigation would be warranted.

4.10.1.1 Vegetation and Other Earthworks Waste

Clearing, grubbing, and grading activities at the Project site generate waste materials, such as vegetation, soil, and rock debris. This material is stockpiled in a remote location on-site and transported off-site as needed. Stockpiles on-site are covered with soil and have vegetative cover. Excavated material not suitable for fill is disposed of in accordance with federal, state, and local regulatory requirements.

4.10.1.2 General Waste

Building waste includes paper, wood, shipping materials, and miscellaneous material that are recycled or properly disposed of in regulatory-permitted and Duke Energy-approved landfills. Inert debris from existing operations is taken to Winston-Salem landfill for disposal. Winston-Salem/Forsyth County Utilities operates a state-permitted, active, municipal solid waste landfill on Hanes Mill Road. This is a composite-lined landfill permitted to accept municipal solid waste from Davie, Forsyth, Stokes, Surry, and Yadkin counties. Additionally, Hanes Mill Road Solid Waste Facility accepts construction debris (CWS, 2024a). The Hanes Mill Road Landfill reported an approximate 27.3 years remaining in the Landfill Capacity Report for Fiscal Year 2022-2023 (NCDEQ, 2024c). The City of Winston-Salem also operates the Old Salisbury Road Landfill for waste materials generated for construction and demolition activities. There is sufficient land at the Old Salisbury Road Landfill to meet construction and demolition waste disposal needs until approximately the year 2030 (CWS, 2024b). Other regional landfills may also be considered to support the waste disposal needs during the building phase.

Common waste includes aerosol cans, antifreeze, lighting, batteries, asbestos, and grease. Duke Energy manages these items in accordance with federal and state waste regulations. The waste is shipped to an approved site and, depending on the waste stream, may be processed by a Duke Energy-approved disposal or recycling facility. NC characterizes suspended or recalled pesticides, mercury-containing devices, lamps, and batteries as universal waste. Universal wastes are a subset of hazardous waste that can be managed under reduced requirements.

4.10.1.3 Metal Waste

Building activities generate metal waste from multiple sources. These sources include, but are not limited to, steel from structural installation, pipe of different alloys (e.g., carbon steel, stainless steel), rigid steel conduit, instrument tubing, steel support materials (e.g., framing, angle iron, tube steel), metal hardware and miscellaneous fasteners, metal shipping material, and building materials, such as purlins and siding. Materials are recycled to the fullest extent possible to reduce the impact on local municipal solid waste landfills and facilities. As stated in Section 3.4.3.3.1, Duke Energy Environmental Programs uses administrative policies and procedures to ensure all employees and contractors properly manage waste. .

4.10.1.4 Equipment Waste

Equipment waste is generated from on-site building-related vehicles and equipment. Routine maintenance is performed at an on-site mechanic shop. Volumes of equipment wastes at the Project site are comparable to other construction projects of similar size. Used oils and grease are stored at a designated location in accordance with applicable regulatory requirements. Used hazardous materials are transported to a licensed disposal facility for recycling and disposal. On-site fueling occurs at a centralized location and locally at the equipment location. Drip pans and other containment systems are utilized to retain any spillage. This waste is disposed of in accordance with permitting conditions and regulatory requirements. As stated in Section 3.4.3.3.1, Duke Energy's existing waste management programs, which comply with federal, state, and local regulations, are followed to manage wastes generated during building.

4.10.1.5 Impacts to Land Summary

Solid waste generation is minimized through the proposed practices mentioned herein and in accordance with Duke Energy waste procedures. In the Project Vicinity, adequate landfill capacity is available to meet the projected demand for waste disposal needs during the building phase. Duke Energy's required pollution prevention activities (e.g., SPCC plans) limit the impacts of wastes. Additionally, management of solid wastes complies with all applicable federal, state, and local requirements and standards. Therefore, the impacts on land from nonradioactive solid wastes generated during building activities are SMALL, and mitigation is not warranted.

4.10.2 IMPACTS TO WATER

Impacts to water from nonradioactive wastes associated with building activities include impacts from construction of the cooling water intake structure and discharge structures, erosion from disturbed areas and associated sedimentation within receiving waters, and potential effects associated with inadvertent spills within the Project site and Project Vicinity. Impacts to water from building activities are presented in Section 4.2.

4.10.2.1 Impacts to Water from Nonradioactive Wastes

Waste affects water primarily from sanitary wastewater treatment, stormwater runoff, vehicle maintenance activities, and accidental spills. Potential impacts related to accidental spills of petroleum products or industrial chemicals necessary for building activities may result in adverse effects on surface water quality. Pursuant to Title 40 of the CFR Part 112, an SPCC plan, which includes the use of BMPs to minimize the occurrence of spills and limit their effects on surface water, has been implemented at the Project site. BMPs include actions such as maintaining vehicles and equipment, containment for fuel or oil storage tanks, and maintaining spill response equipment and materials. As described in Section 3.3.2, designated storage areas for fuel and lubricants on the Project site are equipped with appropriate spill containment measures in accordance with the SPCC plan.

Installing erosion and sediment control devices is necessary to comply with NCDEQ's NPDES Construction Stormwater Permit, as described in Section 3.3.2. These controls include silt fencing, filter socks, stabilized construction entrances potentially with wheel wash systems, sediment basins, floating turbidity barriers, or similar systems used for managing stormwater during construction activities. Additional measures include containment and spill response kits and systems for construction materials such as oils, paints, and chemicals. These practices minimize potential water pollution impacts at the Project site and in the Project Vicinity.

Release points and methods are determined by site-specific characteristics to ensure that water quality standards are upheld during potential dewatering events.

Portable sanitary facilities on-site are used as needed during the peak building period until a permanent connection to the sanitary waste treatment facility is functional. All waste collected from these temporary facilities is disposed off-site by a licensed sanitary waste disposal contractor.

4.10.2.2 Impacts to Water Summary

The impacts of nonradioactive waste on water are minimized through the use of BMPs, which reduce pollutant loading and decrease downstream impacts on water quality. The potential for spills of petroleum or industrial chemicals are managed through the use of SPCC plans. Therefore, the impacts of nonradioactive waste during building activities to water are SMALL.

4.10.3 IMPACTS TO AIR

This section evaluates information on building activities that generate dust or emissions and the related potential impacts to air quality. Plans to mitigate potential associated impacts are also included in this section. Section 2.7 discusses the meteorological characteristics and air quality at and around the Project site. Impacts on air resources during building and operation are further discussed in Sections 4.7 and 5.7, respectively.

4.10.3.1 Air-Quality Impacts

Potential air-quality impacts substantially derived from building activities and inclusive of the development of the associate off-site pipeline corridor include the following:

- Land clearing and material processing, handling, and removal, including the construction of access roads.

- Material replacement (e.g., subsurface preparation and concrete pouring and paving).
- Driving piles and erecting structures.
- Machinery operation and maintenance.
- Truck deliveries of supplies and materials.
- Soil transport and temporary stockpiling.

Emissions of fugitive dust and construction equipment engine exhaust are generally limited in duration and localized to the Project site, as discussed in Section 4.7.1.2. Because emissions are localized, there are negligible impacts to off-site sensitive receptors and recreation areas from dust and air pollution.

Section 4.7.1.3 discusses the potential GHG emissions from construction and preconstruction activities. Building activities, such as operation of on-road construction vehicles, commuter vehicles, and non-vehicle construction equipment, result in GHS emissions, principally carbon dioxide. The atmospheric impacts of GHGs from construction and preconstruction activities are not noticeable and additional mitigation is not warranted.

Table 4.10-1 lists potential major equipment used during building. Initial equipment is primarily related to excavation, along with forklifts and cranes for offloading material. As the Project progresses, cranes, aerial work platforms, truck trailers, forklifts, and grading equipment are used. Preliminary emission estimates are provided in Section 4.7.

To alleviate impacts on air quality, various mitigation measures lower emissions during preconstruction and construction. Section 4.4 lists air emissions mitigation measures that may be used, including the following:

- Phasing activities and equipment use.
- Minimizing the idling time of vehicles.
- Using properly maintained equipment in compliance with applicable regulations minimizing speeds on unpaved roads.
- Watering roads and exposed areas.
- Minimizing soil storage piles.
- Locating stationary equipment (e.g., generators and compressors) away from sensitive receptors.
- Minimizing dust-generating activities during high winds.

As stated in Section 4.4.1.2, emission-specific strategies and measures ensure compliance with the applicable regulatory limits defined by the National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50). Duke Energy implements a dust control program and develops strategies to reduce emissions to ensure compliance with federal, state, and local regulations. Emissions of fugitive dust and construction equipment engine exhaust are limited in duration and localized to the Project area and necessary mitigation is implemented as needed. Therefore, the impacts on air quality from building activities are expected to be SMALL and localized to the Project site.

Table 4.10-1
Major Equipment Used During Building Activities

Major Equipment Classes
Class 02 Trucks - Light Duty
Class 03 Trucks - Heavy Duty
Class 04 Trailers
Class 05 Rebar Shop
Class 06 Personnel Carriers
Class 11 Earthmoving
Class 12 Pipelaying and Trenching Equipment
Class 13 Compaction
Class 14 Cranes
Class 15 Forklift
Class 16 Concrete and Aggregate
Class 17 Air Compressors
Class 18 Crane Accessories
Class 22 Rigging Equipment
Class 23 Gantry Equipment
Class 25 Cable Laying and Pulling Equipment
Class 28 Containers
Class 29 Site Services
Class 51 Winches and Tuggers
Class 52 Welding Equipment
Class 53 Generation Equipment
Class 54 Manlifts and Scissor lifts
Class 55, 56 Small Capital Equipment

4.11 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION

This section summarizes potential adverse environmental impacts from construction and preconstruction activities (collectively referred to as “building activities”) discussed in previous sections of this chapter, and the associated measures and controls to limit those impacts.

Construction activities subject to NRC authorization are those that have a reasonable nexus to radiological health and safety or common defense and security (NRC, 2007). Examples of construction activities defined in Title 10 of the CFR Part 50, specifically 50.10(a)(1) include the following: pile driving, subsurface preparation, placement of backfill, concrete, soil stabilization activities or permanent retaining walls within an excavation; installation of foundations; or in-place assembly, erection, fabrication, or testing of specified structures, systems, or components. This application does not include a Limited Work Authorization permit request - accordingly, Project activities are limited to preconstruction activities.

Preconstruction activities include those described in 10 CFR 50.10(a)(2), such as site preparation (e.g., clearing, grading, and installation of erosion control, and other environmental mitigation measures), erection of fences, excavation, erection of support buildings or facilities, building service facilities (e.g., roads, parking lots, rail lines, transmission lines, sanitary-treatment system, potable water system), and procurement or fabrication of components occurring at a location other than the final, in-place location at the site.

4.11.1 ADVERSE ENVIRONMENTAL IMPACTS

Duke Energy actively avoids and minimizes adverse environmental impacts wherever evident during building activities at the Project site. However, some adverse environmental impacts are unavoidable and result from building activities.

Impacts of building activities are analyzed in the previous sections of Chapter 4. A discrete significance level (i.e., SMALL, MODERATE, or LARGE) of potential impact to each resource is assigned consistent with the criteria established by the NRC in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, footnote 3. This footnote defines the significance levels based on the potential for environmental effects and their ability to be mitigated or avoided and include the following:

- SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC’s regulations are considered small.
- MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resources.
- LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Table 4.11-1 summarizes the potential impacts attributable to building the Project and describes their designated significance levels. If there is no impact to a resource from building activities, a “no impact” descriptor is used.

4.11.2 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS

Table 4.11-1 lists potential adverse building impacts that require mitigation, along with the corresponding measures and controls to minimize these environmental impacts. The listed measures and controls have been designed to be clear, specific, and reasonable; achieve a practical level of mitigation; and involve methods and techniques that are appropriate, achievable, and can be verified through subsequent field reviews and inspections.

Examples of general measures to minimize impacts on the environment include:

- Using BMPs for construction activities.
- Implementing plans to manage stormwater and to prevent and appropriately address accidental spills.

In addition to the general measures discussed above, the following specific factors limit potential adverse environmental impacts related to building activities at the Project site:

- Compliance with federal, state, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental effects (e.g., solid waste management, erosion and sediment control, air emissions, noise control, stormwater management, discharge prevention and response, and hazardous waste management).
- Compliance with applicable requirements, permits, and licenses required for building the Project (e.g., land disturbance permit and other applicable building-related permits) as listed in Section 1.4.
- Implementation of environmental compliance activities during construction for the new plant, including solid waste management, hazardous waste management, and discharge prevention and response.
- Incorporation of environmental requirements into construction contracts.
- Identification of environmental resources and potential effects during development of this ER.
- Development of relevant mitigation measures.

Review and revision of mitigation measures and controls, as appropriate, based on final design, in accordance with appropriate environmental regulations and permits.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 1 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.1 Land Use Impacts			
On-site Impacts	MODERATE	1. Conversion of land (primarily forested land) to an industrial use. 2. Disturbance of approximately 906 acres (ac.) (367 hectares [ha]). 3. Ground-disturbing activities, including clearing, grubbing, excavation, and grading. 4. Generation of general waste, metal waste, and equipment waste. 5. Stockpiling of soils on-site. 6. Planned uses in compliance with current zoning in Stokes and Forsyth counties. 7. Conversion of prime farmland. 8. Discontinuation of hunting on the Project site. 9. Temporary disruption of public access to Duke Energy-owned docks, landings, and launch ramps on Belews Lake during building activities.	1. No mitigation measures or controls identified. 2,3. Grade each Plant Complex area to balance earthwork cut and fill quantities to the greatest extent practical. 4. Dispose of all building material in accordance with federal, state, and local regulatory requirements. 5. BMPs for erosion and sedimentation control are developed and installed prior to building activities and are maintained throughout construction. 6. Obtain appropriate county approvals for zoning as per Table 1.4-2. 7. No required mitigation measures or controls identified in consultation with the U.S. Department of Agriculture Natural Resources Conservation Service. 8. No mitigation measures or controls identified. 9. Access will be restored after building activities are complete.
Off-site Impacts	SMALL	1. Ground-disturbing activities, including clearing, grubbing, grading, trenching, and backfilling. 2. No change in corridor use.	1. BMPs for erosion and sedimentation control will be developed and installed prior to building activities and are maintained throughout construction. 2. No mitigation measures or controls needed.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 2 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.2 Water-Related Impacts			
4.2.1 Hydrologic Alterations			
Surface Water	SMALL	1. Direct effects of up to approximately 16,875 linear feet (ft.) (5144 linear meters [m]) of streams and 100 linear ft. (30.5 m) within the associated off-site wastewater pipeline. Indirect effects to 1256 linear ft. (323 linear m) of streams.	1. Implement avoidance, minimization, and mitigation measures in accordance with Section 401 and 404 permitting by NCDEQ and U.S. Army Corps of Engineers (USACE), respectively. 1. Implement BMPs to stabilize soils, control sedimentation and stormwater flows, and remove construction debris to minimize indirect impacts to streams outside the NDA.
		2. Effects to local stormwater drainage patterns from building activities within the NDA.	2. Implement a stormwater management system that complies with regulatory requirements for site design. 2. Comply with NCDEQ permit for land disturbance and stormwater management. Implement BMPs and USACE 404 permit at completion of building activities. 2-4. Use temporary features to facilitate building and/or protect water quality during construction. These features will comply with relevant regulations, agency approvals, and typical standards for construction-related to erosion control and sedimentation.
		3. Localized and short-term increases in turbidity and sediment deposition and alteration of the Belews Lake shoreline and bottom associated with building intake and discharge structures.	3,4. Use erosion control measures (such as rip rap) placed in proximity to the building area.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 3 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		4. Localized sediment disturbance and alteration of the Dan River associated with building outfall in discharge wastewater pipeline corridor.	4. Obtain and comply with site-specific terms of USACE permit for placement of fill.
		5. Alteration of floodplains from installation of wastewater pipeline.	5. Use BMPs to minimize impacts from use of heavy equipment in the floodplain and revegetate or rehabilitate the floodplain after installation of the wastewater pipeline.
Groundwater	SMALL	1. Localized changes in groundwater levels from dewatering during excavation.	1. No mitigation measures or controls needed.
		2. Reduced infiltration and groundwater recharge in the immediate area of new impervious surfaces.	2. No mitigation measures or controls needed.
4.2.2 Water-Use Impacts			
Surface Water	SMALL	1. Use of surface water for concrete mixing, dust suppression, and other building-related activities.	1. Specific measures and controls are not needed.
Groundwater	SMALL	1. No planned use of groundwater during building activities.	1. No mitigation measures or controls needed.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 4 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.2.3 Water Quality Impacts			
Surface Water	SMALL	1. Erosion and sedimentation associated with impacts to and alteration of on-site streams and stormwater from building activities.	1-3. Use BMPs in addition to NCDEQ 401 permit and controls to protect affected water bodies.
		2. Erosion and sedimentation associated with impacts to and alteration of Belews Lake from building activities.	1-3. Use BMPs to minimize erosion and sedimentation and establish and implement a SWPPP.
		3. Erosion and sedimentation associated with impacts to and alteration of Dan River from building activities.	1-3. Comply with NCDEQ NPDES general construction permit requirements to discharge stormwater associated with building activities and implement and SWPPP.
		4. Release of constituents from potential minor spills of hazardous materials (e.g., fuels, oils) into receiving water resources.	4. Establish and implement an SPCC plan for construction practices. 4. Use best construction practices to maintain equipment and prevent spills and leaks.
Groundwater	SMALL	1. Release of groundwater to the surface from dewatering during excavation.	1. Comply with NCDEQ NPDES permit to discharge water from groundwater dewatering associated with building activities.
		2. Inadvertent spills of fluids may affect groundwater resources.	2. Establish and implement an SPCC plan for construction practices.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 5 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.3 Ecological Impacts			
4.3.1 Terrestrial Ecosystems and Wetlands	MODERATE	1. Direct impacts to terrestrial flora and fauna and habitat loss due to building activities including land clearing, grading, excavation, and filling; displacement of wildlife and loss of less mobile fauna.	1. Use erosion controls and follow BMPs to control erosion from disturbed land and reduce impacts to nearby waters.
		2. Opportunities for invasive species to become established during building activities.	2. Conduct periodic monitoring and control measures.
		3. Potential impacts to bird nests and migratory birds during building activities.	3. Minimize or avoid tree clearing during nesting season from April to July or use Duke Energy compliance recommendations.
		4. Potential impacts from bird collisions with structures and nocturnal pollinator disruption due to artificial lighting during building activities.	4. Minimize the amount of nighttime light, using downshielding, avoiding landscape lighting features, and using only low-pressure sodium, high-pressure sodium, or light-emitting diode light sources.
		5. Direct impacts to 2.45 ac. (0.99 ha) of wetlands within the Project site and 0.26 ac. (0.11 ha) within the associated off-site wastewater pipeline area.	5. Comply with NCDEQ and USACE 404 permit mitigation measures to achieve no net loss objectives.
		6. Indirect impacts to wetlands outside of the NDA associated with hydrologic alterations, erosion and sedimentation, encroachment of invasive species and habitat function.	6. Implement BMPs, such as erosion and sedimentation controls that limit the transport of sediment to wetlands via stormwater, comply with 33 CFR Part 332 “Compensatory Mitigation for Losses of Aquatic Resources,” which promotes the national goal of “no net loss” of wetland acreage and functions.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 6 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		7. Direct impacts to tricolored bat and foraging and roosting habitat due to clearing during building activities.	7. Implement tree-clearing restrictions or consult with USFWS and conduct surveys. Conduct culvert surveys.
		8. Impacts to monarch butterfly foraging habitat on the Project site.	8. Consult with USFWS regarding potential effects to the monarch butterfly if this species becomes federally listed.
		9. Potential impacts to bald eagle during active nesting season.	9. Avoid disturbance within 660 ft. of bald eagle nest during nesting season. Coordinate with the USFWS prior to construction and implement applicable conservation measures.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 7 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.3.2 Aquatic Ecosystems	SMALL	1. Direct impacts on aquatic biota in Project site streams as well as indirect impacts by flow alteration and increased sedimentation and turbidity from building activities.	1. Comply with NCDEQ and USACE 404 permit guidelines. Use BMPs to control erosion and limit the amount of soil and sediment entering surface waters. Develop and implement a SWPPP for collection, mitigation, and control of stormwater runoff in accordance with state and federal regulations and permit requirements.
		2. Potential impacts aquatic biota and habitats related to accidental spills of petroleum products or industrial chemicals.	2. Designate storage areas for fuel and lubricants on the Project site that are equipped with appropriate spill containment measures in accordance with SPCC plans.
		3. Impacts to aquatic habitats and biota, including those to native species and habitats in vicinity of Belews Lake due to dredging, increases in turbidity and sediment deposition during installation of intake and discharge structures and associated pipelines.	3. Use BMPs such as cofferdams, silt curtains, wattles, or turbidity curtains to contain and control sedimentation. Maintain approximate 100-ft. (30.5-m) vegetated buffer around Belews Lake. Shoreline stabilization and buffer zones are protective of native aquatic species and habitats.
		4. Impacts to Dan River habitat due to physical habitat alteration, direct effects to or avoidance of aquatic biota.	4. See 2. and 3. above.
		5. Potential alterations to proposed critical habitat for Green Floater within the Dan River.	5. Consult with USFWS and NCWRC regarding avoidance, minimization, and appropriate conservation measures.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 8 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.4 Socioeconomic Impacts			
4.4.1 Physical Impacts (includes noise, odors, dust, air pollution, physical transportation impacts, and visual intrusions)	SMALL to MODERATE	1. Vibration effects to off-site residences and structures from building-related blasting and equipment use are below the threshold for risk of minor cosmetic damage to fragile buildings. 2. Increase in emissions of on-site gaseous and particulate pollutants from construction vehicles and equipment, delivery vehicles, and personal vehicles. 3. Increase in emissions of fugitive dust and fine PM from earthmoving activities, concrete batch plant operation, and vehicular traffic on recently disturbed areas or unpaved roads. 4. Deterioration of public roads used during building activities. 5. Visual and aesthetic effects during building activities, including effects from lighting for nighttime building and security.	1. No mitigation measures or controls needed. 2. Comply with Clean Air Act National Ambient Air Quality Standards and regulatory limits. 2. Use BMPs and properly maintain construction equipment and vehicles to control emissions. 3. Use BMPs to minimize dust generation and implement dust control measures by watering roadways and exposed areas. 4. Repair damage to public roads, markings, or signs caused by building activities to preexisting conditions or better in accordance with state and local requirements. 5. Maintain natural existing buffers to screen views of the Project site, including an approximately 100 ft. (30.5 m) wide vegetated buffer zone along the edge of the Project site. 5. Implement light shielding to the extent practicable.
4.4.2 Demographic Impacts	SMALL	1. Potential effects related to in-migration of workers and their families.	1. No mitigation measures or controls identified.
4.4.3 Economic Impacts to the Community	MODERATE (Beneficial)	1. No adverse impacts.	1. No mitigation measures or controls needed.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 9 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.4.4 Community Infrastructure (includes transportation, recreation, housing, and public services)	SMALL to MODERATE	1. Increased traffic in the vicinity of the Project site due to transport of workforce and materials, including potentially destabilizing impacts on two-lane segments and intersections providing primary access to the Project site.	1,4. Implement traffic management measures, including a traffic control mitigation plan.
		2. Disruption of recreational experience from building activities, including visual intrusions.	2. Coordinate with the NCWRC, as appropriate, if construction of the cooling water intake and discharge structures impede use of Belews Lake or associated facilities, including marinas. 2. Maintain natural existing buffers to screen views of the Project site. 2. Implement light shielding to the extent practicable.
		3. Increased user demand for recreational resources from in-migrating workforce and their families.	3. No mitigation measures or controls needed.
		4. Possible access delays or disruptions because of increased traffic on local roadways and building activities.	4. Access disruptions are mitigated by traffic management measures and a traffic control mitigation plan and restored when building activities are completed.
		5. Discontinuation of hunting on the Project site.	5. No mitigation measures or controls identified.
		6. Sufficient housing is available within the ROI to accommodate in-migrating and temporary workers.	6,7. No mitigation measures or controls needed.
		7. Increase in demand for public services from in-migrating individuals and their families.	
4.5 Not Used[(a)]	N/A	N/A	N/A

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 10 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.6 Historic Properties	SMALL to MODERATE	1. No impacts to historic structures from building.	1. No mitigation measures or controls needed.
		2. Impacts to any site eligible for listing on the NRHP if avoidance is not possible.	2. Implement avoidance measures for any NRHP-eligible archaeological site as required. 2. If required, develop Phase III data recovery investigations in coordination with NCSHPO for any NRHP-eligible archaeological site that cannot be avoided. 2. Implement procedures for addressing inadvertent cultural resource discoveries per Duke Energy Cultural Resources Procedure.
		3. Potential for effects to undiscovered resources.	3. Consult with the NCSHPO, NCOSA, and Catawba Indian Nation and implement mitigative measures as appropriate, if previously unknown archaeological resources or human remains are discovered during any building activities. Human remains would be treated in accordance with all state and federal laws.
		4. Relocation of Branson Cemetery	4. Conduct archival research on the cemetery, including its history and associated records. 4. Follow provisions regarding exhumation and repatriation provided by North Carolina General Statute Chapter 65-106 as appropriate. 4. Develop cemetery relocation plan in consultation with NCSHPO that includes delineation of the cemetery boundaries, generation of cemetery maps, and completion of historical and genealogical research.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 11 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.7 Air Resources	SMALL	1. Potential for air emissions from preconstruction and construction activities associated with heavy equipment to impact sensitive receptors located in the vicinity of the Project site. 2. Potential for PM emissions from the concrete batch plant in operation. 3. Potential for GHG emissions from preconstruction and construction equipment and on-road vehicles. 4. Varying emissions from preconstruction and construction activities based on level and duration of activity. 5. Emissions from additional commuter vehicles, trucks and other construction vehicles.	1. Adhere to the NCDEQ and USEPA requirements. 2. Implement control methods including water sprays, enclosures, hoods, curtains, shrouds, and movable and telescoping chutes. 3. Develop and implement emission-specific strategies and measures to ensure compliance with the applicable regulatory limits defined by the NAAQS (40 CFR Part 50). 4. Implement dust control program. 5. Implement mitigation measures including additional traffic ramps and changes to intersections to reduce congestion. Encourage workers carpool to minimize the effect of added traffic.
4.8 Nonradiological Health	SMALL	1. Potential for exposure of workers and the public to chemical hazards or physical nonradiological hazards.	1. Implement the SPCC plan; conduct equipment maintenance and stabilize roads and soil stockpiles to minimize fugitive dust. 1. Adhere to NRC, U.S. Occupational Safety and Health Administration, state, and Duke Energy safety standards and provisions for worker safety. 1. Implement worker safety training and require use of personal protective equipment.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 12 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		2. Modeled, worst-case variable and short-term noise levels above 65 dBA at nearby sensitive residential and recreational receptors 3. Short-term and intermittent disruptive vibration levels 4. Potential for minor increase in accident rate with increased construction traffic.	2. Use common practices to mitigate noise, including noise-reduction devices on heavy equipment and limiting driving speeds. 3. No mitigation measures or controls needed. 4. Implement traffic management measures including a traffic control mitigation plan.
4.9 Radiological Health	SMALL	1. Exposure to construction workers is within established regulatory limits.	1. No specific mitigation measures or controls identified.
4.10 Nonradioactive Waste Management			
4.10.1 Impacts to Land	SMALL	1. Increased generation, storage, and disposal of waste during building activities.	1. Implement policies and procedures under Duke Energy's Environmental Programs to properly manage waste to ensure safe handling and minimize environmental impacts. 1. Properly dispose of waste in accordance with federal, state, and local regulatory requirements. 1. Recycle metal waste and other materials to the fullest extent possible to reduce impacts on local municipal solid waste landfills and facilities. 1. Implement BMPs to minimize waste generation from on-site construction vehicles.

Table 4.11-1
Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Sheet 13 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
4.10.2 Impacts to Water	SMALL	1. Potential for accidental spills into water resources.	1. Implement an SPCC plan and associated BMPs to minimize the occurrence of spills and limit their effects on surface water. 1. Adhere to the NCDEQ NPDES Construction Stormwater Permit requirements to minimize impacts from stormwater runoff into receiving waterbodies. 1. Maintain portable sanitary facilities on-site and properly dispose of sanitary waste until a permanent connection to the sanitary waste treatment facility is functional.
4.10.3 Impacts to Air	SMALL	1. Air emissions from building activities including gaseous pollutants and PM.	1. Building-related emissions are typically limited to the vicinity. 1. Implement air emissions mitigation measures to ensure compliance with applicable regulatory limits defined by the National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50) and state and local regulations.

Notes:

(a) Deleted (Executive Order, 2025a, 2025b)

Key: ac. = acre; BMP = best management practice; CFR = Code of Federal Regulations; dBA = A-weighted decibels; ft. = feet; ha = hectare; m = meter; NCOSA = North Carolina Office of State Archaeology; NCSHPO = North Carolina State Historic Preservation Office; NCDEQ = North Carolina Department of Environmental Quality; NCWRC = North Carolina Wildlife Resources Commission; NDA = net disturbance area; NPDES = National Pollutant Discharge Elimination System; NRC = Nuclear Regulatory Commission; NRHP = National Register of Historic Places; ROI = region of influence; SPCC = Spill Prevention, Control, and Countermeasures; SWPPP = stormwater pollution prevention plan; USACE = U.S. Army Corps of Engineers; USFWS = U.S. Fish and Wildlife Service

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Figure 4.1-1
Land Cover Types Disturbed by Building Activities on the Project Site

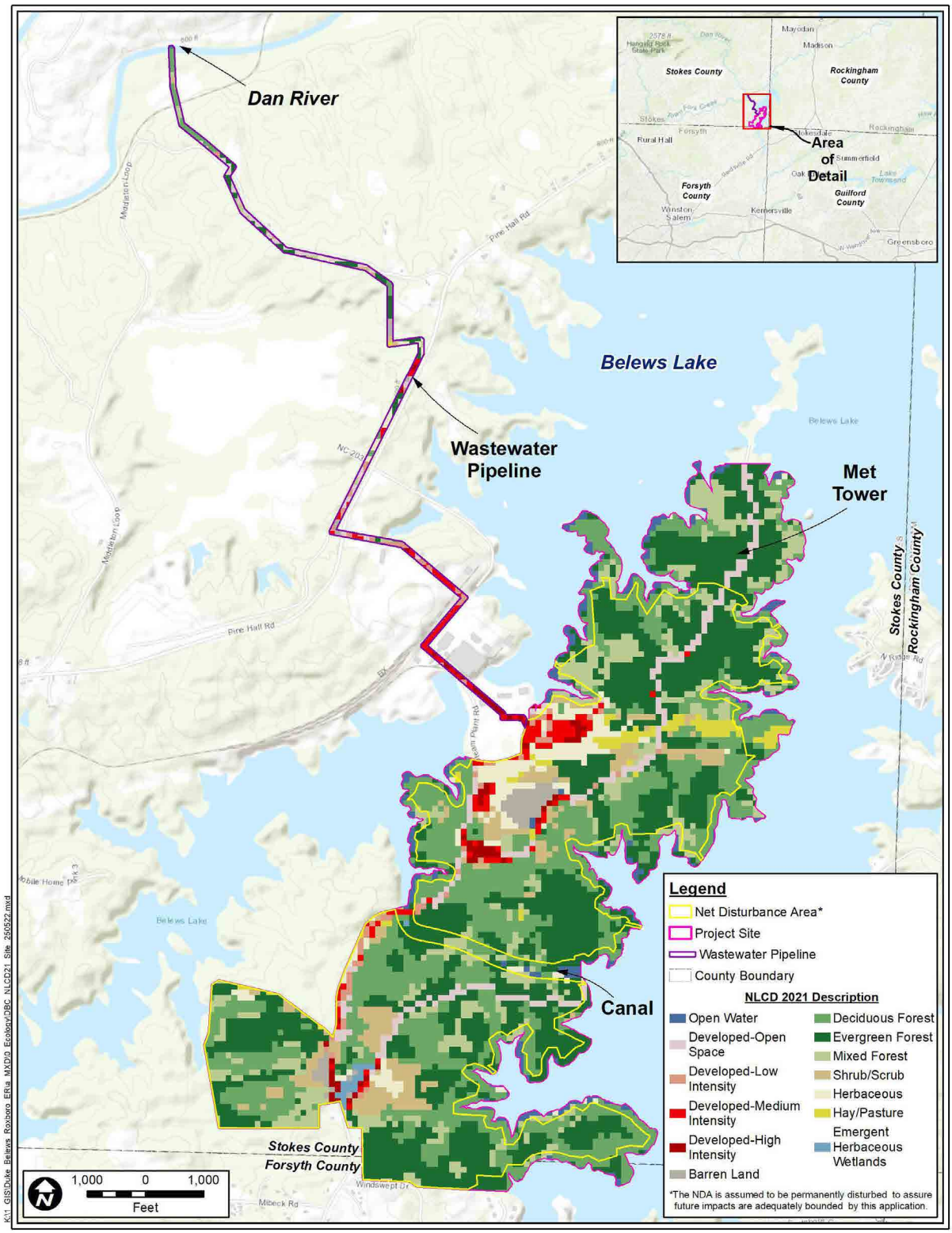


Figure 4.2-1
Streams Impacted by Building Activities

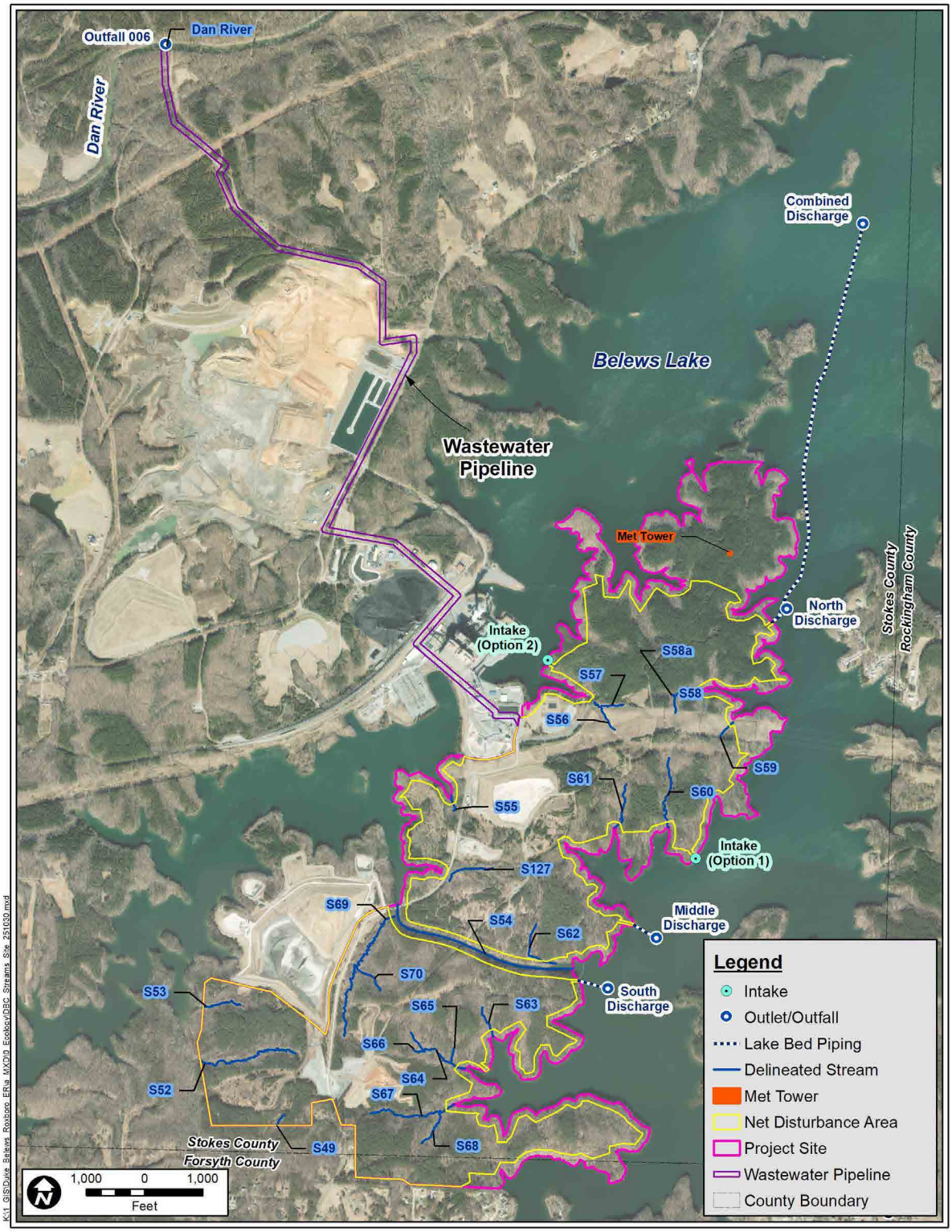


Figure 4.2-2
Floodplains Impacted by Building Activities

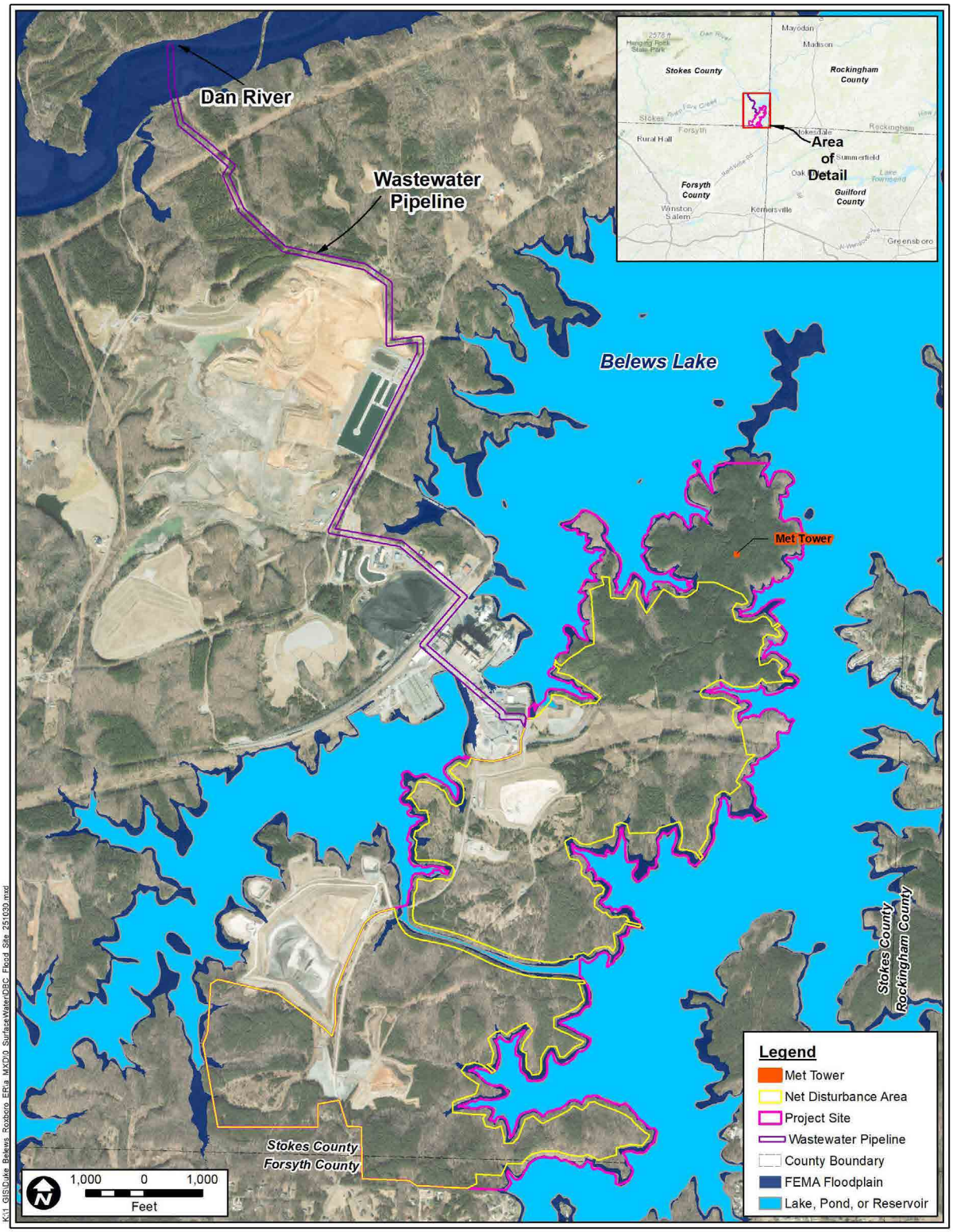


Figure 4.3-1
Habitats Disturbed on the Project Site

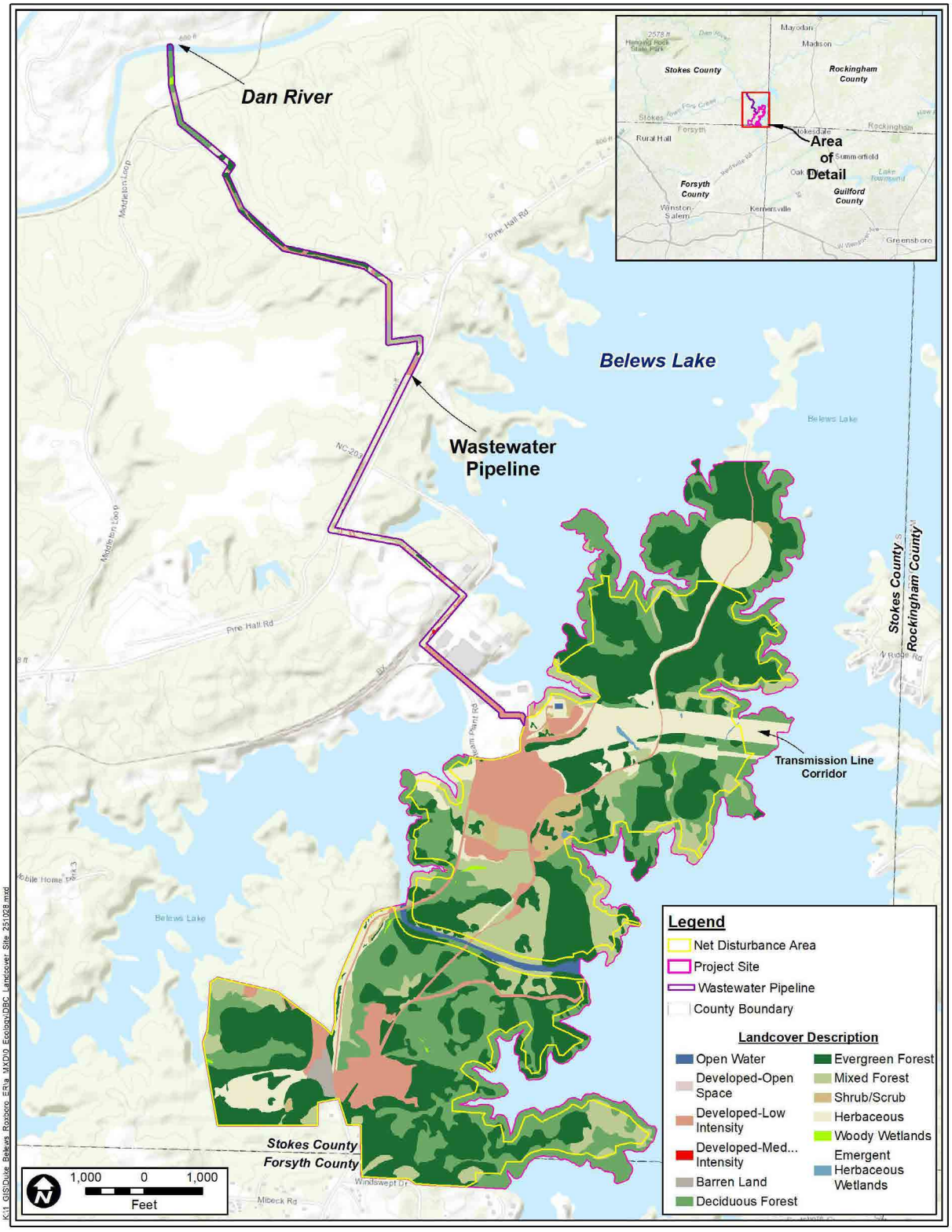


Figure 4.3-2
Wetlands Impacted by Building Activities

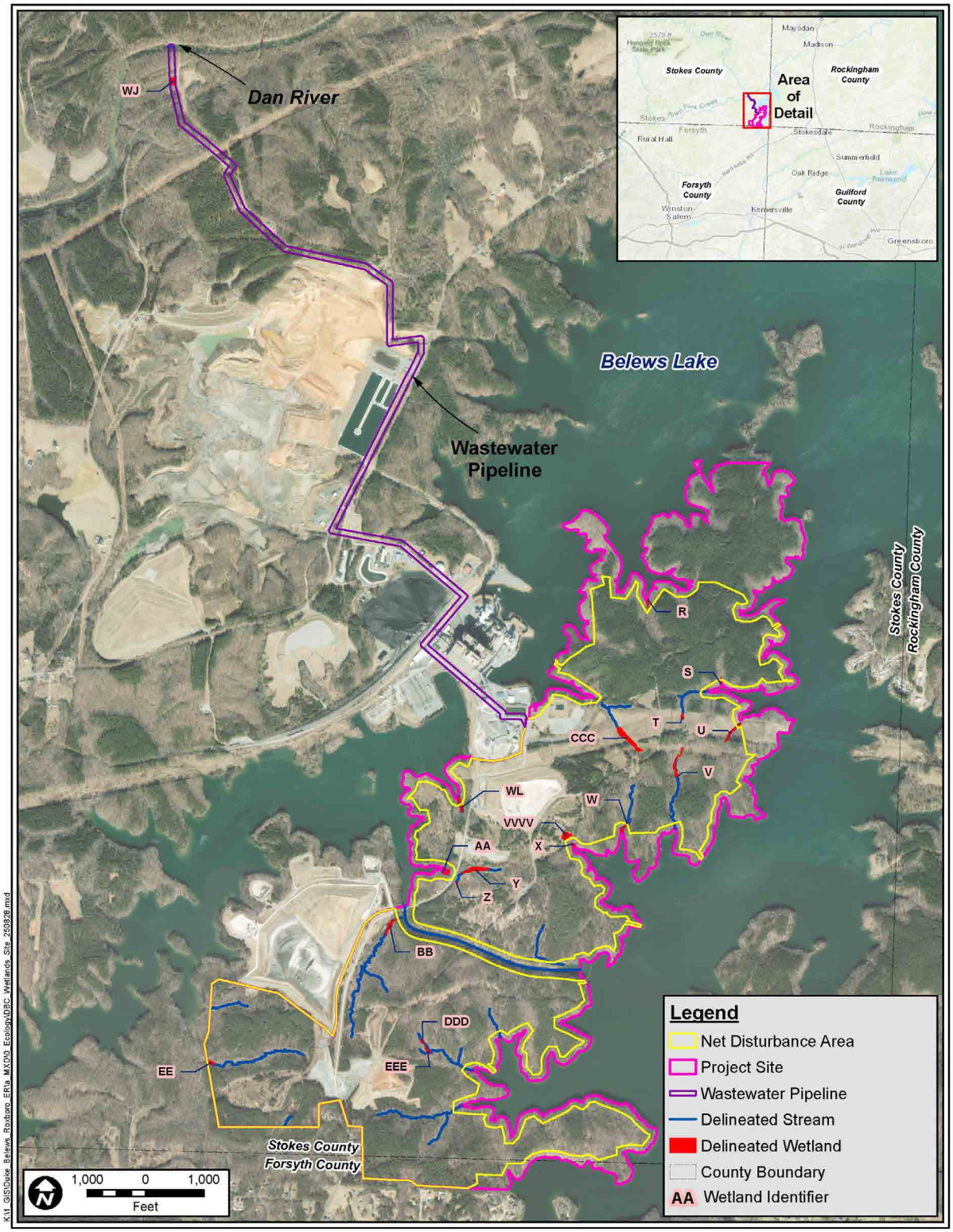


Figure 4.3-3
Raptor Nests Potentially Disturbed by Building Activities

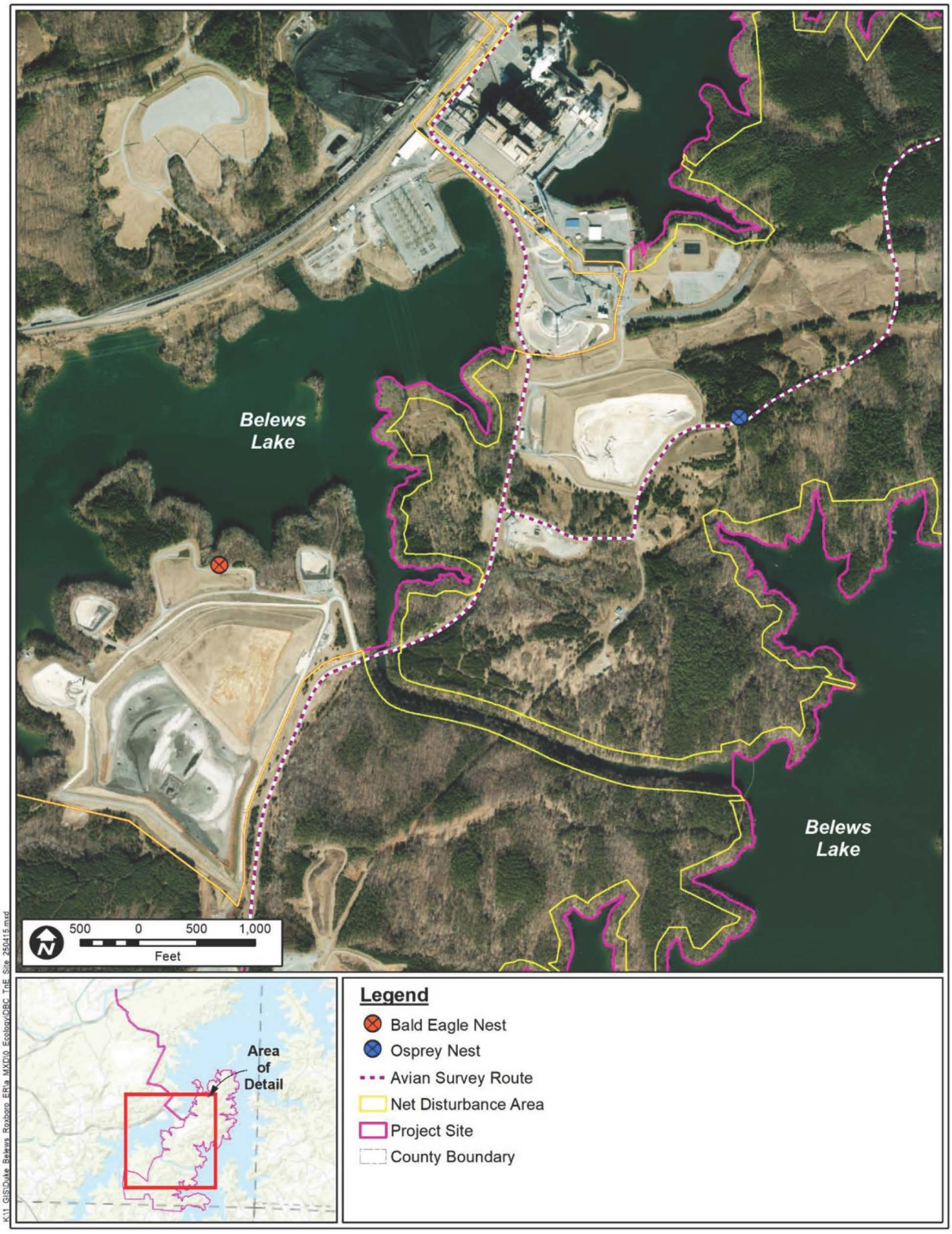


Figure 4.3-4
Sensitive Species Habitat Potentially Impacted by Building Activities

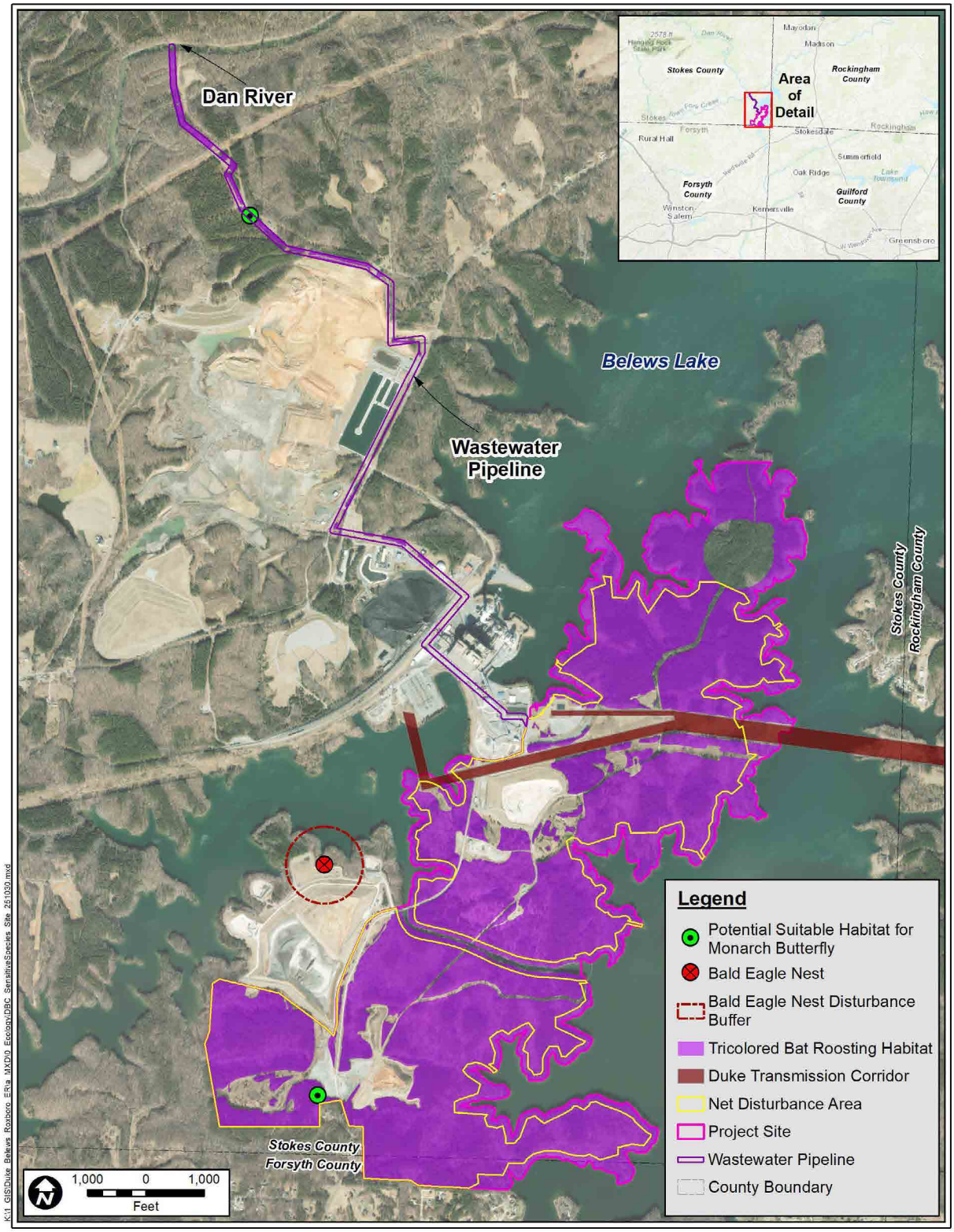
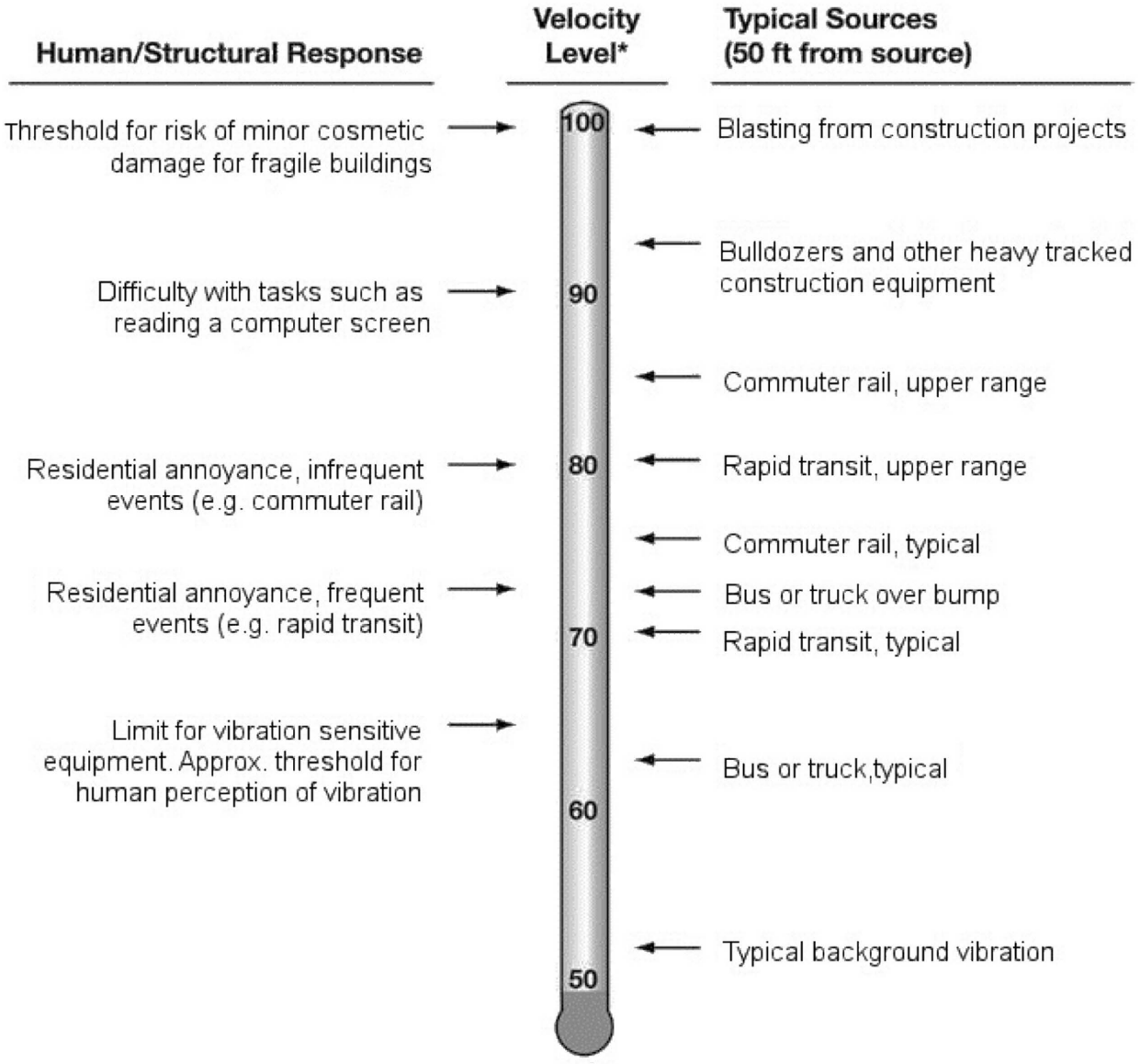


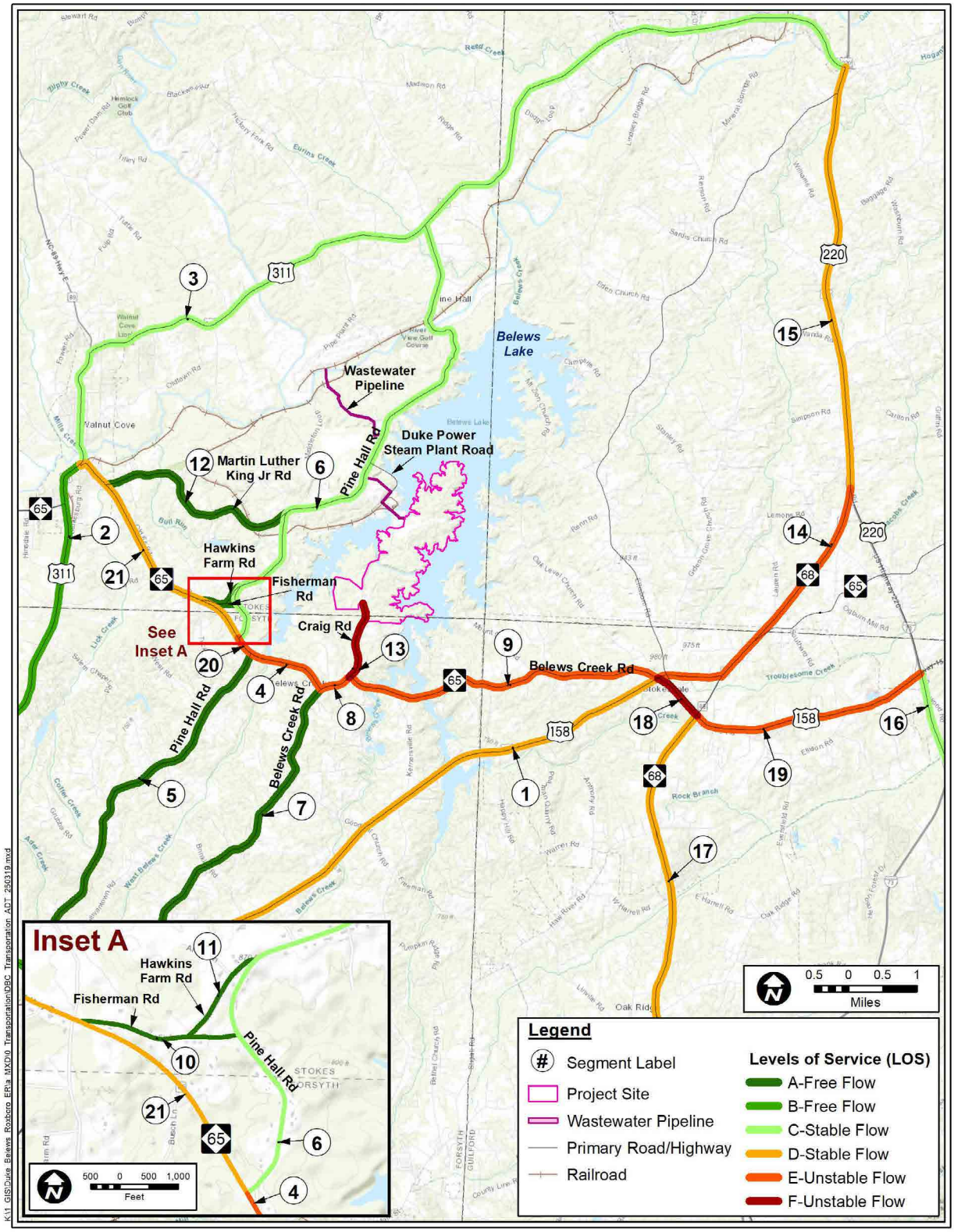
Figure 4.4-1
Typical Levels of Ground-Borne Vibration



Source: FTA, 2018

** RMS Vibration Velocity Level in VdB relative to 10^{-6} inches/second*

Figure 4.4-2
LOS on Primary Roadways During Building Phase



CHAPTER 5
ENVIRONMENTAL IMPACTS FROM OPERATION OF THE PROPOSED PLANT

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GLOSSARY

Term	Definition
°C	degree Celsius
°F	degree Fahrenheit
7Q10	7-day Duration, 10-year Return Period
AADT	average annual daily traffic
ac.	acre
ac-ft	acre-feet
AERMOD	American Meteorological Society/USEPA Regulatory Model
AGL	above ground level
ALARA	as low as is reasonably achievable
APLIC	Avian Power Line Interaction Committee
BCSS	Belews Creek Steam Station
BDBE	beyond design basis event
BLS	U.S. Bureau of Labor Statistics
BMP	best management practice
BTA	best technology available
Btu	British thermal unit
Btu/hr	British thermal unit per hour
BWR	boiling-water reactor

Term	Definition
CCW	condenser cooling water
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
CORMIX	Cornell Mixing Zone Expert System
CTM	critical thermal maxima
CWA	Clean Water Act
CWIS	cooling water intake structure
CWS	circulating water system
dBA	A-weighted scale decibel
DBA	Design Basis Accident
Delta-T	vertical temperature difference
DOE	U.S. Department of Energy
D/Q	Ground Deposition Factor

Term	Definition
EAB	exclusion area boundary
EAB/LPZ	exclusion area boundary/low population zone
EMF	electromagnetic field
EPRI	Electric Power Research Institute
ER	Environmental Report
ESP	Early Site Permit
ESPA	Early Site Permit Application
ESRP	environmental standard review plan
FGD	flue gas desulfurization
ft.	feet
ft/s	feet per second
g	gram
g/s	grams per second
GA	general arrangement
GHG	greenhouse gases
gpd	gallons per day
gpm	gallons per minute
GVH	GE Vernova Hitachi Nuclear Energy

Term	Definition
ha	hectare
HAA	haloacetic acid
HCS	Highway Capacity Software
hr.	hour
HSS	Highway Safety Software
HTGR	High-Temperature Gas-Cooled Reactor
ICRP	International Commission on Radiological Protection
IEEE	Institute of Electrical and Electronic Engineers
ILBA	Instrument Line Break Accident
ISC	industrial source complex
ISFSI	independent spent fuel storage installation
kg	kilogram
kg/ha/mo	kilograms per hectare per month
$kg/km^2/mo$	kilograms per square kilometer per month
kg/s	kilograms per second
km	kilometer
kV	kilovolt
lb/ac/mo	pounds per acre per month

Term	Definition
LLW	low-level waste
LMDCT	linear mechanical draft cooling tower
LOS	level of service
LPGS	Liquid Pathway Generic Study
LPZ	low population zone
LWR	light-water reactor
m	meter
MACCS	MELCOR Accident Consequences Code System
m^3/d	cubic meters per day
m^3/s	cubic meters per second
MEI	Maximally Exposed Individual
MEL	Maximally Exposed Location
mg	milligram
mg/L	milligrams per liter
mi.	mile
MJ/m^2	megajoules per square meter
mgd	million gallons per day
mrad	millirad

Term	Definition
mrad/day	millirad/day
mrem	millirem
mSv	millisievert
MRI	Midwest Research Institute
MW	megawatt
MW/Btu	megawatt per British thermal unit
MWe	megawatts electric
MWIS	Makeup Water Intake Structure
MWt	megawatts thermal
NAAQS	National Ambient Air Quality Standards
NaCl	salt (sodium chloride)
NC	North Carolina
NCAC	North Carolina Administrative Code
NCDEQ	North Carolina Department of Environmental Quality
NCDEQ-DAQ	North Carolina Department of Environmental Quality Department of Air Quality
NCEI	National Centers for Environmental Information
NCSHPO	North Carolina State Historic Preservation Office
NDA	net disturbance area

Term	Definition
NEI	Nuclear Energy Institute
NESC	National Electrical Safety Code
NOAA – ESRL	National Oceanic and Atmospheric Administration – Earth Systems Research Laboratory
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NUREG	NRC Technical Report designation
O_3	ozone
ODCM	Off-site Dose Calculation Manual
OSHA	Occupational Safety and Health Administration
PFAS	perfluoroalkyl and polyfluoroalkyl substances
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter of 2.5 micrometers or less
PM_{10}	particulate matter with a diameter of 10 micrometers or less
PPE	plant parameter envelope
ppm	parts per million
PRA	probabilistic risk assessment

Term	Definition
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc.
Project Region	The area encompassed within a 50-mi. (80-km) radius of the Belews Creek, NC site bounding limit unless otherwise specified for a particular resource.
Project site	Belews Creek, NC site
Project Vicinity	The area encompassed within a 6-mi. (10-km) radius of the Plant site center point unless otherwise specified for a particular resource.
PWR	pressurized-water reactor
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
REMP	radiological environmental monitoring program
RFFA	reasonably foreseeable future action
RG	Regulatory Guide
RIS	representative important species
ROI	region of influence
ROW	right-of-way
SACTI	seasonal and annual cooling tower impact

Term	Definition
SACTI2	seasonal and annual cooling tower impact, version 2
SAV	submerged aquatic vegetation
SCRAM	Support Center for Regulatory Atmospheric Modeling
SD	small depressurization
SMR	small modular reactor
SNL	Sandia National Laboratories
SO_x	sulfur oxide
SPCC	spill prevention, control, and countermeasures
SQG	small quantity generator
SSAR	Site Safety Analysis Report
Sv	Sievert
SWPPP	stormwater pollution prevention plan
TDS	total dissolved solids
TEDE	Total Effective Dose Equivalent
TLD	Thermoluminescent Dosimeter
TRISO	TRi-structural ISOtropic
TTHM	Trihalomethane
U.S.	United States

Term	Definition
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
WER	water effect ratio
WQS	water quality standard
yr.	year
µm	microns
χ/Q	atmospheric dispersion factor

Chapter 5 ENVIRONMENTAL IMPACTS FROM OPERATION OF THE PROPOSED PLANT

5.1 LAND USE IMPACTS

This section assesses impacts to land use and land cover at the Belews Creek, North Carolina (NC) site (Project site), Project Vicinity (6 miles [mi.] [10 kilometers {km}]) and associated off-site areas during operations. Section 5.1.1 discusses impacts to land use on the Project site and Section 5.1.2 discusses land use impacts at associated off-site areas in the Project Vicinity. Adverse impacts to land use at the Project site and associated off-site areas occur primarily during building activities.

5.1.1 ON-SITE IMPACTS

Land use impacts from building activities are described in Section 4.1. As stated in Section 4.1.1, the net disturbance area (NDA) is approximately 906 acres (ac.) (367 hectares [ha]) and encompasses the area that is disturbed during the operational life of the Project. Building support areas are intended to be permanently disturbed and serve operational needs. These needs may include parking or additional structures. In addition, the proposed transmission lines and switchyard areas are located within the NDA. No additional land will be acquired to support operations. Construction and maintenance activities on the Project site that require ground disturbance during operations are conducted in accordance with site-specific procedures and any required federal, state, or local authorizations.

As noted in Section 3.4.2.2, development of an independent spent fuel storage installation (ISFSI) is being considered at the Project site, within the NDA, to store spent fuel. The size and location of the ISFSI is currently undetermined, although it will meet the requirements set forth in 10 Code of Federal Regulations (CFR) Part 72.

As indicated in Section 4.1.1, operation of the Project is consistent with applicable land use planning and zoning in Stokes and Forsyth counties. Additionally, because no further land conversion is expected during operations, there are no additional impacts to prime or unique farmland or floodplains. Potential impacts from operations to water resources are discussed in Section 5.2. As discussed in Section 5.3.1.2, any potential wetland impacts during operation are primarily related to landscape maintenance and are minimized by implementation of appropriate best management practices (BMPs).

Section 4.4.2 states that hunting activities on the Project site will cease during the building phase and remain prohibited throughout operations. However, as stated in Section 2.4.2.6.2, there are several other hunting opportunities available within the Project Vicinity. As shown on Figure 2.4-5, recreational facilities on Belews Lake, such as the Pine Hall public boat ramp, Piney Bluff Boat Launch, and commercial marinas, are situated at a considerable distance from the Project site or across Belews Lake. Therefore, operations do not impact access to these facilities.

Operating the mechanical draft cooling towers has the potential to affect nearby land through fogging, icing, and salt drift. However, the findings from the Seasonal and Annual Cooling Tower Impact (SACTI) analysis, as described in Section 5.7.1.2, indicate that these concerns are minimal. The SACTI analysis predicts no occurrences of fogging or plume rime icing, low rates

of salt deposition, limited visual impacts, and insignificant levels of plume water deposition. Thus, impacts on land use within the Project site and Project Vicinity are minor.

Operation of the Project does not require additional land acquisition, is consistent with applicable zoning and land use, does not impact use of surrounding recreational facilities, and does not impact land within the Project Vicinity. Therefore, impacts during operations on land use are minor.

5.1.2 OFF-SITE IMPACTS

As stated in Section 2.1.2, no new off-site transmission line corridors are needed for the Project, and operation of existing transmission line corridors does not change. Therefore, there are no corresponding off-site transmission-related land use changes during operations.

As described in Section 4.1.2, building activities occur within the approximately 40-ac. (16-ha) associated off-site wastewater pipeline corridor. No additional land is required to support operations, and the corridor would continue to be managed as it is currently. Indirect impacts associated with corridor maintenance to the wetland in the associated off-site area are minimized by implementation of appropriate BMPs as indicted in Section 5.3.1.2. Therefore, impacts on land use on the associated off-site area from operations are minor.

5.1.3 SUMMARY OF LAND USE IMPACTS

Overall, the impacts to land use during operations are minor and would neither destabilize nor noticeably alter any important attribute of land use on the site or in the vicinity. Similarly, impacts to land use from operation of the off-site wastewater pipeline are minimal as all operations are contained within the existing corridor. Therefore, land use impacts during operations on-site and off-site are SMALL.

5.2 WATER RESOURCES

This section identifies impacts to surface water and groundwater resources from Project operations. Water resources at the existing Project site are described in detail in Section 2.2. As described in Section 3.4, Project operations require water for cooling and other operational uses. The sources of this water are Belews Lake and the Dan River.

Analyses of potential impacts to surface water resources are complex in consideration of past and existing operations of the existing Belews Creek Steam Station (BCSS), the operational characteristics of the Project, and the planned closure of BCSS. Belews Lake was constructed to support power generation and began filling in June 1970. Belews Lake reached full pond level in May 1973 and the first BCSS unit was placed into commercial operation in 1974.

As described in Section 3.3.5, the building and operational schedule has not yet been established. However, building of all advanced reactor units at the Project site follows a phased approach over several years. In conjunction with this phased approach, Duke Energy Carolinas, LLC (Duke Energy) will also derate the operations of BCSS during the phased implementation period in a manner that replaces and balances overall generation capacity between both the Project and BCSS. This transitional period is known as the “phased implementation period.” Thus, there will not be a time when no generation is present on the lake prior to advanced reactor commissioning. Therefore, the past 50 years of BCSS operation and its effects on Belews Lake and the surrounding environment represent the existing baseline condition as described in Section 2.2.

As is described in Section 1.2.1, the proposed action is the issuance of an Early Site Permit (ESP) by the U.S. Nuclear Regulatory Commission (NRC) under the provisions of 10 CFR Part 52 for the Project site. The issuance of the ESP does not authorize construction or operation of any facility but establishes the Project site’s suitability for future licensing decisions, contingent on the selection of the specific advanced reactors. Because the decision to close BCSS is a separate action from the Belews Creek, NC site ESP Application Project, BCSS closure is a reasonably foreseeable future action (RFFA) as described in Section 7.1. As described in Section 7.1.2, the BCSS closure results in consequences that include changes in the baseline environmental conditions relative to those described in Chapter 2. The phased approach for implementation of the Project in conjunction with the BCSS closure results in gradual changes in environmental conditions over the phased implementation period. The analysis of operational effects on surface water resources described in this section are based on the affected environment described in Chapter 2. Where appropriate, supplemental analyses are also provided that summarize the existing permitted operational condition of BCSS and effects of BCSS closure that are expected to continue during Project operations.

Project operation impacts, including changes induced from BCSS closure as described in Section 7.1.2.1, to the condition of surface water resources are considered in the following subsections, as appropriate:

- Surface water hydrologic alterations (Section 5.2.1.1)
- Surface water use (Section 5.2.2.1)
- Surface water quality (Section 5.2.3.1)

5.2.1 HYDROLOGIC ALTERATIONS

This subsection presents an analysis of the water use impacts of Project operation in consideration of the phased implementation period and baseline conditions described in Section 5.2. The analysis of operational effects on surface water and groundwater hydrology resources described in this section are based on the affected environment described in Chapter 2. Where appropriate, supplemental analyses are also provided that summarize the BCSS Continuous Maximum Generation Condition as well as the characteristics of the lake based on a condition in which BCSS has ceased operations.

Specific effects of BCSS closure relevant to surface water and groundwater hydrology include the following (with description of how effects relate to the Project):

- Belews Lake water levels are no longer influenced by BCSS consumptive uses (similar effects continue with Project operations).
- Water circulation in Belews Lake is no longer influenced by BCSS Condenser Cooling Water (CCW) intake and discharge flow (effects not prevalent in Project operations).

5.2.1.1 Surface Water

Operational activities may impact surface waters within the Project site, Belews Lake, and the Dan River. These surface waters are directly connected with discharges from Project operation activities and water withdrawn from the Dan River and Belews Lake. Operations-related effects associated with stormwater runoff within the Project site are also evaluated.

5.2.1.1.1 Project Site

As described in Section 4.2.1, the NDA is the entire permanently disturbed area within the Project site (Figure 4.2-1). As described in Section 3.1.5 the approximate 906-ac. (367-ha) NDA encompasses the South, Middle, and North Plant Complex areas. An approximate 100-foot (ft.) (30.5-meter [m]) vegetative buffer zone is retained as part of the operations as an undisturbed area along most of the shoreline of Belews Lake.

In conjunction with Project site building activities, an engineered stormwater collection system is developed to manage stormwater that includes a combination of swales, retention and detention basins, pipes, and culverts. Sediment and erosion control measures are designed to minimize discharge of sediments and site runoff to Belews Lake. Sedimentation basins installed during the building phase may be converted to detention or retention facilities for the permanent stormwater management system during the operational period. Other building phase stormwater facilities may be temporary or converted to permanent stormwater management facilities. Section 3.4.3.3.3.2 describes the stormwater system and BMPs to channel stormwater as required. Localized hydrologic alterations including flow patterns and sedimentation occur within Belews Lake where stormwater is integrated into Belews Lake.

Duke Energy maintains an existing general stormwater permit authorization for the BCSS condition, NCS000573, which complies with both NC water quality standards (WQSs) and federal permitting requirements. Duke Energy plans to either submit a modification request for this permit or terminate this permit and request a new National Pollutant Discharge Elimination System (NPDES) Permit from the North Carolina Department of Environmental Quality

(NCDEQ) for discharge of stormwater associated with industrial activity subject to the requirements of 15A North Carolina Administrative Code (NCAC) 02H.0126 (NCDEQ, 2017).

A small portion of the Project site is located in Forsyth County. Forsyth County is a tipped county which means it is subject to the post-construction portion of the municipal separate storm sewer system requirements of 15A NCAC 02H.1017. The requirements only apply to industrial stormwater discharged into surface waters without the watershed water supply classifications of I through IV (Table 2.2-22) (NCDEQ, 2017). The additional monitoring and BMP requirements from 15A NCAC 02H.1017 are incorporated into future permitting and stormwater management operational programs as applicable.

5.2.1.1.2 Belews Lake

This subsection assesses Project-related effects on surface water hydrology of Belews Lake. During the phased implementation period, the effects of reduced BCSS operations coupled with partial Project operations (a portion of the advanced reactor units) are expected to result in hydrologic effects that differ from those of the base condition described in Section 2.2.1.1. and further discussed in Section 5.2.1.1.2.1. The use of mechanical draft cooling towers in conjunction with Project operations results in increased consumptive water uses (and related hydrologic alterations) (Section 3.2.2 and Section 3.2.3).

Full Project consumptive uses for the advanced reactors exceed those that may be expected during the phased implementation period in which any combination of both BCSS and advanced reactors may be operating in a manner that replaces and balances overall generation capacity. As evident in Table 5.2-1, the total consumptive water use (consumptive withdrawals and forced evaporation) for Belews Lake during full Project operations exceeds that of BCSS operations. For the BCSS operations, the total consumptive use includes the forced evaporation in addition to the consumptive use for flue gas desulphurization (FGD) unit operations, and other in-plant uses.

In conjunction with the phased implementation period, consumptive uses associated with BCSS operations decline as they are correlated with generation capacity. Concurrent consumptive uses associated with Project operations increase as additional advanced reactor units are brought online. However, at no time does the sum of consumptive uses from BCSS operations coupled with Project operations exceed the full Project operational consumptive use (see Table 5.2-1). This consumptive use increase during full Project operations represents the bounded condition and results in increased Belews Lake drawdown levels during drought periods as described below.

Therefore, the impacts of operations captured in Section 5.2.1.1.2.2 are based only on full Project operational water use, which represents a bounded condition for the assessment of impacts associated with hydrologic alterations.

Hydrologic Model Development

The comprehensive hydrologic model was developed to effectively characterize the hydrology of Belews Lake and serve as a tool for predictive analysis of potential project effects. The model is a spreadsheet analysis of Belews Lake mass balance using a monthly time step. The model solves the water balance equation for each month based on the inflows, lake level, and outflows

and provides output regarding Belews Lake levels /storage. Elements of the model inputs/outputs include the following:

Inflows

- Runoff to Belews Lake
- Precipitation
- MWIS pumping from the Dan River

Outflows

- Belews spillway release
- Spillway gate leakage
- Natural lake evaporation
- Forced evaporation
- Consumptive withdrawal
- Seepage through dam
- Net seepage loss to groundwater

The model also provides a characterization of Dan River hydrology and diversion, an analysis of Belews Lake historic water budget, and a predictive analysis of Belews Lake water levels under various MWIS pumping conditions. For the historic condition (1997-2024), the model solves for the Belews Lake watershed runoff based on end-of-month lake level (and associated storage volume). Model scenarios include the BCSS historical conditions, the BCSS Continuous Maximum Generation Condition, and the Project operations condition.

For the future conditions, a longer period of model simulation was incorporated to capture more historic drought periods by using a surrogate Belews Creek watershed runoff record. The USGS Reedy Fork near Oak Ridge streamflow station record extending back to 1956 was substituted for the estimated Belews Lake watershed runoff record from the Historic Condition model, resulting in a 68-year future condition simulation period (1956-2024). The Reedy Fork near Oak Ridge streamflow record was selected from numerous regional USGS streamflow station records. It was used based on its similarity to the estimated Belews Lake watershed runoff on a unit drainage area basis (i.e., cfs/sq mi). The Reedy Fork near Oak Ridge station is also located only approximately 7 mi (11.3 km) from the center of the Belews Lake watershed. The model runoff rate transferred to the Belews Lake runoff was also modified by a scaling factor to make the long-term runoff equivalent to the estimated Belews Lake watershed long-term average runoff from 1997 to 2024.

The Belews Lake elevation – surface area – storage volume relationship in the model is defined by a set of equations for the initial lake condition (no sedimentation) and for selected assumed sedimentation storage loss assumptions in subsequent years.

Analyses of regional streamflow characteristics is an essential step in development of the model. Information characterizing regional streamflow serves three purposes. First, it facilitates selection of a net seepage loss rate that is considered most likely in combination with the Belews Lake watershed back-calculated runoff rate. Second, it allows selection of one or more regional streams as surrogate streams having a lengthy flow record encompassing multiple significant drought periods. The longer surrogate streamflow record is then substituted for the back-calculated Belews Lake watershed historic runoff data to predict Belews Lake storage levels under modeled future conditions. The third use of the regional streamflow information is to identify regional streamflow data useful in extending the short Dan River flow record at the Dan River at Pine Hall gage for use in the modeled future condition water balance model to estimate the ability of the Dan River to augment Belews Lake storage while meeting existing NPDES permit limitations for the MWIS operation.

5.2.1.1.2.1 Permitted Uses of Belews Lake Under BCSS Operations

Water levels within Belews Lake are managed by Duke Energy in conjunction with Project operations. Descriptions of the hydrology and other physical characteristics are included in Section 2.2.1.1.3.1 and Section 2.2.1.1.3.2, respectively. As described in Section 2.2.1.1.3, the Belews Lake surface area at full lake level is approximately 3862 ac. (1562.9 ha).

As described above, a comprehensive hydrologic model evaluates relevant inputs and outputs (i.e., direct precipitation onto the lake surface, stream inflow, consumptive losses from water use, natural evaporation, forced evaporation, seepage losses, and supplemental pumping from the Dan River) using average monthly data to evaluate long-term hydrologic characteristics of Belews Lake and the Dan River. Table 5.2-1 presents the parameters considered for the hydrologic model for each model scenario.

As is summarized in Section 2.2.1.1.3.1.2, the hydrologic model was calibrated using Belews Lake hydrologic conditions for the 27-year historical period from 1997 to 2024 based on historical operations of BCSS (i.e., the historical conditions). The historical condition model calculated the Belews Lake watershed runoff for the study period based on various observed and estimated data for other water balance parameters as an initial step before applying the calibrated model to the other hypothetical conditions (i.e., model scenarios). The 27-year historical conditions model established an estimate of the Belews Lake watershed runoff rates. The estimated runoff rates were subsequently used to select a surrogate U.S. Geological Survey long-term regional streamflow station with similar runoff rates to construct a long-term Belews Lake hydrologic model to predict lake water levels and discharges for modeled future conditions. For this assessment of Project operational effects, a 68-year long simulation period based on data from 1956 through 2024 was used to evaluate all model scenarios—other than the 27-year historical conditions model.

Figure 2.2-9 provides a characterization of the varying Belews Lake water levels over the historical modeling period. The end-of-month water levels plotted are measured water levels. This figure also depicts the primary inflow component (i.e., watershed runoff) and outflow component (i.e., spillway releases). BCSS consumptive uses over the historic period illustrated in Figure 2.2-9 result in noticeable water-level fluctuations within Belews Lake during periods of increased drought severity. Table 5.2-2 summarizes the range of water-level reductions from full pond level of 725.0 feet (ft.) (220.97 m) under the BCSS historical period for mild (e.g., 2-year drought recurrence), moderate (e.g., 10-year drought recurrence), and extreme (e.g., 100-year drought recurrence) drought conditions. The minimum observed water level that occurred during the conditions of the drought in 2002 and 2003 was 7.4 ft. (2.26 m) below full pond level. The extended critical drought period under the historical BCSS operational period was observed to be 23 months. For the historical BCSS conditions, the total consumptive use (including forced evaporation) for the 1997 to 2024 period was approximately 27 cfs (0.76 m^3/s), the spillway release was approximately 28.9 cfs (0.82 m^3/s), and the Dan River diversion using the temporary pumping systems averaged approximately 1.5 cfs (0.042 m^3/s).

While the BCSS capacity factor has lessened in recent years, BCSS operates with a NCDEQ NPDES permit that supports full operational capacity of the BCSS plant. The NPDES permit allows for up to 100 cfs (2.83 m^3/s) of pumping by the makeup water intake structure (MWIS). However, a model pumping rate of 80 cfs [2.27 m^3/s] was used as a bounding value to evaluate the effect on lake levels. Under this modeled operational condition of supplemental pumping of

water by the MWIS (the BCSS Continuous Maximum Generation Condition), BCSS consumptive uses result in noticeable water-level fluctuations within Belews Lake during periods of increased drought severity as illustrated in Figure 5.2-1.

Table 5.2-2 summarizes the range of water-level reductions from full pond level of 725.0 feet (ft.) (220.97 m) under the BCSS Continuous Maximum Generation Condition for mild (e.g., 2-year drought recurrence), moderate (e.g., 10-year drought recurrence), and extreme (e.g., 100-year drought recurrence) drought conditions. The minimum predicted level that is consistent with the conditions of the drought that occurred in 2002 and 2003 was 8.2 ft. (2.50 m) below full pond level. The extended critical drought period under the BCSS Continuous Maximum Generation Condition is estimated to be 22 months. For the BCSS Continuous Maximum Generation Condition, the total consumptive use (including forced evaporation) is approximately 43.3 cfs (1.23 m^3/s), the spillway release is approximately 19.4 cfs (0.55 m^3/s), and the MWIS diversion rate is approximately 7.8 cfs (0.21 m^3/s).

The predictive analysis based on the BCSS Continuous Maximum Generation Condition is similar to that observed for the BCSS historic condition due to the contributing effect of supplemental MWIS pumping from the Dan River to augment the lake levels.

5.2.1.1.2.2 Belews Lake Hydrology Under Project Operations

5.2.1.1.2.2.1 Project Water Uses

Belews Lake is the cooling water source for the Project during operations. As described in Section 3.4.1.1, water interfaces as part of the plant cooling water system include the MWIS located at the confluence of the Dan River and Belews Creek which discharges to Belews Lake near the spillway (Figure 2.2-3), an intake structure in Belews Lake common to all units, and cooling water system discharge(s) to Belews Lake. Two locations are being considered for the Belews Lake intake structure as illustrated in Figure 4.2-1. Section 3.2.2.4.3 describes two cooling tower blowdown discharge options to Belews Lake: either a single combined discharge structure or three separate cooling tower blowdown discharge structures, one for each Plant Complex (Figures 3.1-1 and 4.2-1). Table 3.4-1 identifies the consumptive use from cooling tower evaporation and cooling tower blowdown rates. The MWIS provides supplemental pumping from the Dan River to augment water levels within Belews Lake (see Section 5.2.1.1.3.2). Operating limitations of the MWIS are outlined in the existing NPDES permit as described in Section 3.4.1.1.2.

Cooling tower makeup water is pumped from Belews Lake via the intake structure as indicated on Figure 2.2-13. The inlet to the intake is connected to the shoreline pumping station by a buried conduit (Figure 3.2-1). Water depths in the vicinity of the cooling tower blowdown structures for each discharge are identified in Figure 2.2-14. The offshore inlet and discharge locations are in deep water, within the hypolimnion below the thermocline that may be present at the lowest simulated drought lake level (Table 5.2-4).

Circulation refers to the pattern and magnitude of currents internal to Belews Lake, including natural currents driven by runoff inflows and wind-driven currents, and man-made currents due to discharges and withdrawals. Neither current measurements nor a hydrodynamic model are available to quantify circulation. However, conceptual circulation patterns can be reliably identified based on the locations and magnitudes of inflows and outflows.

Pumping water by the intake structure results in alterations of flow patterns in the vicinity of the offshore intake structure. Additionally, the Project discharges are located such that the positively buoyant effluents mix rapidly with the colder hypolimnion water. The effects of these alterations are localized and minor during typical lake conditions. When runoff inflows are elevated, those inflows dominate the circulation with lake currents all following the natural downstream flow pattern to the spillway. As described in Section 2.2.1.1.3.2.2, under periods of low and normal watershed runoff to Belews Lake, the BCSS CCW system creates a counterclockwise flow circulation pattern with recirculated CCW flowing southwest through the lower West Belews Creek embayment to the BCSS intake

Under the Project condition with no BCSS cooling discharge, circulation in Belews Lake is influenced by the locations of the intake and the discharges, as well as the MWIS discharge location near the spillway. During low watershed runoff conditions, circulation in Belews Lake is influenced by the locations of the intake and the discharges, as well as the MWIS discharge location near the spillway.

However, the magnitude of flow changes by each of these influences is minor in comparison to the existing flows that result from BCSS operations. For example, the maximum BCSS circulating water flow is approximately 2300 cfs, whereas the influencing flows of Project features (see Figure 3.2-4) are substantially lower: maximum intake flow: approx. 90.5 cfs, maximum discharge flow: approx. 14 cfs, maximum MWIS flow into Belews Lake: up to 100 cfs. As such, the resulting dry weather average flow velocities through the Belews Creek arm of the reservoir are negligible as compared to circulation in conjunction with BCSS operations

5.2.1.1.2.2.2 Belews Lake Water Levels

During Project operations, Belews Lake provides water for cooling tower operations and is the source for the water processing plant (Figure 3.2-4). Table 5.2-1 compares the Project conditions to the other modeled scenarios. For the Project Condition, the consumptive use for the Project is approximately 60.7 cfs (1.72 m^3/s), the spillway release is approximately 12.5 cfs (0.34 m^3/s), and the MWIS diversion rate is approximately 18.2 cfs (0.52 m^3/s). Other hydrologic components of the Belews Lake water balance are relatively unchanged. The Project Condition average MWIS diversion rate from the Dan River is 10.4 cfs (0.29 m^3/s) larger than the BCSS Continuous Maximum Generation Condition diversion but well within the existing, permitted limitations.

Operational use of water from Belews Lake for the Project results in fluctuations of water levels. Figure 5.2-2 depicts the modeled water levels of Belews Lake for the Project Condition based on the same rate of MWIS supplemental pumping as that for the BCSS Continuous Maximum Generation Condition. Table 5.2-2 summarizes the range of water-level reductions from full pond level of 725.0 ft. (220.97 m) under Project operations for mild (e.g., 2-year drought recurrence), moderate (e.g., 10-year drought recurrence), and extreme (e.g., 100-year drought recurrence) drought conditions. The minimum observed water level that is consistent with the conditions of the drought that occurred in 2002 and 2003 was 13.1 ft. (2.26 m) below full pond level of 725 ft. (220.98 m). The estimated extended critical drought period under the Project operational period was approximately 31 months.

As described in Section 5.2.1.1.2.2.1, supplemental water is pumped from the Dan River via the MWIS to Belews Lake to maintain lake levels in accordance with normal operations and existing

NPDES permit conditions. Duke Energy's NPDES permit for the MWIS allows for a maximum pumping capacity of up to 100 cfs (2.83 m^3/s) from the Dan River to Belews Lake; however, analyzing a pumping rate of 80 cfs (2.27 m^3/s) provides a more conservative bounding condition to assess hydrologic alterations to Belews Lake from Project operations while providing margin to the 100 cfs (2.83 m^3/s) permitted limits, further minimizing impacts on the Dan River.

Figure 5.2-2 depicts the modeled water levels of Belews Lake under Project operations. This predicted pattern of change in water levels within Belews Lake is similar to the predicted pattern of water levels under existing operations of the BCSS at full capacity under the same NPDES permitted MWIS pumping scenario (i.e., 80.0 cfs [2.27 m^3/s]) (Figure 5.2-1). Because the rate of consumptive water use under Project operations (i.e., approximately 61.0 cfs [1.73 m^3/s] including forced evaporation) is greater than that of the BCSS Continuous Maximum Generation Condition (i.e., approximately 43.0 cfs [1.22 m^3/s] including forced evaporation), Project water use during operations results in lower minimum Belews Lake levels compared to the predicted BCSS Continuous Maximum Generation Condition (Table 5.2-1).

The Belews Lake water levels for the three conditions (BCSS historic, BCSS Continuous Maximum Generation Condition, and Project Condition) for the period 1996 – 2025 are plotted together on Figure 5.2-3. Overall, the Belews Lake water levels are variable and have a predicted potential lower minimum level during Project Condition relative to other modeled scenarios as a result of increased consumptive use. Under each scenario, alterations of Belews Lake water levels are noticeable during periods of increased drought severity but are not considered to be destabilizing. The modeled future predictive analysis based on Project operation indicates lake water-level fluctuations similar to those predicted for BCSS Continuous Maximum Generation Condition. However, the water-level drawdowns under Project operations are more pronounced relative to the BCSS Continuous Maximum Generation Condition and increased by 0.6 ft and 3.0 ft, for the 2-year and 100-year drought return periods, respectively.

The increased operation of the MWIS minimizes the reduction in lake levels from the increased consumptive use. The predicted Belews Lake level fluctuations during Project operations are similar to the BCSS Continuous Maximum Generation Condition but result in somewhat greater drawdowns and an extended critical drought duration relative to the BCSS Continuous Maximum Generation Condition. Overall, however, lake hydrologic function and water levels are generally maintained by the operation of the MWIS, which minimizes the reduction in lake levels from the increased consumptive use. Therefore, impacts on water levels from Project operations are noticeable during periods of increased drought severity, but are not considered to be destabilizing.

5.2.1.1.2.3 Effects of Sediment Transport from the Dan River

As described in Section 2.2.1.1.3, Belews Lake continues to accumulate sediment transported into the lake from the watershed tributaries and shoreline erosion. Conditions contributing to the rate of sediment influx to the lake from these sources are unaffected by the Project operations. Watershed contribution is subject to potential increase if watershed development occurs that may result in increased streamflow rates that result in channel adjustments and increase in erosion. The other source of sediment influx to the lake is the MWIS in conjunction with Project operations.

In conjunction with supplemental pumping from the Dan River, MWIS operations result in the entrainment of sediment and pumping into Belews Lake. The sediment concentration in the pumped diversion flow is dependent upon the sediment concentration in the river. The Dan River suspended sediment concentration increases with river flow. The sediment load discharged to the lake varies only slightly with variable MWIS pumping capacity. The sediment load to the lake at any given time is dependent on the river suspended sediment concentration and the pumping rate. The estimated average annual sediment load via the MWIS is approximately 500 to 550 tons (454 to 499 kilograms [kg]) per year, or approximately 0.42 to 0.47 acre-feet (ac-ft) (518 to 579 cubic meters [m^3]) per year if the average sediment deposit density is 60 pounds per cubic foot (961 kg per m^3). This average annual sedimentation rate is approximately 1.4 percent of the assumed sedimentation rate based on a watershed contribution of 0.52 ac-ft per square mile per year (640.0 $m^3/km^2/yr$) (Section 2.2.1.1.3.2.3.2). Therefore, the impacts of sediment entrainment from the Dan River on Belews Lake are negligible.

5.2.1.1.3 Dan River

5.2.1.1.3.1 Makeup Water Intake Structure Operation

As part of Project operations, diversion pumping via the MWIS will be permitted in accordance with an NPDES permit issued by the NCDEQ. Because of the phased implementation of Project operations with BCSS closure, the effects of this action are consistent with the BCSS Continuous Maximum Generation Condition. The existing permit will be modified for the inclusion of operation of advanced nuclear reactors and is expected to maintain the existing, conservative conditions regarding pumping rates, seasonal restrictions, and amount of bypass flow required in the Dan River as are currently authorized for operation of the BCSS as described in Section 3.4.1.1.2. Relevant conditions similar to those that are in place for existing BCSS operations are considered to be effective for Project operations and are effective for maintaining sufficient water to support aquatic habitat and river discharge characteristics. Specifically, NCDEQ has created a target flow recommendation for this site in the Dan River of 110 cfs (3.11 m^3/s) (NCDEQ, 2025a). This flow value was developed in consultation with the U.S. Fish and Wildlife Service, North Carolina Wildlife Resources Commission, U.S. Army Corps of Engineers (USACE), NCDEQ, and Duke Energy.

Under Project operations, the installed pumping capacity of the MWIS is increased to allow for pumping of up to the amount allowed by the NPDES permit. Diversion at the maximum allowable flow (100 cfs [2.83 m^3/s]) from the Dan River via the MWIS was selected as a bounding value for the purpose of assessing impacts on downstream water users. While MWIS operations include diversion pumping at a wide range of river flow conditions, low flow levels critical to water uses and supply on the Dan River were considered in this analysis.

At higher river flows, pumping by the MWIS has no significant impact of downstream river flows. For example, for a river flow of 1000 cfs (28.3 m^3/s), the minimum downstream flow is 900 cfs (25.4 m^3/s), which is 90 percent of the natural flow. This value is well above natural low flow conditions and has no identified significant adverse impacts. The long-term average is provided in Table 2.2-3. The geomorphic bankfull discharge, the flow identified as most representative of the flow controlling the physical channel conditions through sediment transport, is estimated to be in the range of 5000 cfs to 8000 cfs (142 m^3/s to 227 m^3/s) based on regional hydraulic geometry relationships (Harman, 2024; Page et al., 2024).

The MWIS operation impact on the Dan River annual minimum average monthly flow probabilities under BCSS Continuous Maximum Generation Condition and Project Condition are illustrated on Figure 5.2-4 and in Table 5.2-3. Based upon the statistical characterization of flow in Figure 5.2-4, it is observed that there is not a notable difference from the natural flow condition of water availability downstream of the MWIS for monthly average river flows greater than 350 cfs (9.91 m^3/s) or less than 110 cfs (3.11 m^3/s). Consequently, for Project operations there is a lesser effect on the annual minimum monthly low flow greater than approximately 350 cfs (9.91 m^3/s) and no impact on flows below 110 cfs (3.1 m^3/s), as no pumping is allowed when river flow is 110 cfs (3.11 m^3/s) or lower.

Accordingly, the range of flows of potential concern for impacts by operation of the MWIS are between 110 cfs (3.11 m^3/s) and approximately 350 cfs (9.91 m^3/s). Low flow conditions occurring during the months of July through November (months 7 to 11) are most subject to effects of pumping (Figure 5.2-4). For example, the effects of MWIS pumping are identified in Figure 5.2-4 under moderately low flow conditions when the Dan River discharge is between approximately 350 cfs (9.91 m^3/s) and the NCDEQ NPDES permit target minimum flow of 110 cfs (3.11 m^3/s). This target minimum flow is 30 cfs (0.85 m^3/s) higher than the summer 7-day duration, 10-year return period (7Q10) 80 cfs (2.27 m^3/s) flow (NCDEQ, 2025b). Table 5.2-3 summarizes the monthly average low flows on the Dan River downstream of the MWIS under BCSS Continuous Maximum Generation Condition, Project Conditions, and natural flow conditions. Notably, the 110 cfs (3.11 m^3/s) flow rate is close to the 25-year low flow identified in Table 5.2-3. Greater effects are evident under conditions corresponding to a return period range of 5 to 10 years, in which the flow in the Dan River is reduced by approximately 30 cfs (0.85 m^3/s). In contrast, the effect on the 2-year return period (or more frequent conditions) is an approximate 25 cfs (0.71 m) reduction. For return periods greater than approximately 25 years there is even less, or zero, effect on downstream water availability. That occurs because in that low flow range the diversion rate is controlled by regulatory limits and not the pumping capacity.

Overall, MWIS pumping results in hydrologic alterations on the Dan River that affect river discharge downstream of the MWIS. However, such alterations do not noticeably alter the general hydrologic functions of the Dan River related to water availability, geomorphic processes, and sediment transport function. Operation of the Project conforms with the existing NPDES permit requirements effective for the BCSS and is not anticipated to further impact water levels on the Dan River. Therefore, impacts of MWIS pumping on the hydrology of the Dan River are minor.

5.2.1.1.3.2 Discharge to Dan River

Figure 3.2-4 shows the projected normal and maximum operational flow rates to and from the various water systems, the source water for each system, and the receiving body of water for liquid discharges. Table 3.4-1 summarizes the projected normal and maximum operational flow rates to the Dan River that include liquid discharges which may consist of intermittent cooling tower blowdown, miscellaneous power plant systems (water processing plant, fire protection system, sanitary waste, etc.), and the liquid radioactive waste.

As described in Section 5.2.3.1.2.2, Project nonradioactive discharges are routed through the existing Outfall 006. Liquid radioactive wastes are routed through a new discharge in a corridor adjacent to existing Outfall 006 and are diluted with cooling tower blowdown discharge. Discharges to the Dan River result in localized changes in flow patterns, currents, and total flow.

The approximate maximum discharge to the Dan River is approximately 25 percent of the Dan River Summer 7Q10 80 cfs (2.27 m^3/s) flow, approximately 3 percent of the average 665 cfs (1.48 m^3/s) flow, and approximately 0.4 percent of the geomorphic bankfull flow of approximately 5000 cfs (141.58 m^3/s).

A fraction of the discharge, after mixing with the river flow, may be pumped to Belews Lake during periods when the MWIS is simultaneously operating. Potential effects of normal operations related to the discharge of low-level liquid radiological waste streams are evaluated in Section 5.9. Duke Energy will evaluate administrative and engineering controls regarding discharge and MWIS operations to minimize the potential for transport of radionuclides from the Dan River to Belews Lake. Additionally, as summarized in Section 5.9.6, a radiological monitoring program inclusive of the Dan River and Belews Lake will also be implemented in conjunction with Project operations.

Discharge flow rates are regulated in conjunction with NCDEQ NPDES permitting requirements. As such, overall effects from hydrologic alterations are controlled and minor.

5.2.1.1.4 Transmission Corridors

As discussed in Sections 1.1.5 and 3.2.4, additional transmission lines that extend outside of the existing Project site boundary are not required. Transmission lines are not anticipated to affect hydrological conditions.

5.2.1.1.5 Summary of Hydrologic Alterations to Surface Waters

Hydrologic alterations in Belews Lake and the Dan River result from operation of the intake and discharge structures within Belews Lake, increased consumptive water use within Belews Lake, MWIS operation which transfers water from the Dan River into Belews Lake, and wastewater discharges into the Dan River.

The effects of Project operations on flow and circulation patterns within Belews Lake as a result of intake, discharge, and MWIS are localized and minor. Additionally, the potential impacts of sediment transport into Belews Lake from the MWIS operation are negligible. Belews Lake water levels are noticeably altered as the result of increased consumptive use from Project operations.

Discharge into the Dan River results in localized changes in flow patterns, currents, and total flow and discharge flow rates are regulated in conjunction with NCDEQ NPDES permitting requirements and are expected to be similar to the existing Outfall 006 wastewater discharge. Therefore, the hydrological impacts of discharge are minor. Pumping by the MWIS results in minor hydrologic alterations on the Dan River during higher flow conditions. Pumping by the MWIS is not allowed when natural discharge is less than 110 cfs (3.11 m^3/s).

Overall, Project operations result in increased predicted water-level variations as a result of increased consumptive use. MWIS operation mitigates the reduction in lake levels from the increased consumptive use. The predicted pattern of water levels during Project operations is similar to the BCSS Continuous Maximum Generation Condition, but results in somewhat greater drawdowns and an extended critical drought duration relative to the BCSS Continuous Maximum Generation Condition. Overall, however, lake hydrologic function and features are

generally maintained by operation of the MWIS that mitigates the reduction in lake levels from the increased consumptive use.

The overall impacts on hydrologic alterations to surface waters are SMALL for all Project operations except for the effects associated with consumptive use including that on Belews Lake and the MWIS operations on the Dan River. Under conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping, impacts on Belews Lake hydrology are SMALL. During periods of increased drought intensity, the impacts on Belews Lake hydrology are MODERATE.

5.2.1.2 Groundwater

There are few hydrologic alterations that affect groundwater availability during operations. No groundwater use or dewatering occurs during operation that may affect local aquifers. However, as mentioned in Section 4.2.1.2, building activities result in the development of permanent use areas within the NDA. While specific details of site layout within the NDA have not yet been fully designed, it is expected that the permanent use areas consist of land uses that are impervious to groundwater infiltration. As described in Section 3.1.5 approximately 906 ac. (367 ha) is designated for permanent disturbances such as the power blocks, cooling towers, laydown areas, and switchyards. Impervious surfaces from the development of these areas results in reduced infiltration and groundwater recharge in the immediate area of these structures. Other lands within the NDA are expected to allow for varying degrees of groundwater infiltration and recharge. Surface water that does not infiltrate to groundwater is managed as stormwater runoff and ultimately discharged to Belews Lake. In locations where groundwater recharge is affected, corresponding effects (reductions) in groundwater levels may occur. Overall impacts on groundwater levels are expected to be minor. Therefore, impacts of hydrologic alteration on groundwater from operations are SMALL.

5.2.2 WATER USE IMPACTS

This subsection presents an analysis of the water use impacts from Project operation. Section 5.2 describes the phased approach and Section 2.2 describes the baseline conditions to which Project impacts are compared.

The analysis of operational effects on surface water resources described in this section are based on the affected environment described in Chapter 2. Where appropriate, supplemental bounding analyses are also provided that summarize the BCSS Continuous Maximum Generation Condition as well as the characteristics of Belews Lake based on a condition in which BCSS has ceased operations.

Specific effects of BCSS closure relevant to water use include the following (with description of how effects relate to Project):

- Reduced consumptive water use by BCSS to support FGD operations, forced evaporation, and other water uses (similar effects continue with Project operations).
- Authorized pumping operations associated with the MWIS on the Dan River are transferred to Project operations (effects transition to Project operations).

5.2.2.1 Surface Water

Withdrawal of surface water conducted to support Project operations, which includes water to support the cooling water system and other plant systems, is described in Section 3.4. The anticipated normal and maximum operational flow rates are provided in Table 3.4-1 and illustrated in Figure 3.2-4. For this analysis, impacts to water use associated with operational activities are assessed and quantified by water source.

5.2.2.1.1 Belews Lake

Water use of Belews Lake includes Duke Energy use for thermoelectric power generation and public use for recreational purposes. Thermoelectric power generation includes the use of water for cooling. Details regarding water use for the cooling system associated with Project operation are discussed further below in Section 5.2.2.1.1.1. Details regarding water use for recreation are discussed further in Sections 5.2.2.1.1.2 and 5.4.4.2.

5.2.2.1.1.1 Cooling System

Belews Lake is the principal source of consumptive and nonconsumptive water use for the Project as shown in Figure 3.2-4 and Table 3.4-1. As stated in Section 2.2.2.1.3.2, Belews Lake is designed and built specifically for thermoelectric power generation and does not supply any other water users besides Duke Energy.

As described in Section 5.2.1.1.2.2.2, operational use of cooling water from Belews Lake for the Project results in drawdown of water levels. However, as described in Section 5.2.1.1.2.1, BCSS operates with an NCDEQ NPDES permit that supports the full operational capacity of the BCSS plant. Because of the phased implementation of Project operations with BCSS closure, the capacity for MWIS pumping in accordance with the NPDES permit is extended during the Project operations phase. As described in Section 5.2.1.1.2.1, the MWIS has a permitted limit of 100 cfs (2.83 m^3/s), but a model pumping rate of 80 cfs (2.27 m^3/s) was used as a bounding value to evaluate the effect on lake levels.

Section 5.2.1.1.2.2 describes the supplemental water pumping from the Dan River via the MWIS to Belews Lake to maintain lake levels in accordance with normal operations and existing NPDES permit conditions. Duke Energy's NPDES permit for the MWIS allows for a maximum pumping capacity of 100 cfs (2.83 m^3/s) from the Dan River to Belews Lake; however, a pumping rate of 80 cfs (2.27 m^3/s) provides a more conservative bounding condition to assess hydrologic alterations to Belews Lake from Project operations as it provides a margin to the 100 cfs (2.83 m^3/s) permitted limits, further limiting the impacts on the Dan River. The MWIS is operated in accordance with the conditions of the NPDES permit and the MWIS operating plan to manage Belews Lake levels.

Figure 5.2-2 depicts the modeled water levels of Belews Lake based on supplemental pumping of the MWIS under Project conditions. Section 5.2.1.1.2.2.2 describes the effects of Project operations on the Belews Lake water levels. A comparison of Project operations and the BCSS Continuous Maximum Generation Condition is provided in Tables 5.2-1 and 5.2-2.

Overall, Belews Lake water use as supplemented by MWIS operation is increased compared to the BCSS Continuous Maximum Generation Condition. While hydrologic alterations are noticeable during periods of increased drought severity as described in Section 5.2.1.1.5, the

alterations do not affect the availability of water in Belews Lake to support Project operations. As is described in Section 3.2.2.4.1 and illustrated in Figure 3.2-1, the water intake to the facility is at an adequate depth to not affect full rated power generation capabilities of the facilities during analyzed drought conditions. As such, consumptive use in conjunction with Project operations does not impact water availability and does not preclude the capacity for Belews Lake to continue to provide a reliable source for cooling water in support of thermoelectric power generation (Section 2.2.2.1.4.1). Impacts on water use are therefore minor.

5.2.2.1.1.2 Recreation

The impact to recreational use of Belews Lake from operation of the Project is described in Section 5.4.4.2. Changes in water levels have related effects on recreational use that include those related to boater and pedestrian access to the lake, reduced accessibility to the upper arms of Belews Lake, potential for boater safety hazards, alterations to aesthetic viewsheds, affects to the aquatic ecosystem including recreational and sport fishing, and effects of noise from operating cooling towers. Overall effects of Project operations on recreation are evaluated in Section 5.4.4.2.

5.2.2.1.2 Dan River

As described in Section 2.2.2.1.2.1 the Dan River is used by several downstream communities as a water supply system. These communities include the Town of Madison, NC, City of Eden, NC, and Danville, Virginia (see Table 2.2-20 and Figure 2.2-31). Additionally, the Dan River is a recreational resource that provides opportunities for paddling, canoeing, tubing, fishing, and kayaking (Section 2.4.2.6.2). Potential direct and indirect water use impacts associated with Project operations include those related to the operation of the MWIS and the wastewater pipeline as discussed in the following subsections.

Estimates of Dan River flow available downstream of the MWIS to downstream water users during facility operation are based on existing Dan River flow data from Section 2.2.1.1.2, water use associated with the MWIS and applicable permit limitations regarding Dan River flow.

5.2.2.1.2.1 Effects of MWIS Operation on Dan River Water Users

Section 3.4.1.1.2 describes the existing and permitted MWIS pumping capacity. Even with fluctuations in withdrawal rates resulting from pump performance variability, water withdrawal at the MWIS is less than the maximum withdrawal limit of 100 cfs (2.83 m^3/s), or 64.63 million gallons per day (mgd) (244,658 cubic meters per day [m^3/d]), allowed by the NPDES permit for withdrawals from the Dan River. For this analysis a pumping rate of 100 cfs (2.83 m^3/s) is used as a bounding condition by which to assess hydrologic alterations and water use within the Dan River.

The MWIS operational impact on the Dan River flow operations are discussed in Section 5.2.1.1.3.1. The MWIS operational impact on the Dan River natural and after-diversion annual minimum monthly average flow probabilities are illustrated on Figure 5.2-4 and in Table 5.2-3.

The nearest downstream surface water user on the Dan River is the Town of Madison. The Madison Water Treatment Plant intake is located approximately 8 river miles downstream of the Pine Hall Station (USGS Station No. 02069000) and has a capacity to withdraw 2.3 cfs (0.065 m^3/s) from the Dan River, corresponding to 2.1 percent of the 110 cfs (3.11 m^3/s) Dan River flow

at which MWIS pumping is not allowed.. As provided in Table 2.2-1, the drainage basin area at the Pine Hall Stream Station is 501 mi^2 (1297 km^2) whereas the drainage basin area at the Madison Water Treatment Plant intake is approximately 594 mi^2 (1538 km^2). As such, flow contributions provided by the added drainage basin area between the Pine Hall Stream Station and the Dan River confluence with the Mayo River is minor and downstream water users within this reach predominantly rely on flows influenced by MWIS operation. Ultimately, the Town of Madison's capacity, in addition to other downstream water users, to obtain water is not diminished provided they have implemented water supply systems capable of withdrawing water during minimum 7Q10 low flow conditions in compliance with 15A NCAC 18C.0403 (NCDEQ, 2019). Project operation has no impact on water levels downstream of the MWIS under minimum low flow conditions.

Although MWIS operation reduces the water available to downstream water users, this reduction does not compromise the overall availability or reliability of surface water to users downstream of the Project. Therefore, the overall impacts of MWIS operation on downstream water use by communities is minor.

5.2.2.1.2.2 Recreation

The impact of Project operations on recreational use of the Dan River is described in Section 5.4.4.2. The existing Outfall 006 and the new Dan River outfall within the wastewater pipeline corridor, along with the existing MWIS structure locally affect the area. Additionally, the MWIS operation may reduce water availability for recreators impacting recreation within the Dan River. However, as described in Section 5.2.1.1.3.1, MWIS operation does not affect naturally occurring low flow conditions on the Dan River because pumping is not allowed under conditions in which the natural river discharge is below 110 cfs (3.11 m^3/s). Water levels and availability of the Dan River results in minor effects to Dan River recreation under either low flow conditions or during MWIS use. Although MWIS operation reduces the water available to downstream water users, this reduction does not compromise the overall availability or reliability of surface water to users downstream of the Project. Overall effects of Project operations on recreation are evaluated in Section 5.4.4.

5.2.2.1.3 Municipal Water Impacts in the Project Vicinity

Duke Energy obtains municipal water from Winston-Salem/Forsyth County for Project operation. Winston-Salem/Forsyth County has an existing maximum treatment capacity of 91 mgd (approximately 344 million liters per day) and withdraws water from the Yadkin River and Salem Lake (Winston-Salem, 2023). Table 3.4-1 shows the expected maximum and average withdrawal rates for Project operations. Municipal water use associated with the operation of the Project is a minute percentage of existing municipal potable water capacity and does not destabilize the ability of the municipality to meet the needs of other users. Therefore, the impact on municipal water users is minor.

5.2.2.1.4 Water Use Impacts Summary

Belews Lake consumptive water use, as supplemented by MWIS operation, results in increased water uses as described in Section 5.2.1. However, consumptive uses do not affect the availability of water in Belews Lake to support Project operations. As such, consumptive use in conjunction with Project operations does not adversely affect the availability of water for Project

intake systems. Impacts on water use of Belews Lake are therefore, SMALL. Although MWIS operation reduces the water available to downstream water users, this reduction does not compromise the overall availability or reliability of surface water to users downstream of the Project. Impacts of MWIS operation on downstream water use by communities are SMALL.

Therefore, overall impacts of Project operations on surface water use are SMALL.

5.2.2.2 Groundwater

No groundwater from on-site or off-site sources is used during operation of the Project. Furthermore, no permanent dewatering system is planned for use during operations. Therefore, impacts of groundwater use from operations are SMALL.

5.2.3 WATER QUALITY IMPACTS

This subsection presents an analysis of the water quality impacts of Project operation as compared to the phased approach and baseline conditions described in Section 5.2. These include the impact of operational water use on water quality that could affect the use of water by other users.

The analysis of operational effects on surface water resources described in this section are based on the affected environment described in Chapter 2. Where appropriate, supplemental analyses are also provided that summarize a condition in which BCSS has ceased operations.

Specific effects of BCSS closure relevant to water quality include the following (with description of how effects relate to the Project):

- Water quality that is no longer influenced by the effects of wastewater discharges from fossil fuel power generation. This includes the elimination of inputs from the emergency spillway of the South Coal Pile Basin, treated FGD wet scrubber wastewater, once-through non-contact chiller water, industrial stormwater, and once-through condenser cooling water and intake screen backwash. These effects are generally absent during Project operations.
- Lake water temperatures that reflect characteristics of a lake lacking substantive thermal input from power generation. These effects are generally absent during Project operations.

5.2.3.1 Surface Water

5.2.3.1.1 On-site Streams

The remaining streams on the Project site not impacted by building activities, discussed in Section 4.2.3.1.1, are potentially impacted during operation by industrial stormwater runoff.

As described in Section 5.2.1.1.1, Duke Energy maintains an existing NPDES stormwater permit which is updated as needed to adequately address the potential operational industrial stormwater impact to remaining on-site streams. Duke Energy maintains a stormwater pollution prevention plan (SWPPP) in conjunction with the individual NPDES Industrial Stormwater General Permit to control pollutants in stormwater discharges associated with industrial activity

and implement and manage appropriate BMPs during operations. Existing site storm drainage outfalls may be modified and new outfalls built to route stormwater to either the on-site streams or Belews Lake. Duke Energy maintains an operational spill prevention, control, and countermeasure (SPCC) plan which prevents spilled oil from being released into receiving waters.

Compliance with NCDEQ permit requirements, NPDES permits, and stormwater BMPs maintain water quality in the on-site streams during Project operations. The impact from industrial stormwater and operational activities is therefore minor.

5.2.3.1.2 Belews Lake

As illustrated in Figure 2.2-16, July 2002 surface temperature observations in Belews Lake demonstrate elevated summer water temperatures in the West Belews Creek arm and other areas of Belews Lake as the result of BCSS operations.

As described in Section 5.3.2.1.2.1.1, existing elevated summer temperatures within Belews Lake may be stressful to aquatic biota, whereas elevated winter temperatures may extend the growth season. As a result of BCSS closure, lake-wide temperatures begin to cool upon the beginning of the phased implementation period and are notably cooler following the phased in period. Loss of substantive thermal inputs from power generation result in overall benefits regarding water quality and conditions of reduced stress on aquatic biota during the summer but may potentially reduce or alter the spawning season due to lower winter temperatures for some species.

Thermal stratification profiles in Mayo Reservoir, a lake similar to Belews Lake but with minimal anthropogenic heat load, were reviewed to provide a potential prediction of the stratification dynamics of Belews Lake in the absence of the contributing heat load from BCSS (Table 5.2-4). The observed profiles for Belews Lake and for Mayo Reservoir reflect a generally similar trend in temperature, but with relatively consistent differences as shown in Figure 5.2-5 and Figure 5.2-6 in which temperatures in Mayo Reservoir are generally cooler than those of Belews Lake.

5.2.3.1.2.1 Cooling Tower Blowdown

5.2.3.1.2.1.1 Phased Implementation Period

As described in Section 5.2.1.1.2, Duke Energy considered the hydrologic characteristics of the phased implementation period and determined that because full Project operations are associated with maximum consumptive use, it represents a bounded condition for the assessment of impacts associated with hydrologic alterations and water use. Therefore, hydrologic modeling analyses were based on Project conditions only, as they represent a bounded impact relative to the phased implementation period.

Likewise, for the analysis of potential impacts on the water quality of Belews Lake, Duke Energy considered attributes of cooling water discharged from BCSS operations and the effects of cooling tower blowdown from Project Operations within Belews Lake.

Under existing conditions, the BCSS CCW outfall discharges to West Belews Creek arm where thermal effluents dissipate widely. Thermal effluent within the CCW flow is then conveyed via the CCW canal to the main Belews Creek arm of the lake. Belews Lake is strongly stratified in

summer months (see Figure 2.2-18), which limits the interaction between surface water (epilimnion) and deeper water (hypolimnion). Therefore, the effluents conveyed by the CCW canal are effectively a surface discharge that enters the Belews Creek arm epilimnion with little or no mixing occurring within the hypolimnion. Consequently, the hypolimnion temperatures of the Belews Creek arm are not substantially influenced by BCSS discharges.

In conjunction with the phased implementation period, BCSS operations are reduced (relative to the BCSS Continuous Maximum Generation Condition) and offset by Project operations. Duke Energy plans to balance overall generation at Belews Lake between BCSS and the Project, meaning that as new advanced reactors are brought online, a corresponding amount of BCSS generation is taken offline. As a result, the thermal load to Belews Lake is substantially reduced. This reduced thermal load correspondingly reduces environmental impacts relative to the existing condition described in Chapter 2. Subsections 2.2.3.1.2 and 2.2.3.1.5.1 describe the existing thermal conditions within Belews Lake under existing BCSS operations that represent a condition that bounds thermal effects during the phased implementation period.

In contrast to existing BCSS operations, Project cooling tower blowdown discharges are conveyed at depth to the hypolimnion of the Belews Creek arm of Belews Lake via gravity pipe conveyance(s). Mixing of the cooling tower blowdown to achieve the regulatory temperature excess criterion of 2.8 degrees Celsius (°C) (5.04 degrees Fahrenheit [°F]) is completed entirely within the hypolimnion and is not mixed with the epilimnion. Additionally, during the phased implementation period, the introduction and use of advanced reactor units are phased into operation in a manner that balances the net generation as BCSS is derated. Therefore, Project-related thermal inputs are correspondingly limited and reduced relative to the full BCSS Continuous Maximum Generation Condition and are further described in Section 5.2.3.1.2.1.2.2. The BCSS once-through cooling-water-per-kilowatt heat load to Belews Lake is substantially greater than the per-kilowatt power generation from the advanced reactors because of the use of the cooling towers. Therefore, as each advanced reactor unit is placed into operation during the phased implementation period, the heat load to Belews Lake is correspondingly reduced by derating BCSS operations. Therefore, based on the heat loads and plume characteristics, only the Project full generation condition discharges were modeled.

In summary, no specific thermal model analyses of the phased implementation period discharges to Belews Lake are necessary, and was therefore not completed, because the effects of the bounded thermal condition as described in Chapter 2 had previously been evaluated. Specifically:

- The full operational BCSS discharge to Belews Lake (as represented in Chapter 2 under existing conditions) defines the bounding condition for temperature characteristics of Belews Lake. BCSS plant operations result in a substantially larger thermal load (flow rate and temperature excess) as compared to the full Project.
- BCSS thermal CCW effluents are discharged to the West Belews Creek arm where they dissipate. Thermal effluent within the CCW flow enters the Belews Creek arm where thermal effluents are substantially confined to the epilimnion.
- The phased implementation period consists of notably lower thermal effluents from BCSS and relatively minor Project-related thermal discharges that are substantially unmixed.

- Project operations have a lower per-kilowatt power generation heat contribution compared to the existing BCSS. Therefore, the thermal load during the phased implementation period is reduced as the Project operations come online and BCSS is derated.
- Both the phased implementation period and Project operations have a lower thermal load generated compared to full BCSS operations. Therefore, thermal impacts to Belews Lake are bounded by the existing condition (Chapter 2).
- Full Project operations result in maximum cooling tower blowdown flows and thermal loading that are significantly lower than existing BCSS operations.
- Project cooling tower blowdown effluents are mixed within the hypolimnion and do not substantially affect or mix with the epilimnion.

5.2.3.1.2.1.2 Full Project Operations

As discussed in Section 3.4.1.1.4 conceptual cooling tower discharge designs being considered for Belews Lake include a base discharge design consisting of separate individual discharges for each of the three Plant Complexes. The blowdown for each of the three Plant Complexes discharge via gravity to Belews Lake. An alternative design includes combining the blowdown from each of the three Plant Complexes into a combined discharge located northeast of the most northern Plant Complex as shown on Figure 3.1-1. While blowdown is predominately returned to Belews Lake, blowdown flow may be diverted to the Dan River in a discharge outfall located within the existing corridor adjacent to Outfall 006 as described in Section 5.2.3.1.4.1.

The average and maximum flow rates for the discharges to Belews Lake are described in Table 3.4-1, and the anticipated water treatment chemicals are provided in Table 3.2-1. Table 3.4-3 presents the concentrations of anticipated blowdown constituents. As described in NUREG-1437, Rev. 1, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, surface water quality impacts may occur from the concentration and discharge of chemicals added to the recirculating cooling water to prevent corrosion and biofouling. Table 5.2-5 compares the expected cooling tower blowdown concentrations with applicable U.S. Environmental Protection Agency (USEPA) water quality criteria for human health and aquatic life, and NC water quality criteria for domestic water and surface water, fish, and aquatic life. It includes the most restrictive water quality criteria values for the applicable designated uses.

A supplemental Cornell Mixing Zone Expert System (CORMIX) water quality analysis evaluated the impact of selected cooling tower blowdown constituents that are discharged to Belews Lake. CORMIX is a widely used model developed with support from the USEPA beginning in the 1970s. The model is currently available as proprietary software from MixZon. CORMIX is an expert system model for analyzing discharge plumes. The model performs steady-state hydraulic analyses and can model both near-field and far-field plume regions. The expert system first determines a flow classification for each portion of the plume being analyzed. It then selects the appropriate mixing algorithm for each segment. The CORMIX model was used to analyze the near-field discharges of the cooling tower blowdown discharged to Belews Lake. As described in Subsection 5.2.3.1.2, the thermal stratification profiles in Mayo Reservoir were reviewed to provide a prediction of the stratification dynamics of Belews Lake in the absence of the contributing heat load from BCSS. All CORMIX modeling analyses were conducted only for Project conditions at Belews Lake.

5.2.3.1.2.1.2.1 Analysis of Cooling Tower Blowdown Constituents

Table 5.2-5 identified six constituents in the cooling tower blowdown that exceed NCDEQ regulatory criteria (chronic or acute): copper, cadmium, lead, selenium, total dissolved solids (TDS), and zinc. Copper and cadmium were the two selected water quality constituents for near-field mixing evaluation based on the discharge concentrations being above NCDEQ regulatory criteria (chronic or acute values) among the parameters in Table 5.2-5. Temperature was also selected as a constituent and is discussed further in Section 5.2.3.1.4. CORMIX mixing results are presented in Table 5.2-6 for both the individual discharge scenario and combined discharge scenario. Based on the analysis, a regulatory mixing zone is required during operation for both the combined discharge and individual discharge scenarios to satisfy regulatory requirements.

The term mixing zone in the following discussions refers to a general area within which mixing occurs that is similar to typical regulatory mixing zones defined by federal and state guidance and regulatory documents. It is different than a regulatory mixing zone which is established through the NPDES permitting process with certain length, width, and cross-sectional area limitations. No regulatory mixing zone has been identified through the CORMIX analyses performed for proposed permitting.

Section 3.2.2.4.3 describes two discharge options for cooling tower blowdown to Belews Lake. Based on the CORMIX mixing analysis, there are effectively no substantive differences in near-field mixing predictions for the individual discharges. Should operations discharge to a combined outfall, the only difference in CORMIX model near-field mixing predictions to the individual discharge scenario is that the combined effluent is influenced by the additional discharge momentum due to the combined flow. The larger jet requires slightly more distance than the smaller jets for a given downstream dilution to be attained as shown in Table 5.2-6 and Figure 5.2-7.

Wastewater discharges from the Project are regulated by the NCDEQ through an existing NPDES permit as described in Table 1.4-2. An NPDES permit includes discharge limits established to protect receiving waters and monitoring to ensure compliance with those limits. Chemical concentrations for discharges comply with the terms and conditions of the NPDES permit with the use of a regulatory mixing zone.

Section 3.4.3.1 describes the established Water Chemistry Program that covers cooling tower operations for the existing nuclear fleet to ensure NPDES compliance. The program utilizes several administrative procedures to ensure regulatory compliance and describes the implementation for treatments, maintenance, and testing best suited for the site-specific design and environment.

A summary of the curvilinear distance and vertical plume rise for constituents which exceeded water quality criteria and were evaluated with CORMIX are found in Table 5.2-6. Table 5.2-6 demonstrates that constituents which may exceed WQSs are rapidly diluted within a mixing zone defined based on typical regulatory mixing zones dimensions. The other cooling tower blowdown constituents satisfy existing NPDES discharge limits and are managed under the established Water Chemistry Program, to ensure continued compliance. Therefore, cooling tower blowdown operations have limited water quality impacts and the impact from cooling tower blowdown chemical constituents to Belews Lake is minor.

5.2.3.1.2.1.2.2 Thermal Impacts

As described in Section 5.2.3.1.2.1 and Figure 3.2-4, cooling tower blowdown is routed to Belews Lake and has a peak temperature of 95ºF (35ºC). Discharged wastewater is permitted under the NCDEQ NPDES program and is subject to the NCDEQ temperature narrative standard requirements of 15A NCAC 02B.0211 (18), which states: “Temperature: not to exceed 2.8°C (5.04°F) above the natural water temperature and in no case to exceed 32°C (89.6°F) for lower piedmont and coastal plain waters.” Belews Lake was permitted and constructed as a cooling impoundment and was created solely for the purpose of serving as part of the BCSS cooling water system (HDR, 2022). Under the existing BCSS NPDES permit, the point of thermal compliance for Belews Lake is located on Belews Creek at the dam spillway.

Because of the phased implementation of Project operations with BCSS closure, thermal discharges from BCSS operations are discontinued. As described in Section 7.1.2.1.2, surface water temperatures are reduced (cooler). The CCW discharge would cease, and heated effluent would no longer disperse within the West Belews Creek arm or be conveyed via the CCW canal to the Belews Creek arm as illustrated in Figures 2.2-16 and 2.2-17 (summer and winter temperatures, respectively). General cooling would occur within each reach of Belews Lake until temperatures equilibrate within the lake. Spatial variability in temperature conditions within Belews Lake that are evident under BCSS operations would normalize such that each area of the lake would reflect conditions that are not influenced by the thermal discharges from BCSS. Water temperatures within the West Belews Creek arm of Belews Lake would resemble those observed in the other areas of Belews Lake. As summarized in Section 7.2.2.3, because of the effects of BCSS closure and the minimal effects of plant operations, the cumulative effects on surface water quality in Belews Lake are LARGE and beneficial.

As described in Section 5.2.3.1.2.1, a CORMIX water quality mixing analysis evaluated the near-field (i.e., the lake volume close to the discharge structures) impact of discharging cooling tower blowdown into Belews Lake. The evaluation included estimated projections for wastewater discharge during summer and winter drought conditions as well as normal summer operating conditions.

The CORMIX analyses identified the dimensions of a mixing zone, where applicable, at each discharge to meet regulatory standards. Table 5.2-7 provides a summary of the curvilinear distance and vertical plume rise required to reduce the temperature excess to 2.8°C (5.04°F) above ambient condition. The CORMIX near-field modeling indicates that either of the two basic cooling tower blowdown discharge options, a single combined discharge for all Plant Complexes (i.e., Combined Discharge) or three separate discharges (i.e., South, Middle, and North Discharge), satisfactorily mix the cooling tower blowdown in the near field as well as minimize the chance of direct recirculation with the cooling tower makeup intake location. Therefore, CORMIX predictions indicate the thermal plume disperses rapidly and effects are localized. Therefore, the effects of thermal discharges on Belews Lake are minor.

The impact of thermal discharge on recreation is discussed in Section 5.4.4.2.1.

5.2.3.1.2.2 Nonradioactive Liquid Discharge

As shown in Figure 3.2-4 and described in Section 3.4.1.1, while Belews Lake receives non-radioactive cooling tower blowdown discharges, it does not receive nonradioactive liquid waste

discharges from Project operations. As described in Section 3.4.3.3.3, nonradioactive liquid waste discharges (e.g., turbine building sumps, groundwater sumps, and water treatment discharges) are routed to the consolidated sump, where they undergo treatment before discharging to the Dan River. Liquid effluent discharges are managed in accordance with the Project site-issued NPDES permit.

5.2.3.1.2.3 Supplemental Pumping from the Dan River

As described in Section 5.2.1.1.3.1, pumping from the Dan River into Belews Lake via the MWIS is conducted during operations to supplement lake levels. The periodic addition of Dan River water via the MWIS has the potential to introduce additional trace metals and other contaminants to Belews Lake.

Duke Energy evaluated the impact on Belews Lake from temporary MWIS pumping over three separate periods from December 2002 through March 2009. Section 2.2.3.1.3.3 describes the previous evaluations of the potential effects of supplemental pumping from the Dan River on Belews Lake water quality which determined the impact was temporary and localized to the makeup water discharge location (Figure 2.2-3). The 2008 temporary pumping report noted a long-term, slight upward trend in lake-wide specific conductance thought to be linked to evaporative concentration caused by the preceding drought and not the temporary pumping contribution (Finley, 2008).

As part of the permitting requirements described in Section 2.2.4.1.1, Duke Energy has produced periodic Dan River monitoring reports once per permit cycle to address the potential effects of selenium, arsenic and mercury (NCDEQ, 2025a). The original monitoring plan also suggested cadmium, copper and zinc be included in the analysis (NCDEQ, 1983). The most recent report for a monitoring period between 2019 and 2022 found that all fish collected were below the USEPA's screening value for arsenic, mercury, and selenium (Duke Energy, 2023). As part of the preapplication monitoring of water quality within the Dan River, as summarized in Section 2.2.3, Duke Energy measured arsenic, selenium, cadmium, copper, zinc, and mercury. Each of these target metals were below the NCDEQ aquatic freshwater standard. Based on periodic fish tissue monitoring and data from the preapplication monitoring program within the Dan River, it is not expected that constituent accumulation would occur within Belews Lake as a result of increased MWIS operations.

Section 5.2.1.1.3.1 describes the MWIS NPDES permitting requirements during Project operation which limit the volume and time period in which water may be transferred into Belews Lake. Duke Energy is required to perform routine semi-annual lake monitoring to assess limnological conditions in Belews Lake as a result of pumping which minimizes the potential for unknown, long-term potential impacts (NCDEQ, 2025a). Nonradiological chemical constituents within the Dan River are not appreciably different from Belews Lake, and the Dan River does not have any measured metal accumulation impacts. Historical monitoring demonstrates MWIS operation has only a localized, temporary impact on Belews Lake water quality; therefore, the impact from supplemental pumping is expected to be minor. Potential impacts are mitigated via NPDES permit requirements and limnological monitoring.

Potential sedimentation impacts to Belews Lake as a result of MWIS operation are described in Section 5.2.1.1.2.2.2.

5.2.3.1.3 Summary of Surface Water Quality Impacts on Belews Lake

Direct effects of operation on water quality within Belews Lake include the addition of cooling tower blowdown wastewater constituents, reduced thermal load and supplemental pumping from the Dan River. The additional wastewater discharges are not expected to accumulate and will meet NPDES permitting limits and requirements within a regulatory mixing zone, which will be established during the permitting process. Section 5.2.4.1.2 describes monitoring programs to ensure regulatory compliance. Therefore, the overall impacts on surface water quality are considered SMALL. However, as summarized in Section 7.2.2.3, because of the effects of BCSS closure in substantially eliminating thermal contributions to Belews Lake and the minimal effects of plant operations, the cumulative effects on surface water quality in Belews Lake are LARGE and beneficial.

5.2.3.1.4 Dan River

As described in Section 3.4.1.1 and shown on Figure 3.2-4 water quality within Dan River may be impacted by wastewater discharge consisting of cooling tower blowdown, treated liquid radwaste, water processing plant wastewater, MWIS operation, and sanitary waste.

5.2.3.1.4.1 Cooling Tower Blowdown

As discussed in Section 5.2.3.1.2.1 and shown on Figure 3.2-4, the discharge design concept may route a portion of cooling tower blowdown to the Dan River in a corridor adjacent to existing Outfall 006 to support water quality strategies and provide dilution for treated liquid radiological waste.

As stated in Section 5.2.3.1.2.1, six cooling tower blowdown constituents exceed NCDEQ regulatory criteria. A CORMIX supplemental water quality analysis evaluated the impact of cooling tower blowdown discharge into the Dan River. Copper, cadmium, and TDS were selected as the water quality constituents mixing evaluation based on the discharge concentrations being above NCDEQ regulatory criteria (chronic or acute values) among the parameters in Table 5.2-5. Temperature was also selected as a constituent and is discussed further in Section 5.2.3.1.4.4. CORMIX mixing results are presented in Table 5.2-8 and Table 5.2-9 and determined a mixing zone is required to achieve water quality compliance.

As described in Section 3.4.1.1.4, cooling tower blowdown directed to the Dan River in a corridor adjacent to existing Outfall 006 occurs intermittently which limits potential impacts. Duke Energy maintains several Dan River monitoring programs to assess the impact of metals accumulation within the Dan River and ensure Project operational discharges do not destabilize existing water quality conditions as described in Section 5.2.3.1.2.3. Should impacts be measured, additional BMPs would be considered to mitigate impacts on Dan River water quality.

Duke Energy's wastewater discharges are regulated by the NCDEQ through an existing NPDES permit as described in Section 2.2.3.1.3.2. An NPDES permit includes discharge limits established to protect receiving waters and monitoring to ensure compliance with those limits. Chemical concentrations for discharges comply with the terms and conditions of the NPDES permit with the use of a regulatory mixing zone.

A summary of the direct distance for the select constituents which exceeded water quality criteria and were evaluated with CORMIX are found in Table 5.2-8. Table 5.2-8 demonstrates that constituents which may exceed WQSs are rapidly diluted within a mixing zone of similar size to typical riverine regulatory mixing zones. The other cooling tower blowdown constituents satisfy existing NPDES discharge limits and are managed under the established Water Chemistry Program, as described in Section 5.2.3.1.2.1, to ensure continued compliance. Additional engineering or administrative controls are evaluated, as needed, if further mitigation is required based on the results of the operational water monitoring program described in Section 5.2.4.1.2. Therefore, cooling tower blowdown operations have limited water quality impacts, and the impact from cooling tower blowdown chemical constituents to the Dan River is minor.

5.2.3.1.4.2 Nonradioactive Liquid Discharge

As described in Section 3.4.3.3.3, nonradioactive liquid waste discharges (e.g., turbine building sumps, groundwater sumps, and water treatment discharges) are routed to the consolidated sump, where they undergo treatment before discharging to the Dan River. Liquid effluent discharges are managed in accordance with the Project site-issued NPDES permit.

As discussed in Section 3.4.3.3.3 and illustrated in Figure 3.2-4, nonradioactive liquid waste from Project operations, including industrial stormwater, sanitary waste, and other conventional liquid discharge streams, is routed to the consolidated sump, where it undergoes treatment before discharging to the Dan River via Outfall 006.

Duke Energy's liquid effluent discharges are regulated via an existing NPDES permit as described in Section 5.2.3.1.2.1. The current permit does not include a Dan River regulatory mixing zone. Duke Energy's industrial stormwater discharges are also regulated via an existing NPDES permit. Existing site storm drainage outfalls may be modified, and outfalls built to route stormwater to the Dan River where applicable.

Effluent characteristics and concentrations are managed using appropriate engineering controls in a manner that complies with both state WQSs and federal permitting requirements. Water quality in the Dan River is maintained with the added discharge due to compliance with NCDEQ permit requirements and the impact is minor.

5.2.3.1.4.3 Liquid Radwaste Discharge

As described in Section 3.4.2.4 and Figure 3.2-4, liquid low-level radioactive waste is collected and treated in accordance with the requirements of 10 CFR Part 20 and the "as low as is reasonably achievable" (ALARA) principles of Title 10 CFR Part 50, Appendix I. The bounding annual release of radioactivity in liquid effluents from the proposed Project site is provided in Table 3.4-4, and the bounding average annual liquid effluent release of radioactivity from a single advanced reactor is shown in Table 3.4-5. The potential impact of liquid radwaste discharge is further discussed in Section 5.9. Duke Energy will evaluate administrative and engineering controls as needed regarding discharge and MWIS operations to minimize the potential for transport of radionuclides from the Dan River to Belews Lake. Additionally, as summarized in Section 5.9.6, a radiological monitoring program inclusive of the Dan River and Belews Lake will also be implemented in conjunction with Project operations.

5.2.3.1.4.4 Thermal Impacts

As described in Section 5.2.3.1.4.1 and Figure 3.2-4, a portion of cooling tower blowdown may be discharged to the Dan River in a corridor adjacent to existing Outfall 006. Cooling tower blowdown thermal characteristics and permitting limits are described in Section 5.2.3.1.2.4.

As described in Section 5.2.3.1.4.1, a CORMIX water quality analysis evaluated the impact of discharging cooling tower blowdown into the Dan River. The blowdown is used for dilution of liquid low-level radiological wastewater. The evaluation included estimated projections for wastewater discharge during Dan River summer and winter 7Q10 low-flow condition.

The analyses were based on the following:

- Winter and summer conditions, including 7Q10 river flows and a water temperature not more than 21°F (11.7 °C) (summer) and 28°F (15.6 °C) (winter) above ambient river values.
- Initial temperature excess based on monthly 0.4% probability exceedance wet bulb temperatures and resulting blowdown temperatures,
- Estimated monthly minimum river temperatures based on the monthly air temperature related to the cooling tower wet bulb temperature and 100% relative humidity that maximizes the initial temperature excess.
- Effluent discharge rate based on the bounding rate of 9450 gpm (20.1 cfs or 0.60 m^3/s) (including cooling tower blowdown dilution flow).
- Compliance with the regulatory thermal limitation (2.8°C [5.04°F]) and a potential regulatory mixing zone based on typical length, width, and cross-sectional area limitations of three times the channel width, 50% of the channel width, and 33% of the channel cross-sectional area, respectively.

The CORMIX analyses identified the dimensions of an assumed regulatory mixing zone, where applicable, to assess potential regulatory requirements. Table 5.2-9 provides a summary of the direct distance from the end of the pipe to the end of the mixing zone required to reduce the temperature excess to the regulatory criterion of 2.8°C (5.04°F) above ambient. The CORMIX modeling indicates that wastewater, including blowdown, discharged into the Dan River satisfactorily mixes with river flow. There is a fully-vertically mixed condition in the diffuser jet and plume due to the shallow river depths at low flows, including the winter 7Q10 flow. Therefore, the effects of thermal discharges on the Dan River are minor.

The impact of thermal discharge on recreation is discussed in Section 5.4.4.2.2.

5.2.3.1.4.5 Summary of Surface Water Quality Impacts on Dan River

Direct effects of operation on surface water quality within the Dan River include the addition of cooling tower blowdown wastewater constituents and thermal load and nonradioactive liquid discharges.

Dan River Project operational impacts to water quality are mitigated through engineering and administrative controls and monitoring programs as described in Section 5.2.4.1.2. The additional wastewater discharges are managed within NPDES permitting limits and requirements; therefore, overall impacts of surface water quality are SMALL.

5.2.3.2 Groundwater

Accidental spills of materials such as diesel fuel, hydraulic fluid, or lubricants are unlikely during operations. However, if they occur, impacts are minimized by appropriately designed containment systems and established procedures for cleanup in accordance with a SPCC plan, as described in Section 4.2.3.2. Although actions outlined in an SPCC plan are primarily intended to prevent spilled oil from being released into receiving waters, they also mitigate impacts to local groundwater because accidental spills are quickly attended to and not allowed to penetrate though the soil surface into groundwater. Because the engineering controls described above prevent or minimize the release of harmful effluents, and because concentrations of constituents in surface water are maintained at levels below permitted limits, any impacts to groundwater quality are SMALL.

5.2.4 WATER MONITORING

5.2.4.1 Surface Water Monitoring

This section describes the monitoring programs Duke Energy uses to provide for protection of waterbodies that may be affected during operation of advanced reactors and to obtain timely and accurate information so that actions can be taken to limit operational impacts. This section discusses the thermal and chemical monitoring programs, as applicable, for surface water and groundwater at the Project site and the Dan River. Methodologies and constituents included as part of the operational radiological monitoring program are described in Section 5.9. Operational monitoring programs are compared to baseline conditions to identify potential concerns and take appropriate actions toward limiting the impact on both surface water and groundwater resources. The proposed surface water monitoring program will be submitted at the construction permit or license application phase.

5.2.4.1.1 Preoperational Monitoring Program

The purpose of the preoperational monitoring program is to establish baseline surface water conditions at each of the proposed reactor locations at the North, Middle, and South Complex areas before operation.

Duke Energy monitors existing locations as described in Section 2.2.4.1.1 throughout the preoperational monitoring program. Additional monitoring locations may be included with respect to the surface water preoperational monitoring program following technology selection and final design. Details of the preoperational monitoring program are defined following technology selection and include thermal, chemical, and radiological monitoring as needed. As part of the program, a monitoring plan is developed to specify locations, sampling frequencies, sampling protocols, and quality assurance procedures for sampling and analysis. Samples are analyzed for standard water quality parameters (temperature, pH, conventional pollutants), metals, and selected radionuclides following the guidance of NUREG-1555, Initial, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants* as described in Section 2.2.4.1.2.

5.2.4.1.2 Operational Monitoring Program

Duke Energy maintains NPDES wastewater permit NC0024406 and NPDES stormwater permit NCS000573. An operational monitoring program will be developed as part of its existing wastewater and stormwater NPDES permit applications to include the discharges described in Section 3.4.1.1 and Figure 3.2-4. There is currently no operational Project, so potential additional monitoring requirements for operation of advanced reactors are not included. Discharge of cooling water and other effluents during operations is subject to monitoring to ensure compliance with all federal, state, and local discharge requirements. Discharge of cooling water and other effluents during operations is subject to monitoring to ensure compliance with the NPDES permit.

Regular monitoring is required to ensure that liquid effluent discharges comply with the conditions of the NPDES permit for plant wastewater and stormwater. The specific requirements for hydrologic monitoring, water quality parameters, number of stations, station locations, frequency and method of measurement, and equipment type are specified in the NPDES program. Temperature and contaminant concentration limits will be established, along with modeling efforts needed to demonstrate compliance, and reflected in the NPDES permit.

It is anticipated that the surface water monitoring locations monitored during operation are the same locations used during the preoperational monitoring program. The operational monitoring program cannot be defined until a reactor design is selected but includes thermal, radiological, and chemical monitoring. As part of the program, a monitoring plan would be developed for specific locations, sampling frequencies, protocols, and procedures for sampling and analysis.

5.2.4.2 Groundwater

Duke Energy will prepare preoperational and operational monitoring programs for hydrological and water quality monitoring to establish a baseline for groundwater characteristics to identify impacts to the groundwater during plant operation. Methodologies and constituents included as part of the operational radiological monitoring program are described in Section 5.9. The preoperational and operational monitoring programs cannot be defined until a technology has been selected. These monitoring programs will be developed following the guidance of NUREG-1555. The proposed groundwater monitoring program will be submitted at the construction permit or license application phase.

5.2.4.2.1 Preoperational Monitoring Program

Duke Energy's preoperational monitoring program may consist of a subset of groundwater observation wells used in the preapplication monitoring program as described in Section 2.2.4.2, as well as additional wells depending on the future technology chosen. The purpose of the preoperational monitoring program is to establish baseline groundwater conditions at each of the proposed reactor locations at the North, Middle, and South complex areas before operation. Samples are analyzed for standard water quality parameters (i.e., temperature, pH, conventional pollutants) and metals following the guidance of NUREG-1555. Groundwater elevations will also be measured monthly from the monitoring wells chosen for this preoperational monitoring program. Parameters include selected radionuclides and other parameters, as appropriate and as described in Section 2.2.3.2.

5.2.4.2.2 Operational Monitoring Program

It is anticipated that the groundwater wells that are monitored during operation may be the same wells used during the preoperational monitoring program as well as additional wells depending on the future technology chosen. The operational monitoring program cannot be defined until a reactor design is selected but includes water level and chemical monitoring. As part of the program, a monitoring plan would be developed to specific locations, sampling frequencies, protocols, and procedures for sampling and analysis.

Table 5.2-1
Belews Lake Long-Term Water Balance Components

Parameter	Model Scenario		
	Historical (Actual)[a]	**BCSS Continuous Maximum Generation Condition (Permit)**[b,c]	**Project Condition**[c]
MWIS Pumping Rate (cfs)	(temp. pumps)	80[d]	80[d]
Watershed Runoff (cfs)	68.5	68.4	68.4
Direct Precipitation (cfs)	19.5	19.8	19.5
Dan R Diversion (cfs)[e]	1.5	7.8	18.2
Total Inflow (cfs)	**89.4**	**96.1**	**106.1**
Consumptive Withdrawal (cfs)	10.2	18.3	60.7
Forced Evaporation (cfs)	16.8	25.0	0.2
Subtotal Consumptive Use (cfs)	***27.0***	***43.3***	***60.9***
Natural Evaporation (cfs)	16.9	16.9	16.6
Spillway Release (cfs)	28.7	19.4	12.5
Gate Leakage & Dam Seepage (cfs)	7.8	7.8	7.7
Net Seepage Loss (cfs)	8.8	8.8	8.6
Storage Change (Initial - Final) (gallons)	0.0	-0.1	-0.1
Total Outflow (cfs)	**89.2**	**96.1**	**106.1**
Average Water Level (ft.)[f,g]	723.81 (1.19)	723.76 (1.24)	723.03 (1.97)
Minimum Water Level (ft.) (EOM)[f,g]	717.59 (7.41)	716.76 (8.24)	711.89 (13.11)
Water Level (1%) (ft.)[f,g,h]	718.98 (6.02)	718.67 (6.33)	714.67 (10.33)
Water Level (2%) (ft.)[f,g,h]	720.38 (4.62)	720.57 (4.43)	718.21 (6.79)
Water Level (5%) (ft.)[f,g,h]	721.27 (3.73)	721.18 (3.82)	719.52 (5.48)
Water Level (10%) (ft.)[f,g,h]	722.25 (2.75)	721.72 (3.28)	720.43 (4.57)
Water Level (50%) (ft.)[f,g,h]	724.32 (0.68)	724.07 (0.93)	723.01 (1.99)

Notes:
(a) Based on actual historical BCSS operations 1997 – 2024.
(b) Based on BCSS continuously operating at 100% capacity and permitted conditions.
(c) Based on simulated data from data obtained from 1956 through 2024.
(d) 80 cfs is the bounding condition for Belews Lake MWIS diversions.
(e) Dan River Diversion is the calculated average diversion rate.
(f) Lake level (lake level drawdown below 725.0 ft.).
(g) Parenthetical value is the drawdown (ft.) below the full lake level (725.0 ft.).
(h) Percentile value of the total dataset from 1956 through 2024.
Key: cfs = cubic feet per second; EOM = End of Month; ft. = feet; MWIS = Makeup Water Intake Structure; NA = Not Applicable; temp. = temporary

Table 5.2-2
Belews Lake Minimum Level Frequencies (Minimum Water Levels in ft. NAVD 88)
(Sheet 1 of 2)

	Historical (Actual)[a]		BCSS Continuous Maximum Generation Condition [b,c,d]		Project Condition[c,d]		
	Elevation	Drawdown[e] (ft.)	Elevation	Drawdown[e] (ft.)	Elevation	Drawdown[e] (ft.)	Change Relative to BCSS Continuous Maximum Generation Condition (ft.)
MWIS Pump Capacity (cfs):	(temp. pumps)		80[d]		80[d]		
2-Year[f]	723.26	1.7	722.19	2.8	721.56	3.4	-0.6
5-Year[f]	721.67	3.3	721.20	3.8	720.03	5.0	-1.2
10-Year[f]	720.47	4.5	720.45	4.5	718.87	6.1	-1.6
25-Year[f]	718.88	6.1	719.46	5.5	717.35	7.6	-2.1
50-Year[f]	717.69	7.3	718.72	6.3	716.20	8.8	-2.5
100-Year[f,g]	716.50	8.5	717.97	7.0	715.05	10.0	-3.0
Minimum Observed / Predicted[h]	717.59	7.4	716.8	8.2	711.89	13.1	-4.9
Critical Drought Duration[i]	23 months		22 months		31 months		
End Date of Critical Drought	April 2003		January 2003		January 2013		

Table 5.2-2
Belews Lake Minimum Level Frequencies (Minimum Water Levels in ft. NAVD 88)
(Sheet 2 of 2)

Notes:
(a) Based on actual historical BCSS operations 1997 – June 2024.
(b) Based on BCSS continuously operating at 100% generation capacity and permitted conditions.
(c) Based on data from simulation period 1956 through 2024.
(d) MWIS rate of 80 cfs (2.26 m^3/s) is the bounding condition for Belews Lake MWIS diversions.
(e) Full Pond level is defined as an elevation of 725.0 ft. Drawdown is the difference between the full pond level of 725.0 ft and the predicted pond elevation.
(f) Drought Event Recurrence Condition.
(g) 100-year minimum lake level estimates are approximate, based on simple regression equation fit to annual minimum lake level versus Weibull plotting position.
(h) Data obtained from Table 5.2-1.
(i) Based on drought period lake drawdown below water level 724.0 ft; duration in months.

Key: "--" = Not applicable or evaluated; BCSS = Belews Creek Steam Station; cfs = cubic feet per second; ft = feet; m^3/s = cubic meters per second; MWIS = Makeup Water Intake Structure; NAVD 88= North American Vertical Datum of 1988;; temp. = temporary

Table 5.2-3
Average Monthly Low Flow Frequency Data – Dan River Below MWIS

Return Period	River Flow (cfs)		
	BCSS Continuous Maximum Generation Condition [a,c]	Flow Under Project Conditions[b,c]	Natural Flow[d]
2-Year	231	213	238
5-Year	156	146	171
10-Year	127	118	142
25-Year	109[e]	105[e]	112
50-Year	79[e]	79[e]	79
100-Year	32[e]	32[e]	32

Notes:

(a) Based on BCSS continuously operating at 100% generation capacity,80 pumping cfs, and permitted conditions.

(b) Based on Project 100 cfs pumping at permitted conditions.

(c) All active pumping cases follow the same permit conditions as described in Subsection 3.4.1.1.2.

(d) No BCSS or MWIS pumping.

(e) MWIS pumping would be reduced or halted during Project Operations to maintain entire natural flow when natural flow is less than 110 cfs.

Key: BCSS = Belews Creek Steam Station; cfs = cubic feet per second; MWIS = Makeup Water Intake Station

Table 5.2-4
Thermal Stratification Characteristics of Belews Lake and Mayo Reservoir

Characteristic	Units	Belews Lake	Mayo Reservoir	Difference
Epilimnion Depth	Feet	26-33	13-23	10-13
	Meters	8-10	4-7	3-4
Epilimnion Temp. Range	degrees Celsius	25-35	22-30	3-5
	degrees Fahrenheit	77-95	72-86	5-9
Thermocline Thickness	Feet	26	16	10
	Meters	8	5	3
Thermocline Depth (bottom)	Feet	49-66	30-46	20
	Meters	15-20	9-14	6
Hypolimnion Temp. Range	degrees Celsius	10-13	8-10	2-3
	degrees Fahrenheit	50-55	46-50	4-5

Table 5.2-5
Cooling Tower Blowdown Constituent Concentrations and Water Quality Criteria
(Sheet 1 of 3)

Constituent	Units	Maximum Potential Concentration[a]	Freshwater Water Quality Standards for Class C Waters[b]		Freshwater Water Quality Standards for Class IV Waters[b]	
			Chronic	Acute	Chronic[aa]	Acute[aa]
Alkalinity	mg/L	330	NE	NE	NE	NE
Aluminum	mg/L	11	NE	NE	NE	NE
Ammonia	mg/L	1.2	NE	NE	NE	NE
Arsenic[c]	µg/L	6.5	150	340	150	10
Barium	µg/L	230	NE	NE	NE	1000
Boron	µg/L	540	NE	NE	NE	NE
Biological oxygen demand (BOD), 5-day	mg/L	N/A	NE	NE	NE	NE
Cadmium[c,d]	µg/L	1.2	0.15[e,f,g]	0.85[e,f,h]	0.15[e,f,g] 0.22[bb,f,g]	0.85[e,f,h] 0.64[bb,f,h]
Calcium	mg/L	69	NE	NE	NE	NE
Hardness (as $CaCO_3$)	mg/L	310[a,e]	NE	NE	NE	100
Total Organic Carbon	mg/L	36	NE	NE	NE	NE
Chloride	mg/L	73	NE	230	NE	250
Chromium VI[c]	µg/L	7.3[x]	11[f,y]	16[f,z]	11[f,y]	16[f,z]
Chromium III[c]	µg/L	7.3[x]	24.59[f,g,i]	189.04[f,g,j]	24.59[f,g,i] 20.64[bb,g,i]	189.04[f,g,j] 158.71[bb,g,j]
Copper[c]	µg/L	14	2.83[e,f,k]	3.78[e,f,l]	2.83[e,f,k] 2.36[bb,f,k]	3.78[e,f,l] 3.09[bb,f,l]
Iron[c]	mg/L	5.5	NE	NE	NE	NE
Lead[c]	µg/L	4.1	0.57[e,f,m]	14.51[e,f,n]	0.57[e,f,m] 0.44[bb,f,m]	14.51[e,f,n] 11.4[bb,f,n]
Magnesium[c]	mg/L	32	NE	NE	NE	NE

Table 5.2-5
Cooling Tower Blowdown Constituent Concentrations and Water Quality Criteria
(Sheet 2 of 3)

Constituent	Units	Maximum Potential Concentration[a]	Freshwater Water Quality Standards for Class C Waters[b]		Freshwater Water Quality Standards for Class IV Waters[b]	
			Chronic	Acute	Chronic	Acute
Manganese[c,o]	mg/L	0.35	NE	NE	NE	NE
Mercury[p]	ng/L	N/A	12	NE	12	NE
Nickel[c]	µg/L	12	16.64[e,f,q]	149.81[e,f,r]	16.64[e,f,q] 13.89[bb,f,q]	149.81[e,f,r] 125.04[bb,f,r]
Nitrite plus Nitrate	mg/L	2.4	NE	NE	NE	10[u]
Nitrogen, Total Kjeldahl	mg/L	6.7	NE	NE	NE	NE
pH range	SU	6 – 9	NE	6.0-9.0	NE	6.0-9.0
Phosphate, Ortho (as	mg/L	0.60	NE	NE	NE	NE
Phosphorus, Total as P	mg/L	0.60	NE	NE	NE	NE
Potassium	mg/L	34	NE	NE	NE	NE
Selenium[u]	µg/L	12	Lentic (30-day avg) = 1.5; Lotic (30-day avg) = 3.1	NE	Lentic (30-day avg) = 1.5; Lotic (30-day avg) = 3.1	NE
Silicon	mg/l	78	NE	NE	NE	NE
Sodium	mg/l	61	NE	NE	NE	NE
Sulfate	mg/l	78	NE	NE	NE	250
Total dissolved solids	mg/l	940	NE	NE	NE	≤ 500
Total suspended solids	mg/l	24	NE	NE	NE	NE
Zinc[c]	µg/L	39	37.73[e,f,v]	37.43[e,f,w]	37.73[e,f,v] 31.49[bb,f,v]	37.43[e,f,w] 31.23[bb,f,w]
Thallium[c]	µg/L	2.4	NE	NE	NE	NE
Vanadium	µg/L	18	NE	NE	NE	NE

Table 5.2-5
Cooling Tower Blowdown Constituent Concentrations and Water Quality Criteria
(Sheet 3 of 3)

Notes:

(a) Values are sourced from the PPE Table 2 calculated based on existing water quality at sample location nearest to proposed intake location and assuming maximum normal operating 12 Cycles of Concentration.

(b) NCDEQ Surface Water Quality Standards Rules 15A NCAC 02B.0100 through 0300.

(c) Acute and chronic freshwater aquatic life standards for metals shall be based upon measurement of the dissolved fraction of the metal.

(d) Non-trout waters.

(e) Hardness of 26 mg/L has been used to determine the site-specific NC 2B Water Quality Standards for specific metals. 26 mg/L is taken from water quality data at nearest upstream sample location to proposed intake or Sample Location 410.

(f) The WER shall be assigned a value equal to one unless determined otherwise under Sub-Item (11(b)) of Subchapter 02B – Surface Water and Wetland Standards.

(g) WER·[{1.101672-[ln hardness](0.041838)} · e^{0.7977[ln hardness]-3.909}].

(h) WER·[{1.136672-[ln hardness](0.041838)} · e^{0.9789 [ln hardness]-3.443}].

(i) WER· [0.860 · e^{0.8190[ln hardness]+0.6848}].

(j) WER· [0.316 · e^{0.8190[ln hardness]+3.7256}].

(k) WER· [0.960 · e^{0.8545[ln hardness]-1.702}].

(l) WER· [0.960 · e^{0.9422[ln hardness]-1.700}].

(m) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-4.705}].

(n) WER· [{1.46203-[ln hardness](0.145712)} · e^{1.273[ln hardness]-1.460}].

(o) Manganese has been monitored by NCDEQ and has been shown to have elevated background level concentrations that are somewhat flow related and are caused by the geology of the region. NCDEQ removed manganese as a standard as there was no evidence of to conclude that discharges of manganese will impact any beneficial uses of North Carolina's waters (NCDENR, 2015).

(p) Mercury water quality standards shall be based upon measurement of the total recoverable metal.

(q) WER· [0.997 · e^{0.8460[ln hardness]+0.0584}].

(r) WER· [0.998 · e^{0.8460[ln hardness]+2.255}].

(s) Nickel is limited to either the calculated standard or 25 µg/l, whichever is less.

(t) Nitrate nitrogen limit.

(u) The standard for chronic selenium has the following components: fish egg/ovary tissue, fish whole body or muscle tissue, and water column (lentic and lotic). These components shall be used in the following order of preference provided data is available: 1. Fish egg/ovary tissue; 2. Fish whole body or muscle tissue; 3. Water column (NCDEQ, 2022).

(v) WER· [0.986 · e^{0.8473[ln hardness]+0.884}].

(w) WER· [0.978 · e^{0.8473[ln hardness]+0.884}].

(x) Value for total chromium. Speciation for bounding value in PPE not provided.

(y) WER · 11.

(z) WER · 16.

(aa) The Dan River is a class IV waterbody. Regulatory criteria for hardness dependent metals may vary from Belews Lake, but all other standards will be identical.

(bb) Hardness of 21 mg/L has been used to determine the site-specific NC 2B Water Quality Standards for specific metals for the Dan River. 21 mg/L is taken from water quality data at nearest upstream monitoring station A_2_710.0.

Key: mg/L = milligrams per liter; NCAC = North Carolina Administrative Code; NCDEQ = North Carolina Department of Environmental Quality; NE = Regulatory standard not established for this constituent; ng/L = nanograms per liter; PPE = plant parameter envelope; µg/L = micrograms per liter; SU = Standard Units; WER = Water Effect Ratio

Table 5.2-6
CORMIX Evaluation Distances to Obtain Water Quality Regulatory Compliance in Belews

Constituent	Concentration (µg/L)					Distance from End of Pipe to End of Mixing		
	Ambient[a]	Discharge	Excess	Acute WQS	Dilution Required	North Discharge[b,c]		Combi
						Trajectory[d] (m)	Vertical (m)	Trajectory[d]
Copper	1.17	14	12.8	3.78	4.92	2.96	0.76	10.27
Cadmium	0.1	1.2	1.1	0.85	1.47	0.89	0.16	3.20

Notes:

(a) Ambient condition within Belews Lake is the discharge concentration divided by 12 cycles of concentration.

(b) Based on the bounding summer drought conditions.

(c) North Discharge is representative of Middle and South Discharges and is the most conservative of the three outfalls.

(d) Curvilinear distance from end of pipe discharge to meet WQS.

Key: m = meters; NA = Not Applicable; TDS = Total Dissolved Solids; µg/L = micrograms per liter; WQS = Water Quality Standard

Table 5.2-7
CORMIX Evaluation Distances to Obtain Regulatory Compliance for Temperature in Belews Lake

Hydrologic Condition	Season	Distance from End of Pipe to Obtain 5.04º F Excess Temperature Criteria							
		South, Middle, North Discharges[a]				Combined Discharge			
		Trajectory[b,c]		Vertical		Trajectory[a,b]		Vertical	
		Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet
Drought	Summer	9.7	31.7	3.1	10.2	16.2	53.2	6.3	20.7
Drought	Winter	10.4	34.0	3.4	11.3	17.3	56.8	7.0	23.0
Normal	Summer	9.7	31.9	3.1	10.3	16.2	53.0	6.3	20.6
Normal	Winter	NE[d]	NE[d]	NE[d]	NE[d]	NE[d]	NE[d]	NE[d]	NE[d]

Notes:

(a) For the initial mixing in the near field with no boundary influences, the jet trajectories at the South, Middle, and North Discharges are essentially the same. The primary differences between the South, Middle, and North Discharges are their ambient bounded channel geometries.
(b) The NCDEQ temperature narrative standard requirements of 15A NCAC 02B.0211 (18) states, “Temperature: not to exceed 2.8°C (5.04°F) above the natural water temperature and in no case to exceed 32°C (89.6°F) for lower piedmont and coastal plain waters.”
(c) Curvilinear distance from end of pipe discharge to obtain 2.8 ºC (5.04 ºF) excess criteria. Discharges are located below the thermocline in the hypolimnion region of Belews Lake and the hypolimnion lake temperature range is found in Table 5.2-4.
(d) This condition and season were not evaluated as it has been determined a bounding case is a summer drought. The discharge pipe is located in the hypo limnological region which has a narrow temperature range (Table 5.2-4) with limited seasonal variation.

Key: ºC = degrees Celsius; °F = degree Fahrenheit; ft. = feet; NCDEQ = North Carolina Department of Environmental Quality; NE = Not Evaluated

Table 5.2-8
CORMIX Evaluation Distances to Obtain Water Quality Regulatory Compliance in the Dan River

Constituent	Units	Concentration (µg/L)			Direct Distance (m) from MPD to Meet WQS[b,c]			
		Ambient[a]	Discharge	Excess	Acute WQS	Dilution Required (unitless)	Summer[d]	Winter[e]
Copper	µg/L	0.00	14	14	3.09	4.5	41.77	21.43
Cadmium	µg/L	0.00	1.2	1.2	0.64	1.88	0.75	0.37
TDS	mg/L	61	940	879	500	2.0	0.93	0.46

Notes:
(a) Based on existing upstream water quality monitoring results.
(b) Direct distance accounts for the horizontal (x) parallel to the riverbank, vertical (z) rise, and horizontal (y) distance perpendicular to the bank.
(c) Vertical rise within the Dan River is negligible.
(d) Considers the summer 7Q10 scenario with a five-port multiport diffuser.
(e) Considers the winter 7Q10 scenario with a five-port multiport diffuser.
Key: 7Q10 = 7-day, 10-year river flow; m = meter; mg/L = milligrams per liter; µg/L = micrograms per liter; MPD = multiport diffuser; TDS = total dissolved solids; WQS =water quality standard;

Table 5.2-9
CORMIX Evaluation Distances to Obtain Regulatory Compliance for Temperature in the Dan River

Description	CORMIX Parameter	Summer 7Q10				Winter 7Q10			
		Value	Unit	Value	Unit	Value	Unit	Value	Unit
Dan River Characteristics	River Flow	2.27	m^3/s	80	cfs	4.53	m^3/s	160	cfs
	Chan Width	23.9	m	96	ft	32.9	m	108	ft
	Avg. Chan Depth	0.29	m	0.94	ft	0.4	m	1.3	ft
	Chan Area	8.36	m^2	90	ft^2	13.01	m^2	140	ft^2
CORMIX RMZ Data	RMZ Length[(b)]	88	m	289	ft	99	m	324	ft
	RMZ Width[(c)]	14.7	m	48	ft	16.5	m	54	ft
	RMZ Area[(d)]	2.77	m^2	30	ft^2	4.29	m^2	46	ft^2
Plume characteristics at RMZ[(g)]	Distance[(e,f)]	35.4	m	116	ft	52.4	m	172	ft
	Dilution	4.2	-	4.2	-	5.8	-	5.8	-
	Plume Width	8.9	m	29.2	ft	10.3	m	33.8	ft
	Plume Thickness	0.31	m	1.02	ft	0.42	m	1.38	ft

Notes:
(a) The NCDEQ temperature narrative standard requirements of 15A NCAC 02B.0211 (18) states, “Temperature: not to exceed 2.8 ºC (5.04 ºF) above the natural water temperature and in no case to exceed 32 ºC (89.6 ºF) for lower piedmont and coastal plain waters.”
(b) Assumed RMZ length is equal to three times the channel width.
(c) Assumed RMZ width is equal to half of the channel width.
(d) Assumed RMZ cross-sectional area is equal to one-third of the channel cross-sectional area.
(e) There is no plume rise in the vertical direction prior to obtaining regulatory compliance.
(f) Distance refers to the horizontal distance along the centerline of the plume.
(g) Plume characteristics based on maximum plume cross-sectional area.

Key: Avg. = Average; cfs = cubic feet per second; Chan = Channel; RMZ = regulatory mixing zone; m^3= cubic meters; m = meters; ft. = feet; ft^2 = square feet;

5.3 ECOLOGICAL RESOURCES

This section describes the potential effects on terrestrial, wetland, and aquatic ecological resources from Project operations. The terrestrial and aquatic ecosystems of the Project site are described in detail in Sections 2.3.1 and 2.3.2, respectively. These subsections include information about upland, wetland, and aquatic habitats, associated ecological communities, and important species they support. This section is divided into two subsections: Section 5.3.1 describes terrestrial and wetland impacts, and Section 5.3.2 describes impacts on aquatic resources.

5.3.1 TERRESTRIAL AND WETLAND IMPACTS

This subsection evaluates the potential effects of operation on the terrestrial and wetland ecological resources that occur on the Project site and associated off-site areas. As discussed in Section 2.3.1.2, wetlands are those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Types of wetlands include swamps, marshes, bogs, and similar areas. The wetland discussion in Section 5.3.1.2 includes all potential jurisdictional wetlands on the Project site.

5.3.1.1 Terrestrial Habitat

Due to the extensive size of the NDA, much of the Project site is developed. Thus, remaining terrestrial habitat is limited on the Project site. Impacts to terrestrial habitat primarily during operations consist of landscape maintenance activities such as pesticide/herbicide use, mowing, and disturbance by heavy equipment. Licensed herbicide/pesticide applicators will be used to handle and apply pesticides safely and effectively according to the label-recommended pesticide/herbicide usage and application method and rates. Application areas will include ground cover in corridors while limiting impacts on terrestrial habitat during landscape maintenance. Application will be in accordance with Duke Energy's general NPDES permit for pesticide application (general permit # NCG560000).

Impacts to terrestrial habitat from transmission line maintenance are minimized by appropriate BMPs used in transmission line corridors during corridor maintenance, as discussed above.

Disturbance associated with building activities creates conditions for invasive species to establish in different areas of the Project site and the associated off-site wastewater pipeline corridor (Section 4.3.1.1). Maintenance to reduce the spread of invasive species during operation includes monitoring disturbed lands to identify and control areas that are dominated by invasive plants and the implementation of appropriate control measures. Control methods may include using pesticides/herbicides, hand-pulling, or mechanical treatment as applicable to the species and situation.

As described in Section 3.4.2.2, an ISFSI facility is anticipated within the NDA and is, therefore, within the developed portion of the Project site. Details of the ISFSI including its layout, capacity, and operational characteristics will be determined during the construction permit or license application.

Operation of the mechanical draft cooling towers and associated heat dissipation systems can potentially impact plant communities through salt deposition; increased precipitation, humidity,

fogging, icing; and plume shading. As discussed in NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” these types of impacts can lead to structural damages and changes in plant communities. These small amounts of particulates from cooling towers are dispersed over a wide area, but most of the deposition occurs in relatively close proximity to the cooling towers. Generally, deposition rates at other existing operating nuclear plants have been below those that are known to result in measurable adverse impacts on plants. However, as discussed in NUREG-1555, tolerance levels of native plants, ornamentals, and crops to salt deposition from drift are not precisely known. The NRC recommends using an order-of-magnitude approach to evaluate salt (NaCl) drift deposition thresholds and its potential effects on vegetation. According to NUREG-1555, the following thresholds should be used in such assessments:

- 1 to 2 kilograms per hectare per month (kg/ha/mo) (100 to 200 kilograms per square kilometer per month [kg/km^2/mo]) equivalent to 571 to 1142 pounds per square mile per month [lb/mi^2/mo]: salt deposition generally not damaging to plants.
- Approaching or exceeding 10 kg/ha/mo (1000 kg/km^2/mo) equivalent to 5710 pounds per square mile per month (lb/mi^2/mo): threshold range for visible leaf damage from salt deposition on leaves in any month during the growing season.
- Hundreds or thousands of kg/ha/year (tens of thousands or hundreds of thousands of kg/km^2/year): could cause damage sufficient enough to suggest the need for changes of tower-basin salinities or a reevaluation of tower design, depending on the extent of the area impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition.
- The Seasonal and Annual Cooling Tower Impact Model, Version 2 (SACTI2) model analysis for the Project predicts that the greatest seasonal salt deposition from the cooling towers occurs during the summer at 984 feet (ft.) (300 meters [m]) east-northeast of the Project site center point. This summer deposition rate is 63.51 kg/km^2/mo (362.58 lb/mi^2/mo), which is well below the range that causes leaf damage in many species. During other seasons and on an annual basis, the maximum modeled deposition rates range from 41.57 kg/km^2/mo (237.37 lb/mi^2/mo) (annual basis) to 51.77 kg/km^2/mo (296 lb/mi^2/mo) (spring). These salt deposition rates are below the 1000 – 2000 kg/km^2/mo (5710 – 11,420 lb/mi^2/mo) range that could cause leaf damage in many species, as defined by NUREG-1555.

  The SACTI2 model analysis also indicates that cooling tower operation does not produce additional ground fogging or plume rime icing at any distance from the towers. Additional plume water deposition from cooling towers is insignificant compared to observed climatological precipitation rates. Some increase in relative humidity occurs close to the towers or in an elevated plume. However, based on insignificant levels of modeled plume water deposition, no predicted fogging, and no predicted plume rime icing, the predicted impacts on ground-level humidity from operation of all the cooling towers is minor.

Similar to the findings in NUREG-1437, results of SACTI2 modeling for the operation of cooling towers at the Project site indicate that salt deposition rates are well below the threshold range for damaging plants during the growing season or any season. Thus, the impacts of salt deposition to plants on the Project site is minor.

Overall, the impacts of Project operation on terrestrial habitat are minimized through the use of BMPs during landscape maintenance and transmission line maintenance. Therefore, impacts are minor.

5.3.1.2 Wetlands

As discussed in Section 4.3.1.2, building activities directly or indirectly impact all wetlands on the Project site and the associated off-site wetland. Impacts to remaining wetlands primarily consist of landscape maintenance activities in areas surrounding wetlands such as transmission lines. Impacts to wetlands are limited by use of BMPs, such as prohibiting herbicide usage around wetlands and avoiding mowing and other heavy equipment operation within wetlands. The establishment of invasive species because of building activities in wetlands is minimized by control methods as discussed in Section 5.3.1.1.

Inadvertent spills or stormwater runoff during plant operations have the potential to affect wetlands that may be downgradient of such releases. Measures to control potential effects of inadvertent spills include the implementation of a SPCC plan pursuant to 40 CFR Part 112 during operations at the Project site. A SPCC plan includes BMPs such as proper vehicle and equipment maintenance, containment for fuel or oil storage tanks, and the maintenance of spill response equipment and materials. With adherence to permit conditions and implementation of mitigation measures, including the use of an SPCC plan and BMPs, impacts of operations on wetlands from such releases are minor and are mitigated as described in Section 4.2.3.

In some Project settings, groundwater withdrawals from operations have the potential to affect the hydrology of nearby wetlands. As described in Section 5.2.2.1, there are no hydrologic alterations at the Project site that affect groundwater availability during operations. No groundwater use or dewatering occurs during operation that may affect local aquifers. Thus, no impacts occur to wetlands from groundwater usage or withdrawal that may indirectly alter wetland hydrology.

Heat dissipation systems such as mechanical draft cooling towers can potentially impact plant communities within wetlands. However, as discussed in Section 5.3.1.1, results of SACTI2 modeling for the operation of cooling towers at the Project site indicate that salt deposition rates are well below the threshold range for damaging plants during any season. Thus, the impact of salt deposition to plants within wetlands on the Project site is minor.

Overall, the impacts of Project operation on wetlands are minimized through adherence to applicable wetland permit conditions and regulations, including the use of a SPCC plan and BMPs.

5.3.1.3 Wildlife

Based on the extent of the NDA, much of the Project site is developed and wildlife communities are limited to peripheral habitats of the vegetated buffer area and other habitats. Wildlife remaining on the Project site may be impacted by operational noise, such as the operation of the mechanical draft cooling towers and vehicles. As discussed in Section 2.8.2.1.3, background noise at the Project site is the result of noise emissions from the existing BCSS, vehicles on roadways, boats and other recreational activities on Belews Lake, and natural noises. Wildlife within the vicinity of roads on the Project site are currently exposed to traffic from the existing BCSS, and traffic continues during Project operations. Noise levels associated

with operation of the Project are bounded by the noise emissions from the mechanical draft cooling towers (Section 5.8.2). As described in Section 5.8.2, cooling tower noise emissions are up to 58.1 A-weighted scale decibels (dBA) at a distance of 1000 ft. (305 m) from the source. As discussed in Section 4.3.1.3, the threshold noise level at which birds and small mammals are frightened or startled is 80 to 85 dBA. Based on straight-line noise attenuation, this noise threshold level is expected to occur at 80.35 ft. (24.49 m) from the cooling towers. Based on this noise level across the NDA, noise-sensitive wildlife are expected to avoid areas near the cooling towers characterized by elevated noise levels. Any wildlife occurring in proximity to active areas of the Project site avoid areas characterized by excessive noise levels and move to more suitable habitat nearby.

As described in Section 5.4.4.1.1, traffic level of service (LOS) along most of the roadways analyzed does not change during the operations phase. Traffic impacts occur during the beginning and end of work shift and occur for less than 2 hours a day. Any changes to traffic and traffic patterns during operations are not expected to impact wildlife as wildlife is expected to continue to avoid roads and move to suitable habitat areas.

As described in Section 2.3.1.8, the Project site is located within the Atlantic Flyway migration route. As discussed in Section 2.3.1.3.1, Belews Lake provides suitable habitat for migratory and water dependent birds. Waterfowl and other birds crossing the Project site may occasionally collide with tall structures such as the power block bounding structure, with a height of 176 ft. (53.6 m) above grade, as discussed in Section 3.1.5. Other tall structures on-site include transmission structures, with variable heights that normally range from 80 to 120 ft. (24 to 37 m) (Section 3.2). However, as described in Section 4.3.1.3, bird collisions with nuclear power plant structures occur at rates that are unlikely to affect local or migratory bird populations.

Impacts to wildlife from transmission line maintenance are minor due to the limited frequency of transmission corridor maintenance activities. Potential impacts to nesting birds from transmission line maintenance are also minimized through compliance with the Migratory Bird Treaty Act. Collisions of birds with transmission lines and electrocution of birds by transmission lines may occur during operations. Bird diverters and avian-safe insulator assemblies may be used to minimize effects on the local avian population, reduce the frequency of bird collisions and electrocution, and ensure reliable transmission system operation. Wildlife near transmission lines is also exposed to electromagnetic fields (EMFs). However, according to NUREG-1437, there is no evidence to date that wildlife is affected by EMFs. Therefore, impacts are considered minor.

Operational maintenance that may impact pollinators includes mowing, pesticide use, and other grounds maintenance in transmission corridors and other maintained areas. The greatest impacts on pollinators are in areas with a diverse composition of flowering plants, such as the transmission corridors. When possible, transmission line maintenance activities are scheduled to minimize harm to pollinators by limiting mowing to the fall or winter when flowers are not blooming. Artificial lighting on the Project site during operations also has the potential to disrupt patterns of pollinators. However, much of the Project site is developed during the operational period and does not support pollinator habitat. Additionally, as discussed in Section 4.3.1.3, mitigation measures to limit artificial light impact are incorporated into Project design.

Overall, impacts of operations on wildlife are minimal because wildlife presence is limited on the Project site due to the extent of permanently developed areas. For the limited wildlife on-site, species avoid areas of existing noise emissions. Impacts to birds are also minimized by adherence to the Migratory Bird Treaty Act and use of bird-safe transmission system measures such as those outlined by the Avian Power Line Interaction Committee (APLIC). Populations of wildlife within the Project Vicinity and Project Region are not affected by operations. Therefore, impacts to wildlife during operations are minor.

5.3.1.4 Important Terrestrial and Wetland Species and Habitats

5.3.1.4.1 Important Terrestrial and Wetland Species

Important terrestrial and wetland species that may be impacted by Project activities are discussed in Section 2.3.1.5 and summarized in Table 2.3-9. Species that are federally listed or proposed for listing include Schweinitz's sunflower (*Helianthus schweinitzii*), tricolored bat (*Perimyotis subflavus*), bog turtle (*Glyptemys muhlenbergii*), and monarch butterfly (*Danaus plexippus*). Schweinitz's sunflower has not been documented on the Project site, and operational impacts to this species and its associated plant community are limited due to BMPs for landscape maintenance and reducing the spread of invasive species.

Due to the extensive building activities and resulting development, suitable roosting or foraging habitat for tricolored bats is limited on the Project site during operations. However, bats may move through the Project site between areas of suitable habitat. Impacts on tricolored bats during operation on the Project site are limited due to reduced habitat suitability associated with converted land use and noise levels from cooling tower operation. Bats are also vulnerable to collisions from tall structures on the Project site. As discussed in NUREG-1437, bat collisions with human-made structures at nuclear power plants are not well documented but are likely rare based on the available information. Previous effects assessments from power plants in Ohio, New York, New Hampshire, Virginia, and Wisconsin documented few bat collisions or low potential for bat collisions at these sites.

Bog turtles have not been documented on the Project site, and operational impacts to this species are limited due to BMPs and regulations pertaining to maintenance around wetlands on the Project site.

During 2024 surveys, monarch butterflies were not documented on the Project site, and breeding habitat for this species was limited to rare occurrences during surveys in the southwest portion of the Project site and along the associated off-site wastewater pipeline corridor, as discussed in Section 2.3.1.5.1 and shown in Figure 4.3-4. However, after building activities and development, suitable foraging habitat exists on the Project site in the form of herbaceous areas such as the transmission line corridor. Potential operational effects on habitats that may be used as foraging areas by monarch butterfly and other pollinators are minimized by implementing BMPs such as conducting mowing in the fall or winter when foraging habitat (flowers) are not blooming, controlling invasive species, and following the label-recommended pesticide/herbicide usage to promote foraging habitat quality and extent.

Other important terrestrial species potentially occurring on the Project site include bald eagles (*Haliaeetus leucocephalus*; protected under the Bald and Golden Eagle Protection Act and state-listed); rusty blackbird (*Euphagus carolinus*; state-listed); coppery emerald (*Somatochlora*

georgiana; North Carolina Natural Heritage Program [NCNHP]-designated “significantly rare”); and marsh St. John’s-wort (*Triadenum tubulosum*; NCNHP-designated “significantly rare”). As discussed in Section 4.3.1.4.1, the active bald eagle nest and associated nesting buffer is outside of any on-site and off-site disturbance areas. Therefore, operation of the Project is not expected to directly impact the nest, and operational impacts to bald eagles are limited to behavioral effects associated with avoidance of developed high-activity areas and infrequent bird collisions with structures or powerlines. However, during operations, Duke Energy will update the site’s existing Bald Eagle Nest Management Plan, as appropriate. As discussed above in Section 5.3.1.3, bird collisions with tall structures and transmission lines do not affect local bird populations. Rusty blackbirds were not observed on the Project site, but their preferred hardwood forest habitat along the shoreline is represented by the vegetated buffer. However, no notable impacts occur on this species as Project operations do not affect the vegetated buffer. Therefore, operations have no impact on this species. Impact on stream habitat of the coppery emerald is minor and are discussed in Section 5.3.2.1.1. No notable Project operations impacts occur to marsh St. John’s-wort habitat around Belews Lake, as Project operations do not affect the vegetated buffer.

Important species of recreational value on the Project site include game species, non-game species, and furbearers. White-tailed deer (*Odocoileus virginianus)*, beaver (*Castor canadensis)*, gray fox (*Urocyon cinereoargenteus*), opossum (*Didelphis virginiana)*, raccoon (*Procyon lotor)*, fox squirrel (*Sciurus niger*), gray squirrel (*Sciurus carolinensis)*, striped skunk (*Mephitis mephitis)*, eastern cottontail rabbit (*Sylvilagus floridanus*), wood duck (*Aix sponsa)*, mallard (*Anas platyrhynchos)*, Canada goose (*Branta canadensis)*, wild turkey (*Meleagris gallopavo)*, and mourning dove (*Zenaida macroura)* are recreationally valuable as game species on the Project site, while coyotes (*Canis latrans)* and groundhogs (*Marmota monax*) are non-game species hunted in NC. Beaver, opossum, groundhog, striped skunk, coyote, gray fox, and raccoon are recreationally valuable as furbearers on the Project site. American bullfrogs (*Lithobates catesbeianus*) are non-game species that have not been documented on-site but are common in the Project Vicinity. These species are common in the area and within the Project Vicinity, and based on the extent of the NDA, habitat suitability for these species is limited within the Project site. Species occurring in proximity to active areas of the Project site can relocate to suitable habitat nearby.

Additionally, minimization measures and adhering to the Migratory Bird Treaty Act and guidelines from the APLIC limits collision impacts on birds.

Overall, impacts of Project operation on important species and habitats are minor due to the limited habitat that is suitable to important species during operations. Furthermore, Project operations do not affect populations of important species within the Project Vicinity and Project Region.

5.3.1.4.2 Important Terrestrial and Wetland Habitats

As discussed in Section 2.3.1.6, the only important habitats on the Project site are wetlands. As previously mentioned above in Section 5.3.1.2, wetlands on the Project site are extremely limited due to extensive building activities. Discussion of station operation effects to wetlands are discussed in Section 5.3.1.2 and impacts are minor.

5.3.1.5 Transmission Corridors

As discussed in Section 1.1.5, additional transmission lines that extend outside of the existing Project site boundary are not required. As described in Section 3.2.4.1, transmission improvements within the existing Project site include a new switchyard and other transmission line improvements. Because these improvements are located within the Project site boundary, discussion of operational impacts to habitats and species within transmission corridors is integrated into the preceding subsections of Section 5.3.1.

5.3.1.6 Summary of Impacts to Terrestrial and Wetland Ecology

Operational impacts on terrestrial ecology are foremost limited by the lack of habitat on-site as a result of development of the NDA. Most of the Project site is developed, and the resulting wildlife communities are limited to small areas on the Project site such as the vegetated buffer areas around Belews Lake. Impacts associated with landscape maintenance activities, potential for invasive species establishment, noise emissions, cooling tower salt deposition and potential for collisions with tall structures are minor and are mitigated using BMPs and general landscape maintenance activities. Control methods limit impact of invasive species on vegetation and native wildlife. Compliance with the Migratory Bird Treaty Act reduces impacts to birds during transmission or other maintenance activities. Impacts on important terrestrial species and habitats are also minor. Overall, impacts on terrestrial ecology and wetlands from operation are SMALL.

5.3.2 AQUATIC IMPACTS

This subsection describes the impacts of operation on aquatic communities within the Project site and the Project Vicinity. Operational impacts on Belews Lake are related to the operation of the plant intake and discharge structures, the cooling towers, and the sanitary and radwaste systems. A description of plant interfaces with water are described in Section 3.4.1.1. Impacts of operation on surface water are described in Section 5.2.

5.3.2.1 Aquatic Habitats and Biota

Aquatic habitats on the Project Site and in the Project Vicinity are described in Section 2.3.2. The aquatic ecosystems and aquatic resources of the Project site are described in detail in Section 2.3.2. Aquatic habitats on the Project site, associated off-site areas and in the Project Vicinity include on-site streams, Belews Lake, Belews Creek, and the Dan River. Impacts on surface water resources as a result of operation are described in Section 5.2.

5.3.2.1.1 On-Site Streams

Impacts of building activities on on-site streams are described in Section 4.2.1.1. On-site streams that remain after building activities are limited on the Project site. Stormwater runoff can result in sedimentation and reduction in water quality, which can result in reductions in available suitable aquatic habitats. Additionally, chemical spills or releases can result in reductions in water quality or mortality of aquatic biota in areas affected. Impacts to aquatic ecosystems on the Project site from accidental spills or stormwater runoff are minimized as described in Section 5.2.3.1.1. Stormwater discharges are regulated through an NPDES permit. Stormwater on the Project site is managed in accordance with a site-specific NPDES permit to minimize pollutants, and various BMPs are used to manage stormwater runoff. The operations-related stormwater

system at the Project site is designed to comply with relevant federal, state, and local stormwater regulations. The use of BMPs reduces potential negative impacts on aquatic biota present in on-site streams. An SPCC plan is in place to mitigate potential oil spills.

Based on adherence to regulatory requirements, including an NPDES permit for proper design and operation of stormwater management facilities, impacts of stormwater on the limited number of on-site streams and streams outside of the NDA are localized during operation and do not adversely affect aquatic biota of receiving waterbodies or Belews Lake. Vegetative buffer areas around Belews Lake reduce the amount of stormwater runoff and sedimentation in Belews Lake. Therefore, the impacts of operations on aquatic ecosystems on the Project site are minor.

5.3.2.1.2 Belews Lake

As is described in Section 5.2 and Section 7.1.1, the building and operational schedule for units at the Project site is conducted in a phased approach over several years. In conjunction with this phased approach, Duke Energy will also derate the operations of BCSS in a manner that replaces and balances overall generation capacity between both the Project and BCSS. The closure of BCSS is considered a RFFA (see Table 7.1-2). Accordingly, the BCSS closure results in gradual changes in the baseline environmental conditions relative to those described in Chapter 2.

Although the phased approach for implementation of the Project in conjunction with the BCSS closure results in gradual changes in environmental conditions over the phased implementation period, this analysis of Project operational effects on aquatic ecology considers the characteristics of the BCSS closure condition. Where appropriate, supplemental analyses are also provided that summarize the existing permitted operational condition of BCSS and effects of BCSS closure that are expected to persist during Project operations. These include the following:

- Belews Lake water levels are no longer influenced by BCSS consumptive uses (similar effects continue with Project operations).
- Water circulation in Belews Lake is no longer influenced by BCSS CCW intake and discharge flow (effects not prevalent in Project operations).
- Authorized pumping operations associated with the MWIS on the Dan River are transferred to Project operations (effects transition to Project operations).
- Lake water temperatures are no longer influenced by the BCSS and therefore reflect characteristics of a lake lacking substantive thermal input from power generation (effects not present during Project operations).

5.3.2.1.2.1 Relevant Effects of BCSS Closure on Aquatic Biota

5.3.2.1.2.1.1 Effects of Temperature Changes from BCSS Closure

As a result of BCSS closure (see Section 7.1.2.1.2), lake-wide temperatures begin to cool upon the beginning of the phased implementation period and are notably cooler following the phased in period. Impacts of BCSS closure on lake temperature would occur in conjunction with a

phased implementation period of Project operations. General cooling would occur within each reach of Belews Lake until temperatures normalize. Spatial variability in temperature conditions within Belews Lake that are evident under BCSS operations would normalize such that each area of the lake would reflect conditions that are not influenced by the thermal discharges from BCSS. Water temperatures within the West Belews Creek arm of Belews Lake would resemble those observed in the other areas, similar to those located near the sample location marked "SPILLWAY" in Figure 2.2-34, of Belews Lake. Across Belews Lake, the elimination of CCW discharges leads to reduced temperatures throughout the Lake.

Aquatic macrophyte growth within Belews Lake reflects the presence of established communities within the upper arms of West Belews Creek and Belews Creek. However, the distribution and density of aquatic macrophytes are predominantly associated with depth-related factors (Duke Energy, 2021). Aquatic macrophyte establishment and growth is complex and related to a range of factors that include substrate characteristics and stability, flow rates, temperature and other factors. There was no apparent trend in locations and density of vegetated points and zones of thermal influence (Duke Energy, 2021). Accordingly, BCSS closure and the widespread reduction in temperatures in Belews Lake are likely to have minimal effects on aquatic macrophyte communities.

Temperature-related effects of the closure of BCSS likely results in a taxonomic shift in the fish community, changes in relative abundance of species such as Gizzard Shad (*Dorosoma cepedianum*) and Threadfin Shad (*Dorosoma petenense*) (Section 7.1.2.2). Threadfin Shad in particular, is intolerant of colder temperatures, and is likely to exhibit a reduced population abundance with discontinuation of BCSS thermal effluents that may provide more favorable habitats to Threadfin Shad in winter months. Fish condition shifts are also likely to occur. Normalization of water temperatures and the subsequent loss of warmer winter temperatures in the West Belews Creek arm of Belews Lake will affect the timing of spawning and result in a shorter growth season. Some species may exhibit higher overall condition, as cooler temperatures may reduce the level of caloric intake required to meet the stressful energetic needs associated with habitats with elevated temperatures. With BCSS closure, the loss of winter thermal refugia may result in changes to winter movement patterns of selected fish species within the lake. Changes in the forage base (e.g., forage fish) may reduce diet availability for certain fishes, which may ultimately result in changes in piscivore fish size, population density, and trophic dynamics.

The combination of a truncated growing season and the potential reduction in cold-sensitive forage species such as Threadfin Shad may alter abundance and condition of sportfish through changes to forage for species such as Largemouth Bass, Alabama Bass, Black Crappie, White Crappie (*Pomoxis annularis*), catfishes, and perches (Percidae). The same sportfish species are still expected to persist in Belews Lake. However, the closure of BCSS is expected to have some effects to the composition and abundance of certain fish species within Belews Lake such that there would be greater similarity to the composition of Mayo Reservoir (see Section 5.2.3.1.2) in regard to condition and trophic dynamics.

Operations impacts based on the above-referenced changes to the characteristics of Belews Lake for aquatic ecology are considered in the following subsections, as appropriate.

5.3.2.1.2.2 Project-Related Impacts

Impacts of operation on the aquatic communities in Belews Lake result from the potential for impingement or entrainment at plant intake, water quality alterations associated with plant discharge, and potential changes in water levels within Belews Lake. Characteristics of aquatic ecosystems in Belews Lake are described in Section 2.3.2 but are expected to be altered in conjunction with BCSS closure as described above. No operational activities in Belews Lake result in changes to potential disease vectors for aquatic biota.

5.3.2.1.2.2.1 Cooling Water Intake Structure

Primary issues related to the Belews Lake cooling water intake structure (CWIS) operation are associated with the potential for aquatic organisms to be impinged on the intake screens or entrained within the circulating water system (CWS). Impingement occurs when organisms are trapped against the intake screens by the force of water passing through the intake structure. Impingement can result in death or injury due to exhaustion, asphyxiation (water velocity forces may prevent proper gill movement or organisms may be removed from the water for prolonged periods of time), descaling, and other physical injuries. Entrainment occurs when organisms within the intake water flow are drawn through the intake structure into the CWS. Organisms that become entrained normally are relatively small forms that float or swim freely in the water column, including plankton and early life stages of fish small enough to pass through the intake screen mesh. As entrained organisms pass through the cooling system, they are subject to mechanical, thermal, and toxic stresses that are often lethal (USEPA, 2001).

Operation of the intake structure(s) at the Project site is described in Section 3.2.2.4.1. Belews Lake was permitted and constructed as a cooling impoundment and was created solely for the purpose of serving as part of the BCSS cooling water system. The passive screens of the intake structure are designed with appropriate size, quantity, and depth to support continuous operation. Passive wedgewire screens are designed to have a low through-screen velocity (less than 0.5 feet per second [ft/s]), that meets impingement requirements of Section 316(b) of the Clean Water Act (CWA), and appropriate back flush debris removal systems to maintain clean surface areas. Section 316(b) of the federal CWA (33 USC Section 1326) requires the USEPA to issue regulations on the design and operation of cooling intake structures, in order to minimize adverse environmental impacts. Impingement studies conducted by the USEPA suggest a through-screen velocity of 0.5 (ft/s) is protective of fish survival (survival of 96 percent of the fish tested) (USEPA, 2001).

5.3.2.1.2.2.2 Cooling System Discharge Structure

As described in Section 3.2.2, the cooling system discharge options include one common discharge structure for all three Plant Complexes or three distinct discharge structures, one for each of the three Plant Complexes (Figure 3.1-1). Piping for each discharge structure extends from the shoreline to the submerged discharge structure. The discharge structure(s) are located within Belews Lake as indicated in Figure 4.2-1.

Cooling tower blowdown constituents and concentrations at the discharge point(s) are shown in Table 3.4-3. Additionally, as described in Section 3.2.2.4.3, effluents are managed to minimize release of these chemicals and concentrations to meet NPDES permit requirements, as applicable.

5.3.2.1.2.2.3 Biothermal Impacts of Discharge

The maximum blowdown temperature at the point of discharge to Belews Lake is 95°F (35°C). As described in Section 5.2.3, the CORMIX analysis modeled selected, conservative constituents that are present in cooling tower blowdown. As described in Section 5.2.3.1.2.1, the existing BCSS operating condition as described in Chapter 2 bounds thermal effects to Belews Lake during the phased implementation period. Therefore, thermal effects on aquatic biota were evaluated for the bounding operational condition during full Project operations.

The water quality criteria specify a water temperature not more than 2.8°C (5.04°F) above ambient. The only effluent constituents identified as requiring a mixing zone (i.e., discharge exceeding a regulatory standard) are copper, cadmium, and temperature, which is reduced to the 2.8°C (5.04°F) temperature excess criterion within a curvilinear distance of approximately 32 ft. (10 m) of the cooling tower blowdown at South, Middle, and North Complex Discharges and approximately 53 ft. (16.2 m) at the Combined Discharge for the bounding summer drought condition. The vertical rise of the discharge plume prior to attaining a 2.8°C (5.04°F) temperature excess is approximately 10 ft. (3.1 m) (under the individual discharge options for each Plant Complex at the South, Middle, and North Complex Discharges) and approximately 21 ft. (6.3 m) for the Combined Discharge option for the bounding summer drought condition. The 2.8°C (5.04°F) temperature excess is attained for each model case prior to interacting with the model pycnocline.

Established aquatic macrophyte beds generally occur within the West Belews Creek and Belews Creek arms in shallow water zones (Figure 2.3-11). Because discharge structures are established at depth (Figure 2.2-14), aquatic macrophytes are not subject to exposure to thermal effluents under most Project operational conditions as thermal discharges within Belews Lake are limited to the hypolimnion and are rapidly mixed. Additionally, thermal discharges do not extend to shoreline habitats where macrophytes are more predominant. Therefore, the effects of thermal effluents on aquatic macrophyte beds under such conditions are negligible.

Potential impacts to benthic biota including macroinvertebrates and mussels from thermal discharge is localized to the immediate area of the discharge. Riprap is integrated into discharge outlet design to minimize the effects of scour on sediments and associated benthic communities of Belews Lake. Additionally, the discharge is angled upward slightly to promote mixing and raising the thermal effluent in the water column, thereby limiting impacts to benthic areas. The rapid mixing of thermal effluent results in minimal thermal impacts to benthic macroinvertebrate and mussel communities. As thermal effluents are rapidly mixed and do not result in prolonged exposure of high-temperature effluents to bottom habitats, impacts to the benthic macroinvertebrate and mussel community within Belews Lake are localized and minor.

Critical thermal maxima (CTM) were used to assess acute impacts of thermal discharge on representative important species (RIS) of fish in Belews Lake. The CTM is the pre-mortality thermal maximum at which locomotory movements become disorganized and a fish loses the ability to escape from conditions that may ultimately lead to its death (Beitinger et al., 2000). CTM for those RIS present in Belews Lake are summarized in Table 5.3-1. The selected RIS are species that use a variety of habitats, including pelagic and benthic fish species. One of the species included in the assessment, Gizzard Shad, is considered a thermally sensitive species, and is particularly vulnerable to high temperatures. The estimated thermal dilution as a result of

Project discharges is demonstrated to be extremely localized to the area in the immediate vicinity of the discharges.

Acute temperatures along the longitudinal axis of the plume, as described above, are expected to be limited to areas within the immediate proximity of the discharges, and within the regulatory mixing zone boundary. As such, the CTM of each RIS beyond the mixing zone boundary are not exceeded under model conditions. Accordingly, avoidance behavior based on exceedance of CTM for RIS is not expected.

Thermal avoidance is a behavioral response of mobile species to move from stressful, high-temperature areas to areas with more tolerable temperatures (Mathur et al., 1983). This avoidance response can minimize acute impacts of thermal exposures. Zone of passage issues are most relevant in Project settings where elevated thermal discharges present a potential exclusion area that limits the movement of fishes between upstream and downstream areas. In Belews Lake, the location of the discharge is not bound by physical features, and ample habitat is available to support fish movement within the Belews Creek arm of Belews Lake and other reaches of the lake. Additionally, temperatures associated with the discharge are rapidly diluted, and effects are localized. Therefore, substantial areas of habitat would not be excluded, and a zone of passage would always be maintained for RIS.

Long-term impacts of exposure to elevated temperatures can result in chronic mortality in fishes and other aquatic biota. Although under extreme conditions, temperatures may exist in the immediate vicinity of the discharge that may have the potential to cause mortality under extended chronic exposure, such conditions are limited spatially and of relatively short duration and are not predicted to result in mortality. Additionally, due to the presence of an adequate zone of passage, behavioral avoidance of areas of extreme temperature will mitigate chronic exposure of fishes in Belews Lake. Because the discharges are located in the hypolimnetic zones that are not generally used for spawning, there are no important spawning areas located within the vicinity of the discharges. As such, the limited size of the thermal plume results in negligible impacts on spawning activities of fishes within Belews Lake. At early life stages, fish are highly sensitive to elevated temperatures. Optimal growth temperatures are species specific. Because the elevated temperatures of the thermal plume from the Project are localized to the immediate vicinity of the discharges, there are negligible chronic impacts of thermal stress on juvenile and embryonic fish growth.

Because both the selected discharge constituents and the thermal plume of the discharge(s) are demonstrated to rapidly disperse, and because thermal effluents within the mixing zone are below thermal criteria of aquatic biota, impacts to aquatic biota are localized and minor. Additionally, compliance with thermal discharge limits required under the operational NCDEQ NPDES permit will limit adverse impacts to aquatic biota.

5.3.2.1.2.2.4 Belews Lake Water Levels and Circulation

Operational use of cooling water from Belews Lake for the Project results in fluctuations of water levels (Section 5.2.1) and changes in water circulation patterns. BCSS closure also affects circulation patterns in Belews Lake. As described in Section 2.2.1.1.3, the BCSS CCW flow influences lake circulation patterns whereby water from the CCW discharge flows through the CCW canal and into the Belews Creek arm. As illustrated in Figure 2.2-3 general circulation patterns carry flow within the lake into the West Belews Creek arm and back to the BCSS

CWIS. However, under BCSS closure, the influence of CCW flow is eliminated, resulting in circulation patterns that are more influenced by tributary inflows, wind and releases from the spillway. As described in Section 5.2.1.1.2.3, supplemental water is pumped by the MWIS into Belews Lake in conjunction with Project operations. Figure 5.2-2 depicts the modeled water levels of Belews Lake based on supplemental pumping of the MWIS during Project operations. As summarized in Table 5.2-2, the drawdown from the full pond level under the Project operations is predicted to be approximately 3.4 ft. (1.04 m) under a mild drought condition (e.g., 2-year drought recurrence). Future moderate drought conditions (e.g., 10-year drought recurrence) may result in a drawdown of approximately 6.1 ft (1.86 m). However, during extreme future drought conditions (e.g., 100-year drought recurrence) drawdowns may reach approximately 10.0 ft. (3.05 m). These lake water-level fluctuations are similar to those predicted for BCSS Maximum Generation Condition, which includes MWIS supplemental pumping up to 100 cfs (2.83 m^3/s). However, under drought conditions, as compared to the BCSS Maximum Generation Condition (Section 5.2.1.1.2.3), the water-level drawdowns under Project operations are increased between approximately 0.6 ft (0.18 m) and 3.0 ft (0.91 m) (21 and 43 percent) for the 2-year and 100-year drought return periods, respectively. As such, Project effects on aquatic habitats and biota as described above are marginally increased relative to the BCSS Maximum Generation Condition in conjunction with the increased extent and duration of water-level reductions.

Seasonal fluctuations in surface water level during drought conditions may impact aquatic biota along nearshore areas of Belews Lake including littoral zones, aquatic habitats, aquatic macrophytes and related aquatic biota. Increased frequency and duration of water-level fluctuations is likely to result in changes to macrophyte growth within Belews Lake. Rapid water-level fluctuations can result in inundation of macrophyte beds, resulting in loss of macrophyte growth. Emergent macrophytes rely on stable water levels, and prolonged periods of low water levels or drought can result in drying of a substantive portion of lake littoral habitat (Havens et al., 2005). Water-level fluctuations can lead to changes in diversity of aquatic vegetation, with resulting pronounced negative implications for vegetation diversity (He et al., 2023). Such water-level fluctuations may also be expected to affect fish reproductive success during recurring drought conditions in which macrophyte beds used for spawning and nursery may be less available to fish.

Water-level fluctuations in shallow areas during drought conditions may decrease the overall presence of submerged aquatic vegetation (SAV) in nearshore areas. Oligotrophic lakes, such as Belews Lake, are generally characterized by low densities of SAV. Low water levels that last for a longer period within the growing season than those observed under BCSS operations may result in decreased growth of macrophytes in those shoreline areas that will no longer have surface water present for periods of the growing season. Water-level fluctuations have been demonstrated to influence the extent and abundance of SAV in lake and reservoir systems through influences on water clarity and light limitation (Shivers et al., 2018). Areas with high levels of water fluctuations see decreased SAV, with vegetation shifting to communities dominated by floating leaf plants (Shivers et al., 2018). Some SAV species, such as Hydrilla, are able to rapidly recolonize areas following periods of declines in spatial vegetative coverage (Shivers et al., 2018).

Increased fluctuation and duration in water levels during drought conditions will impact shallow, nearshore areas of Belews Lake, resulting in instability within the benthic macroinvertebrate

community in these species locations. Under operational conditions, intermittent periods of prolonged (e.g., weeks to months) drought will result in expanded areas in which benthic macroinvertebrate habitat is temporarily lost. Recolonization of benthic macroinvertebrate communities in these areas can be expected to occur when water levels stabilize. However, fluctuating water levels that occur on a more frequent basis, such as those for daily industrial or power generation needs, have been demonstrated to reduce macroinvertebrate recruitment by exposing and desiccating eggs laid in shallow water habitats, with some species being affected in as little as 2 hours (Miller et al., 2020). Additionally, in lakes with fluctuating water levels, the effects of the water fluctuations on macroinvertebrates can be significant, particularly for invertebrates with relatively long lifecycles (Aroviita and Hämäläinen, 2008). These more regular water-level fluctuations may have an impact on nearshore aquatic invertebrates.

There are no sensitive (i.e., federally- or state-listed) mussel species present in Belews Lake. Therefore, even with potential changes to habitat suitability as a result of drought condition water-level fluctuations, overall, the mussel communities are likely to remain consistent. Nearshore benthic areas that may be exposed during periods of low water will no longer be suitable habitat for the mussel species, thereby restricting the range of certain mussels to areas that are consistently submerged with water. Unlike benthic macroinvertebrate communities, however, recolonization by mussels in these nearshore areas is likely to be more limited, as these longer-lived species are more susceptible to water-level fluctuations over time.

Increased duration of water-level fluctuations during drought conditions may indirectly impact growth of adult fish. Changes to the macrophyte community may result in changes to habitat and access to foraging for adult fish, particularly during drought or periods of low water levels within Belews Lake. Overall decreases in fish condition may occur due to fluctuations and instability in the forage base (e.g., macrophyte beds) resulting from frequent fluctuations in water level. Water-level fluctuations may result in a loss of nursery and habitat areas. Macrophyte beds are important nursery habitats. SAV provides shelter and food resources for many fish species such as Bluegill (*Lepomis macrochirus*) and Largemouth Bass. Embryonic and larval growth occurs within late spring and summer. These months are critical for survival of larval fish.

Based on the predictive hydrologic model (Figure 5.2-2), the Project operation results in a system that is subject to water-level fluctuations that are similar to those experienced under BCSS Continuous Maximum Generation Condition. Under normal operational conditions, stabilized water levels result in suitable spawning habitat in the nearshore areas of Belews Lake. Under drought conditions, it is predicted that Belews Lake will be subject to increased frequency and severity of drawdown as compared to current BCSS Continuous Maximum Generation Condition (Figure 5.2-2). Many fishes that spawn within shallow littoral zones, including some centrarchids such as Largemouth Bass, will be impacted by drought condition water-level fluctuations. Largemouth Bass spawn at depths between 0.15 m (0.5 ft.) and 1.10 m (3.6 ft.) (Nack et al., 1993). Largemouth Bass build nests in areas which offer protection such as slopes, boulders, ledges, and submerged vegetation (Miller, 1971). Water-level fluctuations, such as those predicted under drought conditions by hydrological modeling, may result in loss of nearshore spawning habitat. Losing access to these areas could reduce Largemouth Bass and other Centrarchid numbers in Belews Lake. While hydrological modeling suggests that during a drought year lake elevation will not fall below full pond during months when Largemouth Bass spawn (typically mid-April through mid-June), there may be minor loss of spawning habitat for those species that are nest building or nest guarding, such as centrarchids.

5.3.2.1.2.3 Summary of Project Effects on Belews Lake

Direct impacts of operation on aquatic ecosystems in Belews Lake include impingement and entrainment associated with the CWIS, effects of cooling tower effluent constituents and thermal effluents, and effects of water-level fluctuations within Belews Lake. Belews Lake was constructed and permitted as a cooling impoundment and is classified as a closed cycle cooling system. Impingement and entrainment are minimized through design elements of the CWIS that comply with regulations adopted to implement Section 316(b) of the CWA that are considered protective of aquatic life.

Potential thermal impacts on all biotic categories, including habitat formers, benthic macroinvertebrates and mussels, fish, and related habitats within Belews Lake, from Project operation include the following:

- Negligible potential for localized acute adverse effects, such as thermal mortality, from recirculation of heated effluent. Potential effects are limited to the immediate area (less than 2 ft. [0.6 m]) around the discharge for RIS.
- Negligible potential for acute impacts of thermal excesses due to avoidance behavior of fish within Belews Lake.

Belews Lake water-level fluctuations during typical conditions are similar to those predicted for BCSS Continuous Maximum Generation Condition (Table 5.2-2). However, during drought conditions, potential impacts to aquatic species and habitats from hydrologic alterations such as increased water-level fluctuations within Belews Lake from Project operations include:

- Changes to the macrophyte communities, including nearshore emergent vegetation communities and SAV communities.
- Decreased habitat availability and potential desiccation of benthic macroinvertebrate and mussel communities in shallow littoral zones.
- Indirect adverse impacts to fish communities through alteration of near shore littoral zone habitats (e.g., spawning habitat, nursery areas, foraging habitat).
- Increased potential for proliferation of nuisance macrophytes, such as Hydrilla. However, the balance of fish communities is not expected to shift in such a way that would promote the expansion of nonindigenous fish beyond those already present in Belews Lake.
- Depending on the frequency of such drought conditions and related water-level fluctuation, corresponding effects may also be evident in the condition of recreationally important sport fish (i.e., smaller fish, changes in community structure, and other factors) that may be sought after by anglers.

Therefore, impacts on aquatic ecosystems within Belews Lake from operations, under normal operational conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping, are minor. However, aquatic ecology is impacted to a greater degree in Belews Lake as a result of water-level fluctuations that result in a noticeable effect on aquatic biota and associated habitats in littoral zones in conjunction with increased drought intensity.

5.3.2.1.3 Dan River

Impacts of operation on the Dan River are primarily related to the operations of the MWIS at the confluence of the Dan River and Belews Creek, and the wastewater pipeline discharge located near Dan River Outfall 006 (Figure 4.2-1). Aquatic ecosystems in the Dan River are described in Section 2.3.2.

5.3.2.1.3.1 Makeup Water Intake System

The MWIS located at the confluence of Belews Creek and the Dan River supplies makeup water to Belews Lake. The NPDES Permit NC0024406 is associated with current BCSS operations. The hydrologic impacts of pumping by the MWIS are described in Section 5.2.1. Impacts to surface water quality as a result of operation of the MWIS are described in Section 5.2.3. Regulatory stipulations required under the operational NPDES permit limit adverse impacts to aquatic ecology within the Dan River. The NPDES permit allows for operation of a four-pump MWIS with a capacity not to exceed 100 cfs (2.83 m^3/s). Operational conditions of the permit as described in Section 3.4.1.1.2 include:

- Pumping will not lower flow in the Dan River below 110 cfs (3.11 m^3/s) to maintain flow and habitat availability within the main channel.
- The intake structures on the Dan River and Belews Creek are positioned above the river bottom and are designed to have a velocity less than 0.5 ft/s (0.15 m/s) at the inlet of the velocity caps. The MWIS is equipped with a 2-millimeter (mm) fine mesh traveling screen to minimize fish entrainment and impingement.
- The withdrawal location is near the confluence of the spillway channel below Belews Lake Dam and the Dan River. This scoured bottom area does not provide suitable aquatic habitat for mollusks.
- Semi-annual lake monitoring to assess limnological conditions in Belews Lake is performed.
- To avoid fish spawning periods, no pumping occurs between April 1 and June 30.
- At least 80 percent of ambient flow of the Dan River is maintained at all times, meaning withdrawals will not exceed 20 percent of the river flow.
- Pumping may occur to a maximum water level in Belews Lake of 724.5 feet above mean sea level (220.8 meters above sea level).

As described in Section 7.1.1, closure of BCSS eliminates the need for supplemental pumping from the Dan River to compensate for consumptive uses from BCSS operations. However, authorized pumping operations associated with the MWIS are transferred to Project operations. Additionally, as described in Section 3.4.1.1.2, routine inspection and cleaning in and around the velocity cap inlet structures, including the removal of silt, sediment, and debris, ensures their effectiveness is maintained. Maintenance activities at the Dan River MWIS include material removal to reduce water debris load at the intake. Methods of material removal include slurry pumping, vacuum operations, air bursts, flush water, or mucking. Material removal is conducted in a preventive manner to maintain operational characteristics of the MWIS. The volume of material removed is variable, but generally small. Removal of materials results in localized loss of benthic habitat in the specific area of sediment removal. Mobile aquatic biota are expected to

avoid effects from maintenance activities, whereas direct effects occur to less mobile organisms. Losses of less mobile organisms are short-term and temporary as recolonization of impacted areas by benthic species occurs rapidly.

The MWIS is operated in compliance with regulations adopted to implement Section 316(b) of the CWA in regard to impingement and entrainment. A Section 316(b) demonstration conducted by Duke Energy in 2022 indicated compliance with impingement mortality best technology available (BTA) requirements under Section 316(b) of the CWA. Debris screens within the MWIS have a maximum through-screen velocity of less than 0.5 ft/s and are equipped with 2.0-mm fine mesh screens and an aquatic organism return system to minimize entrainment and impingement, and flow restrictions (HDR, 2022).

In conjunction with Project operations, Duke Energy will install the number of approved pumps within the MWIS to provide for a pumping capacity of up to 100 cfs (2.3 m^3/s) to provide sufficient makeup water to Belews Lake to supplement the cooling water system. Additional pumps are equipped with similar fish protection technologies as the existing debris screens. Operational pumping from the Dan River for makeup water also encompasses the same operational conditions set forth in the existing NPDES permit listed above to minimize fish entrainment and impingement, avoid fish spawning periods, and maintain ambient flow levels. Duke Energy also continues to perform semi-annual lake monitoring to assess limnological conditions in Belews Lake.

Pumping operation of MWIS also has the potential to affect aquatic biota due to reduced water availability in the Dan River and associated habitat alteration. However, under NPDES Permit NC0024406 the existing Duke Energy MWIS is permitted to withdraw up to 100 cfs for makeup water to Belews Lake. This permitted pumping limit is considered to be protective of aquatic biota and their habitat. Because Duke Energy limits pumping of the MWIS under Project operations to within permitted limits, no additional impacts on aquatic biota or their habitat occur under Project operations.

In summary, the existing MWIS on the Dan River is permitted for the intake of makeup water under the existing NPDES permit. The pumping capacity of the MWIS may be installed up to the maximum permitted pumping rate of 100 cfs. Impingement and entrainment are minimized through compliance with regulations adopted to implement Section 316(b) of the CWA. Further, compliance with NPDES operational conditions is protective of aquatic life and their habitat. Therefore, impacts of operation of the MWIS on the Dan River are minor.

5.3.2.1.3.2 Dan River Discharge

Effluents have the potential to affect aquatic biota through decreases in water quality that can cause chronic and/or acute mortality of species, particularly non-mobile species such as mussels. Nonradioactive liquid waste discharges (e.g., turbine building sumps, groundwater sumps, and water treatment discharges) are routed to the consolidated sump, where they undergo treatment before discharging to the Dan River Outfall 006 (Section 3.4.3.3.3.3). As described in Section 3.4.2.4, after treatment, liquid radiological waste is diluted to acceptable limits using cooling tower blowdown water. After mixing, the wastewater is directed to a new discharge located within the corridor adjacent to existing Outfall 006 described in Section 3.4.2.4 and shown on Figure 3.2-3. The common liquid radioactive waste line is located within the existing corridor, adjacent to the Outfall 006 piping. The discharge is controlled and

monitored to ensure compliance with environmental safety standards as described in Subsection 5.2.3.1.4.1. Liquid radioactive waste processing systems are designed to keep radiation exposures of plant personnel ALARA and ensure that discharges to the Dan River stay within the limits set by the NRC and other applicable regulations, including those integrated in an NPDES permit issued by NCDEQ. The NPDES permit establishes discharge limitations for quantity and quality parameters to protect surface waters and maintain aquatic biological communities. Additionally, the NPDES permit is expected to require ongoing assessment of aquatic biological communities downstream of permitted releases. Any uptake of constituents of the discharge at the MWIS downstream and into Belews Lake are evaluated and controlled through operational measures.

5.3.2.1.3.2.1 Biothermal Impacts of Discharge

A CORMIX analysis and description evaluating the thermal load is provided in Subsection 5.2.3.1.4.4. A biothermal analysis was conducted to assess impact of thermal discharge on aquatic communities in the Dan River. Table 5.2-9 describes the assumed mixing zone characteristics required to obtain regulatory compliance including the width, thickness, and area with respect to the Dan River. As described in Section 5.2.3.1.4.4, the width of the thermal plume is limited to approximately 37 percent of the channel width in the summer and 31 percent in the winter.

Potential impacts of discharge on benthic macroinvertebrates are related to elevated temperatures of the new discharge and the potential for benthic scour. More mobile species may be able to behaviorally avoid areas of excess high temperature by moving laterally or downstream. In areas of excess high temperatures near the new discharge, taxonomic composition of benthic macroinvertebrates may shift to more tolerant taxa. These temperature-related effects are expected to be localized based on rapid mixing demonstrated by the CORMIX analysis as described in Subsection 5.2.3.1.4.4. Thermal effluents, particularly in the immediate vicinity of the discharge, may also locally modify available habitat where benthic habitat is disturbed from building or installation of the new discharge structure. Benthic scour can also result in decreased habitat quality in areas in the immediate vicinity of the discharge diffuser. However, such effects are mitigated through the implementation of scour protection measures. As the impacts of thermal discharge on benthic communities are localized, overall impacts to macroinvertebrate communities in the Dan River are negligible.

In general, mussel habitat was limited at the survey locations upstream of the pump station at the confluence of Belews Creek, while at and below the pump station, mussel habitat was more widespread. Potential impacts of discharge on mussels are related to exposure to elevated temperatures of thermal discharge and the potential effects related to benthic scour. Freshwater mussels are particularly vulnerable to thermal stressors because they are relatively sedentary which limits their ability to seek refuge, and due to their relatively complex life histories (Fogelman et al., 2023). Elevated temperatures can result in stress, reduced growth, and potentially death. For example, Eastern Elliptio has a lethal thermal maxima of 42.7°C (108.9°F); (Fogelman et al., 2023). Benthic scour additionally can result in decreased habitat quality, as the velocity and frequency of discharge can negatively impact benthic habitat within the mixing zone. In 2024 sampling, only one mussel species Eastern Elliptio was observed in the area of the discharge. Thermal discharge may further locally reduce available mussel habitat. Potential thermal discharge impacts on habitat are localized and limited to the assumed mixing zone. Therefore, because suitable mussel habitat in proximity to the new discharge is

poor, and both temperature and scour effects are localized, impacts to mussels in the Dan River are minor.

An assessment of RIS present indicates that predicted temperatures are expected to be near, but not exceed the CTM for RIS with the lowest CTM, Black Crappie and White Sucker (CTM = 34.9°C), within the thermal plume at higher discharge velocities. For the other RIS, CTM temperatures are not exceeded, except for in potential extreme temperature events. Winter ambient temperatures, combined with temperature excesses from routine operation, may in some cases result in thermal shock of fishes within the thermal plume. However, as the extent of the thermal plume is approximately one-third of the width of the river, adequate area exists to avoid thermal impacts. Acute temperatures of the plume are expected to be limited to areas within the immediate proximity of the diffuser ports, and within the assumed mixing zone boundary. As such, the CTM of RIS beyond the mixing zone boundary are not exceeded under model conditions. Accordingly, acute thermal effects on fish beyond the mixing zone boundary are minor. There is minor potential for acute adverse effects on fish, but these effects are localized and limited to the immediate area around the discharge for RIS.

As the length of thermal exposure for larval and embryonic fish is primarily related to the length of time spent in the plume, exposure is reliant on plume length and river flow. At high flow, embryonic and larval fish are expected to pass through the thermal plume more quickly, thereby reducing exposure. Because of the relatively short length of the thermal plume and the flow within the Dan River, exposure of embryonic and larval fishes to elevated temperatures is expected to be for a relatively short duration, limiting chronic impacts.

For some species, such as White Sucker and Fantail Darter, summer temperatures at the edge of the assumed mixing zone (78.98°F) are expected to exceed the optimal growth temperature. However, this exceedance is limited to summer temperatures, and temperature dissipates with increasing distance downstream of the mixing zone. As the water temperature is less than the species-specific minimum acceptable weekly mean temperature for growth for the assessed RIS, no impacts to growth are expected at the edge of the mixing zone. Behavioral avoidance of areas by adult fish in the immediate vicinity of the discharge diffuser and mixing within downstream areas decrease effects to adult fish growth as a result of thermal exposure. As the thermal plume is localized, chronic effects on fishes of thermal discharge are minor.

Long-term impacts of exposure to elevated temperatures can result in chronic mortality in fishes and other aquatic biota. For mobile species, such as fishes, behavioral avoidance of the thermal plume will reduce impacts of chronic thermal exposure within the mixing zone. Chronic exposure to elevated temperatures above the species-specific minimum acceptable weekly mean temperature for growth results in cessation of growth and may result in elevated stress. For many species, the upper avoidance temperature, or the temperature at which fish behaviorally avoid the thermal stressor, may be greater than the minimum acceptable weekly mean temperature for growth. This may result in fish remaining in areas characterized by water temperatures that are greater than their minimum acceptable weekly mean temperature for growth. However, because the extent of the thermal plume is limited to the mixing zone and is less than 33 percent of the width of the Dan River, chronic exposure is unlikely to impact mobile species. Therefore, chronic impacts of thermal discharge in the Dan River are expected to be negligible for fishes.

Spawning generally occurs during late spring and early summer. Peak spawning occurs between April and June. The thermal plume is not expected to result in altered spawning conditions within the Dan River, as the minimum acceptable weekly mean temperature for growth for RIS are not exceeded beyond the mixing zone. As no important spawning areas are within the assumed mixing zone, impacts to spawning timing and aggregations are negligible. Impacts to nursery habitats, or areas which are important for juvenile fish growth, can result in chronic impacts to larval and juvenile fishes. However, no important nursery areas are located within the geographic area of the assumed mixing zone. Impacts on important nursery areas are therefore minor.

The portion of cross-sectional area or volume of flow of the receiving stream not included in the mixing zone is termed the zone of passage. The existence of a zone of passage for fish at the location of the discharge diffuser minimizes impacts of thermal discharge. The assumed mixing zone width is equal to half of the total channel width. The width of the thermal plume is limited to approximately 37 percent of the channel width in the summer and 31 percent in the winter. This results in a zone of passage that is approximately 2/3 of the width of the Dan River along the length of the thermal plume. This zone of passage allows the free passage of fish upstream or downstream without subjecting them to adverse conditions associated with the thermal plume.

Compliance with NPDES discharge limitations is protective of aquatic ecosystems in the Dan River. The selected discharge effluents and the thermal plume of the discharge are demonstrated to rapidly disperse, such that concentrations at the edge of the mixing zone are in accordance with expected NPDES permit limits. Additionally, thermal effluents are below thermal criteria of aquatic biota outside of the assumed mixing zone. Therefore, impacts to aquatic biota within the Dan River are localized and minor.

5.3.2.1.4 Summary of Effects on the Dan River

Direct effects of operation on aquatic ecosystems in Dan River include potential impingement and entrainment impacts associated with the MWIS, effects on aquatic biota and their habitats from water withdrawals from the MWIS, and effects of wastewater discharge effluents including radiological and nonradiological constituents and thermal effluents. Direct impacts to aquatic species are limited to the MWIS and the wastewater discharge in the Dan River. Impacts of impingement and entrainment at the MWIS are minimized through compliance with regulations adopted to implement Section 316(b) of the CWA. Potential thermal effects on biotic categories, including habitat formers, benthic macroinvertebrates, mussels, fish, and related habitats within the Dan River, from Project operation include the following:

- Minor effects to biotic categories including habitat formers, benthic macroinvertebrates, mollusks, and fish;

- Minor potential for acute adverse effects. Potential effects to fish are localized and limited to the immediate area around the discharge;

- Minor potential for acute impacts of thermal excesses due to avoidance behavior in fishes within the Dan River. The thermal plume is limited to, at most, 37 percent of the width of the river, resulting in the presence of an adequate zone of passage;

- Limited potential for impacts to adult fish growth, spawning, and embryonic and juvenile fish development;

- Minimal long-term (chronic) impacts on fish are expected;

- Minor impacts to aquatic invasive species, as elevated thermal excesses are localized and constitute a relatively low level of thermal excess beyond the assumed mixing zone;

- No important spawning habitat or nursery areas are located within the assumed mixing zone; therefore, no impacts to important spawning habitat are predicted as a result of thermal discharge; and

- Benthic scour is expected to be localized in the vicinity of the diffuser. However, effects are minimized by incorporation of appropriate scour protection (i.e., riprap protection downstream of the discharge diffuser) in conceptual diffuser design.

Impacts of the MWIS and discharge operation are minimized through compliance with NPDES permit requirement. Therefore, anticipated impacts of operation on aquatic species within the Dan River are minor.

5.3.2.2 Important Aquatic Species and Habitats

5.3.2.2.1 Important Aquatic Species

Important aquatic species that may be present in the Project site are described in Section 2.3.2.3. Impacts of building activities on important aquatic species are described in Section 4.3.2.2. Impacts of operation on aquatic systems occur primarily in Belews Lake and in the Dan River. No federally listed or state-listed freshwater mollusk species or fish species have been documented in Belews Lake or in on-site streams. Therefore, no impacts to federally or state-listed species occur in Belews Lake as a result of operation.

Within the Dan River, operational impacts are limited to the operation of the MWIS at the confluence of the Dan River and Belews Creek, and the wastewater pipeline discharge to the Dan River.

Federal- and state-listed aquatic species present in the Dan River are described in Section 2.3.2.3. In the Dan River, the MWIS is managed under restrictions that are protective of aquatic ecosystems in the immediate area as described above. One live individual green floater (*Lasmigona subviridis*) mussel was identified at the location of the MWIS within the Dan River in a 2024 survey (Duke Energy, 2024). Previous surveys have indicated the presence of green floater upstream and downstream of the MWIS in 2014. However, the risk of impacts of impingement and entrainment of these species is minimized based upon existing BTA integrated in the operation of the MWIS (HDR, 2022). As described in Section 5.2.1.1.3.1 operational pumping from the Dan River also encompasses the same restrictions as the existing NPDES permit listed above in order to minimize fish entrainment and impingement, avoid fish spawning periods, and maintain ambient flow levels. Such measures provide protection for listed important species. As Section 5.2.1.1.3.2 describes, effluents associated with the wastewater discharge at Dan River are managed in compliance with NPDES requirements to ensure protection of aquatic ecosystems of the Dan River, thereby minimizing impacts on

important aquatic species. One individual state-listed Roanoke Logperch (*Percina rex*) was observed in the Dan River near the wastewater discharge during mussel surveys in 2004.

Potential impacts of operations on recreationally important species within Belews Lake and other important aquatic species within the Dan River are minor.

In summary, impacts to federal- and state-listed aquatic species in the Dan River are minimized through compliance with NPDES permitting of the Dan River discharge, and through compliance with regulations adopted to implement Section 316(b) of the CWA for the MWIS. Impacts to recreationally important species in Belews Lake are limited. Therefore, impacts on important aquatic species are minor.

5.3.2.2.2 Important Aquatic Habitats

Important aquatic habitats on the Project site, associated off-site areas, and in the Project Vicinity are described in Section 2.3.2.4. Proposed critical habitat for state-endangered species and federally proposed threatened freshwater mussel (green floater) is present in the Dan River. As is described in Section 2.3.2.2.3.2, the location of the wastewater pipeline in the Dan River has been determined to consist of poor habitat for the green floater, and no live individuals were observed in the immediate vicinity. In a 2024 mussel survey in Dan River, no green floater individuals were observed near the wastewater discharge in the Dan River. Seven individual green floater were observed downstream within the Dan River.

Maintenance activities at the MWIS, including material removals, impact benthic habitat in the Dan River. In a 2024 survey, one live green floater was observed in the area around the MWIS. Therefore, any activities related to maintenance and material removals at the MWIS are done after consultation with the U.S. Fish and Wildlife Service, the NCDEQ, and USACE regarding avoidance, minimization, and appropriate conservation measures to limit potential effects on proposed critical habitat in the Dan River. Ground-disturbing activities, such as sediment removal or disturbance in the area of the intake structure, which have the potential to affect surface water quality are permitted by applicable federal, state, and local regulations and are regulated by the USACE.

Effluents from the wastewater discharge to the Dan River may result in alterations to water quality which may impact the suitability of the Dan River green floater critical habitat. At the location of the discharge diffuser, mussel habitat is limited. Impacts to mussel habitat is described in Subsection 5.3.2.1.2.2.3. Therefore, impacts of thermal discharge on Critical Habitats are minor.

Impacts of operation activities on proposed critical habitat for green floater are limited to material removal impacts at the MWIS and potential impacts of effluents at the wastewater discharge. Through compliance with state and federal regulations regarding material removal and effluent chemical concentrations, impacts on water quality and habitats within the Dan River are limited; therefore, impacts of operation on important aquatic habitats are minor.

5.3.2.3 Transmission Corridors

As discussed in Section 1.1.5, additional transmission lines that extend outside of the existing Project site boundary are not required.

5.3.2.4 Summary of Impacts to Aquatic Species and Habitats

Direct impacts of operation on aquatic ecosystems in Belews Lake include impingement and entrainment associated with the CWIS, effects of cooling tower effluent constituents and thermal effluents, and effects of water-level fluctuations within Belews Lake. Operational impacts to aquatic ecosystems include impacts related to on-site stormwater runoff and incidental spills. Impacts on-site are managed through stormwater management systems and, therefore, are minor. In Belews Lake, impacts are associated with the intake and discharge structures operations, and changes in water levels. Impacts of the discharge(s) are expected to dissipate rapidly, limiting impacts on aquatic ecosystems. Impacts of intake operation are minimized through compliance with regulations adopted to implement CWA Section 316(b).

Potential thermal impacts on all biotic categories, including habitat formers, benthic macroinvertebrates and mussels, fish, and related habitats within Belews Lake are localized and negligible. Compliance with thermal discharge limits required under the operational NCDEQ NPDES permit will limit adverse impacts to aquatic biota.

In conjunction with closure of BCSS, the aquatic ecological community will reflect a lake lacking significant thermal input from power generation, including recreationally important sport fish. Impacts to recreationally important species in Belews Lake are limited.

Impacts on aquatic species and habitats within Belews Lake from operations, under normal operational conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping are minor. Potential impacts to aquatic species and habitats from hydrologic alterations associated with increased water-level fluctuation under drought conditions within Belews Lake relate to effects on aquatic macrophyte communities, benthic macroinvertebrates and mussels, effects on fish communities through alteration of habitats (e.g., spawning habitat, nursery areas, foraging habitat), and increased potential for proliferation of nuisance macrophytes. The balance of fish communities is not expected to shift in such a way that would promote the expansion of nonindigenous fish beyond those already present in Belews Lake.

In the Dan River, operational impacts are associated with operation of the MWIS at the confluence of Belews Creek and the Dan River, and with the wastewater discharge. Impacts of MWIS operation on impingement and entrainment in the Dan River are regulated through intake flow requirements under the existing NPDES permit and are minimized through the use of technologies and design features. Discharge effluents released to the Dan River are regulated through an NPDES permit obtained in support of operations. Impacts of thermal discharge are expected to be minor for all aquatic biota. Impacts to important species and their habitats are minor.

Overall impacts of Project operations on aquatic species and habitats are SMALL, but MODERATE under drought conditions. Supplemental pumping from the MWIS in accordance with the limits established in the NCDEQ NPDES permit mitigates the reduction in lake levels and associated effects on near shore aquatic habitats and minimizes potential effects related to water-level fluctuations.

Table 5.3-1
Critical Thermal Maxima for Representative Important Species within Belews Lake

Common Name	Scientific Name	Indigenous	Trophic Guild	Thermally Sensitive Species	Acclimation Temperature (°C)	Critical Thermal Maximum (°C)	Critical Thermal Maximum (°F)	Source
Common Carp	*Cyprinus carpio*		OM		25.0	35.7	96.3	Hokanson, 1977
Bluegill	*Lepomis macrochirus*	X	IN		26.0	36.4	97.5	Beitinger et al., 2000
Largemouth Bass	*Micropterus nigric*ans	X	TC		20	36.7	98.1	Beitinger et al., 2000
Channel Catfish	*Ictalurus punctatus*	X	OM		20	35.5	95.9	Beitinger et al., 2000
Black Crappie	*Pomoxis nigromaculatus*	X	TC		23.8	34.9	94.8	Reutter and Herdendorf, 1974
Yellow Perch	*Perca flavescens*	X	IN		25	33.4	92.1	Hokanson, 1977
Gizzard Shad	*Dorosoma cepedianum*	X	OM	X	15.9	31.7	89.1	Reutter and Herdendorf, 1974

Source: Reutter and Herdendorf, 1974; Hokanson, 1977; Beitinger et al., 2000

Key: OM = omnivore, IN = insectivore, TC = top carnivore, BI = benthic invertivore

5.4 SOCIOECONOMICS

This section describes the potential socioeconomic impacts associated with operation of the Project at the Project site. As described in Section 2.4, the region of influence (ROI) for the socioeconomic analysis is defined by the areas where the workforces and their families for the building and operations phases reside, spend their income, and use their benefits. Because of expected commuter patterns, the distribution of residential communities in the area, and the likely socioeconomic impacts, the ROI is composed of the four counties nearest to the site: Rockingham, Stokes, Forsyth, and Guilford counties. These counties serve as the basis for the assessment of social and economic impacts from the Project.

Section 5.4.1 presents a summary of the physical impacts of the Project. Section 5.4.2 provides a description of the demographic impacts. Section 5.4.3 describes the economic impacts, including impacts on the local economy and tax revenues. Section 5.4.4 describes the impacts on infrastructure and community services.

5.4.1 PHYSICAL IMPACTS

This subsection provides an analysis of physical impacts due to operation of the Project that may affect people, buildings, and roads in the nearby communities. Potential impacts include the effects of noise and vibration, odors, dust and air pollution, thermal emissions, roadway deterioration and aesthetics. Duke Energy is committed to meeting all federal, state, and local environmental regulations applicable to these potential effects to reduce the potential for adverse impacts to relevant sensitive receptors.

5.4.1.1 Noise

The principal sources of noise from nuclear power plant operations are cooling towers, transformers, and loudspeakers. Other occasional noise sources may include auxiliary equipment (such as pumps to supply cooling water and diesel generators) and corona discharge from the high-voltage transmission lines. The primary source of continuous noise associated with the operation of the Project is the mechanical draft cooling towers.

As described in Section 5.8.2, during operations, overall impacts from noise are minor as residents and recreators nearest the Project site experience cooling tower noise below the 65 dBA threshold considered acceptable and allowable outside a residence by the USEPA (Section 4.8.2.1). Other residences further from the Project site and across Belews Lake also experience noise from operation of the cooling towers below 65 dBA, which is further attenuated by the distance from the towers and the vegetative buffer. Although residents experience noise at higher levels than the existing average ambient condition, the resulting noise levels remain well below 65 dBA. Additionally, due to the exclusion area boundary (EAB) proposed for each of the three Plant Complexes, recreational users of Belews Lake are not permitted in areas of the lake where noise levels are above 65 dBA. Additional analysis of potential effects of noise emissions from these noise sources on nonradiological health are evaluated in Section 5.8.2.

5.4.1.2 Odors, Dust, and Air Pollution

Operation-related air quality impacts are addressed in Section 5.7.2. Principal sources of air emissions from operations include mechanical draft cooling towers, auxiliary boilers, emergency equipment, and emergency power supply system diesel generators, and gas turbines.

Additional operation-related traffic may also result in nominal, localized increases in fugitive dust and exhaust emissions from worker and delivery vehicles that travel to and from the Project site. Operations-related exhaust emissions could also result in odors.

As described in Section 5.7.2, operating equipment releases air pollutants which include substances like nitrogen oxides (NO_x), carbon monoxide (CO), sulfur oxides (SO_x), hydrocarbons in the form of volatile organic compounds (VOCs), and particulate matter (PM). However, standby and auxiliary equipment are operated on an intermittent basis rather than continuously. As indicated in Section 4.4.1, dust and odors resulting from emissions are localized and dissipate rapidly. Dust emissions are minimized by relevant management measures, as appropriate.

The Project site is located in an attainment area for all National Ambient Air Quality Standards (NAAQS) criteria pollutants. As noted in Section 5.7.2, Project-related emissions do not result in exceedances of the NAAQS. Therefore, air quality impacts from operation onto nearby residences, recreation areas, and facilities are minor.

5.4.1.3 Thermal Emissions

As described in Section 3.4.1, the cooling system includes mechanical draft cooling towers, which remove excess heat by evaporating water. Physical impacts to structures from operational activities are related to cooling tower drift and deposition of salts. Detailed analyses of the transfer and dissipation of heat from the cooling tower as a visible vapor plume and the associated deposition of salt from the vapor plume water droplets are discussed in Section 5.7.1. As documented in the SACTI2 analysis (Section 5.7.1.2.2.3), the maximum modeled plume drift is located near the central and north-central parts of the Project site and as shown in Figure 5.7-9, does not reach off-site structures.

5.4.1.4 Transportation

This subsection discusses the physical impacts on off-site roadways resulting from increased traffic during operations. As described in Section 2.4.2.2.7, the waterways located within the Project Vicinity are not used for transportation-related purposes. As described in Section 3.3.2, rail unloading areas with heavy haul roads will be developed leading from the unloading areas to the construction storage and staging areas. The primary access roads to the Project site are identified in Table 2.4-13 and in Figure 2.4-4. Traffic-related impacts are discussed in Section 5.4.4.1.

As noted in Section 4.4.1.3, Craig Road provides ingress and egress to the Project site during the operations phase. Consequently, the Project-related increased traffic during the building phase accelerates the deterioration of Craig Road and other roadways providing access to the Project site. However, during operations, Project-related traffic volumes are substantially reduced from those observed during the building phase (see Section 5.4.4.1). Therefore, the physical impacts to roads are correspondingly reduced, and the operations-related impacts are minor.

5.4.1.5 Aesthetics

Visual and aesthetic effects occur as a result of viewshed alterations that may relate to alteration of natural or developed landscapes, increased or decreased visibility of structures, or

the addition of visible nonstructural features that are not consistent with the existing viewshed. The existing visual resources near the Project site are described in Section 2.4.2.6.1. Based on the bounding values in the plant parameter envelope described in Table 3.1-1, the principal visual features of the Project site are the power block structures (up to 176 ft. [53.6 m] tall), cooling towers (up to 75 ft. [23 m] tall), and the switchyard and its associated powerlines. These principal visual features are illustrated in Section 3.1, Figures 3.1-4 through 3.1-7 which present representative renderings of the plant from various angles. Additionally, vapor plumes associated with operation of the cooling towers are also a prominent visual feature of the Project site.

Sensitive visual receptors that may be affected by changes in the viewshed are described in Section 2.4.2.6.1 and include recreators on Belews Lake, users of parklands (Belews Lake Park), residents along the southern Project site boundary, property owners across Belews Lake opposite the Project site boundary, and motorists along roadways in the Project Vicinity (6 mi. [10 km]).

Cooling tower plumes have both height and length characteristics that are influenced by weather conditions. As described in Section 5.7.1.2.1, the SACTI2 model simulates the visible plume from cooling towers under different meteorological conditions and frequencies. As summarized in Table 5.7-14, modeled plumes are longest in the winter and shortest in the summer, which is generally consistent with the annual temperature cycle. Similarly, plumes have a greater height in the winter and a lower height during summer. The longest plumes extend to 2.7 km (1.7 mi.) which would occur approximately 2 percent of the time on an annual basis while a 100 m (325 ft.) plume occurs 100 percent of the time during operations. As shown in Table 5.7-15, the modeled plume heights are typically 30 m (98.4 ft.) or less.

To evaluate the potential impact of operations on the visual environment, consideration was given to both attributes of the principal visual feature (height, size) of the Project site and its frequency as a feature in the viewshed. Structures potentially visible from receptors represent features that are permanent and therefore, have a greater effect on visual intrusion. By comparison, the degree of visibility of cooling tower plumes depends on the season, weather conditions (e.g., clear skies, storms, fog), location and perspective of the observer, amount of intervening tree cover, and time of day. Therefore, plumes may be visible and intermittent during an average year and not a constant feature in the viewshed. Therefore, persistent visual intrusions are recognized as having a greater effect on aesthetics than the infrequent occasions when plumes may be visible. Persistent visual intrusions are represented by the permanent alteration of the site, which occurs during the building phase with the clearing of vegetation. These intrusions are further defined by the introduction of the principal visual features at each of the three Plant Complexes.

As described in Section 7.1, plant closure is a RFFA in which BCSS operations are discontinued. As such, the existing stacks of BCSS are evaluated as long-term, persistent structures in the viewshed, whereas the plume from the BCSS stacks are absent in the long term as operations of BCSS are discontinued.

As shown in Figures 3.1-4 through 3.1-7, the principal structures on the Project site are prominent in relation to the surrounding landscape. These structures are mostly visible to recreators at Belews Lake and residents and businesses along the shoreline across the lake. Vegetation clearing within the Project site, the new structures within the Plant Complex areas,

and the associated plumes add an industrial aspect to a mostly natural landscape, noticeably altering the existing viewshed. For sensitive visual receptors near the Project site, aesthetic effects are noticeable. However, due to the vegetative buffer along the shoreline, and the presence of the existing BCSS facility, impacts to recreators on Belews Lake are not destabilizing. Impacts are minor on those receptors at greater distances. Therefore, the visual intrusion due to operation ranges from minor to noticeable, but not destabilizing, depending on the location of the observer and the atmospheric conditions.

5.4.1.6 Summary of Physical Impacts

The physical impacts from noise, odors, dust, and air pollution, thermal emissions, and transportation from operations-related activities are SMALL. Additionally, new plant structures and related cooling tower plumes at the Project site noticeably affect the aesthetic qualities of the natural landscape for nearby residents and recreators on Belews Lake. Thus, physical impacts on aesthetic quality from operations are MODERATE.

5.4.2 DEMOGRAPHIC IMPACTS

The following evaluation assesses potential impacts associated with the operations workforce on the ROI population. The evaluation is focused on impacts within the ROI identified in Section 2.4 and is based on the maximum number of workers required when all advanced reactor units are operating.

As described in Section 3.3.5, the Project is expected to operate at full capacity by the late 2030s. Therefore, the projected 2040 population serves as the baseline for assessing demographic impacts during operation. This evaluation also assumes that due to the anticipated duration of building activities (see Section 1.3.2), approximately 50 percent of the population from the building phase (see Section 4.4.2) retain their permanent residence in the ROI upon completion of building activities. As a result, 512 construction workers and their families remain in the ROI. An additional 170 people that in-migrated during the building phase reside in counties outside the ROI and do not commute to the ROI for operations-related activity. The population remaining in the ROI from the building phase and their families are assumed to follow the same residential distribution as detailed in Section 4.4.2.

Duke Energy anticipates the total operations staff to be approximately 818 full-time employees once all units are operational. It is conservatively assumed that all approximately 818 operations workers are sourced from outside the ROI. In addition, as stated in Section 5.4.4.4.1, an additional 350 temporary outage workers are needed during refueling and major maintenance activities. However, because these activities are infrequent and short-term, temporary outage workers needed from outside the ROI are assumed to relocate to the area temporarily without their families. In-migrating outage workers primarily use temporary housing such as hotels, motels, or short-term rentals, and do not have a notable impact on local demographics or community services. Thus, the following analysis focuses on the full-time operations staff (818 employees) plus 50 percent of the population from the building phase that retain a permanent residence in the ROI (512 employees).

The residential distribution of the in-migrating operations workforce is assumed to be the same as the residential distribution of the existing BCSS workforce. Consistent with these commuting patterns, 25 percent, or 204 of the 818 full-time operations staff reside in counties outside the

ROI and commute to the Project site. Accordingly, the remaining 614 operations workers relocate to the ROI and are assumed to bring a family. The average household size in North Carolina is approximately 2.48 (USCB, 2022). Therefore, the in-migrating operations workforce of 614 people and their families, along with the remaining population from the building phase and their families, increases the ROI's population by approximately 2790. The distribution of this new population within the ROI is shown in Table 5.4-1. The estimated population increases have the greatest effects in Rockingham and Stokes counties, where new residents increase the population by approximately 1.2 percent and 2.0 percent, respectively, based on 2040 projections. Forsyth and Guilford counties each experience population increases of approximately 0.1 percent, while the population in the ROI increases by approximately 0.2 percent.

The population increases associated with the in-migration of operations workforce, together with the construction workforce that remain within the ROI, and their families account for less than 1 percent of the ROI's projected total population in 2040 (Table 5.4-1). Therefore, impacts to demographics within the ROI associated with operation are SMALL.

5.4.3 ECONOMIC IMPACTS TO THE COMMUNITY

This subsection describes the projected economic and tax revenue impacts of operations on the ROI. Economic impacts of operational activities occur both within the ROI as well as the Project Region (50-mi. [80 km] radius of the Project site). As described in Section 4.4.3, counties within the ROI are the most affected due to proximity to the Project site. Other counties in the Project Region also experience economic impacts, but these impacts are widespread and dispersed across the Project Region.

This subsection describes the economic and tax impacts in the ROI during operations. As described in Section 4.4.3, because economic impacts are generally positive, the bounding economic condition is the configuration or option that results in the lower economic benefit. For this Project, multiple advanced reactors are considered for development over three Plant Complexes. Therefore, the development of a single Plant Complex (two reactor units) represents a conservative economic scenario. As such, a single Plant Complex deployment is the bounding condition for this analysis as this would result in lower capital costs and a lower economic benefit as compared to the operation of multiple Plant Complexes.

5.4.3.1 Economy

5.4.3.1.1 Economic Input-Output Model

Economic effects over the course of the 40-year operational life of the Project are linked to both direct and indirect expenditures and operations-related employment. Direct expenditures include payment of wages and salaries to the operating workforce, purchase of goods and services, and capital expenditures. Indirect effects are related to spending and purchases of goods and services by the operations workforce. As described in Section 4.4.3, the multiplier effect creates more jobs, income, and economic activity in the ROI and Project Region. Regional input-output multipliers are economic tools for estimating the broader economic impact of initial changes in economic activity across various sectors.

The economic multiplier used in this analysis is from the Regional Input-Output Modeling System (RIMS) II developed by the U.S. Department of Commerce, Bureau of Economic

Analysis (BEA), Economics and Statistics Division. This model calculates multipliers for various industries and earnings within a specific region (BEA, 2024). The BEA RIMS II multipliers obtained for the ROI are used to model impacts to employment and economic output based on total employment and total operation-related expenditures (payroll).

5.4.3.1.2 Economic Model Predictions

The RIMS II direct effect employment multiplier in the electric power generation industry is 3.76. As such, for every direct job created, an estimated 2.76 indirect jobs are generated in the ROI. The change in indirect employment in the ROI during the operations phase is estimated by applying the RIMS II direct effect employment multiplier to the total operations workforce. Based on the operations workforce needed for a single Plant Complex (339 workers), approximately 935 indirect jobs are created within the ROI. Most indirect jobs are service-related, and those jobs are conservatively assumed to be filled by the existing workforce in the ROI. Some of these jobs could benefit unemployed or underemployed workers in the ROI. Overall, based on 2022 data, the combined approximately 1274 jobs (direct and indirect employment) represent 0.2 percent of the total labor force within the ROI.

The RIMS II multipliers are also used to estimate the economic impact resulting from operations-related payroll expenses. The RIMS II direct effect earnings multiplier for the electric power generation industry is 2.05. Meaning that for every dollar spent on operations payroll, an estimated $1.05 is added to the economy within the ROI. For a single Plant Complex (two reactor units) payroll is estimated to be approximately $30.5 million annually. Using the RIMS II direct effect earnings multiplier and the annual operations-related payroll results in a total economic output of approximately $62.4 million across local industries annually. During the operations phase, the construction-related workforce that remains within the ROI is expected to earn salaries comparable to those received during the building phase, resulting in additional spending within the ROI.

Capital expenditures and purchases of goods and services during operations have a multiplier effect that results in an increase in business activity, particularly in the retail and service industries. However, at this stage, the extent of the capital expenditures and purchase of goods and services occurring within the ROI or the Project Region is unknown. As described in Section 4.4.3.1.2, nuclear power plants are highly specialized in nature and operations-related expenditures are likely to be sourced from retailers outside the Project Region. However, generic operations-related goods and services can be purchased in the ROI and are likely to have a minor but beneficial impact on the economy.

Project operation introduces millions of dollars into the economy annually and indirectly creates employment opportunities. The economic impacts during operations are conservatively analyzed for a single Plant Complex (two reactor units). As Section 4.4.3 states, Duke Energy is analyzing a range of reactor technologies, including multiple reactor units across three Plant Complexes, which would result in substantially greater beneficial economic effects within the ROI and Project Region. Operations-related payroll expenditures are primarily realized within the ROI, making the economic impact of operations beneficial and noticeable.

5.4.3.2 Taxes

Primary tax revenues associated with operations at the Project site arise from individual income tax, corporate income tax and franchise tax, sale of electricity tax, sales and use tax, and property taxes which are beneficial to both the state and the Project Region.

5.4.3.2.1 Individual Income Tax

The in-migrating operations workforce, together with the construction workforce that remains within the ROI, increases the workforce total associated with the Project to 1126 (see Table 5.4-1). As shown on Table 2.4-9, in 2022, more than 500,000 individuals were employed in the ROI. Therefore, the addition of 1126 workers represents a minor increase in the total employed population in the ROI.

Construction workers that remain within the ROI after the building phase concludes are expected to make similar salaries when they transition to new employment within the ROI. Based on the projected 2026 North Carolina income tax rate described in Section 2.4.2.3 and a salary of $40,830 per year, the construction workers that remain in the ROI generate approximately $0.8 million in income tax revenue for the State of North Carolina (BLS, 2023a). Income tax revenue generated from operations workers for one Plant Complex based on an estimated average annual salary of $90,000 per year is approximately $1.2 million for the State of North Carolina. This combined estimated increase in income tax revenue represents 0.01 percent of the total tax revenues for the State of North Carolina in fiscal year 2023. Additionally, employment created through the multiplier effect described in Section 5.4.3.1.2 results in state income tax generation within the ROI. Therefore, there is a minor but beneficial increase in individual income tax revenue within the ROI and for the State of North Carolina associated with operations-related employment.

5.4.3.2.2 Corporate Income Tax and Franchise Tax

As stated in Section 2.4.2.3, for tax year 2023, the State of North Carolina imposed a 2.5 percent income tax on corporations. However, by 2030, this tax is reduced to zero percent. Therefore, operation of the Project has no impact on corporate income and franchise tax.

5.4.3.2.3 Sale of Electricity

The State of North Carolina imposes a 7 percent tax on the sale of electricity (Section 2.4.2.3). Operations of the Project is not anticipated to change Duke Energy's power assets. BCSS is slated to be retired by the mid-2030s (Section 1.2.2). Therefore, the tax revenues from the sale of electricity remain unchanged, and no impacts to electricity tax revenues are expected.

5.4.3.2.4 Sales and Use Taxes

Sales and use taxes are generated by purchases supporting operations at the Project site. While the exact amount of local operational expenditures is unknown, over the 40 year operational life of the plant, a beneficial and minor impact occurs throughout the ROI and Project Region.

Total sales and use taxes collected in the ROI increase because of (1) the in-migrating operations workforce and their families and (2) the operations workforce that resides outside the

ROI but travels into the ROI. While the state collects 4.25 percent state sales and use tax, local jurisdictions levy and collect additional sales and use taxes, ranging from 2.0 to 2.75 percent (see Section 2.4.2.3). The average operations worker salary is approximately $90,000 per year, which is saved or spent on goods and services. Over the Project's 40-year licensing period, sales and use tax revenues are generated from the expenditures of the operations workforce, the remaining construction workforce, and their families. However, due to the small population increase (see Section 5.4.2), the resulting annual revenue return is beneficial and minor.

5.4.3.2.5 Property Tax

Property tax revenues are generated through property taxes on the Project site based on assessed valuation and through property taxes paid by the operations workforce. The construction of a single Plant Complex increases the appraised value of the Project site. As identified in Section 2.4.2.3, Duke Energy paid Stokes County $6.8 million in property taxes for 2024. Improvements made to the Project site are expected to increase its appraised value. These improvements suggest a potential increase in future property tax obligations. However, the exact amount of these obligations is currently unknown.

Members of the in-migrating workforce and the remaining construction workers pay property taxes within the ROI county in which they reside. Based on the residential patterns illustrated in Table 5.4-1, a majority of the operations workers are expected to reside in Rockingham County. While many of these in-migrating workers buy existing homes and pay property tax rates, some workers may choose to build their own homes and thus generate a minor increase in property tax revenues within the ROI.

Therefore, the impact on property taxes from the operational facility, the in-migrating workforce, and the construction workers that remain within the ROI is beneficial and noticeable.

5.4.3.3 Summary of Economic Impacts on the Community

Operational activity introduces millions of dollars into the economy and creates jobs. These positive economic impacts are primarily realized within the ROI. Minor tax revenue impacts on local jurisdictions are accrued through increases in revenue generated from individual income taxes, sales and use taxes, and property taxes. Therefore, the economic and tax impacts are SMALL and beneficial.

5.4.4 COMMUNITY INFRASTRUCTURE IMPACTS

This subsection provides the estimated impacts on infrastructure and community services, including traffic, recreation, and public services.

5.4.4.1 Transportation

This subsection evaluates the traffic impacts generated by operations activities. Section 5.8.3 discusses the accident-related consequences of additional traffic from operations activities.

5.4.4.1.1 Roadway Traffic

Impacts to traffic as a result of operations are generally dependent on five factors:

1. Number of operations workers and their vehicles on the roads.
2. Distribution of the workforce within the ROI and related commuting patterns.
3. Number of truck deliveries to the Project site.
4. Projected population growth rate in the ROI.
5. Capacity of the potentially affected roadways.

As identified in Section 4.4.1.1, the total number of workers accessing the Project site during operations on any day is 450. Conservatively, approximately 90 truck deliveries are made daily to the Project site. Operations workers are divided into two 12-hour shifts. The day shift begins between 5:00 a.m. and 7:00 a.m. and ends between 5:00 p.m. and 7:00 p.m. A total of 400 operations workers enter for the day shift when 50 operations workers leave after the night shift. This analysis conservatively assumes one worker per vehicle because shared transportation information cannot be determined. As noted in Section 4.4.1.3, Project-related traffic, including Project deliveries and refueling and maintenance workers, is expected to access the Project site via Craig Road during operations. Delivery traffic is evenly distributed throughout the work hours of the day and avoids peak traffic hours.

During refueling and maintenance operations, a 350-person temporary outage workforce travels to the Project site during scheduled outages. Using the same shift breakdown as described for the operations workers, temporary outage workers are divided into two shifts: in the morning, 300 enter for the day shift while 50 leave from the previous night shift; in the evening, 50 enter the Project site for the night shift as 300 leave from the day shift. Together, the total number of vehicles accessing the Project site during operations and scheduled outages (800) is less than the total number of construction and operations workers accessing the site during the building phase (2546) (Section 4.4.4.1.1). Therefore, it is expected that impacts on LOS, on surrounding roadway segments and intersections analyzed are less impactful than at peak employment during the building phase. Additionally, potential effects on traffic during the building phase may be minimized by implementing traffic management measures (Section 4.4.1.1), which may also be effective during periodic outage operations, to address impacts during the building phase. As a result, the temporary traffic impact from the outage workforce is considered minimal and is not analyzed further.

As shown on Table 2.4-3, the population in the ROI is projected to grow at a rate of approximately 0.7 percent annually throughout the operations phase. Therefore, any increase in traffic due to population growth is minimal and is not further considered in this analysis.

As described in Section 2.4.2.2.3, the average annual daily traffic (AADT) is calculated by dividing the total volume of motorized vehicle traffic on a highway or roadway segment over the course of the year by 365. Following the same analysis approach described in Section 4.4, the estimated traffic generated by operations activities is based on the assumptions listed above regarding peak employment and on the North Carolina Department of Transportation AADT values shown in Table 2.4-13. Traffic operations for existing conditions and conditions during operations were analyzed using the Highway Capacity Software (HCS), which uses methodology from the seventh edition of the Highway Capacity Manual (NASEM, 2022).

Also noted in Section 2.4.2.2.3, LOS is a qualitative measure of operational conditions at a roadway segment or intersection. LOS is given a letter designation ranging from A to F (free

flow to heavily congested). The primary roadways in the Project Vicinity currently operate at an acceptable LOS C or better, except for U.S. 158 (east of NC Highway 68) and U.S. 158 (between Belews Creek Road and NC Highway 68), which operate at a LOS D. Roadways described in Section 2.4.2.2.3 and evaluated in this subsection are the roadways in the Project Vicinity that operations workers and other Project-related traffic use to access the Project site.

Peak traffic on primary roadways to the Project site in the evening, or the "p.m. peak hour," was analyzed for impacts to LOS during peak employment because p.m. peak-hour traffic is generally heavier than morning traffic, or the "AM peak-hour" traffic, due to additional activities like school pickups, errands, extracurricular activities, and social events. LOS during operations is shown on Figure 5.4-1 and presented in Table 5.4-2.

LOS along most of the roadways analyzed does not change during the operations phase. Changes in LOS from an A to a B during operations are anticipated on U.S. 311 (north and south of NC Highway 65), and Belews Creek Road (between Craig Road and NC Highway 65). LOS on NC Highway 65 (between Belews Creek Road and Pine Hall South), Belews Creek Road (east of Craig Road), and NC Highway 65 (north and south of Pine Hall Road) changes from A and B to C during the operations phase. Under LOS C conditions, speeds along these roadway segments are noticeably reduced during peak hours.

The LOS on NC Highway 68 (north of U.S. 158) changes from a C to D during operations. Under LOS D conditions, vehicles become more closely spaced, with volumes near capacity, on two-way highways. The LOS on U.S. 158 (between Belews Creek Road and NC Highway 68) experiences a degradation from LOS D to E during peak hours. Under LOS E volumes are at or near capacity.

Because of the focused traffic at intersections providing primary access to the Project site, four intersection locations were also reviewed to further analyze traffic impacts during operations. Table 5.4-3 summarizes the results of the analysis for these unsignalized intersections during both existing conditions and operations in the p.m. peak hour. Increased traffic at these intersections results in a decrease in LOS from LOS C or D to LOS E or F for at least one of the traffic movements at each intersection. This results in unstable traffic conditions characterized by low speeds, volumes exceeding capacity, and long delays with stop-and-go traffic.

Overall impacts at two of the intersections providing access to the Project site are noticeable and potentially destabilizing (LOS C/D to F). These impacts are most evident to local residents closest to the Project site that rely on Craig Road to access Belews Creek Road. The most noticeable traffic impacts occur during the beginning and end of the shift and occur for less than 2 hours per day. Impacts to roadway capacity are minor during other times of the day. Duke Energy has identified several planned traffic management measures to minimize congestion and unstable traffic conditions during building phase, as described in Section 4.4.4.1.1, that will alleviate congestion and unstable conditions during operations. With the incorporation of traffic management measures during daily short durations of increased traffic in the immediate area near the Project site, impacts to traffic are noticeable, but not destabilizing.

5.4.4.1.2 Railroads

As described in Section 4.4.4.1.2, deliveries made by rail enter the Project site via an existing Norfolk Southern spur that connects to the BCSS. The use of this rail spur for operational

deliveries does not impact other transportation systems used by the local communities, and the impact on railroads are minor.

5.4.4.1.3 Waterways

As described in Section 2.4.2.2.7, the waterways located within the Project Vicinity are not used for transportation-related purposes. Therefore, there are no operations-related activities on waterways that affect water-based transportation.

5.4.4.1.4 Public Transportation

Public transportation services in the ROI are identified in Section 2.4.2.2.9. However, there are no transit services that provide direct access to the Project site. Therefore, there is no impact on public transportation.

5.4.4.2 Recreation

Recreational resources within the Project Vicinity are potentially affected by operations at the Project site. Impacts may include disruption of recreational experience due to operational use of water, increased user demand associated with the projected increase in population as a result of the in-migrating workforce and their families, and impaired recreational experience associated with operational noise and visual intrusion.

5.4.4.2.1 Operational Water Effects on Recreation

As described in Section 5.2 and Section 7.1.1, the building and operational schedule for units at the Project site is conducted in a phased schedule over several years. In conjunction with this phased approach, Duke Energy will also derate the operations of BCSS in a manner that replaces and balances overall generation capacity between both the Project and BCSS. The closure of BCSS is considered a RFFA (see Table 7.1-2). Accordingly, the BCSS closure results in gradual changes in the environmental conditions relative to those described in Chapter 2.

As is described in Section 5.2.1.1.2.2.2, operational use of water from Belews Lake for the Project results in water-level fluctuations. Figure 5.2-2 depicts the modeled water levels of Belews Lake for the Project operations condition based on supplemental pumping of the MWIS. Specific changes in the affected environment relevant to recreation include the following:

- The future predictive analysis based on Project operation reflects a condition of water levels that fluctuate in a manner that is similar to that predicted for BCSS under full operation. However, the water-level drawdowns under Project operations are more pronounced relative to the BCSS Continuous Maximum Generation Condition and increased by 0.6 ft and 3.0 ft for the 2-year and 100-year drought return periods, respectively.
- Aquatic ecological communities that reflect a lake lacking significant thermal input from power generation including recreationally important sport fish (Section 5.3.2).
- Depending on the frequency of drought conditions and related water-level fluctuation, corresponding effects may also be evident in the condition of recreationally important sport fish (i.e., smaller fish, changes in community structure, and other factors) that may be sought after by anglers (Section 5.3.2).

- Restricted access to several small coves that fall within the EAB as described in Section 5.4.1.1.

Operations impacts based on the above-referenced changes for recreation are considered in the following subsections, as appropriate.

5.4.4.2.1.1 Belews Lake

As described in Section 5.2.1, operational use of cooling water from Belews Lake for advanced reactor technologies results in fluctuations of water levels. Additionally, as a result of BCSS closure, water quality (notably, temperature) within Belews Lake is normalized to that characteristic of other regional lakes that lack thermal inputs from power generation. As described in Section 5.2.3, thermal profiles in Mayo Reservoir, a lake similar to Belews Lake but with minimal anthropogenic heat load, were reviewed to provide a potential predictive future condition of Belews Lake without the contributing heat load from BCSS. Temperature-related changes that potentially affect recreation are attributable to BCSS closure rather than the proposed action. As such, these effects are assessed in Section 7.1 as part of the cumulative effects analysis.

Under conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping, impacts on Belews Lake recreation are minor. However, impacts on Belews Lake recreation are more noticeable in conjunction with the effects of increased drought intensity for the following:

- Altered recreational access and use due to limitations of boat ramps and boat docks under low water conditions. As identified in Figure 2.4-5, potentially affected access areas include the Pine Hall public boat ramp, Carolina and Humphrey's Ridge marinas, the Piney Bluff boat launch, and individual boat docks within the residential areas of Belews Lake. An accessible fishing dock is also planned for Belews Lake Park. Potential effects to each of these resources may occur depending upon the extent and frequency of each specific drawdown period as described in Section 5.2.1.1.2.2.2 and illustrated in Table 5.2-2, and the specific characteristics of each feature (length and depth of boat ramps, dock design details, etc.).
- Reduced water depth in arms and tributary inlets of Belews Lake that restrict or limit boating access to public boat ramps and approximately 63 permitted private docks and structures (Section 2.4.2.6.2). Several locations within Belews Lake are potentially affected by reduced water levels. Duke Energy will work with the North Carolina Water Resources Commission to extend public boat ramps during these conditions as necessary. Key locations where boat access is potentially impacted by reduced water levels include:
  - Cove near Oak Level Church Road
  - Belews Creek Road underpass on the Belews Creek Arm
  - East Belews Creek Arm at Belews Creek Road
  - East Belews Creek Arm at Reidsville Road
  - Several locations within Belews Creek Arm between Belews Creek Road and Reidsville Road.

Accessibility to the arms of Belews Lake via these key connection areas varies with water-level conditions. Under most conditions accessibility may be possible but more constrained due to water depth limitations. As illustrated in Figure 5.2-3, under moderate and extreme drought conditions, access from Belews Lake to the upper arms of Belews Lake may not be possible due to low water conditions.

- Drought related effects may also indirectly affect fishing including the ability to use boat ramps, as described above, and access all areas of the lake. This may reduce accessibility for fishing and angling activities in Belews Lake. As such, the frequency of fishing tournaments at Belews Lake and the related benefits to local businesses that depend on such recreators may also be affected.
- Pedestrian shoreline access to the water may be limited in certain areas depending on the extent of mud flats or other exposed shoreline areas, particularly during periods of low water levels.
- Increased incidence of boater safety hazards may be present in areas of reduced water levels. Lower water levels may affect boater safety in conjunction with greater frequency of boater contact with exposed or submerged stumps, rocks, and other underwater obstructions.
- The fluctuation of water levels has the effect of creating unvegetated reservoir “rings” and mud flats along the perimeter of the lake. Increased depth of drawdown has the potential to expand the exposed mud flats and shoreline relative to the BCSS full operational condition. Such effects have the potential to diminish the visual appeal of these areas thereby affecting a wide range of activities that rely on scenic quality.
- Changes in water levels and temperature characteristics of Belews Lake described in Sections 5.2.1 and 5.2.3, may also affect fishing. Belews Lake water-level fluctuations during typical conditions are similar to those predicted for BCSS under full operation. However, potential impacts to aquatic species and habitats from hydrologic alterations such as increased water-level fluctuations during drought conditions within Belews Lake from Project operations may include changes to the macrophyte communities, including loss of nearshore emergent vegetation communities and SAV communities. Indirect negative impacts to fish communities may occur through alteration of habitats (e.g., spawning habitat, nursery areas, foraging habitat) and increased potential for proliferation of nuisance macrophytes, such as Hydrilla. Increased frequency and duration of water-level fluctuations during drought conditions have the potential to affect impacts to adult fish growth, spawning, and embryonic and juvenile fish development in conjunction with habitat alteration. However, the balance of fish communities is not expected to shift in such a way that would promote the expansion of nonindigenous fish beyond those already present in Belews Lake. Depending on the frequency of drought conditions and related water-level fluctuation, corresponding effects may also be evident in the condition of recreationally important sport fish (i.e., smaller fish, changes in community structure, and other factors) that may be sought after by anglers.
- As discussed in Section 7.1.2, thermal loading to Belews Lake is significantly reduced in conjunction with the closure of BCSS. The CCW discharge would cease, and heated effluent would no longer disperse within the West Belews Creek arm or be conveyed via the CCW canal to the Belews Creek arm. Loss of warmer winter temperatures in the West Belews Creek arm of Belews Lake will result in a shorter growth season and may result in decreased fish condition through the loss of winter thermal refugia. However, in

conjunction with BCSS closure, normalization of water temperatures across Belews Lake including cooler temperatures within the West Belews Creek arm of Belews Lake in winter, would result in a shorter growing season. However, improved (cooler) summer high water temperatures may also result in reduced stress on the aquatic ecosystem within Belews Lake that may also improve overall fish condition. Accordingly, reductions of elevated temperatures may result in benefits of overall higher fish condition and decreased fish stress in the summer. The loss of thermal discharges from the closure of BCSS will affect recreational sportfishing in Belews Lake. Belews Lake is a popular destination for fishing. Largemouth Bass, Black Crappie, and Alabama Bass are the primarily targeted species for fishing. However, Belews Lake is also fished for catfish, Bluegill, and other sunfish. Due to its warm temperatures resulting from the BCSS discharge, Belews Lake is one of the state's more productive lakes for fishing in the winter. With the establishment of cooler water within Belews Lake under BCSS closure, Belews Lake fish will no longer be attracted to thermal discharges, thereby changing winter movement patterns, which may result in reduction in the degree of winter sportfishing success. The combination of a truncated growing season and the potential reduction in thermally sensitive forage species such as Threadfin Shad may alter abundance and condition of sportfish such as Largemouth Bass, Alabama Bass, Black Crappie, White Crappie (*Pomoxis annularis*), catfishes, and perches (Percidae) that prey upon shad species in the short term; however, the same sportfish species are still expected to persist in Belews Lake.

Potential effects of operations on recreation as noted above result in fluctuating water levels that affect Belews Lake and its recreational characteristics. However, recreational use and quality within Belews Lake and its associated shoreline are subject to Duke Energy policy. Because Duke Energy owns all the land within and immediately adjacent to Belews Lake, adjoining property owners own water view, not waterfront property. Duke Energy grants shoreline access leases to adjacent property owners for permission to access the lake across Duke Energy property and, in limited cases, to maintain existing private piers. Duke Energy's primary goal as it relates to shoreline management is to provide for public and private access to Duke Energy lands while appropriately managing natural, cultural, and recreational resources and protecting the primary function of Belews Lake—supporting electricity production (Duke Energy, 2020).

In summary, overall effects of Project operation on recreation within Belews Lake are primarily dependent upon the water use and related water-level fluctuations. Such effects are intensified by periodic droughts that further depress water levels for short periods. Given the size of Belews Lake and its capacity to continue to provide water-based recreation, impacts are noticeable but not destabilizing.

5.4.4.2.1.2 Dan River

As described in Section 2.4.2.6.2, 90 mi. (145 km) of the Dan River is part of a state paddle trail. During operations, water is withdrawn from the Dan River for makeup to Belews Lake that may alter water levels on the Dan River and potentially impact recreators along the state paddle trail. As stated in Section 3.4.1.1.2, the existing BCSS NPDES Permit NC0024406 and design of the MWIS allow for a pumping capacity of 100 cfs (2.83 m^3/s). Naturally occurring fluctuations of river flow result in an existing condition in which water levels fluctuate seasonally and annually (see Section 2.2.1). Operation of the Project conforms with the existing NPDES permit requirements effective for the BCSS and is not anticipated to further impact water levels on the

Dan River. Additionally, the effects of pumping on bypass flow and associated uses on the Dan River are determined to be minor as described in Section 5.2.1.

Discharge to the Dan River from a new outfall within a corridor adjacent to the existing Outfall 006 results in intermittent flows and hydrologic alterations associated with periodic releases of wastewater effluents in conjunction with blowdown from the cooling tower. Discharges from existing Outfall 006 consist of conventional waste from advanced reactors upon closure of BCSS. The Project discharge structure is designed to be a low-profile structure to limit obstruction to river flow and promote mixing. Because the structure has a low-profile design the effects of the structure on paddlers or recreators on the Dan River are minor. Periodic releases of water from the Project discharge are in accordance with NPDES permit requirements and result in localized flow and current alterations in the vicinity of the release points, but do not result in overall adverse alterations of Dan River flow (Section 5.2.1). Cautionary signage is posted to minimize impacts on recreators. Therefore, due to adherence to NPDES permitted conditions and effective design of the discharge that does not result in an impediment to recreators, impacts to recreators on the Dan River from operations are minor.

5.4.4.2.2 Impacts on Recreational Resources in the Project Vicinity

The Project Vicinity offers various recreational opportunities that are described in Section 2.4.2.6.2 and include Belews Lake and the Dan River. Belews Lake supports aquatic recreation and fishing, while the Dan River provides options for paddling, canoeing, tubing, fishing, and kayaking. Opportunities for camping, bicycling, hunting, and hiking are available throughout the Project Vicinity. The population increase attributable to the operations workers and the remaining building phase workers and their families places additional demand on recreational areas within the Project Vicinity. However, the extent of this impact depends on the capacity of existing facilities. As noted in Section 5.4.2, the overall population increase during the operational phase is minor and this population is expected to use recreational areas and facilities at a rate similar to that of the existing population. Because many of the recreational opportunities in the area are outdoor activities that extend over large areas, recreational venues can effectively accommodate an increased number of users. Consequently, the impacts on recreational resources by the operations workforce and their families is minor.

As described in Section 5.8.2, during operations, overall impacts from noise are minor as residents and recreators nearest the Project site experience cooling tower noise below the 65 dBA threshold considered acceptable and allowable outside a residence by the USEPA (Section 4.8.2.1). Due to the EAB proposed for each of the three Plant Complexes, recreational users of Belews Lake are not permitted in areas of the lake where noise levels are above 65 dBA. Additionally, Duke Energy plans to install buoys or other suitable barriers to demarcate the EABs and provide notification to recreational users of the lake that crossing the boundary is prohibited. In addition to dispersed recreation occurring on Belews Lake, J. Dudley Watts Jr. Park (Belews Lake Park) is the closest developed recreational area located within the Project Vicinity (Section 4.8.2.1). As discussed in Section 5.8.2, the noise produced by the nearest cooling towers at the park boundary is lower than the 65 dBA threshold. Thus, impacts to recreators at Belews Lake Park from noise during plant operation are minor.

As discussed in Section 5.4.1.5, the principal structures on the Project site are prominent in relation to the surrounding landscape and are mostly visible to recreators at Belews Lake and residents and businesses along the shoreline across the lake. Vegetation clearing within the

Project site, the new structures within the Plant Complex areas, and the associated plumes add an industrial aspect to a mostly natural landscape, noticeably altering the existing viewshed. For recreators on Belews Lake, aesthetic effects are noticeable. However, due to the vegetative buffer along the shoreline, and the presence of the existing BCSS facility, impacts are not destabilizing. Impacts are minor on recreators at greater distances. Therefore, the visual intrusion due to operation ranges from minor to noticeable, but not destabilizing, depending on the location of the observer and the atmospheric conditions.

5.4.4.2.3 Summary of Impacts to Recreation

Recreational resources in the Project Vicinity may be affected by operations activities at the Project site. Impacts may include (1) effects associated with water-level changes in Belews Lake; (2) effects of pumping and discharge operations on the Dan River; (3) increased user demand because of the in-migrating workforce and their families as well as the additional population from the building phase that retain a permanent residence in the ROI; (4), noise associated with operation of the cooling towers; and (5) aesthetic changes to the Project site as viewed from recreators on Belews Lake. Under conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping, impacts on Belews Lake recreation are minor. However, impacts on Belews Lake recreation are noticeable in conjunction with the effects of increased drought intensity and alteration of the existing viewshed. As described above, the overall effects of operations on recreation are noticeable but not destabilizing.

5.4.4.3 Housing

As described in Section 5.4.2, during operation, a total of 1126 Project-related personnel (in-migrating operations workers and construction workers that remain within the ROI) reside within the ROI as shown on Table 5.4-1. Table 5.4-4 identifies the demand placed on available vacant housing, defined as housing units listed as for rent and for sale, by the increased population. Approximately 7.6 percent of the available vacant housing in the ROI is expected to be occupied by this increased population. Based on the distribution of the population across the ROI, Forsyth and Guilford counties have ample housing supply to meet demand. While housing availability in Stokes and Rockingham counties is more constrained, housing units are available to meet demand in these counties.

Workers on short-term outage and maintenance assignments may use temporary housing in the form of hotels, seasonal homes (for long-term rentals), and recreational vehicle parks and campgrounds. As discussed in Section 2.4.2.7 and Section 4.4.4.3, there is abundant temporary housing available within the ROI to accommodate these workers.

Overall, sufficient housing is available within the ROI to accommodate both operations-related workers and temporary short-term workers. Therefore, impacts on housing are minor.

5.4.4.4 Public Services

This subsection discusses the impacts on the existing water supply, wastewater treatment, police, fire protection, healthcare services, and education in the ROI. The impact on public services is primarily driven by the population increase associated with the Project, specifically, in-migrating operations workers, construction workers who remain within the ROI, and their families. As shown in Table 5.4-1, the estimated population increase associated with the Project is 2790.

5.4.4.4.1 Water Supply and Wastewater Treatment

Table 2.4-21 outlines the municipal water suppliers within the ROI with their capacities and utilization rates, indicating that all ROI counties have surplus water capacity. As stated in Section 4.4.4.4.1, the average water usage in the United States is 82 gallons per person per day. Given the projected population increase during operations, water usage increases by 0.2 mgd (909 m^3/d) in the ROI. Table 5.4-5 presents the impact of this increased demand on public water supply systems. Overall, this change results in a capacity reduction of less than 1 percent across the ROI. Therefore, the impact on water supply is minor.

Table 2.4-22 details wastewater systems in the ROI, including their treatment capacity and utilization rates, indicating that these facilities are operating below capacity. The impact on wastewater treatment systems from operations is assessed assuming that 100 percent of the water used by the increased population (82 gallons per person per day) is processed through existing wastewater treatment facilities. Table 5.4-6 presents the impact of increased demand on these facilities. During operations, population growth generates 94.1 mgd (427,787 m^3/d) of wastewater in the ROI. The largest impact to wastewater treatment capacity is in Stokes County where the additional wastewater represents a 13 percent increase over baseline levels. Despite this increase, Stokes County wastewater treatment facilities maintain excess capacity of 71 percent. Across the remaining counties and the broader ROI, wastewater generated by operations-related population growth accounts for less than 1 percent of the available capacity within existing treatment systems. Therefore, the increased demand on wastewater treatment capacity from the in-migrating operations workers and construction workers who remain within the ROI, and their families is minor.

5.4.4.4.2 Police and Fire Protection Services

The ratio of police officers to residents for the counties in the ROI are presented in Table 2.4-23. The number of police officers per resident in the ROI falls below the nationwide average ratio of 2.4 officers per 1000 residents (1 officer per 417 residents) (Section 2.4.2.8). Table 5.4-7 details the distribution of the population increase associated with the Project and the impact on police services within the ROI. Although the population increase raises the ratio of officers to residents across the ROI, the overall percent change of the ratio is minimal. While the service level remains below the national average, the net increase in police service demand within the ROI is relatively minor.

Table 2.4-24 details the existing fire protection services within the ROI. The number of firefighters per resident in Forsyth and Guilford counties falls below the nationwide average ratio of one firefighter for every 318 residents, while the ratio of firefighters to residents in remaining counties and the ROI exceeds the nationwide ratio (Section 2.4.2.8.). Table 5.4-8 details the distribution of the population increase associated with the Project and the impact on fire protection services within the ROI. The change in percentage of the ratio of firefighters to residents in the ROI is minimal and the increased population does not notably alter the ratio of firefighters to residents within the counties in the ROI. Therefore, the increased demand for fire protection service needs is minor.

5.4.4.4.3 Medical Services

Available hospitals in the ROI are shown in Table 2.4-25. Table 5.4-9 presents the effect of the Project-related population increase on the availability of hospital beds within the ROI. Although the increased population places a demand on hospital services, the overall population increase is minimal. As a result, the change in hospital bed demand is negligible, with the ratio shifting slightly from one hospital bed per 298 residents to one hospital bed per 299 residents. This minor change indicates that the increase in population has a minimal effect on medical facilities within the ROI.

Physicians and dentists located in the ROI are detailed in Table 2.4-27. Table 5.4-10 presents the effect of the Project-related population increase on the availability of these healthcare providers. The increased population affects physicians and dental services by increasing the number of patients each provider must serve. However, as detailed in Table 5.4-10, the in-migrating population represents a minimal increase in the total population in the ROI, resulting in a minimal change in provider workload. The number of residents per physician increases from 1169 to 1172, and the number of residents per dentist increases from 1702 to 1707. This limited increase indicates that the impact on healthcare service availability is minor.

5.4.4.4.4 Education

Schools and student populations in the ROI are discussed in Section 2.4.2.9. According to the 2022 U.S. Census Bureau American Community Survey, approximately 19 percent of the population of North Carolina is between the ages of 5 and 19 (i.e., school age) (Section 4.4.4.4). Applying the statewide percentage, approximately 531 of the 2790 operation-related population are school aged. This represents a less than 1 percent increase in overall school enrollment within the ROI as shown in Table 5.4-11. However, the student-to-teacher ratios within the ROI counties and the ROI as a whole remain unchanged and continue to fall below the thresholds outlined in Section 2.4.2.9. Therefore, the impact of the increased population on education services is minor.

5.4.4.5 Summary of Community Infrastructure Impacts

Operation-related impacts on all infrastructure and community services are SMALL within the ROI, with the exception of impacts to traffic and recreation. Impacts to transportation due to operations traffic are SMALL within the broader transportation network, but MODERATE on two-lane segments and intersections that provide access to the Project site. Additionally, overall impacts on recreation are SMALL to MODERATE. Under conditions in which water levels lin Belews Lake are stabilized and consumptive losses are offset by MWIS pumping, impacts on Belews Lake recreation are SMALL. However, impacts on Belews Lake recreation are MODERATE in conjunction with the effects of increased drought intensity and visual intrusion.

Table 5.4-1
Population Increase in ROI During Operations

	Percentage of Existing BCSS Workforce by Place of Residence	Workforce from Building Phase Remaining	Operations Workforce	Total New Residents[a]	Baseline Population (2040 Projections)[b]	Percent Increase in Population
ROI	75.0%	512[c]	614[c]	2790[c]	1,219,453	0.2%
Forsyth County	11.0%	75	90	409	453,437	0.1%
Guilford County	10.0%	68	82	372	626,975	0.1%
Rockingham County	29.0%	198	237	1079	91,570	1.2%
Stokes County	25.0%	171	205	930	47,471	2.0%
Outside ROI	25.0%	170[d]	204[e]	N/A	N/A	N/A
Total	100.0%	682	818	–	–	–

Note:

(a) Values derived from sum of remaining building phase workforce and operations phase workforce multiplied by the average household size in North Carolina of 2.48.

(b) Source: NCOSBM, 2023; estimates are rounded to the nearest whole number.

(c) Expected to maintain a permanent residence in the ROI throughout the operational life of the facilities.

(d) The remaining construction workforce and their families would continue to reside outside the ROI and would not impact ROI population.

(e) Expected to commute from counties outside the ROI; workers and families would continue to reside outside of the ROI and would not impact the ROI population.

Key: ROI = region of influence

Table 5.4-2
Existing and Operations Phase P.M. Peak Hour LOS for Primary Roads Used to Access the Project Site
(Sheet 1 of 3)

Segment Number[a]	Road Name	Existing			Operations				
		Inbound PM Peak Volume[b]	Outbound P.M. Peak Volume[b]	LOS	Inbound Volume Added	Outbound Volume Added	Inbound Total Volumes	Outbound Total Volumes	LOS
1	U.S. 158 (South of Belews Creek Road)	555	555	C	3	22	558	577	C
2	U.S. 311 (South of NC Highway 65)	255	255	A	3	22	258	277	B
3	U.S. 311 (North of NC Highway 65)	255	255	A	8	61	263	316	B
4	NC Highway 65 (Between Belews Creek Road and Pine Hall Road South)	300	300	B	21	166	321	466	C
5	Pine Hall Road (South of NC Highway 65)	105	105	A	3	22	108	127	A
6	Pine Hall Road (North of NC Highway 65)	128	128	A	8	61	135	189	A
7	Belews Creek Road (West of NC Highway 65)	128	128	A	3	23	130	151	A
8	Belews Creek Road (Between Craig Road and NC Highway 65)	128	128	A	24	189	151	317	B
9	Belews Creek Road (East of Craig Road)	285	285	A	26	211	311	496	C
10	Fisherman Road	90	90	A	0	0	90	90	A

Table 5.4-2
Existing and Operations Phase P.M. Peak Hour LOS for Primary Roads Used to Access the Project Site
(Sheet 2 of 3)

Segment Number[a]	Road Name	Existing			Operations				
		Inbound PM Peak Volume[b]	Outbound P.M. Peak Volumes[b]	LOS	Inbound Volume Added	Outbound Volume Added	Inbound Total Volumes	Outbound Total Volumes	LOS
11	Hawkins Farm Road	90	90	A	0	0	90	90	A
12	Martin Luther King Jr. Road	60	60	A	0	0	60	60	A
13	Craig Road	68	68	A	50	400	118	468	C
14	NC Highway 68 (North of U.S.158)	480	480	C	16	127	496	607	D
15	U.S. 220 (North of NC Highway 68)	2025	2025	C	16	127	2041	2152	C
16	U.S. 220 (South of U.S. 158)	2025	2025	C	4	31	2029	2056	C
17	NC Highway 68 (South of U.S. 158)	480	480	C	4	31	484	511	C
18	U.S. 158 (Between Belews Creek Road and NC Highway 68)	728	728	D	24	189	751	917	E
19	U.S. 158 (East of NC Highway 68)	728	728	D	4	31	731	759	D
20	NC Highway 65 (Between Pine Hall South and Pine Hall North)	300	300	B	18	144	318	444	C

Table 5.4-2
Existing and Operations Phase P.M. Peak Hour LOS for Primary Roads Used to Access the Project Site
(Sheet 3 of 3)

Segment Number[a]	Road Name	Existing			Operations				
		Inbound PM Peak Volume[b]	Outbound P.M. Peak Volumes[b]	LOS	Inbound Volume Added	Outbound Volume Added	Inbound Total Volumes	Outbound Total Volumes	LOS
21	NC Highway 65 (Between Pine Hall North and U.S. 311)	300	300	B	19	83	310	383	B

Notes: All analysis performed with HCS 7 Two-Lane Version 7.9.6

(a) Refer to Figure 5.4-1.

(b) Hourly peak is assumed to be equal for analysis of inbound and outbound peak volume.

Key: Inbound = Vehicles Entering Project site; LOS = Level of Service; Outbound = Vehicles Leaving Project site

Table 5.4-3
Existing and Operations Phase P.M. Peak Hour LOS for Unsignalized Intersections

Intersection	Approach	Existing Conditions	Operations
		LOS	LOS
Belews Creek Road at Craig Road	SB	C	F
	EB	A	A
NC Highway 65 at Belews Creek Road (to the south)	SB	D	F
	EB	A	A
NC Highway 65 at Pine Hall Road (to the south)	NB	A	A
	EB	C	E
NC Highway 65 at Pine Hall Road (to the north)	SB	A	A
	WB	C	E

Note: HCS requires the yield control for Craig Road at the Belews Creek Road intersection therefore the analysis assumed a stop control for Craig Road.

Key: NB =Northbound, SB = Southbound, WB = Westbound, EB = Eastbound, LOS = Level of Service

Table 5.4-4
Housing Demand in the ROI Associated with Operations

County	Number of Workers Relocating to ROI[(a)(b)]	Available Vacant Housing Units - For Rent (2022)[(c)]	Available Vacant Housing Units – For Sale (2022)[(c)]	Total Available Vacant Housing Units (2022)	Projected Net Vacant Housing Unit Supply/Deficit
Forsyth	165	5531	1401	6932	6767
Guilford	150	5405	1404	6809	6659
Rockingham	435	443	251	694	259
Stokes	376	76	351	427	51
ROI	**1126**	**11,455**	**3407**	**14,862**	**13,736**

Notes:
(a) Represents individual households.
(b) See Table 5.4-1; estimates are rounded to the nearest whole number.
(c) See Table 2.4-18.
Key: ROI = region of influence

Table 5.4-5
Public Water Supply Systems Demand in the ROI During Operations

	Existing Conditions				Operations Demand			
Water Systems	**Total Available Supply (mgd)**	**Service Area Demand (mgd)**	**Utilized Capacity**	**Excess Capacity**	**Increased Average Daily Usage (mgd)**	**Utilized Capacity**	**Excess Capacity**	**Change in Capacity**
Forsyth County	133.0	36.7	27.6%	72.4%	36.7	27.6%	72.4%	0.0%
Guilford County	91.8	49.9	54.3%	45.7%	49.9	54.4%	45.6%	-0.03%
Rockingham County	69.3	7.7	11.1%	88.9%	7.8	11.2%	88.8%	-0.1%
Stokes County	50.5	2.0	4.0%	96.0%	2.1	4.1%	95.9%	-0.2%
ROI	**344.5**	**96.3**	**27.9%**	**72.1%**	**96.5**	**28.0%**	**72.0%**	**-0.1%**

Sources: USEPA, 2023; NCDEQ, 2023

Key: mgd =million gallons per day; ROI = region of influence

Table 5.4-6
Public Wastewater Treatment Facility Demand in the ROI During Operations

Water Systems	Total Design Flow (mgd)	Existing Conditions			Operations Demand			Change in Capacity
		Total Flow (mgd)	Flow as Percent of Design	Excess Capacity	Total Flow (mgd)	Flow as Percent of Design	Excess Capacity	
Forsyth County	51.0	37.9	74.2%	25.8%	37.9	74.3%	25.7%	-0.1%
Guilford County	82.0	44.4	54.2%	45.8%	44.5	54.2%	45.8%	0.0%
Rockingham County	25.5	11.6	45.4%	54.6%	11.7	45.7%	54.3%	-0.3%
Stokes County	0.6	0.1	16.7%	83.3%	0.2	29.4%	70.6%	-12.7%
ROI	**158.5**	**94.0**	**59.3%**	**40.7%**	**94.2**	**59.4%**	**40.6%**	-0.1%

Source: USEPA, 2012

Key: mgd = million gallons per day; ROI = region of influence

Table 5.4-7
Police Protection in the ROI During Operations

ROI County	Total Population in 2020	Additional Population During Operations[a]	Total Population	Number of Sworn Law Enforcement Officers[b]	Current Officer-to-Resident Ratio[b]	Officer-to-Resident Ratio with Additional Population	Percent Change from Current Officer-to-Resident Ratio
Forsyth	382,590	409	382,999	805	1:475	1:476	0.2%
Guilford	541,229	372	541,671	1276	1:424	1:425	0.1%
Rockingham	91,096	1079	92,175	225	1:405	1:410	1.2%
Stokes	44,520	930	45,450	73	1:610	1:623	2.1%
ROI	**1,059,505**	**2,790**	**1,062,295**	**2379**	**1:445**	**1:447**	**0.3%**

Source: USCB, 2020

Notes:

(a) See Table 5.4-1 .

(b) See Table 2.4-23 .

Key: ROI = region of influence

Table 5.4-8
Fire Protection in the ROI During Operations

Counties	Total Population in 2020	Additional Population During Operations[a]	Total with Additional Population	Number of Firefighters (Full-Time and Volunteer)[b]	Current Firefighter-to-Resident Ratio[b]	Firefighter-to-Resident Ratio with Additional Population	Percent Change from Current Firefighter-to-Resident Ratio
Forsyth	382,590	409	382,999	1125	1:340	1:340	0.0%
Guilford	541,229	372	541,671	1470	1:368	1:368	0.0%
Rockingham	91,096	1,079	92,175	580	1:157	1:159	1.2%
Stokes	44,520	930	45,450	361	1:123	1:126	2.4%
ROI	**1,059,505**	**2790**	**1,062,295**	**3536**	**1:300**	**1:300**	**0.0%**

Source: USCB, 2020

Notes:

(a) See Table 5.4-1 .

(b) See Table 2.4-24 .

Key: ROI = region of influence

Table 5.4-9
Available Hospital Beds in the ROI During Operations

Counties	2024 Population	Additional Population During Operations[a]	Total with Additional Population	Current Number of Hospital Beds[b]	Current Ratio of Hospital Beds-to-Residents[b]	New Ratio of Hospital Beds-to-Residents	Percent Change
Forsyth	389,157	409	389,566	1940	1:201	1:201	0.0%
Guilford	546,101	372	546,473	1365	1:400	1:400	0.0%
Rockingham	91,957	1079	93,036	231	1:398	1:403	1.0%
Stokes	45,175	930	46,105	59	1:766	1:781	2.0%
ROI	**1,072,390**	**2790**	**1,075,180**	**3595**	**1:298**	**1:299**	**0.3%**

Source: County Health Rankings, 2024

Notes:

(a) See Table 5.4-1.

(b) See Table 2.4-25.

Key: ROI = region of influence

Table 5.4-10
Physicians and Dentists in the ROI During Operations

Counties	2024 Population	Additional Population During Operations[a]	Total with Additional Population	Current Number of Physicians[b]	Current Ratio of Physicians to Residents[b]	New Ratio of Physicians to Residents	Percent Change	Current Number of Dentists[b]	Current Ratio of Dentists to Residents[b]	New Ratio of Dentists to Residents	Percent Change
Forsyth	389,157	409	398,566	439	1:886	1:887	0.2%	255	1:1526	1:1528	0.1%
Guilford	546,101	372	546,473	438	1:1247	1:1248	0.1%	333	1:1640	1:1641	0.1%
Rockingham	91,957	1079	93,036	28	1:3284	1:3323	1.2%	35	1:2627	1:2658	1.2%
Stokes	45,175	930	46,105	12	1:3765	1:3842	2.0%	7	1:6454	1:6586	2.1%
ROI	**1,072,390**	**2790**	**1,075,180**	**917**	**1:1169**	**1:1172**	**0.3%**	**630**	**1:1702**	**1:1707**	**0.3%**

Source: County Health Rankings, 2024

Notes:

(a) See Table 5.4-1.

(b) See Table 2.4-27.

Key: ROI = region of influence

Table 5.4-11
Education Impacts in the ROI During Operations

Counties	Total Number New Residents[a]	New School Aged Children[b]	Baseline Student Enrollment (K–12, 2022–2023)[c]	New Student Enrollment	Percent Change over baseline enrollment	Teachers (FTE)[c],[d]	Current Student-to-Teacher Ratio[c]	New Student-to-Teacher Ratio	Difference
Forsyth	409	78	56,563	56,641	0.1%	3747.7	1:15	1:15	0.0
Guilford	372	71	78,961	79,032	0.1%	4977.1	1:16	1:16	0.0
Rockingham	1079	206	12,177	12,383	1.7%	786.3	1:16	1:16	0.0
Stokes	930	177	5606	5783	3.2%	378.6	1:15	1:15	0.0
ROI	**2790**	**531**	**153,307**	**153,838**	**0.3%**	**9889.7**	**1:16**	**1:16**	**0.0**

Source: USCB, 2022

Notes

(a) See Table 5.4-1.

(b) Based on percentage of North Carolina population of school age children.

(c) See Table 2.4-28 .

(d) "FTE" includes part-time workers that are reported as a fraction of one full-time worker.

Key: FTE = Full-Time Equivalent Employee; ROI = region of influence

5.5 NOT USED

Deleted (Removed based on Executive Order, 2025).

5.6 HISTORIC AND CULTURAL RESOURCES

Potential impacts from Project operations at the Project site on historic and cultural resources are assessed in this section. Section 2.6 presents the cultural context of the Project site and describes the archaeological sites identified as eligible for listing on the National Register of Historic Places (NRHP). Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA) (54 USC 300101 et seq.), requires that federal agencies consider the effects of the agency's undertaking on historic properties included in, or eligible for, the NRHP. The NRC will consider the information presented herein and make a recommendation regarding the issuance of an ESP. Therefore, the Project is subject to review and consultation under Section 106 of the National Historic Preservation Act (16 USC 470 et seq.) and its implementing regulations (36 CFR 800.8).

5.6.1 HISTORIC ARCHITECTURE RESOURCES

As noted in Section 2.6.3.1, the North Carolina State Historic Preservation Office (NCSHPO) determined that the Project as proposed would not have an effect on historic structures in the Project Vicinity. Therefore, there are no impacts to historic structures from operations.

5.6.2 ARCHAEOLOGICAL RESOURCES

The advanced reactor units and supporting facilities are located on the Project site within the NDA identified in Figure 3.3-1. The 906-ac. (367-ha) NDA is located within the 1080-ac. (436-ha) area of potential affect established for the Project and described in Section 2.6.

The operation of the advanced reactor units and supporting facilities occurs in areas that are disturbed during the building phase. Following construction, it is unlikely that archaeological resources in disturbed areas are intact.

No operations phase ground-disturbing activities are identified beyond the NDA. Nonetheless, if ground-disturbing activities are undertaken beyond the NDA during operations, the potential exists for affecting undiscovered resources within the Project site. As described in Section 4.6.2, mitigative measures developed in consultation with NCSHPO and the North Carolina Office of State Archaeology are proposed for addressing the previously undiscovered resources, and internal procedures will be followed for such discoveries. Therefore, impacts to archaeological sites during operations are expected to be minimal to none and are therefore considered SMALL.

5.6.3 CEMETERIES

Site 31SK269, the Branson Cemetery, is present on the Project site, and, as described in Section 2.6.3.1, it was determined to be ineligible for the NRHP. However, cemeteries are protected under North Carolina General Statutes Chapter 14-148 and 14-149 and are afforded consideration under Chapter 65. As described in Section 4.6, avoidance of the cemetery is not possible based on the extent of the NDA. Duke Energy has undertaken work to conduct archival research with respect to the cemetery, including its history and associated records. Accordingly, the provisions regarding exhumation and repatriation provided by North Carolina General Statute Chapter 65-106 will be followed as appropriate. All cemetery relocation activities will be undertaken in advance of, or during, the building phase. As such no cemetery will be present on the Project site during operation. Therefore, there are no impacts to cemeteries during operations.

5.7 AIR RESOURCES

The primary impacts of operating a new nuclear power plant at the Project site on air resources are from releases to the environment of heat and moisture from linear mechanical draft cooling towers (LMDCTs), operation of auxiliary equipment (e.g., generators and auxiliary boilers), and mobile emissions (e.g., vehicles driven by workers).

Section 5.7.1 discusses potential impacts from the mechanical draft cooling towers. Potential air quality impacts from criteria pollutant and greenhouse gas (GHG) effluent releases are discussed in Section 5.7.2. Section 5.7.3 discusses potential air quality impacts associated with transmission lines during plant operation.

5.7.1 COOLING SYSTEM IMPACTS

5.7.1.1 Mechanical Draft Cooling Towers

Duke Energy proposes to construct up to three nuclear power Plant Complexes on the Project site. Each complex may contain multiple advanced reactors. A specific reactor design has not been selected by Duke Energy. Details of the required cooling systems have also not been finalized. For modeling purposes back-to-back cell LMDCTs are used.

LMDCTs remove excess heat by evaporating water. Upon exiting a cooling tower, a plume of water vapor mixes with the surrounding air which generally leads to condensation and formation of a visible plume, which may have aesthetic impacts. Associated meteorological impacts of the plume may include ground-level fogging/icing, plume shadowing, drift particulate deposition from dissolved solids in the cooling water, and ground-level temperature and humidity increases. Plumes from the cooling towers may also contribute to regional pollutant increases.

Although the final design has not been selected, the normal operating drift loss for cooling towers is estimated based on 0.001 percent of the cooling water flow in the plant parameter envelope (PPE). This drift loss is consistent with current mechanical draft cooling tower designs.

5.7.1.2 Cooling Tower Impact Modeling

The NRC has identified several plume-related codes as acceptable methodologies. A model endorsed by NUREG-1555, Environmental Standard Review Plan (ESRP) Section 5.3.3.1, is described by Carhart et al., (1992). In NUREG-1555, the NRC suggests using the Carhart and Policastro, (1991) reference that shows their model predicts plume rise within a factor of 2 approximately 75 percent of the time and visible plume length within a factor of 2.5 approximately 70 percent of the time. The model was incorporated in the Electric Power Research Institute's (EPRI) Seasonal/Annual Cooling Tower Impact Prediction Code (SACTI) in 1991, and later modified in 2015 (EPRI, 2015).

EPRI, 2015 discusses improvements incorporated in SACTI2. Among the improvements is SACTI2's ability to model multiple natural- or mechanical draft cooling towers in any geometric orientation and to merge multiple plumes to show combined impacts across the modeled domain. SACTI2's multiple plume algorithm has been validated with field and laboratory data.

The current version of the SACTI plume modeling code (EPRI, 2015), hereinafter referred to as SACTI2, is used to develop the model for the evaluation of potential plumes from LMDCTs at the Project site. SACTI2 defines seasons based on the dates for astronomical seasons (see Table 4-2 in EPRI, 2015).

SACTI2 is used for assessing near-field impacts of cooling towers out to approximately 10 km (6.2 mi.) (EPRI, 2015). Key assumptions incorporated in the core SACTI2 model are listed below (see, Section 1.1 of EPRI, 2015).

- Impacts are only computed at ground level.
- Receptor height is zero (i.e., the terrain is locally flat).
- All cooling tower cell exit ports are assumed to be at the same height.
- "Flagpole" receptors, or elevated terrain receptors such as those used in the USEPA American Meteorological Society/EPA Regulatory Model (AERMOD) air dispersion model, or the Industrial Source Complex (ISC) model are not used in SACTI2. The terrain is assumed to be flat in SACTI2 as noted above.

Modern LMDCTs may employ hybrid (wet/dry) configurations which use dry air to abate the effluent plume so that the effluent plume is less visible or completely invisible compared to wet cooling. The current version of SACTI2 does not simulate emissions from towers employing plume abatement (EPRI, 2015).

The SACTI2 plume prediction code is run on a desktop computer via an executable at the disk operating system prompt (console mode). The program creates a series of output tables in text format that are processed with standard plotting programs, spreadsheets, and text editors.

Per NUREG-1555 Section 5.3.3.2, Terrestrial Ecosystems, an order-of-magnitude approach is used to analyze potential impacts from modeled salt drift deposition:

- Deposition of salt (NaCl) drift at rates of 1 to 2 kg/ha/mo (100 – 200 kg/km^2/mo) equivalent to 571 to 1142 pounds per square mile per month (lb/mi^2/mo), is generally not damaging to vegetation.
- Deposition rates approaching or exceeding 10 to 20 kg/ha/mo (1000 – 2000 kg/km^2/mo) equivalent to 5710 to 11,420 lb/mi^2/mo in any month during the growing season could cause leaf damage in many species.
- Deposition rates of hundreds or thousands of kg/ha/yr could cause damage sufficient to suggest the need for changes of tower-basin salinities or a reevaluation of tower design, depending on the amount of land impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition.

In addition to potential impacts from salt deposition on terrestrial ecosystems, excessive salt deposition may cause operational issues for exposed electrical equipment. Mineral deposition may not only cause incidents of insulator failure, but also accelerates corrosion on metal surfaces (equipment and structures) increasing rust and decreasing the metal's integrity.

The Institute of Electrical and Electronic Engineers (IEEE) *Electric Power Engineering Handbook* (IEEE, 2001) provides mineral deposition ranges for salt on electrical components above which increased incidents of insulator failure and flashover may occur. Salt deposition severity ranges in milligrams per square centimeter (mg/cm^2) from IEEE, 2001 and their

corresponding ranges in units used in NUREG-1555 Section 5.3.3.2 (kg/km^2/mo) are provided in Table 5.7-1.

IEEE, 2001 does not specify an accumulation time for deposition, whereas SACTI2 provides monthly deposition rates. For purposes of comparing the results from SACTI2, the deposition rates specified by IEEE, 2001 are taken to persist for an entire month. Effectively this assumes that no precipitation occurs which may wash off some deposited salts. At sites with relatively frequent rainfall such as the Project site, this is a conservative assumption.

Per NUREG-1555, an order-of-magnitude approach is used to analyze potential impacts from fogging or icing:

- Fogging or icing of vegetation on the order of a few hours per year is generally not severe.
- Fogging or icing of vegetation on the order of tens of hours per year may cause detectable damage to vegetation.
- Fogging or icing of vegetation on the order of hundreds of hours per year could be severe enough to suggest the need for design changes, depending upon the amount of land impacted and the uniqueness of the terrestrial ecosystems.

5.7.1.2.1 Model Inputs

Model inputs for SACTI2 are described in the following subsections.

5.7.1.2.1.1 Meteorological Data

SACTI2 requires one year of input surface meteorological data. The source of the surface data can be an airport or other facility with data available in the National Centers for Environmental Information (NCEI) Integrated Surface Database format, or data from an on-site tower in NRC format. However, RG 1.23, Rev. 1 specifies use of a minimum of one year (12 consecutive months) of on-site meteorological data. An on-site meteorological tower was installed at the Project site in late January 2024. The on-site tower is described in Section 2.7.4. The location of the tower is shown in Figure 5.7-1.

Input meteorological data from the first year of operation of the on-site tower covers the period February 7, 2024 through February 6, 2025. During this period, the joint data availability of 92.98 percent was captured for 10 m (32.8 ft.) and 60 m (196.9 ft.) wind speed/direction, vertical temperature difference (Delta-T) between 10 m (32.8 ft.) and 60 m (196.9 ft.), dewpoint and relative humidity at the 10 m-level (32.8 ft-level) used in SACTI2. This joint data availability exceeds the annual 90 percent data availability requirements in RG 1.23, Rev. 1 and USEPA, 2000. Based on input meteorological data completeness, the on-site data are suitable for use in SACTI2.

Figure 5.7-2 shows an annual wind rose at the 10 m (32.8 ft.) above ground level (AGL) reference level from the on-site tower. The annual wind rose shows a multi-modal wind direction distribution with winds most frequently blowing from the southwest through south sectors, west-northwest, or east. Southwest is consistent with the general southwest-northeast orientation of the terrain features in the region around the Project site as shown in Figure 5.7-1.

Corresponding wind roses based on astronomical seasons are shown in Figure 5.7-3 through Figure 5.7-6. The seasonal wind roses show that northwest winds are more frequent in spring,

fall, and winter. East winds are more frequent in spring. Southwest winds are typical all year. Northeast winds are relatively infrequent at the Project site, with the exception of summer, despite the regional tendencies. Southeast winds are least frequent, which is consistent with regional conditions.

SACTI2 also requires input morning and afternoon mixing heights. Section 3.2 of EPRI, 2015 provides two methods for determining mixing heights. One of these methods uses daily radiosonde observations from National Oceanic and Atmospheric Administration – Earth Systems Research Laboratory (NOAA – ESRL). This data set is no longer available as of late 2024 (see page 3-23 of USEPA, 2024a). However, Appendix B of EPRI, 2015 provides an alternative method when daily radiosonde observations of morning and afternoon mixing heights are not available. This method uses a customized utility "SeasonalZi" that is packaged with the SACTI2 code in EPRI, 2015. This utility re-formats user-supplied seasonal average mixing heights into a format compatible with SACTI2. The procedure for running "SeasonalZi" and its input is described in Appendix B of EPRI, 2015. Mixing heights for Greensboro, NC, were obtained from the USEPA Support Center for Regulatory Atmospheric Modeling (SCRAM) (USEPA, 2024b). The USEPA data are more current than the traditional reference from Holzworth (1972) that is often used as a source of seasonal mixing height data.

Seasonal and annual estimates of mixing heights for the Project site are presented in Table 5.7-2. Mixing heights vary during the day, with the lowest average mixing heights (approximately 379 m [1243 feet {ft.}]) generally recorded during the morning hours in the fall and the highest readings (approximately 1609 m [5278 ft.]) recorded during the afternoon in the summer for the 7-year period of record (1984-1987 and 1989-1991) of the SCRAM dataset.

SACTI2 also requires input of monthly cloudiness indices and monthly average total global radiation. These parameters are available from Knapp et al., 1980 for Greensboro, NC. These parameters are presented in Table 5.7-3 and Table 5.7-4, respectively.

SACTI2 requires input of approximate roughness length when using surface meteorological data from a site-specific tower. The Project site is in a forested region. From values for forested areas presented in Table 3.5 of USEPA, 2024a, a roughness length of 1 m (3.28 ft.) is used.

5.7.1.2.1.2 Cooling Tower Parameters

The final cooling tower design has not been determined, but certain site-specific input is required by SACTI2. Therefore, the bounding design uses a total of six LMDCTs. Each LMDCT consists of 18 cells (two banks containing nine cells in each bank) for a total of 108 cooling tower cells (6 LMDCTs x 18 cells per tower = 108 cells). However, there is a limit to the number of cells that can be processed in SACTI2 due to limitations on the field width in certain input/output files. The field width is limited to two digits, which corresponds to a maximum of 99 cells. Thus, SACTI2 was run with 96 cells (corresponding to six towers, each with 16 cells), with the cell exit diameter adjusted upward from 10.4 m (34.1 ft.) to 11.0 m (36.1 ft.) to maintain the same mass airflow rate per cooling tower. The dimensions of the towers were not changed.

The locations of the LMDCTs are provided in Figure 5.7-7. Modeled bounding cooling tower design parameters from the PPE are provided in Table 5.7-5.

Unlike air quality models that are used in industrial source air permitting, such as AERMOD or the ISC models, which typically use geographical coordinate systems, SACTI2 uses a local coordinate system for modeling impacts of all LMDCTs in the model domain. In practice the

center of this coordinate system is set at a convenient point near all the LMDCTs being modeled (see examples in EPRI, 2015). The representative locations of the LMDCTs are extracted from site general arrangement (GA) drawings. The locations of the six cooling towers modeled in SACTI2 are plotted in Figure 5.7-7.

The locations of all cooling towers and cells are located relative to the site center point in SACTI2. All cooling towers are oriented with their long axes set to 35 degrees east of true north as shown in the site GA diagram developed for the bounding plant configuration, or in an approximate southwest-northeast orientation.

The source of water for the cooling towers is Belews Lake. Based on water quality measurements at the cooling water intake, a bounding value of TDS concentration of 940 parts per million (ppm) is used from the PPE. As cooling water evaporates from the towers or is lost via drift, the concentration of minerals in the water increases, which can lead to scaling and corrosive conditions. To control TDS levels, a portion of the circulating water is blown down through a planned discharge. A bounding value of 12 cycles of concentration is used.

In lieu of design-specific droplet size information, a drift droplet size distribution from Reisman and Frisbie, 2002 is input into SACTI2 to model drift deposition. This distribution is provided in Table 5.7-6. Table 5.7-6 shows that approximately 89 percent of the mass of the droplet size distribution consists of droplets with diameters ranging from 60 microns (µm) to 180 µm with a peak diameter of approximately 90 µm. This is consistent with a droplet size distribution from cooling tower tests conducted by the Midwest Research Institute () published in MRI, 1991 and cited in USEPA, 1995. The peak of the droplet size distribution in MRI, 1991 includes droplets with diameters ranging from approximately 40 µm to 100 µm.

5.7.1.2.2 Modeled Impacts

5.7.1.2.2.1 Ground Fogging

Ground fog events are defined to occur when a modeled plume contacts the ground and/or the plume is below the height of the cooling towers. The maximum modeled number of hours with fogging per season and on an annual basis for all the LMDCTs are provided in Table 5.7-7. No hours of fogging are predicted. These results are generally consistent with modeling results reported in the ESPA for a SMR project at the Clinch River Nuclear site near Oak Ridge, Tennessee. The Clinch River Nuclear site reported no additional hours of fogging in its SACTI2 modeling of LMDCTs (NRC, 2019a).

5.7.1.2.2.2 Plume Rime Icing

Rime icing occurs when the ambient air temperature is below freezing during a plume ground fogging event. Rime icing occurs when supercooled water droplets freeze on contact with structures.

The maximum modeled number of hours with rime icing per season and on an annual basis are provided in Table 5.7-8. No hours of icing are predicted. Given the relatively warm climate of the Project site, this result is reasonable. This result is also consistent with modeling results reported in the ESPA for an SMR project at the Clinch River Nuclear site near Oak Ridge, Tennessee. The Clinch River Nuclear site reported no hours of icing in its SACTI2 modeling of LMDCTs at their site (NRC, 2019a). The Clinch River Nuclear site and the Project site are both

located in a humid subtropical climate with warm summers (see page 8 of Espenshade and Morrison, 1978) and therefore should have similar plume rime icing frequencies.

5.7.1.2.2.3 Plume Drift Deposition

The maximum modeled seasonal and annual salt deposition rates from operation of all LMDCTs are summarized in Table 5.7-9. The highest seasonal deposition rate (summer — 63.51 kg/km^2/mo [0.64 kg/ha/mo]) is located 300 m (984 ft.) east-northeast of the site center point. The maximum modeled seasonal salt deposition rate is in the very light range as classified in Table 5.7-1. The maximum modeled seasonal salt deposition rate is well below the 1000 – 2000 kg/km^2/mo range that could cause leaf damage in many species as noted in NUREG-1555. Conservatively applying the threshold from NUREG-1555, locations within Duke Energy property along Craig Road may be slightly impacted by plume deposition.

The maximum modeled seasonal deposition rates from all LMDCTs (summer) are plotted in Figure 5.7-8, along with the approximate locations of the cooling towers. The salt deposition pattern in Figure 5.7-8 shows the highest deposition rates located near the central and north-central parts of the site. The deposition pattern is consistent with the annual and seasonal wind roses in Figure 5.7-2 and Figures 5.7-3 through 5.7-6, respectively. In general, deposition often occurs within a smaller horizontal extent than the other impacts, primarily because larger water droplets carrying dissolved salts settle out of the air quickly due to gravity.

During the other seasons and on an annual basis, the maximum modeled deposition rates shown in Table 5.7-9 range from 41.57 kg/km^2/mo (0.42 kg/ha/mo) (annual basis) to 51.77 kg/km^2/mo (0.52 kg/ha/mo) (spring), which are all in the very light range as classified in Table 5.7-1. These deposition rates are below the 1000 – 2000 kg/km^2/mo (10-20 kg/ha/mo) range that could cause leaf damage in many species. The locations of the maximum modeled salt deposition on a seasonal and annual basis are on-site.

To inform the future design of the switchyards and other electrical systems, a plot of the annual salt deposition rates is provided in Figure 5.7-9. The modeled deposition rates in Figure 5.7-9 include contributions from all four seasons. Figure 5.7-9 shows that the highest annual deposition rates are located near the central and north-central parts of the site — similar to results shown in Figure 5.7-8 for summer. Figure 5.7-9 also shows an area of very light deposition ranging from 3 – 12 kg/km^2/mo (0.03 – 0.12 kg/ha/mo) located approximately 500 – 1000 m (1640 – 3280 ft.) southeast of the site center point. This is due to winds from the northwest that are more frequent in spring, fall, and summer as discussed in Section 5.7.1.2.1.1. The maximum annual deposition rates are well below the range that could cause leaf damage.

Significant levels of chloride runoff can contribute to water quality degradation which can affect aquatic life. However, since the predicted deposition rates are relatively low and precipitation is relatively high and frequent at the Project site, deposited salts will be diluted quickly and therefore do not greatly impact Belews Lake and the surrounding area. However, SACTI2 does not predict the dilutive effects of precipitation on deposited solids. Overall, salt drift deposition is not expected to be a significant concern.

5.7.1.2.3 Visible Plumes

5.7.1.2.3.1 Plume Shadowing

Visible cooling tower plumes are those elevated plumes that occur and have sufficient optical density to appear opaque to an observer. The maximum modeled number of hours with plume shadowing on seasonal and annual bases are summarized in Table 5.7-10. The modeled annual hours with plume shadowing (with a maximum of 380.9 hours per year) are plotted in Figure 5.7-10. Figure 5.7-10 shows that modeled visual impacts are most pronounced near the center of the Project site. The overall shape of the area with the highest plume shadowing is consistent with the multi-modal wind direction distribution depicted in the annual wind rose in Figure 5.7-2. Locations along the onsite private plant road accessed via Craig Road may be most impacted by plume shadowing. Plume shadowing is the most frequent in central parts of the site near the LMDCTs. Maximum plume shadowing effects are expected to occur within the site boundary.

On a seasonal basis Table 5.7-10 shows that impacts are the highest in the winter (137.0 hours), and lowest in the summer and fall which is generally consistent with the annual temperature cycle. In all seasons and on an annual basis, the location of the highest number of hours with plume shadowing are predicted near central parts of the site.

5.7.1.2.3.2 Solar Radiation Losses

Incoming solar radiation consists of direct solar radiation from the solar disk and diffuse radiation. Direct solar radiation is also referred to as beam radiation. Total solar radiation is the sum of beam and diffuse radiation components.

Visible cooling tower plumes may have sufficient optical density to reduce incoming solar radiation, resulting in solar radiation losses at the surface. SACTI2 computes total solar radiation losses (in megajoules per square meter [MJ/m^2]), fractional total solar radiation losses (in percent), and fractional beam radiation losses (in percent).

The maximum modeled annual and seasonal total solar radiation losses are summarized in Table 5.7-11. The modeled annual losses arising from operation of all the LMDCTs (with a maximum modeled loss of 233 MJ/m^2 [20,517 BTU/ft^2]) are plotted in Figure 5.7-11. Figure 5.7-11 shows that the overall shape of the area with the largest solar radiation losses is consistent with the multi-modal annual wind direction distribution depicted in the annual wind rose in Figure 5.7-2. The highest modeled solar radiation losses are located near the center point which is consistent with the location of the highest modeled plume shadowing frequencies in Table 5.7-10 and Figure 5.7-10.

The maximum modeled fractional total solar radiation losses are summarized in Table 5.7-12. Table 5.7-12 shows that the maximum modeled annual solar radiation losses arising from operation of all the LMDCTs is 4.5 percent. The modeled annual fractional total solar radiation losses are plotted in Figure 5.7-12. The highest modeled annual fractional solar radiation losses are located near the center point and are consistent with the location of the highest modeled plume shadowing in Table 5.7-10 and Figure 5.7-10.

The maximum modeled fractional beam radiation losses are summarized in Table 5.7-13. The maximum modeled annual fractional beam radiation losses associated with operation of the LMDCTs is 7.9 percent. The modeled annual fractional beam losses are plotted in Figure 5.7-

13. The highest modeled fractional solar radiation losses are located near the center point and are consistent with the location of the highest modeled plume shadowing frequencies in Table 5.7-10 and Figure 5.7-10.

5.7.1.2.3.3 Plume Length

SACTI2 provides summaries of seasonal and annual visible plume length. Table 5.7-14 shows the percentage of the time that plumes exceed a specified length. Table 5.7-14 shows that modeled plumes are longest in the winter and shortest in the summer. This is consistent with the annual air temperature cycle at the Project site and annual trends in the modeled hours with plume shadowing described in Section 5.7.1.2.3.1. The longest plumes extended to 2.7 km (1.7 mi.).

5.7.1.2.3.4 Plume Height

SACTI2 provides summaries of the modeled seasonal and annual visible plume height. Table 5.7-15 shows the percentage of time that plumes exceed a specified height. Table 5.7-15 shows modeled plume heights are typically 30 m (98.4 ft.) or less.

5.7.1.2.3.5 Plume Radius

SACTI2 provides summaries of the modeled seasonal and annual visible plume radius. Table 5.7-16 shows the percentage of time that plumes exceed a specified maximum radius. Table 5.7-16 shows that the modeled plume radius is typically 15 m (49.2 ft.) or less.

5.7.1.2.4 Additional Precipitation and Humidity

SACTI2 provides annual average water deposition rates for distances to a maximum of 10 km (6.2 mi.). The maximum plume water deposition rates are summarized in Table 5.7-17. The highest annual plume water deposition rate is 34,700 kg/km^2/mo (347 kg/ha/mo) which occurs 100 m (330 ft.) east-northeast of the Project site center point. This rate, which is equivalent to approximately 0.0014 inches (in.) (0.0036 cm) of deposited water per month, is insignificant when compared to the corresponding average monthly precipitation measured at the on-site meteorological tower (3.17 in. [8.05] precipitation per month) between February 7, 2024 and February 6, 2025. This rate is also an insignificant amount when compared to the average monthly normal precipitation recorded at the Piedmont Triad International Airport (3.66 in. [9.30] per month from NCEI, 2022). Thus, additional water deposition from all the LMDCTs at the Project site is expected to be insignificant.

No calculations for predicted relative humidity levels are provided by the SACTI2 model. Some increase in relative humidity may occur close to the LMDCTs or in an elevated plume. However, based on insignificant levels of modeled plume water deposition and no predicted fogging, the impacts on ground-level humidity from operation of all the LMDCTs is expected to be minimal.

5.7.1.2.5 Summary of Modeled Impacts of the Cooling Towers

Given no predicted fogging, no predicted plume rime icing, low predicted salt deposition rates, limited visual impacts, and insignificant plume water deposition rates, the predicted impacts from operation of all LMDCTs at the Project site are SMALL.

5.7.2 AIR QUALITY IMPACTS

Air emission sources associated with a new nuclear power plant would be managed in accordance with federal, state, and local air quality control laws and regulations. A new plant at the Project site would comply with all regulatory requirements of the Clean Air Act, and the NCDEQ Department of Air Quality (DAQ) requirements to minimize impacts on state and regional air quality.

The Project site is located in Stokes and Forsyth counties, NC, and is bordered by Rockingham County to the east and Guilford County to the southeast. The Project site is located in an attainment area for all NAAQS criteria pollutants (NCDEQ, 2024). Therefore, the proposed Project is not subject to a Nonattainment New Source Review.

After the final Project design is selected, air dispersion modeling, if required by NCDEQ, will be conducted to demonstrate that Project emissions do not result in exceedances of the NAAQS.

5.7.2.1 Air Pollutant Sources

5.7.2.1.1 Criteria Pollutants

The principal sources of criteria air pollutants at a new nuclear power plant at the Project site are mechanical draft cooling towers, auxiliary boilers, standby equipment, and emergency power supply system diesel generators and/or gas turbines.

Auxiliary boilers are used for heating buildings, primarily during the winter months, and for process steam during site startups. The diesel generators/gas turbines and engine-driven emergency equipment are used intermittently and for brief durations. Emissions from the equipment include NO_x, CO, SO_x, hydrocarbons in the form of VOCs, and PM.

A specific reactor technology and supporting equipment have not been selected. Bounding annual emission rates from the PPE for the cooling towers are provided in Table 5.7-18. Bounding annual emissions rates for the auxiliary boilers and diesel generators are provided in Tables 5.7-19 and 5.7-20, respectively. Annual estimated criteria pollutant emissions from the assumed supporting equipment are summarized in Table 5.7-21. These values were obtained from the PPE table and assumed worst case emissions scenarios from all potential technology vendors and are based on 8760 operating hours per year per cooling towers, 864 hours per year for each auxiliary boiler at 36 days per year, and 4 hours per month for each standby and / or ancillary diesel generators.

Additional operations-related traffic may also result in vehicular air emissions. Nominal localized increases in emissions occur due to the increased numbers of cars, trucks, and delivery vehicles that travel to and from the Project site. Most of the increased traffic is associated with employees driving to and from work. Once the workers are at the Project site, the volume of traffic and its associated emissions are expected to decrease. Mitigation measures that may be considered during operations include staggering work shifts, requiring delivery vehicles to shut down engines while off-loading, restricting idling times of on-site vehicles, using electric and hybrid vehicles, and supporting and promoting van/carpooling and other commuter programs.

Impacts from operations-related traffic are transient and can be mitigated. Operation of the advanced reactors increases gaseous and particulate emissions to the air, primarily from

cooling towers, auxiliary boilers, standby equipment, and standby power supply system diesel generators and/or gas turbines. The diesel generators/gas turbines and engine-driven emergency equipment are used intermittently and for brief durations. Air emission sources would be managed in accordance with federal, state, and local air quality control laws and regulations. Air dispersion modeling, if required by NCDEQ-DAQ, will be conducted to demonstrate that Project-related emissions of criteria pollutants do not result in exceedances of the NAAQS and the North Carolina Air Toxics Regulation. Accordingly, air quality impacts from emissions from the Project site are SMALL.

5.7.2.2 Greenhouse Gas Emissions

As discussed in Section 2.7, the impact of GHG emissions from the Project site on air quality is compared to GHG emissions at the state and national levels. At the state level, annual GHG emissions in North Carolina are 115.6 million metric tons total carbon dioxide (CO_2) (EIA, 2024). At the national level, net GHG emissions in the United States in 2022 totaled 6,343.2 million metric tons carbon dioxide equivalent (CO_2eq) after accounting for sequestration from the land sector (USEPA, 2024c). The GHG emissions footprint of a generic 1000-megawatt-electric (MWe) reactor provides a conservative estimate of impacts. The lifetime GHG emissions footprint of a generic 1000 MWe reactor is 10.5 million metric tons CO_2eq. (Table A-3. Nuclear Power Plant Lifetime GHG Footprint in NUREG-1437). Lifetime GHG emissions from a generic reactor are an estimated 9.1 percent of the annual GHG emissions in North Carolina (10.5 million to 115.6 million metric tons) and 0.17 percent of the annual 2022 carbon equivalent emissions in the U.S. (10.5 million to 6343.5 million metric tons). Given the relatively small lifetime GHG emission footprint of a generic reactor, impacts of GHG emissions from the Project site are SMALL.

5.7.3 TRANSMISSION LINE IMPACTS

Small amounts of ozone (O_3) and substantially smaller amounts of oxides of nitrogen (NO_X) are produced by transmission lines during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface such as abrasions, dust particles, raindrops, and insects.

The NRC NUREG 1437, Volume 1 (2013) quantified the impacts of existing transmission lines on air quality resulting from corona. Specifically, the amount of O_3 generated from even the largest lines in operation (765 kilovolts [kV]) is insignificant. Further, monitoring of O_3 levels for two years near a Bonneville Power Administration 1200-kV prototype line revealed no increase in ambient O_3 concentrations caused by the line. NUREG 1437, concluded that O_3 concentrations generated by transmission lines are too low to cause any significant effects to air quality. Additionally, the small amounts of NO_X produced are similarly insignificant.

Depending upon the generation technology selected, the potential for a new 230-kV switchyard may be constructed at the Project site. Construction of a new switchyard involves new 230-kV transmission lines and relocation of existing 230-kV transmission lines within the Project site.

The capacities of existing transmission lines and any additions at the Project site are well within the range of transmission line capacities evaluated in NUREG-1437. Therefore, the air quality impacts of existing transmission lines and additions at the Project site are SMALL.

Table 5.7-1
Salt Deposition Ranges for Impacts on Exposed Electrical Equipment

	Salt Deposition	
Category	**mg/cm^2 (from IEEE, 2001)**	**kg/km^2/mo (from NUREG-1555; Subsection 5.3.3.2)**
Very light	0 – 0.03	0 – 300
Light	0.03 – 0.06	300 – 600
Moderate	0.06 – 0.1	600 – 1000
Heavy	> 0.1	> 1000

Key: kg/km^2/mo = kilograms per square kilometer per month; mg/cm^2 = milligrams per square centimeter

Table 5.7-2
Seasonal and Annual Average Mixing Heights at Greensboro, NC

	Morning		Afternoon	
Season[a,b]	**(m)**	**(ft.)**	**(m)**	**(ft.)**
Winter	465	1526	858	2816
Spring	476	1562	1538	5046
Summer	472	1547	1609	5278
Fall	379	1243	1143	3749
Annual	448	1470	1287	4222

Source: USEPA, 2024b

Notes:

(a) Period of record 1984-1987 and 1989-1991 (SCRAM station #13723).

(b) The USEPA SCRAM data files were last modified Jan. 5, 2001, and the SCRAM description indicates they were originally created on July 7, 1992.

Key: ft. = feet, m = meters; NC = North Carolina; SCRAM = Support Center for Regulatory Atmospheric Modeling; USEPA = U.S. Environmental Protection Agency

Table 5.7-3
Global Cloudiness Index at Greensboro, NC

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
0.455	0.481	0.504	0.532	0.528	0.529	0.516	0.512	0.501	0.509	0.491	0.456

Source: Knapp et al., 1980

Table 5.7-4
Total Global Radiation at Greensboro, NC (MJ/m^2)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
8.118	11.009	14.903	19.103	21.200	22.166	21.150	19.255	16.088	12.953	9.524	7.475

Source: Knapp et al., 1980

Key: MJ/m^2 = megajoules per square meter

Table 5.7-5
Bounding Mechanical Draft Cooling Tower Parameters and Related Model Inputs from the Plant Parameter Envelope

Description	Value and Units	Comments
Number of banks of cooling towers	6	6 LMDCTs from PPE
Number of cells	108	6 LMDCTs; each LMDCT has 18 cells (2 x 9); 2 x 9 x 6 = 108 cells (modeled in SACTI2 as 6 LMDCTs each with 16 cells (2 x 8) as explained in ER Section 5.7.1.2.1.2)
LMDCT orientation (long axis), degrees east of true north	35° (southwest – northeast alignment of long axis of towers)	Based on bounding technology in PPE
Cell height (m)	15.3 m	Tower height = 50 ft. (15.2 m) (based on lower bound of heights in PPE of 50 – 75 ft.)
Fan diameter (m)	10.4 m	Fan diameter = 34.0 ft. (10.4 m)
Total heat dissipation (rejection) rate (MW)	3869 MW	Based on rate of 1.32×10^{10} Btu/hr from PPE for all six towers (1.32×10^{10} Btu/hr x 2.9307×10^{-7} MW/Btu = 3869 MW, or 645 MW/tower)
Total mass airflow rate (kg/s)	84,327 kg/s	Based on air delivery per fan of 1,377,637 cfm and an air density of 1.2 kg/m^3
Length of LMDCT housing (m)	148.2 m	Length = 486 ft.
Width of LMDCT housing (m)	32.9 m	Width = 108 ft.
Locations of the centers of the LMDCT housings	Tower center locations shown in Figure 5.7-7.	Based on bounding technology in PPE
Total drift emission rate for all cells (g/s)	974.2 g/s	Based on drift rate = 0.001% of circulating water flow rate. Circulating water flow rate = 110% x 233,950 gpm
Salt concentration (g salt/g solution)	0.00094	940 ppm, per PPE. Value based on existing water quality at sample location nearest to proposed intake location and assuming maximum normal operating 12 cycles of concentration.

Key:

Btu/hr = British thermal units per hour; cfm = cubic feet per minute; ER = environmental report; ft. = feet; g/s = grams per second; gpm = gallon per minute; kg/s = kilograms per second; LMDCT = linear mechanical draft cooling tower; m = meter; MW = megawatt; MW/Btu = Megawatt per British thermal unit; PPE = plant parameter envelope; ppm = parts per million; SACTI2 = seasonal and annual cooling tower impact, version 2

Table 5.7-6
Input Droplet Size Distribution in SACTI2

Droplet Diameter (µm)	Mass of Droplet Distribution Smaller than Diameter (%)	Mass Fraction
10	0.000	0.00000
20	0.196	0.00196
30	0.226	0.00030
40	0.514	0.00288
50	1.816	0.01302
60	5.702	0.03886
70	21.348	0.15646
90	49.812	0.28464
110	70.509	0.20697
130	82.023	0.11514
150	88.012	0.05989
180	91.032	0.03020
210	92.468	0.01436
240	94.091	0.01623
270	94.689	0.00598
300	96.288	0.01599
350	97.011	0.00723
400	98.340	0.01329
450	99.071	0.00731
500	99.071	0.00000
600	100.000	0.00929

Source: Reisman and Frisbie, 2002
Key: µm = microns; SACTI2 = seasonal and annual cooling tower impact, version 2

Table 5.7-7
Maximum Modeled Hours with Cooling Tower Plume Ground Fogging

Season	Plume Ground Fogging (hours)
Spring	0.0
Summer	0.0
Fall	0.0
Winter	0.0
Annual	0.0

Table 5.7-8
Maximum Modeled Hours with Plume Rime Icing

Season	Plume Rime Icing (hours)
Spring	0.0
Summer	0.0
Fall	0.0
Winter	0.0
Annual	0.0

Table 5.7-9
Maximum Modeled Plume Drift Deposition

Season	Salt Deposition ($kg/km^2/mo$)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	51.77	300	East-northeast
Summer	63.51	300	East-northeast
Fall	45.11	200	Northeast
Winter	51.60	200	East
Annual	41.57	300	East-northeast

Key: $kg/km^2/mo$ = kilograms per square kilometer per month; m = meter

Table 5.7-10
Maximum Modeled Cooling Tower Plume Shadowing (Hours)

Season	Plume Shadowing (hours)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	111.7	200	Southeast
Summer	105.4	200	East-southeast
Fall	96.4	200	West-northwest
Winter	137.0	200	Northeast
Annual	380.9	200	Southeast

Key: m = meter

Table 5.7-11
Maximum Modeled Total Solar Radiation Losses (MJ/m^2)

Season	Maximum Solar Radiation Loss (MJ/m^2)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	83	200	Southeast
Summer	56	200	Northwest
Fall	53	200	Northwest
Winter	61	200	South-southeast
Annual	233	200	South-southeast

Key: m = meter; MJ/m^2 = megajoules per square meter

Table 5.7-12
Maximum Modeled Fractional Total Solar Radiation Losses (Percent)

Season	Fractional Solar Radiation Loss (Percent)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	5.3	200	Southeast
Summer	3.2	200	Northwest
Fall	4.6	200	Northwest
Winter	8.6	200	South-southeast
Annual	4.5	200	South-southeast

Note:

Due to rounding, the Annual values may not be the exact arithmetic mean of the Spring, Summer, Fall, and Winter values. All numbers listed are extracted from the SACTI2 run output files.

Key: m = meter

Table 5.7-13
Maximum Modeled Fractional Beam Radiation Losses (Percent)

Season	Fractional Beam Radiation Loss (Percent)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	9.4	200	Southeast
Summer	5.8	200	Northwest
Fall	7.9	200	Northwest
Winter	14.6	200	South-southeast
Annual	7.9	200	South-southeast

Note:

Due to rounding, the annual values may not be the exact arithmetic mean of the Spring, Summer, Fall, and Winter values. All numbers listed are extracted from the SACTI2 run output files.

Key: m = meter

Table 5.7-14
Maximum Modeled Plume Length Frequency (Percent)

Season/Distance	100 m	200 m	300 m	400 m	500 m	1.0 km	2.5 km	2.7 km	2.8 km
Spring	100.00	3.22	2.61	2.61	2.61	2.61	2.61	2.41	0.00
Summer	100.00	0.17	0.17	0.17	0.17	0.17	0.17	0.00	0.00
Fall	100.00	3.08	2.47	2.47	2.47	2.47	2.42	1.73	0.00
Winter	100.00	9.75	8.11	8.11	8.11	8.11	7.97	4.26	0.00
Annual	**100.00**	**4.05**	**3.34**	**3.34**	**3.34**	**3.34**	**3.29**	**2.09**	**0.00**

Note:

Due to rounding, the annual values may not be the exact arithmetic mean of the Spring, Summer, Fall, and Winter values. All numbers listed are extracted from the SACTI2 run output files.

Key: km = kilometer; m = meter

Table 5.7-15
Modeled Plume Height Frequency (Percent)

Season/Height from Towers	10 m	20 m	30 m	50 m	100 m	250 m	500 m	1.0 km
Spring	100.00	99.95	32.58	3.89	2.61	2.56	2.51	2.41
Summer	100.00	100.00	24.49	0.43	0.17	0.10	0.05	0.05
Fall	100.00	100.00	43.09	4.62	2.47	2.13	2.13	1.93
Winter	100.00	100.00	51.13	12.91	8.11	6.98	6.48	5.29
Annual	100.00	99.99	37.93	5.45	3.34	2.94	2.79	2.41

Note:

Due to rounding, the annual values may not be the exact arithmetic mean of the Spring, Summer, Fall, and Winter values. All numbers listed are extracted from the SACTI2 run output files.

Key: km = kilometer; m = meter

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Table 5.7-16
Modeled Plume Radius Frequency (Percent)

Season/Maximum Radius	5 m	10 m	15 m	30 m	50 m	100 m	250 m	500 m
Spring	100.00	100.00	29.60	7.01	3.28	2.61	2.61	2.61
Summer	100.00	100.00	15.76	1.74	0.25	0.17	0.17	0.17
Fall	100.00	100.00	35.86	7.93	3.97	2.47	2.47	2.37
Winter	100.00	100.00	51.03	16.38	11.23	8.11	8.11	7.72
Annual	100.00	100.00	33.12	8.26	4.68	3.34	3.34	3.21

Note:

Due to rounding, the Annual values may not be the exact arithmetic mean of the Spring, Summer, Fall, and Winter values. All numbers listed are extracted from the SACTI2 run output files.

Key: m = meter

Table 5.7-17
Maximum Modeled Plume Water Deposition

Season	Maximum Plume Water Deposition Rate ($kg/km^2/mo$)	Equivalent Monthly Precipitation (in.)	Distance from Site Center Point (m)	Direction from Site Center Point
Spring	43,400	0.0017	100	East-northeast
Summer	50,100	0.0020	100	East-northeast
Fall	41,100	0.0016	200	Northeast
Winter	47,700	0.0019	200	East
Annual	34,700	0.0014	100	East-northeast

Key: in. = inch; $kg/km^2/mo$ = kilograms per square kilometer per month; m = meter

Table 5.7-18
Estimated Annual Emissions from Cooling Towers at the Belews Creek, NC Site

Effluent [a,b]	Cooling Towers (lb/yr)
NO_x	N/A
CO	N/A
VOC / hydrocarbon	N/A
PM_{10}	52,745
$PM_{2.5}$	202
SO_x	N/A

Notes:

(a) Based on 6 total towers.

(b) Assumes 8760 hr/yr.

Key: CO = carbon monoxide; hr/yr = hours per year; lb/yr = pounds per year; N/A = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter – 2.5 micrometers or less in diameter; PM_{10} = particulate matter – 10 micrometers or less in diameter; SO_x = sulfur oxides; VOC = volatile organic compounds

Table 5.7-19
Estimated Annual Emissions from Auxiliary Boilers at the Belews Creek, NC Site

Effluent [a,b]	Auxiliary Boilers (lb/yr)
NO_x	33,875
CO	5930
VOC/Hydrocarbons	465
PM	7700
SO_x	41,575

Notes:

(a) Auxiliary boiler operation during each startup: 36 days/yr, 864 hr/yr per boiler.

(b) Auxiliary boiler information obtained from the bounding parameters (worst case emissions) from all potential vendor technologies.

Key: CO = carbon monoxide; hr/yr = hours per year; lb/yr = pounds per year; NO_x = Nitrogen oxides; PM = particulate matter; SO_x = sulfur oxides; VOC = volatile organic compounds

Table 5.7-20
Estimated Annual Emissions from Diesel Generators at the Belews Creek, NC Site

Effluent [a,b]	Diesel Generators (lb/yr)
NO_x	233,898
CO	18,744
VOC/Hydrocarbons	9000
PM	4830
SO_x	14,580

Notes:

(a) Diesel Generator emissions obtained from the bounding parameters (worst case emissions) from all potential vendor technologies.

(b) Assumes 4 hours of operation per month per generator.

Key: CO = carbon monoxide; hr/yr = hours per year; lb/yr = pounds per year; NO_x = Nitrogen oxides; PM = particulate matter; SO_x = sulfur oxides; VOC = volatile organic compounds

Table 5.7-21
Estimated Annual Emissions from Cooling Towers, Auxiliary Boilers, and Diesel Generators, at the Belews Creek, NC Site

Effluent [(a)]	Cooling Towers (lb/yr)	Auxiliary Boilers (lb/yr)	Diesel Generators (lb/yr)	Total Emissions	
				(lb/yr)	(ton/yr)
NO_x	N/A	33,875	233,898	267,773	133.9
CO	N/A	5930	18,744	24,674	12.3
VOC/Hydrocarbons	N/A	465	9000	9465	4.7
PM_{10}	52,745	N/A	N/A	52,745	26.4
$PM_{2.5}$	202	N/A	N/A	202	0.1
PM_{total}	N/A	7700	4830	12,530	6.3
SO_x	N/A	41,575	14,580	56,425	28.2

Note:

(a) 8760 hours of operation for cooling towers, 864 hours per year for auxiliary boilers, and 4 hours per month for diesel generators.

Key: CO = carbon monoxide; lb/yr = pounds per year; N/A = not applicable; NO_x = Nitrogen oxides; $PM_{2.5}$ = particulate matter – 2.5 micrometers or less in diameter; PM_{10} = particulate matter – 10 micrometers or less in diameter; SO_x = sulfur oxides; VOC = volatile organic compounds

5.8 NONRADIOLOGICAL HEALTH

This section addresses the health impacts associated with the Project's operational activities at the Project site. Nonradiological health impacts on the public during operations are evaluated for several factors, including the cooling system, noise from operations, EMFs, and transportation activities related to operations and outage workers. Potential impacts on workers during operations are also discussed. Radiological health impacts during operations are addressed in Section 5.9.

5.8.1 ETIOLOGICAL AGENTS AND EMERGING CONTAMINANTS

5.8.1.1 Etiological Agents

The cooling system associated with the Project is described in Section 3.2.2. This system draws source water for cooling from Belews Lake, circulates it through mechanical draft cooling towers, and discharges the resulting cooling tower blowdown back to Belews Lake. Intermittent use of cooling tower blowdown is also conveyed to the Dan River for dilution of effluent constituents prior to discharge. The potential for exposure exists for recreators using Belews Lake, the Dan River, and for workers conducting maintenance on the mechanical draft cooling towers. The Project water source is described in Section 2.2.1.1.3, and water quality of Belews Lake and the Dan River are characterized in Section 2.2.3. The water source is neither reclaimed nor impaired water. Nonradioactive waste streams during operations are described in Section 3.4.3. As described in Section 3.2.2 the normal blowdown rate is based on eight cycles of concentration, and the maximum blowdown rate is based on six cycles of concentration. Temperature increases associated with cooling tower blowdown are the only identified operational feature that is considered to potentially affect human health.

As discussed in Section 2.8.1.2, etiological agents associated with nuclear power plant operations can be found in cooling ponds or towers or thermal discharges. According to NUREG-1555, etiologic agents, including organisms formerly referred to as thermophilic microorganisms, can increase in frequency of occurrence and population size due to heat in aquatic systems. Etiologic agents can also resist moderately high temperatures long enough to be released into a cooler water body where they can reproduce. When such microorganisms are etiologic agents capable of causing human disease (pathogens), they can pose a risk to workers and the public from exposure. Potential pathways for exposure include thermal cooling system discharge or workers performing cooling tower maintenance. Microorganisms of concern include enteric pathogens (such as *Salmonella* spp. and *Pseudomonas aeruginosa*), bacteria (including *Legionella* spp. and *Vibrio* spp.), free-living amoeba (such as *Naegleria fowleri* and *Acanthamoeba* spp.), thermophilic fungi, blue-green algae, and dinoflagellates (*Karenia brevis*).

As indicated in Section 2.8.1.2, the BCSS discharged thermal effluents into the Belews Creek arm of Belews Lake from May to October 2017, raising water temperatures to as high as approximately 100°F (38°C), a range that permits the growth of *Legionella* spp. Thermophilic fungi are fungi species that can grow in temperatures above 68°F (20°C), with a maximum growth temperature at or above 122°F (50°C). Although the presence of blue-green algae was confirmed in Belews Lake in 2012, the toxins associated with blue-green algae were not confirmed. Additionally, no known records exist of the presence of dinoflagellates in Belews Lake. As such, while elevated temperature conditions within selected areas of Belews Lake have occasionally been documented, no established populations or outbreaks of etiological agents have been documented within Belews Lake.

Section 5.2.3.1.2.4 describes the potential effects of the hydrothermal discharge from the cooling system on water temperatures in Belews Lake. The maximum temperature of the cooling water discharge from the cooling tower is 95°F (35°C) which is released to the cooler hypolimnetic waters of Belews Lake. Modeling of the discharges indicates that thermal mixing occurs rapidly and does not achieve the elevated temperatures that are favorable to the growth of thermophilic organisms (etiological agents). As described in Section 7.1, BCSS plant closure is a RFFA in which operations of BCSS are discontinued. In conjunction with the phased approach for implementation of the proposed action, the continued operation of BCSS action results in a phased decline in the thermal discharges to Belews Lake over the Project building period. As such, overall lake temperatures are reduced as operation of BCSS is discontinued. In conjunction with full Project operations, Belews Lake is expected to be notably cooler within surface areas as water temperatures in Belews Lake during operations lack the thermal influence from the operation of BCSS and are several degrees cooler at the surface (see Section 5.2.3). As such, they do not support conditions favorable to the establishment and growth of etiological agents. Therefore, potential effects associated with the development of etiological agents as a result of operation of advanced reactors at the Project site within Belews Lake are minor.

5.8.1.2 Emerging Contaminants

As discussed in Section 2.8.1.2,emerging contaminants of concern in drinking water include perfluoroalkyl and polyfluoroalkyl substances (PFAS), trihalomethanes (TTHMs), and Haloacetic acids (HAAs).

Operations from the Project entail the release of chemical constituents to the Dan River as part of wastewater. However, as described in Section 3.4.3, PFAS and TTHMs and HAAs are not constituents identified as part of the wastewater discharge stream. As such, there are no contributing effects of plant operation on concentrations of emerging contaminants in the Dan River.

As described in Section 3.4.3.2, sanitary wastewater is routed to the existing BCSS domestic wastewater treatment plant for treatment prior to discharge. The NPDES permit establishes discharge limitations for quantity and quality parameters to protect surface waters, and the Project complies with these requirements. Therefore, impacts are minor. Water quality impacts from the Project discharge are further addressed in Section 5.2.

5.8.2 NOISE IMPACTS

Section 2.8.2 provides information and data related to background noise levels at the Project site. As described in Section 2.8.2.2, there are no municipal, county, or state-level regulations that establish quantitative noise level limits applicable to the Project site.

The principal sources of noise from nuclear power plant operations include cooling towers, and intermittent noise from transformers and loudspeakers. Other occasional noise sources may include the operation of auxiliary equipment (such as pumps to supply cooling water) and corona discharge associated with high-voltage transmission lines. The primary source of continuous noise is associated with the operation of the mechanical draft cooling towers. Based on the bounding condition in the PPE (Table 3.1-1), cooling towers produce noise levels of up to 55.1 dBA per cooling tower array at a distance of 1000 ft. (305 m) from the source. There are up to two cooling tower arrays per Plant Complex. Because of the logarithmic nature of the dBA scale, adding two identical sources of noise (doubling the signal) increases the total noise level

by 3 dBA. Thus, the operation of two cooling towers generates noise levels up to 58.1 dBA at a distance of 1000 ft. (305 m).

As discussed in Section 4.8.2.1, noise levels are acceptable and allowable if the day-night average sound level outside a residence is less than or equal to 65 dBA. NUREG-1437, Rev. 2, indicates that noise levels below 65 dBA are considered acceptable outside a residence. It also notes that cooling towers emit noise of a broadband nature, which is largely indistinguishable from, and less obtrusive than, noise of a specific tonal nature (such as transformer or loudspeaker noise). Applying straight-line noise attenuation, noise levels from the cooling towers attenuate to 65 dBA at a distance of 450 ft. (137 m). The nearest noise-sensitive receptor is a residence located along Craig Road, located approximately 1197 ft. (365 m) south of the cooling tower area in the South Plant Complex. At this residence, noise levels from the cooling towers attenuate to 56.5 dBA. Other sensitive receptors including residents along Windswept Drive near the South Plant Complex and those across Belews Lake northeast of the Project site (Figure 3.1-2), are farther away from the cooling tower areas than the nearest residence along Craig Road and noise will further attenuate at these locations because of distance and the vegetative buffer along the perimeter of the Project Site. While noise levels from operations are below the 65 dBA threshold at the surrounding sensitive receptors, they represent an increase over the existing average ambient community noise levels described in Section 2.8.2.1.4 which range from 49 and 53 dBA L_{dn}. Considering that noise levels from cooling towers attenuate below the 65 dBA threshold at nearby residences, noise impacts are minor.

The nearest recreational area is Belews Lake, which is located immediately adjacent to the Project site boundary (Figure 2.4-5). The lake supports recreational boating and fishing, and lake users may experience cooling tower noise. However, based on straight-line noise attenuation described above, cooling tower noise attenuates to 65 dBA at 450 ft. (137 m) from the towers. EABs are proposed for each of the three Plant Complexes and extend into Belews Lake beyond the 450 ft. radius (137 m) where in most areas noise levels from the cooling towers attenuate to 65 dBA or less. Duke Energy plans to install buoys or other suitable barriers to demarcate the EABs and provide notification to recreational users of the lake that crossing the boundary is prohibited. As a result, recreators are restricted from entering areas on the lake that are within a 450 ft. (137 m) radius from the cooling towers and within the EAB.

In addition to dispersed recreation occurring on Belews Lake, J. Dudley Watts Jr. Park (Belews Lake Park) is the closest developed recreational area located within the Project Vicinity (Section 4.8.2.1). Assuming straight-line noise attenuation, the noise produced by the nearest cooling towers attenuates to approximately 47.17 dBA at the park boundary, which is less than the acceptable and allowable threshold of 65 dBA. Thus, impacts to recreators at Belews Lake Park from noise during plant operation are minor.

During operations, the nearest residence to the Project site experiences cooling tower noise at 56.5 dBA which is below the 65 dBA threshold. Other residences near the Project site and across Belews Lake also experience noise from operation of the cooling towers below the 65 dBA threshold which is further attenuated with distance from the towers and the vegetative buffer. Although residents experience noise at higher levels than the existing average ambient condition, the resulting noise levels remain well below the 65 dBA threshold. Recreational users of Belews Lake are not permitted in areas of the lake where noise levels are above the 65 dBA threshold. Therefore, the overall impacts from noise during operations are minor.

5.8.3 ELECTRIC SHOCK IMPACTS

The interconnection of the existing Belews Creek 230-kV line to the Project site is presented in Section 3.2.4. A new 230-kV switchyard will connect each unit to the new switchyard via individual bus lines. Four individual bus lines will then connect the new switchyard to the existing Belews Creek 230-kV switchyard. All new structures will be designed and constructed to comply with all National Electrical Safety Code (NESC) provisions as well as Duke Energy safety standards.

The NRC indicates that the greatest electrical shock hazard from a transmission line is direct contact with the conductors. Tower designs preclude direct public access to the conductors. However, electrical shocks can occur without physical contact. Secondary shock can occur when humans contact either capacitively charged bodies (such as a vehicle parked near a transmission line) or magnetically linked metallic structures (such as fences near transmission lines), and these shocks could be painful. The intensity of the shock would depend on the EMF strength, the size of the object, and the degree of insulation between the object, the person, and the ground.

The NESC has a provision that describes how to establish minimum vertical clearances to the ground for electric lines with voltages exceeding 98 kV. The clearance must limit the induced current due to electrostatic effects to 5 milliamperes if the largest anticipated vehicle or equipment is short-circuited to ground (IEEE, 2006).

As described in Section 3.2.4.2, the transmission lines are designed to conform with NESC requirements, which include standards related to line clearance to limit shocks from induced currents. Because the on-site transmission lines comply with the NESC standards, impacts to the public and operations personnel associated with potential electrical shock are minor.

5.8.4 CHRONIC EFFECTS OF ELECTROMAGNETIC FIELDS

As discussed in Section 2.8.4, the scientific evidence regarding the chronic health effects from EMFs, including the potential effects associated with exposure of electrical fields that are associated with electric power usage, does not conclusively link EMF exposure to adverse health impacts. In addition, as noted in NUREG-1437, Table B-1, chronic effects of EMFs are of uncertain impact. Thus, impacts to the public attributable to EMF exposure from transmission system operations are minor.

5.8.5 OCCUPATIONAL HEALTH

Occupational health risks for nuclear power plant workers engaged in operational maintenance, testing, or plant modifications generally include those associated with exposure to toxic nonradioactive materials or other industrial safety and health hazards such as falls, confined space, and equipment energization hazards (OSHA and NRC, 2013). Public and occupational health impacts may result from exposure to noise, hazardous materials, emissions, EMFs, and infectious diseases.

The U.S. Bureau of Labor Statistics (BLS) publishes statistics on incidence rates of occupational illnesses, injuries, and fatalities for all U.S. companies. As presented in Section 2.8.1.1, in 2022 the utilities industry incidence rate for nonfatal occupational injuries and illness was 1.7 per 100 full-time workers and the rate of fatal work injuries was 3.4 per 100,000 full-time equivalent workers (BLS, 2023b, 2023c).

The incidence of nonfatal injuries and illnesses during the operations phase has been calculated as the incidence rate times the number of workers. Using the daily operations workforce of 450 (as provided in Section 5.4.2), recordable nonfatal injuries and illnesses during the operations phase is estimated at an annual average of approximately eight incidents. Based on the 2022 fatal occupational injury incidence rate from BLS and the daily operations workforce of 450, fatal occupational injuries during operations would be less than one (0.02 incidents) per year.

Occupational injury and fatality risks are minimized through Duke Energy's robust safety culture, use of established internal safety guides and procedures, and strict adherence to NRC requirements and Occupational Safety and Health Administration (OSHA) safety standards (29 CFR Part 1910) practices and procedures during operations.

Therefore, based on this analysis, it is anticipated that the operation of the Project will result in no more potential occupational injuries and fatalities than other similarly sized power plants.

5.8.6 HUMAN HEALTH IMPACTS FROM TRANSPORTATION

This subsection analyzes how potential impacts related to increased traffic on roadways near the Project site during operations could increase the number of vehicle accidents involving injuries and fatalities. The analysis estimated new vehicle trips and additional traffic crashes including injuries and fatalities based on the number of operations workers (450), truck deliveries per day (90), and outage workers (350) as described in Section 5.4.4.1.1. Although operations-related deliveries do not occur when operations workers arrive and depart the Project site, these deliveries are accounted for in the operations activities AADT along the roadways providing access to the Project site.

As described in Section 4.8.3, the crash rates (number of crashes per mile per year) for the Project were estimated using the University of Florida Transportation Institute Highway Safety Software (HSS) (UFTI, 2025). The crash rates are estimated by considering the increase in AADT due to operations phase traffic on the primary roadways that provide access to the Project site. The predicted increase in traffic volume is used to estimate potential changes in crash rates consistent with the methodologies outlined in the Highway Safety Manual (AASHTO, 2024). Crash rates (predicted crashes per mile per year) were developed for the existing condition (2024) to provide a baseline and the operations for the roadway segments that commuters and delivery trucks use to access the Project site. In addition, predicted crash rates for the existing condition and operations were developed at four intersections along these roadways: Belews Creek Road at Craig Road, Belews Creek Road at NC Highway 65, NC Highway 65 at Pine Hall Road (to the south), and NC Highway 65 at Pine Hall Road (to the north).

The HSS crash rate estimates predict average crash rates as a function of traffic volumes, roadway type (e.g., controlled-access), roadway characteristics (e.g., roadway geometry, number of lanes, lane width, shoulder type) and road segment length. The predicted crash rate (injuries and fatalities) associated with the increase in AADT during operations for surrounding roadway segments (identified in Figure 4.4-2) is shown in Table 5.8-1. Crash rates are variable. For example, the highest crash rates are predicted for United States (U.S.) Highway 220, which is a high volume controlled-access freeway (AADT greater than 25,000). By comparison crash rates are lowest on small local roads having a low AADT such as Craig Road, Fisherman Road, Hawkins Farm Road, and Pine Hall Road. Crash rates for most roadway segments analyzed are predicted to be slightly higher during operations relative to the existing condition. The increase in crash rates for Craig Road was greater than any other roadway segment (0.11 crashes per

vehicle mile traveled to 0.26 crashes per vehicle mile traveled). While notable, this increase is relatively minor. Overall, predicted crashes along the roadway network serving the Project site during operations are minor and do not destabilize traffic safety.

Table 5.8-2 presents the number of predicted crashes (resulting in injuries and fatalities) at the four intersections that provide access to the Project site per year. The HSS estimates the number of predicted crashes based on factors including traffic volume, intersection geometry, and control. The number of predicted crashes at the four intersections analyzed increases marginally during operations. The increase in predicted crashes (both injury and fatality) at the intersection of Belews Creek Road and Craig Road is slightly higher than predicted at the other intersections analyzed. Overall, the effects of predicted increases in crash rates at intersections during operations on human health are minor.

The addition of vehicles associated with operations traffic results in a minor increase in traffic accident injury risk on the surrounding roadway network relative to the base condition. This minor increase is minimized through implementation of the traffic management mitigation measures identified in Section 4.4.4.1 that are implemented to accommodate the higher building phase traffic volumes.

5.8.7 SUMMARY

During operations, water temperatures in Belews Lake do not support conditions favorable to etiological agent establishment and growth. Therefore, potential effects associated with the development of etiological agents within Belews Lake resulting from operation of advanced reactors at the Project site are minor. Sanitary wastewater discharged to the Dan River complies with NPDES permit requirements. Additionally, there are no contributing effects of plant operation on concentrations of emerging contaminants in the Dan River. Because the on-site transmission lines comply with the NESC and Duke Energy safety standards, impacts associated with potential electrical shock and impacts to the public attributable to EMF exposure from transmission system operations are minor. Operations result in cooling tower noise emissions that vary with distance, however overall effects of noise are minor. The additional vehicles associated with operational traffic results in a minor increase in the risk of traffic accidents (both injury and fatality) on the surrounding roadway network relative to the base condition. Therefore, impacts on nonradiological health are SMALL.

Table 5.8-1
Predicted Operations Phase Crash Rates on Roadways in the Project Vicinity

	Roadway Segments	Segment Length (mi)	AADT		Predicted Crash Rate (crashes / mile / year)	
			Existing Condition	Operations	Existing Condition	Operations
1	U.S. 158 (S of Belews Creek Rd)	5.00	7400	7459	0.91	0.92
2	U.S. 311 (S of NC Highway 65)	5.00	3400	3460	0.44	0.45
3	U.S. 311 (N of NC Highway 65)	5.00	3400	3565	0.59	0.62
4	NC 65 (between Belews Creek Rd and Pine Hall Rd S)	1.20	4000	4449	0.44	0.49
5	Pine Hall Rd (S of NC 65)	5.00	1400	1459	0.23	0.24
6	Pine Hall Rd (N of NC 65)	5.00	1700	1865	0.22	0.25
7	Belews Creek Rd (W of NC 65)	5.00	1700	1762	0.30	0.32
8	Belews Creek Rd (between Craig and NC 65)	0.15	1700	2211	0.35	0.45
9	Belews Creek Rd (E of Craig Rd)	4.75	3800	4370	0.50	0.57
10	Fisherman Rd	0.50	1200	1200	0.13	0.13
11	Hawkins Farm Rd	0.40	1200	1200	0.13	0.13
12	Martin Luther King Jr Rd	3.15	800	800	0.14	0.14
13	Craig Rd	2.75	900	1980	0.11	0.26
14	NC 68 (N of U.S. 158)	3.20	6400	6743	0.76	0.80
15	U.S. 220 Hwy (N of NC 68)	5.00	27,000	27,343	2.95	2.99
16	U.S. 220 Hwy (S of NC 65)	1.00	27,000	27,084	2.55	2.56
17	NC 68 (S of U.S. 158)	5.00	6400	6484	0.89	0.90
18	U.S. 158 (between Belews Creek Rd and NC 68)	1.30	9700	10,210	1.21	1.27
19	U.S. 158 (E of NC 68)	3.50	9700	9784	1.17	1.18
20	NC 65 (between Pine Hall S and Pine Hall N)	0.30	4000	4389	0.73	0.79
21	NC 65 (between Pine Hall N and U.S. 311)	3.60	4000	4224	0.53	0.55

Key: AADT=Annual Average Daily Traffic; mi= mile

Table 5.8-2
Predicted Crashes During the Operations Phase at Intersections Near the Project Site

Unsignalized Intersection	AADT		Predicted Number of Crashes (per year)	
	Existing	Operations	Existing	Operations
Belews Creek Road at Craig Road	1300	2096	0.22	0.39
NC Highway 65 at Belews Creek Road at NC Highway 65	2850	3330	0.58	0.72
NC Highway 65 at Pine Hall Road (to the south)	2700	2954	0.53	0.59
NC Highway 65 at Pine Hall Road (to the north)	2850	3127	0.58	0.66

Key: AADT = Annual Average Daily Traffic

5.9 RADIOLOGICAL HEALTH DURING NORMAL OPERATION AND RADIOACTIVE WASTE MANAGEMENT

This section describes the radiological impacts of normal plant operation from the Project site to members of the public, plant workers, and biota. Section 5.9.1 describes the exposure pathways by which radiation and radiological effluents could be transmitted from the Project site to members of the public and biota occupying areas near the Project site. Section 5.9.2 estimates individual and collective doses to members of the public. Section 5.9.3 evaluates the impact of these doses by comparing them to regulatory limits. Section 5.9.4 discusses occupational doses. Section 5.9.5 evaluates the impact to non-human biota. Section 5.9.6 discusses the Radiological Environmental Monitoring Program (REMP). Section 5.9.7 contains information regarding solid waste management and on-site spent fuel storage.

As stated in Section 3.1, the Project site is expected to be comprised of three individual site areas (the north, middle, and south site areas) where nuclear power plants may be sited and are referred to as the North Plant Complex, Middle Plant Complex, and South Plant Complex. These locations are shown in Figure 3.1-7.

5.9.1 EXPOSURE PATHWAYS

During normal operation of the plants considered for the Project site, radiological effluents are expected to be discharged to the environment. Exposure to the radiological effluents from normal operation is dependent on the radiological exposure pathway. A radiological exposure pathway is the vehicle by which a receptor may become exposed to radiological releases from nuclear facilities. The major pathways of concern are those that could yield the highest radiological doses for a given receptor. These pathways are determined from the type and amount of radioactivity transported, the transport mechanism, and the consumption or usage factors of the receptor. Environmental transport mechanisms for gaseous effluents consider the historical meteorological characteristics of the area that are defined by windspeed and wind direction. Additional factors such as location of homes, use of cattle for milk, and gardens for vegetable consumption are considered when evaluating exposure pathways.

Radioactive effluent pathways to humans and non-human biota consist of a combination of liquid and gaseous effluents and exposure from direct radiation. Radioactive liquid effluent pathways include drinking water, ingestion of fish and invertebrates, direct radiation from exposure during shoreline activities (i.e., boating, swimming, and recreational shoreline use), and ingestion of vegetables; meat; and milk irrigated by the Dan River. Radioactive gaseous effluent pathways considered include direct radiation from immersion in the gaseous plume, inhalation of iodines and particulates, ingestion of iodines and particulates through the milk cow; milk goat; meat animal; vegetation pathways, and deposition on plants and soil. Additionally, exposure to direct radiation is considered from the project site due to normal operating conditions.

The exposure pathways considered for the Project site are analyzed and estimated for the maximally exposed individual (MEI), nearby off-site receptor locations (Table 5.9-1), and the general population surrounding the Project site. The MEI is the member of the public who is positioned to receive the maximum possible calculated dose. The doses estimated for the Project site are based on NRC Regulatory Guide (RG) 1.109, Rev. 1, “Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I” and NRC RG 1.111, “Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-

Water-Cooled Reactors." These estimated doses are used to confirm that anticipated releases, associated with normal operation of the plants (being considered for the Project site), will result in doses that are within the dose limits to the public described in 10 CFR Part 50, Appendix I; 10 CFR Part 20; and 40 CFR Part 190, the U.S. Environmental Protection Agency (USEPA) limits on dose to the public.

The projected population within 50 miles (mi.) (80 kilometer [km]) of the Project site for the year 2079 is provided in Table 5.9-2. Additionally, since the Project site has not selected an advanced reactor technology, the activity released for the plant is based on a total bounding approach, as discussed in Section 3.4.2.

5.9.1.1 Liquid Pathways

As stated in Section 3.4.2.1, small quantities of radioactive liquid effluents are expected to be discharged to the environment at designated release points, typically in the conventional water discharges and liquid radwaste. The Project site will release small quantities of treated and diluted radioactive liquid effluent into the Dan River. As such, the liquid effluent pathways associated with the Dan River are analyzed to estimate the dose from liquid releases during normal operation.

The LADTAP II module of the NRCDose computer code implements the methodology discussed in RG 1.109, Rev. 1 to estimate doses from liquid effluents from the Project site (NRC, 1986). The code estimates the dose to the MEI and to the average individual through the following pathways:

- Internal exposure from ingestion of aquatic foods.
- Internal exposure from ingestion of drinking water.
- Internal exposure from ingestion of milk and meat from livestock consuming pasture feed from farms irrigated by contaminated water.
- Internal exposure from ingestion of vegetables and fruits from farms irrigated by contaminated water.
- External exposure to shoreline sediments.
- External exposure from boating and swimming.

The reactor effluent discharge flow rate of 7.35 cubic feet per second (cfs) (0.208 cubic meters per second [m^3/s]) and a mean flow rate for the Dan River of 498.4 cfs (14.11 m^3/s) is utilized for the analysis. Additionally, transit time from liquid discharge to the Dan River is assumed to be zero. This is conservative since the Dan River is greater than 2.24 mi. (3.61 km) from the Project site, and thus some decay will occur before it is discharged into the river.

The shoreline, swimming, and boating usage is determined by multiplying the 50-mile population for the year 2079 (Table 5.9-2) by the average shoreline usage rate. The fish consumption is similarly determined by multiplying the 50-mile population for the year 2079 (Table 5.9-2) by the average adult fish consumption; however, the only identified location of fish supply within 50-miles of the project site produces 250,000 pounds of tilapia per year. Therefore, the average adult fish consumption is reduced by 50 percent to account for the

fraction of consumption attributed to the Dan River.

The drinking water usage rate is determined using the survey conducted in 2024, which shows that the Dan River is used as drinking water for two locations (i.e., city of Eden and town of Madison in North Carolina). The 2025 population for both locations (i.e., 17,455) was used and scaled appropriately to 2079, using the same scale factors (i.e., 1.39) used for the projected 2079 50-mile population.

The milk production, meat production, and produce production that utilized irrigation from the Dan River, downstream of the radioactive liquid effluent discharge location, is determined using the survey conducted in 2024 and consumption rates from the GASPAR II Technical Manual (NRC,1987). Using the survey, the sum of the fraction of irrigated cropland is determined to be 0.0153. Additionally, the ratio of total cropland from counties using irrigation to the total cropland within 50 miles is identified to be 0.585. For the analysis, the national irrigation usage rate in 2024 of 38.1 liters/m^2/month is utilized. Using this information and the consumption rates in Table 5.9-6, the production rates for milk, meat and produce that use Dan River water for irrigation are determined.

Table 5.9-3 contains an overview of the liquid pathway parameters used by LADTAP II. Table 5.9-4 contains the fish and invertebrate consumption rates and aquatic recreation usage rates used for the MEI and average individual. The most conservative consumption factor (infant, child, teen, or adult) from RG 1.109, Rev. 1 is used to determine the dose to the average individual and MEI. Additionally, these consumption factors are multiplied by the projected population (Table 5.9-2) within 50 mi. (80 km) of the Project site. The bounding liquid release activity utilized for the Project site and for each reactor is provided in Tables 3.4-4 and 3.4-5, respectively.

A pump station located roughly three miles downstream from the discharge location can pump river water into Belews Lake in accordance with permitted limitations related to river flow and season. However, any dose contributions from pathways associated with the Belews Lake would be negligible due to the distance from the discharge location, additional dilution from the Dan River and Belews Lake, and the assumption that liquid radioactive effluent is released in batch releases and could be discharged when the pump is not operating.

5.9.1.2 Gaseous Pathways

As stated in Section 3.4.2.2, radioactive gaseous effluents are released to the environment through a controlled and monitored release point (e.g., plant vent). Additionally, radioactive gases from plant system leakage to the building atmosphere will travel through ventilation systems, passing through filtration, and be released through monitored building ventilation system release points.

Section 2.7.3 contains discussion regarding the atmospheric dispersion (χ/Q) and ground deposition (D/Q) factors for the Project site. The χ/Q factors in Section 2.7.3 are determined using the XOQDOQ computer code, which implements RG 1.111, Rev. 1 methodology (NRC, 1982). Table 5.9-7 contains the χ/Q and D/Q values for the maximally exposed location (MEL) and off-site receptors that are utilized for the evaluation.

The GASPAR II module of the NRCDose computer code implements the methodology discussed in RG 1.109, Rev. 1 to estimate doses from gaseous effluents from the Project site (NRC, 1987). The code calculates the radiation exposure to people through the following

potential pathways:

- External exposure to airborne radioactivity
- External exposure to deposited activity on the ground
- Inhalation of airborne radioactivity
- Ingestion of contaminated agricultural products

Table 5.9-5 contains an overview of the gaseous pathway parameters used by GASPAR II. The fraction of the year that leafy vegetables are grown, and milk and meat animals are on pasture is based on-site-specific conditions. North Carolina experiences all four seasons; Therefore, it is not expected that vegetables are grown all year and milk and meat animals are on pasture all year.

Figure 2.2 in the GASPAR II technical manual (NRC,1987) is used to determine the length of the growing season. In the case of the Project site, the growing/pasture season is 8 months. The GASPAR II technical manual states to add one month for goats for nine total months and to subtract 3 months for leafy greens for 5 months.

The fraction of the maximum individual's vegetable intake that is from their own garden is expected to be lower than the default GASPAR II value. The land survey conducted in December of 2024 identified the nearest vegetable garden as a soybean farm. Furthermore, the survey found that the crop production within 2 miles of the Project site is comprised of corn, sorghum, soybeans, tobacco, winter wheat, triticale, and hay. The crop production within 2 miles also appears to be operations that would require the crops to be processed and shipped outside of the project area. As such, it is not reasonable to assume that 76 percent (i.e., the value from Table E-15 of RG 1.109) of vegetables consumed are from an individual's garden. Therefore, it is reasonable, and still conservative to assume that an individual consumes roughly a third of their vegetable intake (i.e., 0.35) for 42 percent (i.e., 5 months) of the year from their own garden.

Table 5.9-6 contains the food consumption rates for the average individual and the MEI within 50 mi. (80 km) of the Project site. The table is based on the most conservative consumption factor (infant, child, teen, or adult) from the GASPAR II technical manual (NRC,1987), which is used to determine the dose to the average individual and the MEI. Additionally, these consumption factors are multiplied by the projected population (Table 5.9-2) within 50 mi. (80 km) of the Project site. Because milk and meat animals are not identified to be within 5 mi. (8 km) of the Project site, dose contributions from milk and meat animals do not contribute to the MEI dose.

Additionally, since Duke Energy has not yet selected a technology for the Project site, the activity assumed to be released from the site is based on an enveloping approach to bound the technologies considered in this application. The bounding gaseous release activity per reactor utilized for the Project site and for each reactor is provided in Tables 3.4-6 and 3.4-7, respectively.

5.9.1.3 Direct Radiation

As noted in NRC Technical Report (NUREG)-2226 (NRC, 2019b), direct radiation from sources

within a light-water reactor (LWR) is due primarily to nitrogen-16. Because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of LWRs are generally undetectable and less than 1 mrem/yr at the unrestricted area boundary. Some plants (mostly boiling-water reactors [BWRs]) do not have completely shielded secondary systems and may contribute some measurable off-site doses. Additionally, since the dose rates discussed in NUREG-2226 and NUREG-1437 relate more to units that are larger than the advanced reactors considered in the analysis, the dose is expected to be less for the technologies considered for the Project site. Therefore, a dose rate for direct radiation of 1 mrem/yr at the unrestricted area boundary is utilized. However, since 40 CFR Part 190 applies to the MEI, which is located at the nearest resident, and since the nearest resident is located farther from the unrestricted area boundary, any contributions to the MEI from direct radiation are expected to be negligible.

5.9.2 RADIATION DOSES TO MEMBERS OF THE PUBLIC

This subsection provides an evaluation of the calculated doses to the MEI and calculated doses at other sensitive receptor locations (Table 5.9-1). This section also evaluates the collective population dose from liquid and gaseous effluents released from the Project site using the methodologies and parameters specified in Section 5.9.1.

5.9.2.1 Liquid Pathway Doses

Table 5.9-8 provides the resultant doses from LADTAP II to the MEI at each pathway location determined. Table 5.9-9 provides the collective population doses from liquid effluents to individuals living within a 50 mi. (80 km) radius of the Project site. For the collective population doses, the projected population data to the year 2079 is used (Table 5.9-2).

5.9.2.2 Gaseous Pathways Doses

Table 5.9-10 provides the resultant doses from GASPAR II to the MEI at each pathway location. Table 5.9-11 provides the collective population doses from gaseous effluents to individuals living within a 50 mi. (80 km) radius of the Project site. Similar to 5.9.2.1, the collective population doses are determined using the projected population data to the year 2079 (Table 5.9-2).

5.9.3 IMPACTS TO MEMBERS OF THE PUBLIC

As noted in Sections 5.9.1.1 through 5.9.1.2, the exposure pathways analyzed for the Project site are from liquid and gaseous effluents. The exposure pathways are analyzed using methodologies and parameters specified in Sections 5.9.1.1 and 5.9.1.2.

Table 5.9-12 compares 10 CFR Part 50, Appendix I, dose limits for liquid and gaseous effluents to the MEI doses for a single unit. The MEI doses calculated from liquid and gaseous effluents for the Project site are compared to 40 CFR Part 190, as shown in Table 5.9-13.

The collective population dose resulting from natural background radiation to individuals within a 50 mi (80 km) radius of the Project site of 9.48E+05 person-rem/yr Total Effective Dose Equivalent (TEDE) is presented in Table 5.9-14. The natural background radiation dose is based on a dose rate of 310 mrem/yr (3.1 mSv/yr), as presented in Section 2.9 and the total 2079 projected population within a 50-mile radius (Table 5.9-2). Comparing this value to the sum of the calculated population doses in Tables 5.9-9 and 5.9-11 demonstrate that the calculated person-rem/yr exposure from the plant is less than the estimated person-rem/yr

exposure from natural background radiation.

Considering the results discussed above, impacts to members of the public from normal operation of the Project site are SMALL.

5.9.4 OCCUPATIONAL DOSES TO WORKERS

The annual occupational dose to operational workers, including workers involved with major maintenance and outage activities, will be provided in the construction permit or license application. This dose will be maintained ALARA in compliance with 10 CFR 20.1101.

5.9.5 DOSES TO NON-HUMAN BIOTA

Radiation exposure pathways to non-human biota are examined. This assessment uses surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms. Surrogates are typically used for judging doses to biota since important attributes are well defined and accepted. This assessment uses pathway models adopted from RG 1.109.

5.9.5.1 Liquid Effluents

Surrogate biota doses from liquid effluents are determined using the LADTAP II computer code. Table 5.9-15 presents the maximum liquid effluent dose to biota. Surrogate aquatic biota includes algae, invertebrates, and fish. Liquid effluent pathways that can irradiate biota include:

- Ingestion of water.
- Ingestion of aquatic food including fish, invertebrates, and aquatic plants.
- External exposure from water immersion and shoreline sediments.

5.9.5.2 Gaseous Effluents

Surrogate biota doses from gaseous effluents are determined using the site boundary doses from Table 5.9-10 and are presented in Table 5.9-16. This results in the dose to the maximally exposed animal. Surrogate terrestrial biotas include muskrat, racoon, heron, and duck. Pathways of irradiation include:

- External exposure to immersion in gaseous effluent plumes.
- Surface exposure from deposition of iodine and particulates from gaseous effluents.
- Inhalation of gaseous effluents.
- Ingestion of terrestrial vegetation and organisms.

Since GASPAR II does not determine biota dose, the following methodology is utilized to determine the maximum biota dose from gaseous effluents. Because doses from immersion in plume and ground deposition are largely independent of organism size, and it is conservative because the internal dose for humans is based on a much longer retention period than would be expected for biota, the doses for humans can also be applied to the surrogate terrestrial

animals. The human ground plane doses are increased by a factor of two for animals to account for their close proximity to the ground. This assumption is based on the approach for biota used in NUREG/CR-4013, LADTAP II Technical Reference and User Guide. Inhalation and vegetation ingestion doses are approximated by human doses as well. The total body inhalation dose and total body vegetation ingestion dose, rather than organ specific dose, are used since the biota doses are assessed on a total body basis. Based on these assumptions, all non-human biota have the same exposure.

5.9.5.3 Biota Doses

Table 5.9-17 presents the calculated maximum biota doses from liquid and gaseous effluents and direct radiation. The total maximum biota dose of 148 mrem/yr does not meet the 40 CFR Part 190 limit of 25 mrem/yr.

Although the 40 CFR Part 190 whole-body dose limit of 25 mrem/yr is exceeded, the dose is conservatively based on 100 percent occupancy at the maximum gaseous and maximum liquid effluent locations. However, the geological position for both maximum gaseous and liquid effluent locations are not the same. As such, it is not reasonable to expect that biota would receive the maximum dose from both pathways. Furthermore, use of exposure guidelines, such as 40 CFR Part 190, which apply to members of the public, in unrestricted areas, is considered very conservative when evaluating calculated doses to biota.

When actions taken to protect humans from radiation and radioactive materials are not adequate to protect biota in accordance with 4.j(2)(b) of the Department of Energy (DOE) Order 458.1 (DOE, 2011), an alternative approach may be used to demonstrate that the dose rates to representative biota populations do not exceed the dose rate criteria in Table 2.2 of DOE-STD-1153-2002 (DOE, 2022). The dose rate criteria in Table 2.2 of DOE-STD-1153-2002 are 1 rad/day for aquatic biota and 0.1 rad/day for terrestrial biota. As indicated in Table 5.9-17, all biota analyzed for the Project site are within the dose limits of 1 rad/day (1000 mrad/day) for aquatic biota and 0.1 rad/day (100 mrad/day) for terrestrial biota.

5.9.6 RADIOLOGICAL MONITORING

The REMP for the Project site is designed to adequately characterize the radiological environment of the biosphere in the vicinity of the Project site. The REMP provides data on measurable levels of radiation and radioactive materials in the site environs and baseline data from surveillance of principal pathways of exposure to the public.

The primary objective of the REMP is to monitor for potential radiological exposures to operations and construction workers, the public, and the surrounding environment prior to and during construction and active facility operations.

The REMP includes:

- Number and location of sample collection points and measuring devices, and the pathway sampled or measured.
- Sample collection frequency.
- Type and frequency of analysis.

Sampling locations have been selected based on their relative location to the Project site and prevailing wind direction. Sampling locations are selected in accordance with the requirements of Table 6.2-2 of NUREG-1555.

5.9.6.1 Belews Creek, NC Site Radiological Environmental Monitoring Program

The REMP is implemented in accordance with 10 CFR 20.1501 and Criterion 64 of 10 CFR Part 50, Appendix A. The program is developed using the following guidance published by the NRC:

- RG 1.21, Rev. 3, *Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste*.
- RG 4.1, Rev. 2, *Radiological Environmental Monitoring for Nuclear Power Plants*.
- RG 4.13, Rev. 2, *Environmental Dosimetry – Performance Specifications, Testing, and Data Analysis*.
- RG 4.15, Rev. 2, *Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination) – Effluent Streams and the Environment*.
- RG 1.109, Rev. 1, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*.
- NUREG-1301, *Off-site Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors*.
- NUREG-1302, *Off-site Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors*.

The REMP has the following objectives:

- Survey the radiological conditions in the vicinity of the Project site before initial reactor operation to establish the baseline radiological conditions in the local environment.
- Measure radiological conditions in the local environment during operational lifetime of the Project site.
- Evaluate the measurements to determine the effects on proposed operations relative to the local radiological environment.
- Collect data needed to refine environmental radiation transport models used in off-site dose calculations.
- Verify that radioactive material containment systems are functioning to minimize environmental releases to levels ALARA.
- Demonstrate compliance with regulations by reporting measurement results, summaries, and trends regarding radiation and radioactive materials in the local

environment.

Implicit in these objectives are the requirements to analyze trends and assess radiation exposure rates and radioactivity concentrations in the environment that may contribute to radiation exposure to plant personnel and the general public. The program consists of two phases: preoperational and operational.

- Preoperational radiological environmental monitoring: The preoperational REMP is used to adequately characterize the radiological conditions in the vicinity of the reactor site before initial facility operation. The preoperational REMP measures background levels and their variations along the anticipated critical pathways in the area surrounding the Project site; trains personnel; and evaluates procedures, equipment, and techniques. The preoperational monitoring program, which is implemented two years before initial facility operation, monitors the radiological environment around the Project site. The duration of the preoperational program for specific media is presented in Table 5.9-18.

- Operational radiological environmental monitoring: The operational REMP monitors the radiological environment around the Project site once the facility becomes operational and evaluates any differences observed between the preoperational REMP and operational REMP. The operational REMP documents the effectiveness of procedures and processes that restrict or control releases of radioactive materials to the environment.

The sampling media and analysis type for both the preoperational and operational REMP phases are essentially the same. Sampling media for both the preoperational and the operational REMP are identified in Table 5.9-18. Sampling locations (Table 5.9-19) are chosen based on the Project site design parameters (e.g., land use, expected pathways, census data, etc.).

The REMP monitors the environment by sampling air, water, soil, and food products (aquatic, meat, milk, and produce), as well as measuring radiation directly. According to Table 3.12-1 of NUREG-1301/1302, milk samples should be taken from three locations within 3 mi. (5 km) of the Project site that are likely to have the highest dose potential. If there are no milking locations within 3 mi. (5 km), then one sample should be taken between 3 and 5 mi. (5 and 8 km) of the Project site. Additionally, one sample should be taken from a control location 9 to 19 mi. (15 to 30 km) from the Project site. Since no milk-producing animals (cows or goats) are identified within 5 mi. (8 km) of the Project site, no milk samples will be collected and analyzed.

5.9.6.2 Pathways Monitored

Radiological exposure pathways are ways by which people might become exposed to radioactive material. The major pathways of concern are those that could cause the highest calculated radiological dose. The projected pathways are determined from the type and amount of radioactive material that might be released, the environmental transport mechanism, and the use of the environment. Environmental transport mechanisms include, but are not limited to, local hydrology (water) and meteorology (weather).

The release of radioactive gaseous effluents can affect the public via pathways such as external whole-body exposure, deposition on plants and soils, and human inhalation/ingestion. The release of radioactive constituents in liquid effluents can affect the public via pathways such as drinking water, fish consumption, direct exposure from shoreline sediments, and submersion

dose while swimming.

The following radiological exposure pathways are monitored for the Project site:

- Direct (dosimeters)
- Airborne (iodine and particulates)
- Ingestion (vegetation, fish, and invertebrates)
- Waterborne (surface water and river sediment)

5.9.6.3 Indicator and Control Locations

The REMP includes sampling indicator and control locations for the identified exposure pathways. A description of Project site monitoring, sampling and control locations to be used to monitor the exposure pathways is provided in Table 5.9-19 and approximate locations are shown in Figures 5.9-1 and 5.9-2. Indicator locations near and around the Project site are used to show any increase or buildup of radioactivity that might occur from operation of the Project site. Control locations are farther away from the site 9 to 19 mi. (15 to 30 km) and are used to indicate the background radiation levels. Indicator results are compared with control and preoperational results to assess any impact that the Project site might have on the surrounding environment.

Pathways are monitored at sampling indicator and control locations. REMP indicator locations chosen for the Project site are based on meteorological factors, preoperational monitoring requirements, and results of the land use surveys. A number of locations have been selected as controls per guidance from NUREG-1301/1302.

Samples from these control locations provide a basis for measuring background fluctuations in radioactivity at indicator locations caused by natural phenomena and fallout. By comparing radioactive material concentrations at indicator locations to these control locations, increases resulting from commercial operation are distinguishable.

Monitoring locations consist of an inner ring of thermoluminescent dosimeters (TLDs) in each 22.5-degree direction sector in the vicinity of the site boundary, with a TLD for each compass direction (T-1 through T-16), and an outer ring of TLDs ranging from 4 to 5 miles from the center of the Project site (T-17 through T-32). Monitoring is also provided at eight special interest locations identified in Table 5.9-19 (T-33 through T-40). Particulate and airborne iodine are monitored close to the Site Boundary in the direction sectors that have the highest calculated annual average ground-level deposition, in the vicinity of a community with the highest annual average ground-level D/Q, and at a control location. Waterborne and ingestion pathways are monitored as outlined in NUREG-1301/1302.

Table 5.9-20 summarizes the sampling frequency and analysis method of each sample type. The Off-site Dose Calculation Manual (ODCM) provides a detailed description of the monitoring program including the general types of sample collection and measuring equipment and lower limit of detection for each analysis. Sample media and sample size are defined in environmental monitoring and laboratory standard operating procedures.

5.9.6.4 Reporting Requirements

An Annual Radiological Environmental Operating report will be submitted to the NRC. The report includes summaries, interpretations, and an analysis of the radiological environmental surveillance activities for the report period. These reports include a comparison with preoperational studies with operational controls (as appropriate), previous environmental surveillance reports, and an assessment of the observed impacts of plant operation on the environment.

A land use census will be conducted annually to ensure that changes at and beyond the site boundary are identified and that modifications to the REMP are made, if required. This census satisfies the requirements of Section IV.B.3 of 10 CFR Part 50, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion “As Low as is Reasonably Achievable” for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents. Land use census results are included in the Annual Radiological Environmental Operating Report

5.9.6.5 Quality Assurance Program

The standards for quality assurance (QA) related to the REMP program are established in RG 4.15, “Quality Assurance for Radiological Monitoring Programs.” The purpose of the QA program is “to ensure the quality of the results of measurements of radioactive materials in the effluents from, and environment outside of, facilities that process, use, or store radioactive materials during all phases of the facility’s life cycle.”

QA is made up of all those planned and systematic actions that are necessary to provide adequate confidence in the assessment of monitoring results. Quality control (QC) is made up of those QA actions that provide a means to measure and control the characteristics of measurement equipment and processes to meet established standards; QA includes QC.

QA is necessary to ensure that all radiological and nonradiological (flowrate, run time, etc.) measurements that support the radiological monitoring program are reasonably valid and of a defined quality. These programs are needed (1) to identify deficiencies in the sampling and measurement processes and report them to those responsible for these operations so that licensees may take corrective action and (2) to obtain some measure of confidence in the results of the monitoring programs to assure the regulatory agencies and the public that the results are valid. All steps of the monitoring process should involve QA (for example, sampling, shipment of samples, receipt of samples in the laboratory, preparation of samples, radiological measurements, data reduction, data evaluation, and reporting of the measurement and monitoring results).

Examples of the activities of the QA program typically include the following:

- Perform duplicate analysis of the samples to check laboratory precision.
- Perform regular review of sample collection and records.
- Perform regular review of laboratory procedures and methods.
- Count quality indicator and control samples routinely.

- Review analytical results provided by the laboratory monthly to validate that the required minimum sensitivities have been achieved, and the correct analyses have been performed.

- Ensure known concentrations of radioactivity are used by laboratory in test samples to ensure consistent quality results on an ongoing basis.

- Ensure laboratory participation in intercomparison programs.

- Track deviations/non-conformances, including associated corrective measures using the corrective action program.

The REMP uses QA programs and processes to accomplish the following tasks:

- Ensure personnel are trained and qualified to perform radiological monitoring.

- Ensure laboratory processes are documented (that is, maintenance, storage, and use of radioactivity reference standards), and calibration and checks of radiation radioactivity measurement systems and sample tracking and control are performed.

- Ensure the processes and procedures of the REMP are documented.

- Ensure periodic audits of analysis laboratory functions and their facilities are conducted.

5.9.7 SOLID WASTE MANAGEMENT AND ON-SITE SPENT FUEL STORAGE

Section 3.4 discusses the plans for minimizing the production and processing of low-level waste (LLW) on-site. Additionally, Section 3.4 contains discussion on the amount of LLW to be stored on-site and spent fuel stored in an ISFSI.

Table 5.9-1
Off-Site Receptor Locations

Off-Site Receptor No.	Receptor Description	Distance from Site Boundary to Receptor (m)	Sector	Distance from North Plant Complex (m)	Distance from Middle Plant Complex (m)	Distance from South Plant Complex (m)
1	Residence	13	SSW	2228	1258	362
2	Vegetable Garden	521	SSW	2735	1766	870

Key: m = meter; No. = number; SSW = south-southwest

Table 5.9-2
Total Population (50 mi. Radius) 2079

Compass Direction Sector	Distance (mi.)									
	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 10	10 - 20	20 - 30	30 - 40	40 - 50
N	84	66	160	330	201	1537	2749	5070	9016	16,879
NNE	33	66	120	193	525	5706	5908	15,305	14,166	9186
NE	42	102	200	204	276	2684	8814	18,825	10,907	19,729
ENE	363	104	255	341	360	2053	8484	18,452	15,056	27,983
E	57	103	265	415	533	2918	11,057	14,851	9346	10,303
ESE	54	210	362	889	971	10,152	78,898	51,019	205,187	97,668
SE	162	354	522	743	1266	12,246	328,571	126,504	25,122	37,549
SSE	115	260	510	763	1404	12,377	139,009	62,072	52,117	47,590
S	193	221	357	744	788	25,967	106,623	119,719	28,425	15,598
SSW	172	317	280	382	1042	19,912	99,007	56,550	76,034	91,252
SW	64	159	223	319	889	12,249	272,070	117,988	37,164	38,984
WSW	33	91	236	288	384	4422	95,606	26,794	20,368	26,171
W	33	367	78	298	474	2902	27,320	9007	13,725	26,001
WNW	33	56	80	249	882	2264	6628	13,176	34,111	10,794
NW	33	73	192	290	311	2150	4033	3891	4888	8063
NNW	33	66	141	147	167	1197	2848	4206	2384	9182

Note: Total population within 50 miles - 3,057,906.

Key: E = east; ENE = east-northeast; ESE = east-southeast; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; W = west; WNW = west-northwest; WSW = west-southwest

Table 5.9-3
Liquid Pathway Parameters

Parameter	Value
Water Type	Fresh Water
Discharge Rate	7.35 cfs
Dilution Factor	68
Transit Time to Receptor	0 hour
Impoundment Reconcentration Model	None
Shore-Width Factor	0.2
Population within 50 mi	3,057,906
50-mi. Shoreline Usage (person -hr/yr)	39,141,197
50-mi. Swimming Usage (person -hr/yr)	39,141,197
50-mi. Boating Usage (person -hr/yr)	39,141,197
50-mi. Sport Fishing Harvest (kg/yr)	10,549,775.7
50-mi. Commercial Fishing Harvest	0
50-mi. Sport Invertebrate Harvest	0
50-mi. Commercial Invertebrate Harvest	0
Drinking Water Population	24,500
Milk Production using Dan River as Irrigation (L/yr)	10,947,915.1
Meat Production using Dan River as Irrigation (kg/yr)	3,010,676.6
Produce Production using Dan River as Irrigation (kg/yr)	18,994,632.6

Key: cfs = cubic feet per second; hr/year = hours per year; kg/year = kilograms per year; L/yr = liters per year; mi. = miles

Table 5.9-4
Fish and Invertebrate Consumption Rates and Aquatic Recreation Usage Rates

Consumption Factor	MEI Annual Rate				Average Annual Rate				Average Rate
	Adult	Teen	Child	Infant	Adult	Teen	Child	Infant	
Fish Consumption (kg/yr)	21	16	6.9	0	6.9	5.2	2.2	0	5.9
Invertebrate Consumption (kg/yr)	0	0	0	0	1.0	0.75	0.33	0	0.85
Shoreline Usage (hr/yr)	12	67	14	0	8.3	47	9.5	–	12.8
Swimming (hr/yr)	12	67	14	0	8.3	47	9.5	–	12.8
Boating (hr/yr)	12	67	14	0	8.3	47	9.5	–	12.8
Drinking Water Consumption (L/yr)	730	510	510	330	370	260	260	–	–

Key: hr/year = hours per year; kg/year = kilograms per year; L/yr = liters per year

Table 5.9-5
Gaseous Pathway Parameters

Value	Description
0.42	Fraction of the year that leafy vegetables are grown.
0.67	Fraction of the year that milk cows are on pasture.
0.35	Fraction of the maximum individual's vegetable intake that is from his own garden.
1.0	Fraction of milk-cow feed intake that is from pasture while on pasture.
8.0	Average absolute humidity over the growing season (g/m^3).
0.75	Fraction of the year that goats are on pasture.
1.0	Fraction of goat-feed intake that is from pasture while on pasture.
0.67	Fraction of the year that beef cattle are on pasture.
1.0	Fraction of beef-cattle feed intake that is from pasture while the cattle are on pasture.

Key: g/m^3 = grams per cubic meter

Table 5.9-6
Food Consumption Rates

Consumer	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (L/yr)	Meat (kg/yr)
Average Adult	190	30	110	95
Average Teen	240	20	200	59
Average Child	200	10	170	37
Maximum Adult	520	**64**	310	**110**
Maximum Teen	**630**	42	**400**	65
Maximum Child	520	26	330	41
Maximum Infant	0	0	330	0

Note: Maximum values are bold.

Key: kg/year = kilograms per year; L/yr = liters per year

Table 5.9-7
MEI and Off-Site Receptor χ/Q and D/Q Factors

MEI Location	Sector	Distance (mi.)	χ/Q (s/m³)			D/Q (1/m²)
			No Decay	2.26 day Decay	8 day Decay	
			Undepleted	Undepleted	Depleted	
North Plant Complex (Unrestricted Area Boundary MEL)	NE	0.15	2.60E-04	2.60E-04	2.50E-04	6.00E-07
Middle Plant Complex (Unrestricted Area Boundary)	ESE	0.16	1.40E-04	1.40E-04	1.40E-04	3.80E-07
Middle Plant Complex (Unrestricted Area Boundary MEL)	N	1.11	7.20E-06	7.10E-06	6.20E-06	1.80E-08
South Plant Complex (unrestricted area boundary)	N	0.24	1.30E-04	1.30E-04	1.20E-04	2.40E-07
South Plant Complex (Unrestricted Area Boundary MEL)	N	1.53	3.40E-06	3.30E-06	2.90E-06	8.10E-09
Nearest Resident (North)	SSW	1.38	1.30E-06	1.30E-06	1.10E-06	3.10E-09
Nearest Resident (Middle)	SSW	0.78	5.60E-06	5.60E-06	5.00E-06	1.40E-08
Nearest Resident (South)	SSW	0.22	5.00E-05	5.00E-05	4.70E-05	1.00E-07
Nearest Vegetable Garden (North)	SSW	1.70	8.40E-07	8.20E-07	7.00E-07	1.90E-09
Nearest Vegetable Garden (Middle)	SSW	1.10	2.40E-06	2.30E-06	2.10E-06	5.60E-09
Nearest Vegetable Garden (South)	SSW	0.54	1.10E-05	1.10E-05	1.00E-05	2.60E-08

Key: D/Q = Ground Deposition Factor; ESE = east-southeast; m² = square meters; MEI = Maximally Exposed Individual; MEL = Maximally Exposed Location; N = north; NE = northeast; SSW = south-southwest

Table 5.9-8
LADTAP II Liquid Pathway Doses for Maximally Exposed Individuals
(Sheet 1 of 2)

Pathway	Skin (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Total Body (mrem/yr)	Thyroid (mrem/yr)	Kidney (mrem/yr)	Lung (mrem/yr)	GI-LLI (mrem/yr)
Fish								
Adult	0.00E+00	2.68E+00	6.08E-01	4.20E-01	1.39E-02	1.68E-01	5.08E-02	5.36E-01
Teen	0.00E+00	2.91E+00	6.31E-01	2.98E-01	1.25E-02	1.69E-01	5.84E-02	4.09E-01
Child	0.00E+00	3.74E+00	5.65E-01	2.22E-01	1.25E-02	1.41E-01	4.62E-02	1.63E-01
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Drinking								
Adult	0.00E+00	1.21E-02	1.67E-01	1.64E-01	1.82E-01	1.61E-01	1.59E-01	1.71E-01
Teen	0.00E+00	1.15E-02	1.20E-01	1.15E-01	1.32E-01	1.14E-01	1.12E-01	1.20E-01
Child	0.00E+00	3.32E-02	2.31E-01	2.19E-01	2.66E-01	2.20E-01	2.15E-01	2.22E-01
Infant	0.00E+00	3.22E-02	2.31E-01	2.14E-01	2.93E-01	2.16E-01	2.12E-01	2.15E-01
Shoreline								
Adult	1.13E-03	9.60E-04	9.60E-04	9.60E-04	9.60E-04	9.60E-04	9.60E-04	9.60E-04
Teen	6.29E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03
Child	1.31E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Swimming								
Adult	0.00E+00	1.90E-05	1.90E-05	1.90E-05	1.90E-05	1.90E-05	1.90E-05	1.90E-05
Teen	0.00E+00	1.06E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04
Child	0.00E+00	2.21E-05	2.21E-05	2.21E-05	2.21E-05	2.21E-05	2.21E-05	2.21E-05
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boating								
Adult	0.00E+00	9.49E-06	9.49E-06	9.49E-06	9.49E-06	9.49E-06	9.49E-06	9.49E-06
Teen	0.00E+00	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05	5.30E-05
Child	0.00E+00	1.11E-05	1.11E-05	1.11E-05	1.11E-05	1.11E-05	1.11E-05	1.11E-05
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 5.9-8
LADTAP II Liquid Pathway Doses for Maximally Exposed Individuals
(Sheet 2 of 2)

Pathway	Skin (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Total Body (mrem/yr)	Thyroid (mrem/yr)	Kidney (mrem/yr)	Lung (mrem/yr)	GI-LLI (mrem/yr)
Irrigated Vegetation								
Adult	0.00E+00	2.55E-02	1.32E-01	1.26E-01	1.17E-01	1.19E-01	1.14E-01	1.31E-01
Teen	0.00E+00	4.16E-02	1.70E-01	1.51E-01	1.45E-01	1.48E-01	1.41E-01	1.59E-01
Child	0.00E+00	9.96E-02	2.72E-01	2.32E-01	2.32E-01	2.34E-01	2.23E-01	2.32E-01
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Irrigated Milk								
Adult	0.00E+00	1.77E-02	8.61E-02	8.00E-02	7.73E-02	7.43E-02	6.86E-02	7.14E-02
Teen	0.00E+00	3.13E-02	1.20E-01	1.01E-01	1.03E-01	9.96E-02	9.06E-02	9.24E-02
Child	0.00E+00	7.53E-02	1.93E-01	1.53E-01	1.71E-01	1.58E-01	1.43E-01	1.42E-01
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Irrigated Meat								
Adult	0.00E+00	4.96E-03	2.77E-02	2.61E-02	2.41E-02	2.61E-02	2.44E-02	5.47E-02
Teen	0.00E+00	4.03E-03	1.73E-02	1.56E-02	1.44E-02	1.61E-02	1.48E-02	3.28E-02
Child	0.00E+00	7.50E-03	2.12E-02	1.89E-02	1.76E-02	1.96E-02	1.79E-02	2.81E-02
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total								
Adult	1.13E-03	2.74E+00	1.02E+00	8.17E-01	4.15E-01	5.49E-01	4.18E-01	9.65E-01
Teen	6.29E-03	3.00E+00	1.06E+00	6.86E-01	4.12E-01	5.52E-01	4.22E-01	8.19E-01
Child	1.31E-03	3.96E+00	1.28E+00	8.46E-01	7.00E-01	7.74E-01	6.46E-01	7.88E-01
Infant	0.00E+00	3.22E-02	2.31E-01	2.14E-01	2.93E-01	2.16E-01	2.12E-01	2.15E-01

Key: GI-LLI = gastrointestinal tract - lower large intestine; mrem/yr = millirem per year

Table 5.9-9
Collective Population Dose from Liquid Pathways

Pathway	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI	Skin
	person-rem/yr							
Fish Ingestion	1.31E+03	3.27E+02	2.00E+02	5.16E+00	9.36E+01	2.95E+01	2.19E+02	0.00E+00
Water Consumption	1.95E-01	2.16E+00	2.10E+00	2.35E+00	2.07E+00	2.04E+00	2.16E+00	0.00E+00
Shoreline	0.00E+00	0.00E+00	3.13E+00	3.13E+00	0.00E+00	0.00E+00	0.00E+00	3.67E+00
Swimming	0.00E+00	0.00E+00	6.19E-02	6.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boating	0.00E+00	0.00E+00	3.09E-02	3.09E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vegetation	1.38E+00	5.72E+00	5.24E+00	4.77E+00	5.07E+00	4.87E+00	5.27E+00	0.00E+00
Milk	1.09E+00	3.87E+00	3.34E+00	3.33E+00	3.25E+00	2.98E+00	3.03E+00	0.00E+00
Meat	1.74E-01	8.29E-01	7.72E-01	7.14E-01	7.77E-01	7.23E-01	1.55E+00	0.00E+00
Total	**1.31E+03**	**3.40E+02**	**2.15E+02**	**1.95E+01**	**1.05E+02**	**4.01E+01**	**2.31E+02**	**3.67E+00**

Key: rem/yr = roentgen equivalent man per year

Table 5.9-10
Gaseous Effluent Site Boundary and Off-Site Receptor Dose
(Sheet 1 of 2)

Pathway	Total Body (mrem/yr)	GI Tract (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Kidney (mrem/yr)	Thyroid (mrem/yr)	Lung (mrem/yr)	Skin (mrem/yr)
Unrestricted Area Boundary Location with Maximum Doses (Six Reactors)								
Plume	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.15E+01	1.16E+01	2.34E+01
Ground Shine	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.38E-01	3.98E-01
Inhalation Dose[(a)]								
Teen	6.46E-01	3.60E-01	6.61E+00	4.80E+00	2.00E+00	8.66E+00	1.34E+00	3.25E-01
Vegetable Dose for Biota								
Child	6.12E+01	6.11E+01	3.03E+02	6.13E+01	6.13E+01	9.45E+01	6.10E+01	6.10E+01
Nearest Residence Dose Used for MEI								
Plume	2.49E+00	2.49E+00	2.49E+00	2.49E+00	2.49E+00	2.49E+00	2.51E+00	5.06E+00
Ground Shine	6.33E-02	6.33E-02	6.33E-02	6.33E-02	6.33E-02	6.33E-02	6.33E-02	7.45E-02
Plume Plus Ground Shine (Six Reactors)				**Plume Plus Ground Shine (Per Reactor)**				
Total Body External		2.55E+00	mrem/yr	Total Body External			4.26E-01	mrem/yr
Total Skin External		5.14E+00	mrem/yr	Total Skin External			8.57E-01	mrem/yr
Inhalation Dose[(b)]								
Adult	1.29E-01	7.36E-02	1.29E+00	9.33E-01	3.90E-01	1.39E+00	1.91E-01	6.76E-02
Teen	1.34E-01	7.55E-02	1.35E+00	9.86E-01	4.12E-01	1.80E+00	2.77E-01	6.83E-02
Child	1.13E-01	6.58E-02	1.05E+00	7.12E-01	2.93E-01	2.18E+00	2.47E-01	6.03E-02
Infant	5.76E-02	3.78E-02	4.23E-01	3.02E-01	1.32E-01	1.96E+00	1.46E-01	3.47E-02
Nearest Vegetable Garden Dose Used for MEI								
Adult	8.26E-01	8.28E-01	4.06E+00	8.28E-01	8.28E-01	1.59E+00	8.25E-01	8.25E-01
Teen	1.34E+00	1.34E+00	6.61E+00	1.34E+00	1.35E+00	2.29E+00	1.34E+00	1.34E+00
Child	3.22E+00	3.21E+00	1.59E+01	3.22E+00	3.22E+00	5.00E+00	3.21E+00	3.21E+00

Table 5.9-10
Gaseous Effluent Site Boundary and Off-Site Receptor Dose
(Sheet 2 of 2)

Total MEI Organ Dose (Nearest Resident Plume, Ground Shine, Inhalation Plus Nearest Vegetable Garden Dose)							
Total	**T. Body**	**GI Tract**	**Bone**	**Liver**	**Kidney**	**Thyroid**	**Lung**
Adult	3.51E+00	3.46E+00	7.90E+00	4.31E+00	3.77E+00	5.54E+00	3.59E+00
Teen	4.02E+00	3.97E+00	1.05E+01	4.88E+00	4.31E+00	6.65E+00	4.19E+00
Child	5.89E+00	5.83E+00	1.95E+01	6.49E+00	6.07E+00	9.73E+00	6.03E+00
Infant	2.61E+00	2.59E+00	2.98E+00	2.86E+00	2.68E+00	4.52E+00	2.72E+00

Notes:

(a) The location of the inhalation doses is at the unrestricted area boundary maximally exposed location.

(b) The location of the inhalation doses is at the nearest residence.

Key: MEI = Maximally Exposed Individual; mrem/yr = millirem per year

Table 5.9-11
Collective Population Dose from Gaseous Pathways

Pathway	Total Body	GI Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
	person-rem/yr							
Plume	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.24E+00	4.05E+00
Ground	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.71E-01
Inhalation	4.67E-01	2.96E-01	3.93E+00	2.88E+00	1.23E+00	4.75E+00	7.33E-01	2.81E-01
Vegetables	1.95E+01	1.95E+01	9.64E+01	1.95E+01	1.95E+01	1.98E+01	1.95E+01	1.95E+01
Milk	8.60E+00	8.60E+00	4.26E+01	8.61E+00	8.63E+00	1.58E+01	8.60E+00	8.60E+00
Meat	9.68E+00	9.71E+00	4.80E+01	9.69E+00	9.69E+00	1.01E+01	9.68E+00	9.68E+00
Total	3.95E+01	3.94E+01	1.92E+02	4.20E+01	4.05E+01	5.17E+01	3.98E+01	4.24E+01

Key: rem/yr = roentgen equivalent man per year

Table 5.9-12
Comparison of Belews Creek, NC Site Annual Dose Estimates to 10 CFR Part 50 Dose Limits

Type of Dose	Annual Dose per Reactor	
	Dose	Limit
Gaseous Effluent Pathway		
Gamma Air (mrad/yr)	8.54E+00	10
Beta Air (mrad/yr)	6.16E+00	20
Total Body (mrem/yr)	1.12E+00	5
Skin (mrem/yr)	2.26E+00	15
Maximum Organ (Bone) (mrem/yr)	7.74E+00	15
Liquid Effluent Pathway – Dan River		
Total Body (mrem/yr)	1.41E-01	3
Maximum Organ (Bone) (mrem/yr)	6.59E-01	10

Key: mrad/yr = millirads per year; mrem/year = millirems per year

Table 5.9-13
Comparison of Belews Creek, NC Site Annual Dose Estimates to 40 CFR Part 190 Dose Limits

Type of Dose	Site Dose (mrem/yr)			
	Gaseous Dose	Liquid Dose	Total Dose	Limit
Total Body	5.89E+00	8.46E-01	6.73E+00	25
Thyroid	9.73E+00	7.00E-01	1.04E+01	75
Other Organ (Bone)	1.95E+01	3.96E+00	2.35E+01	25

Key: CFR = Code of Federal Regulations; mrem/year = millirems per year

Table 5.9-14
Belews Creek, NC Site Calculated to Natural Background Dose Comparison

	Annual Individual Dose (mrem/yr)	Annual Population Dose (person-rem/yr)
Estimated Total Background Radiation Dose[(a)]	310	9.48E+05
Calculated Population Dose (Total Body)	–	2.54E+02
Calculated Population Dose (Max Organ)	–	1.51E+03

Note:

(a) The estimated total background radiation dose is determined by multiplying the annual estimated individual background dose of 310 mrem/yr by the approximate 2079 total population within a 50-mile radius of the Belews Creek, NC site.

Key: mrem/year = millirems per year; rem/yr = roentgen equivalent man per year

Table 5.9-15
Maximum Liquid Biota Doses

Biota	Internal (mrad/yr)	External (mrad/yr)	Total (mrad/yr)
Fish	1.07E+01	3.52E+00	1.42E+01
Invertebrate	1.74E+01	7.02E+00	2.44E+01
Algae	5.15E+01	1.39E-02	5.16E+01
Muskrat	7.08E+01	2.34E+00	7.31E+01
Raccoon	4.41E+00	1.75E+00	6.16E+00
Heron	4.61E+01	2.34E+00	4.85E+01
Duck	6.89E+01	3.51E+00	7.24E+01

Key: mrad/yr = millirads per year

Table 5.9-16
Maximum Gaseous Biota Doses

Pathway	Human Dose	Multiplier for Biota	Biota Dose
External Total Body (mrem/yr)			
Plume	1.15E+01	1	1.15E+01
Ground Shine	3.39E-01	2	6.78E-01
		Total External (mrem/yr)	**1.22E+01**
Internal Total Body (mrem/yr)			
Inhalation	6.46E-01	1	6.46E-01
Vegetable Ingestion	6.12E+01	1	6.12E+01
		Total (External + Internal) (mrem/yr)	**7.40E+01**

Key: mrem/year = millirems per year

Table 5.9-17
Total Belews Creek, NC Site Annual Biota Dose Estimates

Biota	Gaseous (mrad/yr)	Liquid (mrad/yr)	Direct Radiation (mrad/yr)	Total (mrad/yr)	Total (mrad/day)
Algae	0.00E+00	5.16E+01	0.00E+00	5.16E+01	1.41E-01
Invertebrate	0.00E+00	2.44E+01	0.00E+00	2.44E+01	6.68E-02
Fish	0.00E+00	1.42E+01	0.00E+00	1.42E+01	3.89E-02
Muskrat	7.40E+01	7.31E+01	1.00E+00	1.48E+02	4.06E-01
Raccoon	7.40E+01	6.16E+00	1.00E+00	8.12E+01	2.22E-01
Heron	7.40E+01	4.85E+01	1.00E+00	1.23E+02	3.38E-01
Duck	7.40E+01	7.24E+01	1.00E+00	1.47E+02	4.04E-01

Key: mrad/yr = millirads per year

Table 5.9-18
Duration of Preoperational Monitoring Program for Specific Media

Six Months	One Year	Two Years
• Airborne iodine • Iodine in milk* (while animals are in pasture)	• Airborne particulates • Milk[(a)] (remaining analyses) • Surface water • Groundwater • Drinking water	• Direct radiation • Fish and invertebrates • Food products • Sediment from shoreline

Note:

(a) No milk cows or goat cows are located within 5 mi. of the Belews Creek, NC site. Therefore, no monitoring for radionuclide activity will be performed.

Table 5.9-19
Preliminary Radiological Environmental Monitoring Program Sample Station Locations
(Sheet 1 of 4)

Location	Description	Approx. Distance	Direction Sector
T-1	TLDs	Site boundary	N
T-2			NNW
T-3			NW
T-4			WNW
T-5			W
T-6			WSW
T-7			SW
T-8			SSW
T-9			S
T-10			SSE
T-11			SE
T-12			ESE
T-13			E
T-14			ENE
T-15			NE
T-16			NNE
T-17		4.0 to 5.0 mi. from center of Belews Creek, NC site	N
T-18			NNW
T-19			NW
T-20			WNW
T-21			W
T-22			WSW
T-23			SW
T-24			SSW

Table 5.9-19
Preliminary Radiological Environmental Monitoring Program Sample Station Locations
(Sheet 2 of 4)

Location	Description	Approx. Distance	Direction Sector
T-25		4.0 to 5.0 mi. from center of Belews Creek, NC site	S
T-26			SSE
T-27			SE
T-28			ESE
T-29			E
T-30			ENE
T-31			NE
T-32			NNE
T-33		TBD	TBD
T-34		TBD	TBD
T-35		TBD	TBD
T-36		TBD	TBD
T-37		TBD	TBD
T-38		TBD	TBD
T-39		TBD	TBD
T-40		TBD	TBD
Airborne			
A-1	Airborne: Radioiodine and Particulates	Three samples close to three site boundary locations, in different sectors of the highest calculated annual average ground level D/Q	N
A-2			NNE
A-3			NE
A-4		One sample from the vicinity of a community having the highest calculated annual average ground level D/Q	TBD
A-5		One sample from a control location, as for example 15 to 30 km from the site boundary, and in the least prevalent wind direction	TBD

Table 5.9-19
Preliminary Radiological Environmental Monitoring Program Sample Station Locations
(Sheet 3 of 4)

Location	Description	Approx. Distance	Direction Sector
Waterborne			
W-1	Surface Water	One sample upstream and one sample downstream from the Dan River	N
W-2			NW
W-3	Ground Water	Sample from one or two sources if likely to be affected	TBD
W-4			TBD
W-5	Drinking Water	One sample from up to three of the nearest water supplies that could be affected by its discharge	TBD
W-6			TBD
W-7			TBD
W-8		One sample from a control location	TBD
W-9	Sediment from Shoreline	One sample from a downstream area with existing or potential recreational value; Dan River	TBD
Ingestion			
FI-1	Fish and Invertebrates	One sample of representative commercially and recreationally important species in vicinity of discharge point	TBD
FI-2		One sample of same species in areas not influenced by plant discharge	TBD
FP-1	Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged	TBD
FP-2		Three samples of broadleaf vegetation grown nearest an off-site location of the highest calculated annual average ground-level D/Q-	TBD
FP-3			TBD
FP-4			TBD
FP-5		One sample of each of the similar vegetation grown 15-30 km distant in the least prevalent wind direction	TBD

Table 5.9-19
Preliminary Radiological Environmental Monitoring Program Sample Station Locations
(Sheet 4 of 4)

Note: Proposed locations are contained in the table. Locations identified as “TBD” will be provided in the construction permit or license application.

Key: E = east; ENE = east-northeast; ESE = east-southeast; mi. = mile; N = north; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; TBD = to be determined; W = west; WNW = west-northwest; WSW = west-southwest

Table 5.9-20
Radiological Environmental Monitoring Program Sampling Frequency
(Sheet 1 of 2)

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations	Sample and Collection Frequency	Type and Frequency of Analysis
Airborne			
Direct Radiation	40 Monitoring Locations	Continuous monitoring with sample collection quarterly	Gamma exposure rate quarterly
Airborne Radioiodine and Particulates	Five Locations	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent	Radioiodine Canister – Analyze weekly for I-131 Particulate Sampler – Gross beta radioactivity following filter change, composite (by location) for gamma isotropic quarterly
Waterborne Radiation			
Surface	Two Locations	Composite sample over 1-month period	Gamma isotopic analysis monthly Composite for tritium analyses quarterly
Ground	One or Two Locations If Likely to be Affected	Quarterly	Gamma isotopic and tritium analysis quarterly
Drinking	Two or Four Locations If Likely to be Affected	Composite sample over 2-week period if I-131 analysis is performed, monthly composite otherwise	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem/yr Composite for gross beta and gamma isotopic analyses monthly Composite for tritium analyses quarterly

Table 5.9-20
Radiological Environmental Monitoring Program Sampling Frequency
(Sheet 2 of 2)

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations	Sample and Collection Frequency	Type and Frequency of Analysis
Sediment from Shoreline	One Location	Semiannually	Gamma isotopic analyses semiannually
Radiation by Ingestion			
Fish and Invertebrates	Two Locations	Sample in season, or semiannually if they are not seasonal	Gamma isotopic analysis on edible portions
Food Products	Five Locations	At time of harvest Monthly during growing season	Gamma isotopic analysis on edible portion. I-131 analysis on green leafy vegetables

5.10 NONRADIOACTIVE WASTE MANAGEMENT

This section describes the impacts on the environment that could result from the generation, handling, and disposal of nonradioactive waste and mixed waste during operations at the Project site. As stated in Section 3.4.3, types of nonradioactive waste that are generated, handled, and disposed of during operational activities include cooling water that may contain water treatment chemicals or biocides, waste from floor and equipment drains, water treatment residuals, sanitary effluents, stormwater runoff, gaseous effluents, used oils, universal waste, and hazardous waste. Regulations for generating, managing, handling, storing, treating, and disposing of these wastes are contained within certain provisions of 10 CFR (NRC regulations), 40 CFR (USEPA regulations), NC Administrative Code, and NC General Statutes.

5.10.1 IMPACTS TO LAND

Operating the Project site will generate solid and hazardous waste not contaminated with radionuclides, as well as potential mixed waste, all of which could impact land.

5.10.1.1 Solid Waste Management and Disposal

As stated in Section 3.4.3.3.1, Duke Energy Environmental Programs uses administrative policies and procedures to ensure all employees and contractors properly manage waste.

The waste is segregated based on waste type and its potential hazards and is stored in appropriate containers. Waste segregation occurs at the point of generation and is labeled accordingly to facilitate proper disposal. An approved waste vendor list is also used to ensure waste is recycled or disposed of through an approved facility.

Solid waste generated on-site includes trash, paper, wood, sewage residuals, water treatment wastes, and laboratory wastes. Solid waste, defined as nonhazardous waste by 40 CFR Part 261 are collected and disposed of in a local landfill. Winston-Salem/Forsyth County Utilities operates a state-permitted, active municipal solid waste landfill on Hanes Mill Road, which has approximately 27 years remaining in permitted volume. Other regional landfills may also be considered to support the waste disposal needs during the operations period. Section 3.4.3.2 states that sanitary wastes are discharged to internal Outfall 009 which ultimately discharges into the Dan River. Under the proposed Project, sanitary NPDES effluent limits for internal Outfall 009 will remain in effect as specified in the existing permit. The Project site will continue to operate in compliance with the existing permit.

As stated in Section 3.4.3, Duke Energy's existing waste management programs, which comply with federal, state, and local regulations, are followed to manage wastes generated during operation. Therefore, impacts to land from nonradioactive waste generated, handled, stored, and disposed of during operations are SMALL.

5.10.1.2 Hazardous Waste Management and Disposal

The USEPA defines hazardous waste in the Resource Conservation and Recovery Act (RCRA), specifically in 40 CFR Part 261. The Project site complies with RCRA requirements as a Small Quantity Generator (SQG) of hazardous waste, as detailed in Section 3.4.3.3.2. Common hazardous waste generated at the Project site includes waste paints, lab packs, and solvents. These wastes are typically stored in designated on-site areas before being shipped off-site for treatment and disposal. Hazardous waste, according to the USEPA, may be listed as known

hazardous waste or exhibit one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity.

The quantities of hazardous waste generated at individual plants vary but are typically small compared to those produced at most other industrial facilities. Numerous RCRA-authorized treatment and disposal facilities exist across the United States and are able to handle the hazardous waste generated from operations.

Operations at the Project site are expected to generate waste in quantities similar to those outlined in the Environmental Impact Statement for an ESP at the Clinch River Nuclear site (NUREG-2226), classifying the site as a SQG of hazardous waste. SQGs generate more than 100 kg (220 lb.), but less than 1000 kg (2205 lb.) of hazardous waste per month. Major requirements for SQGs include:

- SQGs may accumulate hazardous waste on-site for 180 days without a permit (or 270 days if shipping a distance greater than 200 mi. [322 km]).
- The quantity of hazardous waste on-site must never exceed 6000 kg (13,227 lb.).
- SQGs must comply with the hazardous waste manifest requirements of 40 CFR Part 262, subpart B and the pre-transport requirements at 40 CFR 262.30 through 262.33.
- SQGs must manage hazardous waste in tanks or containers subject to the requirements of 40 CFR 262.16(b)(2) and (3).
- SQGs must comply with the preparedness and prevention requirements of 40 CFR 262.16(b)(8) and (9), and the land disposal requirements at 40 CFR Part 268.
- There must always be at least one employee available to respond to an emergency. This employee is the emergency coordinator responsible for coordinating all emergency response measures. SQGs are not required to have detailed, written contingency plans (USEPA, 2025).

As noted in Section 3.4.3.3.2, the existing BCSS holds this classification, and hazardous waste generated from ongoing operations are disposed of through licensed vendors.

All activities related to the management of hazardous wastes—storage, treatment, transport, and disposal—are conducted pursuant to federal, state, and local regulations as described in Section 3.4.3. Therefore, impacts to land from nonradioactive waste generated, handled, stored, and disposed of during operations are SMALL.

5.10.1.3 Mixed Waste Management and Disposal

Mixed waste contains both radioactive and hazardous wastes and is generally accumulated in designated areas on-site and then shipped off-site for treatment and disposal. This waste is regulated by both the USEPA and by the NRC under the Atomic Energy Act.

The management of mixed waste must adhere to NRC requirements for general radiation protection in 10 CFR Part 20, emission control requirements for low-level mixed waste in 10 CFR Part 61, and relevant provisions of the RCRA for managing hazardous waste in 40 CFR Parts 260 through 268.

5.10.1.3.1 Generating Mixed Waste

The NRC identified several common mixed wastes generated at nuclear power plants in NUREG-1437, Rev. 1, *Final Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. These include organics (e.g., liquid scintillation fluids, waste oils, halogenated organics), metals (e.g., lead, mercury, chromium, and cadmium), solvents, paints, and cutting fluids. NUREG-1437, while specific to license renewals, determined the impacts from mixed waste to be SMALL.

Although the quantities generated during operations are generally small, the dual regulation complicates the management and disposal of mixed wastes compared to other types. While there is potential to generate mixed waste at the Project site, Duke Energy uses site-specific Nuclear Operating Fleet Administrative Procedures to minimize this potential. Additionally, advanced technologies under consideration are designed to segregate waste and reduce mixed waste streams.

5.10.1.3.2 Mixed Waste Storage and Disposal

Duke Energy operates 11 nuclear units at six sites in NC and South Carolina (Duke Energy, 2025). These sites use nuclear-specific operating procedures to ensure safe and compliant handling of mixed waste. These procedures are designed to minimize the generation of mixed waste and ensure that any mixed waste generated is properly stored, managed, and disposed of in accordance with NRC, USEPA, and state-specific regulations.

5.10.1.3.3 Impacts of Mixed Waste

Based on Duke Energy's established practices, plans to manage mixed waste consistent with the current operating nuclear fleet, and consistent with the NRC findings described in NUREG-2226, the environmental impacts from mixed waste generated at the Project site are expected to be SMALL.

5.10.1.4 Summary of Impacts to Land

Duke Energy maintains administrative policies and procedures to ensure waste streams are properly managed and disposed of in accordance with federal and state guidelines. The Project site produces SQG quantities of hazardous waste as described in Section 3.4.3.3.2. Although the reactor technology has not been selected, Duke Energy manages all solid, hazardous, and mixed waste generated from the site in accordance with federal and state regulations. Therefore, impacts to land from waste management and disposal are SMALL.

5.10.2 IMPACTS TO WATER

Nonradioactive liquid waste from plant operation includes sanitary wastewater, cooling tower blowdown, stormwater discharges, and other conventional liquid discharge streams (i.e., turbine building sumps, groundwater sumps, water treatment discharges).

5.10.2.1 Sanitary Wastes

Management of sanitary waste during operation is described in Section 3.4. Wastewater discharges to support the Plant Complexes are routed to the BCSS sanitary wastewater treatment system and are managed using appropriate engineering controls in compliance with the NPDES permit number NC0024406 associated with BCSS operations for combined industrial and domestic wastewater discharges. The NPDES permit establishes discharge limitations for quantity and quality parameters to protect surface waters. Maximum effluent flow rates from the sanitary system are described in Section 3.4.3.2. Sanitary wastewater is treated on-site and discharged to the Dan River via Outfall 006. Because sanitary wastes are discharged in accordance with an NPDES permit, the impacts of these wastes are SMALL.

5.10.2.2 Stormwater

Stormwater is managed in accordance with a site-specific NPDES permit, as described in Section 3.4.3.3.3.2. The NPDES permit provides for implementation of BMPs to control and mitigate stormwater quantity and impacts to surface water quality. The stormwater system is designed to comply with relevant federal, state, and local stormwater regulations. Because the stormwater system on the Project site is managed under a NPDES permit and impacts are minimized through BMPs, impacts of stormwater are SMALL.

5.10.2.3 Liquid Effluents

Discharges associated with liquid effluents are described in Section 3.4.3.3.3. Cooling tower blowdown is routed to Belews Lake or the Dan River based on operational needs. Discharges to Belews Lake are released through either a combined discharge structure or a separate discharge structure for each Plant Complex. Nonradiological discharges are released to the Dan River at the existing Outfall 006 location. NPDES Permit NC0024406 is associated with current BCSS operations. The normal and maximum cooling tower blowdown to Belews Lake are described in Section 3.4. A portion of the cooling tower blowdown is diverted as dilution flow to be combined with the other liquid wastewater including liquid radiological wastes. As stated in Section 3.4, the NPDES permit authorizes an average discharge of 9 mgd (34,069 m^3/day) to the Dan River and includes pollutant discharge limits and routine monitoring.

As described in Section 3.4.3.1, the Project site uses biocides and other chemicals to treat cooling and process waters to avoid scaling or fouling. Operational effluents are processed to minimize the release of these treatments but may still contain some low-level chemicals or biocides. Chemical concentrations are managed to adhere to NPDES permit requirements. Specific chemicals and biocides to be used depend upon the characteristics of the water to be treated and the design requirements of the selected reactor technology. The projected constituents and their concentrations in the Belews Creek nonradioactive liquid waste discharges are provided in Table 3.4-3 in Section 3.4. Because the concentration of all potential chemical releases is managed under the NPDES permit, impacts are SMALL.

Other nonradiological liquid waste discharges (i.e., turbine building sumps, groundwater sumps, and water treatment discharges) are routed to the consolidated sump, treated, and discharged to the Dan River Outfall 006, as described in Section 3.4. As stated in Section 3.4, NPDES Permit No. NC0024406 is associated with current BCSS operations and authorizes discharges to the Dan River and includes pollutant discharge limits and requirements for routine monitoring. These waste discharges are managed under the existing NPDES permit, and therefore impacts are SMALL.

5.10.2.4 Summary of Impacts to Water

Operational discharges to water, including sanitary wastes, stormwater, and liquid effluents, are managed in accordance with federal, state, and local laws and regulations. The impacts of sanitary wastes and liquid effluents are managed through engineering controls in accordance with a NPDES permit. All stormwater discharges are managed through a separate NPDES stormwater permit and controlled and minimized using BMPs. Therefore, environmental impacts to water from nonradioactive waste discharges are SMALL.

5.10.3 IMPACTS TO AIR

This Section evaluates the impacts to air quality from nonradioactive waste streams associated with operating activities at the Project site.

5.10.3.1 Air Emissions

The Project site is located in an attainment area, as discussed in Section 5.7.2. Operating the site will increase gaseous emissions to the air from equipment associated with plant auxiliary systems such as diesel generators and auxiliary boilers. This equipment will operate infrequently during startup, shutdown, or testing, and the related emissions will be intermittent. Cooling towers will frequently run, except during scheduled or maintenance outages, and will result in PM emissions. Emissions from the cooling towers are discussed in Section 5.7.1. Results from cooling tower impact modeling in Section 5.7.1 show no predicted fogging, no predicted plume rime icing, low predicted salt deposition rates, limited visual impacts, and insignificant plume water deposition rates; therefore, the predicted impacts from operational activities at the Project site are SMALL. Additionally, emissions from the diesel generators and auxiliary boilers are discussed in Section 5.7.2.

As discussed in Section 3.4.3.3.2, the Project site operates as a SQG and manages and disposes of hazardous waste in accordance with the RCRA to minimize the potential for air emissions from this waste. Additionally, nonradioactive gaseous effluents generated at the Project site are described in Section 3.4.3.3.4.

5.10.3.1.1 Summary of Impacts to Air

Air emission sources associated with operating the Project site are managed in accordance with federal, state, and local air quality control regulations. Based on the estimated amount of potential air emissions, the intermittent nature of the potential emissions, and the requirement to adhere to prevention of significant deterioration requirements, impacts to air quality are anticipated to be SMALL.

5.11 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

5.11.1 DESIGN BASIS ACCIDENTS

5.11.1.1 Accident Selection

As discussed in Section 1.2.1, Duke Energy is considering several nuclear technologies for potential construction and operation on the Project site. A specific technology has not yet been selected. Accordingly, as discussed in Section 3.0, Duke Energy is employing a PPE approach in the ESPA. The advanced reactor technologies considered in development of the PPE for this ESPA include enhanced design and passive safety features expected to improve overall reactor safety compared to current operating reactors. These technologies include:

- GVH BWRX-300 – An advanced BWR design with passive safety features that uses standard LWR fuel and generates 870 megawatts thermal (MWt).
- NuScale VOYGR – An advanced, integral pressurized-water reactor (PWR) design with passive design features that uses standard LWR fuel with a shorter fuel assembly length with up to 12 reactors generating 250 MWt each, with the containment of each reactor submerged in the Reactor Building pool.
- Holtec SMR-300 – An advanced PWR design that includes passive safety features, uses standard LWR fuel, and generates approximately 1000 MWt.
- WEC AP300 – An advanced PWR design that includes passive safety features, uses standard LWR fuel, and generates 990 MWt.
- TerraPower Natrium – An advanced, metal fueled, pool-type sodium fast reactor with passive design features that generates 840 MWt and uses sodium-bonded metallic fuel with high chromium martensitic steel cladding, that operates at near atmospheric pressures and includes a molten salt energy storage system.
- X-energy Xe-100 – An advanced high-temperature gas-cooled (helium) reactor (HTGR) that includes passive safety features. Each reactor generates 200 MWt. The X-energy Xe-100 uses TRi-structural ISOtropic (TRISO) particle fuel. The reactor and steam generator are located inside the containment structure.

As discussed in NRC Regulatory Guide (RG) 4.2, Rev. 3 Section 5.11.1, *Design Basis Accidents*, the evaluation of design basis accidents in the Environmental Report (ER) is intended to provide a realistic assessment of the environmental consequences of postulated design basis accidents. Whereas the Design Basis Accident (DBA) analyses in the Final Safety Analysis Report or in the case an ESPA, the Site Safety Analysis Report (SSAR), are developed to provide adequate assurance that radiological impacts to the public do not exceed regulated dose limits as the measure to demonstrate adequate safety to the public, the conservatisms inherent to these analyses do not provide a realistic assessment of the actual consequences of such accidents. Thus, NRC RG 4.2 states that within the ER, the applicant should evaluate DBAs using site-specific data and realistic meteorology (i.e., 50th percentile atmospheric dispersion factors) to estimate doses at off-site locations. Accordingly, this subsection provides an assessment of the DBA dose consequences for the EAB and the Low Population Zone (LPZ) using 50th percentile atmospheric dispersion factors to provide a more realistic assessment of the dose consequences for the limiting DBA. For the Project site, the EAB and LPZ are

established at the same boundary as shown in SSAR Figure 2.1-5.

As discussed above, Duke Energy is considering several potential technologies for the Project site and is thus employing a PPE approach for this ESPA. As discussed in the SSAR, Chapter 15, in accordance with that approach, Duke Energy has selected a source term expected to yield the highest post-accident doses at the EAB/LPZ as the surrogate for the purpose of evaluating the Project site against the site radiological consequence evaluation factors set forth in 10 CFR 52.17(a)(1)(ix) and 10 CFR 50.34(a)(1)(ii)(D).

The surrogate accident source term selected for analysis is for a postulated instrument line break accident (ILBA) associated with one of the light water reactors identified above (GVH BWRX-300). The accident assumes a non-isolable circumferential break of a primary cooling system instrument line located outside of primary containment, resulting in release of the activity to the environment with no credit for holdup or filtration of the effluent.

Using the surrogate source term, doses have been calculated using 50th percentile atmospheric dispersion factors at the EAB/LPZ for the two-hour period producing the highest dose following initiation of the accident, and for the 30-day period following initiation of the accident. The 50th percentile atmospheric dispersion factors are presented in Section 2.7.3. The accident is modeled assuming an instantaneous release to maximize doses at the EAB/LPZ. The doses calculated using the surrogate source term are expected to be the largest accident doses of the technologies under consideration in this ESPA at the site EAB/LPZ over any two-hour period and the 30-day period following initiation of the accident.

5.11.1.2 Source Term

The surrogate accident source term (integral activity released to the environment as a function of time) used in evaluating the EAB/LPZ doses is provided in Table 5.11-1. As discussed above, the surrogate accident source term is based on a GVH BWRX-300 primary cooling system ILBA and modeled as an instantaneous release. Refer to SSAR Chapter 15, Section 15.2 for further details concerning the development of the DBA source term.

5.11.1.3 Evaluation Methodology and Conclusions

Doses for the surrogate accident at the limiting EAB/LPZ boundary are shown in Table 5.11-2. The two-hour EAB short-term atmospheric dispersion factor is conservatively applied to the LPZ dose determination because the EAB and the LPZ boundary are the same, the release is an instantaneous release, and the zero to two-hour EAB short-term atmospheric dispersion factor is larger than the zero-to-eight-hour LPZ short-term atmospheric dispersion factor, and thus conservative.

Key inputs to determination of the doses in Table 5.11-2 include:

- Use of short-term 50th percentile accident atmospheric dispersion factors (χ/Qs) for the Project site in accordance with the guidance in NRC RG 4.2, Rev. 3. Table 2.7-47 identifies the limiting χ/Q value used in calculating the zero to two-hour and the 30-day accident doses at the EAB/LPZ.

- Use of the surrogate accident source term to calculate doses at the EAB/LPZ.

The Project site short-term dispersion factors were calculated using conservative assumptions:

- Radiological releases are assumed to occur at ground level instantaneously with no credit for dilution or holdup.

- No building wake effects were credited.

- Effluent release points are assumed to occur at the perimeter of each of the technology composite footprints depicted as power block areas in Figure 2.1-5. This adds additional conservatism as the actual releases in most cases occur at the perimeter of the reactor building, located well inside of the perimeter of each vendor's technology plot footprint.

- It is assumed that the LPZ dose is equal to the 0-2 hour EAB dose for the instantaneous release since the EAB and the LPZ are the same boundary. This is conservative as the 0-8 hour LPZ χ/Q is smaller than the 0-2 hour EAB χ/Q factor, which would result in a smaller dose at the LPZ. Since an instantaneous release is assumed, it is acceptable to utilize the 0-2 hour EAB χ/Q as the 0-8 hour LPZ χ/Q.

The resulting accident doses are expressed as TEDE, consistent with 10 CFR 50.34(a)(1)(ii)(D). As shown in Table 5.11-2, the accident doses of the selected technologies are significantly below the 25 roentgen equivalent man (rem) (0.25 sieverts [Sv]) TEDE limits specified in 10 CFR 50.34(a)(1)(ii)(D) at the EAB/LPZ for the Project site. Therefore, impacts to the public from radiation exposure due to postulated accidents are expected to be SMALL.

5.11.2 SEVERE ACCIDENTS

This section evaluates the potential environmental impacts of severe accidents at the Project site. The environmental impacts from postulated severe accidents are calculated using site-specific data to demonstrate acceptability.

Duke Energy requested that each of the potential advanced reactor vendors provide information from the probabilistic risk assessment (PRA) for its design to allow the assessment of potential severe accident consequences. However, final PRA information was not available for any vendors at the time of preparation of this ESPA. While information regarding severe accident release categories, source terms, and release frequencies was provided to Duke Energy from some vendors, information was not received from all vendors. Therefore, Duke Energy assessed the potential severe accident consequences of two vendors that provided sufficient information and presented the vendor with the most conservative results for the majority of the evaluated consequence metrics.

This section uses PRA information for severe accidents, along with site-specific characteristics, to estimate the impacts of severe accidents. The results identify the environmental impacts from potential severe accidents.

5.11.2.1 Methodology

The MELCOR Accident Consequences Code System (MACCS) computer code (Version 4.2, with the WinMACCS graphical user interface) is developed to model the environmental consequences of the severe accidents. MACCS is developed specifically for the NRC to evaluate severe accidents at nuclear power plants (SNL, 2021). The MACCS analysis uses three accident source terms (shown in Table 5.11-3). The accidents include a steam generator tube rupture accident, a depressurization accident, and a seismic accident. The associated

accident frequencies are shown in Table 5.11-4.

5.11.2.2 MACCS Code

The MACCS computer code is used to evaluate the environmental consequences of the severe accidents. The radiation exposure pathways modeled include external exposure from the passing plume, external exposure from material deposited on the ground, inhalation of material in the passing plume or re-suspended from the ground, and ingestion of contaminated food and surface water. The MACCS code primarily addresses radiation dose from the air pathway, but also calculates dose from surface runoff and deposition on surface water. The code also evaluates the extent of contamination. The analysis uses site-specific meteorology and population data and also includes the ingestion pathway over the entire life cycle of the accident.

To assess human health impacts, the assessment includes the collective dose, risk of early fatalities, and the risk of latent cancer fatalities from a severe accident for the population within a 50-mile (mi.) (80-kilometer (km)) radius. Economic costs are also determined, including the costs associated with short-term relocation of people, decontamination of property and equipment, and interdiction of food supplies.

Five files provide input to a MACCS analysis: ATMOS, EARLY, CHRONC, a meteorological file, and a site characteristics file. ATMOS provides data to calculate the amount of material released to the atmosphere that is dispersed and deposited. The calculation uses a Gaussian plume model. Important reactor specific inputs in this file include the released activity and duration of the accidents. EARLY provides inputs to calculations regarding exposure in the time period immediately following the release. CHRONC provides data for calculating long-term impacts and economic costs and includes region-specific data on agriculture and economic factors. These files access and use input from a meteorological file and a site characteristics file. The meteorological file provides meteorological monitoring data (hourly data that includes wind speed and direction, stability class, and rainfall) representative of the site for one year. The Project site had an on-site meteorological tower installed in early 2024. The tower was installed at the approximate grade elevation of the finished reactors. Meteorological data from the tower during February 6, 2024 – February 6, 2025, is used to create the MACCS meteorological data input file. The site characteristics file generated by SecPop 4.3.0 provides site-specific population data, land usage, watershed index, and economic data for the region. For this analysis, the transient population projected to 2079 in addition to the resident population projected to 2079 is used.

The MACCS calculation results and the release frequency are used to determine risk. Risk is the product of the release frequency of an accident multiplied by the consequences of the accident. The consequence can be radiation dose, fatalities, economic cost, or farmland that needs to be decontaminated. Dose risk is the product of the collective dose times the accident frequency. The same process is applied to estimating the risk of fatalities (fatalities per reactor per year), the economic cost-risk (dollars per reactor per year), and the risk of farmland requiring decontamination (hectares per reactor per year).

5.11.2.3 Consequences to Population Groups

This Section evaluates impacts of severe accidents from air, surface water, and groundwater pathways. The MACCS code is used to evaluate the doses from the air pathway and from water ingestion with site-specific data. MACCS does not model other surface water and groundwater

dose pathways. These are analyzed qualitatively based on a comparison of doses from the atmospheric (air) pathway for the Project site to those of the existing fleet of United States nuclear reactors.

5.11.2.3.1 Air Pathways

The three accidents are analyzed in MACCS to estimate population dose, number of early and latent fatalities, cost, and farmland requiring decontamination. The analysis assumed that no emergency evacuation of the 50-mi. (80-km) population occurred after the start of the accident. The total dose risk to the 50-mi. (80-km) population, risk of fatalities, economic cost, and farmland decontamination is provided in Table 5.11-7.

5.11.2.3.2 Surface Water Pathways

People are exposed to radiation when airborne radioactivity is deposited onto the ground and washed into surface water or directly deposited into the surface water. The exposure pathway can be from drinking the water, submersion in the water, activities taking place near the shoreline, or ingestion of fish. For the surface water pathway, MACCS only calculates the dose from ingestion of water. The water ingestion dose risk to the 50-mi. (80-km) population is provided in Table 5.11-7.

Surface waters located near the Project site are discussed in Section 2.2.2.1 and include streams, rivers, and reservoirs that were constructed for flood control, water supply, and power generation. In NUREG-1437, Rev. 0, the NRC evaluates doses from the aquatic food pathway (fishing) for the current nuclear fleet of reactors. For sites discharging to small rivers, the NRC evaluation estimates the uninterdicted population exposure including the aquatic food pathway dose risk as 0.4 person-rem (4E-03 person-Sv) per reactor year. For sites near large water bodies, values range from 270 person-rem (2.7 person-Sv) per reactor year (Hope Creek on Delaware Bay) to 5500 person-rem (55 person-Sv) per reactor year (Calvert Cliffs on Chesapeake Bay). The NRC evaluation concludes that with interdiction, the risk associated with the aquatic food pathway is found to be small relative to the atmospheric pathway for most sites. Therefore, the dose risk from other surface water pathways is expected to be less than the Project site atmospheric pathway dose risk.

5.11.2.3.3 Groundwater Pathways

People can also receive a dose from groundwater pathways. Radioactivity released during a severe accident can enter groundwater or can move through an aquifer that eventually discharges to surface water.

NUREG-1437 Rev. 0 also evaluates the groundwater pathway dose, based on the analysis in NUREG-0440, the Liquid Pathway Generic Study (LPGS) (NRC, 1978). NUREG-0440 analyzes a core meltdown that contaminated groundwater that subsequently contaminated surface water. However, NUREG-0440 does not analyze direct drinking of groundwater because of the limited number of potable groundwater wells and limited accessibility. The LPGS results provide conservative, uninterdicted population dose estimates for six generic plant-site categories: small rivers, large rivers, the Great Lakes, oceans, estuaries, and “dry” sites (located a considerable distance from surface water or where groundwater flow is away from surface water). These dose estimates are one or more orders of magnitude less than those attributed to the atmospheric pathway. Because the LPGS values are much less than the atmospheric pathway, it is reasonable to conclude that the atmospheric pathway dominates the groundwater pathway.

Therefore, the dose risk from the Project site groundwater pathway is expected to be less than the dose risk from the Project site atmospheric pathway.

5.11.2.4 Health Risks

The MACCS analysis evaluates the early and latent fatality risks and compares the risks to the NRC Safety Goals. The risk to an average individual in the vicinity of a nuclear power plant of experiencing a prompt fatality resulting from a severe reactor accident should not exceed one-tenth of one percent (0.1%) of the sum of "prompt fatality risks" resulting from other accidents to which members of the U.S. population are generally exposed. As noted in the Safety Goals Policy Statement (FR, 1986), "vicinity" is defined as the area within one mi. (1.61 km) of the plant-site boundary. "Prompt Fatality Risks" are defined as the sum of risks which the average individual residing in the vicinity of the plant is exposed to as a result of normal daily activities (driving, household, chores, occupational activities, etc.). For this evaluation, the sum of prompt fatality risks is taken as the U.S. accidental death risk value of 57.6 deaths per 100,000 people per year (CDC, 2023).

The risk to the population in the area near a nuclear power plant of latent cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1%) of the sum of the cancer fatality risks resulting from all other causes. As noted in the Safety Goal Policy Statement (FR, 1986), "near" is defined as within 10 mi. (16.1 km) of the plant. The cancer fatality risk is taken as an average of 148.0 deaths per 100,000 people per year for 2017 to 2020 (CDC, 2023).

5.11.2.5 Conclusions

The MACCS analysis calculates the estimated number of people within 50 mi. (80-km) of the Project site who receive acute or lifetime doses exceeding a threshold. The estimated number of people exceeding the dose limits of 25 rem (0.25 Sv) and 200 rem (2 Sv) is zero (Table 5.11-5).

As previously described, dose risk is a product of dose and frequency. Normal operation has a frequency of one. For comparison, the total population dose within 50 mi. (80-km) of the Project site from normal operation is provided in Table 5.11-6. The total whole-body effective dose risk to the 50-mile (80-km) population of 7.83E+00 person-rem (7.83E-02 person-Sv) per plant year from severe accidents (calculated by summing the dose risks from all accident scenarios) is lower than the dose risk of 2.54E+02 person-rem (2.54 person-Sv) per plant year for Project site normal operation. The total dose risk to the 50-mile (80-km) population is less than the dose risks from five of the reactors listed in Table 5.11-8 and is less than the maximum, mean, and median dose risks for current generation reactors that have undergone license renewal (Table 5.11-9).

The early and latent cancer fatality risks from a severe accident are provided in Table 5.11-7 and 5.11-8. The prompt cancer fatality risk of zero is below the NRC Safety Goal of 5.76E-07 per plant year and the latent cancer fatality risk of 1.22E-09 per plant year is below the NRC Safety Goal of 1.48E-06 per plant year.

The total calculated dose risk to the 50-mi. (80-km) population is less than the maximum, mean, and median dose risks for current generation reactors, the early and latent cancer fatality risks meet the NRC Safety Goals, and the estimated number of people within 50 mi. (80-km) exceeding the dose limits of 25 rem (0.25 Sv) and 200 rem (2 Sv) is zero. Therefore, the

environmental impacts of severe accidents are expected to be SMALL.

5.11.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

This section is not required for an ESPA.

Table 5.11-1
DBA Accident Source Term (Curies)
(Sheet 1 of 2)

Nuclide	Integrated Activity Released to the Environment as a Function of Time				
	2.0 hr	8.0 hr	24.0 hr	72.0 hr	78.0 hr
I-131	4.60E+00	1.80E+01	5.50E+01	1.60E+02	1.70E+02
I-132	4.60E+01	1.80E+02	5.50E+02	1.60E+03	1.70E+03
I-133	3.40E+01	1.40E+02	4.10E+02	1.20E+03	1.20E+03
I-134	1.30E+02	5.40E+02	1.60E+03	4.80E+03	4.90E+03
I-135	6.70E+01	2.70E+02	8.00E+02	2.40E+03	2.50E+03
Rb-89	1.30E+00	5.40E+00	1.60E+01	4.80E+01	4.90E+01
Cs-134	1.90E-02	7.80E-02	2.30E-01	7.00E-01	7.20E-01
Cs-136	1.50E-02	6.10E-02	1.80E-01	5.50E-01	5.60E-01
Cs-137	3.00E-02	1.20E-01	3.60E-01	1.10E+00	1.10E+00
Cs-138	1.40E+00	5.80E+00	1.70E+01	5.20E+01	5.30E+01
Ba-137m	3.00E-02	1.20E-01	3.60E-01	1.10E+00	1.10E+00
H-3	9.90E-02	3.90E-01	1.20E+00	3.60E+00	3.60E+00
Na-24	2.90E-03	1.20E-02	3.50E-02	1.00E-01	1.10E-01
P-32	1.20E-04	4.70E-04	1.40E-03	4.20E-03	4.30E-03
Cr-51	2.80E-03	1.10E-02	3.40E-02	1.00E-01	1.00E-01
Mn-54	1.40E-03	5.60E-03	1.70E-02	5.10E-02	5.20E-02
Mn-56	5.30E-03	2.10E-02	6.30E-02	1.90E-01	2.00E-01
Fe-55	2.90E-03	1.20E-02	3.50E-02	1.10E-01	1.10E-01
Fe-59	7.70E-04	3.10E-03	9.30E-03	2.80E-02	2.90E-02
Co-58	6.70E-04	2.70E-03	8.00E-03	2.40E-02	2.50E-02
Co-60	1.30E-03	5.20E-03	1.60E-02	4.70E-02	4.80E-02
Ni-63	2.90E-06	1.20E-05	3.50E-05	1.10E-04	1.10E-04
Cu-64	1.40E-02	5.50E-02	1.60E-01	4.90E-01	5.10E-01
Zn-65	6.00E-04	2.40E-03	7.20E-03	2.20E-02	2.20E-02
Sr-89	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Sr-90	1.10E-04	4.40E-04	1.30E-03	3.90E-03	4.00E-03
Y-90	1.10E-04	4.40E-04	1.30E-03	3.90E-03	4.00E-03
Sr-91	1.30E+00	5.20E+00	1.60E+01	4.70E+01	4.80E+01
Sr-92	2.80E+00	1.10E+01	3.40E+01	1.00E+02	1.00E+02
Y-91	2.90E-02	1.10E-01	3.40E-01	1.00E+00	1.10E+00
Y-92	8.80E-01	3.50E+00	1.10E+01	3.20E+01	3.30E+01
Y-93	9.50E-02	3.80E-01	1.10E+00	3.40E+00	3.50E+00

Table 5.11-1
DBA Accident Source Term (Curies)
(Sheet 2 of 2)

Nuclide	Integrated Activity Released to the Environment as a Function of Time				
	2.0 hr	8.0 hr	24.0 hr	72.0 hr	78.0 hr
Zr-95	6.00E-02	2.40E-01	7.20E-01	2.20E+00	2.20E+00
Nb-95	6.00E-02	2.40E-01	7.20E-01	2.20E+00	2.20E+00
Mo-99	2.80E-01	1.10E+00	3.30E+00	1.00E+01	1.00E+01
Tc-99m	2.80E-01	1.10E+00	3.30E+00	1.00E+01	1.00E+01
Ru-103	1.40E-02	5.80E-02	1.70E-01	5.20E-01	5.30E-01
Rh-103m	1.40E-02	5.80E-02	1.70E-01	5.20E-01	5.30E-01
Ru-106	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Rh-106	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Ag-110m	2.90E-06	1.20E-05	3.50E-05	1.10E-04	1.10E-04
Te-129m	2.90E-02	1.10E-01	3.40E-01	1.00E+00	1.10E+00
Te-131m	3.90E-02	1.60E-01	4.70E-01	1.40E+00	1.40E+00
Te-132	6.70E-03	2.70E-02	8.00E-02	2.40E-01	2.50E-01
Ba-140	3.00E-01	1.20E+00	3.60E+00	1.10E+01	1.10E+01
La-140	3.00E-01	1.20E+00	3.60E+00	1.10E+01	1.10E+01
Ce-141	1.40E-02	5.80E-02	1.70E-01	5.20E-01	5.30E-01
Ce-144	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
Pr-144	2.10E-03	8.60E-03	2.60E-02	7.70E-02	7.90E-02
W-187	6.70E-04	2.70E-03	8.00E-03	2.40E-02	2.50E-02
Np-239	2.30E-01	9.20E-01	2.70E+00	8.20E+00	8.50E+00

Key: hr = hours

Table 5.11-2
DBA Accident Doses

Location	Time (hr)	Dose (rem TEDE) [(a)]
EAB	0 - 2	2.68
LPZ	0 - 720	2.68[(b)]

Notes:

(a) As compared to the 25 rem Total Effective Dose Equivalent (TEDE) limit specified in 10 CFR 52.17(a)(1)(ix).

(b) The 50th percentile two-hour EAB short-term atmospheric dispersion factor calculated using the PAVAN code is conservatively applied to the LPZ dose determination because the EAB and the LPZ boundary are the same, the release is an instantaneous release, and the zero to two hour EAB short-term atmospheric dispersion factor is larger than the zero to eight-hour LPZ short-term atmospheric dispersion factor.

Key: EAB = exclusion area boundary; hr = hours; LPZ = low population zone; rem = roentgen equivalent man; TEDE = Total Effective Dose Equivalent

Table 5.11-3
Severe Accident Source Terms

Isotope	Depressurization Released Activity (Bq)	Steam Generator Tube Rupture Released Activity (Bq)	Seismic Released Activity (Bq)
Kr-83m	3.71E+11	1.22E+11	8.32E+10
Kr-85	1.74E+11	4.23E+09	2.09E+10
Kr-85m	1.38E+12	2.83E+11	2.21E+11
Kr-87	1.15E+12	5.65E+11	2.92E+11
Kr-88	2.88E+12	7.88E+11	5.70E+11
Xe-131m	3.64E+10	3.57E+09	4.92E+09
Xe-133	3.61E+12	6.02E+11	4.49E+11
Xe-133m	1.44E+11	2.89E+10	1.92E+10
Xe-135	1.05E+12	8.35E+11	3.92E+11
Xe-135m	1.76E+11	2.53E+11	5.29E+10
Xe-138	8.60E+11	1.35E+12	2.57E+11
I-131	1.78E+12	1.29E+11	3.72E+11
I-132	2.56E+12	2.70E+11	7.01E+11
I-133	2.70E+12	3.53E+11	5.65E+11
I-134	1.58E+12	4.14E+11	4.47E+11
I-135	1.96E+12	3.55E+11	4.48E+11
Cs-137	2.44E+13	1.86E+11	1.73E+13
Cs-134	2.82E+13	5.30E+10	5.53E+12
Ag-110m	2.55E+13	9.36E+10	1.82E+12
Sr-90	1.43E+13	3.52E+10	1.05E+13
Eu-152	7.76E+09	8.01E+04	2.61E+10
Eu-154	9.20E+10	6.09E+05	2.11E+11
Eu-155	7.16E+10	4.86E+05	1.71E+11
Te-132	1.29E+14	3.67E+11	1.58E+14
La-140	1.23E+14	2.27E+11	1.52E+14

Key: Bq = becquerel

Table 5.11-4
Severe Accident Frequencies

Severe Accident	Frequency (per plant year)
Depressurization	4.93E-06
Seismic	1.00E-04
Steam Generator Tube Rupture	1.81E-05

Table 5.11-5
People Exceeding Dose Criteria

Severe Accident	Number of People Exceeding 25 rem (per plant year)	Number of People Exceeding 200 rem (per plant year)
Depressurization	0.00E+00	0.00E+00
Seismic	0.00E+00	0.00E+00
Steam Generator Tube Rupture	0.00E+00	0.00E+00
Total	0.00E+00	0.00E+00

Key: rem = roentgen equivalent man

Table 5.11-6
Dose Risk Comparison

Normal Operation Dose Risk (person rem per plant year)	Total Severe Accident Dose Risk (person rem per plant year)
2.54E+02	7.83E+00

Key: rem = roentgen equivalent man

Table 5.11-7
Environmental Impacts within a 50-mile Radius Area for Severe Accidents

Severe Accident	Release Frequency (per plant year)	Population Dose (0-50 mi) (person-rem per plant year)		Fatalities (0-50 mi) (per plant year)		Economic Cost (dollars per plant year)	Farmland Decontamination (ha per plant year)	Individual Early Fatality Risk (0-1 mi) (per plant year)	Individual Latent Cancer Fatality Risk (0-10 mi) (per plant year)
		Water Ingestion	Total	Early	Latent				
Depressurization	4.93E-06	1.68E-03	7.05E-01	0.00E+00	3.65E-04	1.98E+03	1.09E-03	0.00E+00	9.56E-11
Seismic	1.00E-04	1.71E-02	7.11E+00	0.00E+00	3.57E-03	1.49E+04	4.87E-03	0.00E+00	1.12E-09
Steam Generator Tube Rupture	1.81E-05	2.19E-05	1.39E-02	0.00E+00	7.42E-06	3.35E-01	0.00E+00	0.00E+00	3.04E-12
Total	1.23E-04	1.88E-02	7.83E+00	0.00E+00	3.94E-03	1.69E+04	5.96E-03	0.00E+00	1.22E-09

Key: rem = roentgen equivalent man; ha = hectacre; mi = mile

Table 5.11-8
Environmental Impacts of the Project Site Reactors Compared to NUREG-1150 Plants

Reactor Facility	Severe Accident Frequency (per reactor year)	50-mi Population Dose Risk (person-rem per reactor year)	Fatalities (per reactor year)		Average Individual Fatality Risk (per reactor year)	
			Early	Latent Cancer	Early	Latent Cancer
Grand Gulf[a]	4.0E-06	5E+01	8E-09	9E-04	3E-11	3E-10
Peach Bottom[a]	4.5E-06	7E+02	2E-08	5E-03	5E-11	4E-10
Sequoyah[a]	5.7E-05	1E+03	3E-05	1E-02	1E-08	1E-08
Surry[a]	4.0E-05	5E+02	2E-06	5E-03	2E-08	2E-09
Zion[a]	3.4E-04	5E+03	4E-05	2E-02	9E-09	1E-08
Project site[b]	1.23E-04	7.83E+00	0.00E+00	3.94E-03	0.00E+00[d]	1.22E-09[d]
NRC Safety Goals[c]	N/A	N/A	N/A	N/A	5.76E-07	1.48E-06

Note:

(a) Risks were calculated using the MACCS code and presented in NUREG-1150.

(b) Risks were calculated with MACCS code using Project site-specific inputs. Values are the 99.5 percentile estimates with the exception of the average individual prompt and latent fatalities. The per plant year and person-rem per plant year units used in the Project site values from Table 5.11-7 are assumed to be equivalent to the per reactor year and person-rem per reactor year units used for the other reactor facilities in this table.

(c) Discussed in the NRC Safety Goal Policy Statement (51 FR 30028). Values are 0.1 percent of the risks discussed in 5.11.2.7.

(d) Per the NRC Safety Goal Policy Statement (51 FR 30028), mean estimates are used for implementing the policy. Average individual prompt and latent fatality risks are calculated for 0-1 mi. and 0-10 mi. ranges, respectively.

(e) Risks were calculated using the MACCS code and presented in NUREG-1437.

Key: rem = roentgen equivalent man

Table 5.11-9
Comparison of 50-mile Population Doses of the Project Site to Current Plants

	Severe Accident Frequency (per reactor year)	50-mi Population Dose Risk (person-rem per reactor year)
Current Reactor Maximum[(a)]	2.4E-04	6.9E+01
Current Reactor Mean[(a)]	3.1E-05	1.5E+01
Current Reactor Median[(a)]	2.5E-05	1.3E+01
Current Reactor Minimum[(a)]	1.9E-06	5.5E-01
Project site[(b)]	1.23E-04	7.83E+00

Note:

(a) Based on MACCS calculations for over 70 current plants at over 40 sites (NUREG-2168).

(b) The 99.5 percentile dose risk was calculated with MACCS code using site-specific input. The per plant year and person-rem per plant year units used in the Project site values from Table 5.11-7 are assumed to be equivalent to the per reactor year and person-rem per reactor year units used for the other values in this table.

Key: rem = roentgen equivalent man

5.12 MEASURE AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION

5.12.1 ADVERSE ENVIRONMENTAL IMPACTS

Sections 5.1 through 5.11 identify adverse impacts resulting from the operation of the Project and the measures and controls to avoid, minimize, or mitigate those impacts. Table 5.12-1 summarizes the impact finding for each resource category, a description of the impacts or activities that result in impacts, and the mitigation measures and controls that are identified in previous sections.

The assignment of significance levels as SMALL, MODERATE, or LARGE assumes that for each impact, corresponding feasible and adequate measures and controls (or equivalents) are implemented. If a significance determination of SMALL is made without the implementation of measures and controls, then no additional measures and controls are identified in Table 5.12-1. If there is no impact to a resource from operation of the Project, a “no impact” descriptor indicates such and no mitigative measures are needed. Each “Impact Description or Activity” attribute is assigned a number, and each “Mitigating Measures and Controls” attribute is assigned a number corresponding to the respective “Impact Description or Activity.”

Based on a review of the operational impacts described in this chapter, generally feasible and adequate measures and controls for reducing adverse impacts at the Project site include:

- Implementing terms of agreements or conservation measures that are developed in conjunction with applicable consultations with federal and state agencies as indicated in Table 1.4-1.
- Complying with applicable requirements of permits or licenses required for plant operations at the Project site as summarized in Table 1.4-2.
- Complying with applicable federal, state, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emissions, noise control, stormwater management, discharge prevention and response, and hazardous material management).

The feasible and adequate measures and controls described in Table 5.10-1 are based on statutes and regulatory requirements or are generally accepted practices within the utility industry. General feasible and adequate measures and controls for reducing adverse impacts at the Project site include:

- Implementing an environmental safety and health plan for the Project site that governs operations. This includes Safety Data Sheets for applicable hazardous materials at the Project site. Operational employees are trained in the appropriate safety measures and use of hazardous materials.
- Treating, storing, and disposing of hazardous waste in accordance with the RCRA and other applicable federal, state, and local laws and regulations and Duke Energy procedures. Operational employees are trained in the appropriate handling and disposal of hazardous waste.
- Performing operational activities in accordance with applicable local, state, and federal ordinances, laws, and regulations and Duke Energy procedures intended to prevent or

minimize adverse environmental effects of operational activities on air, water, land, plants, animals, workers, and the public.

- Performing operational activities in compliance with applicable Duke Energy corporate environmental, safety, and operational procedures, which place controls on how activities are performed.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 1 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
5.1 Land Use Impacts			
5.1.1 On-site Impacts	SMALL	1. No adverse impacts.[(a)]	1. No mitigation measures or controls are needed.
5.1.2 Off-site Impacts	SMALL	1. No adverse impacts.[(a)]	1. No mitigation measures or controls are needed.
5.2 Water-Related Impacts			
5.2.1 Hydrologic Alterations			
Surface Water	SMALL (MODERATE under drought conditions)	1. Hydrologic alterations, including flow patterns and sedimentation, where stormwater is discharged to Belews Lake.	1. Manage stormwater and minimize discharge of sediment and site runoff to Belews Lake through an engineered stormwater collection system and sediment and erosion control measures. 1. Comply with the requirements of the NCDEQ NPDES permit for discharge of stormwater associated with industrial activity. 1. Comply with the monitoring and BMP requirements from 15A NCAC 02H.1017 and incorporate these into future permitting and stormwater management operational programs as applicable.
		2. Variable lake water levels and a lower predicted minimum level during operations compared to modeled BCSS operational scenarios as a result of increased consumptive use. Lake water-level drawdowns are noticeable during periods of increased drought severity but are not considered to be destabilizing.	2,3. Regulate supplemental pumping from the Dan River in conjunction with NCDEQ NPDES permitting requirements consistent with existing BCSS permitted conditions.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 2 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		3. Extended critical drought duration compared to the BCSS full generation scenario.	
		4. Localized and minor effects on flow and circulation patterns in Belews Lake as a result of intake, discharge, and MWIS operations.	4. Regulate discharge flows in conjunction with NCDEQ NPDES permitting requirements.
		5. Negligible sedimentation impacts on Belews Lake from sediment entrainment from the Dan River during MWIS operations.	5. No mitigation measures or controls are needed.
		6. Localized changes in flow patterns, currents, and total flow in the Dan River due to discharge adjacent to existing Outfall 006.	6. Install cautionary signage to mark outfall and intake locations in the Dan River for watercraft awareness.
		7. Minor hydrologic alterations in the Dan River from MWIS operations that affect river discharge downstream.	7. Regulate supplemental pumping from the Dan River in conjunction with NCDEQ NPDES permitting requirements consistent with existing BCSS permitted condition.
Groundwater	SMALL	1. Reduced infiltration and groundwater recharge in immediate area of new structures and impervious surfaces.	1. No mitigation measures or controls are identified.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 3 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
5.2.2 Water Use Impacts			
Surface Water	SMALL	1. Belews Lake water use as supplemented by MWIS operation is increased compared to the BCSS Continuous Maximum Generation Condition. While water use is noticeable during periods of increased drought severity this water use does not preclude the capacity for Belews Lake to continue to provide a reliable source for cooling water in support of thermoelectric power generation; therefore, impacts on water use are minor. 2. Minor impacts to water availability and reliability for downstream water users along the Dan River.	1. No mitigation measures or controls are needed. 2. Comply with NPDES permit limits for water withdrawals from the Dan River.
Groundwater	SMALL	1. No adverse impacts.[(a)]	1. No mitigation measures or controls are needed.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 4 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
5.2.3 Water Quality Impacts			
Surface Water	SMALL	1. Minor impacts to water quality in on-site streams from industrial stormwater. 2. Minor water quality impacts on Belews Lake from cooling tower blowdown, including temperature changes and chemical constituents. 3. Localized, temporary impact on Belews Lake water quality from MWIS operation. 4. Minor water quality impacts in the Dan River from cooling tower blowdown and wastewater discharge, including temperature changes, nonradioactive liquid discharges, and radwaste.	1. Manage stormwater through an engineered stormwater collection system and sediment and erosion control measures. 1. Comply with NPDES permit requirements, maintain an operational SWPPP and SPCC, and implement stormwater BMPs. 1-4. Conduct thermal and chemical monitoring programs, as applicable, for surface water at the Project site and Dan River. 2,3,4. Mitigate by rapid mixing and adherence to NPDES permitting requirements in Belews Lake and by administrative and engineering controls as needed to meet NPDES requirements, monitoring programs, dilution effects, and mixing within the pipeline prior to mixing within the Dan River.
Groundwater	SMALL	1. Potential for accidental spills.	1. Minimize by containment systems and established procedures in SPCC plan pursuant to 40 CFR Part 112 to minimize the release of constituents associated with accidental spills.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 5 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
5.3 Ecological Impacts			
5.3.1 Terrestrial and Wetland Impacts	SMALL	1. Impacts to plant communities and wetlands primarily consist of landscape maintenance activities such as pesticide/herbicide use and mowing, within the Project site and the associated off-site wastewater pipeline corridor.	1. Use BMPs including following the label-recommended pesticide/herbicide usage and application method and rates, only using licensed herbicide/pesticide applicators, maintaining ground cover in corridors, prohibiting herbicide usage around wetlands, and avoiding mowing and other heavy equipment operation within wetlands.
		2. Potential establishment and spread of invasive plant species.	2. Monitor disturbed lands to identify and control areas that are dominated by invasive species. Control methods may include using pesticides/herbicides, hand-pulling, or mechanical treatment as applicable.
		3. Impacts to wetlands from inadvertent spills or stormwater runoff.	3. Implement an SPCC plan pursuant to 40 CFR Part 112 to minimize the release of constituents associated with accidental spills on wetlands.
		4. Impacts to wildlife from operational noise. Noise-sensitive wildlife are expected to avoid areas within the NDA and other habitats characterized by elevated noise levels.	4-5. No mitigation measures identified.
		5. Occasional bird collisions with tall structures. Bird collisions with nuclear power plant structures occur at rates that are unlikely to affect local or migratory bird populations.	
		6. Minor impacts to wildlife from transmission line maintenance due to the limited frequency of maintenance activities. Bird collisions with transmission lines may occur during operations.	6. Comply with the Migratory Bird Treaty Act. May use bird diverters and avian-safe insulator assemblies to reduce the frequency of bird collisions and ensure reliable transmission system operation.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 6 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		7. Minor impacts to wildlife from EMFs.	7. No mitigation measures or controls are needed.
		8. Impacts to pollinators from mowing and pesticide use, and artificial lighting.	8. Schedule transmission line activities to minimize harm to pollinators, when possible, by limiting mowing to the fall or winter when flowers are not blooming. Incorporate mitigation measures to limit artificial light impact.
		9. Limited impacts on tricolored bat (*Perimyotis subflavus*) from reduced habitat suitability, noise levels from cooling tower operations, and low risk of collision with tall structures.	9. No mitigation measures or controls are identified.
		10. Potential effects on habitats that may be used as foraging habitats by monarch butterfly (*Danaus plexippus*) and other pollinators.	10. Conduct mowing in the fall or winter when foraging habitat (flowers) are not blooming, controlling invasive species, and following the label-recommended pesticide/herbicide usage.
		11. Limited impacts to bald eagle (*Haliaeetus leucocephalus*) from behavioral effects associated with avoidance of developed high-activity areas and infrequent collisions with structures or powerlines.	11. Update the Project site's existing Bald Eagle Nest Management Plan as appropriate.
5.3.2 Aquatic Impacts	SMALL (MODERATE under drought conditions)	1. Potential impacts to aquatic ecosystems in on-site streams from stormwater runoff or accidental spills.	1. Comply with requirements of the site-specific NPDES permit for stormwater discharges and relevant federal, state, and local stormwater regulations. Implement stormwater BMPs. 1. Implement an SPCC plan pursuant to 40 CFR Part 112 to minimize the release of constituents associated with accidental spills.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 7 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		2. Impingement and entrainment of organisms by the intake structure on Belews Lake.	2. Intake structure is designed to meet the impingement and entrainment requirements in regulations adopted to implement Section 316(b) of the CWA.
		3. Impacts to aquatic biota and associated habitats along nearshore areas of Belews Lake from seasonal fluctuations in surface water levels and changes in water circulation patterns. Effects of lake water-level drawdowns are increased under modeled extreme drought conditions.	3. Increased supplemental pumping from the MWIS in accordance with the limits established in the NCDEQ NPDES permit mitigates the reduction in lake levels and near shore aquatic habitats and minimizes potential effects related to water-level fluctuations.
		4. Minor, localized impacts to aquatic biota within Belews Lake from thermal discharges.	4. Comply with thermal discharge limits required under the operational NCDEQ NPDES permit to limit adverse impacts to aquatic biota.
		5. Direct impacts to aquatic species are limited to the MWIS and the wastewater discharge in the Dan River.	5. Impacts of the MWIS and discharge operation are minimized through compliance with NPDES permit requirement and through the use of technologies and design features.
		5. Localized loss of benthic habitat and loss of less mobile organisms during maintenance activities at the Dan River MWIS.	5. No mitigation measures or controls are needed.
		6. Impingement and entrainment of organisms and potential effects to aquatic habitat from operation of the MWIS at the confluence of Belews Creek and the Dan River.	6. Operate the intake structure in compliance with regulations adopted to implement Section 316(b) of the CWA in regard to impingement and entrainment.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 8 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		7. Minor water quality impacts on aquatic biota in Belews Lake and the Dan River associated with operational effluents.	7. Comply with regulatory stipulations required under the operational NPDES permit to limit adverse impacts to aquatic ecology. 7. Design liquid waste processing systems and apply administrative and engineering controls and monitoring to manage concentrations of constituents within effluents in compliance with the site-specific NCDEQ NPDES permit.
		8. Impacts to proposed critical habitat for green floater from maintenance activities at the MWIS that affect benthic habitat.	8. Consult with the U.S. Fish and Wildlife Service, State of North Carolina, and U.S. Army Corps of Engineers and implement appropriate avoidance, minimization, and conservation measures to limit potential effects on proposed critical habitat for any activities related to maintenance or material removals at the MWIS.
5.4 Socioeconomic Impacts			
5.4.1 Physical Impacts (includes noise, odors, dust, air pollution, physical transportation impacts, and visual intrusions)	SMALL to MODERATE (AESTHETICS)	1. Minor effects from increase in noise level from cooling tower operation. 2. Air emissions including dust during operations do not exceed the NAAQS for criteria pollutants. 3. Vapor plume from the cooling towers does not reach off-site structures. 4. Minimal operations-related impacts on road conditions from physical deterioration due to reduced traffic volumes compared those during the building phase.	1 No mitigation measures or controls are identified. 2. Air emission sources are managed in accordance with federal, state, and local air quality control laws and regulations. 3. No mitigation measures or controls are identified. 4. No mitigation measures or controls are needed.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 9 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		5. Minor to noticeable, but not destabilizing, visual intrusions of structures and cooling tower plumes depending on the location of the observer and atmospheric conditions.	5. Maintain an approximate 100-ft. (30.5-m) vegetative buffer along most of the shoreline of Belews Lake.
5.4.2 Demographic Impacts	SMALL	1. No adverse impacts.[(a)]	1. No mitigation measures or controls are needed.
5.4.3 Economic Impacts to the Community	SMALL (beneficial)	1. No adverse impacts.[(a)]	1. No mitigation measures or controls are needed.
5.4.4 4 Community Infrastructure Impacts (includes transportation, recreation, housing, and public services)	SMALL to MODERATE (RECREATION under drought conditions, AESTHETICS, and TRANSPORTATION)	1. Impacts to level of service along roadways and selected intersections providing access to the Project site. 2. Impacts to recreation on Belews Lake from fluctuating water levels, noise, and visual intrusions. 3. Effects of the discharge structure on paddlers or recreators on the Dan River. 4. Limited effects on recreation in the Dan River during MWIS operations.	1. Implement relevant traffic management measures from building phase. 2. Regulate supplemental pumping from the Dan River in conjunction with NCDEQ NPDES permitting requirements consistent with existing BCSS permitted condition. 2. Work with the North Carolina Water Resources Commission to extend public boat ramps during low water conditions as necessary. 3. Post cautionary signage to minimize impacts on recreators. 3. Design discharge structure to be low profile to limit effects on recreators. 4. Regulate supplemental pumping from the Dan River in conjunction with NCDEQ NPDES permitting requirements consistent with existing BCSS permitted condition.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 10 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		5. Minor increase in demand for housing, recreational facilities, and public services (water supply, wastewater treatment, police, fire protection, healthcare services, and education) within the region of influence.	5. No mitigation measures or controls are needed.
5.5 Not Used	N/A	N/A	N/A
5.6 Historic and Cultural Resources	SMALL	1. Potential effects to undiscovered archaeological resources within the Project site if ground-disturbing activities occur outside of the net disturbance area.	1. Comply with mitigative measures developed in consultation with the North Carolina State Historic Preservation Office and North Carolina Office of State Archaeology.
5.7 Air Resources	SMALL	1. Particulate emissions and plumes from LMDCT cooling towers. 2. Emissions from operation of auxiliary equipment (e.g., generators and auxiliary boilers), and mobile emissions from operations-related traffic (e.g., vehicles driven by workers). 3. Nominal localized increases in vehicular emissions. 4. Small lifetime greenhouse gas (GHG) emissions footprint compared to annual GHG emissions in North Carolina.	1. No mitigation measures or controls are identified. 2. Conduct dispersion modeling, if required, to demonstrate that emissions do not result in exceedances of the NAAQS. 3. Stagger work shifts, require delivery vehicles to shut down engines while off-loading, restrict idling times of on-site vehicles, use electric and hybrid vehicles, and support and promote van/carpooling and other commuter programs. 4. No mitigation measures or controls are needed.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 11 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
		5. Small emissions of ozone and substantially smaller amounts of nitrogen oxides produced by transmission lines during corona discharges.	5. No mitigation measures or controls are needed.
5.8 Nonradiological Health	SMALL	1. Low potential for impacts from etiological agents. 2. Minor water quality impacts from operational and sanitary wastewater discharges. 4. Minor risk of electric shock from electrical infrastructure at the Project site. 5. Occupational health risks for nuclear power plant workers. 6. Minor human health effects from predicted increases in vehicle crash rates at intersections providing access to the Project site.	1. No mitigation measures or controls are identified. 2. Comply with discharge limitations established in the site-specific NPDES permit. 4. Comply with the National Electrical Safety Code standards for transmission lines. 5. Adhere to Duke Energy's robust safety culture, established internal safety guides and procedures, and NRC requirements and Occupational Safety and Health Administration safety standards. 6. Implement traffic management mitigation measures identified in Section 4.4.4.1.
5.9 Radiological Health			
5.9.1 Exposure Pathways	SMALL	1. Releases to the environment from gaseous and liquid effluents are within regulatory limits. 2. Exposure from direct radiation is negligible.	1,2. No specific mitigative measures or controls are identified.
5.9.3 Impacts to Members of the Public	SMALL	1. Exposure to the public from the release of gaseous and liquid effluents are within design objective of 10 CFR Part 50 Appendix I and within the regulatory limits of 40 CFR Part 190.	1. Implement off-site monitoring in accordance with the radiological environmental monitoring program is conducted to evaluate off-site exposure.
5.9.4 Occupational Doses to Workers	SMALL	1. Exposure to the occupational workforce is within regulatory limits.	1. Develop monitoring programs for the occupational workforce to maintain ALARA in compliance with 10 CFR 20.1101.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 12 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
5.9.5 Impacts to Biota Other than Members of the Public	SMALL	1. Exposure to terrestrial and aquatic ecosystems from the release of gaseous and liquid effluents are within the 25 millirem per year whole-body limit prescribed by 40 CFR Part 190 and less than 100 mrad/day (threshold cited in NUREG-1555 per scientific literature).	1. Implement off-site monitoring in accordance with the radiological environmental monitoring program is conducted to evaluate off-site exposure.
5.10 Nonradioactive Waste Management			
5.10.1 Impacts to Land	SMALL	1. Disposal of solid, hazardous, and mixed waste.	1. Manage wastes in accordance with all applicable federal, state, and local requirements and standards and Duke Energy Environmental Programs' policies and procedures and dispose of wastes within landfills having sufficient capacity.
5.10.2 Impacts to Water	SMALL	1. Discharge of sanitary wastewater to the Dan River. 2. Discharge of nonradioactive liquid effluent waste streams to Belews Lake or the Dan River. 3. Discharge of stormwater runoff.	1,2. Control and monitor discharges associated with all liquid discharges (sanitary waste and nonradioactive liquid effluents) in accordance with NPDES permit requirements. 3. Manage stormwater discharges in accordance with NPDES stormwater permit requirements and minimize discharges using BMPs.
5.10.3 Impacts to Air	SMALL	1. Gaseous emissions into the air from equipment associated with auxiliary systems such as diesel generators and auxiliary boilers. 2. Particulate matter emissions from cooling towers. 3. Air emissions from hazardous wastes.	1,2. No mitigation measures beyond mitigation measures discussed in Section 5.7 and adhering to federal, state, and local air quality control regulations. 3. Manage and dispose of hazardous waste in accordance with the Resource Conservation and Recovery Act to minimize air emissions.

Table 5.12-1
Summary of Measures and Controls to Limit Adverse Operational Impacts
(Sheet 13 of 13)

Environmental Resources (Section Reference)	Summary Impact Finding	Impact Description or Activity	Mitigating Measures and Controls
5.11 Environmental Impacts of Postulated Accidents	SMALL	1. The calculated dose consequences of design basis accidents at the Project site were found to be within regulatory limits. 2. The calculated probability-weighted dose risk of severe accidents at the Project site were found to be less than the maximum, median, and mean dose risk for current operating reactors and the individual prompt and latent cancer fatality risks are below the NRC safety goals.	1. Radioactive releases and doses comply with regulatory limits.

Note:

(a) A “no impact” descriptor indicates there is no impact to a resource from operation of the Project, and no mitigative measures are needed.

(b) Deleted (Executive Order, 2025).

Key: ALARA = as low as is reasonably achievable; BCSS = Belews Creek Steam Station; BMP = best management practice; CFR = Code of Federal Regulations; cfs = cubic feet per second; CWA = Clean Water Act; EMF = electromagnetic field; ft. = feet; LMDCT = linear mechanical draft cooling tower; m = meter; m^3/s = cubic meters per second; mrad/day = millirad/day; MWIS = makeup water intake structure; NAAQS = National Ambient Air Quality Standards; NC = North Carolina; NCAC = North Carolina Administrative Code; NCDEQ = North Carolina Department of Environmental Quality; NDA = net disturbance area; NPDES = National Pollutant Discharge Elimination System; NRC = U.S. Nuclear Regulatory Commission; PM = particulate matter; SPCC = Spill Prevention and Control Countermeasures; SWPPP = stormwater pollution prevention plan

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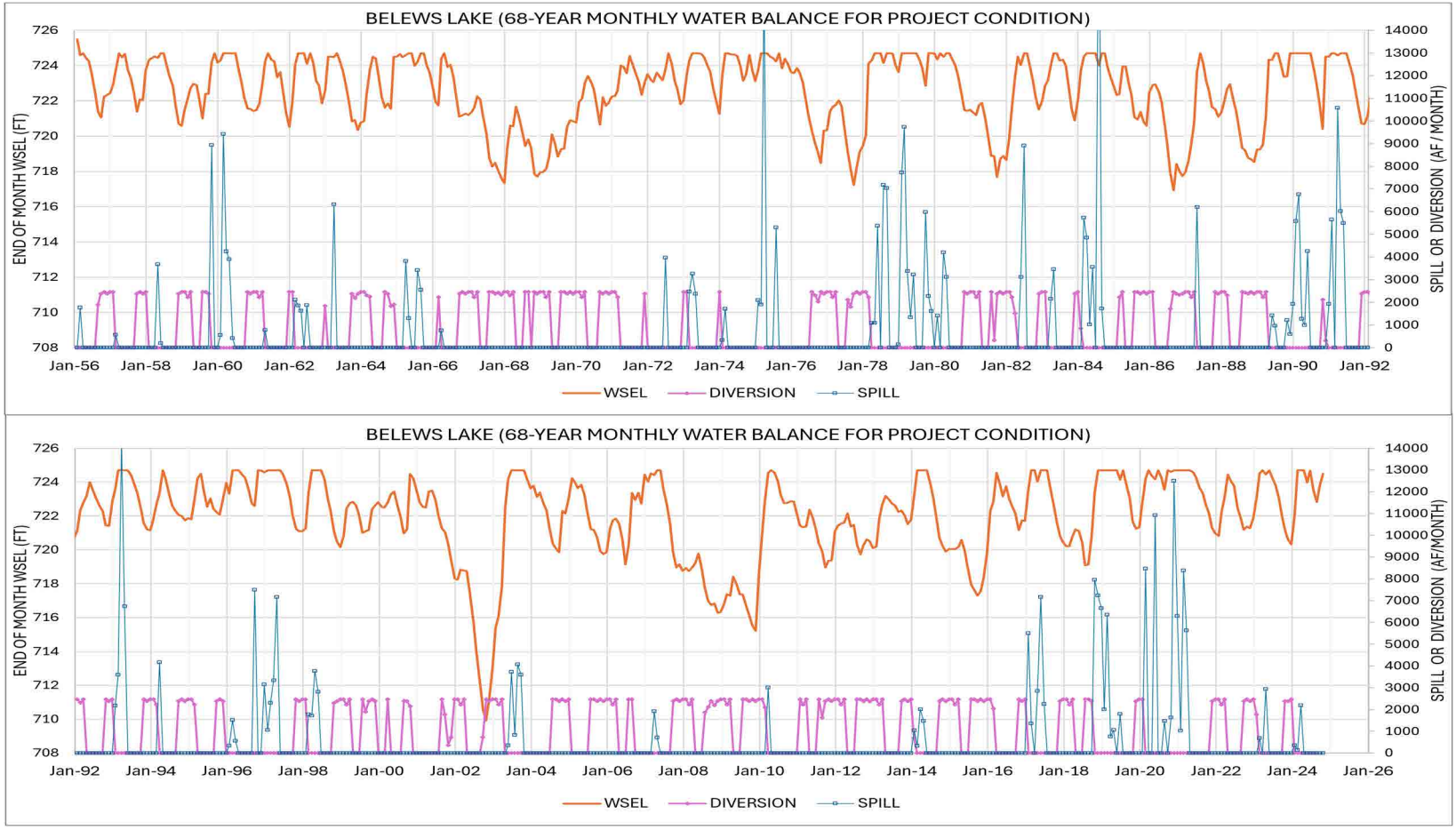
Figure 5.2-1
Water Surface Elevation, Dan River Diversion, and Spillway Release Under the BCSS Continuous Maximum Generation Condition: (80 cfs Diversion Capacity)

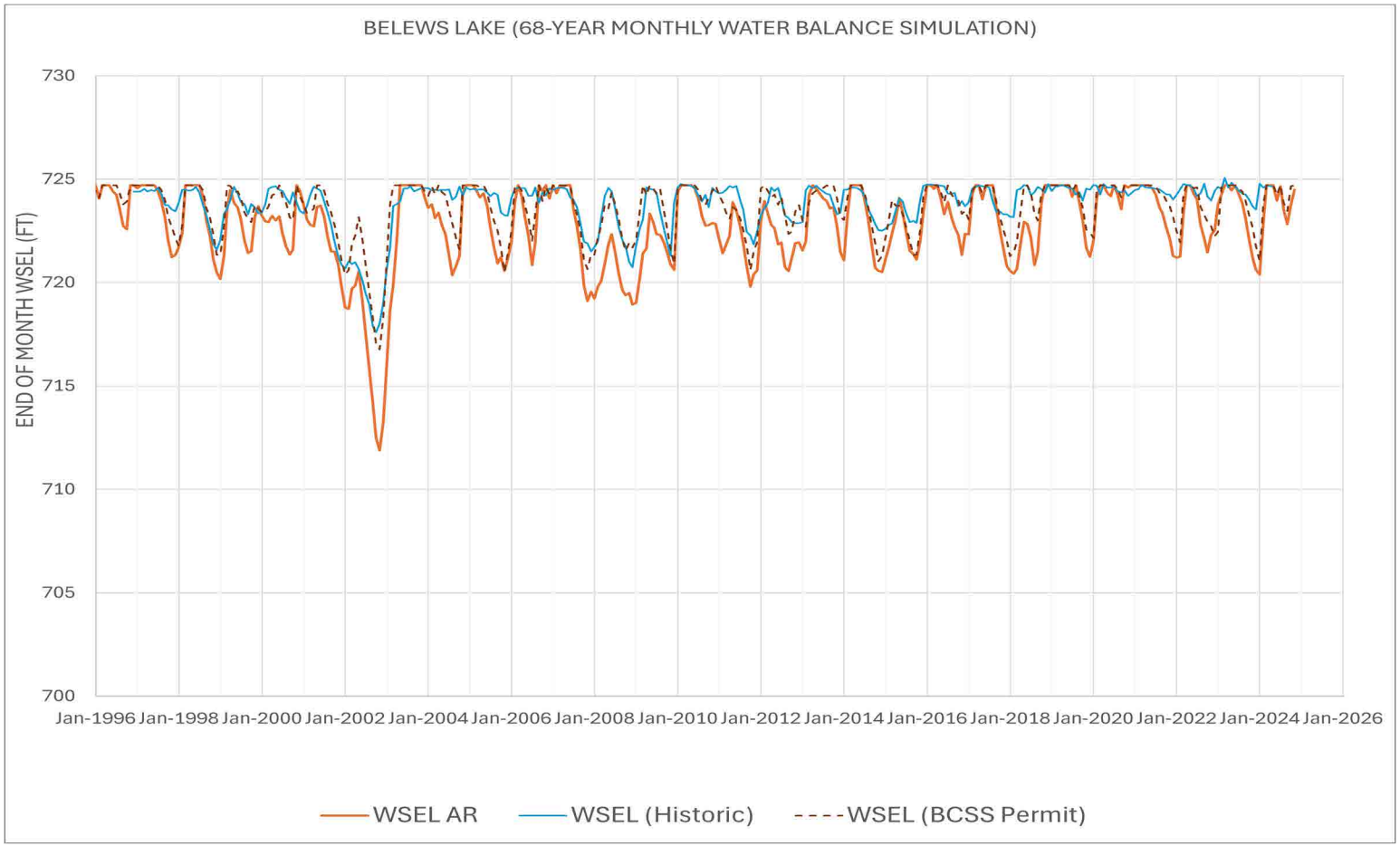
Key: af/month = ; BCSS = Belews Creek Steam Station; cfs = cubic feet per second; ft. = foot; WSEL = water surface elevation

Figure 5.2-2
Water Surface Elevation, Diversion, and Spillway Release Hydrographs Under the Project Condition (80 cfs Diversion Capacity)



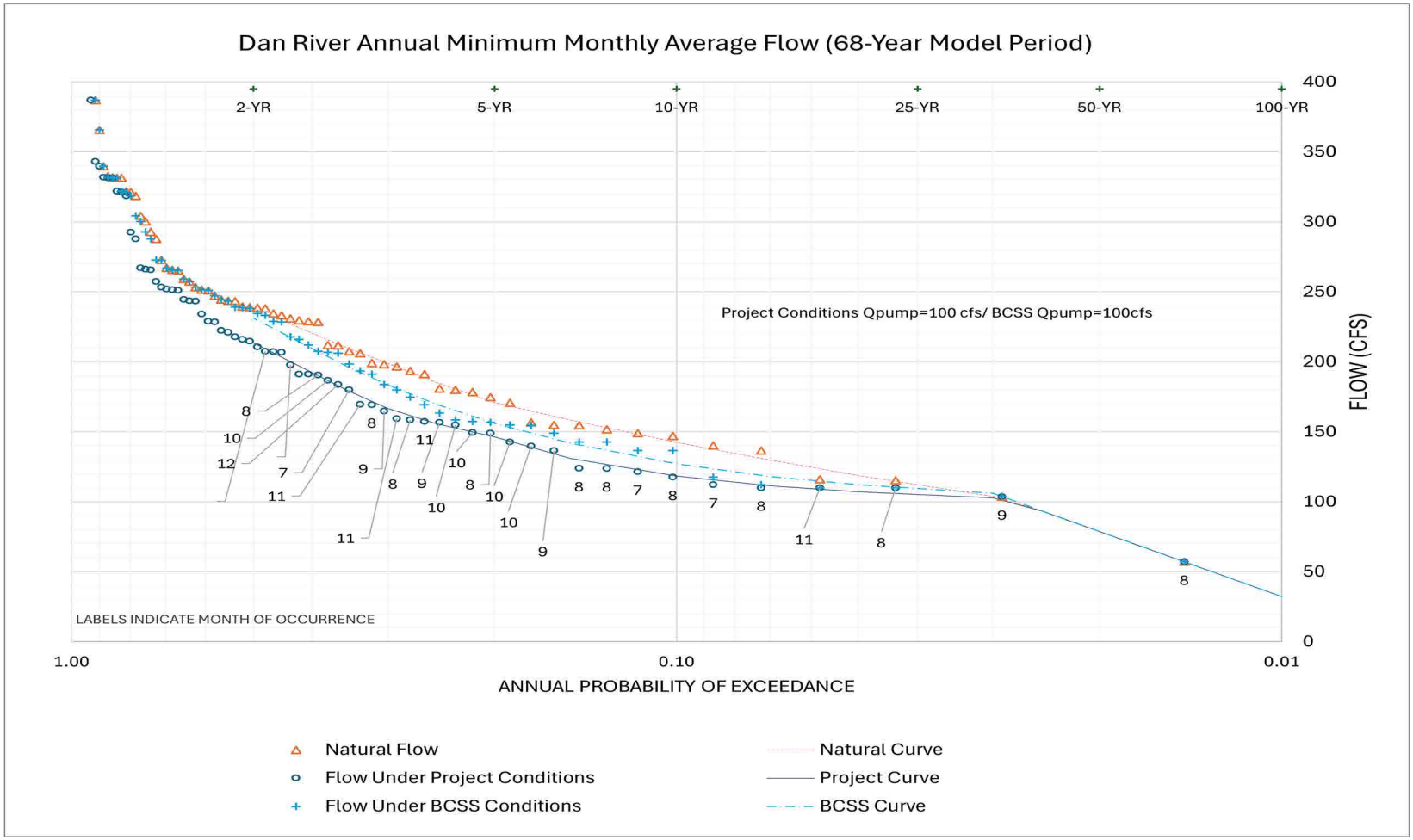
Key: af/month = ; cfs = cubic feet per second; ft. = foot; WSEL = water surface elevation

Figure 5.2-3
Comparative Analysis of Water Surface Elevations: Historic, BCSS Continuous Maximum Generation Condition and Project Condition



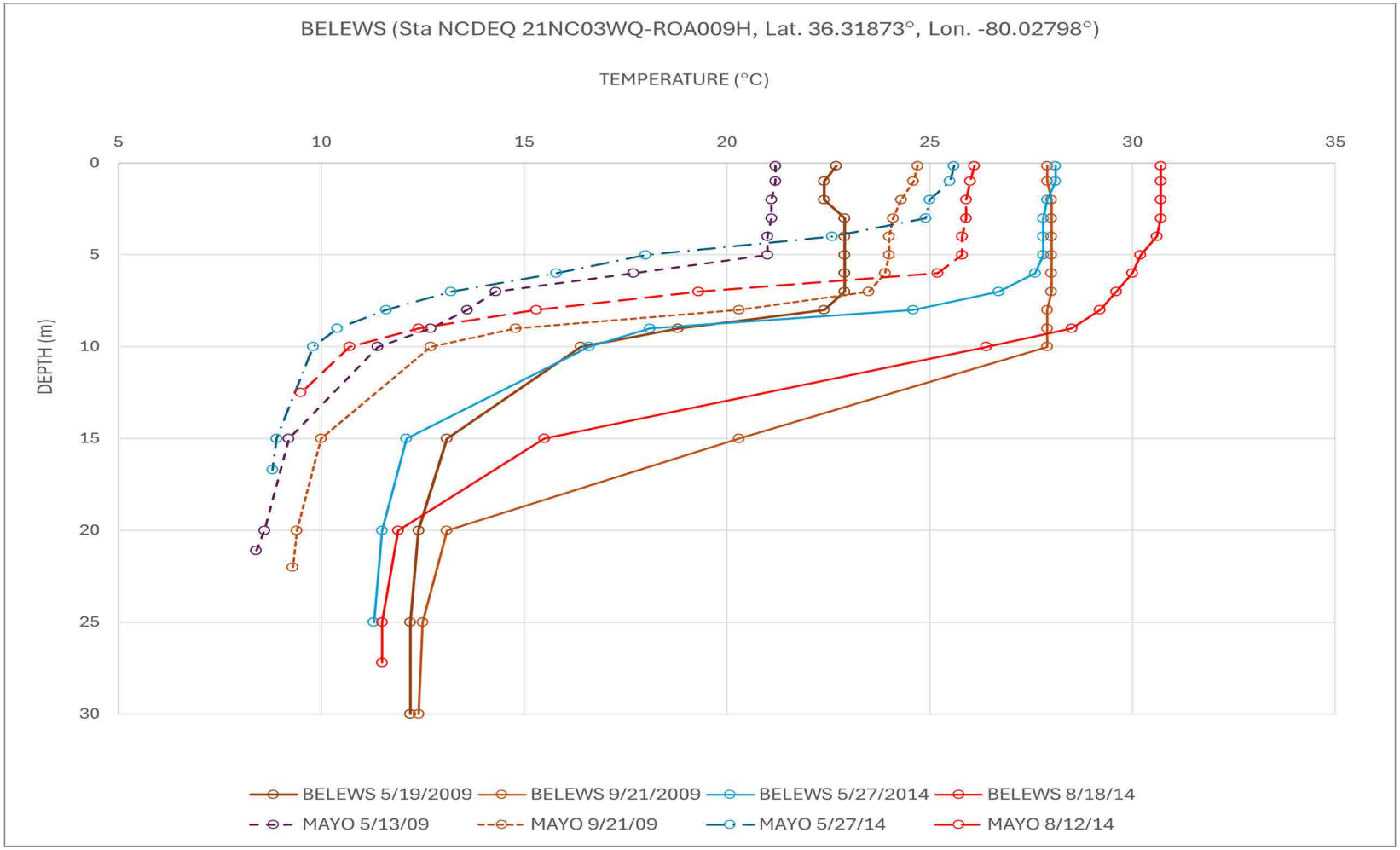
Key: BCSS = Belews Creek Steam Station; ft. = foot; WSEL = water surface elevation

Figure 5.2-4
Dan River Flow Frequency for Varying Conditions



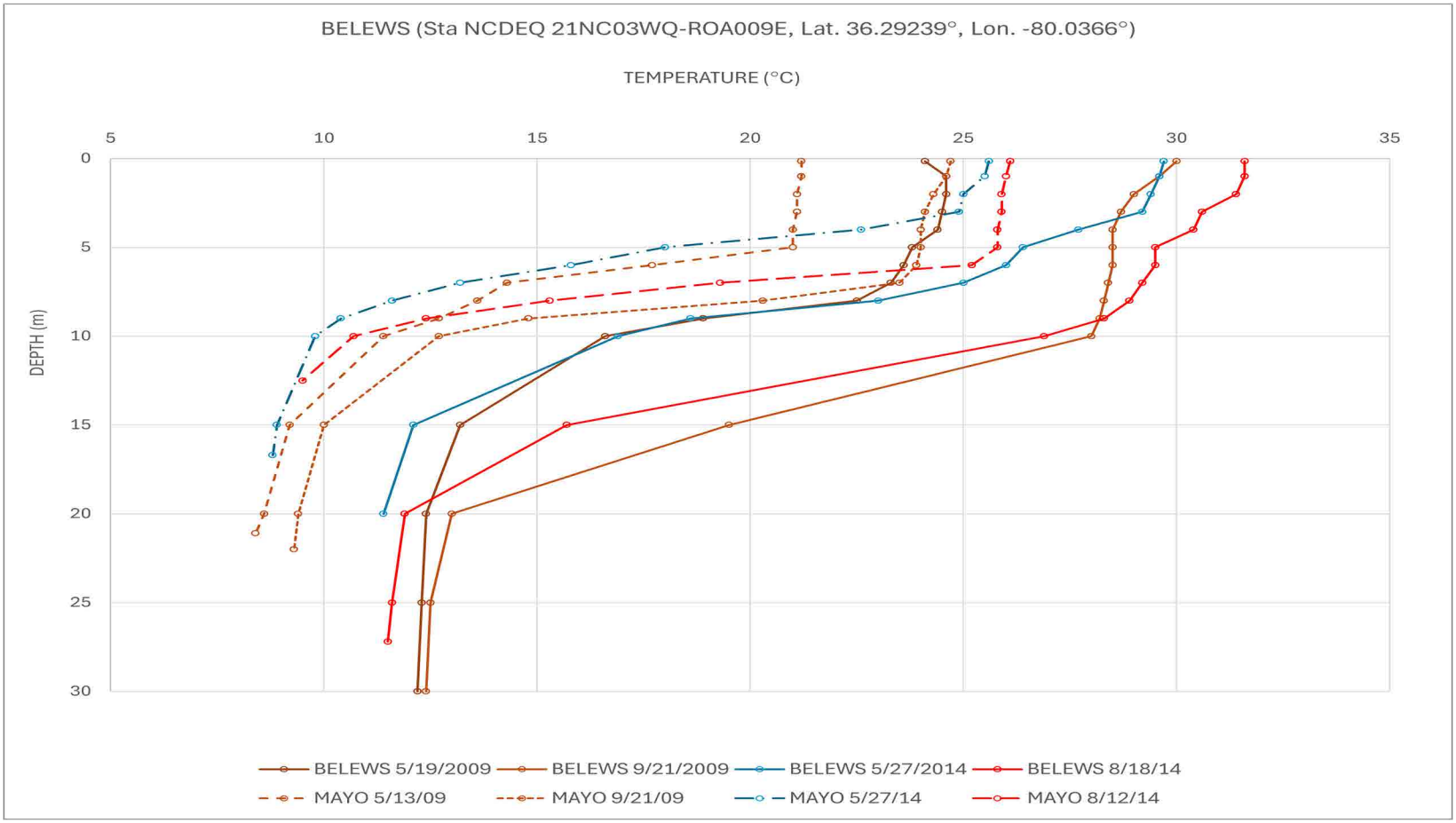
Key: BCSS = Belews Creek Steam Station; cfs = cubic feet per second; MWIS = makeup water intake structure

Figure 5.2-5
Belews Lake Station 21NC03WQ Comparison to Mayo Reservoir Station ROA009H Temperature



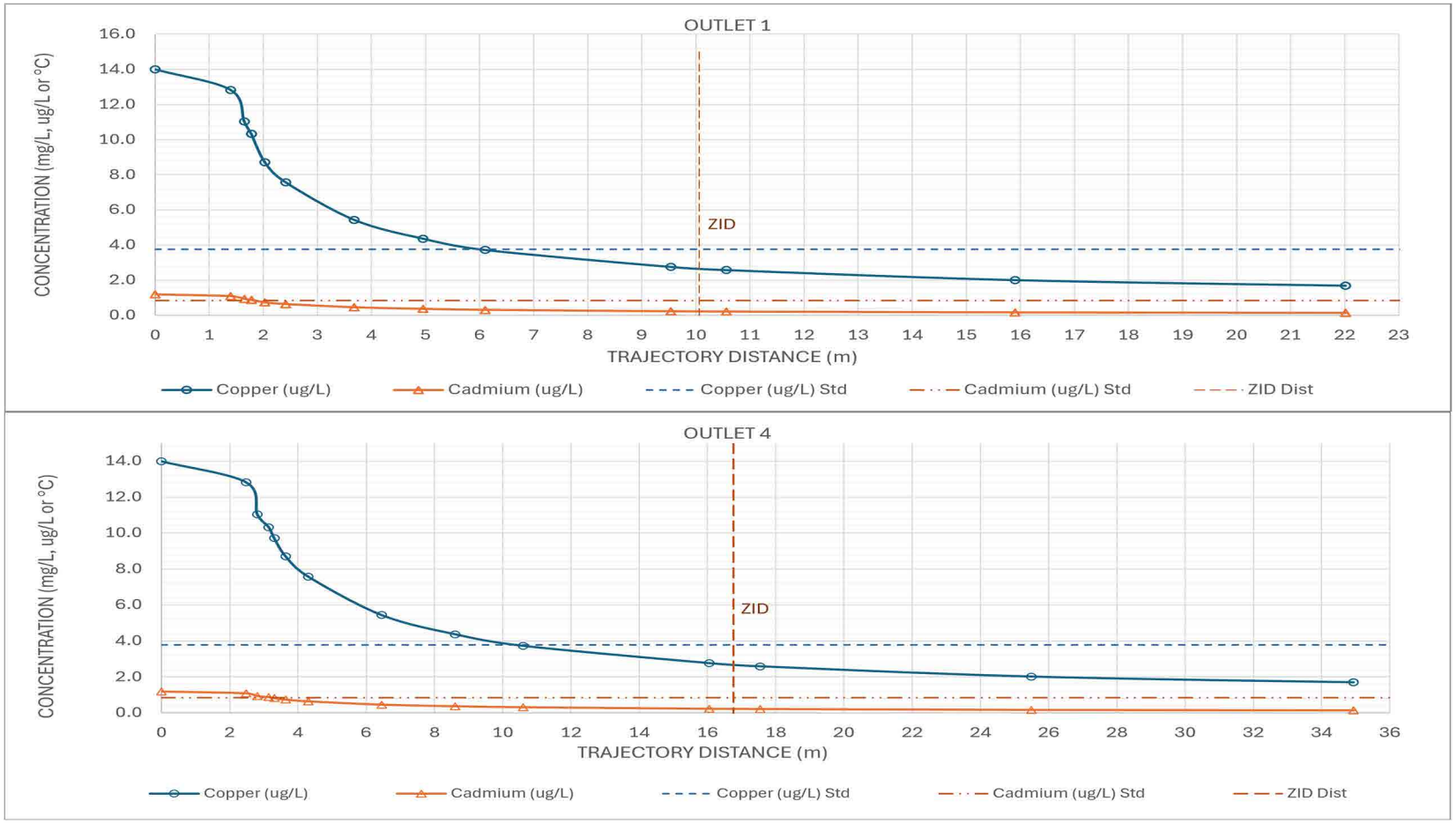
Key: °C = degrees Celsius; m = meter

Figure 5.2-6
Belews Lake Station 21NC03WQ Comparison to Mayo Reservoir Station ROA009E Temperature



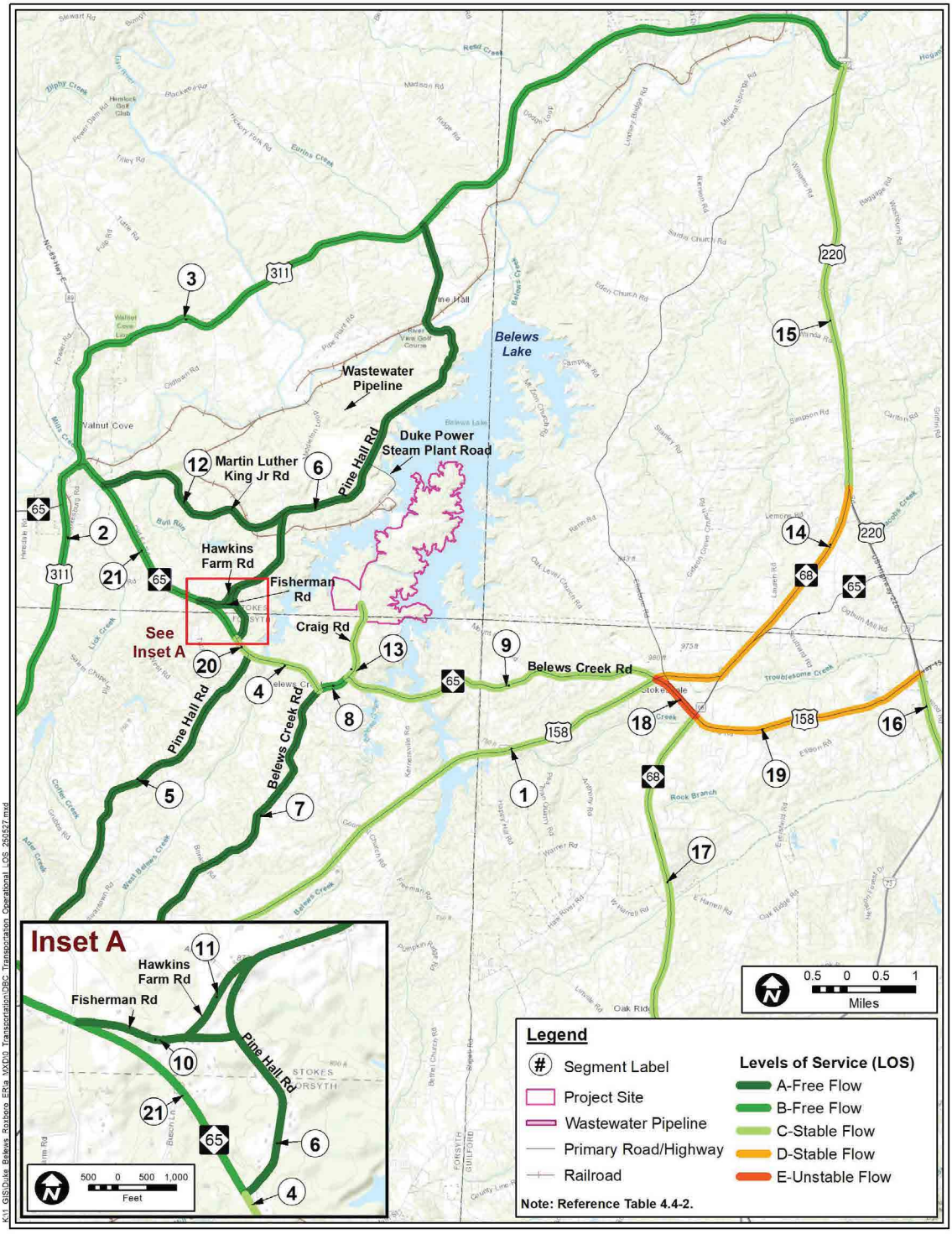
Key: °C = degrees Celsius; m = meter

Figure 5.2-7
Belews Lake CORMIX Near-Field Water Quality Concentrations



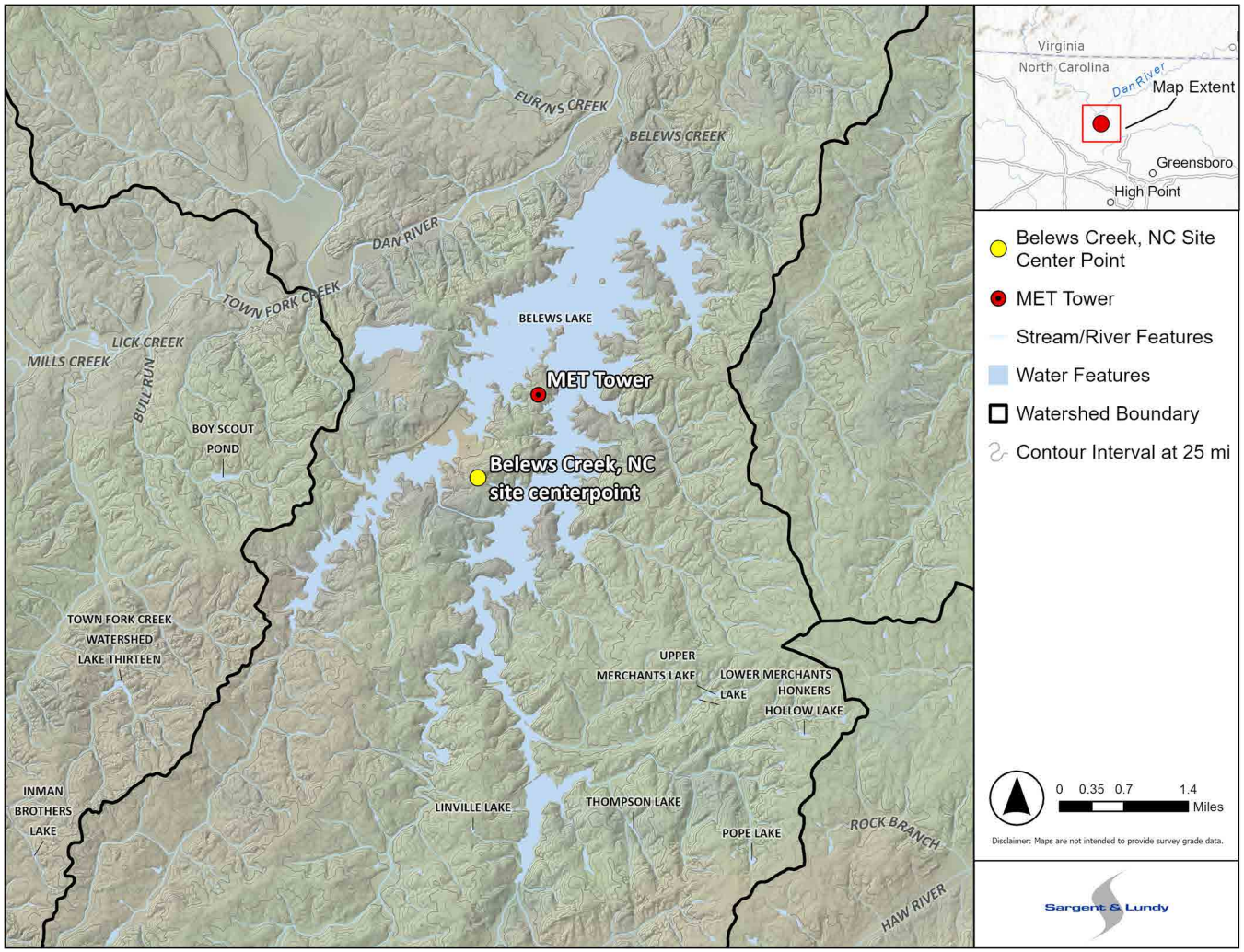
Key: µg/L = micrograms per liter; CORMIX = Cornell Mixing Zone Expert System; m = meter; ZID = Zone of Initial Dilution

Figure 5.4-1
LOS on Primary Roadways During Operations Phase



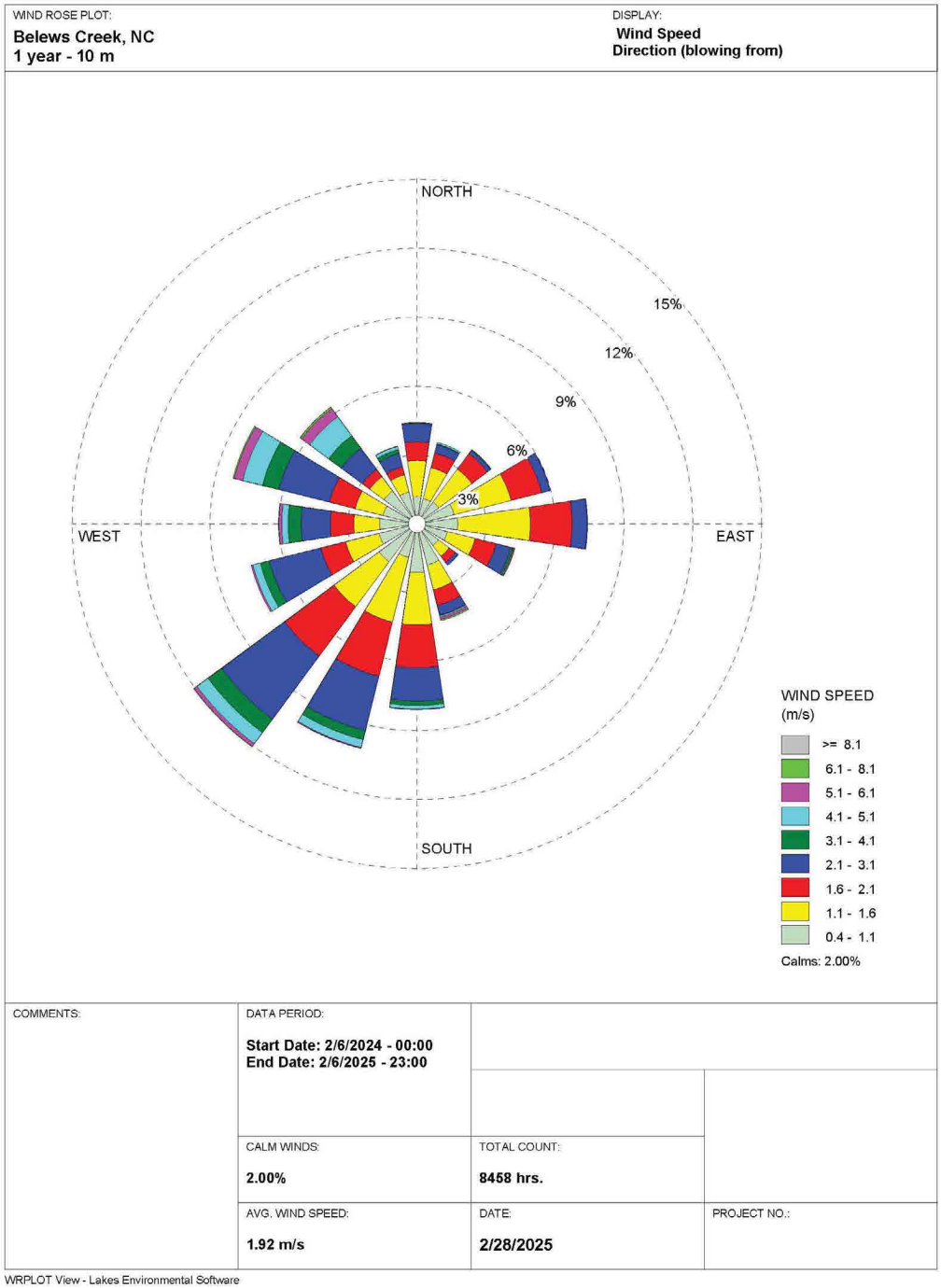
Key: LOS = level of service; Rd = Road

Figure 5.7-1
Location of the Belews Creek, NC Site Meteorological Tower



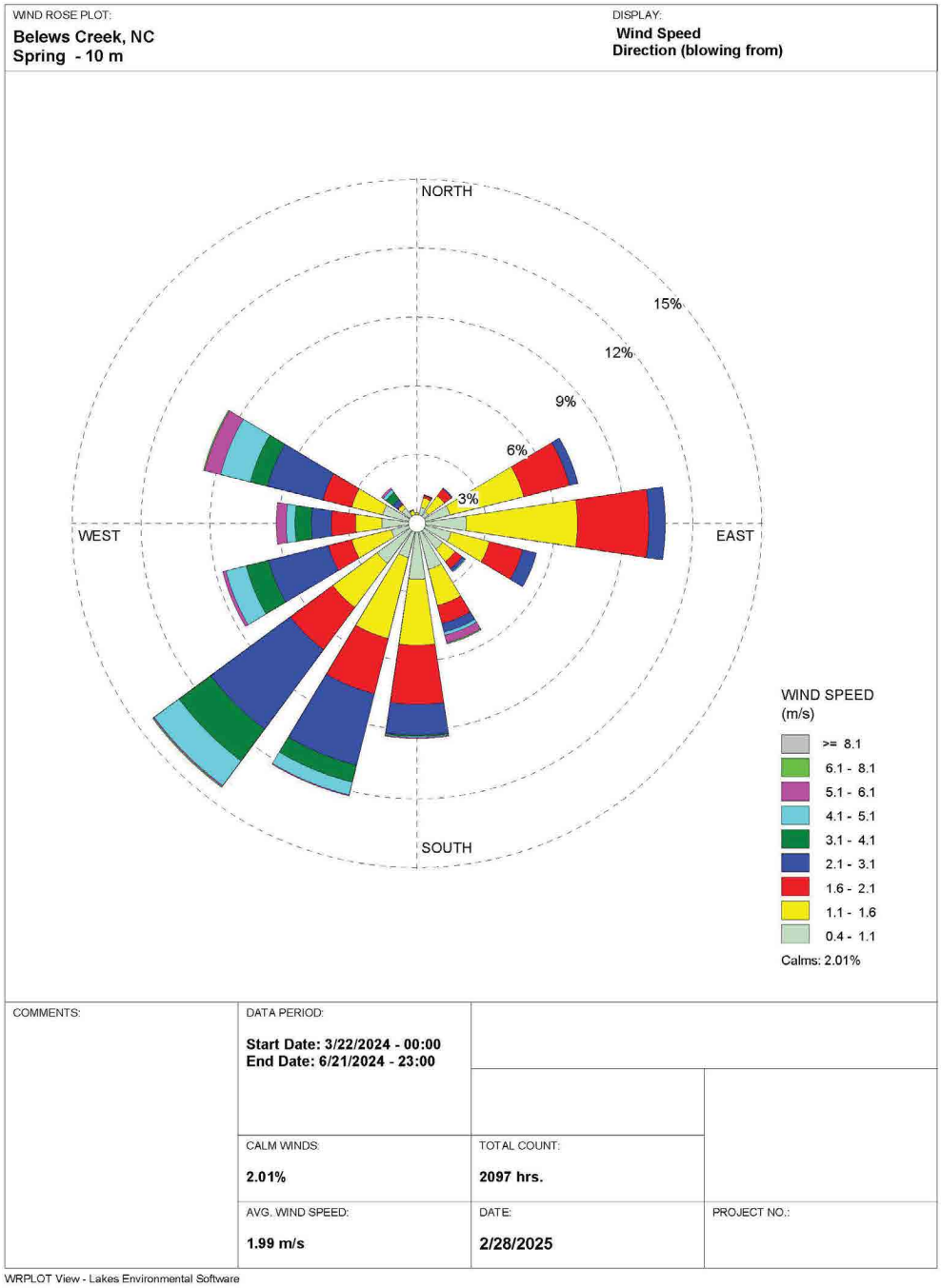
Key: ft = foot; MET = meteorological ; mi = mile; NC = North Carolina

Figure 5.7-2
Annual Wind Rose (10 m AGL) On-Site Meteorological Tower Project Site



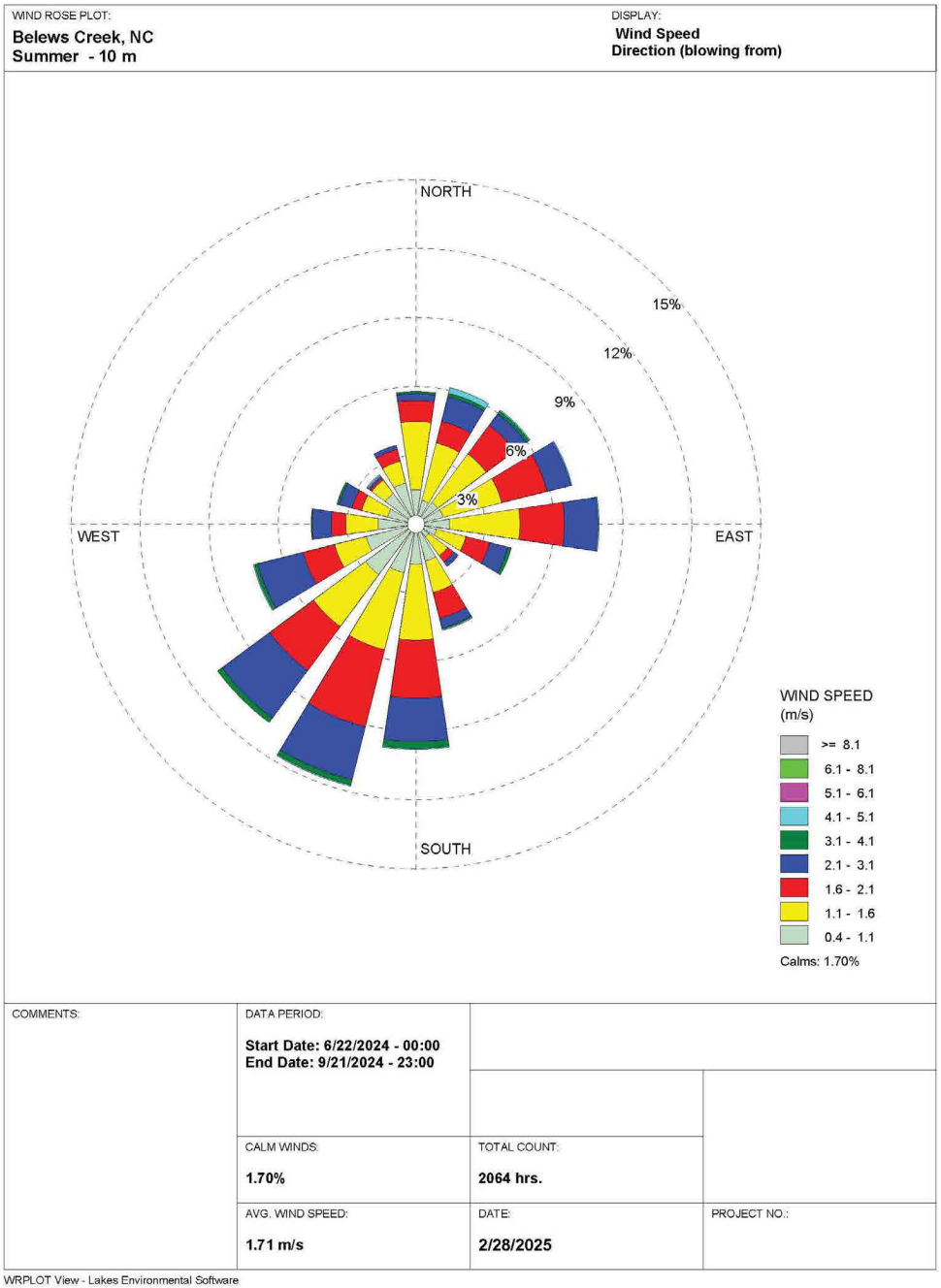
Key: AGL = above ground level; hrs. = hours; m = meter; m/s = meters per second; NC = North Carolina

Figure 5.7-3
Spring Wind Rose (10 m AGL) On-Site Meteorological Tower Project Site



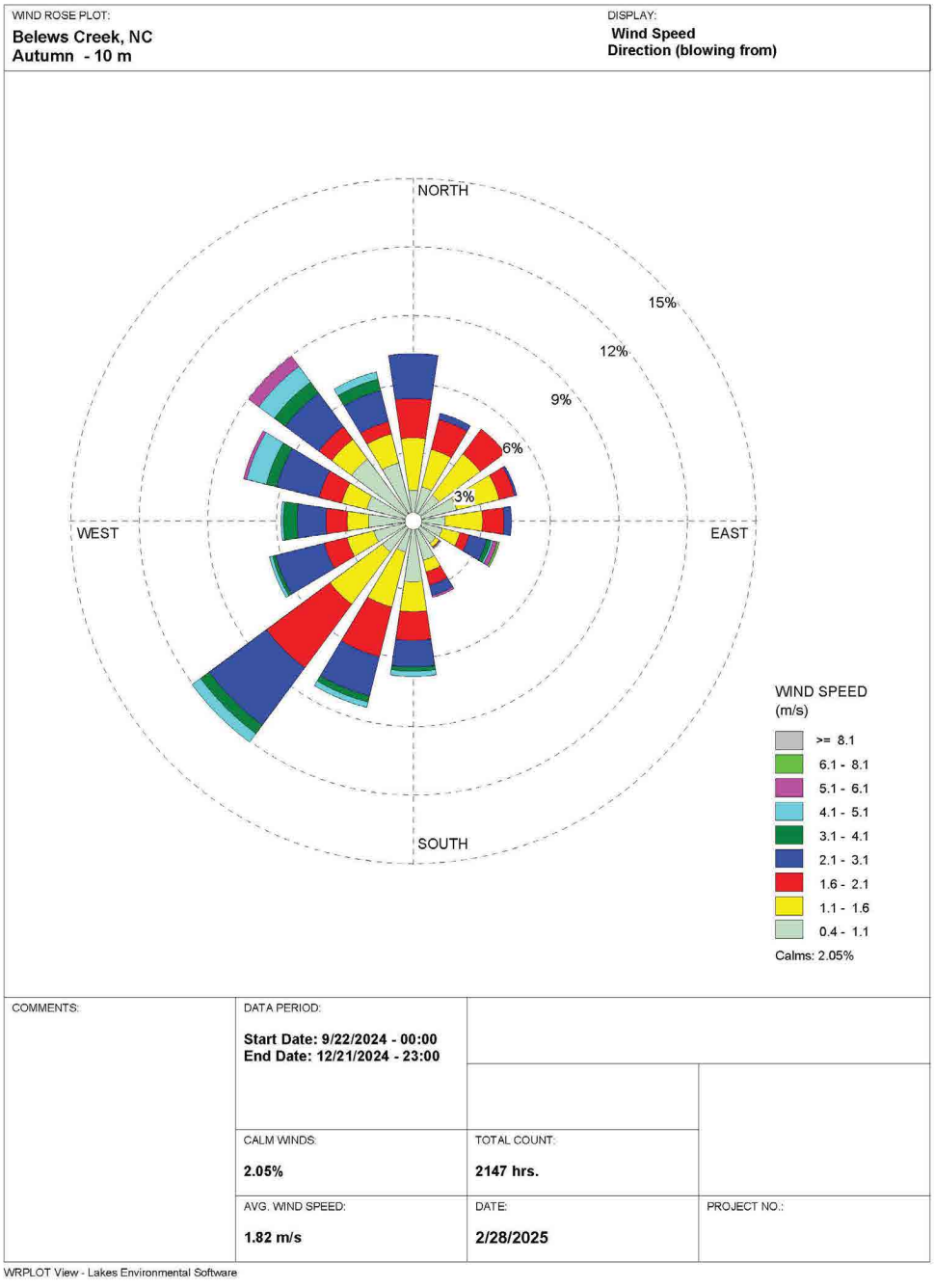
Key: AGL = above ground level; hrs. = hours; m = meter; m/s = meters per second; NC = North Carolina

Figure 5.7-4
Summer Wind Rose (10 m AGL) On-Site Meteorological Tower Project Site



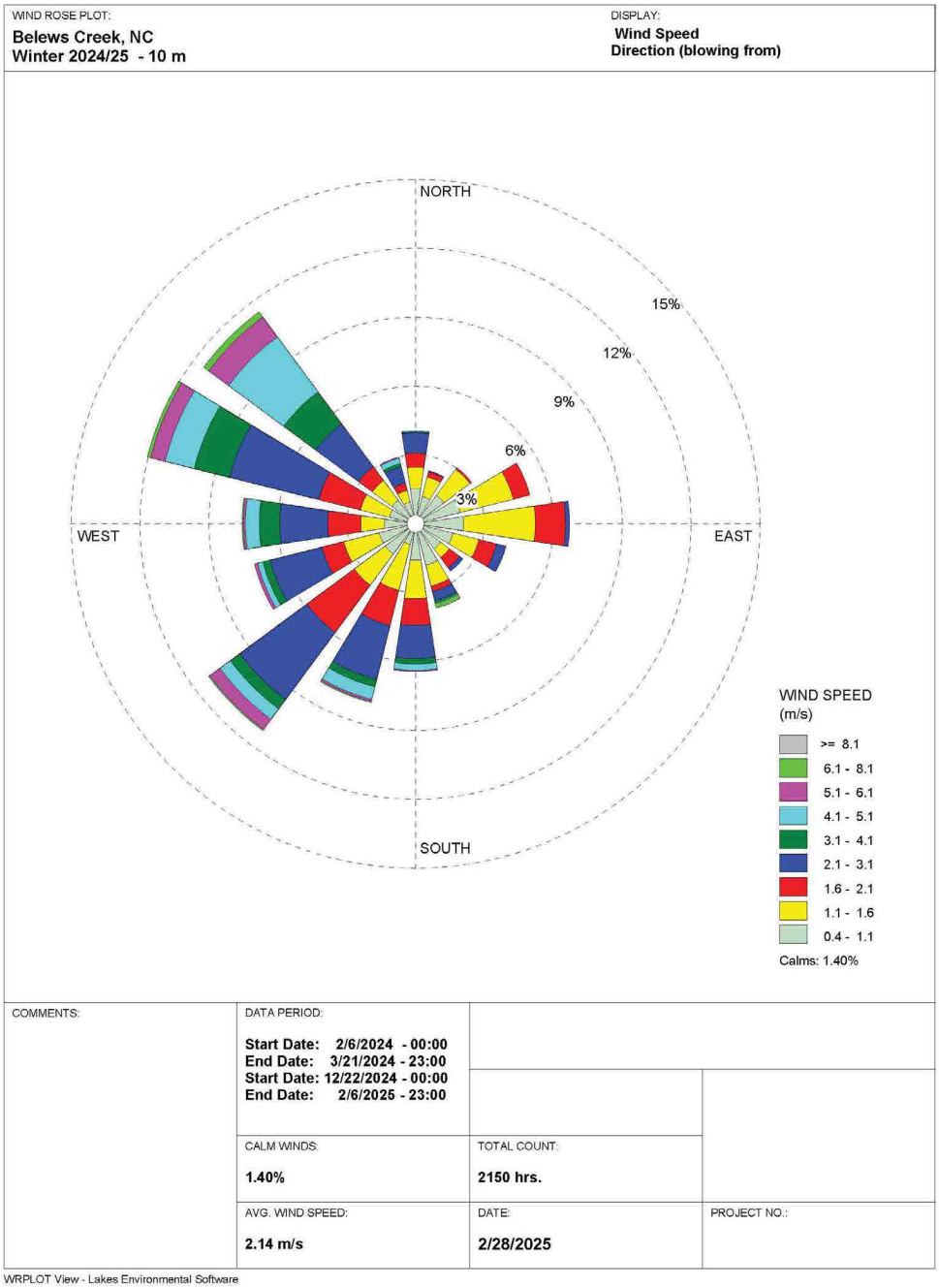
Key: AGL = above ground level; hrs. = hours; m = meter; m/s = meters per second; NC = North Carolina

Figure 5.7-5
Fall Wind Rose (10 m AGL) On-Site Meteorological Tower Project Site



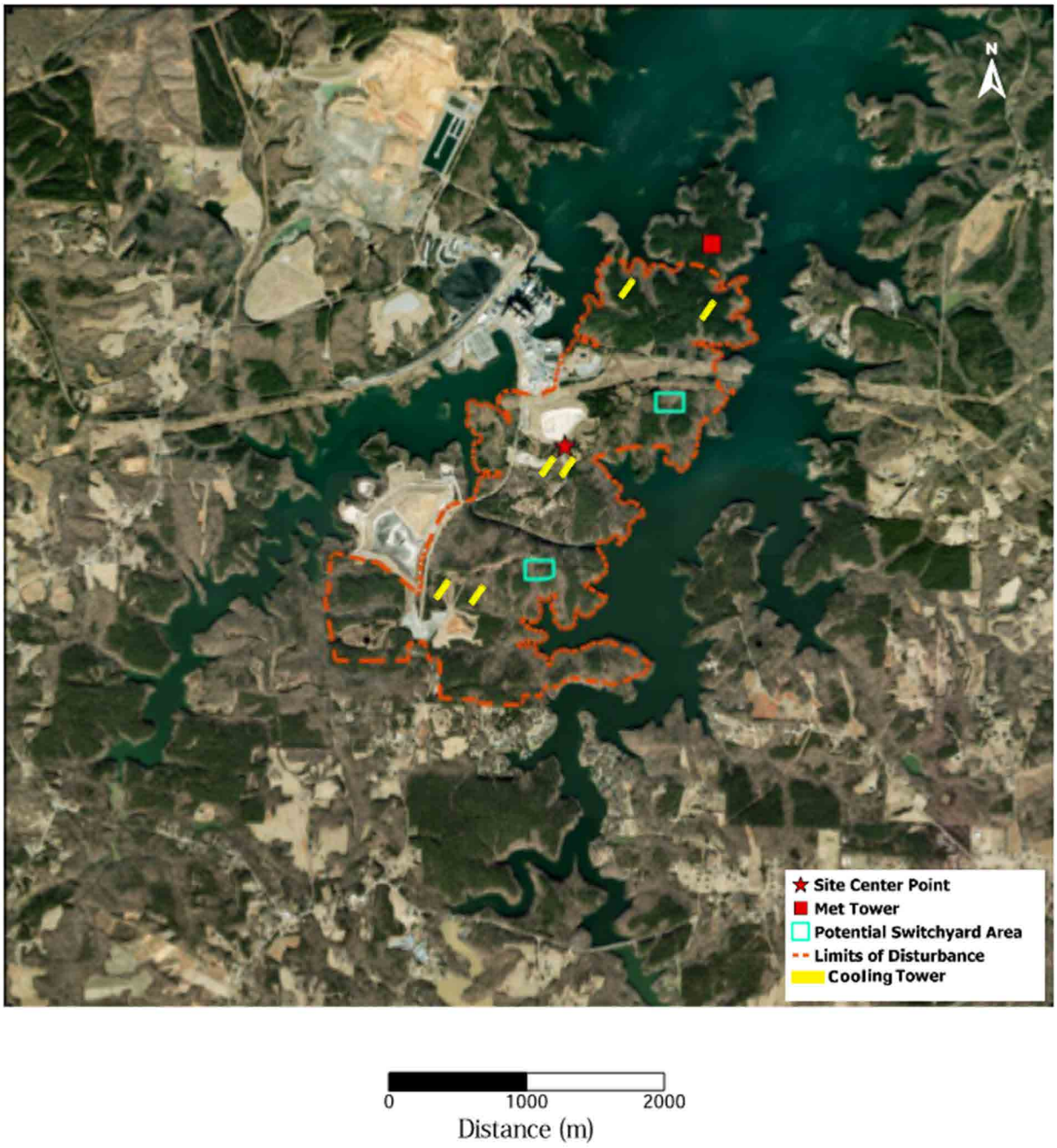
Key: AGL = above ground level; hrs. = hours; m = meter; m/s = meters per second; NC = North Carolina

Figure 5.7-6
Winter Wind Rose (10 m AGL) On-Site Meteorological Tower Project Site



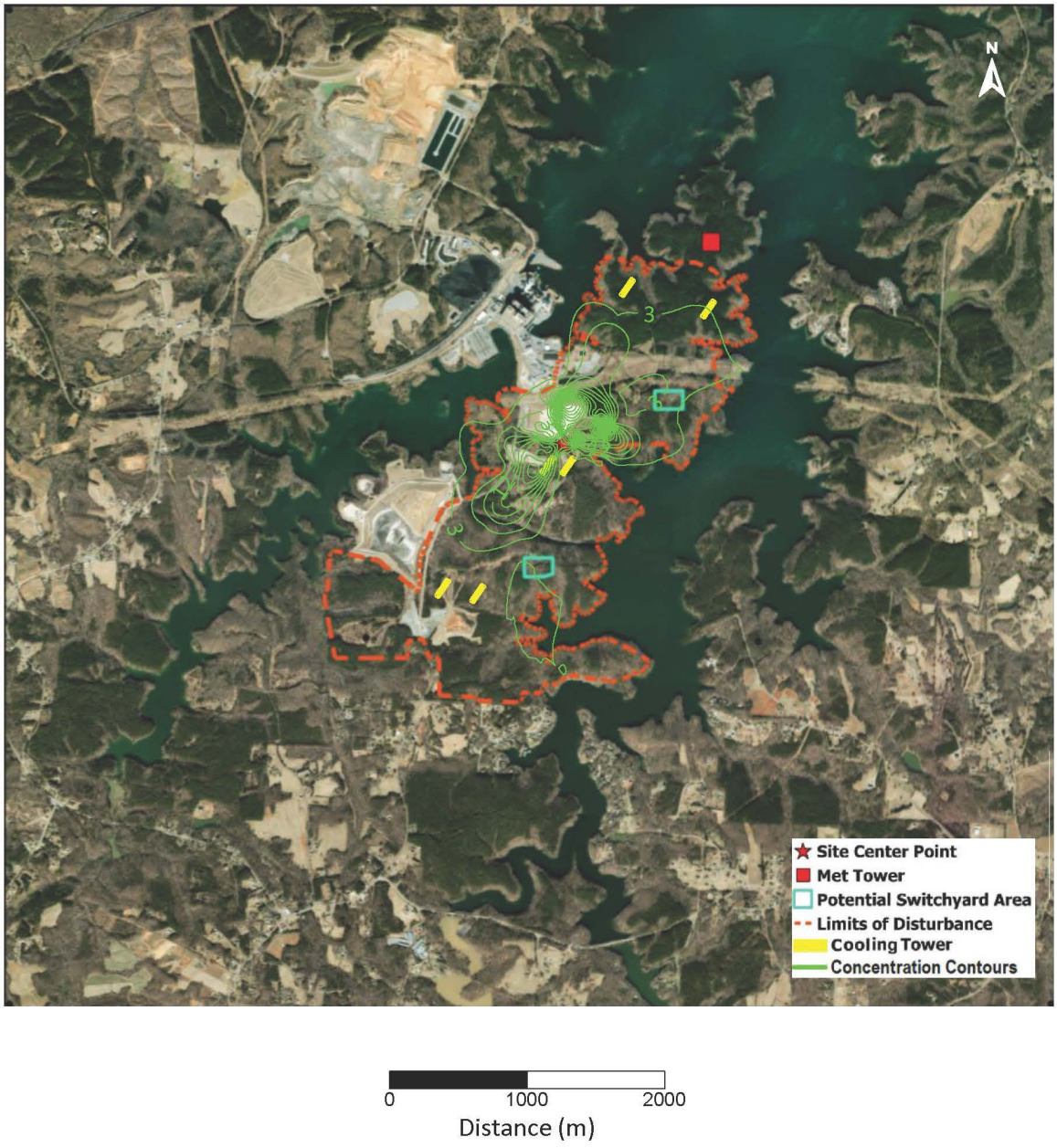
Key: AGL = above ground level; hrs. = hours; m = meter; m/s = meters per second; NC = North Carolina

Figure 5.7-7
Approximate Locations of the Linear Mechanical Draft Cooling Towers at the Belews Creek, NC Site



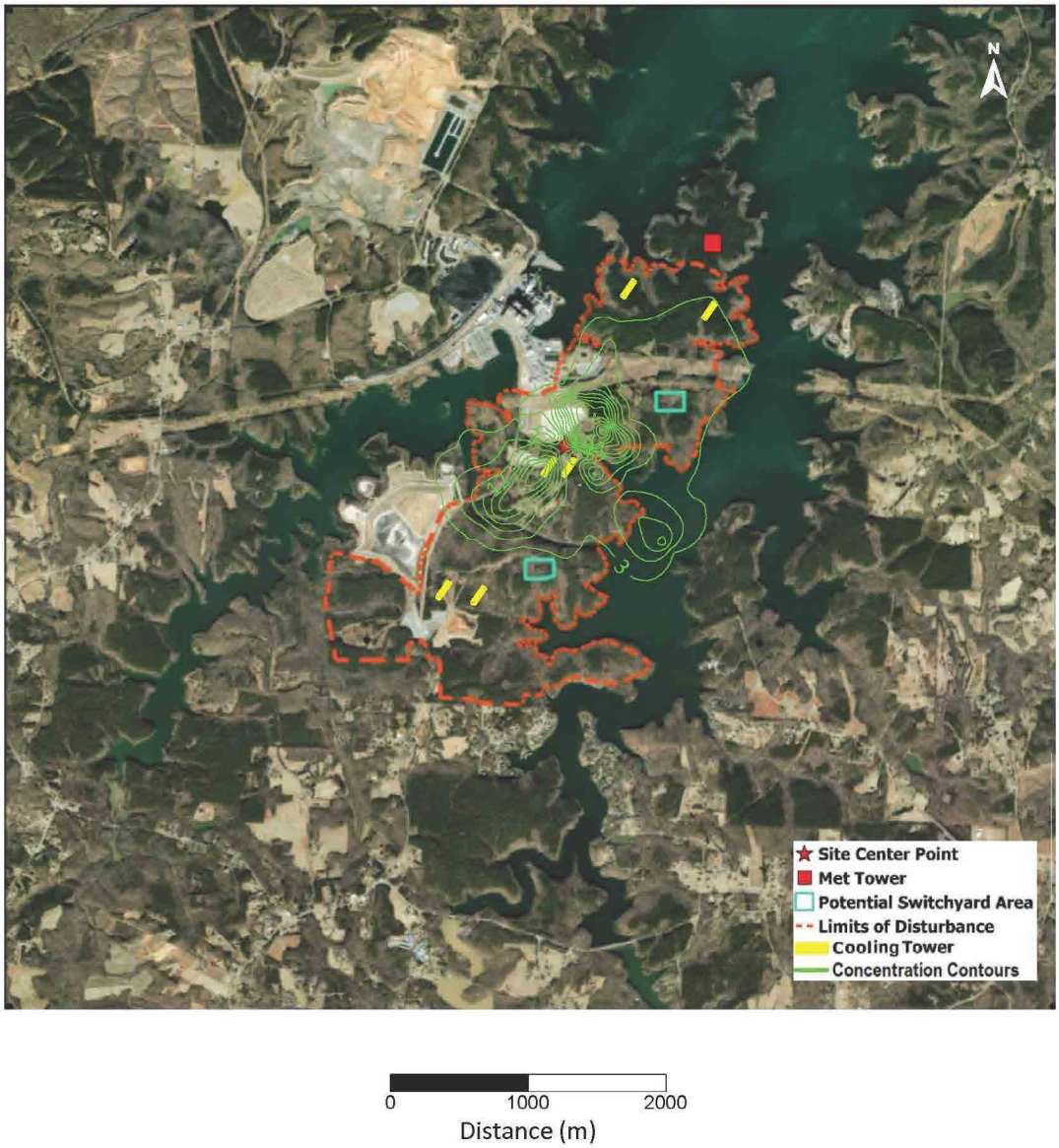
Key: m = meter

Figure 5.7-8
Maximum Modeled Seasonal Plume Salt Deposition (Summer, kg/km^2/mo)



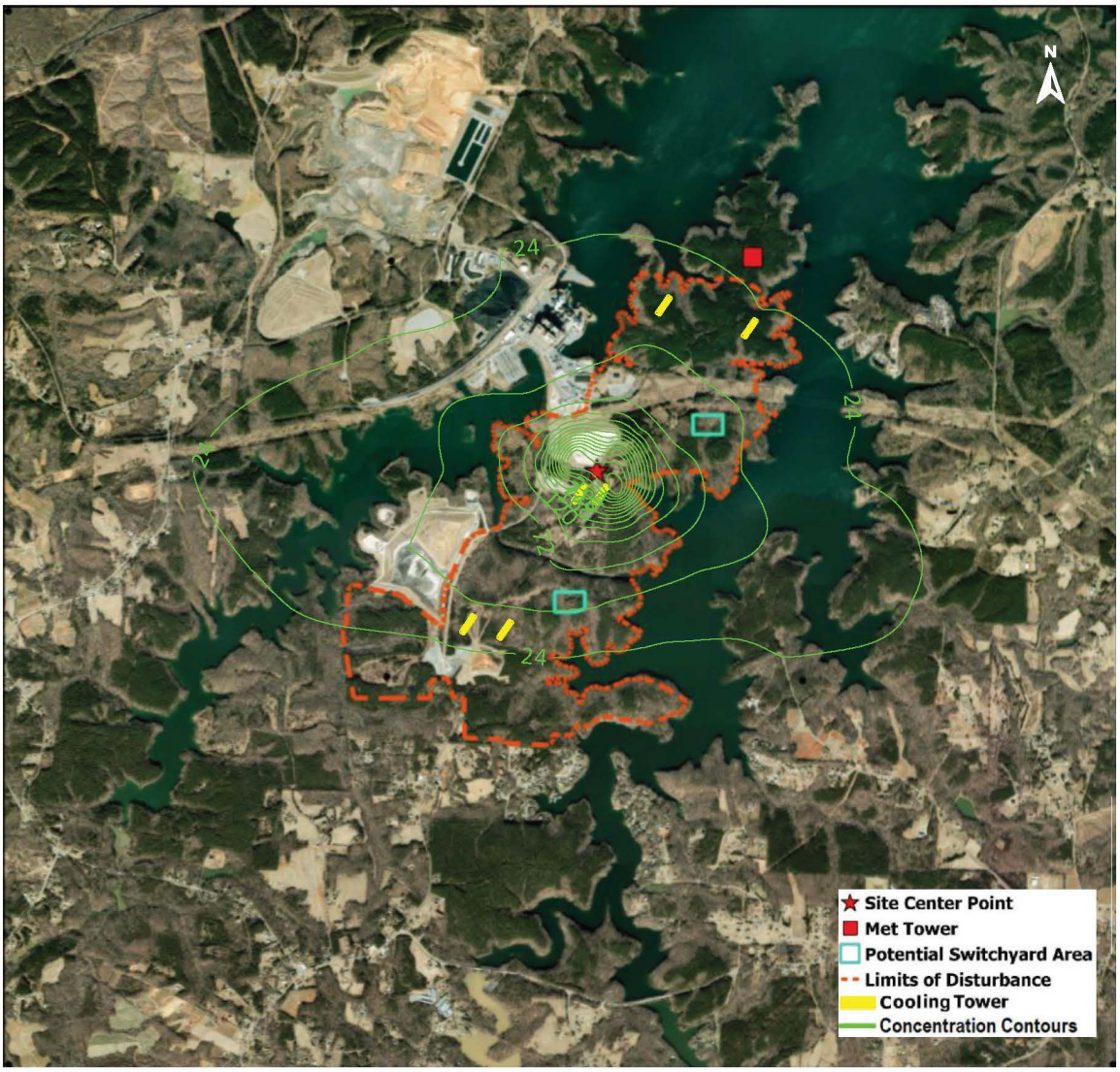
Key: kg/km2/mo = kilograms per square kilometer per month; m = meter

Figure 5.7-9
Modeled Annual Plume Salt Deposition (kg/km^2/mo)



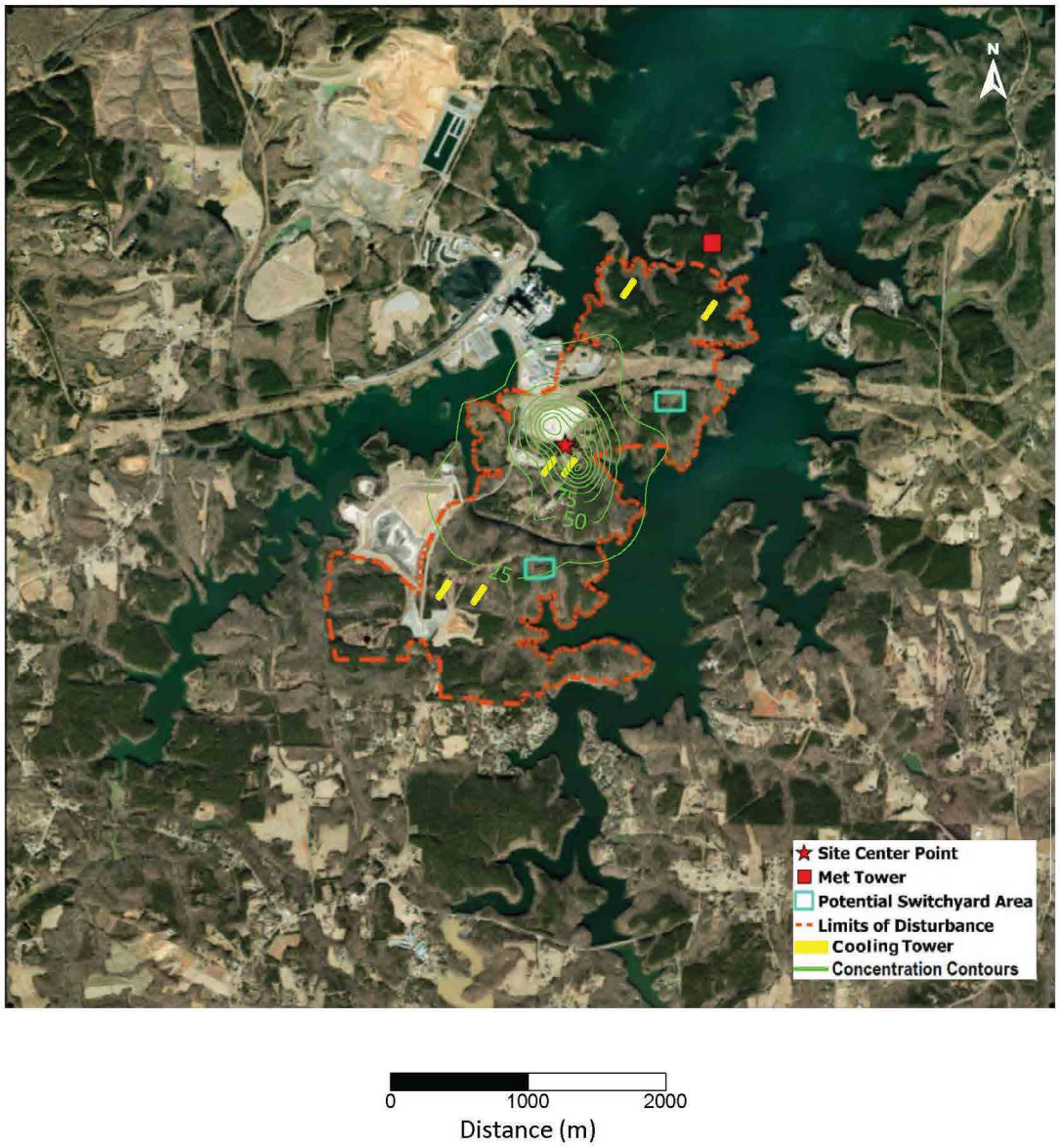
Key: kg/km2/mo = kilograms per square kilometer per month; m = meter

Figure 5.7-10
Maximum Modeled Cooling Tower Plume Shadowing (Annual, Hours)



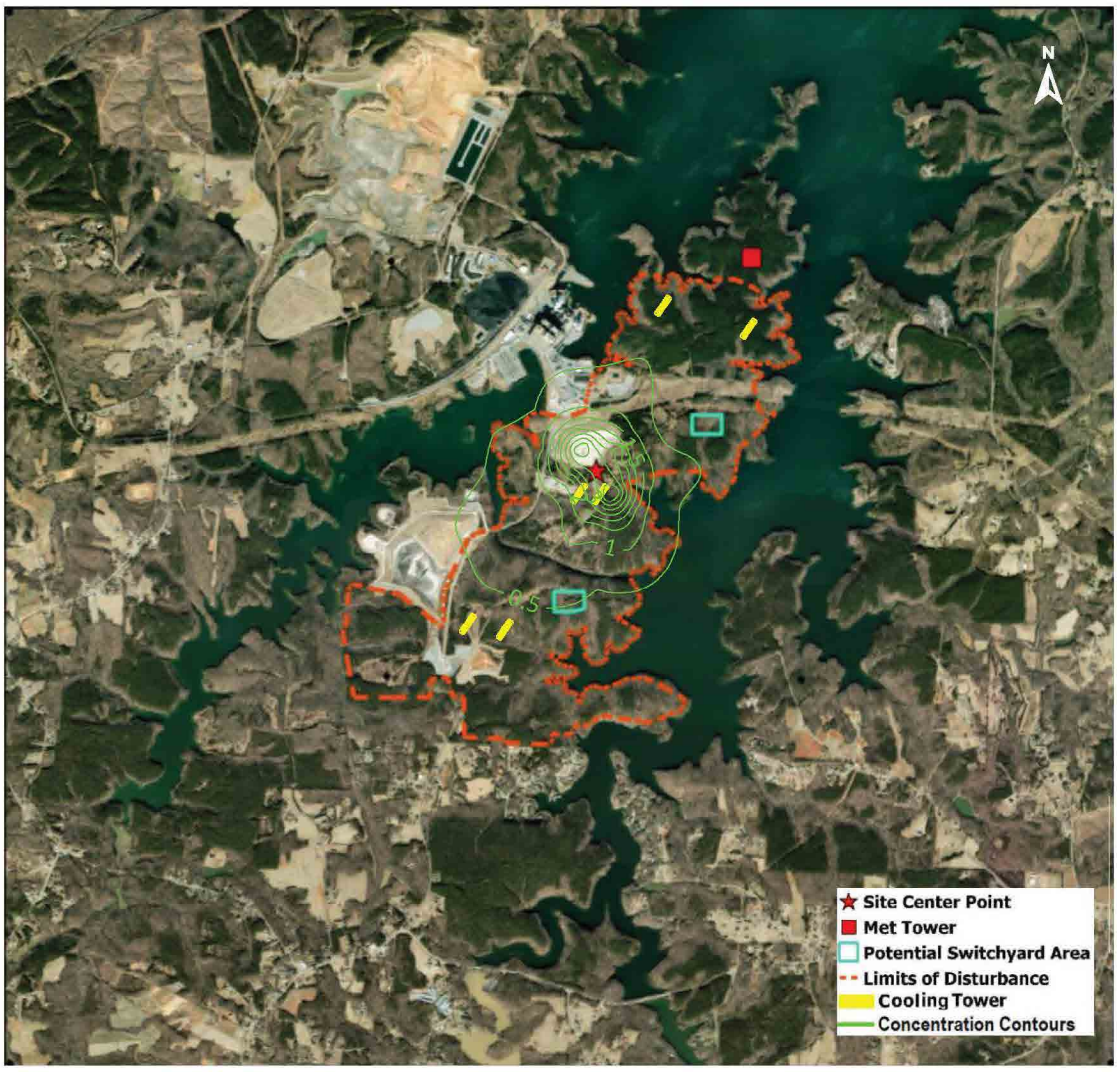
Key: m = meter

Figure 5.7-11
Modeled Annual Total Solar Radiation Losses (MJ/m^2)



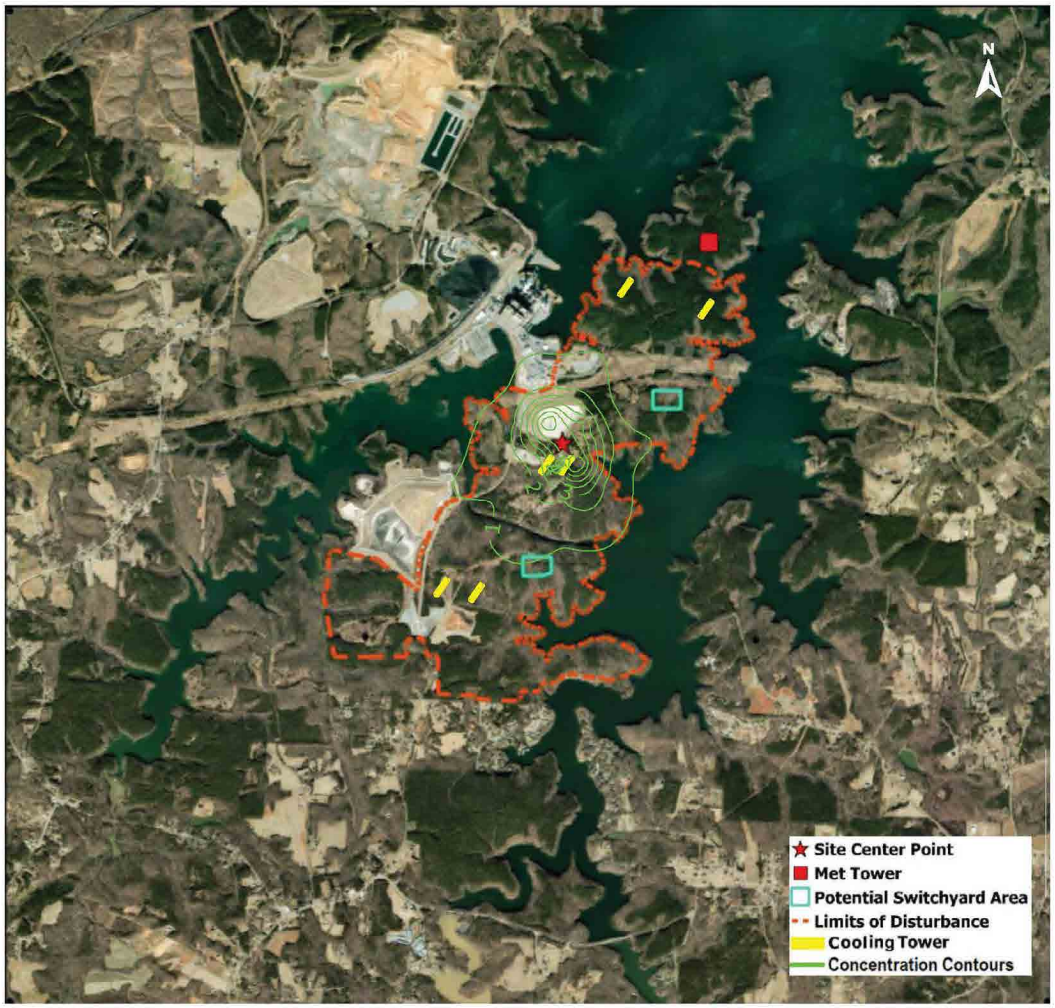
Key: m = meter; MJ/m^2 = megajoules per square meter

Figure 5.7-12
Modeled Annual Fractional Total Solar Radiation Losses (Percent)



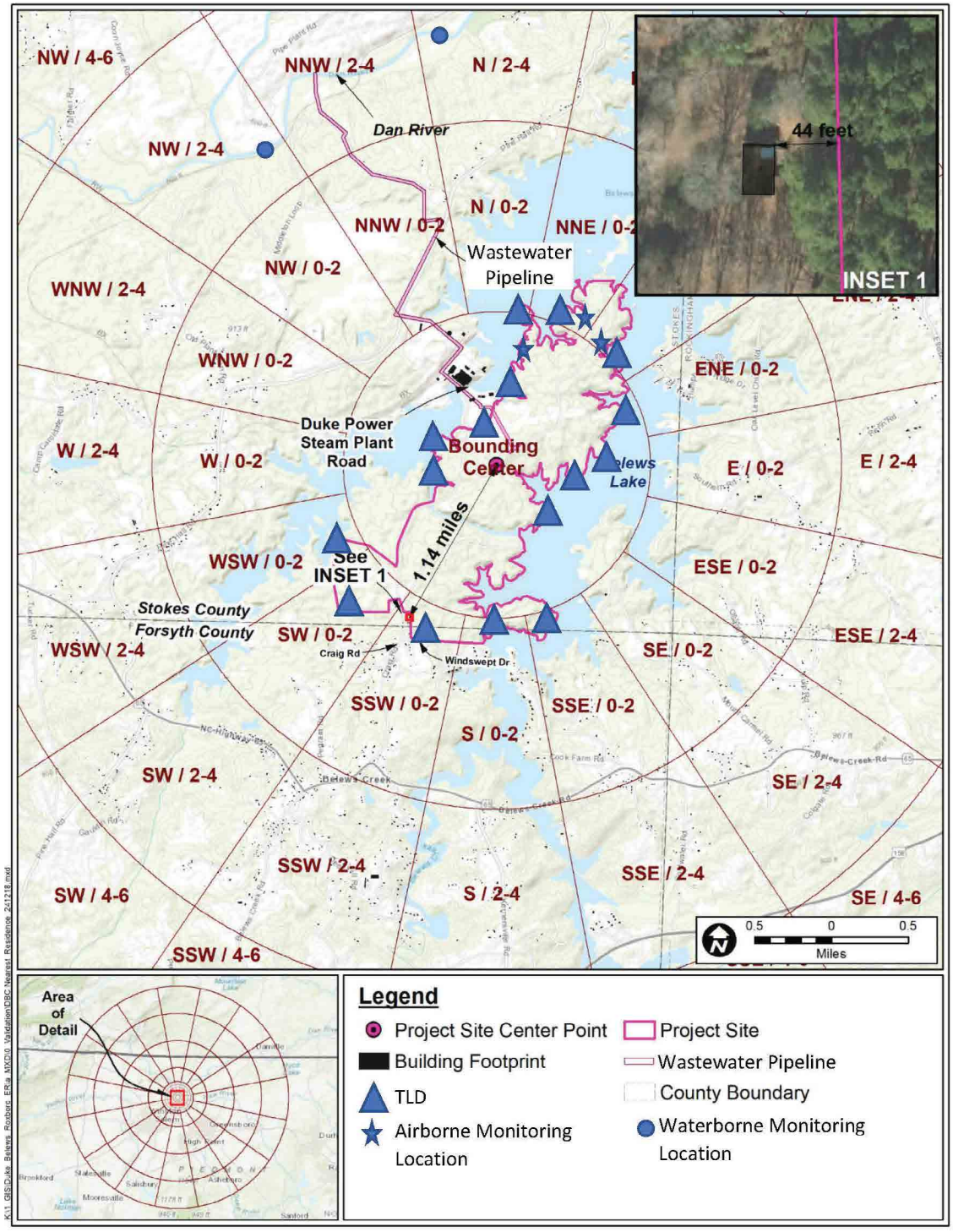
Key: m = meter

Figure 5.7-13
Modeled Annual Fractional Beam Radiation Losses (Percent)



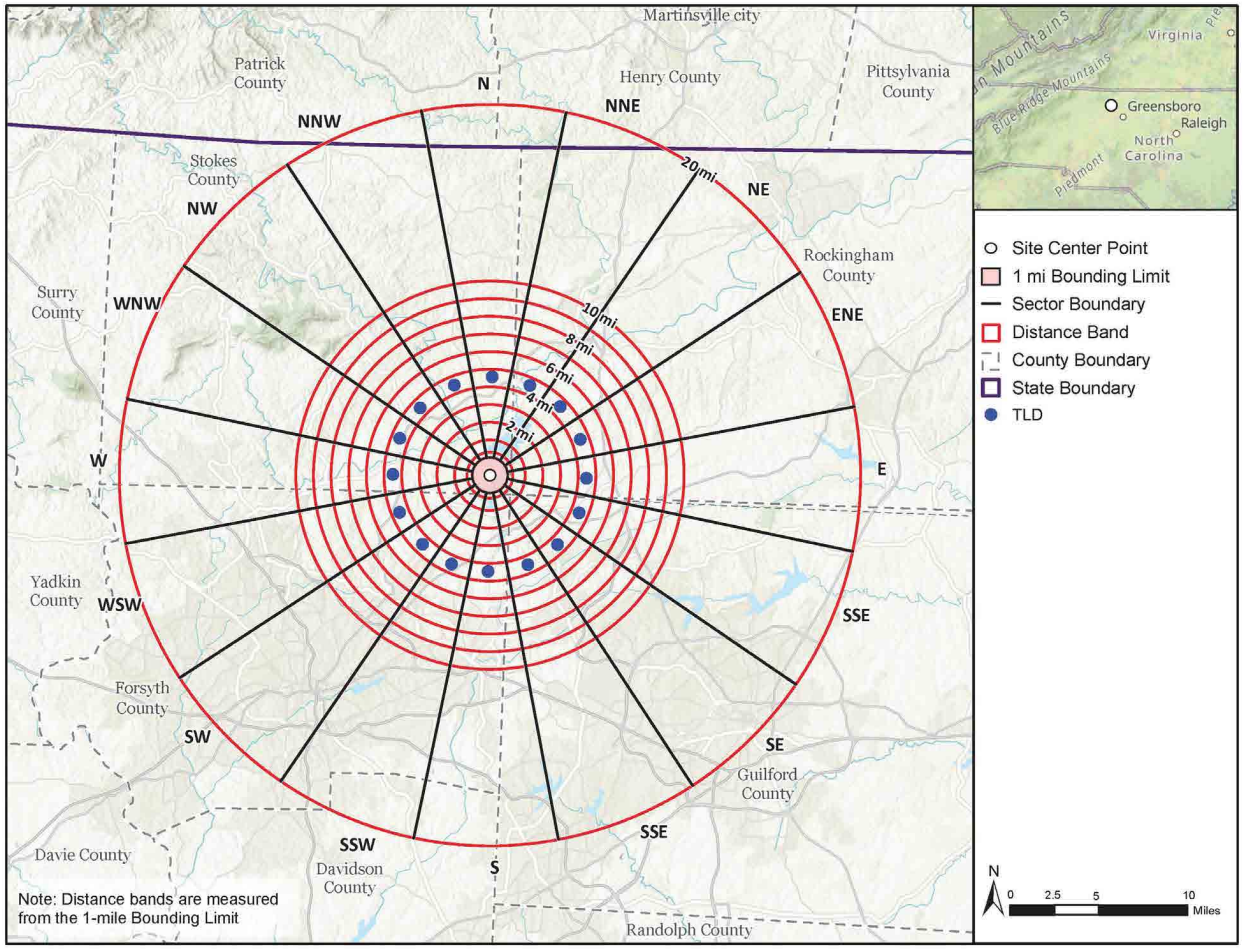
Key: m = meter

Figure 5.9-1
Belews Creek, NC Site Local Radiological Monitoring and Sampling Locations



Key: E = east; ENE = east-northeast; ESE = east-southeast; N = north; NC = North Carolina; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; TLD = thermoluminescent dosimeter; W = west; WNW = west-northwest; WSW = west-southwest

Figure 5.9-2
Belews Creek, NC Site Remote Radiological Monitoring and Sampling Locations



Key: E = east; ENE = east-northeast; ESE = east-southeast; mi = mile; N = north; NC = North Carolina; NE = northeast; NNE = north-northeast; NNW = north-northwest; NW = northwest; S = south; SE = southeast; SSE = south-southeast; SSW = south-southwest; SW = southwest; TLD = thermoluminescent dosimeter; W = west; WNW = west-northwest; WSW = west-southwest

CHAPTER 6
FUEL CYCLE, TRANSPORTATION, AND DECOMMISSIONING IMPACTS

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None.

GLOSSARY

Term	Definition
ac.	acre
BWR	boiling-water reactor
CFR	Code of Federal Regulations
Ci/yr	Curies per year
CO	carbon monoxide
CO_2	carbon dioxide
DECON	Immediate Dismantling
DOE	U.S. Department of Energy
EA	Environmental Assessment
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
ENTOMB	Entombment
ER	Environmental Report
ESP	Early Site Permit
ft^3/yr	cubic feet per year
GEIS	Generic Environmental Impact Statement
GHG	greenhouse gases
GNF-A	Global Nuclear Fuels – Americas, LLCs

GVH	GE Vernova Hitachi Nuclear Energy
ha	hectare
HALEU	high-assay, low-enriched uranium
HLW	high-level waste
HRCQ	Highway Route-Controlled Quantities
HTGR	High-Temperature Gas-Cooled Reactor
ICRP	International Commission on Radiological Protection
in.	inch
ISG	Interim Staff Guidance
kg	kilogram
km	kilometer
km^2	square kilometer
kWh	kilowatt hour
lb.	pound
LLW	low-level waste
LWR	light-water reactor
m/s	meter per second
m^3	cubic meter
mCi	millicuries

mi.	mile
mm	millimeter
mrem	millirem
mrem/hr	millirem per hour
mrem/yr	millirem per year
MT	metric ton
MT CO_2e	metric tons carbon dioxide equivalent
MTU	metric tons uranium
MWd/MTU	megawatt-day per metric ton uranium
MWe	megawatts electric
MWh	megawatt hours
MWt	megawatts thermal
NC	North Carolina
NCRP	National Council on Radiation Protection and Measurements
NFFF	Natrium Fuel Fabrication Facility
NNSS	Nevada National Security Site
NO_X	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission

NuScale	NuScale Power, LLC
NUREG	NRC Technical Report designation
PPE	plant parameter envelope
Project site	Belews Creek, NC site
PWR	pressurized-water reactor
RG	Regulatory Guide
ROW	right-of-way
SAFSTOR	Safe Storage
SMR	small modular reactor
SNF	spent nuclear fuel
SO_X	sulfur oxides
SSCs	structures, systems, and components
SWU	separative work unit
TerraPower	TerraPower, LLC
TRISO	TRi-structural ISOtropic
TRU	transuranic
U-235	uranium-235
U-238	uranium-238
U_3O_8	triuranium octaoxide

UF_6	uranium hexafluoride
UFC	uranium fuel cycle
UO_2	uranium dioxide
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WCS	Waste Control Specialists
X-energy	X-energy, LLC
yr.	year

Chapter 6 Fuel Cycle, Transportation, and Decommissioning Impacts

6.1 FUEL-CYCLE IMPACTS AND WASTE MANAGEMENT

This section discusses the effects on the environment from the uranium fuel cycle (UFC) associated with the technologies under consideration for the Duke Energy Belews Creek, North Carolina (NC) site (Project site). The UFC is defined as the total of those operations and processes associated with the provision, utilization, and ultimate disposition of fuel for nuclear power reactors.

The United States (U.S.) Nuclear Regulatory Commission (NRC) evaluated the environmental impacts associated with operating UFC facilities other than reactors in two documents: WASH-1248, *Fuel Fabrication Environmental Impacts* and NUREG 0116, *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR [light water reactor] Fuel Cycle*. The types of facilities and their environmental impacts considered in these two documents include:

- Uranium recovery facilities:
    - Uranium mining – facilities in which the uranium ore is mined.
    - Uranium milling – facilities in which the uranium ore is refined to produce uranium concentrates in the form of triuranium octaoxide (U_3O_8).
- Uranium conversion – facilities in which the uranium concentrates are converted to uranium hexafluoride (UF_6).
- Enrichment – facilities in which the isotopic ratio of the uranium-235 (U-235) isotope in natural uranium is increased to meet the requirements of LWRs.
- Fuel fabrication – facilities in which the enriched UF_6 is converted to uranium dioxide (UO_2) and made into sintered UO_2 pellets. The pellets are subsequently encapsulated in fuel rods, and the rods are assembled into fuel assemblies ready to be inserted into the reactors.
- Reprocessing – facilities that disassemble the spent fuel assemblies, chop up the fuel rods into small sections, chemically dissolve the spent fuel out of sectioned fuel rod pieces, and chemically separate the uranium in spent fuel from the plutonium for reuse and from other radionuclides (primarily fission products and actinides).
- Storage and disposal of radiological wastes – facilities in which the radioactive wastes generated at all fuel cycle facilities, including the reactors, are buried. Spent nuclear fuel (SNF) that is removed from the reactors and not reprocessed was also assumed to be disposed of at a geologic repository.

Title 10 of the Code of Federal Regulations (CFR) 51.51(a) requires that:

> "Every environmental report prepared for the construction permit stage or early site permit stage or combined license stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S–3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects

> of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S–3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility."

10 CFR 51.51 and Table S-3 are specific to applications for light-water cooled nuclear power reactors. However, as required in 10 CFR 51.50(b)(3) and 51.50(c), for other than light-water-cooled nuclear power reactors (i.e., non-LWRs), an Environmental Report (ER) for an Early Site Permit (ESP) or a Combined License shall contain the basis for evaluating the contribution of the environmental effects of fuel cycle activities for the nuclear power reactor.

Four of the six technologies under consideration for the Project site are small modular reactors (SMRs) that are based on traditional LWR technology and that use conventional fuel (i.e., UO_2 fuel pellets with an enrichment of less than 5 percent): the GE Vernova Hitachi Nuclear Energy (GVH) BWRX-300, the NuScale VOYGR, the Holtec SMR-300, and the Westinghouse AP300. Therefore, environmental impacts from the UFC for these reactors can be appropriately estimated using Table S-3 as described in 10 CFR 51.51.

To estimate environmental impacts of the UFC using Table S-3, environmental impacts from Table S-3 (which are estimated for a reference 1000 megawatts electric [MWe] LWR with a capacity factor of 80 percent) must be scaled to the proposed plant using the effective electric output, which is the product of the net electric output of the plant and the capacity factor.

Because each SMR listed above has a different power output, different technologies would utilize differing numbers of units on the site and produce a different total output. For this analysis, the bounding value of 2250 MWe maximum gross output is used as the total site output (2100 MWe net output). The maximum capacity factor among the advanced reactors listed above is the Westinghouse AP300, with a capacity factor of 97 percent or higher, and 97 percent has been used as the bounding value for this analysis. Table 6.1-1 shows these values and the associated scaling factor used to complete the comparison with Table S-3.

Table 6.1-2 shows environmental impacts of the reference reactor from Table S-3 and environmental impacts estimated for the Project site LWRs, using the bounding values for power output and capacity factor described above. Section 6.1.1 presents a detailed discussion of environmental impacts from the UFC for LWRs at the Project site.

The fifth technology under consideration for the Project site is X-energy's Xe-100. This advanced reactor is a gas-cooled reactor using TRi-structural ISOtropic (TRISO) fuel, which also uses high-assay, low-enriched uranium (HALEU) metallic fuel. Because this is not an LWR using traditional UO_2 fuel, this reactor is considered separately in Section 6.1.2.

The sixth technology under consideration for the Project site is the TerraPower Natrium reactor. This is a sodium-cooled reactor using HALEU metallic fuel. Because this is not an LWR using traditional UO_2 fuel, this reactor is considered separately in Section 6.1.3.

The United States does not currently reprocess spent fuel, therefore, only the no-recycle option is described here. The data provided in Table S-3, however, are bounding of the maximum recycle option impact for each element of the fuel cycle. Thus, the analysis of the environmental

impacts of the uranium fuel cycle based on Table S-3 presented here is not related to selection of a specific recycling option. As described in Section 6.1.2, reprocessing is not considered for TRISO fuel.

6.1.1 COMPARISON TO TABLE S-3 FOR LWR TECHNOLOGIES

In general, environmental impacts from the UFC for LWRs have decreased since Table S-3 was developed, for the following reasons:

- In situ recovery uranium mining is increasingly common; unlike methods in general use when Table S-3 was developed, this method does not produce mine tailings and releases less radon gas.
- U.S. uranium enrichment technology is transitioning from gaseous diffusion to gas centrifugation. The latter process uses only a small fraction of the electrical energy per separation unit compared to gaseous diffusion.
- Current LWRs use nuclear fuel more efficiently because of higher fuel burnup. Less uranium fuel per year of reactor operation is required than in the past to generate the same amount of electricity. This increase in fuel use efficiency means that lower environmental impacts from fuel production activities are attributable to a given amount of electricity generation. In addition, LWRs are discharging fewer spent fuel assemblies per reactor-year, so the waste storage/repository impact is lessened.
- Closure of U.S. coal plants means that electrical generation sources used by UFC facilities produce less gaseous effluent.

For all these reasons, Table S-3 is a conservative estimate of environmental impacts from the UFC. In NUREG-1437, Rev. 0, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, issued in 1996, the NRC provided a detailed analysis and concluded that the assumptions and methodologies used in preparing Table S-3 were conservative enough that the impacts described by the use of Table S-3 would still be bounding. In NUREG-1437, Rev. 1, issued in 2013, and Rev. 2, issued in 2024, the NRC confirmed that this conclusion still holds. Because the extensive discussion found in NUREG-1437, Rev. 0, is not repeated in the newer revisions, the subsections below reference information and analyses from Rev. 0 of NUREG-1437. These analyses and the resulting conclusions are all confirmed in the newer revisions of the document. Therefore, the information in Table S-3 remains adequate for use in the bounding approach used in this analysis.

6.1.1.1 Land Use

The total annual land requirement for the UFC supporting an LWR plant at the Project site is presented in Table 6.1-2. This includes values for both permanently and temporarily committed land. NUREG-1555, Initial, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan* states that a “temporary” land commitment is a commitment for the life of the specific UFC plant (for example, a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after plant shutdown or decommissioning. This is because decommissioning activities on the pertinent land cannot remove sufficient radioactive material to meet the limits in 10 CFR Part 20, Subpart E, for release of land for unrestricted use. The division of temporarily committed land

into undisturbed and disturbed land is presented in Table 6.1-2. Based on values for coal plants presented in NUREG-1437, Rev. 0, a coal-fired power plant using strip-mined coal with the same power output capacity as the Project site requires the disturbance of approximately 450 acres (ac.) (182 hectares [ha]) per year for fuel alone, a larger value than the combined temporary and permanent land use shown for the Project site LWRs in Table 6.1-2. The values shown in Table 6.1-2 demonstrate that impact on land use from the UFC to support the Project site for the LWR technologies is SMALL.

6.1.1.2 Water Use

The primary water requirement of the UFC is waste heat removal from power stations supplying electrical energy to the enrichment stage of the UFC. Values for water uses required for the Project site LWRs are presented in Table 6.1-2.

In Table S-3, water requirements for the UFC supporting a 1000-MWe reference reactor are compared to the annual requirements for an LWR. The amount of water withdrawn from surface and groundwater and discharged to air by UFC activities represents only 2 percent of the annual discharges to air of an LWR with cooling towers. The UFC discharges are spread among facilities involved in the various stages of the fuel cycle; thus, the water discharge to air from any one of these facilities is less than 2 percent of LWR annual discharges. The environmental impacts of water withdrawal, use, and discharge from LWRs with cooling towers are found to have only small, or in special, but unusual, circumstances, moderate environmental impacts. Given that the water discharged to the air from fuel cycle facilities for a reference reactor year is only a small fraction of the discharge from an LWR, the environmental consequences are even smaller.

The amount of water withdrawn from surface and groundwater and discharged to water bodies and to the ground to support the reference reactor represents only 4 percent of the annual discharges to water bodies and the ground of an LWR with once-through cooling. The fuel cycle discharges are spread among UFC facilities; thus, the water discharges from any one of these facilities is less than 4 percent of LWR annual discharges. The environmental impacts of water withdrawal and discharge from LWRs with once-through cooling are found to be small. Given that the water discharged to water bodies and to the ground from UFC facilities for a reference reactor year is only a small fraction of the discharge from an LWR, the environmental consequences are even smaller.

The expected thermal effluent values for the Project site for the LWR technologies are presented in Table 6.1-2. On a thermal-effluent basis, annual discharges from the UFC for a 1000 MWe reference reactor are about 4 percent of those from a 1000-MWe LWR using once-through cooling. In NUREG-1437, Rev. 0, the NRC concluded that even given maximum consumptive water use, thermal effluents would be negligible for the reference reactor, and that environmental impacts associated with the combinations of thermal loadings and water consumption described for the UFC of the reference 1000-MWe reactor were acceptable relative to water use and thermal discharges. Therefore, the Project site LWRs have SMALL environmental impacts associated with water use for the UFC.

6.1.1.3 Fossil Fuel Impacts

Electrical energy and process heat are required during various phases of the UFC process. The electrical energy is usually produced by combustion of fossil fuels at power plants. Electrical energy needs for the UFC associated with the Project site LWRs are presented in Table 6.1-2.

While fossil fuels (coal and natural gas) are consumed to produce electrical energy and process heat during the various phases of the UFC, the use of fossil fuels in the UFC enables the production of electricity with nuclear fuel, resulting in a net savings in the requirements for fossil fuels in order to produce electricity. Electrical energy needs associated with the UFC represents about 5 percent of the annual electrical power production of the reference reactor. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity rather than in the UFC, would produce less than 0.4 percent of the electrical output from the reference reactor.

The NRC provided guidance in Attachment 1 of COL/ESP-ISG-026, Interim Staff Guidance (ISG) on Environmental Issues Associated with New Reactors, for estimating the impacts of greenhouse gas (GHG) emissions from the UFC for a proposed plant. In Appendix A of ISG-026, Attachment 1, fossil fuel use information presented in Table S-3 was used to estimate that the GHG footprint of the fuel cycle to support the reference reactor for a 40-year operational period is on the order of 10,100,000 metric tons of carbon dioxide equivalent (MT CO_2e). This estimate can be scaled to the proposed Project site LWRs using the same scaling factor used throughout the Table S-3 analysis, resulting in an estimate of 27,270,000 MT CO_2e produced over the 40-year life of the plant, or 681,750 MT CO_2e annually. This is approximately 0.47% of NC's annual GHG (USEPA, 2023) and 0.011% of total U.S. annual GHG emissions (USEPA, 2024).

The largest source of CO_2 emissions associated with nuclear power is from electric power generation to support the UFC, and the largest use of electricity in the UFC is the enrichment process. As described above, the switch from gaseous diffusion to the more efficient gas centrifugation, as well as the widespread replacement of coal-based power with natural gas, means that the values for electricity use and air emissions in Table S-3 continue to be appropriate bounding values.

The fossil fuel effects, including GHG emissions, from the consumption of electrical energy for UFC operations are SMALL relative to the net power production of the proposed plant.

6.1.1.4 Chemical Effluents

The quantities of chemical effluents from UFC processes needed to support the Project site LWRs are presented in Table 6.1-2.

The gaseous effluents sulfur oxides (SO_x), nitrogen oxides (NO_x), hydrocarbons, carbon monoxide (CO), and particulates listed in Table S-3 are the consequence of the coal-fired electrical energy used in the UFC. The volume of effluent associated with the UFC of the reference reactor is equivalent to that of a small (45-MWe) coal-fired plant; thus, the contribution to the degradation of air quality is small. The generation of electricity with nuclear rather than coal-fired power, as enabled by the use of fossil fuels in the UFC, results in a net improvement in air quality. For these reasons, the impact of these effluents is considered SMALL.

Table S–3 states that the fuel cycle for the reference 1000-MWe LWR requires 323,000 megawatt hours (MWh) of electricity. The fuel cycle for Project site LWRs would therefore require 872,100 MWh of electricity, or 0.021 percent of the 4.2 billion MWh of electricity generated in the United States in 2023 (EIA 2024). Therefore, the gaseous and particulate chemical emissions would add about 0.021 percent to the national gaseous and particulate chemical effluents for electricity generation, a small additional atmospheric loading in comparison with these total emissions.

Liquid chemical effluents produced in UFC processes are related to fuel enrichment and fabrication and may be released to receiving waters. These effluents are usually present in such small concentrations that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table 6.1-2 presents the amount of dilution water required for specific constituents. Additionally, any liquid discharges into the navigable waters of the United States from plants associated with UFC operations are subject to requirements and limitations set in a National Pollutant Discharge Elimination System (NPDES) permit issued by an appropriate federal, state, regional, local, or affected Native American tribal regulatory agency. The impacts of these liquid chemical effluents from the UFC are SMALL and, therefore, mitigation is not required.

Tailings solutions and solids are generated during the milling process. These materials are not released in quantities sufficient to have a significant effect on the environment.

The impacts of chemical effluents are SMALL.

6.1.1.5 Radiological Effluents

The estimates of radioactive effluent releases to the environment are presented in Table 6.1-2. These are from waste management activities and certain other phases of the UFC process. In NUREG-1437, Rev. 0, the NRC presented an analysis of the effects of radiological effluents from the UFC for the reference reactor, including the effects of radon-222 and technetium-99. which are not addressed in Table S-3. The NRC concluded that the effects of radiological effluents from the UFC for the reference reactor are small. Because the dose to members of the public is a very small fraction of the regulatory limit and an even smaller fraction of natural background exposure, the effects of radiological effluents from the UFC for Project site LWRs, based on the scaling factor applied to the reference reactor UFC effluents as presented in Table 6.1-2, can also be considered SMALL.

6.1.1.6 Radiological Wastes

Quantities of buried radioactive waste material (low level waste [LLW], high level waste [HLW], and transuranic [TRU] wastes), associated with the UFC for the Project site LWRs are specified in Table 6.1-2.

The NRC notes in the reference reactor data presented in Table S-3 that no significant radioactive release to the environment is expected from LLW disposed of at land burial facilities. Land disposal facilities are licensed and regulated by the NRC according to requirements set forth in 10 CFR Part 61. Experience from the operation of these facilities shows that the additional environmental impacts are not significant compared to the impacts described in Table S–3.

The NRC notes in Table S-3 that TRU and HLW wastes are expected to be buried at a repository, and that no release to the environment is expected to be associated with such disposal. The gaseous and volatile radionuclides contained in the spent fuel would have been released and monitored before disposal. The NRC is one of three federal agencies under the Atomic Energy Act with a role in the disposal of spent nuclear fuel and other HLW. Responsibility among the three agencies is described as follows:

- The U.S. Department of Energy (DOE) is responsible for developing permanent disposal capacity for spent fuel and other high-level radioactive waste.

- The U.S. Environmental Protection Agency (USEPA) is responsible for developing environmental standards to evaluate the safety of a geologic repository.

- The NRC is responsible for developing regulations to implement the USEPA safety standards and for licensing the repository.

Because a repository has not yet been licensed, there are no current regulatory limits for off-site releases of radionuclides. If it is assumed that limits for the future repository are developed along the lines of the 1995 National Academy of Sciences report, Technical Bases for Yucca Mountain Standards, and that in accordance with the 2010 update of the NRC's Waste Confidence Decision, 10 CFR 51.23, *Environmental impacts of continued storage of spent nuclear fuel beyond the licensed life for operation of a reactor*, a repository can, and likely will, be developed at some site that will comply with such limits; peak doses to virtually all individuals will be 100 millirem per year (mrem/yr) or less. NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel*, presented an NRC analysis of the environmental impacts of at-reactor storage, away-from-reactor storage, and cumulative impacts of cumulative storage. Most impacts were found to be SMALL and SMALL to MODERATE. The analyses of NUREG-2157 were codified in 10 CFR 51.23.

The NRC regulations for geologic disposal of HLW in 10 CFR Part 60 limit the releases of radioactive material to the accessible environment. In addition to satisfying an overall performance objective to be established by USEPA, the basic requirements are that containment of HLW within the waste packages will be substantially complete for a period determined by the NRC but for a period that shall not be less than 300 nor more than 1000 years after permanent closure of the geologic repository, and that the annual releases from the engineered barrier system thereafter should not exceed one part in 100,000 of the total inventory of each radionuclide calculated to be present 1000 years following permanent closure of the repository. For HLW, 10 CFR 60.111 requires compliance with 10 CFR Part 20 and with USEPA general environmental standards in 40 CFR Part 191.

Based on the discussion presented above, the environmental impact of radioactive waste disposal from the UFC for the Project site LWRs is expected to be SMALL.

6.1.1.7 Occupational Dose

The annual occupational dose attributable to all phases of the UFC for the Project site LWRs is presented in Table 6.1-2. Occupational doses would be maintained to meet the dose limit in 10 CFR Part 20, which is 5 rem/yr. On this basis, it is concluded that environmental impacts from this occupational dose are anticipated to be SMALL.

6.1.1.8 Transportation Dose

The transportation dose to workers and the public is presented in Table 6.1-2 for the Project site LWRs. For comparison, the estimated collective dose from natural background radiation to the population within 80 kilometers (km) (50 miles [mi.]) of the Project site is 6508 person-Sv/yr (650,840 person-rem/yr). This is based on a 2020 population of 2,032,605 and an average individual dose of 320 mrem/yr in NC (Mauro and Briggs, 2005). On this basis, the environmental impacts of transportation are anticipated to be SMALL.

6.1.1.9 Conclusions for the LWRs

Based on the discussion in the above subsections and using Table S-3 as stipulated in 10 CFR 51.51, the environmental effects from the UFC for any of the SMR technologies based on LWRs being considered for use at the Project site would be SMALL.

6.1.2 COMPARISON TO TABLE S-3 FOR THE XE-100 TECHNOLOGY

The Xe-100 is a gas-cooled reactor that uses TRISO fuel pebbles. TRISO fuel is composed of fuel particles or seeds less than 1 millimeter (mm) (0.04 inches [in.]) in diameter. Each has a kernel (approximately 0.5 mm [0.02 in.]) of uranium oxycarbide (or UO_2), and the uranium is likely to be enriched up to 20 percent by weight of U-235. This kernel is surrounded by layers of carbon and silicon carbide, giving a containment for fission products that is expected to be stable up to very high temperatures (up to 1800 degrees Celsius [3272 degrees Fahrenheit]). These particles are arranged in billiard ball-sized pebbles of graphite encased in silicon carbide, each with about 19,000 fuel particles and 0.25 ounces (7 grams) of uranium.

The DOE report *Non-LWR Fuel Cycle Environmental Data* (PNNL-29367) estimated the environmental impacts of the UFC for several non-LWR technologies, including a helium-cooled pebble bed modular reactor using TRISO fuel (Napier, 2020).

As described in PNNL-29367, because TRISO is a uranium based fuel, its UFC relies on uranium recovery facilities and processes similar to those used in developing Table S-3 and described in Section 6.1 above. Similarly, the decrease in environmental impacts since the development of Table S-3 described in Section 6.1.1 is applicable to the discussion of the TRISO fuel cycle, because uranium used in TRISO fuel is mined, converted, and enriched at the same facilities (Napier, 2020). Each of the six types of facilities described in the introduction to Section 6.1 is considered below in more detail.

NUREG-1910, *Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities* addresses common environmental issues associated with the building, operating, and decommissioning of this type of facility, as well as groundwater restoration. In situ recovery has removed many of the causes of harmful uranium recovery impacts because this process does not directly remove the uranium ore from a site, transport the uranium ore to a large milling facility, and process large volumes of uranium ore that produce tailing piles and leachate ponds and the associated release of radon gas. Thus, the in situ recovery process avoids many of the environmental impacts of these past uranium recovery processing steps. Therefore, the environmental impacts for in situ recovery are expected to be less than those listed in Table S-3 for uranium recovery facilities. Thus, Table S-3 can be considered to be bounding for environmental impacts related to uranium recovery for the UFC supporting the Xe-100, even though this technology was not considered during development of Table S-3.

Uranium conversion in the United States occurs at a single facility. Since the development of Table S-3, improvements in efficiency at both the conversion facility and operating nuclear plants, the passage of more stringent environmental regulations, and the conversion of coal-fired power generation stations to less environmentally impactful alternatives have reduced the overall environmental impacts of uranium conversion compared to those assessed for Table S-3. Therefore, it is appropriate to consider Table S-3 bounding for the UFC supporting the Xe-100 with regard to uranium conversion, even though this technology was not considered during development of Table S-3.

A similar argument applies for enrichment. The separative work unit, or SWU, is the standard measure of the effort required to separate isotopes of uranium (U-235 and uranium-238 [U-238]) during an enrichment process and is independent of the enrichment process (either gaseous or centrifuge). To obtain 2200 pounds (lb.) (1000 kilograms [kg]) of uranium enriched 4 percent by weight from natural uranium, assuming the tails are 0.25 percent U-235 by weight, requires 5832 SWU. To obtain the same amount of 20 percent enriched uranium (the maximum for TRISO fuel), requires 41,579 SWU (UXC, 2024). The gaseous-diffusion process consumes about 2500 kilowatt hours (kWh) per SWU, while modern gas centrifuge plants require only about 50 kWh per SWU (WNA, 2022).

Based on standard technology at the time of development, Table S-3 assumed the use of a gaseous diffusion plant to obtain 4 percent by weight enriched uranium. Based on the above, this facility would require approximately 14,600,000 kWh of power to obtain 2200 lb. (1000 kg) of 4 percent enriched uranium. Using centrifuge enrichment, a modern plant would require 2,100,000 kWh to obtain 2200 lb. (1000 kg) of 20 percent by weight enriched uranium. The additional power required to enrich fuel past the limit assumed in Table S-3 is offset by the more efficient power use of modern enrichment technology. Thus, Table S-3 can be considered bounding for TRISO fuel with regard to enrichment, even though this technology was not considered during development of Table S-3.

The processes used to fabricate TRISO fuel are not the same as those used in existing NRC-licensed fuel fabrication facilities. To demonstrate that fuel fabrication environmental impacts for TRISO fuel can be bounded by Table S-3, it must be shown that impacts are bounded by the model fuel fabrication plant described in Appendix E of WASH-1248 (AEC, 1974). This model plant operates 300 days per year with a plant lifetime of 20 years and has a capacity of 3 metric tons uranium (MTU) per day. It produces the annual fuel requirements for up to 26 model LWRs. The model plant used a wet process method of UF_6 to UO_2 conversion, which involves the use of ammonium hydroxide to form an intermediate ammonium diuranate compound prior to final conversion to UO_2. Electricity to supply the plant is largely from coal power plants, with some natural gas used for process heat.

Table 6.1-3 was developed to compare the TRISO fuel fabrication process with the values provided in Appendix E of WASH-1248 (AEC, 1974), using information provided in the application made to the NRC for the TRISO-X fuel fabrication facility in Oak Ridge, Tennessee (TRISO-X, 2022). The proposed TRISO-X fuel fabrication facility produces 16 MTU of fuel per year. An Xe-100 plant producing 2250 MWe requires approximately 11.3 MTU of fuel per year. The comparison provided in this table indicates that Table S-3 can be considered bounding for the UFC supporting the Xe-100 with regard to fuel fabrication. Furthermore, as described above, greater efficiency at operating nuclear plants and less reliance on coal-fired electrical generation has the effect of decreasing environmental impacts from the fuel fabrication portion of the UFC and increasing the conservatism of the Table S-3 estimates.

Because TRISO is so structurally sound, reprocessing is currently unlikely. An open fuel cycle is anticipated. Used TRISO fuel is assumed to be stored on-site in an NRC-licensed facility until ultimate disposal. Therefore, there are no reprocessing environmental impacts to consider, and Table S-3 can be considered bounding for impacts of reprocessing.

WASH-1248 (AEC, 1974) stated that the total volume of low-level radioactive waste generated during UFC operations is variable and difficult to estimate, but provided an analysis that suggests that even the most conservative estimates still only represent a fraction of the annual LLW shipped from all U.S. sources to the four Agreement State-licensed LLW disposal facilities.

Low-level waste generated at operating nuclear reactors includes items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation. This waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipment and tools, luminous dials, medical tubes, swabs, injection needles, syringes, and laboratory animal carcasses and tissues. Advanced nuclear reactors like the Xe-100 are expected to generate LLW in the same ways as currently operating LWRs. Thus, the environmental impacts of LLW described in Table S-3 are applicable to the Xe-100. Moreover, the WASH-1248 (AEC, 1974) analysis was based on lower burnup levels than those currently allowed for LWRs and anticipated for the Xe-100 using TRISO fuel. Higher burnup means that uranium fuel is used more efficiently, which results in lower cumulative environmental impacts.

Overall, much of the impact analysis related to storage, shipping, and disposal of high-level radioactive waste and spent fuel is not related to reactor or fuel type. This is because storage, transportation, and disposal are each stringently regulated with regard to packaging, physical protection, and dose impacts to workers and members of the public. In general, regulations for waste and spent fuel inventories, as well as their associated certified spent fuel shipping and storage containers, are expected to be broad enough to address new types of fuel associated with advanced reactor designs, including TRISO fuel. The LWR evaluations in NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel,* are expected to be applicable to advanced reactor fuels. In addition, the following regulatory requirements of 10 CFR Part 40, *Domestic Licensing of Source Material*, 10 CFR Part 50, *Domestic Licensing of Production and Utilization Facilities*, 10 CFR Part 70, *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71, *Packaging and Transportation of Radioactive Material*, 10 CFR Part 72, *Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste*, and 10 CFR Part 73, *Physical Protection of Plants and Materials* must be satisfied for any fuel type or technology.

The above discussion indicates that although the Xe-100 and TRISO fuel are not LWRs and thus were not considered in the development of Table S-3, it is still appropriate to consider Table S-3 impacts as bounding for this reactor and fuel type. Therefore, the following subsections present a detailed comparison of environmental impacts from the UFC for an Xe-100 plant at the Project site generating 2250 MWe. Xe-100 units have a capacity factor of greater than 95 percent. These power output and capacity factor values are used to scale the Project site with the Xe-100 technology to the reference reactor, as shown in Table 6.1-1.

6.1.2.1 Land Use

The total annual land requirement for the UFC supporting the Project site for the Xe-100 plant is presented in Table 6.1-2. This includes values for both permanently and temporarily committed land (both undisturbed and disturbed), as described in Section 6.1.1.1. As a comparison, based on values for coal plants presented in NUREG-1437, Rev. 0, a coal-fired power plant using strip-mined coal with the same power output capacity as the bounding value for the Project site requires the disturbance of approximately 450 ac. (182 ha) per year for fuel alone. The impact on land use from the UFC to support the Project site for the Xe-100 plant is SMALL.

6.1.2.2 Water Use

Values for the various water uses required for the Xe-100 plant at the Project site and the expected thermal effluent from this plant are presented in Table 6.1-2. Section 6.1.1.2 discusses

UFC water requirements and thermal effluent and provides some comparisons to the annual water requirements and thermal effluent for an LWR. An Xe-100 plant at the Project site has SMALL environmental impacts associated with water use for the UFC.

6.1.2.3 Fossil Fuel Impacts

Electrical energy needs for the UFC associated with an Xe-100 plant at the Project site are presented in Table 6.1-2. Using the guidance in ISG-026, Attachment 1, as described in Section 6.1.1.3, the reference reactor GHG estimate can be scaled to the proposed Xe-100 plant at the Project site using the same scaling factor used throughout the Table S-3 analysis, resulting in an estimate of 27,270,000 MT CO_2e produced over the 40-year life of the plant, or 681,750 MT CO_2e annually. This is approximately 0.47% of NC's annual GHG (USEPA, 2023) and 0.011% of total U.S. annual GHG emissions (USEPA, 2024). Section 6.1.1.4 further describes the use of fossil fuels in the UFC and provides some comparisons between electrical energy needs of the UFC and reference reactor power production. The fossil fuel effects, including GHG emissions, from the consumption of electrical energy for UFC operations are SMALL relative to the net power production of the proposed plant.

6.1.2.4 Chemical Effluents

The quantities of chemical effluents from UFC processes needed to support an Xe-100 plant at the Project site are presented in Table 6.1-2.

Section 6.1.1.5 describes gaseous and particulate effluents from the UFC and compares this to effluent from a coal-fired power plant. Table S–3 states that the fuel cycle for the reference 1000-MWe LWR requires 323,000 MWh of electricity. The fuel cycle for an Xe-100 plant at the Project site would therefore require 872,100 MWh of electricity, or 0.021 percent of the 4.2 billion MWh of electricity generated in the United States in 2023 (EIA 2024). Therefore, the gaseous and particulate chemical emissions would add about 0.021 percent to the national gaseous and particulate chemical effluents for electricity generation, a small additional atmospheric loading in comparison with these total emissions.

Table 6.1-2 presents the amount of dilution water required for specific constituents of liquid effluents. The limited impacts of liquid chemical effluents produced in UFC processes are described in Section 6.1.1.5.

Tailings solutions and solids generated during the milling process are described in Section 6.1.1.5.

The impacts of chemical effluents are SMALL.

6.1.2.5 Radiological Effluents

The estimates of radioactive effluent releases to the environment are presented in Table 6.1-2. These are from waste management activities and certain other phases of the UFC process. In NUREG-1437, Rev. 0, the NRC presented an analysis of the effects of radiological effluents from the UFC for the reference reactor, including the effects of radon-222 and technetium-99, which are not addressed in Table S-3. The NRC concluded that the effects of radiological effluents from the UFC for the reference reactor are small. Because the dose to members of the public is a very small fraction of the regulatory limit and an even smaller fraction of natural background exposure, the effects of radiological effluents from the UFC supporting an Xe-100

plant at the Project site, based on the scaling factor applied to the reference reactor effluents as presented in Table 6.1-2, can also be considered SMALL.

6.1.2.6 Radiological Wastes

Quantities of buried radioactive waste material (LLW, HLW, and TRU wastes), associated with the UFC for an Xe-100 plant at the Project site are specified in Table 6.1-2. Section 6.1.1.6 provides a discussion of radiological wastes from the UFC, including low-level waste, high-level waste, and spent fuel. Based on this discussion and the information in Table 6.1-2, the environmental impact of radioactive waste disposal from the UFC for an Xe-100 at the Project site is expected to be SMALL.

6.1.2.7 Occupational Dose

The annual occupational dose attributable to all phases of the UFC for an Xe-100 plant at the Project site is presented in Table 6.1-2. Occupational doses would be maintained to meet the dose limits in 10 CFR Part 20, which is 5 rem/yr. On this basis, it is concluded that environmental impacts from this occupational dose are anticipated to be SMALL.

6.1.2.8 Transportation Dose

The transportation dose to workers and the public is presented in Table 6.1-2 for an Xe-100 plant at the Project site. Section 6.1.1.8 provides a comparison of this dose to the dose to the NC population from natural background radiation. On this basis, the environmental impacts of transportation are anticipated to be SMALL.

6.1.2.9 Conclusions for the Xe-100

Based on the discussion in the above subsections and using Table S-3 as stipulated in 10 CFR 51.51, the environmental effects from the UFC for an Xe-100 plant at the Project site would be SMALL.

6.1.3 COMPARISON TO TABLE S-3 FOR NATRIUM

The Natrium reactor is a sodium-cooled fast reactor using HALEU metallic fuel. Its initial core will include 162 fuel assemblies containing enriched uranium-235 as fuel. The fuel employs a metal fuel system instead of oxides. The enrichment level of the fuel is less than 20 weight percent, and the burnup is in the range exhibited by Generation III+ LWR designs and Power Reactor Innovative Small Module (greater than 33,000 megawatt-days/MTU).

Because Natrium, like the Xe-100, uses a uranium-based fuel, its UFC relies on uranium recovery facilities and processes similar to those used in developing Table S-3 and described in Section 6.1. The decreases in environmental impacts since the development of Table S-3 described in Section 6.1.1 and considered applicable to the TRISO fuel cycle, as described in Section 6.1.2, are also generally applicable to the Natrium fuel cycle. Each of the six types of facilities described in the introduction to Section 6.1 is considered below. Where the previous discussion is valid for Natrium and HALEU fuel, the section above is referenced; where Natrium or HALEU-specific information is available, this is presented.

The discussion of uranium recovery (mining and milling) in Section 6.1.2 is applicable to Natrium fuel. Table S-3 can be considered bounding based on the technology advancements

that have generally reduced environmental impacts for this stage of the fuel cycle.

The discussion of uranium conversion in Section 6.1.2 is applicable to Natrium fuel. Table S-3 can be considered bounding based on the overall reduced environmental impact of uranium conversion facilities in the United States.

A similar argument applies for enrichment. To obtain 2200 lb. (1000 kg) of uranium enriched 4 percent by weight from natural uranium, assuming the tails are 0.25 percent U-235 by weight, requires 5832 SWU. To obtain the same amount of 20 percent enriched uranium requires 41,579 SWU (UXC, 2024). Enrichment for the Natrium fuel is identified as 19.75 percent but is conservatively analyzed as 20 percent enriched uranium for this argument. The gaseous-diffusion process consumes about 2500 kWh per SWU, while modern gas centrifuge plants require only about 50 kWh per SWU (WNA, 2022). As such, a similar conclusion to Section 6.1.2 can be applied and Table S-3 can be considered bounding for Natrium fuel with regard to enrichment, even though gas centrifuge technology was not considered during development of Table S-3.

As noted in the Kemmerer Unit 1 ER (TerraPower, 2024), the proposed Natrium fuel fabrication facility (NFFF) at the Global Nuclear Fuels – America, LLC's (GNF-A) facility, located at Wilmington, NC, is expected to support fuel fabrication for Kemmerer Unit 1 with an estimated throughput of 18 MTU per year. A single Natrium unit requires roughly 3.8 MTU for every fuel reload (i.e., every 24 months) or 1.9 MTU every year; therefore, it is reasonable to assume that the proposed NFFF would be able to support fuel demands for the Project site if the Natrium technology is selected. According to a GNF-A NFFF schedule update on July 11, 2023, the license amendment request is expected to be submitted in the third quarter of 2025 for NRC review (GNF, 2023). The Kemmerer Unit 1 ER states that the Environmental Assessment (EA) for the proposed NFFF demonstrated that the addition of the NFFF would provide fabrication of fuel less than 20 weight percent U-235 and would not change the scope or nature of the activity at the existing GNF-A facility at Wilmington, NC, and that the environmental impacts would be the same as those from the existing facility (TerraPower, 2024).

Because the NFFF is not expected to change the scope or nature of the GNF-A facility, the values from WASH-1248 (AEC, 1974) are scaled to represent values for the NFFF, without considering deconversion and metallization. A scale factor is determined by identifying the amount of fuel required by the Project site producing 2250 MWe per year. As mentioned above, a single Natrium reactor requires 1.9 MTU of fuel each year. In order for the Project site to reach the desired output, 6.88 (i.e., 2250 MWe/327 MWe) Natrium units would need to be constructed. Multiplying the amount of fuel required for a single Natrium reactor by the number of units needed to reach the desired power output results in a yearly fuel requirement of 13.1 MTU (i.e., 6.88 Natrium Reactors x 1.9 MTU per Natrium Reactor). Using the lifetime average annual fuel requirement for a model LWR from WASH-1248 of 35 MTU, a scale factor of 0.37 (13.1 MTU/35 MTU) is determined. As such, to compare the environmental impacts associated with the NFFF, not including deconversion or metallization, the values in Appendix E of WASH-1238 would be multiplied by 0.37, resulting in a reduction of environmental impacts by more than 60 percent.

While the proposed NFFF is expected to be bounded by the analysis performed in WASH-1248 (AEC, 1974), the processes at the current GNF-A facility do not include deconversion or metallization as steps in the uranium fuel cycle. These steps are part of the Natrium fuel cycle because the Natrium reactor utilizes metallic fuel. Therefore, it is necessary to demonstrate that the environmental impacts from Appendix E of WASH-1248 bound the environmental impacts from the proposed NFFF, including the impacts associated with deconversion and metallization.

DOE/EA-2087 (DOE, 2019) discusses the environmental impacts associated with deconversion and metallization for a 5000-kg throughput facility. The document states that a federal agency can prepare an EA at any time for a proposed action. If potential significant environmental impacts are identified, an environmental impact statement can always be pursued. Conversely, if no significant environmental impacts are identified, the EA is the appropriate level of documentation and no further evaluation is necessary. Because an EA was completed for the deconversion and metallization action, environmental impacts not discussed with the EA are expected to be minimal.

DOE/EA-2087 (DOE, 2019) stated that the only anticipated source of greenhouse gas emissions in the proposed action analyzed in the document would be from a diesel backup generator. Emissions from the transport of nuclear material would also be included. 100% renewable diesel fuel would be used, resulting in '0' metric tons carbon dioxide equivalent (MT CO2e) of anthropogenic GHG emissions. If 100% renewable diesel is not available, the total anthropogenic GHG emissions are estimated to be less than 0.5 MT CO2e, assuming heavy-duty vehicle burning 100% diesel and taking 20 one-way trips at 20 miles per trip. As such, fossil fuel impacts associated with deconversion, and metallization are considered negligible.

Environmental impacts from chemical effluents associated with deconversion and metallization are briefly discussed in DOE/EA-2087 (DOE, 2019), but ultimately are identified as being minimal. Therefore, impacts from chemical effluents associated with deconversion and metallization is considered negligible.

Environment impacts from radiological effluents associated with deconversion and metallization are discussed in DOE/EA-2087 (DOE, 2019). Site boundary and offsite receptors are identified for the INL site. These receptors are analyzed with the radionuclide inventory that is potentially emitted from the processing facility. Additionally, groundwater exposure pathways and surface soil exposure pathways are evaluated within the EA and the impacts were determined to be SMALL. While the meteorological data and offsite receptors for the NFFF are expected to be different than those at the INL site, any fuel fabrication facility would need to be compliant with regulatory limits or provide additional mitigation to be within regulatory limits. Therefore, impacts from radiological effluents associated with deconversion and metallization would need to be considered for the license amendment of the fabrication facility and would be expected to be SMALL.

DOE/EA-2087 (DOE, 2019) states that the environmental impacts from radioactive waste associated with deconversion and metallization are generally less than 20 cubic meters (700 cubic feet) of LLW and 1 cubic meter (35 cubic feet) of transuranic waste. Comparing to the bounding waste value transported from the Project site of 38,988 cubic feet per year (see Table 6.2-1), the impacts associated with radioactive waste associated with deconversion and metallization are expected to be SMALL.

Lastly, environmental impacts associated with transportation associated with deconversion and metallization in DOE/EA-2087 (DOE, 2019) are identified as SMALL, which includes the impacts of transportation accidents. Per 10 CFR 51.52, Table S-4 classifies radiological effects from transportation accidents as SMALL. As such, it is expected that transportation impacts associated with deconversion, and metallization is expected to be SMALL.

While the DOE/EA-2087 (DOE, 2019) discusses a facility with a throughput limit of 5 MTU annually, the NFFF would have a throughput roughly 3.6 times (i.e., 18 MTU/5MTU) that analyzed in DOE/EA-2087. However, accounting for the increase in production for deconversion

and metallization by a factor of 3.6, using the discussion above, the environmental impacts would still be considered SMALL. Furthermore, it is not expected that the environmental impacts associated with deconversion and metallization would outweigh the 60 percent reduction in impact identified for the proposed fabrication facility as discussed above. Thus, the environmental impacts contained in Appendix E of WASH-1248 (AEC, 1974) are expected to bound the NFFF, and, therefore, Table S-3 can be considered bounding for impacts associated with the fuel fabrication process.

There are no current plants to reprocess Natrium fuel, nor is progress on reprocessing in the United States anticipated in the foreseeable future (TerraPower, 2024). Therefore, it is anticipated that fuel cycle impacts of reprocessing Natrium fuel are bounded by those in Table S-3.

The discussion of high-level waste and LLW from the UFC in Section 6.1.2 is applicable to the Natrium fuel cycle. The ER for Kemmerer Unit 1 states that scaling environmental impacts to Table S-3 based on the annual fuel requirement is acceptable for this environmental impact (TerraPower, 2024).

The above discussion indicates that although the Natrium is not a LWR and thus was not considered in the development of Table S-3, it is still appropriate to consider Table S-3 impacts as bounding for this reactor and fuel type. Therefore, the following subsections present a detailed comparison of environmental impacts from the UFC for the Project site generating 2250 MWe using Natrium technology. The Natrium has a capacity factor of 92.5 percent or greater. The power output and capacity factor are used to scale the Project site with the Natrium technology to the reference reactor, as shown in Table 6.1-1.

6.1.3.1 Land Use

The total annual land requirement for the UFC supporting the Project site for the Natrium plant is presented in Table 6.1-2. This includes values for both permanently and temporarily committed land (both undisturbed and disturbed), as described in Section 6.1.1.1. As a comparison, based on values for coal plants presented in NUREG-1437, Rev. 0, a coal-fired power plant using strip-mined coal with the same power output capacity as the bounding value for the Project site requires the disturbance of approximately 450 ac. (182 ha) per year for fuel alone. The impact on land use from the UFC to support the Project site for the Natrium Plant is SMALL.

6.1.3.2 Water Use

Values for the various water uses required for the Natrium plant at the Project site and the expected thermal effluent from this plant are presented in Table 6.1-2. Section 6.1.1.2 discusses UFC water requirements and thermal effluent and provides some comparisons to the annual water requirements and thermal effluent for an LWR. A Natrium plant at the Project site has SMALL environmental impacts associated with water use for the UFC.

6.1.3.3 Fossil Fuel Impacts

Electrical energy needs for the UFC associated with a Natrium Plant at the Project site are presented in Table 6.1-2. Using the guidance in ISG-026, Attachment 1, as described in Section 6.1.1.3, the reference reactor GHG estimate can be scaled to the proposed Natrium plant at the Project site using the same scaling factor used throughout the Table S-3 analysis, resulting in

an estimate of 26,260,000 MT CO_2e produced over the 40-year life of the plant or 656,500 MT CO_2e annually. This is approximately 0.46% of NC's annual GHG (USEPA, 2023) and 0.010% of total U.S. annual GHG emissions (USEPA, 2024). Section 6.1.1.4 further describes the use of fossil fuels in the UFC and provides some comparison between electrical energy needs of the UFC and reference reactor power production. The fossil fuel effects, including GHG emissions, from the consumption of electrical energy for UFC operations are SMALL relative to the net power production of the proposed plant.

6.1.3.4 Chemical Effluents

The quantities of chemical effluents from UFC processes needed to support a Natrium plant at the Project site are presented in Table 6.1-2.

Section 6.1.1.5 describes gaseous and particulate effluents from the UFC and compares this to effluent from a coal-fired power plant. Table S-3 states that the fuel cycle for the reference 1000-MWe LWR requires 323,000 MWh of electricity. The fuel cycle for a Natrium Plant at the Project site would therefore require 839,800 MWh of electricity, or 0.020 percent of the 4.2 billion MWh of electricity generated in the United States in 2023 (EIA 2024). Therefore, the gaseous and particulate chemical emissions would add about 0.020 percent to the national gaseous and particulate chemical effluents for electricity generation, a small additional atmospheric loading in comparison with these total emissions.

Table 6.1-2 presents the amount of dilution water required for specific constituents of liquid effluents. The limit impacts of liquid chemical effluents produced in UFC processes are described in Section 6.1.1.5.

Tailings solutions and solids generated during the milling process are described in Section 6.1.1.5.

The impacts of chemical effluents are SMALL.

6.1.3.5 Radiological Effluents

The estimates of radioactive effluent releases to the environment are presented in Table 6.1-2. These are from waste management activities and certain other phases of the UFC process. In NUREG-1437, Rev. 0, the NRC presented an analysis of the effects of radiological effluents from the UFC for the reference reactor, including the effects of radon-222 and technetium-99, which are not addressed in Table S-3. The NRC concluded that the effects of radiological effluents from the UFC for the reference reactor are small. Because the dose to members of the public is a very small fraction of the regulatory limit and an even smaller fraction of natural background exposure, the effects of radiological effluents from the UFC supporting a Natrium plant at the Project site, based on the scaling factor applied to the reference reactor effluents as presented in Table 6.1-2, can also be considered SMALL.

6.1.3.6 Radiological Wastes

Quantities of buried radioactive waste material (LLW, HLW, and TRU wastes), associated with the UFC for a Natrium plant at the Project site are specified in Table 6.1-2. Section 6.1.1.6 provides a discussion of radiological wastes from the UFC, including low-level waste, high-level waste, and spent fuel. Based on this discussion and the information in Table 6.1-2, the environmental impact of radioactive waste disposal from the UFC for a Natrium at the Project

site is expected to be SMALL.

6.1.3.7 Occupational Dose

The annual occupational dose attributable to all phases of the UFC for a Natrium plant at the Project site is presented in Table 6.1-2. Occupational doses would be maintained to meet the dose limits in 10 CFR Part 20, which is 5 rem/yr. On this basis, it is concluded that environmental impacts from this occupational dose are anticipated to be SMALL.

6.1.3.8 Transportation Dose

The transportation dose to workers and the public is presented in Table 6.1-2 for a Natrium Plant at the Project site. Section 6.1.1.8 provides a comparison of this dose to the dose to the NC population from natural background radiation. On this basis, the environmental impacts of transportation are anticipated to be SMALL.

6.1.3.9 Conclusions for the Natrium

Based on the discussion in the above subsections and using Table S-3 as stipulated in 10 CFR 51.51, the environmental effects from the UFC for a Natrium plant at the Project site would be SMALL.

6.1.4 CONCLUSIONS

Although the technology and reactor vendor have not yet been selected for the Project site, the above discussion demonstrates that a comparison to Table S-3, as described in 10 CFR 51.51, is appropriate for all reactors under consideration. Furthermore, the above discussion demonstrates that the UFC supporting a plant with a maximum net power output of 2250 MWe at the Project site has SMALL environmental impacts, regardless of the technology selected.

Table 6.1-1
Scaling Factor – Reference Plant, LWRs, Xe-100, and Natrium Plant

Parameter	10 CFR 51.51 Reference Plant (1000 MWe LWR) Reactor	Project site[a]		
		LWRs	Xe-100	Natrium
Net Electric Output	1000 MWe	2250 MWe[b]	2250 MWe[b]	2250 MWe[b]
Capacity Factor	80 percent	97 percent	95 percent	92.5 percent
Effective Electric Output	800 MWe	2183 MWe	2138 MWe	2081 MWe
Ratio of Effective Electric Output Values to the Reference Plant	1	2.7	2.7	2.6

Notes:

(a) Values are presented for the LWRs, the Xe-100, and the Natrium.
(b) Bounding value for site.

Key: CFR = Code of Federal Regulations; LWR = light water reactor; MWe = megawatt electric

Table 6.1-2
Environmental Impacts from the Uranium Fuel Cycle for Project site Reactor Technologies Based on Table S-3
(Sheet 1 of 7)

Environmental Considerations	Annual Fuel Requirement Impacts 10 CFR 51.51 Reference Plant	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000-MWe LWR	Annual Fuel Requirement Impacts—Project site[(a)]		
			LWRs	Xe-100	Natrium
Natural Resource Use					
Land (acres)					
Temporarily committed	100		270	270	260
Undisturbed area	79		213	213	205
Disturbed area	22	Equivalent to a 110-MWe coal-fired power plant	59	59	57
Permanently committed	13		35	35	34
Overburden moved, million MT	2.8	Equivalent to 95-MWe coal-fired power plant.	7.6	7.6	7.3
Water (millions of gal)					
Discharged to air	160	= 2 percent of model 1000 MWe LWR with cooling tower.	432	432	416
Discharged to water bodies	11,090		29,943	29,943	28,834
Discharged to ground	127		343	343	330
Total	11,377	<4 percent of model 1000 MWe LWR with once through cooling.	30,718	30,718	29,580

Table 6.1-2
Environmental Impacts from the Uranium Fuel Cycle for Project site Reactor Technologies Based on Table S-3
(Sheet 2 of 7)

Environmental Considerations	Annual Fuel Requirement Impacts 10 CFR 51.51 Reference Plant	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000-MWe LWR	Annual Fuel Requirement Impacts—Project site[a]		
			LWRs	Xe-100	Natrium
Fossil fuel					
Electrical energy, MW hour (MWh)	323,000	<5 percent of model 1000 MWe output.	872,100	872,100	839,800
Equivalent coal (MT)	118,000	Equivalent to the consumption of a 45-MWe coal-fired power plant.	318,600	318,600	306,800
Natural gas (standard cubic feet [scf])	135 million	<0.4 percent of model 1000 MWe energy output.	365 million	365 million	351 million
Chemical Effluents (MT)					
Gases, incl. entrainment					
SO_x	4400		11,880	11,880	11,440
NO_x	1190	Equivalent to emissions from 45-MWe coal-fired plant for a year.	3213	3213	3094
Hydrocarbons	14		38	38	36
CO	29.6		79.9	79.9	77.0
Particulates	1154		3116	3116	3000

Table 6.1-2
Environmental Impacts from the Uranium Fuel Cycle for Project site Reactor Technologies Based on Table S-3
(Sheet 3 of 7)

Environmental Considerations	Annual Fuel Requirement Impacts 10 CFR 51.51 Reference Plant	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000-MWe LWR	Annual Fuel Requirement Impacts—Project site[a]		
			LWRs	Xe-100	Natrium
Other gases					
F	0.67	Principally from UF_6, production, enrichment, and reprocessing. Concentration within range of state standards-below level that has effects on human health.	1.81	1.81	1.74
HCl	0.014		0.038	0.038	0.036
Liquids					
SO^{-}_{4}	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. NH_3 – 17 cubic meters per second (m^3/s) (600 ft^3/sec), NO_3 – 0.56 m^3/s (20 ft^3/sec), and Fluoride – 2 m^3/s (70 ft^3/sec).	26.7	26.7	25.7
NO^{-}_{3}	25.8		69.7	69.7	67.1
Fluoride	12.9		34.8	34.8	33.5
Ca^{++}	5.4		14.6	14.6	14.0
Cl^{-}	8.5		23.0	23.0	22.1
Na^{+}	12.1		32.7	32.7	31.5
NH_3	10		27	27	26

Table 6.1-2
Environmental Impacts from the Uranium Fuel Cycle for Project site Reactor Technologies Based on Table S-3
(Sheet 4 of 7)

Environmental Considerations	Annual Fuel Requirement Impacts 10 CFR 51.51 Reference Plant	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000-MWe LWR	Annual Fuel Requirement Impacts—Project site[a]		
			LWRs	Xe-100	Natrium
Fe	0.4		1.1	1.1	1.0
Tailings solutions	240,000	From mills only—no significant effluents to environment.	648,000	648,000	624,000
Solids	91,000	Principally from mills—no significant effluents to environment.	245,700	245,700	236,600
Radiological Effluents, Ci					
Gases, incl. entrainment					
Rn-222	-	Presently under reconsideration by the Commission.	-	-	-
Ra-226	0.02		0.05	0.05	0.05
Th-230	0.02		0.05	0.05	0.05
U	0.034		0.092	0.092	0.088
H-3 (thousands of Ci)	18.1		48.9	48.9	47.1
C-14	24		65	65	62

Table 6.1-2
Environmental Impacts from the Uranium Fuel Cycle for Project site Reactor Technologies Based on Table S-3
(Sheet 5 of 7)

Environmental Considerations	Annual Fuel Requirement Impacts 10 CFR 51.51 Reference Plant	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000-MWe LWR	Annual Fuel Requirement Impacts—Project site[a]		
			LWRs	Xe-100	Natrium
Kr-85 (thousands of Ci)	400		1080	1080	1040
Ru-106	0.14	Principally from fuel reprocessing plants.	0.38	0.38	0.36
I-129	1.3		3.5	3.5	3.4
I-131	0.83		2.24	2.24	2.16
Tc-99	-	Presently under consideration by the Commission	-	-	-
Fission products and transuranics (TRU)	0.203		0.548	0.548	0.528
Liquids					
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on the environment.	5.7	5.7	5.5
Ra-226	0.0034	From UF_6 production.	0.0092	0.0092	0.0088
Th-230	0.0015		0.0041	0.0041	0.0039

Table 6.1-2
Environmental Impacts from the Uranium Fuel Cycle for Project site Reactor Technologies Based on Table S-3
(Sheet 6 of 7)

Environmental Considerations	Annual Fuel Requirement Impacts 10 CFR 51.51 Reference Plant	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000-MWe LWR	Annual Fuel Requirement Impacts—Project site[a]		
			LWRs	Xe-100	Natrium
Th-234	0.01	From fuel fabrication plants—concentration 10 percent of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR.	0.03	0.03	0.03
Fission and Activation	5.9×10^6		15.9×10^6	15.9×10^6	15.3×10^6
Solids (buried on-site)					
Other than high level waste (HLW) (shallow)	11,300	9100 Ci comes from low level reactor wastes and 1500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.	30,510	30,510	29,380
TRU and HLW (deep)	11,000,000	Buried at Federal Repository	29,700,000	29,700,000	28,600,000

Table 6.1-2
Environmental Impacts from the Uranium Fuel Cycle for Project site Reactor Technologies Based on Table S-3
(Sheet 7 of 7)

Environmental Considerations	Annual Fuel Requirement Impacts 10 CFR 51.51 Reference Plant	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000-MWe LWR	Annual Fuel Requirement Impacts—Project site[(a)]		
			LWRs	Xe-100	Natrium
Other Environmental Considerations					
Thermal Effluents, (Billions of Btu)	4063 billion Btu	<5 percent of model 1000 MWe LWR.	10,970 billion Btu	10,970 billion Btu	10,564 billion Btu
Transportation					
Exposure of workers and the general public	2.5 person-rem		6.8 person-rem	6.8 person-rem	6.5 person-rem
Occupational exposure	22.6 person-rem	From reprocessing and waste management.	61.0 person-rem	61.0 person-rem	58.8 person-rem

Note:
(a) Values are presented for the LWRs, the Xe-100, and the Natrium.
Key: LWR = light water reactor

Table 6.1-3
WASH-1248 Fuel Fabrication Environmental Impacts Compared to TRISO Fuel Fabrication Impacts
(Sheet 1 of 3)

Environmental Impact	WASH-1248 Value for the Model Plant	TRISO Value for Fuel Fabricated to Support a Plant Generating 2250 MWe	Comments
Site Size (ac.)	100	110 (TRISO-X fuel fabrication facility area)	The model plant uses less than 5 percent of the land area committed by the rest of the fuel cycle. WASH-1248 notes that actual fuel fabricators surveyed occupied sites ranging from a few acres up to a few thousand acres and that even for a 1000 ac. site, the temporarily committed land for an annual fuel requirement would be less than 5% of that committed by the rest of the fuel cycle. Based on this information, the land use impacts for the TRISO-X fuel fabrication facility are bounded by those described in WASH-1248.
Annual Water Consumption (gallons)	5,200,000[(a)]	81,148,125[(b)(c)]	The model plant uses about 0.05 percent of the water used by the model LWR evaluated by WASH-1248. While the TRISO-X facility requires a larger volume of water to support annual fuel production for a given plant, the amount of water used to support fuel fabrication for the 2250-MWe Xe-100 plant is still less than 0.8 percent of the water used by the model LWR evaluated in WASH-1248.
Power Required Whole facility Annual fuel requirement	 6 MWe 1700 MWh[(a)]	 not available	The model plant uses about 0.5 percent of the electricity of the enrichment plant evaluated by WASH-1248. The power requirement for the TRISO fuel fabrication plant is not available at this time. However, the model plant is assumed to use power generated from coal. The TRISO fuel fabrication plant is located in Oak Ridge, Tennessee. In Tennessee, nearly half of the electric power generated is from nuclear plants and only approximately 20 percent from coal. Therefore, the environmental impacts of power generation to support the facility are lower than those for the model plant because of the lower impact of the plants generating electricity.

Table 6.1-3
WASH-1248 Fuel Fabrication Environmental Impacts Compared to TRISO Fuel Fabrication Impacts
(Sheet 2 of 3)

Environmental Impact	WASH-1248 Value for the Model Plant	TRISO Value for Fuel Fabricated to Support a Plant Generating 2250 MWe	Comments
Annual Natural Gas Usage for Process Heat (cubic feet)	3,600,000	not available	The model plant uses about 4 percent of the natural gas consumed by the total nuclear fuel cycle. The natural gas usage for process heat for the TRISO fuel fabrication facility is not available at this time. While natural gas consumed for process heat represents an environmental impact of the fuel fabrication process, this use allows the production of electricity with nuclear fuel, which results in a substantial reduction in the overall requirements for coal and natural gas as fuels to produce electricity. Thus, the use of fossil fuels in the UFC, including for fuel fabrication, still represents a net savings in the use of resources compared to the case where the electrical output of the nuclear plant is supplied by a coal- or natural gas-fired plant. Table 6.1-2 presents the electrical energy needed by the UFC for a 2250-MWe Xe-100 plant and shows that the impacts associated with this energy use are small compared to plant electrical output.
Liquid Waste Stream Volume (gallons per day)	25,000	70,625[(b)]	At the model plant, this is combined with about 425,000 gpd of process cooling water in the holding ponds prior to release off-site. The TRISO-X facility discharges only to the Oak Ridge Municipal Sewer. While the TRISO-X facility liquid waste stream has a greater volume for the annual fuel requirement to support a given plant, the total facility release is only 0.3 percent of City of Oak Ridge Treatment capacity.
Annual Solid Waste Volume (MT) Whole facility Annual fuel requirement	 680 26	 919 672[(b)]	For the model plant, this consists of calcium fluoride precipitate from the liquid waste stream for retaining on site (11 cubic yards [8.4 cubic meters]) [(e)]

Table 6.1-3
WASH-1248 Fuel Fabrication Environmental Impacts Compared to TRISO Fuel Fabrication Impacts
(Sheet 3 of 3)

Environmental Impact	WASH-1248 Value for the Model Plant	TRISO Value for Fuel Fabricated to Support a Plant Generating 2250 MWe	Comments
Annual Gaseous Airborne Activity Released (curies) Whole facility Annual fuel requirement	 0.005 0.000192[a]	 0.0000452 0.000032[b]	For the model plant, this release is less than 0.1 percent of the applicable 10 CFR Part 20. The TRISO-X facility has a lower release than the model plant.
Annual Liquid Activity Released (mCi)	40	0	For the model plant, this release is less than 10 percent of 10 CFR Part 20 limits for release to an unrestricted area. The TRISO-X fuel fabrication facility does not release radioactive liquid effluent.
Annual Solid Activity for Disposal (mCi)	25[a]	624[d]	Activity shipped per annual fuel requirement[e]

Notes:

(a) 10 CFR 51.51 Table S-3, states that there are 26 annual fuel requirements produced by the model LWR fuel fabrication facility (the fuel fabrication facility produces the annual fuel requirements for 26 1000-MWe reference reactors). This assumption was used to scale whole-facility values to determine the amount attributable to the annual fuel requirement to support one reference reactor.

(b) A process similar to that described in footnote (a) was used for the TRISO-X facility, assuming that the proposed 2250-MWe plant at the Project site would use 11.3 MTU of the total annual facility production of 16 MTU.

(c) Appendix E of WASH-1248 (AEC, 1974) assumed that the model fuel fabrication plant operated 300 days per year. It has also been assumed that the TRISO-X fuel fabrication facility operates for 300 days. This assumption was used in calculating annual water consumption.

(d) This value was calculated using the ratio of activity to volume from WASH-1248, where 26 MT waste attributable to the annual fuel requirement of the reference reactor was associated with 25 mCi, and the 672 MT solid waste associated with the annual fuel requirement for the 2250-MWe Xe-100 plant.

(e) The solid waste volume and the solid radioactive waste activity for disposal generated for the annual fuel requirement of an Xe-100 plant at the Project site exceeds the values determined for the annual fuel requirement of the model LWR plant analyzed in WASH-1248. However, Table 2.1-5 of the TRISO-X Fuel Fabrication Facility ER shows that the extent of impact from waste management is SMALL (TRISO-X, 2022). Section 4.2, of the TRISO-X Fuel Fabrication Facility ER states that shipments of radiological waste meet the surface dose rate limit of 10 CFR 71.47(a) and 49 CFR 173.441(a) and the group of containers meet the 1 m (3.3 ft) dose rate limits of 49 CFR 173.441(d). Additionally, environmental impacts from transporting radioactive materials are identified as SMALL (TRISO-X, 2022).”

Key: MT = metric tons | mCi = millicuries

6.2 TRANSPORTATION OF FUEL AND WASTES

This section discusses the impacts to the environment of normal conditions of transport and postulated transportation accidents involving shipment of radioactive materials including unirradiated fuel, irradiated fuel, and radioactive waste to and from the Project site.

The NRC performed a generic analysis of the environmental effects of the transportation of fresh fuel to and irradiated fuel / radioactive waste from LWRs in the WASH-1238, Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants (AEC, 1972), and in Supplement 1 to WASH-1238, NUREG-75/038, and found the impact to be small. These documents provided the basis for Table S-4 in 10 CFR 51.52, Environmental effects of transportation of fuel and waste, which summarizes the environmental impacts of transportation of fuel and waste to and from one 3,000 to 5,000 megawatts thermal (MWt) (1,000 to 1,500 MWe) LWR. Impacts are provided for normal conditions of transport and accidents in transport for a reference 1,100 MWe LWR.

Per 10 CFR 51.52, every ER prepared for the construction permit stage or ESP stage or combined license stage of a LWR, and submitted after February 4, 1975, shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in 10 CFR 51.52(a) or all the conditions of 10 CFR 51.52(b).

As shown in Table 6.2-1, conditions 2 and 3 of 10 CFR 51.52(a) are not met by the technologies considered. More specifically, fuel enrichment for the different technologies shows a minimum enrichment of 4.95 percent, up to 19.75 percent. Furthermore, all the technologies exceed the average level of irradiation to the irradiated fuel of 33,000 megawatt-day per metric ton uranium (MWd/MTU). Therefore, as stated in 10 CFR 51.52(b), a full description and a detailed transportation analysis are required as part of the ER.

6.2.1 COMPONENTS OF A FULL DESCRIPTION AND DETAILED ANALYSIS

As discussed in Section 6.2, the Project site does not meet all of the conditions in 10 CFR 51.52(a), therefore, to be in accordance with 10 CFR 51.52, a full description and a detailed transportation analysis of the environmental effects of transportation of fuel and radioactive waste to and from the Project site, including values for the environmental impact under normal conditions of transport and environmental risk from accidents in transport, is required as part of the ER.

Guidance from Regulatory Guide (RG) 4.2 states that the detailed analysis of transportation impacts should include the following:

- Transportation of unirradiated fuel, including the radiological impacts associated with the normal conditions of transport and the nonradiological impacts associated with transportation accidents.

- Transportation of irradiated fuel, including the radiological impacts associated with the normal conditions of transport and the radiological and nonradiological impacts associated with transportation accidents.

- Transportation of radioactive waste, including the radiological impacts associated with

the normal conditions of transport and the nonradiological impacts associated with transportation accidents.

While radiological impacts associated with transportation accidents involving unirradiated fuel and radioactive waste are not designated in RG 4.2, the impacts are discussed in Section 6.2.1.2 for the Project site.

The detailed transportation analysis utilizes guidance from RG 4.2 and NUREG-1555. As such, the WebTRAGIS and NRC-RADTRAN computer codes are used to determine the impacts of transporting radioactive materials to and from the Project site.

WebTRAGIS is used to determine the distance traveled by truck for each route analyzed in the detailed transportation analysis. For fabricated fuel and radioactive waste, the Highway Route-Controlled Quantities (HRCQ) option is utilized. The irradiated fuel route utilizes the HRCQ-Nevada National Security Site (NNSS) option. The significant output from WebTRAGIS, other than the route itself, is the population densities potentially exposed along the route based on 2010 U.S. Census data (USCB, 2010). WebTRAGIS uses 2010 U.S. Census data because that is the data set that is the population dataset that is maintained in the WebTRAGIS population database. Both the route information and population densities are used as input to NRC-RADTRAN.

NRC-RADTRAN is used to calculate population doses from a single truck shipment given the routes defined by WebTRAGIS. Other parameters utilized for each shipment (during normal conditions of transport and an accident), such as packaging, dose rate from shipment, and characteristics of the truck are used as input for the NRC-RADTRAN analysis.

Annual doses to transportation workers and the general public, and the annual transportation population accident risk to the general public are calculated based on the number of annual shipments, discussed in Section 6.2.2, for each shipment type (i.e., unirradiated fuel, irradiated fuel, and radioactive waste), and the associated results for a single truck shipment from the NRC-RADTRAN output.

6.2.1.1 Radiological Impacts of Normal Conditions of Transport

NRC-RADTRAN is used to calculate the crew and population doses associated with transport of radioactive material during normal conditions to and from the Project site from a single shipment given the routes defined by WebTRAGIS. As mentioned in Section 6.2.1, three types of nuclear shipments are identified to be shipped to and from the Project site: Shipment of fabricated fuel from a fabrication facility, shipment of low-level radwaste from the project site to a disposal site, and shipment of irradiated fuel from the project site to a proposed geological repository. Information used as input into NRC-RADTRAN regarding the dose rate, characteristics of the truck, population density, and other shipment details are contained in Table 6.2-2.

Since the population count from WebTRAGIS uses 2010 Census data (USCB, 2010), the doses need to be adjusted to account for the increase in population for when the plant is expected to receive the first fuel shipment for Unit 1, which is estimated to be in 2033. As such, to account for the total population increase between 2010 and 2033, a scaling factor of 1.185 is applied to the population dose to account for the increase in population. The scaling factor is based on the increase in population from the year 2010 to 2020 of 7.4% and the average increase in population from the year 2000 to 2020 of roughly 0.855% each year. The scale factor is determined by adding the increase in population from the year 2010 to 2020 of 7.4% to the

product of the yearly average population increase of 0.855% by 13 years (i.e., 2033 – 2020 = 13) to result in 1.185 (i.e., 1.074 + [0.00855 x 13]).

Transportation of Unirradiated Fuel During Normal Conditions

WebTRAGIS is used to determine the route from the fuel fabrication facility, which is assumed to be the Framatome fuel fabrication facility in Richland, WA to the Project site. Shipment of fabricated fuel from the Framatome fuel fabrication facility is acceptable because it is the furthest identified licensed fuel fabrication facility to be used from the list of technologies considered for the Project site. Table 6.2-3 shows the shipment route link data utilized from WebTRAGIS. Table 6.2-7 presents the dose from a single shipment and annual dose to the workers and general public associated with shipment of fabricated fuel.

Transportation of Radwaste During Normal Conditions

WebTRAGIS is used to determine the route from the Project site to two potential radwaste disposal facilities, which are assumed to be the Waste Control Specialists (WCS) facility near Andrews, TX and the EnergySolutions disposal facility in Clive UT. Shipment of radwaste to both the WCS facility and EnergySolutions disposal facility is acceptable because both locations accept radwaste from all regions of the United States, pending prior permission (required for WCS). Tables 6.2-4 and 6.2-5 shows the shipment route link data utilized from WebTRAGIS for the WCS and EnergySolutions routes, respectively. Tables 6.2-8 and 6.2-9 presents the dose from a single shipment and annual dose to the workers and general public associated with shipment of radwaste to Andrews, TX and Clive, UT, respectively.

Transportation of Irradiated Fuel During Normal Conditions

WebTRAGIS is used to determine the route from the Project site to a proposed geological repository, which is assumed to be the Yucca Mountain site in Nye County, NV. Shipment of irradiated fuel to the Yucca Mountain site is acceptable because Yucca Mountain is identified as a possible repository for irradiated fuel. Table 6.2-6 shows the shipment route link data utilized from WebTRAGIS. Table 6.2-10 presents the dose from a single shipment and annual dose to the workers and general public associated with shipment of irradiated fuel.

The DOE Resource Handbook on DOE Transportation Risk Assessment suggests an irradiated fuel truck dose rate of 14 millirem per hour (mrem/hr) at 1 meter from the shipment. However, the NRC developed a probabilistic distribution of dose rates based on fuel cooling times that indicates that approximately three-fourths of the spent fuel to be transported will have dose rates less than half of the regulatory limit. Based on the analysis performed by the NRC, the dose rate was reduced to 5 mrem/hr, which is approximately 50 percent confidence interval of the dose rate distribution estimated for future spent fuel shipments.

Conclusion of Normal Conditions of Transport Analysis

Table 6.2-11 presents a summary of the transportation dose to workers and the general public from the Project site.

General public doses in Table 6.2-11 meet the 3 person-rem dose criterion for transportation of fabricated fuel, however, the doses for transportation of radwaste and irradiated fuel exceed the Table S-4 dose criterion. General public doses due to radwaste shipments are determined for the GVH BWRX-300 reactor, which has the largest waste volume of the 6 reactor types

evaluated. The large waste volume along with the large distances to the radwaste facilities result in larger doses to the general public.

While it is briefly noted above, the large distance for each route is a contributor for the dose exceeding the limits contained in Table S-4 of 10 CFR 51.52, a more in-depth discussion is contained in this paragraph. The limits contained in Table S-4 were established using significantly shorter distances than those used in the normal conditions of transport calculation. More specifically, the largest distance traveled for a shipment in WASH-1238 was roughly 1000 mi., which included shipments of fabricated fuel and spent fuel. As can be seen in Tables 6.2-3 through 6.2-6, the distances analyzed in the normal conditions of transport calculation range from 1500 to 2800 mi. Additionally, the doses determined in the normal conditions of transport calculation are further inflated compared to the limits contained in Table S-4 of 10 CFR 51.52 because the population has increased, which is a significant variable in determining the total population dose.

The largest total population dose from transporting material from the Project site of 13.4 person-rem includes shipping radwaste to Clive, UT. This value is lower than the value of 1754 person-rem, determined by the International Commission on Radiological Protection (ICRP) and National Council on Radiation Protection and Measurements (NCRP), that would suggest a result in zero excess health effects. Furthermore, the bounding maximum in-transit dose to a member of the public, determined by NRC-RADTRAN, of 9.66E-05 mrem per radioactive waste shipment can be multiplied by the number of shipments per year to determine the annual maximum individual in-transit dose of 9.70E-02 mrem/yr (i.e., [9.66E-06 mrem/fabricated fuel shipment x 11 fabricated fuel shipments] + [9.66E-05 mrem/radioactive waste shipment x 234 radioactive waste shipments] + [1.35E-03 mrem/irradiated fuel shipment x 55 irradiated fuel shipments]) and compared against the estimated average radiation dose from natural background radiation of 310 mrem/yr, determined in Section 2.9, which results in the annual maximum individual in-transit dose being several orders of magnitude lower than the estimated average radiation dose from natural background radiation. Therefore, while the doses exceed the limits provided in Table S-4, the environmental impact associated with normal conditions of transport of radioactive materials from the Project site is still considered SMALL.

6.2.1.2 Radiological Impacts – Accident Conditions of Transport

NRC-RADTRAN is used to calculate the crew and population risk associated with an accident while transporting radioactive material to and from the Project site from a single shipment given the routes defined by WebTRAGIS. As mentioned in Section 6.2.1, three types of nuclear shipments are identified to be shipped to and from the Project site: Shipment of fabricated fuel from a fabrication facility, shipment of low-level radwaste from the project site to a disposal site, and shipment of irradiated fuel from the project site to a proposed geological repository. Information used as input into NRC-RADTRAN regarding the dose rate, characteristics of the truck, population density, and other shipment details are contained in Table 6.2-12.

Similar to 6.2.1.1, since the population count from WebTRAGIS uses 2010 Census data, the doses need to be adjusted to account for the increase in population for when the plant is expected to receive the first fuel shipment for Unit 1, which is estimated to be in 2033. As such, to account for the total population increase between 2010 and 2033, a scaling factor of 1.185 is applied to the population dose to account for the increase in population (See Section 6.2.1.1).

Accident rates are the probability of an accident per kilometer of travel. The transportation accident analysis utilizes accident rates based on 2006 data instead of the accident rates

provided in NUREG-2266. This is because the accident rates utilized in the transportation accident are larger (i.e., more conservative) than the accident rates provided in NUREG-2266 (which are limited to truck involved accidents). The highway accident rates for each state are shown in Table 6.2-13.

The conditional probability fractions for LWRs are taken from Table 7.31 of NUREG/CR-6672. The conditional probability fractions utilized for the X-energy Xe-100 and TerraPower Natrium are from PNNL-29365 (PNNL, 2020). The conditional probability fractions for each accident scenario has an associated release fraction for each group of radionuclides in the package. Release fractions are typically lower for accident scenarios that are more likely to happen. Similarly, accident scenarios that have a lower probability to happen typically have larger release fractions.

The release fraction for each reactor type is included in the NRC-RADTRAN analysis. The release fraction for LWR technology is taken for each respective reactor type from NUREG-2266, Table B-12 and B-13. Since the Xe-100 and Natrium are non-LWR technologies, the release fractions in NUREG-2266 are not applicable to be used. However, appropriate release fractions are determined in PNNL-29365, where Group 5 applies to the Xe-100 and Group 1 applies to the Natrium reactor. Additionally, all release categories utilize a deposition velocity of 0.1 meters per second (m/s), except for gases, which utilize a deposition velocity of 0 m/s. The release fractions and deposition velocities associated with each reactor technology are shown in Tables 6.2-16 through 6.2-19.

Accident While Transporting Unirradiated Fuel

As stated in WASH-1238 (AEC, 1972), the radiological impact to the environment from an accident while transporting unirradiated fuel is negligible. Therefore, any risk contributed from an accident of unirradiated fuel would not contribute to the risk from an accident while transporting radwaste or irradiated fuel.

Accident While Transporting Radwaste

The WebTRAGIS routes utilized for normal conditions of transport of radwaste are utilized for the transportation accident analysis. Additionally, the radionuclide inventory is a parameter used in the NRC-RADTRAN analysis. The radionuclide inventory for solid radwaste is adjusted based on Table 3.4-8 of this ER. It should be noted that not all radionuclides from Table 3.4-8 of this ER are used in the detailed analysis. The radionuclides utilized from Table 3.4-8 are presented in Table 6.2-15. These radionuclides were utilized because they are contained in the radionuclide library contained in NRC-RADTRAN.

Accident While Transporting Irradiated Fuel

The WebTRAGIS route utilized for normal conditions of transport of irradiated fuel is utilized for the transportation accident analysis. Additionally, the radionuclide inventory associated with irradiated fuel shipments is taken from Table A-1 of NUREG-2266 (NRC, 2024) and is presented in Table 6.2-14 on a 0.5 MTU fuel assembly basis.

Conclusion of Transportation Accident Analysis

Table 6.2-20 presents a summary of the transportation risk to the general public from the Project site due to an accident while transporting radioactive material. While a detailed

transportation analysis is required as part of the ER since all the reactor technologies in the Plant Parameter Envelope (PPE) exceed the burnup criterion in 10 CFR 51.52(a), no numerical value is listed in Table S-4 of 10 CFR 51.52 for comparison of environmental risks. However, the bounding risk from a single route can be used to compare against values that affect health and the population dose associated with background radiation. The bounding risk from a single route is associated with transportation of irradiated fuel from a pressurized-water reactor (PWR), which is shown as 3.04E-03 person-rem. Similar to 6.2.1.1, this value is lower than the value of 1754 person-rem, determined by the ICRP and NCRP, that results in zero excess health effects. Additionally, the total estimated collective annual population dose from natural background radiation along the route is estimated to be 7.00E+06 person-rem using the estimated average radiation dose from natural background radiation of 310 mrem/yr, determined in Section 2.9 of this ER. Although the total estimated collective population background dose is associated with only one route, the background dose from one route is larger than the total annual transportation population risk associated with shipment of radioactive material for each reactor technology. Therefore, the environmental risk associated with transportation accidents in this evaluation is considered SMALL.

6.2.1.3 Non-Radiological Impacts of Transport

Non-radiological impacts associated with postulated transportation accidents are calculated for:

- Injuries and fatalities during transportation of unirradiated fuel
- Injuries and fatalities during transportation of irradiated fuel
- Injuries and fatalities during transportation of radwaste

The non-radiological impacts from postulated transportation accidents are evaluated using the WebTRAGIS code to define appropriate routing and population density along the route, and NRC-RADTRAN to calculate the non-radiological impacts (e.g., injuries and fatalities).

The injury and fatality rates (i.e., injuries/accident and fatalities/accident) are determined by using the accidents per km, injuries per km, and fatalities per km from NUREG-2266 and are presented in Table 6.2-21. More specifically, the injuries per km or fatalities per km are divided by the accidents per km. The accident rates from NUREG-2266, presented in Table 6.2-21, are used for the non-radiological analysis.

The non-radiological impacts are based on round-trip distances because the return of the empty truck is included in the evaluation. Therefore, the frequency (fatalities/shipment and injuries/shipment) are multiplied by double the number of shipments identified in Section 6.2.2 for each transportation route.

Accident While Transporting Unirradiated Fuel

The routing parameters that are used to analyze non-radiological impacts of transporting unirradiated fuel are the same as those used to analyze the radiological impacts associated with transporting unirradiated fuel. Additionally, the accident rates and injury/fatality rates from Table 6.2-21 are utilized in the analysis. The number of unirradiated fuel shipments each year is identified in Section 6.2.2.1.

Accident While Transporting Radwaste

The routing parameters that are used to analyze non-radiological impacts of transporting radwaste are the same as those used to analyze the radiological impacts associated with transporting radwaste. Additionally, the accident rates and injury/fatality rates from Table 6.2-21 are utilized in the analysis. The number of radwaste shipments each year is identified in Section 6.2.2.3.

Accident While Transporting Irradiated Fuel

The routing parameters that are used to analyze non-radiological impacts of transporting irradiated fuel are the same as those used to analyze the radiological impacts associated with transporting irradiated fuel. Additionally, the accident rates and injury/fatality rates from Table 6.2-21 are utilized in the analysis. The number of irradiated fuel shipments each year is identified in Section 6.2.2.2.

Conclusion of Transportation Accident Analysis

Table 6.2-22 uses the NRC-RADTRAN injury and fatality results per shipment to determine the injuries and fatalities per 10 years and 100 years, respectively, from the Project site due to an accident while transporting radioactive material. A detailed transportation analysis is required as part of the ER since all the reactor technologies in the Plant Parameter Envelope (PPE) exceed the burnup criterion in 10 CFR 51.52(a). A numerical value of 1 fatal injury in 100 reactor years and 1 nonfatal injury in 10 reactor years is listed in Table S-4 of 10 CFR 51.52 for comparison of environmental risks for non-radiological impacts. The estimated number of fatal injuries is 2.54E-02 per reactor year (2.54 in 100 years) for the Project site, which is more than the fatal numerical value listed in Table S-4. The estimated number of non-fatal injuries is 3.13E-01 per reactor year (3.13 in 10 reactor years), which is more than the non-fatal numerical value listed in Table S-4.

The values contained in Table S-4 were established using significantly shorter distances than those used in the analysis for non-radiological impacts associated with an accident while transporting radioactive material. More specifically, the largest distance traveled for a shipment in WASH-1238 was roughly 1000 mi., which included shipments of fuel and radwaste. As can be seen in Tables 6.2-3 through 6.2-6, the distances analyzed for the non-radiological transport analysis range from 1500 to 2800 mi. Furthermore, the injury and fatality frequencies include a return trip, which increases the total distance traveled by a factor of two. While the increase in distance directly contributes to the increase in injury and fatality frequencies, less than one fatality and non-fatal injury is estimated per year. Therefore, the non-radiological environmental risks associated with transportation accidents in this evaluation is considered SMALL.

6.2.2 ESTIMATING THE NUMBER OF SHIPMENTS AND NORMALIZATION OF SHIPMENTS

As mentioned in Section 6.2.1, NRC-RADTRAN is used to calculate population doses from a single truck shipment given the routes defined by WebTRAGIS. However, to fully determine the annual population dose for each route defined by WebTRAGIS, the estimated annual number of shipments for each route type needs to be determined and normalized to a 1100 MWe LWR using guidance from RG 4.2. The following subsections discuss the methods used to determine the estimated number of shipments for each route analyzed in this section.

6.2.2.1 Number of Shipments of Unirradiated Fuel

RG 4.2 is used to estimate and normalize the number of shipments for fabricated fuel. Parameters given in Table 6.2-1 for the six reactor types, discussed in the PPE, are used with the equations given in RG 4.2.

Since the equation requires the number of initial core shipments and the average annual shipment per year over 39 years, and the PPE provides the number of fuel assemblies, the methodology in WASH-1238 (AEC, 1972) is utilized to determine the number of shipments required for initial core load and reloading using the number of fuel assemblies. WASH-1238 states that two fuel assemblies consist of one package and a truckload minimally fits six packages.

Using this information, the BWRX-300 reactor is used to determine the number of unnormalized fabricated fuel shipments since that reactor results in the maximum number of shipments, which is determined to be 21 unnormalized shipments per year. The reactor power level and capacity factor given for the BWRX-300 for the Project site are used with the normalization equation given in RG 4.2, which results in 11 normalized shipments per year.

6.2.2.2 Number of Shipments of Irradiated Fuel

RG 4.2 is used to estimate and normalize the number of shipments for irradiated fuel. RG 4.2 states that a transportation cask capacity of 0.5 MTU per shipment should be used to estimate the number of unnormalized shipments. The Westinghouse AP300 contains the largest amount of MTU per fuel reload from the technologies considered. Following the guidance from RG 4.2 of 0.5 MTU per shipment, 114 unnormalized shipments of irradiated fuel are estimated each year. The reactor power level and capacity factor given for the AP300 for the Project site are used with the normalization equation given in RG 4.2, which results in 55 normalized shipments per year.

However, the guidance in RG 4.2 regarding a transportation cask capacity of 0.5 MTU per shipment is based on shipping casks designed to transport shorter-cooled fuel (i.e., 90 days out of the reactor). Since there are no active irradiated fuel disposal repositories, irradiated fuel is expected to be cooled longer than 90 days before shipped from the site. The cask capacity in the Environmental Impact Statement (EIS) for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada assumes 1.8 MTU. The NRC believes this is a reasonable projection for future spent fuel truck shipping capacities; therefore, use of 1.8 MTU per shipment is utilized for the normal conditions of transport analysis in this ER. Using the larger cask capacity from the EIS of 1.8 MTU the number of irradiated fuel shipments is reduced to 32 shipments per year, which is normalized to 16 shipments of irradiated fuel per year.

6.2.2.3 Number of Shipments of Radwaste

RG 4.2 is used to estimate and normalize the number of shipments for radwaste. RG 4.2 states that a shipment capacity of 2.34 cubic meters (m^3) per shipment should be used to estimate the number of unnormalized shipments. As can be seen in Table 6.2-1, the BWRX-300 generates the largest waste volume per year. Utilizing the guidance from RG 4.2, 472 unnormalized radwaste shipments are estimated each year. The reactor power level and capacity factor given for the BWRX-300 for the Project site is used with the normalization equation given in RG 4.2, which results in 234 normalized shipments per year.

Table 6.2-1
PPE Reactor Parameters

Reactor Technology (Type)	Power Level (MWe)	Capacity Factor	Number of Units/Reactor Type	Initial Fuel Loading # of Assemblies	Cycle Duration (Reload Frequency)	# Reload Assemblies	Annual Radioactive Waste Volume (ft^3/yr)	Fuel Enrichment	Maximum Average Assembly Burnup (MWD/MTU)
BWRX-300 (BWR)	1890	94	6	1440	12 to 24 months	192 (12 months) 432 (24 months)	38,988	5%	65,000
AP300 (PWR)	1896	> 97	6	726	36 months	360	9162	< 5%	43,000
VOYGR (PWR)	924	≥ 95	12	444	18 months	156	8460	≤ 4.95%	62,000
Xe-100 (HTGR)	1252	95	14	–	Online	–	16,660	15.5%	169,450
SMR-300 (PWR)	2310	>95	6	–	18 months	–	22,219	< 5%	51,000
Natrium (Sodium)	654	92.5	2	–[(a)]	24 months	–	4140	Less than or equal to 19.75%	160,000

Note:
(a) Section 6.2.2.1 of the Kemmerer Power Station Unit 1 Environmental Report (TerraPower, 2024) states that an annual average of 1.4 shipments of fabricated fuel is expected to be shipped for one TerraPower Natrium unit; therefore, the number of unnormalized fabricated fuel shipments per year for two TerraPower Natrium units is estimated at roughly 3 shipments per year.

Key: BWR = boiling-water reactor; HTGR = High-Temperature Gas-Cooled Reactor; ft^3/yr = cubic feet per year; MWD/MTU = megawatt-day per metric ton uranium; MWe = megawatts electric; PWR = pressurized-water reactor

Table 6.2-2
Incident-Free NRC-RADTRAN Input Parameters

NRC-RADTRAN Tab	Parameter	Value
Vehicle	Transportation Mode	Truck (Default)
	Exclusive Use?	No (Default)
	Size	12 m
	Dose Rate at 1 m	0.1 mrem/hr (Fabricated Fuel) 1 mrem/hr (Radwaste) 5 mrem/hr (Irradiated Fuel)
	Gamma Fraction	1.0 (Default)
	Neutron Fraction	0.0 (Default)
	Crew Size	2 persons
	Crew Distance	5.2 m
	Width Facing Crew	2 m
	Crew Shielding Factor	1=None
	Number of Shipments	1
Links	Distance Traveled from TRAGIS Output	-
	Speed mph (kph)	55 (88.5)
	Adjacent Vehicle Occupants	1.5 persons/vehicle
	Traffic	Varies
	Farm Fraction if Rural	0.5 (default)
Stops	Population Density	30,000 p/km^2
	Inner Radius	1 m
	Outer Radius	10 m
	Crew Shielding Factor	1=None
	Duration	0.3 hr per stop
Packages	Optional for incident-free dose	-
Default Parameters	Default values used	-

Key: kph = kilometers per hour; m = meter; mrem/hr = millirem per hour; p/km^2 =persons per square kilometer

Table 6.2-3
Richland, WA Shipment Route Link Data

State	Zone	Distance Traveled (mi.)	Distance Traveled (km)	Vehicle Density (vehicle/hr)	Population Density (people/km^2)
NC	Rural	78.28	125.95	1427	28.7
	Suburban	151.36	243.54	2776	457.1
	Urban	8.84	14.22	5611	1968.0
TN	Rural	167.11	268.88	1427	25.1
	Suburban	114.71	184.57	2776	459.5
	Urban	10.38	16.70	5611	1531.4
KY	Rural	81.42	131.00	1427	15.1
	Suburban	11.66	18.76	2776	283.4
	Urban	0	0.00	5611	0.0
IL	Rural	135.76	218.44	1200	20.8
	Suburban	37.87	60.93	2466	206.8
	Urban	0.65	1.05	4408	1361.3
MO	Rural	145.36	233.88	926	15.6
	Suburban	92.86	149.41	1610	636.9
	Urban	13.52	21.75	2463	1478.8
KS	Rural	374.76	602.99	926	10.4
	Suburban	48.65	78.28	1610	388.6
	Urban	7.88	12.68	2463	1610.0
CO	Rural	200.29	322.27	795	15.7
	Suburban	49.43	79.53	1956	347.5
	Urban	7.72	12.42	3708	1846.5
WY	Rural	342.79	551.55	795	9.5
	Suburban	23.86	38.39	1956	251.5
	Urban	0.01	0.02	3708	1284.7
UT	Rural	116.34	187.19	795	14.6
	Suburban	32.61	52.47	1956	352.2
	Urban	0.15	0.24	3708	1313.4
ID	Rural	227.01	365.26	1123	13.7
	Suburban	46.93	75.51	2670	328.6
	Urban	1.45	2.33	5624	1687.5
OR	Rural	193.34	311.08	1123	14.4
	Suburban	15.2	24.46	2670	365.3
	Urban	0.13	0.21	5624	1330.7
WA	Rural	32.06	51.58	1123	8.0
	Suburban	12.93	20.80	2670	582.5
	Urban	0.06	0.10	5624	1295.9

Key: km = kilometer; km^2 = square kilometer; mi. = mile

Table 6.2-4
Radwaste – Andrews, TX Shipment Route Link Data

State	Zone	Distance Traveled (mi.)	Distance Traveled (km)	Vehicle Density (vehicle/hr)	Population Density (people/km^2)
NC	Rural	29.15	46.90	1427	33.4
	Suburban	104.26	167.75	2776	492.5
	Urban	10.34	16.64	5611	1726.3
SC	Rural	38.15	61.38	1427	29.9
	Suburban	66.01	106.21	2776	249.5
	Urban	2.49	4.01	5611	1503.5
GA	Rural	64.8	104.26	1427	21.2
	Suburban	70.01	112.65	2776	564.8
	Urban	22.08	35.53	5611	1825.2
AL	Rural	141.54	227.74	1427	18.2
	Suburban	69.93	112.52	2776	302.8
	Urban	1.78	2.86	5611	1468.0
MS	Rural	105.44	169.65	1427	16.7
	Suburban	48.34	77.78	2776	310.4
	Urban	1.08	1.74	5611	1417.5
LA	Rural	128.13	206.16	897	14.5
	Suburban	63.5	102.17	1498	206.4
	Urban	1	1.61	3003	1480.0
TX	Rural	415.07	667.85	897	15.2
	Suburban	127.55	205.23	1498	330.7
	Urban	10.06	16.19	3003	1578.6

Table 6.2-5
Radwaste – Clive, UT Shipment Route Link Data

State	Zone	Distance Traveled (mi.)	Distance Traveled (km)	Vehicle Density (vehicle/hr)	Population Density (people/km^2)
NC	Rural	78.28	125.95	1427	28.7
	Suburban	151.36	243.54	2776	457.1
	Urban	8.84	14.22	5611	1968.0
TN	Rural	167.11	268.88	1427	25.1
	Suburban	114.71	184.57	2776	459.5
	Urban	10.38	16.70	5611	1531.4
KY	Rural	81.42	131.00	1427	15.1
	Suburban	11.66	18.76	2776	283.4
	Urban	0	0.00	5611	0.0
IL	Rural	135.76	218.44	1200	20.8
	Suburban	37.87	60.93	2466	206.8
	Urban	0.65	1.05	4408	1361.3
MO	Rural	145.36	233.88	926	15.6
	Suburban	92.86	149.41	1610	636.9
	Urban	13.52	21.75	2463	1478.8
KS	Rural	374.76	602.99	926	10.4
	Suburban	48.65	78.28	1610	388.6
	Urban	7.88	12.68	2463	1610.0
CO	Rural	200.29	322.27	795	15.7
	Suburban	49.43	79.53	1956	347.5
	Urban	7.72	12.42	3708	1846.5
WY	Rural	342.79	551.55	795	9.5
	Suburban	23.86	38.39	1956	251.5
	Urban	0.01	0.02	3708	1284.7
UT	Rural	119.32	191.99	795	14.9
	Suburban	41.58	66.90	1956	512.7
	Urban	11.79	18.97	3708	1712.4

Table 6.2-6
Irradiated Fuel – Nye County, NV Shipment Route Link Data

State	Zone	Distance Traveled (mi.)	Distance Traveled (km)	Vehicle Density (vehicle/hr)	Population Density (people/km^2)
NC	Rural	78.28	125.95	1427	28.7
	Suburban	151.36	243.54	2776	457.1
	Urban	8.84	14.22	5611	1968.0
TN	Rural	167.11	268.88	1427	25.1
	Suburban	114.71	184.57	2776	459.5
	Urban	10.38	16.70	5611	1531.4
KY	Rural	81.42	131.00	1427	15.1
	Suburban	11.66	18.76	2776	283.4
	Urban	0	0.00	5611	0.0
IL	Rural	135.76	218.44	1200	20.8
	Suburban	37.87	60.93	2466	206.8
	Urban	0.65	1.05	4408	1361.3
MO	Rural	145.36	233.88	926	15.6
	Suburban	92.86	149.41	1610	636.9
	Urban	13.52	21.75	2463	1478.8
KS	Rural	374.76	602.99	926	10.4
	Suburban	48.65	78.28	1610	388.6
	Urban	7.88	12.68	2463	1610.0
CO	Rural	200.29	322.27	795	15.7
	Suburban	49.43	79.53	1956	347.5
	Urban	7.72	12.42	3708	1846.5
WY	Rural	342.79	551.55	795	9.5
	Suburban	23.86	38.39	1956	251.5
	Urban	0.01	0.02	3708	1284.7
UT	Rural	164.11	264.05	795	13.4
	Suburban	42.5	68.38	1956	510.6
	Urban	11.79	18.97	3708	1712.4
NV	Rural	456.16	733.96	1421	2.5
	Suburban	12.12	19.50	3732	231.5
	Urban	0	0.00	7517	0.0

Table 6.2-7
Fabricated Fuel – Richland, WA Annual Transport Dose

Exposed Population	Dose per Shipment (person-rem)	Shipments per Year	Dose per Year (person-rem)
Crew	1.51E-03	11	1.66E-02
Handling	1.26E-03	11	1.39E-02
General Public			
Off Link	3.07E-04	11	3.38E-03
On Link	1.69E-03	11	1.86E-02
Stops	2.96E-03	11	3.26E-02
General Public Total	4.96E-03	11	5.46E-02

Table 6.2-8
Radwaste – Andrews, TX Annual Transport Dose

Exposed Population	Dose per Shipment (person-rem)	Shipments per Year	Dose per Year (person-rem)
Crew	8.25E-03	234	1.93E+00
Handling	1.26E-02	234	2.95E+00
General Public			
Off Link	2.16E-03	234	5.05E-01
On Link	1.13E-02	234	2.64E+00
Stops	1.65E-02	234	3.86E+00
General Public Total	2.99E-02	234	7.01E+00

Table 6.2-9
Radwaste – Clive, UT Annual Transport Dose

Exposed Population	Dose per Shipment (person-rem)	Shipments per Year	Dose per Year (person-rem)
Crew	1.24E-02	234	2.90E+00
Handling	1.26E-02	234	2.95E+00
General Public			
Off Link	2.82E-03	234	6.60E-01
On Link	1.41E-02	234	3.30E+00
Stops	2.30E-02	234	5.38E+00
General Public Total	3.99E-02	234	9.34E+00

Table 6.2-10
Irradiated Fuel – Nye County, NV Annual Transport Dose

Exposed Population	Dose per Shipment (person-rem)	Shipments per Year	Dose per Year (person-rem)
Crew	7.55E-02	16	1.21E+00
Handling	6.30E-02	16	1.01E+00
General Public			
Off Link	1.43E-02	16	2.29E-01
On Link	8.65E-02	16	1.38E+00
Stops	1.48E-01	16	2.37E+00
General Public Total	2.49E-01	16	3.98E+00

Table 6.2-11
Project Site Annual Normal Conditions of Transport Dose Summary

Exposed Population	Fabricated Fuel Richland, WA (person-rem)	Radwaste Andrews, TX (person-rem)	Radwaste Clive, UT (person-rem)	Irradiated Fuel Nye County, NV (person-rem)	Total Transportation Dose (person-rem)[(a)]	10 CFR 51.52 Dose Criteria (person-rem)
Crew	1.66E-02	1.93E+00	2.90E+00	1.21E+00	3.16E+00 / 4.13E+00	–
Handling	1.39E-02	2.95E+00	2.95E+00	1.01E+00	3.97E+00 / 3.97E+00	–
Transportation Worker Dose	3.05E-02	4.88E+00	5.85E+00	2.22E+00	7.13E+00 / 8.10E+00	4.00E+00
General Public	5.46E-02	7.01E+00	9.34E+00	3.98E+00	1.10E+01 / 1.34E+01	3.00E+00

Note:
(a) The total transportation doses are separated as such that the first dose in each row includes the radwaste dose from Andrews, TX and the second dose includes the radwaste dose from Clive, UT.

Table 6.2-12
Transportation Accident NRC-RADTRAN Input Parameters

NRC-RADTRAN Tab	Parameter	Value
Vehicle	Transportation Mode	Truck (Default)
	Exclusive Use?	No (Default)
	Size	12 m
	Dose Rate at 1 m	1 mrem/hr (Radwaste) 14 mrem/hr (Irradiated Fuel)
	Gamma Fraction	1.0 (Default)
	Neutron Fraction	0.0 (Default)
	Crew Size	2 persons
	Crew Distance	4 m
	Width Facing Crew	2 m
	Crew Shielding Factor	1=None
	Number of Shipments	1
Links	Distance Traveled from TRAGIS Output	–
	Speed mph (kph)	55 (88.5)
	Adjacent Vehicle Occupants	1.5 persons/vehicle
	Population Density	Varies
	Traffic	Varies
	Accident Rate	Varies
	Farm Fraction if Rural	0.5 (default)
Stops	Not used for accidents	–
Packages	Largest dimension	12 m
	Dose Rate	1 mrem/hr (Radwaste) 14 mrem/hr (Irradiated Fuel)
	Gamma Fraction	1.0 (Default)
	Neutron Fraction	0.0 (Default)
Accidents	Severity Probabilities	Varies
	Release Groups	Varies
	Weather	National Average (Default)
	Isopleths (Dispersion Areas)	From Links table (Default)
Radionuclides	Radionuclides	Varies
Loss of Shielding	Loss of Shielding is not applied	–
Economic Model	Economic Model is not applied	–
Default Parameters	Default Parameters is not applied	–

Key: kph = kilometers per hour; m = meter; mph = miles per hour; mrem/hr = millirem per hour

Table 6.2-13
Accident Rates by State

State	Highway Accidents/Vehicle km	State	Highway Accidents/Vehicle km	State	Highway Accidents/Vehicle km	State	Highway Accidents/Vehicle km
AL	2.61E-06	IA	1.63E-06	NE	1.96E-06	RI	2.18E-06
AZ	1.70E-05	KS	2.50E-06	NV	8.37E-06	SC	1.59E-06
AR	2.07E-06	KY	3.29E-06	NH	3.46E-06	SD	5.36E-06
CA	3.98E-06	LA	2.85E-06	NJ	5.19E-06	TN	3.00E-06
CO	9.58E-07	ME	2.91E-06	NM	4.78E-06	TX	1.11E-05
CT	2.08E-06	MD	4.09E-06	NY	1.21E-06	UT	2.04E-06
DE	1.90E-06	MA	1.57E-06	NC	4.78E-06	VT	1.16E-06
DC	6.83E-06	MI	1.20E-06	ND	1.15E-06	VA	2.67E-06
FL	1.27E-05	MN	1.43E-06	OH	1.63E-06	WA	6.91E-06
GA	1.40E-06	MS	1.50E-06	OK	7.61E-06	WV	1.55E-06
ID	6.69E-06	MO	3.98E-06	OR	1.22E-06	WI	1.79E-06
IL	5.68E-06	MT	3.78E-06	PA	2.45E-06	WY	5.21E-06
IN	1.32E-06						

Source: NRC, 2024

Table 6.2-14
Irradiated Fuel Radionuclide Inventory

Radionuclide	Bounding 0.5 MTU Inventory (Curies)
Co-60	4.380E+03
Kr-85	8.040E+03
Sr-90	8.070E+04
Y-90	8.070E+04
Ru-106	1.760E+04
Cs-134	5.050E+04
Cs-137	1.100E+05
Pu-238	7.980E+03
Pu-239	2.610E+02
Pu-240	3.990E+02
Am-241	1.120E+03
Pu-241	1.030E+05
Cm-244	1.420E+04

Key: MTU = metric tons uranium

Table 6.2-15
Radwaste Radionuclide Inventory

Radionuclide	Inventory (Ci/yr)	Radionuclide	Inventory (Ci/yr)
Ba-140	5.54E+02	Pr-143	2.78E-03
Ce-141	1.88E+02	Rb-86	1.73E-01
Ce-144	9.93E+01	Ru-103	1.56E+02
Co-57	6.66E-07	Ru-106	1.05E-01
Co-58	1.35E+03	Sb-124	1.15E-04
Co-60	1.04E+04	Sb-125	3.80E-02
Cr-51	1.61E+04	Sb-127	1.32E-05
Cs-134	1.22E+03	Sr-89	8.12E+02
Cs-137	4.13E+03	Sr-90	1.87E+00
Fe-55	1.72E+02	Tc-99	1.09E-01
Fe-59	2.59E+02	Te-125m	1.22E-01
I-129	1.80E-03	Te-127	1.50E+00
I-131	4.28E+03	Te-127m	1.53E+00
Mn-54	1.24E+03	Te-129m	1.94E+02
Mo-99	5.62E+02	Te-132	3.31E+00
Nb-95	3.88E+01	Y-90	2.88E+00
Ni-63	1.39E+02	Zn-65	3.13E+04
Np-239	1.92E+03	Zr-95	9.96E+01
P-32	3.14E-07		

Key: Ci/yr = Curies per year

Table 6.2-16
TerraPower Natrium Release Fractions

Severity Level	Release Fraction				
	Krypton	Cesium	Ruthenium	Particulates	CRUD
1	0	0	0	0	0
2	5.66E-05	3.54E-07	2.29E-08	1.83E-09	5.71E-06
3	0	0	0	0	0
4	7.86E-04	1.42E-07	6.63E-08	5.80E-08	1.93E-04
5	4.00E-03	7.87E-05	4.72E-06	3.20E-08	6.35E-05
6	7.70E-03	2.74E-04	7.57E-05	3.68E-07	1.13E-03
Deposition Velocity (m/s)	0	0.1	0.1	0.1	0.1

Note:
Severity Level = Estimated truck accident case and associated conditional probability (severity fraction) based on PNNL-29365 (PNNL, 2020) and NUREG/CR-6672 (NRC, 2000).
Key: m/s = meters per second

Table 6.2-17
X-Energy Xe-100 Release Fractions

Severity Level	Release Fraction				
	Krypton	Cesium	Ruthenium	Particulates	CRUD
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	7.50E-04	5.63E-10	5.63E-10	5.63E-10	0
5	0	0	0	0	0
6	3.52E-03	2.72E-09	2.64E-09	2.64E-09	0
Deposition Velocity (m/s)	0	0.1	0.1	0.1	0.1

Note:
Severity Level = Estimated truck accident case and associated conditional probability (severity fraction) based on PNNL-29365 (PNNL, 2020) and NUREG/CR-6672 (NRC, 2000).
Key: m/s = meters per second

Table 6.2-18
PWR Release Fractions

Severity Level	Release Fraction				
	Krypton	Cesium	Ruthenium	Particulates	CRUD
1	8.16E-01	2.45E-08	6.12E-07	5.51E-06	2.04E-03
2	3.47E-01	1.04E-08	2.60E-07	2.34E-06	1.73E-03
3	4.07E-01	1.22E-08	3.05E-07	2.74E-06	2.03E-03
4	8.41E-01	2.93E-05	2.55E-06	2.30E-05	3.11E-03
5	8.16E-01	2.45E-08	6.12E-07	5.51E-06	2.04E-03
6	8.88E-01	2.66E-08	6.66E-07	5.99E-06	2.22E-03
7	9.10E-01	5.90E-06	6.82E-07	6.14E-06	2.47E-03
8	9.43E-01	2.83E-08	7.07E-07	6.37E-06	2.36E-03
9	9.65E-01	2.90E-08	7.24E-07	6.52E-06	2.41E-03
10	9.72E-01	5.90E-06	7.29E-07	6.56E-06	2.63E-03
11	9.43E-01	2.83E-08	7.07E-07	6.37E-06	2.36E-03
12	9.65E-01	2.90E-08	7.24E-07	6.52E-06	2.41E-03
13	9.72E-01	5.90E-06	7.29E-07	6.56E-06	2.63E-03
14	9.49E-01	8.15E-05	7.24E-05	1.26E-04	7.01E-03
15	9.72E-01	5.90E-06	6.46E-06	6.56E-06	3.41E-03
16	9.72E-01	5.90E-06	6.46E-06	6.56E-06	3.41E-03
17	9.72E-01	5.90E-06	6.46E-06	6.56E-06	3.41E-03
18	8.39E-01	1.68E-05	6.71E-08	3.02E-04	2.52E-03
Deposition Velocity (m/s)	0	0.1	0.1	0.1	0.1

Note:

Severity Level = Estimated truck accident case and associated conditional probability (severity fraction) based on NUREG/CR-6672 (NRC, 2000).

Key: m/s = meters per second

Table 6.2-19
BWR Release Fractions

Severity Level	Release Fraction				
	Krypton	Cesium	Ruthenium	Particulates	CRUD
1	8.16E-01	2.45E-08	6.12E-07	5.51E-06	2.04E-03
2	1.55E-02	3.22E-10	8.06E-09	7.25E-08	4.48E-04
3	3.00E-02	9.00E-10	2.25E-08	2.03E-07	1.25E-03
4	8.36E-01	4.06E-05	4.73E-06	4.26E-05	3.12E-03
5	2.58E-01	7.75E-09	1.94E-07	1.74E-06	1.62E-03
6	3.14E-01	9.41E-09	2.35E-07	2.12E-06	1.96E-03
7	8.38E-01	3.21E-05	3.04E-06	2.73E-05	3.14E-03
8	8.16E-01	2.45E-08	6.12E-07	5.51E-06	2.04E-03
9	8.88E-01	2.66E-08	6.66E-07	5.99E-06	2.22E-03
10	9.10E-01	5.90E-06	6.82E-07	6.14E-06	2.47E-03
11	8.16E-01	2.45E-08	6.12E-07	5.51E-06	2.04E-03
12	8.88E-01	2.66E-08	6.66E-07	5.99E-06	2.22E-03
13	9.10E-01	5.90E-06	6.82E-07	6.14E-06	2.47E-03
14	8.37E-01	1.19E-04	1.03E-04	2.11E-04	6.46E-03
15	8.38E-01	7.79E-05	6.88E-05	1.26E-04	6.19E-03
16	9.10E-01	5.90E-06	6.42E-06	6.14E-06	3.25E-03
17	9.10E-01	5.90E-06	6.42E-06	6.14E-06	3.25E-03
18	8.39E-01	1.68E-05	6.71E-08	3.02E-04	2.52E-03
Deposition Velocity (m/s)	0	0.1	0.1	0.1	0.1

Note:
Severity Level = Estimated truck accident case and associated conditional probability (severity fraction) based on NUREG/CR-6672 (NRC, 2000).

Key: m/s = meters per second

Table 6.2-20
Project Site Annual Transportation Population Risk Summary

Reactor Technology	Radwaste Andrews, TX (person-rem)	Radwaste Clive, UT (person-rem)	Irradiated Fuel Nye County, NV (person-rem)	Total Annual Transportation Population Risk (person-rem)[(a)]
Xe-100	4.38E-13	4.30E-13	4.82E-07	4.82E-07 / 4.82E-07
Natrium	3.10E-06	3.05E-06	5.93E-04	5.96E-04 / 5.96E-04
PWR	8.12E-04	7.98E-04	3.04E-03	3.85E-03 / 3.84E-03
BWR	2.98E-04	2.92E-04	2.79E-03	3.09E-03 / 3.08E-03

Note:
(a) The total accident dose risk is separated as such that the first dose includes the radwaste dose from Andrews, TX and the second dose includes the radwaste dose from Clive, UT.

Table 6.2-21
Non-Radiological Injury and Fatality Rates

State	Accidents/km[(a)]	Injuries/km[(a)]	Injuries/ Accident[(b)]	Fatalities/ km[(a)]	Fatalities/ Accident[(b)]
Alabama	4.60E-07	1.72E-07	3.74E-01	1.56E-08	3.39E-02
Arizona	2.11E-07	3.98E-08	1.89E-01	1.04E-08	4.93E-02
Arkansas	4.25E-07	1.73E-07	4.07E-01	1.47E-08	3.46E-02
California	2.64E-07	1.25E-07	4.73E-01	8.40E-09	3.18E-02
Colorado	2.92E-07	8.71E-08	2.98E-01	1.50E-08	5.14E-02
Connecticut	4.00E-07	1.46E-07	3.65E-01	6.58E-09	1.65E-02
Delaware	5.41E-07	2.69E-07	4.97E-01	5.43E-09	1.00E-02
Florida	2.74E-07	1.26E-07	4.60E-01	9.74E-09	3.55E-02
Georgia	2.42E-07	1.05E-07	4.34E-01	8.95E-09	3.70E-02
Idaho	1.94E-07	1.07E-07	5.52E-01	1.16E-08	5.98E-02
Illinois	3.96E-07	1.93E-07	4.87E-01	9.25E-09	2.34E-02
Indiana	4.15E-07	1.23E-07	2.96E-01	1.12E-08	2.70E-02
Iowa	3.53E-07	1.26E-07	3.57E-01	1.10E-08	3.12E-02
Kansas	2.89E-07	8.16E-08	2.82E-01	1.40E-08	4.84E-02
Kentucky	3.42E-07	1.44E-07	4.21E-01	1.18E-08	3.45E-02
Louisiana	4.63E-07	3.66E-07	7.90E-01	1.53E-08	3.30E-02
Massachusetts	1.72E-07	6.87E-08	3.99E-01	2.03E-09	1.18E-02
Michigan	5.55E-07	1.46E-07	2.63E-01	9.92E-09	1.79E-02
Mississippi	2.72E-07	1.38E-07	5.07E-01	9.97E-09	3.67E-02
Missouri	3.84E-07	1.48E-07	3.85E-01	1.02E-08	2.66E-02
Nebraska	1.28E-07	4.96E-08	3.88E-01	6.57E-09	5.13E-02
Nevada	1.83E-07	9.00E-08	4.92E-01	1.14E-08	6.23E-02
New Jersey	3.72E-07	2.03E-07	5.46E-01	4.89E-09	1.31E-02
New Mexico	1.11E-07	4.15E-08	3.74E-01	7.97E-09	7.18E-02
New York	4.66E-07	2.93E-07	6.29E-01	6.75E-09	1.45E-02
North Carolina	4.23E-07	2.72E-07	6.43E-01	9.39E-09	2.22E-02
Ohio	3.08E-07	1.33E-07	4.32E-01	1.03E-08	3.34E-02
Oklahoma	2.67E-07	1.00E-07	3.75E-01	9.72E-09	3.64E-02
Oregon	2.31E-07	6.52E-08	2.82E-01	9.35E-09	4.05E-02
Pennsylvania	5.84E-07	2.35E-07	4.02E-01	1.32E-08	2.26E-02
South Carolina	2.98E-07	1.75E-07	5.87E-01	1.09E-08	3.66E-02
Tennessee	3.92E-07	1.46E-07	3.72E-01	1.64E-08	4.18E-02
Texas	4.13E-07	2.18E-07	5.28E-01	1.60E-08	3.87E-02
Utah	9.76E-08	3.88E-08	3.98E-01	4.89E-09	5.01E-02
Virginia	4.54E-07	1.73E-07	3.81E-01	1.05E-08	2.31E-02
Washington	2.48E-07	4.68E-08	1.89E-01	8.44E-09	3.40E-02
Wyoming	3.55E-07	8.23E-08	2.32E-01	5.67E-09	1.60E-02

Notes:

(a) The accident, injury, and fatality rates per km are taken from NUREG-2266 (NRC, 2024).

(b) The injury and fatality rates per accident are determined by dividing the injury and fatality rates per km from columns three and five by the accident rate in column two.

Table 6.2-22
Project Site Annual Transportation Non-Radiological Accident Impacts Summary

Injury Analysis				
Shipment Type	**Injuries per Shipment**	**Shipments per Year**	**Injuries per Year[a]**	**Injuries per 10 Years[b]**
Fabricated Fuel (Richland, WA)	5.32E-04	11	1.17E-02	1.17E-01
Irradiated Fuel (Nye County, NV)	5.31E-04	55	5.84E-02	5.84E-01
Radwaste (Clive, UT)	4.60E-04	234	2.15E-01	2.15E+00
Radwaste (Andrews, TX)	5.20E-04	234	2.43E-01	2.43E+00
Total[d]	–	300	3.13E-01	3.13E+00
Fatality Analysis				
Shipment Type	**Fatalities per Shipment**	**Shipments per Year**	**Fatalities per Year[a]**	**Fatalities per 100 Years[c]**
Fabricated Fuel (Richland, WA)	4.92E-05	11	1.08E-03	1.08E-01
Irradiated Fuel (Nye County, NV)	4.94E-05	55	5.43E-03	5.43E-01
Radwaste (Clive, UT)	4.04E-05	234	1.89E-02	1.89E+00
Radwaste (Andrews, TX)	3.31E-05	234	1.55E-02	1.55E+00
Total[d]	–	300	2.54E-02	2.54E+00

Notes:

(a) The injuries/fatalities per year are determined as a product of the injuries/fatalities per shipment and double the number of shipments per year.

(b) The injuries per 10 years is determined by multiplying the injuries per year by a factor of 10.

(c) The fatalities per 100 years is determined by multiplying the fatalities per year by a factor of 100.

(d) The totals row for both the injury and fatality analysis sums the fabricated fuel value, irradiated fuel value, and the larger radwaste value between the Clive, UT route and the Andrews, TX route.

6.3 DECOMMISSIONING

This section reviews the environmental impacts of decommissioning the Project site. The NRC defines decommissioning in 10 CFR 50.2, which involves safely removing the facility from service and reducing residual radioactivity to levels that allow for either unrestricted property release or release under restricted conditions along with the termination of the operating license.

Upon license termination, both the NRC and the licensee must follow 10 CFR 50.82, for decommissioning actions, ensuring that the radiological criteria for license termination, as specified in 10 CFR Part 20, Subpart E, are satisfied.

NRC regulation 10 CFR 50.82 prohibits decommissioning activities that result in significant environmental impacts not previously reviewed. Licensees can refer to the NUREG-0586, *Generic Environmental Impact Statement (GEIS) on Decommissioning of Nuclear Facilities*, Supplement 1 (GEIS-DECOM), for guidance. Published in 2002, the GEIS-DECOM incorporates technological advances, operational experience, and regulatory changes since the original 1988 version. It outlines decommissioning activities and establishes an envelope of potential environmental impacts associated with the process. Because detailed decommissioning plans are only required after a decision to cease operations, this section focuses on the general environmental impacts of decommissioning.

6.3.1 DECOMMISSIONING APPROACH

Environmental impacts from three decommissioning options are evaluated in the GEIS-DECOM and include:

- Immediate Dismantling (DECON): The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations. DECON comprises four distinct periods of effort: (1) pre-shutdown planning/engineering, (2) facility deactivation and transition (no activities are conducted during this period that will affect the safe operation of the spent fuel pool), (3) decontamination and dismantlement with concurrent operations in the spent-fuel pool until the pool inventory is zero, and (4) license termination.

- Safe Storage (SAFSTOR): The facility is placed in a safe, stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel is removed from the reactor vessel and radioactive liquids are drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement of the facility at the end of the storage period.

- Entombment (ENTOMB): This alternative involves encasing radioactive systems, structures, and components (SSC) in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

NRC regulations do not require ESP or combined license applicants to select one of these decommissioning alternatives or prepare specific decommissioning plans. Applicants must prepare these plans after a decision to cease operations is made, as outlined in 10 CFR 50.82.

6.3.1.1 Scope of Decommissioning Activities

Environmental impacts during decommissioning arise from the removal of SSC, the management of radioactive materials, and the potential for land contamination. Activities and impacts the NRC considered to be within the scope of the GEIS-DECOM include:

- Activities performed in preparation of removing the facility from service such as, removal of fuel from the reactor and organizational changes, beginning when the licensee certifies that the facility has permanently ceased operations.
- Activities performed in support and the resulting impacts of radiological decommissioning, including decontamination and dismantlement of radioactive SSC and any activities required to support the decontamination and dismantlement process.
- Activities performed in support of dismantlement of nonradiological SSCs required for the operation of the reactor, such as the cooling towers and backup generator buildings.
- Activities performed up to license termination and their resulting impacts as provided in the definition of decommissioning such as removal of radioactive waste.
- Nonradiological impacts occurring after license termination from activities conducted during decommissioning.
- Activities related to release of the facility such as any necessary site boundary modifications or ongoing surveillance.
- Human health impacts from radiological and nonradiological decommissioning activities.
- Activities related to preparing the facility for entombment, if selected as part of the decommissioning strategy.

Decommissioning activities will comply with the provisions of 10 CFR 50.82 and are considered during the reactor technology decision process for the site, which are anticipated to be within the bounding parameters established in the GEIS-DECOM.

6.3.2 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

The NRC's evaluation of the environmental impacts of decommissioning presented in the GEIS-DECOM, considered 22 nuclear units with thermal power ratings ranging from 23 MWt to 3411 MWt per unit, which were shut down between 1963 and 1997. The technologies analyzed included LWRs, two high-temperature gas-cooled reactors, and a fast breeder reactor. Three of these units were permanently shut-down facilities.

The GEIS-DECOM concludes that decommissioning a nuclear facility generally has a positive environmental impact. Environmental effects on air quality, water quality, and ecosystems are expected to be smaller during decommissioning than during construction and operation. Based on the assessed environmental issues, most impacts are generic and SMALL (defined in 6.3.2.1) for all nuclear plants, regardless of the decommissioning activity.

However, if decommissioning activities occur beyond the operational area, these are considered

site-specific impacts that require further analysis. These site-specific impacts can include off-site land use to support decommissioning activities, such as land used for waste burial or storage. Impacts on aquatic and terrestrial resources outside of the facility's operational area may result from runoff or additional land clearing, and impacts to cultural, historic, or archeological resources beyond the operational area such as needing additional corridors.

The primary environmental impact, regardless of the chosen decommissioning option, is the use of land for off-site waste burial. On-site disposal is not considered when using the DECON approach, as the focus is on removing contamination and waste. Additionally, the decommissioning process can create both positive and negative socioeconomic effects on the local community. These include increased demands on infrastructure such as housing, transportation, services, and economic contributions from workers employed to carry out the decommissioning tasks.

Impacts from decommissioning are expected to be smaller than those during construction and will be bounded by the GEIS-DECOM.

6.3.2.1 Levels of Significance and Applicability of Environmental Impacts

The GEIS-DECOM provides a measure of significance and severity of potential environmental impacts and the applicability of these impacts to a variety of nuclear plants both permanently shut down and operating. The significance of the environmental impact is described as either SMALL, MODERATE, or LARGE. The definitions of significance are as follows:

- SMALL – Environmental impacts are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts in NUREG-0586, the NRC concluded that radiological impacts are considered small if the impacts do not exceed permissible levels in the NRC's regulations.
- MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The applicability of these impacts to a nuclear plant decommissioning activities is categorized as either generic or site-specific. Environmental issues categorized as generic can be applied to all nuclear plants, while the site-specific category requires further evaluation as part of the decommissioning plan submitted in accordance with 10 CFR 50.82.

Environmental issues were assessed and most of the impacts were determined to be generic and SMALL, because the impacts are limited to operational areas. Threatened and endangered species was identified as an area that requires site-specific analysis. Four issues were determined to be conditionally site-specific relating to land use, aquatic ecology, terrestrial ecology, and historic and cultural resources primarily involving off-site areas to support decommissioning activities.

The GEIS-DECOM concluded that decommissioning activities closely resemble construction activities, meaning their associated impacts are similar to those described in Chapter 4 of this ER. Based on the findings in ER Chapter 4, the environmental impacts from decommissioning activities are anticipated to be SMALL to MODERATE. These impacts will be evaluated in more

detail pursuant to the requirements specified in 10 CFR 50.82 prior to ceasing operations.

6.3.2.2 Air Quality Impacts from Greenhouse Gases

The GEIS-DECOM does not specifically address the GHG footprint of decommissioning activities. However, it does conclude that the decommissioning workforce is expected to be smaller than the operational workforce and that the decontamination and demolition activities could take up to ten years to complete. Given this information, the NRC prepared Attachment 1 of COL/ESP-ISG-026, which provides a generic GHG footprint.

Using a reference 1000-MWe reactor, the NRC staff estimated the GHG footprint for various nuclear plant activities, including decommissioning. Based on the GEIS-DECOM and evaluation of air quality impacts from GHG in COL/ESP-ISG-026, the NRC concludes that if regulatory requirements on decommissioning activities are met, the decommissioning activities will result in a SMALL impact.

Construction activities at the Project site are described in Section 4.7 and GHG emissions are detailed in Section 4.7.1.3. Based on the advanced technologies being considered for the site, the GHG estimates from the 1000-MWe reference reactor in COL/ESP-ISG-026 are considered conservative given SMRs have a modular design, smaller footprint, fewer components to dismantle, and a lower power output per reactor. Decommissioning activities at the Project site are anticipated to fall within the bounds of the GEIS-DECOM and GHG emissions will be bounded by COL/ESP-ISG-026.

6.3.3 FINANCIAL ASSURANCE FOR DECOMMISSIONING

The ESP process outlined in 10 CFR 52.17 requires site-specific factors such as environmental considerations and site-safety characteristics rather than financial details related to construction, operation, and decommissioning of the site. As such, the NRC regulation 10 CFR 50.75, which requires financial resources for reasonable assurance to perform decommissioning, does not apply to ESP applications. The following information provides general information relevant to SMR and advanced reactor decommissioning costs.

Currently, the NRC regulations do not provide specific decommissioning cost estimates formulas for SMR designs. They do allow the use of a site-specific estimate instead of the amount calculated through a generic formula for large pressurized-water and boiling-water reactors, as long as the site-specific estimate is equal to or greater than the amount of the generic formula.

With respect for funding assurance of advanced nuclear technologies, the NRC has identified some differences between advanced SMR technologies and previously licensed reactors in SECY-11-0181, such as:

- Reduced size and quantity of components and equipment to be disposed.
- Reduced area to be decontaminated (depending on the number of modules).
- Possible difficulty with accessibility for decontamination because of the small size of the components.
- Possible difficulties related to the decommissioning of modules while other modules are in operation.

Additionally, in 2004 the DOE funded a compilation of five studies that included a comparative analysis of decommissioning and funding requirements between existing reactors and advanced reactors. Four advanced reactor designs were evaluated using the prompt decommissioning alternative, DECON, which is undertaken shortly after the facility ceases operation (DOE, 2004).

The decommissioning cost estimates for advanced reactors consider typical site features, such as the steam supply systems, power generation, support services, buildings, and ancillary facilities. These estimates are based on necessary assumptions like regulations, project risks, and low-level radioactive waste disposal practices. The main costs come from labor and managing radioactive waste (DOE, 2004). The 2004 DOE, study concluded that with similar operating and management assumptions, decommissioning costs for advanced reactors are comparable to those for existing reactors, with some savings due to smaller plant inventories.

Under current regulations, to obtain permission to use a site-specific estimate less than the mandatory minimum in 10 CFR 50.75, an applicant would have to request and technically justify an exemption from the regulation. Requirements for financial assurance detailed in 10 CFR 50.33(k)(1) will be provided as part of the construction permit or license application.

6.3.4 SUMMARY

Duke Energy compared the activities analyzed in the GEIS-DECOM (NUREG-0586) on the environmental impacts of decommissioning the existing fleet of domestic nuclear power reactors with those used by DOE to estimate decommissioning costs for advanced reactor designs and determined that the scope of activities is generally the same.

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CHAPTER 7
CUMULATIVE IMPACTS

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LIST OF FIGURES

Number	Title

None.

GLOSSARY

Term	Definition
°C	degree Celsius
°F	degree Fahrenheit
ac.	acre
APE	area of potential effect
BCSS	Belews Creek Steam Station
BMP	best management practice
CAA	Clean Air Act
CAM	Chatham Advanced Manufacturing
CCW	condenser cooling water
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO_2-eq	carbon dioxide equivalent
CWA	Clean Water Act
dBA	A-weighted decibel
DBA	Design Basis Accident
EAB	exclusion area boundary
EMF	electromagnetic field
ESF	Educational State Forest

Term	Definition
FERC	Federal Energy Regulatory Commission
FGD	flue gas desulphurization
ft.	feet
GAI	geographic area of interest
GHG	greenhouse gas
GTCC	Guilford Technical Community College
ha	hectare
HALEU	high-assay, low-enriched uranium
km	kilometer
LPZ	low population zone
LWR	light-water reactor
m	meter
m^3/s	cubic meters per second
MACCS	MELCOR Accident Consequences Code System
mi.	mile
MMT	million metric tons
MVP	Mountain Valley Pipeline
MWe	megawatts electric

Term	Definition
MWIS	makeup water intake structure
NC	North Carolina
NCDEQ	North Carolina Department of Environmental Quality
NCTPC	North Carolina Transmission Planning Cooperative
NDA	net disturbance area
NPDES	National Pollution Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NUREG	NRC Technical Report designation
OSHA	U.S. Occupational Health and Safety Administration
Piedmont	Piedmont physiographic province
PLC	Piedmont Land Conservancy
PRA	probabilistic risk assessment
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc.
Project Region	The area encompassed within a 50-mile (80-km) radius of the Belews Creek, NC site bounding limit unless otherwise specified for a particular resource
Project site	Belews Creek, NC site

Term	Definition
Project Vicinity	The area encompassed within a 6-mile (10-km) radius of the Project Site Center Point unless otherwise specified for a particular resource
rem	roentgen equivalent man
rev.	revision
RFFA	reasonably foreseeable future action
RNG	renewable natural gas
ROI	Region of Influence
SMR	small modular reactor
SPCC	spill prevention, control, and countermeasure
Sv	sievert
SWPPP	stormwater pollution prevention plan
TEDE	total effective dose equivalent
TRISO	TRi-structural ISOtropic
UFC	uranium fuel cycle
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VADCR	Virginia Department of Conservation and Recreation
WTP	Water Treatment Plant

Chapter 7 Cumulative Impacts

Cumulative impacts of the proposed action and all other past, present, and reasonably foreseeable future actions (RFFAs) in the geographic areas of interest (GAIs) for various impacted resources are described in this chapter. After a brief introduction to cumulative impact analysis, the chapter contains the following sections:

- Past, Present, and Reasonably Foreseeable Future Actions – Section 7.1
- Resource Impact Assessment – Section 7.2
- Impact Assessment Conclusions – Section 7.3

The U.S. Nuclear Regulatory Commission (NRC), under Title 10 of the Code of Federal Regulations (CFR) Part 51 (10 CFR 51), implements the National Environmental Policy Act of 1969, as amended (42 U.S. Code § 4321 et seq.). The regulations in 10 CFR 51.71(d) require the NRC to evaluate the cumulative impacts of proposals under its review.

Cumulative impacts are the impacts on the environment that result from the incremental impact of an action when added to other past, present, and RFFAs regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions that take place over time.

The cumulative impact analysis focuses on the environmental resources of concern and the geographic areas where site-specific activities—both direct and indirect—could potentially alter (degrade) the quality of regional resources. For each resource area, the GAI refers to the specific impact areas over which past, present, and RFFAs could contribute to cumulative impacts. As indicated by Regulatory Guide 4.2, Rev. 3, the GAIs for each environmental resource must be suited both to the resource and the individual action under consideration.

Therefore, the GAI may be different for each resource. Table 7.1-1 identifies the GAI for each resource considered in the cumulative effects analysis.

The cumulative impact analysis evaluates the combined effects of the proposed action (i.e., the Project) with the past, present, and RFFAs within the GAI of each resource. It specifically considers the incremental effects of building and operation activities contained in Chapters 4 and 5. The analysis incorporates the effects of past and present actions into the baseline environmental conditions described in Chapter 2. It also accounts for the potential effects of RFFAs listed in Table 7.1-2 within the specified GAI of each resource, as described in Section 7.2.

The assessment of cumulative effects to each of the identified environmental resources are provided in Section 7.2. Table 7.2-1 provides a summary of the cumulative impact on each resource.

7.1 PAST, PRESENT, AND REASONABLY FORESEEABLE FUTURE ACTIONS

Table 7.1-2 identifies relevant past, present, and RFFAs within the 50-mile (mi.) (80-kilometer [km]) Project Region. It highlights past and present actions that may have significantly affected the existing environment as described in Chapter 2. RFFAs include future actions likely to occur and are capable of contributing to cumulative impacts.

To support the cumulative impacts analysis, a search was conducted to identify other relevant projects in the Project Region. This search included information from regional economic development agencies, state and federal agencies, county and municipal governments, and additional sources. Sources used to identify past, present, and RFFAs are referenced in the status column of Table 7.1-2.

The analysis considers actions to be reasonably foreseeable when supported by published permit applications, secured funding, or reasonable extensions of current trends. It excludes actions deemed speculative, conceptual, or lacking concrete evidence of progression.

7.1.1 EFFECTS OF BELEWS CREEK STEAM STATION CLOSURE

Among the RFFAs identified in Table 7.1-2, the closure of Belews Creek Steam Station (BCSS) is noted to have particular relevance to the assessment of cumulative effects in conjunction with the Project. As described in Section 1.2, the proposed federal action is the NRC issuance of an Early Site Permit under 10 CFR Part 52.

As described in Section 1.3.2, the building and operational schedule has not been established. However, as described in Section 3.3.5, a Conceptual Preconstruction and Construction Activities Schedule has been developed to support analyses. Building of the advanced reactors at the Belews Creek, NC site (Project site) is anticipated to proceed in a phased manner over several years. In conjunction with this phased approach, Duke Energy Carolinas, LLC (Duke Energy) will also derate the operations of BCSS in a manner that replaces and balances overall generation capacity between the Project and BCSS. This transitional period is known as the “phased implementation period.”

The closure of BCSS is considered an RFFA (see Table 7.1-2). Deconstruction of BCSS is also considered reasonably foreseeable (see Table 7.1-2), but this action would not be undertaken during the phased implementation of the Project. Phased implementation of the Project, in conjunction with BCSS closure, results in gradual changes in the environmental conditions relative to the selected resources described in Chapter 2 of this Environmental Report. The effects of BCSS closure result in conditions in which the relevant GAIs are not influenced by BCSS operations. These effects are characterized in this subsection. Furthermore, because such effects of BCSS closure have near-term temporal and spatial effects relative to the Project, such effects are used in the assessment of Project impacts in Chapter 5 as appropriate.

Key considerations regarding the BCSS closure that affect the characteristics of the affected environment include:

- Belews Lake water levels are no longer influenced by BCSS consumptive uses (similar effects continue with Project operations) (see Section 5.2.1).
- Water circulation in Belews Lake is no longer influenced by BCSS condenser cooling water (CCW) intake and discharge flow. (Effects not prevalent in Project operations) (see Section 5.2.1).
- Reduced water use by BCSS to support flue gas desulphurization (FGD) operations, forced evaporation, and other water uses. (Similar effects continue with Project operations) (see Section 5.2.2).

- Authorized pumping operations associated with the makeup water intake structure (MWIS) on the Dan River are transferred to Project operations (Effects transition to Project operations) (see Section 5.2.2).
- Water quality that reflects characteristics lacking the effects of wastewater discharge inputs from fossil fuel power generation including discharge from the emergency spillway of the South Coal Pile Basin, treated flue gas desulfurization wet scrubber wastewater, ash basin dewatering discharge, once-through non-contact chiller water, industrial stormwater, and once-through cooling water and intake screen backwash (Effects generally not present during Project operations) (see Section 5.2.3).
- Lake water temperatures that reflect characteristics of a lake lacking substantive thermal input from power generation (Effects not present during Project operations) (see Section 5.2.3).
- Elimination of air emissions from BCSS.
- Cessation of operational noise from BCSS.

Accordingly, Duke Energy considered the effects of BCSS closure on all relevant environmental resources to assess the contribution of BCSS closure on cumulative effects. The following subsections summarize the anticipated effects of the BCSS action on relevant environmental resources for the purposes of this cumulative effects analysis.

7.1.2 RESOURCE ANALYSIS

The effects of BCSS closure on groundwater, terrestrial ecology, demographics, traffic, employment, nonradiological health, and nonradioactive waste management were also reviewed. However, these resources are not included in the analysis below because they are not adversely affected, or the effects are negligible. Therefore, only the resources below are considered in greater detail to provide a characterization of the relevant substantive effects of BCSS closure relative to the effects of the Project.

7.1.2.1 Surface Water Resources

Effects of BCSS closure on relevant surface water resources are described in this subsection. Effects of Project operations for surface water are examined in Sections 5.2.1 and 5.2.3.

7.1.2.1.1 Belews Lake Water Levels and Circulation

BCSS closure results in a condition in which Belews Lake is not subject to water-level fluctuations from BCSS operational water use, including forced evaporation and consumptive use. Forced evaporation is a type of consumptive use calculated separately in the hydrologic model due to its influence on water levels at Belews Lake. Under BCSS closure, Duke Energy continues to maintain and operate the Belews Lake dam and spillway. Water levels are controlled by the spillway in response to lake water levels resulting from direct precipitation and runoff along with losses to groundwater; however, as described in Section 5.2, this condition is largely theoretical and is not expected to persist because at no point will there be a time frame when no generation is present on the lake prior to advanced reactor commissioning. Although Belews Lake water levels are no longer influenced by BCSS consumptive uses, similar effects continue with Project operations.

BCSS closure also affects circulation patterns in Belews Lake. As described in Section 2.2.1.1.3, the BCSS CCW flow influences lake circulation patterns whereby water from the CCW discharge flows through the CCW canal and into the Belews Creek arm. As illustrated in Figure 2.2-3 general circulation patterns carry flow within the lake into the West Belews Creek arm and back to the BCSS cooling water intake structure. However, under BCSS closure, the influence of CCW flow is eliminated, resulting in circulation patterns that are more influenced by tributary inflows, and releases from the spillway.

7.1.2.1.2 Belews Lake Water Quality

Thermal loading to Belews Lake is significantly reduced in conjunction with the closure of BCSS. The CCW discharge would cease, and heated effluent would no longer disperse within the West Belews Creek arm or be conveyed via the CCW canal to the Belews Creek arm as illustrated in Figures 2.2-16 and 2.2-17 (summer and winter temperatures, respectively). As described in Section 5.2.3.1.2, temperatures within Belews Lake are affected and undergo a process in which temperatures are reduced and general cooling occurs within each reach of Belews Lake until temperatures stabilize to a condition influenced mainly by seasonal patterns in a manner similar to Mayo Reservoir, a similar regional lake with minimal anthropogenic heat load. Water temperatures within the West Belews Creek arm of Belews Lake would resemble those observed in the other areas of Belews Lake not influenced by BCSS thermal inputs.

Across Belews Lake, the elimination of CCW discharges leads to decreased temperatures through the Lake. Based on the closure of BCSS, temperatures in West Belews Creek arm during winter are expected to be like those currently observed in the Belews Creek arm, with a decrease in the mean winter temperature of approximately 16 degrees Celsius (°C) (30 degrees Fahrenheit [°F]).

7.1.2.1.3 Dan River Flow

As described in Section 7.1.1, closure of BCSS eliminates the need for supplemental pumping from the Dan River to compensate for consumptive uses from BCSS operations. However, authorized pumping operations associated with the MWIS are transferred to Project operations., It is anticipated that Project operations will utilize the MWIS to provide supplemental water to Belews Lake. Under Project operations, pumping by the MWIS is conducted using the same conditions of the existing North Carolina Department of Environmental Quality (NCDEQ) National Pollution Discharge Elimination System (NPDES) permit as described in Section 3.4.1.1.2. Although supplemental pumping from the Dan River is no longer influenced by BCSS uses, the MWIS pumping in conjunction with Project operations results in similar effects to the Dan River flow as those authorized by the existing NPDES permit. Discharges from the Project will be added to the existing NPDES permit.

7.1.2.1.4 Dan River Water Quality

BCSS closure eliminates the need for most wastewater discharge inputs from fossil fuel power generation currently discharged from Outfall 006 to the Dan River, including discharge from the emergency spillway of the South Coal Pile Basin, treated flue gas desulfurization wet scrubber wastewater, ash basin dewatering discharge, once-through non-contact chiller water, industrial stormwater, and once-through cooling water and intake screen backwash.

As described in Section 3.4.3.3.3.3, Project operations will utilize the existing Outfall 006 for nonradioactive wastewater streams (e.g., turbine building sumps, groundwater sumps, water treatment discharges). These nonradioactive waste streams are directed through a series of sumps and then routed to either the existing "Lined Retention Basin" system for further treatment or directly to current NPDES Outfall 006. While nonradioactive discharges via Outfall 006 are no longer influenced by BCSS uses, some minor BCSS effects from groundwater remediation and landfill leachate continue during Project operations.

7.1.2.2 Aquatic Ecology

7.1.2.2.1 Belews Lake Aquatic Ecology

Previous studies conducted by Duke Energy used Mayo Reservoir as a reference lake because it has similar characteristics to Belews Lake; however, it lacks the thermal influence that Belews Lake has because of operation of BCSS. Mayo Reservoir has similar productivity and nutrient loads to Belews Lake and has a similar long retention time for water. Additionally, in 2018, the North Carolina Division of Water Resources found the Mayo Reservoir to have a relatively balanced and stable fish community (Duke Energy, 2021).

With the closure of BCSS, elevated summer temperatures evident in Figure 2.2-16 are eliminated resulting in reduced stress on aquatic biota. No notable changes in overall composition of planktonic, benthic macroinvertebrate, or freshwater mussel communities in Belews Lake are expected to occur in conjunction with BCSS closure.

Aquatic macrophyte growth within Belews Lake reflects the presence of established communities within the upper arms of West Belews Creek and Belews Creek. Aquatic macrophyte establishment and growth is complex and related to a range of factors that include depth, substrate characteristics and stability, flow rates, temperature and other factors. There was no apparent trend in locations and density of vegetated points and zones of thermal influence. Accordingly, BCSS closure and the significant reduction in temperatures in Belews Lake are likely to have minimal effects on aquatic macrophyte communities.

The closure of BCSS may result in a taxonomic shift in the fish community, likely resulting in a community that is more closely aligned with that observed in Mayo Reservoir. Taxonomic shifts may be directly related to decreased temperatures. Threadfin Shad in particular, is intolerant of colder temperatures, and is likely to exhibit a reduced population abundance with discontinuation of BCSS thermal effluents that may provide more favorable habitats to Threadfin Shad in winter months. Fish condition shifts are also likely to occur. Changes to cooler water temperatures and the subsequent loss of warmer winter temperatures in the West Belews Creek arm of Belews Lake will affect the timing of spawning and result in a shorter growth season. Some species may exhibit higher overall condition, as cooler temperatures may reduce the level of caloric intake required to meet the stressful energetic needs associated with habitats with elevated temperatures. With BCSS closure, the loss of winter thermal refugia may result in changes to winter movement patterns of selected fish species within the lake. Changes in the forage base (e.g., forage fish) may reduce diet availability for certain fishes, which may ultimately result in changes in piscivore fish size, population density, and trophic dynamics.

7.1.2.2.2 Sport Fish Abundance and Condition

As described in Section 5.4.4.2.1.1, improved (cooler) summer high-water temperatures may also result in reduced stress on the aquatic ecosystem within Belews Lake that may also

improve overall fish condition. Accordingly, reductions of elevated temperatures may result in benefits of overall higher fish condition and decreased fish stress in the summer. The loss of thermal discharges from the closure of BCSS will affect recreational sportfishing in Belews Lake. Belews Lake is a popular destination for fishing. Largemouth Bass, Black Crappie, and Alabama Bass are the primarily targeted species for fishing. However, Belews Lake is also fished for catfish, Bluegill, and other sunfish. Due to its warm temperatures resulting from the BCSS discharge, Belews Lake is one of the state's more productive lakes for fishing in the winter. With the establishment of cooler water within Belews Lake under BCSS closure, Belews Lake fish will no longer be attracted to thermal discharges, thereby changing winter movement patterns, which may result in reduction in the degree of winter sportfishing success. The combination of a truncated growing season and the potential reduction in thermally-sensitive forage species such as Threadfin Shad may alter abundance and condition of sportfish such as Largemouth Bass, Alabama Bass, Black Crappie, White Crappie (*Pomoxis annularis*), catfishes, and perches (Percidae) that prey upon shad species in the short term; however, the same sportfish species are still expected to persist in Belews Lake.

7.1.2.2.3 Dan River Aquatic Ecology

As described in Section 7.1.1, closure of BCSS eliminates the need for supplemental pumping from the Dan River to compensate uses from BCSS operations. However, authorized pumping operations associated with the MWIS are transferred to Project operations. It is anticipated that Project operations will utilize the MWIS to provide supplemental water to Belews Lake. Under Project operations, pumping by the MWIS is conducted using the same conditions of the existing NCDEQ NPDES permit as described in Section 3.4.1.1.2. Although supplemental pumping from the Dan River is no longer influenced by BCSS uses, the MWIS pumping in conjunction with Project operations incorporates restrictions that are protective to aquatic biota of the Dan River.

While supplemental pumping from the Dan River is no longer influenced by BCSS uses, similar effects related to potential impingement and entrainment of aquatic biota continue with Project operations. However, the permitted and installed design of the MWIS includes fish protection technologies that are compliant with Clean Water Act Section 316(b) requirements that minimize effects and aquatic biota within the Dan River.

7.1.2.3 Socioeconomics

7.1.2.3.1 Physical Impacts

Although the closure of BCSS will eliminate noise emissions associated with plant operations, similar noise emissions continue with advanced reactor operations. As described in Section 5.8.2, during operations, residents and recreators nearest the Project site experience cooling tower noise below the 65 A-weighted decibel (dBA) threshold is considered acceptable and allowable outside a residence by the U.S. Environmental Protection Agency (USEPA) (Section 4.8.2.1). Other residences further from the Project site and across Belews Lake also experience noise from operation of the cooling towers below 65 dBA, which is further attenuated by the distance from the towers and the vegetative buffer.

As described in Section 2.4.2.6, the BCSS is an industrial facility that is visible in the surrounding viewshed. Major visual features, such as stacks and transmission lines will remain

in place under BCSS closure. Ultimately stacks will be removed as part of deconstruction while transmission lines will remain for life of the Project. However, the steam plume from the stacks will no longer be visible within the viewshed. While the removal of the visible steam plume from BCSS reduces the vertical visual prominence of the facility, the remaining infrastructure continues to define the viewshed in the short term. As a result, the overall visual presence of the site is diminished but not eliminated, and the facility remains a noticeable feature in the landscape. While BCSS closure and deconstruction eliminate certain visual intrusions, other visual intrusions continue with Project operations.

7.1.2.3.2 Recreation

In conjunction with BCSS closure, water quality conditions (notably, temperature) within Belews Lake stabilize to a condition influenced mainly by seasonal patterns. As is described in Section 5.2.3, thermal profiles in Mayo Lake, a lake like Belews Lake but with minimal anthropogenic heat load, were reviewed to provide a potential predictive future condition of Belews Lake without the contributing heat load from BCSS. Profiles from Mayo Lake as compared to Belews Lake indicate typical thermal stratification within Mayo Lake during summer months is consistent with that observed for Belews Lake. However, based upon temperature characteristics of Mayo Lake, mean surface temperatures of Belews Lake after closure of BCSS may be approximately 3 to 5°C (5 to 9°F) cooler than current conditions.

Potential recreational effects of both water-level changes and changes in water temperature within Belews Lake after closure of BCSS may include the following:

- Belews Lake water levels are no longer influenced by BCSS consumptive water uses (see Section 5.2.1).
- Aquatic ecological communities that reflect a lake lacking significant thermal input from power generation including recreationally important sport fish (Section 5.3.2).
- Depending on the frequency of drought conditions and related water-level fluctuation, corresponding effects may also be evident in the condition of recreationally important sport fish (i.e., smaller fish, changes in community structure, and other factors) that may be sought after by anglers (Section 5.3.2).
- The number of fishing tournaments held at Belews Lake (as described in Section 2.4.2.6.2) and the related benefits to local businesses that depend on such recreators may also be correspondingly reduced.
- Restricted access to several small coves that fall within the exclusion area boundary (EAB) as described in Section 5.4.1.1.

7.1.2.4 Air Quality

Closure of the BCSS would result in reduced air emissions over the Project Region. As described in Section 5.7.2.1, the criteria air pollutants at the new nuclear plant would occur from mechanical draft cooling towers, auxiliary boilers, standby equipment, and emergency power supply system diesel generators and/or gas turbines, which would result in reduced emissions from the sources currently at the BCSS. Table 7.1-3 compares the emissions from the BCSS during the year 2024, while operating at less than 30 percent capacity factor, to the estimated new annual nuclear plant emissions. Percent decreases in criteria pollutant emissions exceed 97.7 percent.

Closure of the BCSS would also result in reduced greenhouse gas (GHG) emissions over the Project Region. As described in Section 5.7.2.2, the GHG emissions footprint of a generic 1000-megawatt-electric (MWe) reactor provides a conservative estimate of impacts. The lifetime GHG emissions footprint of a generic 1000- MWe reactor is 10,500,000 metric tons carbon dioxide equivalent (CO_2-eq). For comparison, in 2022 and 2023 and while operating at less than 50 percent capacity factor, the BCSS emitted 5,922,637 and 5,584,208 metric tons CO_{2}-eq, respectively, per USEPA Flight data. In 2022 and 2023 combined (the two most recent years of USEPA flight data), the BCSS has emitted more CO_{2}-eq than the estimated lifetime emissions of the new nuclear facility.

As described in Section 4.7, overall emission impacts from preconstruction and construction activities would be temporary and minimal in magnitude for both criteria pollutants and GHGs.

Table 7.1-1
Geographic Area of Interest by Resource

Resource	Project Geographic Area of Interest
Land Use	Project site and 6-mi. (10-km) Project Vicinity.
Water Resources (Hydrology, Water Use and Quality)	
Surface Water	Project site, Belews Creek (includes Belews Lake), Dan River, and Town Fork Creek in Project Vicinity.
Groundwater	Project site and Belews Lake. GAI based on potential for direct and indirect effects on groundwater.
Ecology	
Terrestrial Ecology	Project site and Project Vicinity.
Aquatic Ecology	Project site, Belews Lake, Dan River, and Town Fork Creek. GAI based on watershed connectivity.
Socioeconomics	
Physical Impacts	Project site and Project Vicinity. GAI based on area of direct and indirect effects.
Demographics	Region of Influence (ROI) (Forsyth, Guilford, Rockingham, Stokes Counties). GAI based on effects associated with workforce population.
Economic Impacts	ROI. GAI based on direct and indirect project expenditures associated with the workforce.
Community Infrastructure Impacts	ROI. GAI based on effects associated with workforce population.
Historic and Cultural Resources	Area of Potential Effect (APE) as described in Chapter 2, the Project site, and a wastewater pipeline corridor to the Dan River.
Air Quality	Region of Influence (ROI) (Forsyth, Guilford, Rockingham, and Stokes counties). All counties in North Carolina are in attainment.
Greenhouse Gas	Global.
Nonradiological Health	The Project site and surrounding area (etiological agents, noise, EMFs and electric shock) for occupational health, and ROI (for public and transportation-related impacts).
Radiological Health	The 50-mi. (80-km) Project Region.
Nonradioactive Waste Management	The 50-mi. (80-km) Project Region. GAI is dependent on type of waste generated and available disposal locations. Identified land-based waste disposal facilities include those within the Project Region.
Postulated Accidents	The 50-mi. (80-km) Project Region.
Fuel Cycle, Transportation, and Decommissioning	Nationwide or global for fuel cycle and transportation. Much of the uranium fuel cycle impact occurs at facilities scattered throughout the United States, or in the case of foreign-purchased uranium, in other countries. The 50-mi. (80-km) Project Region for decommissioning.

Key: APE = Area of Potential Effect; EMF = electromagnetic fields; GAI = Geographic Area of Interest; km = kilometer; mi. = mile; ROI = Region of Influence

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 1 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
NATURAL GAS AND COAL-FIRED ELECTRIC POWER PLANTS			
Belews Creek Steam Station (BCSS) Operation	2220 megawatt (MW) dual unit coal and natural gas-fired electric generating facility.	Adjacent	Past, present, and reasonably foreseeable. Operation began in 1974. Natural gas added in 2020 and 2021. (Duke Energy, 2020a)
BCSS Closure	Phased closure of the BCSS.	Adjacent	Reasonably foreseeable. Per Duke Energy retirement planned for mid-2030s.
BCCS Deconstruction	Deconstruction of the BCSS	Adjacent	Reasonably foreseeable, subsequent to BCSS closure. Timeline has not been defined.
BCSS Ash Basin Closure and Landfill Construction	Excavation of approximately 12 million tons of ash and relocation to lined on-site landfill, adjacent to Pine Hall Road and approximately 125 ft. (38 m) in height.	Adjacent	Past, present, and reasonably foreseeable. Placement of material in the new landfill began in 2023 and is expected to take approximately 11 years. (Duke Energy, 2020b; WFDD, 2023)
WAGABOX® Renewable Natural Gas (RNG) Plant	Construct and operate a RNG plant at Rockingham County Landfill.	14 mi. (22 km) ENE	Reasonably foreseeable. Construction is expected to be finished in 2026. (Rockingham County, 2024)
NATURAL GAS PIPELINES			
Enbridge – T-15 Reliability Project	Construct a 45 mi. (72 km) natural gas pipeline (along previously existing rights of way) from Eden to Roxboro, NC. Also includes construction of a new compressor station.	24 mi. (39 km) ENE	Reasonably foreseeable. Permitting expected by mid-2025. Construction is expected to begin in 2025, with the majority of construction planned for 2026. In service by late 2027 – early 2028. (Enbridge, 2025)
Transco, LLC – Southeast Supply Enhancement Project	Construct and operate two natural gas pipeline loops totaling approximately 55 mi. (89 km) and replace existing facilities to provide additional capacity.	7 mi. (11 km) E and 24 mi. (39 km) NE, respectively	Reasonably foreseeable. Targeted construction start date by mid-2026. Targeted in-service date by end of 2027. (FERC, 2024; Williams, 2024)

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 2 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
Mountain Valley Pipeline (MVP) – Southgate Project	Construct and operate an approximately 75 mi. (121 km) natural gas pipeline and associated aboveground facilities interconnecting with MVP's mainline system.	23 mi. (37 km) NE	Reasonably foreseeable. The Federal Energy Regulatory Commission (FERC) granted MVP a three-year extension to construct and make available for service by June 18, 2026. (FERC, 2023)
ELECTRIC-SOLAR POWER PLANTS			
Baxter Creek Solar Center	Construct a new solar photovoltaic facility with a generative capacity of roughly 30 MW owned by Duke Energy Carolinas, LLC.	45 mi. NW	Reasonably foreseeable. Per Duke Energy, operation is scheduled to begin in June 2026.
Bear Branch Solar Project	Construct and operate a new solar photovoltaic facility on roughly 320 ac. (130 ha) near Walnut Cove.	6 mi. (10 km) NNW	Reasonably foreseeable. Anticipated commercial operation date is third quarter of 2026. (Gem Wiki, 2025; Capital Power, 2025)
TRANSMISSION LINES/SUBSTATIONS			
NCTPC 2023-2033 Collaborative Transmission Plan	Various transmission projects that include reconductoring, upgrading, replacing, and adding new transmission lines to enhance system reliability and resiliency, support the addition of new generation resources, and potentially enable increased economic electricity transpires across the transmission network.	Throughout the 50-mi. (80 km) Project Region.	Past, present, and reasonably foreseeable. Various projects scheduled for commission between 2023 and 2033. (NCTPC, 2024a; NCTPC, 2024b)

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 3 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
PARKS AND RECREATION			
Future Mayo River State Park in Virginia	State Park on 637 ac. (258 ha) at the confluence of the North and South Mayo Rivers. Managed by the VADCR.	19 mi. (31 km) N	Past, present, and reasonably foreseeable. All parcels were acquired in 2021. The VADCR expects to adopt the Master Plan to guide long-range development objectives by Summer 2026. (VADCR, 2024)
Belews Lake Park	Phase I includes Construction of a 215-ac. (87 ha) park featuring picnic areas, natural trails, comfort stations, and fishing dock. Phase II will expand these facilities.	2 mi. (3 km) S	Present and reasonably foreseeable. Construction of Phase 1 completed in February 2025. Funding for construction of Phase 2 is included in the 2024 North Carolina Parks and Recreation Trust Fund. (FCPR, 2025; NCGOV, 2024)
Future Bashavia Creek Preserve	Planned 127-ac. (51 ha) nature preserve owned and managed by the Piedmont Land Conservancy (PLC) to protect wildlife and provide low-impact recreational opportunities to the public.	21 mi. (34 km) WSW	Present and reasonably foreseeable. PLC is currently in the process of creating a master plan to guide future development within the Preserve. Expected to open to the public in 2025-2026 (PLC, 2024)
Dan River State Trail	Designate approximately 90 mi. (145 km) of the Dan River as a State Blueway with multiple public access points.	Throughout the 6-mi. (10 km) Project Vicinity	Past, present, and reasonably foreseeable. Approximately 59 mi. (95 km) of the planned 90-mi. (145 km) Blueway has been designated for use as of August 1, 2024. (NCDPR, 2025)
Mountains-to-Sea State Trail	Planned Statewide trail that traverses approximately 1400 mi. (2253 km) across the width of North Carolina. Connect multiple existing trails to form one continuous path.	Throughout the 50-mi. (80 km) Project Region.	Past, present, and reasonably foreseeable. Approximately 684 mi. (1101 km) of the planned 1400-mile (2253 km) trail has been designated for use as of August 1, 2024. (NCDPR, 2025)
Windsor Chavis Nocho Community Complex	Construct a 65,000 sq. ft. (ft^2) (6,039 m^2) indoor/outdoor community recreation center in Greensboro.	22 mi. (35 km) SE	Present and reasonably foreseeable. Construction is expected to begin in 2025 and conclude by 2027. (City of Greensboro, 2025a)

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 4 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
Horizons Park Multi-modal Trails	Construct multi-modal trail system. Includes addition of parking areas and amenities at Horizon's Park. Construction activities will include erosion control, grading, surveying, tree removal, trail construction, retaining wall construction, asphalt parking lot construction, site amenities installation, and seeding/landscaping/grading.	10 mi. (16 km) WSW	Reasonably foreseeable. Invitation to Bid, submitted by Forsyth County Parks and Recreation, closed on December 11, 2024. (City of Winston-Salem, 2024)
TRANSPORTATION PROJECTS			
Future I-685	Designate a new approximately 86-mi. (138 km) interstate route from I-85 in Greensboro to I-95 near Dunn. Approximately 56 mi. (89 km) of the route will follow existing U.S. HWY 421.	22 mi. (35 km) SE	Present and reasonably foreseeable. The corridor was designated by congress as part of the Infrastructure Investment and Jobs Act and is currently in the planning and design stage. (NCDOT, 2022)
Winston-Salem Northern Beltway	Construct an approximate 35-mi. (56-km) multi-lane freeway loop around northern Winston-Salem to alleviate traffic congestion and improve safety along heavily traveled routes in Forsyth County.	10 mi. (16 km) WSW	Past, present, and reasonably foreseeable. Portions of the Eastern and Western Loop will be completed by 2030. (NCDOT, 2024)
Big Mill Farm/Hopkins Road Improvements	Improve Hopkins Road from West Mountain Street (NC 66) to Big Mill Farm Road and improve and extend Big Mill Farm Road from U.S. 421 to Harmon Creek Road with a new interchange at U.S. 421.	10 mi. (16 km) SSW	Reasonably foreseeable. Construction is expected to begin in early 2025. (NCDOT, 2023a)

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 5 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
U.S. 158 (Reidsville Road) Improvements	Widen approximately 19 mi. (30 km) of the existing two-lane, two-way roadway to a multi-lane, median-divided roadway from U.S. 421 in Winston-Salem to U.S. 220 in Guilford County to relieve increased traffic congestion.	5 mi. (8 km) SSW	Present and reasonably foreseeable. Construction of the first phase is in progress as of 2024. (NCDOT, 2018; NCDOT, 2023b)
Johnson Street and Sandy Ridge Road Widening	Widen approximately 4 mi. (6 km) of Johnson Street and Sandy Ridge Road in Guilford County to help reduce congestion and traffic delays. Includes construction of bike lanes and a multiuse path.	13 mi. (21 km) SSE	Past, present, and reasonably foreseeable. Construction in progress as of December 2023 with estimated completion by Fall 2027. (NCDOT, 2023c)
U.S. 220 Widening (Greensboro)	Widen U.S. 220 in Greensboro to six lanes from Westridge Road to the I-840 ramps to address congestion and improved mobility. Work would also involve installing a median and sidewalks.	14 mi. (23 km) SE	Reasonably foreseeable. Planning and development are underway. (NCDOT, 2025)
NC 65 (Belews Creek Road) and NC 68 Intersection Improvements	Improve six intersections along the NC 65, NC 65/NC 68, and NC 68 corridor between U.S. 158 in Stokesdale and I-73 in Rockingham County to reduce the incidence and severity of crashes.	8 mi. (13 km) ESE	Past, present, and reasonably foreseeable. Right-of-Way Acquisition complete. Construction is expected to begin in May 2026. (NCDOT, 2023d)
Carolinian Piedmont Passenger & Freight Improvements	Improve the capacity of North Carolina Railroad Company's NC-Line to meet the growing demands of both freight and passenger rail traffic. The project would add over 5 miles of sidings, reconstruct up to 69 mi. (111 km) of track, eliminate one grade crossing, and improve track geometry at key locations including Hillsborough, Burlington, and Greensboro.	Throughout the 6-mi (10 km) Project Vicinity	Present and reasonably foreseeable. Construction is expected to begin in 2025, following design and environmental permitting. (FRA, 2024; NCRR, 2024)

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 6 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
Walnut Cove Greenway	Add two walking/biking trails to provide safe and effective transportation between the Walnut Tree neighborhood and downtown Walnut Cove.	4 mi. (6 km) W	Reasonably foreseeable. Funding for the Project is included in the 2023 U.S. Department of Transportation Reconnecting Communities and Neighborhoods Grant Program. (PTRC, 2022; USDOT, 2023)
Piedmont Greenway	Develop a shared-use path extending 19 mi. (31 km) from Salem Lake to Summerfield.	9 mi. (14 km) SSE	Reasonably foreseeable. The Master Plan is finalized and feasibility studies have been completed for certain sections. (PLC, 2021)
OTHER ACTIONS/PROJECTS			
Madison River Park Restoration	Replace the Lindsey Bridge Dam with a series of small rapids to facilitate upstream migration of a federally endangered fish species and to provide public recreation opportunities. Phase II will involve additional facility expansions after the bridge on Lindsey Bridge Road is replaced.	8 mi. (13 km) NNE	Past, present, and reasonably foreseeable. Phase I opened to the public on May 1, 2021. Underbrush has been cleared and surveys have been performed for Phase II. (DRBA, 2023; Madison River Park, 2025)
Dan River Educational State Forest (ESF) – Shoebuckle Tract	Develop infrastructure for an ESF that prioritizes public recreation and outdoor education on approximately 848 ac. (343 ha) on the Dan River in Stokes County, North Carolina.	8 mi. (13 km) NNE	Present and reasonably foreseeable. PLC acquired the land in 2023. The future goal is to acquire funding to build infrastructure and staff positions. (PLC, 2023)
Marshall Aerospace Maintenance and Engineering Facility	Construction and operation of a 192,000 ft^2 (17,837 m^2) aircraft maintenance facility at Piedmont Triad International Airport in Greensboro, North Carolina.	13 mi. (21 km) SSE	Present and reasonably foreseeable. Construction ongoing. Fully operational by early 2025. (Marshall Group, 2024)
Guilford Technical Community College (GTCC) Aviation Training Center	Construct a new 100,000 ft^2 (9290 m^2) aviation training facility at GTCC's Donald W. Cameron Campus.	13 mi. (16 km) SSE	Reasonably foreseeable. Phase 1 construction expected to begin mid-2025. The initial phase is expected to open in January 2027. (GTCC, 2024; North Carolina Construction News, 2024)

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 7 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
SBA Home Manufacturing Facility	Convert an existing 500,000 ft^2 (46,451 m^2) facility to manufacture furniture at the Davie Industrial Center.	39 mi. (63 km) SW	Present and reasonably foreseeable. Production is expected to begin in October 2025. (DCEDC, 2024)
Morinaga Hi-Chew Facility Expansion	Expand existing operations by constructing a roughly 100,000 ft^2 (9290 m^2) production space adjacent to the existing plant in Mebane, NC.	47 mi. (76 km) ESE	Reasonably foreseeable. Construction is expected to be complete by 2027. (Orange County, 2024)
Microporous Project Stellar Phase I	Construct a coated lithium-ion battery separator plant on approximately 212 ac. (85 ha) at the Southern Virginia Megasite.	35 mi. (56 km) NE	Present and reasonably foreseeable. Groundbreaking in November 2024. Construction is anticipated to last for approximately 12 months for building installation, and 24 months for equipment installation. (Alston Construction, 2024; NETL, 2024)
Project Ice – Innovative Construction Group	Construct and operate a housing component manufacturing facility on approximately 46 ac. (19 ha) at the Chatham Advanced Manufacturing (CAM) Site.	47 mi. (76 km) SE	Reasonably foreseeable. Fully operational by 2029. (CCEDC, 2024; EDPNC, 2024)
John Palmour Manufacturing Center for Silicon Carbide	Operation and future expansion of a silicon carbide semiconductor manufacturing plant on approximately 445 ac. (180 ha) at the CAM Site.	47 mi. (76 km) SE	Past, present, and reasonably foreseeable. The first unit began production in June 2024. Additional capacity will be added, as needed, by 2030. (Wolfspeed, 2022; Wolfspeed, 2025)
Toyota Battery Manufacturing North Carolina	Construct and operate a battery manufacturing facility for hybrid and electric-powered vehicles on approximately 1850 ac. (749 ha) at the Greensboro-Randolph Megasite.	35 mi. (56 km) SE	Past, present, and reasonably foreseeable. Operation began in April 2025. Final construction of all facilities to be completed by 2030. (City of Greensboro, 2023; Toyota, 2024; Toyota Global, 2025)

Table 7.1-2
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Impact Analysis
(Sheet 8 of 8)

Project Name	Description	Approximate Distance from the Project Site	Status
WATER AND WASTEWATER IMPROVEMENT PROJECTS			
Mitchell WTP Improvements Project	Install a Granular Activated Carbon contractor system for the existing Mitchell WTP to ensure compliance with U.S. Environmental Protection Agency National Primary Drinking Water Regulation Maximum Concentration Levels.	19 mi. (31 km) SE	Present and reasonably foreseeable. WTP upgrades are anticipated to be completed by 2029. (City of Greensboro, 2025b)
Town of Oak Ridge Water Tower	Construct a 250,000 gal (946 m^3) elevated water storage tank on Town property to support further development of the municipal water system in Oak Ridge.	8 mi. (13 km) SSE	Present and reasonably foreseeable. Groundbreaking ceremony held January 23, 2025. Water tower construction expected to be completed by January 2026. (Town of Oak Ridge, 2025)
Wolfspeed Watermain Extension Project	Construct a watermain extending from Asheboro to the CAM site to provide water for Wolfspeed's John Palmour Manufacturing Center.	41 mi. (66 km) SSE	Reasonably foreseeable. Construction is expected to begin in early 2025. Completed by 2026. (Asheboro City Government, 2024)

Sources: Each source is noted in the Status column of each project.

Key: BCSS = Belews Creek Steam Station; CAM = Chatham Advanced Manufacturing; ESF = Educational State Forest; FERC = Federal Energy Regulatory Commission; GTCC = Guilford Technical Community College; mi. = Mile; km = Kilometer; MVP = Mountain Valley Pipeline; NC = North Carolina; NCTPC = North Carolina Transmission Planning Cooperative; PLC = Piedmont Land Conservancy; RNG = Renewable Natural Gas; VADCR = Virginia Department of Conservation and Recreation; WTP = Water Treatment Plant; MW = megawatt

Table 7.1-3
Comparison of Criteria Pollutants

Pollutant	New Nuclear Plant Annual Estimated Emissions (tons/yr)[(a)]	BCSS 2024 Annual Emissions Inventory (tons/yr)[(b)]	Pollutant Emission Reductions (tons/yr)	Percent Change (%)
NO_X	134	8242	8109	-98.4%
CO	12.3	2606	2593	-99.5%
VOC	4.7	121	117	-96.1%
PM_{10}	26.4	576	550	-95.4%
$PM_{2.5}$	0.1	546	546	-99.9%
SO_X	28.2	1218	1190	-97.7%

Notes:
(a) Emissions from Section 5.7.2.1, Table 5.7-21
(b) Emissions from Duke Energy submission to North Carolina Department of Environmental Quality – Annual Air Emissions Inventory for Reporting Year 2024

7.2 RESOURCE IMPACT ASSESSMENT

As described above, the time frame for the cumulative impact analysis incorporates the combined effects from building and operation of the Project in combination with past, present, and RFFAs as impacts may accumulate or develop over time. The baseline assessment presented in the affected environment for each resource (as discussed in Chapter 2) accounts for past and present actions. Direct and indirect impact analyses (Chapter 4 and 5) address the incremental impacts of building and operation. These combined impacts may be individually minor but may collectively result in significant impacts from actions taking place over a period of time. An impact that may be SMALL by itself could result in a MODERATE or LARGE cumulative impact when considered in combination with the impacts of other actions on the affected resource. Table 7.2-1 summarizes the cumulative impact on each resource. The potential for cumulative effects to each of the identified environmental resources of concern are analyzed below.

7.2.1 LAND USE

The description of the affected environment in Section 2.1.1 serves as a baseline for the cumulative impacts assessment for land use. Within the Project Region, predominant land uses include undeveloped forested land and hay/pasture. Large tracts of forested land are located within the northern portion of the Project Region. Developed land is concentrated in major cities in the south-central portion of the Project Region. Land use within the Project Vicinity comprises undeveloped forested land, followed by hay/pasture. Evergreen forest is primarily located around Belews Lake with undisturbed pockets of mixed forest, deciduous forest, and hay/pasture dispersed throughout the Project Vicinity. Developed land classified as low intensity or open space is located sparsely throughout the Project Vicinity, whereas most of the high intensity and medium intensity developed lands are found within the BCSS, Walnut Cove, and Stokesdale areas. As summarized in Table 2.1-2, the Project Vicinity encompasses approximately 99,000 acres (ac.) (40,063 hectares [ha]). All developed lands account for approximately 12.4 percent of the Project Vicinity, and lands converted to agricultural uses (cultivated, hay/pasture) account for approximately 20.4 percent of the Project Vicinity (Table 2.1-2).

As Sections 4.1 and 5.1 describe the impacts on land use from building and operation of the Project are characterized as MODERATE (building activities) and SMALL (operation). Impacts to land use at the Project site and in the Project Vicinity occur primarily during building. Land use impacts from building activities associated with the Project result from effects to undeveloped lands within the Project site that are located adjacent to the BCSS. During operation, the Project does not result in additional land use conversion. Additionally, operation does not conflict with established land use controls.

Table 7.1-1 identifies the GAIs for land use to be the Project site and Project Vicinity. Table 7.1-2 identifies past, present, and RFFAs that have the potential to result in impacts to land use. However, many of these identified projects are located outside of the GAI and have limited or no relevance to land uses within the GAI. For example, RFFAs such as the Enbridge – T-15 Reliability Project, the Southeast Supply Enhancement Project, the Mountain Valley Pipeline, the Baxter Creek Solar Center, the Winston-Salem Northern Beltway, and other similar actions have the potential for adverse effects to land uses, but these projects are substantially outside of the GAI. Several RFFAs are linear projects (transmission, roadway and rail improvements, greenway developments) that are identified within the Project Vicinity, including:

- U.S. 158 (Reidsville Road) Improvements
- North Carolina Transmission Planning Cooperative (NCTPC) 2023-2033 Collaborative Transmission Plan
- Carolinian Piedmont Passenger & Freight Improvements
- Walnut Cove Greenway
- Mountain to Sea State Trail

The above actions are generally expected to consist of improvements to lands that are either within or along existing established corridors and do not result in substantial land use alterations within the GAI. Therefore, these new or updated actions do result in noticeable conversion of land that is not previously disturbed or categorized as developed. NCTPC transmission improvements may be required for various transmission projects that include reconductoring, upgrading, replacing, and adding new transmission lines to enhance system reliability and resiliency. These potential actions require final decision-making resulting from future interconnect studies that Duke Energy will conduct to determine the type and location of the uprates and reconductoring activities. It is expected that uprate and reconductoring activities and other RFFAs that are transportation improvements would predominantly be conducted within or along established corridors. Therefore, impacts associated with these activities on land use are expected to be minor.

The following actions identified in Table 7.1-2 are considered to have greater potential to substantially contribute to cumulative impacts on land use:

- BCSS Deconstruction
- BCSS Ash Basin Closure and Landfill Construction
- J. Dudley Watts Jr. Belews Lake Park (Belews Lake Park)
- Bear Branch Solar Project

BCSS deconstruction may entail decommissioning and removal of all previously developed features and infrastructure associated with the fossil plant. Similarly, the BCSS Ash Basin Closure and Landfill Construction Project will entail long-term maintenance in conjunction with closure. Therefore, no other substantive land use changes would occur with this action. However, the BCSS site and the landfill areas are likely to remain in industrial use and may be subject to future development. Therefore, no alterations of the designated land use or zoning of the BCSS site are expected.

Belews Lake Park is a designated recreational area located south of the Project site that is undergoing development. As Table 7.1-2 indicates, Phase I includes construction of a 215-ac. (87-ha) park featuring picnic areas, natural trails, comfort stations, and a fishing dock. Phase II will include additional development of these facilities. Therefore, the reasonably foreseeable future development of the park furthers the recreational services of the area and maintains overall designated land uses.

The Bear Branch Solar Project is an energy generation development on approximately 320 ac. (130 ha) located 6 miles (mi.) (3.2 kilometers [km]) north-northwest of the Project site that is anticipated to begin commercial operation in 2026. The project is located on previously cleared, vacant land and lacks forested land cover. The project entails conversion of herbaceous and

shrub land cover to developed uses. Therefore, the conversion of undeveloped non-forested lands to developed uses is a minor land cover conversion relative to the Project Vicinity (see Table 2.1-2).

As described above, corridor improvement projects, such as the U.S. 158 (Reidsville Road) improvement and the Carolinian Piedmont Passenger and Freight improvement, are expected to consist of land alterations that are either within or along existing established corridors. Therefore, they do not result in substantial land use alterations within the GAI.

In summary, the cumulative impact of building and operating activities from the Project on land use, added to the effects associated with past, present, and RFFAs within the GAI on land use is noticeable but not destabilizing and therefore MODERATE. Because of extensive past and present modification of land use within the GAI, and the Project site's proximity to the adjacent existing industrial BCSS site, the impact of building of the Project is a noticeable, but not a destabilizing contributor to the cumulative impact on land use. The impact of operation of the Project is a minor contributor to the cumulative impact on land use.

7.2.2 WATER

As described in Table 7.1-1, the GAI established for surface water includes the Project site, Belews Creek (includes Belews Lake), Dan River, and Town Fork Creek in the Project Vicinity. The GAI established for groundwater includes the Project site and Belews Lake. The GAI is based on potential for direct and indirect effects on groundwater.

7.2.2.1 Hydrology

7.2.2.1.1 Surface Water Hydrology

The description of the affected environment in Section 2.2.1.1 of this document serves as a baseline for the cumulative impacts assessment for surface water hydrology. As further described below, the Project may have limited effects on Belews Lake, the Dan River, Belews Creek downstream of the Belews Lake spillway, and smaller tributary streams on the Project site. The Dan River is a free-flowing unchanneled river system that is relatively narrow with mid-channel depths that range from less than 1 foot (ft.) (0.3 meters [m]) to approximately 3 ft. (0.9 m). Potential flow diversions are associated with the MWIS located on the Dan River at the confluence with Belews Creek that provides makeup water to Belews Lake. Belews Lake is a man-made reservoir with primary arms of the reservoir formed by Belews Creek and West Belews Creek. Belews Lake drains to the Dan River downstream of the dam spillway via Belews Creek. Project site streams include intermittent and perennial streams that connect to Belews Lake, the Dan River, or downstream surface waters. Stream characteristics are somewhat variable but are generally narrow and have evidence of an ordinary high-water mark, clear natural shelving, sediment sorting, changes in the character of the soil, a natural bank line, and moderately continuous bed and bank.

Impacts to surface water hydrology associated with the building and operation of the Project is described in Sections 4.2.1 and 5.2.1, respectively. Impacts to Belews Lake during building activities are limited to the locations of the intake, discharge, and associated lakebed piping structures. Stormwater runoff patterns across the net disturbance area (NDA) are altered resulting in changes in stormwater runoff rates across the Project site. Implementation of design measures and best management practices (BMPs) coupled with adherence to federal, state, and local permit conditions related to Sections 401 and 404 of the Clean Water Act (CWA)

reduce direct and indirect impacts from building activities on stormwater runoff rates to Belews Lake and the Dan River. For impacts that cannot be reduced, Duke Energy implements specific compensatory mitigation measures in accordance with 33 CFR Part 332. The overall impacts of hydrologic alterations to surface waters during building activities are mitigated and are therefore SMALL.

During operations, sedimentation basins installed during the building phase are converted to detention or retention facilities for the permanent stormwater management system during the operational period, minimizing discharge of sediments and site runoff to Belews Lake. The effects of Project operations on flow patterns within Belews Lake as a result of intake, discharge, and MWIS are localized and minor. Additionally, the potential impacts of sediment transport into Belews Lake from the MWIS operation are negligible. Overall, Project operations result in predicted Belews Lake water-level variations that result from increased consumptive use. Under conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping, impacts on Belews Lake hydrology are SMALL. However, impacts on Belews Lake hydrology are MODERATE in conjunction with the effects of increased drought intensity.

Project discharges into the Dan River in a corridor adjacent to existing Outfall 006 results in localized changes in flow patterns, currents, and total flow. Discharge flow rates are regulated in conjunction with NCDEQ NPDES permitting requirements. Therefore, the hydrological impacts of discharge are minor. Pumping by the MWIS results in minor hydrologic alterations on the Dan River during higher flow conditions but does not affect Dan River flow when natural discharge is less than 110 cfs (3.1 m^3/s). Hydrological impacts of MWIS operation on the Dan River are SMALL. As described in Table 7.1-1, the GAI established for surface water hydrology includes the Project site, Belews Creek (includes Belews Lake), Dan River, and Town Fork Creek in the Project Vicinity. Many of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in some effects to surface water hydrology. However, most projects are located outside of the GAI, are relatively minor in scope, and have limited or no connectivity to surface water hydrology affected by the Project. Several RFFAs are within the GAI but are not expected to greatly impact surface water hydrology including:

- U.S. 158 (Reidsville Road) Improvements
- Carolinian Piedmont Passenger & Freight Improvements
- NCTPC 2023-2033 Collaborative Transmission Plan
- Bear Branch Solar Project
- BCSS Ash Basin Closure and Landfill Construction

These projects represent the continued or new operation of industrial infrastructure such as roads, railways, transmission projects, solar facilities, or other industrial uses. While these projects do not have direct impacts on surface water hydrology within the GAI, indirect impacts, such as degradation of water quality from sedimentation and potential accidental spills, could occur to streams flowing into the Dan River, Belews Lake, or Town Fork Creek. Compliance with federal, state, and local requirements minimizes these potential indirect impacts on surface water hydrology. Compliance with the terms of applicable Section 404 permits (including minimization and mitigation) and using BMPs further reduces impacts.

As described in Section 2.2.1.1.3, Belews Lake is a man-made reservoir formed in 1970 following construction of an earthen embankment dam across Belews Creek. The lake was constructed primarily to serve as a CCW source for the BCSS. Three named streams flow into

Belews Lake: Belews Creek, West Belews Creek, and East Belews Creek. The impoundment of Belews Lake resulted in persistent noticeable hydrologic effects related to watershed runoff and residence time, water currents and circulation, water retention and depth characteristics within Belews Lake, sedimentation and sediment transport.

The BCSS closure identified in Table 7.1-2 may also contribute to substantial cumulative impacts on surface water hydrology through direct impacts to waters within the GAI.

As described in Section 7.1.2, BCSS closure has several potential effects on surface water hydrology that include reduced water use by BCSS to support FGD operations, forced evaporation, and other water uses. Pumping operations associated with the MWIS on the Dan River and discharge flow from Outfall 006 are transferred to Project operations. The cumulative effects of BCSS closure in conjunction with the Project are generally offsetting as the phased implementation of the Project in conjunction with BCSS closure has the effect of impacting surface water hydrology in a similar manner with respect to the effects on Belews Lake and the Dan River. The Project is also subject to federal and state permitting. Therefore, effects are reduced by mitigation in accordance with the U.S. Army Corps of Engineers (USACE) and NCDEQ, and Section 7 of the Endangered Species Act, as appropriate.

In summary, because of extensive past and present modification of Belews Creek and its tributaries, as a result of the impoundment of Belews Lake, the cumulative impact of building and operating the Project on surface water hydrology, added to the effects associated with past, present, and RFFAs within the GAI on surface water hydrology is MODERATE. The impact of building the Project is a minor contributor to the cumulative impact on surface water hydrology due to the mitigation of impacts to low-quality streams on-site, impacts to Belews Lake, and stormwater runoff changes. However, the impact of operation of the Project is a noticeable contributor to the cumulative impact on surface water hydrology in conjunction with the effects of increased drought intensity.

7.2.2.1.2 Groundwater Hydrology

Section 2.2.1.2 of this document serves as a baseline for the cumulative impacts assessment for groundwater hydrology. The Project site is situated in the Piedmont physiographic province (Piedmont), which is characterized by gently rolling, well-rounded hills and long, low ridges. The Project Region receives groundwater recharge through infiltration of precipitation. Local groundwater is influenced by many perennial and ephemeral streams, creeks, and lakes within the Project Vicinity.

Permanent and temporary impacts to groundwater hydrology associated with the future building and operation of the Project is described in Sections 4.2.1.2 and 5.2.1.2, respectively. Alterations to groundwater hydrology during building include those associated with dewatering. However, once building activities are completed, dewatering is no longer needed, and the water table is returned to static baseline conditions. Groundwater flow patterns may be affected during building and grading activities; however, effects are localized and are not noticeably altering. Structure foundation development does not result in long-term impacts on groundwater levels, availability, or flow patterns. Additionally, loss of pervious surfaces associated with permanent use areas results in localized alterations in groundwater patterns associated with reduced groundwater infiltration from some areas of the Project site during operations. No groundwater use or dewatering occurs during operation that may affect local aquifers. As described in Sections 4.2.1.2 and 5.2.1.2, the impacts on groundwater hydrology from building and operation of the Project are SMALL.

As described in Table 7.1-1, the GAI established for groundwater hydrology is based on aquifers evident on the Project site and Belews Lake. Several of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in some effects to groundwater hydrology. However, none are located within the GAI and would not have the potential to substantially contribute to cumulative impacts on groundwater hydrology.

Groundwater hydrology in the GAI is influenced by surface water bodies and seasonal precipitation patterns. The effects of other past and ongoing projects on groundwater are localized and cumulative effects to groundwater hydrology are minor.

In summary, the cumulative impact of building and operating the Project on groundwater hydrology, added to the effects associated with past, present, and RFFAs within the GAI on groundwater hydrology, is minor, and therefore, SMALL. Because the Project's groundwater alterations are limited to the building phase and result in localized effects from dewatering and reduced infiltration due to site grading and the construction of new impervious surfaces, the impact of building and operating the Project is not a significant contributor to the cumulative impact on groundwater hydrology.

7.2.2.2 Water Use

7.2.2.2.1 Surface Water Use

The description of the affected environment in Section 2.2.2.1 serves as a baseline for the cumulative impacts assessment for surface water use. Regional surface water use includes public water supply, industrial, thermoelectric power, mining, livestock, aquaculture, and irrigation. Consumptive water use in the Project Region consists of that used in thermoelectric power generation and irrigation. Recreation is prevalent in the Project Region including opportunities for fishing, paddling, canoeing, tubing, and kayaking in the Dan River. There are no public water supply facilities that withdraw water from surface water resources within the Project Vicinity. Vicinity recreational water use include the Dan River State Trail and Belews Lake. Belews Lake is used for various kinds of recreation including fishing, boating and other aquatic forms of recreation. Belews Lake is not used for consumptive water uses such as municipal water supply, irrigation, or thermoelectric power generation associated with entities outside of Duke Energy. On the Project site, BCSS draws water from Belews Lake via an intake structure located in a natural cove on the western arm of Belews Lake. Heated effluent discharges into West Belews Creek. A man-made canal crosses the site peninsula to convey cooling water from the discharge area to the eastern portion of Belews Lake.

As Sections 4.2.2.1 and 5.2.2.1 describe the impacts on surface water use from building and operation of the project are characterized as SMALL. Water is required for dust suppression and withdrawn from Belews Lake during building activities, but the effects are negligible. No building phase water use is obtained from the Dan River. The effects of potable water usage during building activities are minor since the potable water supply has excess capacity. Proposed facility operations require water use of Belews Lake. Consumptive use in conjunction with Project operations does not adversely affect the availability of water for Project intake systems and does not affect the overall purpose of Belews Lake in providing water to support thermoelectric power generation. Given the minimum flow requirements established in the NPDES permit, which is expected to carry over to the Project, water availability and reliability downstream of the MWIS are not destabilizing to downstream water users. Additionally, adherence to the NPDES permit along with a low-profile MWIS structure result in minor impacts

that do not noticeably impact the recreational use of the Dan River. Therefore, the overall impacts of Project operations on surface water use are considered SMALL.

As described in Table 7.1-1, the GAI established for surface water use includes the Project site, Belews Creek (includes Belews Lake), Dan River, and Town Fork Creek in the Project Vicinity. Table 7.1-2 identifies past, present, and RFFAs that have the potential to result in impacts to surface water use. All actions listed in Table 7.1-2 are expected to be permitted in accordance with state and federal regulations that ensure the protection of surface water use. Similarly, most are expected to represent a substantial potential to contribute to additional stressors on surface water use within the GAI. The Dan River State Trail project, where more of the Dan River is designated as a State Blueway, is discussed further in Section 7.2.4.

The BCSS closure identified in Table 7.1-2 may contribute to substantial cumulative impacts on surface water use through direct impacts to waters within the GAI, including beneficial impacts.

As described in Section 7.1.2, BCSS closure has several potential effects on surface water use that include reduced water use by BCSS to support FGD operations, forced evaporation, and other water uses; transfer of pumping operations associated with the MWIS on the Dan River; and elimination of most discharge flow to the Dan River from Outfall 006. The cumulative effects of BCSS closure in conjunction with the Project are generally offsetting in which the phased implementation of the Project in conjunction with BCSS closure has the effect of impacting surface water use in a similar manner with respect to the effects on Belews Lake and the Dan River. The Project is also subject to federal and state permitting. Therefore, effects are reduced by mitigation in accordance with USACE and NCDEQ, and Section 7 of the Endangered Species Act, as appropriate.

In summary, the cumulative impact of building and operating activities from the Project on surface water use, added to the effects associated with past, present, and RFFAs within the GAI on surface water use is SMALL. The impact of building and operation of the Project have a minor effect on water use.

7.2.2.2.2 Groundwater Use

Section 2.2.2.2 of this document serves as a baseline for the cumulative impacts assessment for groundwater use. Regional and Project Vicinity groundwater use is primarily for public water supply. Other than water withdrawals associated with the Duke Energy groundwater corrective action plan remediation system located approximately 2.2 mi. (3.5 km) northwest of the Project site, no groundwater withdrawals currently exist at the operating BCSS. Impacts to groundwater use from building and operating the Project is described in Sections 4.2.2.2 and 5.2.2.2. While dewatering may be required during building, groundwater is not used as a source of water for building activities or operation. As such, the impacts from groundwater use are SMALL.

As described in Table 7.1-1, the GAI established for groundwater use is based on aquifers evident on the Project site and Belews Lake. All actions listed in Table 7.1-2 are expected to be permitted or authorized in accordance with state and federal regulations concerning groundwater use. Several of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in some effects to groundwater use. However, none are located within the GAI and would have the potential to substantially contribute to cumulative impacts on groundwater use.

In summary, the cumulative impact of building and operating activities from the Project on groundwater use, added to the effects associated with past, present, and RFFAs within the GAI on groundwater use, is minor, and therefore, SMALL. Because no groundwater is used by the Project during building or operation, the impact of building and operation of the Project is negligible and not a significant contributor to the cumulative impact on groundwater use.

7.2.2.3 Water Quality

7.2.2.3.1 Surface Water Quality

Section 2.2.3.1 of this document serves as a baseline for the cumulative impacts assessment for surface water quality. As described in Section 2.2.3.1, Project site streams are characterized by narrow channels with moderate gradients. Temperatures in the on-site streams did not exceed any NCDEQ water quality standards. The upper portion of the West Belews Creek arm of Belews Lake currently receives heated effluent from the BCSS. Belews Lake and a major portion of the discharge arm near BCSS maintain temperatures adequate to support biological communities under adverse lake-level and weather conditions. Water quality sampling results indicate that the seasonal water quality and chemistry of Belews Lake provides a suitable physicochemical environment for sustaining a balanced and indigenous biological community. Measured temperatures in the Dan River did not exceed any NCDEQ water quality standards. Water quality impacts from pumping Dan River water into Belews Lake to augment the water level were found to be localized to the immediate pump outlets in the lake and are insignificant compared to effects, such as stormwater runoff. Town Fork Creek within the Project Vicinity is meeting quality standards and is not impaired.

Impacts to surface water quality associated with building and operation of the Project is described in Sections 4.2.3.1 and 5.2.3.1. Direct physical alteration of surface waters from building activities resulting in the filling of streams in conjunction with site grading, results in adverse impacts to surface water quality. Activities such as erosion and sedimentation, accidental spills, or releases of stormwater can result in indirect impacts on surface water quality. Surface water impacts during building activities are regulated by NCDEQ and the USACE. BMPs are used to control erosion and limit the amount of soil and sediment entering surface waters. A spill prevention, control, and countermeasure (SPCC) plan will be implemented to control the discharge of oil spills and limit their effects on surface water. A site-specific stormwater pollution prevention plan (SWPPP) mitigates the impact of building activities on off-site stream water quality caused by the permanent impact to streams within the NDA. Permitting requirements including the implementation of appropriate BMPs and control measures minimizes impacts such that impacts to the water quality of Belews Lake are localized and temporary.

Excavation in the Dan River is conducted to install the discharge pipeline and results in localized sediment disturbance and water quality alterations related to turbidity and suspended solids. Riprap is placed in conjunction with the discharge to minimize scour and erosion of the riverbed. Disturbance of riparian vegetation by construction equipment operations within the wastewater pipeline corridor can also indirectly reduce the water quality of the Dan River due to erosion, associated sedimentation, and potential accidental releases from spills. As a result of mitigative measures and engineering controls (e.g., BMPs, SWPPP, and SPCC) regulated by NCDEQ and USACE that are implemented during building activities, impacts to surface water quality are controlled, localized, and temporary. Therefore, the impacts on surface water quality are SMALL.

Impact from operations to on-site streams is limited due to the removal of the majority of on-site streams during building activities. The remaining streams on the Project site not impacted by building activities are potentially impacted during operation by industrial stormwater runoff, which is minimized by an existing NPDES stormwater permit and SPCC plan. Direct effects of operation on water quality within Belews Lake include the addition of cooling tower blowdown wastewater constituents and thermal load and supplemental pumping from the Dan River. The additional wastewater discharges are not expected to accumulate and will meet NPDES permitting limits and requirements with a regulatory mixing zone. As described in Section 5.2.4.1.2, Duke Energy maintains monitoring programs to ensure regulatory compliance. Therefore, the overall impacts of surface water quality during operations are considered SMALL.

As described in Table 7.1-1, the GAI established for surface water quality includes the Project site, Belews Creek (includes Belews Lake), Dan River, and Town Fork Creek in the Project Vicinity. Many of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in some effects on surface water quality. However, most projects are located outside of the GAI and have limited or no connectivity to surface water quality affected by the Project. Therefore, the effects of such projects on cumulative effects to surface water quality are expected to be minor. Several RFFAs are within the GAI but are not expected to greatly impact surface water quality including:

- U.S. 158 (Reidsville Road) Improvements
- Carolinian Piedmont Passenger & Freight Improvements
- NCTPC 2023-2033 Collaborative Transmission Plan
- Bear Branch Solar Project
- BCSS Ash Basin Closure and Landfill Construction

These projects represent the continued or new operation of industrial infrastructure such as roads, railways, transmission projects, solar facilities, or other industrial uses. While these projects do not have direct impacts on surface water quality, indirect impacts, such as degradation of water quality from sedimentation and potential accidental spills, could occur with streams flowing into the Dan River, Belews Lake, or Town Fork Creek. Compliance with federal, state, and local requirements minimizes these potential indirect impacts on surface water quality. Compliance with the terms of applicable Section 404 permits (including minimization and mitigation) and using BMPs further reduces impacts.

The BCSS closure identified in Table 7.1-2 may contribute to substantial cumulative impacts on surface water hydrology through direct impacts to waters within the GAI.

As described in Section 7.1, BCSS closure has several potential effects on surface water quality including the cessation of thermal inputs from BCSS. As described in Section 7.1.2.1.2, thermal loading to Belews Lake is significantly reduced in conjunction with the closure of BCSS. Therefore, water temperatures within Belews Lake are primarily affected and undergo a process by which temperatures are greatly reduced resulting in reduced stress to aquatic biota within the lake. General cooling would occur within each reach of Belews Lake until temperatures stabilize to a condition influenced mainly by seasonal patterns and would result in significant beneficial improvement in overall water quality within Belews Lake. BCSS closure would also result in the substantial elimination of discharges of BCSS constituents to the Dan River from Outfall 006. This action is also subject to federal and state permitting. Therefore, effects are reduced by appropriate mitigation in accordance with USACE and NCDEQ, and Section 7 of the

Endangered Species Act, as appropriate. Impacts associated with this activity on water quality are minor.

In summary, the cumulative impact of building and operating activities from the Project on surface water quality, added to the effects associated with past, present, and RFFAs within the GAI on surface water quality, is noticeable and stabilizing, primarily due to the beneficial effects of BCSS closure. Overall impacts, therefore, are LARGE and beneficial. Because of adherence to regulations and permits by the NCDEQ and USACE, use of BMPs, and implementation of SPCC plan and SWPPP, the impact of building and operation of the Project is minor and not a significant contributor to the cumulative impact on surface water quality.

7.2.2.3.2 Groundwater Quality

Section 2.2.3.2 of this document serves as a baseline for the cumulative impacts assessment for groundwater quality. As described in 2.2.3.2, groundwater quality from the Piedmont and Blue Ridge aquifers is generally suitable for drinking. Some pre-site development exceedances of pH, metals, and coliforms were detected in groundwater wells. As described in Section 2.2.3.2.3.2, constituents such as aluminum, arsenic, iron, and manganese commonly have elevated naturally occurring groundwater concentrations in the Piedmont. Other than water withdrawals associated with the Duke Energy groundwater corrective action plan remediation system, no groundwater withdrawals currently exist at the operating BCSS.

Impacts to groundwater quality associated with building and operation of the Project are described in Sections 4.2.3.2 and 5.2.3.2. Dewatering of the power block areas usually occurs within a limited area during the duration of the building of the below-grade nuclear island structures and foundations. Drainage sumps at the bottom of the excavation area pump water that may enter the excavation area into an on-site permanent stormwater basin prior to its permitted release to Dan River. Water quality effects of such releases on surface water are discussed in Section 4.2.3.1. An SPCC plan will be prepared and implemented at the Project site, which would include the use of BMPs to minimize the occurrence of spills and limit their effects on groundwater. Because engineering controls prevent or minimize the release of harmful effluents, and effluent concentrations are maintained at levels below permitted limits that are established to be protective of water quality, impacts to groundwater quality from building and operation are SMALL.

As described in Table 7.1-1, the GAI established for groundwater quality is based on aquifers evident on the Project site. All actions listed in Table 7.1-2 are expected to be permitted or authorized in accordance with state and federal laws and regulations concerning groundwater quality. Several of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in some effects on groundwater quality. However, none are located within the GAI and would have the potential to substantially contribute to cumulative impacts on groundwater use.

In summary, the cumulative impact of building and operation of the Project on groundwater quality, added to the effects associated with past, present, and RFFAs within the GAI on groundwater quality, is minor, and therefore, SMALL. Because engineering controls as described above prevent or minimize the release of harmful effluents and effluent concentrations are maintained at levels below permitted limits that are established to be protective of water quality, the impact of building and operation of the Project is negligible and not a significant contributor to the cumulative impact on groundwater quality.

7.2.3 ECOLOGY

7.2.3.1 Terrestrial Ecosystems

Section 2.3.1 provides a description of the affected environment and serves as a baseline for the cumulative impact assessment for terrestrial ecosystems, including wetlands. The Project site and Project Vicinity are located within the Piedmont Ecoregion which has changed over the last 200 years - shifting from forest to farm, then back to forest, and now reflects a greater abundance of developed land cover types from growing urbanization. The most prevalent land cover in the Project Vicinity is deciduous forest, followed by hay/pasture, evergreen forest, and mixed forest. Many terrestrial plant communities and associated habitats within the Project site are composed of previously disturbed communities consisting of developed lands or marginal evergreen, herbaceous, and scrub shrub habitat. Wildlife habitat value and associated wildlife communities are considered limited in these areas. However, deciduous forest and associated stream valley habitats and wetlands provide higher-quality wildlife habitat and breeding and nesting areas for wildlife.

Impacts from building activities and operations of the Project are described in Sections 4.3.1 and 5.3.1 respectively. Impacts on plant communities and habitats from building activities are noticeable based on the size of the area affected. Although much of the impacts on-site are on low-quality habitats, higher-quality habitats on-site are also impacted. Wildlife composition within the Project site is altered to naturalized communities, and impacts on wildlife are limited because of mitigation measures, BMPs, and the short duration of building activities. The only important terrestrial habitat on-site are wetlands, and these impacts are mitigated by BMPs and federal or state mitigation requirements. Impacts on important species are also limited because of the low probability of occurrence, the presence of extensive habitat characterized by low-quality plant communities, and the abundance of similar suitable habitat within the Project Vicinity. In addition, implementation of appropriate conservation measures minimizes impacts on important terrestrial species. As described in Section 4.3.1, impacts to terrestrial ecology and wetlands from building activities are MODERATE.

Impacts from operations on the Project site are limited by the lack of on-site habitat due to development of the Project site during the preceding building activities phase. Impacts associated with landscape maintenance activities, potential for invasive species establishment, noise emissions, cooling tower salt deposition, and potential for collisions with tall structures are minor and mitigated by using BMPs, invasive species control methods, compliance with the Migratory Bird Treaty Act, and use of bird-safe transmission system measures. As described in Section 5.3.1 the impact on terrestrial ecosystems and wetlands from operation of the Project is SMALL.

As identified in Table 7.1-1, the GAI for terrestrial ecosystems is the Project site and Project Vicinity. Table 7.1-2 identifies past, present, and RFFAs that have the potential to result in impacts to terrestrial ecosystems. However, many of these identified projects are either relatively minor in scope or located outside of the GAI and have limited or no connected action to terrestrial ecosystems, including wetlands, within the GAI. For example, RFFAs such as the Enbridge – T-15 Reliability Project or the Future Bashavia Creek Preserve have the potential for adverse or beneficial effects associated with habitat alteration or preservation respectively. But such projects are substantially outside of the GAI, and therefore, are not expected to contribute to cumulative effects to terrestrial ecosystems and wetlands within the GAI.

The following RFFAs are linear roadway and rail improvement projects that are identified within the GAI but are not expected to greatly impact terrestrial resources within the Project Vicinity:

- U.S. 158 (Reidsville Road) Improvements
- Carolinian Piedmont Passenger and Freight Improvements

These road and railway projects represent the continued and future operation of existing industrial infrastructure and are expected to alter habitat that is either within or along existing established corridors within the GAI. These established, developed corridors along roads and railways are considered low-quality habitat and thus, additional development within them would not result in a substantial loss to terrestrial ecosystems. Any potential effects of these actions are subject to federal and state permitting. Effects are reduced by appropriate mitigation in accordance with USACE, NCDEQ, Section 7 of the Endangered Species Act, and the Migratory Bird Treaty Act, as appropriate. Therefore, impacts associated with these activities on terrestrial ecosystems are expected to be minor.

The following actions identified in Table 7.1-2 within the GAI have the potential to substantially contribute to cumulative impacts on terrestrial ecosystems:

- NCTPC 2023-2033 Collaborative Transmission Plan
- Bear Branch Solar Project

New industrial developments such as transmission and solar projects are expected to commit additional land to industrial uses. The NCTPC Transmission Plan may involve adding new transmission lines which could involve the conversion of habitat to more developed or maintained land. Although specific details of potential impacts to terrestrial ecosystems and wetlands are not known for the NCTPC transmission project, any potential effects of these actions are subject to federal and state permitting. Therefore, effects are reduced by appropriate mitigation in accordance with USACE and NCDEQ, Section 7 of the Endangered Species Act, and the Migratory Bird Treaty Act, as appropriate.

Bear Branch Solar Project is an energy generation development on approximately 320 ac. (130 ha) located 6 mi. (3.2 km) north-northwest of the Project site, within the Project Vicinity. The project is located on previously cleared, vacant land and lacks forested habitat. The project entails conversion of herbaceous and scrub shrub habitat to developed uses. With approximately 2917 ac. (1180 ha) of herbaceous habitat and 2387 ac. (966 ha) of scrub shrub habitat in the Project Vicinity (Table 4.3-1), the loss of herbaceous and shrub habitat to this solar project is a minor habitat conversion. However, this RFFA could prevent larger wildlife from using this area as a habitat corridor for traveling between areas of higher habitat. Smaller animals could move through the solar project under or through the fences, so not all wildlife movement would be restricted.

In summary, the cumulative impact of building and operating activities from the Project on terrestrial ecology and wetlands, added to the effects associated with past, present, and RFFAs within the GAI on terrestrial ecology and wetlands, is noticeable but not destabilizing and therefore MODERATE. The impact of building activities on terrestrial ecosystems and wetlands results in degradation of quality habitat that is persistent. Because of extensive forest habitat loss on the Project site and associated impacts with wildlife, the impact of the building and operation of the Project would be a noticeable contributor to the MODERATE cumulative impact on terrestrial ecology.

7.2.3.2 Aquatic Ecosystems

The description of the affected environment in Section 2.3.2 serves as a baseline for the cumulative impacts assessment for aquatic ecosystems. On-site streams contain species representative of relatively low water and habitat quality. Belews Lake contains species that are indicators of moderate to good water quality with reproductive, self-sustaining fish populations. Dan River contains habitat suitable for mussels and sensitive fish species that may include good water quality, suitable foraging, low pollutant loads, and a variety of substrate/habitat types.

Impacts to aquatic ecosystems associated with the Project are described in Sections 4.3.2 and 5.3.2, respectively. Building activities result in impacts to several on-site streams. However, given their small size, intermittent nature, and indicators of lower water and habitat quality, on-site streams are of poor quality. Impacts on aquatic habitat in Belews Lake during building activities is minor based on lack of high quality or unique habitats in the areas of impact. Within Belews Lake, impacts are temporary and localized to the specific location of intake and discharge structures. Indirect impacts to aquatic communities are minimized under permitting and SWPPP requirements and with BMPs. Unavoidable impacts to on-site aquatic habitats are mitigated in conjunction with regulatory requirements in conjunction with CWA Section 401 and Section 404 permitting by NCDEQ and USACE, respectively (see Section 4.2.1). Given the small size of stream features supporting common and widespread aquatic biota, and the commitment to implement appropriate compensatory mitigation, overall impacts are minor. Duke Energy will consult with U.S. Fish and Wildlife Service and the North Carolina Wildlife Resources Commission regarding avoidance and mitigation measures to limit potential effects on proposed critical habitats within the Dan River. As described in Sections 4.3.2, the impacts on aquatic ecology from building and operation of the Project are SMALL.

Operational impacts to aquatic ecosystems include impacts related to on-site stormwater runoff and incidental spills that are managed through stormwater management systems. In Belews Lake, operational impacts are associated with the location of the intake and discharge structures, and with changes in water levels. Impacts of the discharge(s) are expected to dissipate rapidly, limiting impacts on aquatic ecosystems. Impacts of intake operation are minimized through compliance with CWA Section 316(b) requirements. In the Dan River, operational impacts are associated with operation of the MWIS at the confluence of Belews Creek and the Dan River, and with the wastewater discharge. Impacts of MWIS operation on impingement and entrainment in the Dan River are regulated through intake flow requirements under the existing BCSS NPDES permit NC0024406 and are minimized by technologies and design features, therefore impacts on important species and their habitats are minor.

Additionally, as described in Section 5.3.2, consumptive uses of Belews Lake in support of Project operations, result in water-level fluctuations. Depending upon the extent and duration of droughts, aquatic communities may be adversely affected by water-level fluctuations that result in the desiccation of aquatic substrates and impacts on benthic organisms, aquatic macrophytes, and valuable spawning and nursery areas for fish. Under conditions in which water levels are stabilized and consumptive losses are generally offset by MWIS pumping, impacts on Belews Lake aquatic ecology are SMALL. However, impacts on Belews Lake aquatic ecology are impacted to a greater degree as a result of noticeable and prolonged water-level fluctuations in conjunction with increased drought intensity. Under such conditions, effects on aquatic biota of Belews Lake are MODERATE.

As described in Section 5.3.2, the impacts on aquatic ecology from building and operation of the Project are SMALL for most conditions but are MODERATE within Belews Lake under periods of increased drought intensity.

As described in Table 7.1-1, the GAI established for aquatic ecology is based on watershed connectivity and includes the Project site, Belews Lake, Dan River, and Town Fork Creek. Table 7.1-2 identifies past, present, and RFFAs considered in assessing cumulative impacts to aquatic ecosystems. Many of these identified projects are either relatively minor in scope or are not within the GAI. Several RFFAs are within the GAI but are not expected to greatly impact aquatic ecosystems, including:

- U.S. 158 (Reidsville Road) Improvements
- Carolinian Piedmont Passenger & Freight Improvements
- NCTPC 2023-2033 Collaborative Transmission Plan
- Bear Branch Solar Project
- BCSS Ash Basin Closure and Landfill Construction

These projects represent the continued or new operation of industrial infrastructure such as roads, railways, transmission projects, solar facilities, or other industrial uses. While these projects do not have direct impacts on aquatic resources described in the GAI, indirect impacts, such as degradation of water quality from sedimentation and potential accidental spills, could occur to streams flowing into the Dan River, Belews Lake, or Town Fork Creek. Compliance with federal, state, and local requirements minimizes these potential indirect impacts on aquatic ecosystems. Compliance with the terms of applicable Section 404 permits (including minimization and mitigation) and using BMPs further reduces impacts.

As described in Section 2.2.1.1.3, Belews Lake is a man-made reservoir formed in 1970 following construction of an earthen embankment dam across Belews Creek. The lake was constructed primarily to serve as a CCW source for the BCSS. Three named streams flow into Belews Lake: Belews Creek, West Belews Creek, and East Belews Creek. As described in Section 2.3.2.2.2, the impoundment of Belews Lake resulted in effects related to the development of an aquatic ecological community that is characteristically different from that of Belews Creek and its tributaries. Recent monitoring on Belews Lake reflected the presence of a balanced and indigenous aquatic biological community. The presence of macrophytes was limited to shallower areas of the reservoir. Benthic macroinvertebrate communities were dominated by pollution-tolerant species; however, the presence of pollution intolerant mayflies in spring and summer were indicators of moderate to good water quality. The fish community was characterized by multiple trophic guilds, with a size-structure that indicated reproductive, self-sustaining populations. While the aquatic communities of Belews Lake represent a valuable aquatic ecological community that is an important recreational resource, the effects on the aquatic community are persistent and noticeable.

The BCSS closure, identified in Table 7.1-2 may also contribute to substantial cumulative impacts on aquatic ecosystems through direct impacts to waters within the GAI.

As described in Section 7.1.2, BCSS closure has several potential effects on aquatic ecology that result from the elimination of thermal discharges to Belews Lake that provide for improved water quality, and reduced stress on aquatic biota within Belews Lake. It is anticipated that Project operations will be authorized under a modification of the existing BCSS NCDEQ NPDES

permit NC0024406 to manage intake flow requirements, minimize effects on Dan River aquatic biota, and minimize impingement and entrainment by the MWIS. Thus, permitted supplemental pumping from the Dan River is no longer influenced by BCSS uses, but similar effects continue with Project operations.

Within Belews Lake, cumulative effects of BCSS closure in conjunction with the Project are mixed in which periods of water-level fluctuations caused by increased drought intensity may lead to increased instability in aquatic macrophyte communities, with resulting adverse effects on vegetation diversity. Water-level fluctuations under drought conditions are expected to lead to decreased habitat availability and potential desiccation to benthic macroinvertebrates and mussels. Such water-level fluctuations may also be expected to affect fish reproductive success during recurring drought conditions in which macrophyte beds are used for spawning and nursery may be less available to fish. Further, there is increased potential for proliferation of nuisance macrophytes, such as Hydrilla under these conditions. However, the balance of fish communities is not expected to shift in such a way that would promote the expansion of nonindigenous fish beyond those already present in Belews Lake.

Additionally, closure of BCSS results in significant benefits that result in cooler water temperatures within Belews Lake that persist throughout the licensing period. Effects of Project thermal discharges on whole lake temperatures within Belews Lake are localized and negligible. Therefore, aquatic communities are expected to reflect a taxonomic shift in the fish community, likely to result in a community that is more closely aligned with that observed in Mayo Reservoir. Fish condition shifts are also likely to occur. Changes to cooler water temperatures and the subsequent loss of warmer winter temperatures in the West Belews Creek arm of Belews Lake will affect the timing of spawning and result in a shorter growth season. Some species may exhibit higher overall condition, as cooler temperatures may reduce the level of caloric intake required to meet the stressful energetic needs associated with habitats with elevated temperatures. Changes to the forage base may result in changes in trophic and population dynamics across the lake. Within the Dan River, the cumulative effects of BCSS closure in conjunction with the Project are generally offset due to the phased implementation of the Project, and because the BCSS closure impacts aquatic resources through the same level of MWIS pumping.

In summary, the cumulative impact of building and operating activities from the Project on aquatic ecology, added to effects associated with past, present, and RFFAs within the GAI on aquatic ecology is MODERATE. This conclusion accounts for the cumulative effects of past impoundment of Belews Creek and its resultant effects on the aquatic ecosystem within Belews Creek and its tributaries. The incremental contribution of building and operation of the Project is a minor contributor to the cumulative impact on aquatic ecosystems under normal conditions and noticeable in conjunction with the effects of increased drought intensity.

7.2.4 SOCIOECONOMICS

As described in Section 2.4, socioeconomic impacts primarily affect the four counties (Guilford, Forsyth, Rockingham and Stokes Counties) that make up the region of influence (ROI) where expected shifts in workforce demographics are expected to influence socioeconomic conditions. Therefore, the ROI is the GAI for assessing cumulative socioeconomic impacts unless otherwise specified. Table 7.1-2 details recent past, present, and RFFAs within the GAI.

7.2.4.1 Physical Impacts

Section 4.4.1 describes physical impacts from building activities, including those associated with noise and vibration, odors, dust and air pollution, transportation, and visual impacts. The impact of noise and vibration on nearby structures is minimal due to the distance between the areas on the Project site where vibration-inducing activities take place and the closest residence. Air emissions are effectively managed through mitigation measures and adherence to regulatory limits, resulting in only minor air quality impacts. Physical impacts on transportation infrastructure are minor. Any damage to public roads, pavement markings, or signage caused by building activities are repaired to preexisting conditions or better, in accordance with state and local requirements. Aesthetic impacts associated with building activities are noticeable but not destabilizing. These impacts are primarily related to the introduction of new structures, use of construction equipment, and increased traffic in the Project Vicinity. Therefore, physical impacts of building activities are SMALL for most factors, but MODERATE for aesthetics.

As stated in Section 5.4.1 physical impacts from operation including odors, dust, and air pollution, thermal emissions, noise, and transportation-related impacts are SMALL. However, the addition of new cooling towers, associated steam plumes, and reactor facilities at the Project site noticeably alters the visual environment for nearby residents and recreators on Belews Lake. Thus, physical impacts on aesthetics from operations are MODERATE.

Because most physical impacts from construction and operation diminish rapidly with distance, the GAI for physical impacts is generally limited to the Project site. However, for impacts with a broader reach, such as transportation-related effects, noise, and aesthetics, the GAI extends into the surrounding Project Vicinity.

Many of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in some physical effects to the surrounding environment. However, most projects are located outside of the GAI and have limited or no connectivity to resources potentially affected by physical impacts from the Project. Additionally, several of the projects are past, present, and ongoing actions that have been captured in the affected environment and building and operations-related impacts analysis and therefore do not represent an additional cumulative impact. These include:

- BCSS operation
- BCSS Ash Basin Closure and Landfill Construction
- NCTPC 2023-2033 Collaborative Transmission Plan
- Dan River State Trail
- Mountains-to-Sea State Trail
- Carolinian Piedmont Passenger & Freight Improvements
- Walnut Cove Greenway

Among the RFFAs, the following are considered to have the potential to substantially contribute to cumulative impacts on the physical environment:

- BCSS closure
- BCSS Deconstruction

- Bear Branch Solar Project
- Belews Lake Park
- U.S. 158 (Reidsville Road) improvements

Future actions including the BCSS closure and deconstruction, solar projects, Belews Lake Park, and U.S. 158 (Reidsville Road) Improvements, could contribute to physical impacts associated with air emissions, noise, impacts to structures, and visual impacts. Like the Project, these impacts — particularly air emissions, noise, and structural impacts — are expected to be localized, diminishing rapidly with distance from each Project site. Visual impacts of these RFFAs depend on existing topography, proximity to sensitive receptors, and operations-related activities. The solar projects are expected to have a lasting impact on the visual landscape. In contrast, construction at Belews Lake Park and along U.S. 158 are anticipated to cause temporary visual impacts during construction, with minimal impact once operational.

As described in Section 7.1.2.3, following closure of the BCSS, the disappearance of the steam plume reduces the facility's visual prominence. However, the remaining infrastructure continues to define the viewshed. As a result, the overall visual presence of the site is diminished but not eliminated, and the facility remains a notable feature in the landscape.

Deconstruction activities associated with the BCSS may result in minor, short-term increases in air emissions, noise levels, and traffic within the Project Vicinity. These impacts are expected to be limited in scale and duration, occurring only during the defined deconstruction period. Temporary visual changes, such as the presence of equipment and structural dismantling, may also be noticeable. Although the exact timeline for deconstruction has not been established, any associated impacts would be confined to that period and may overlap with ongoing Project operations.

The cumulative physical impacts of building activities and operations of the Project, together with past, present, and RFFAs within the GAI on the physical environment is SMALL for all categories except aesthetics, which is MODERATE. The Project is a noticeable contributor to the cumulative impact on aesthetics-related to physical impacts within the GAI. In contrast, its contributions to other physical impacts are minor and do not alter the overall SMALL cumulative impact to those resources.

7.2.4.2 Demographic Impacts

The description of the affected environment in Section 2.4.1 serves as the baseline for assessing cumulative demographic impacts. As detailed in Sections 4.4.2 and 5.4.2, population increases resulting from the in-migration of workers and their families are estimated to raise the population in the ROI by approximately 0.3 percent during the building phase and 0.2 percent during operations. Given the limited scale of these changes, the cumulative demographic impacts are SMALL.

The GAI for demography includes four counties: Forsyth, Guilford, Rockingham, and Stokes that comprise the ROI where socioeconomic impacts are expected based on the effects associated with the workforce population. Many of the past, present, and RFFA projects listed in Table 7.1-2 are located outside of the GAI and do not influence demographic conditions within the ROI.

Several RFFAs within the GAI are primarily construction projects (pipelines, solar projects, transmission, roadway and rail improvements, greenway developments, water treatment plant

improvements, water tower construction) and do not require a substantial operational workforce that would result in notable demographic changes in the GAI. Additionally, projects involving park and recreational facility improvements primarily attract transient populations, rather than permanent residents, and therefore do not result in a notable change in existing demographic patterns.

Among the RFFAs the following actions listed in Table 7.1-2 are considered to have the potential to contribute to cumulative impacts on demography:

- BCSS closure
- BCSS Deconstruction
- WAGABOX Renewable Natural Gas (RNG) Plant
- Windsor Chavis Nocho Community Complex
- Marshall Aerospace Maintenance and Engineering Facility
- Guilford Technical Community College (GTCC) Aviation Training Center
- Toyota Battery Manufacturing North Carolina

Future actions, including the deconstruction of BCSS, and the construction and operation of energy facilities and other industrial and manufacturing projects, create jobs and are likely to bring in-migrating workers to the ROI. While changes in population are expected to be minor in areas near the Project and in other rural parts of the ROI, larger demographic shifts are more likely in urban centers such as Kernersville, Winston-Salem, and High Point, which tend to attract a greater share of in-migrating populations.

As discussed in Section 2.4.1, the population within the ROI is projected to grow at an average annual rate of approximately 0.8 percent, with the most significant growth occurring in Guilford and Forsyth Counties. Urban centers already possess the infrastructure (housing, schools, healthcare, and other services) needed to accommodate modest population increases without significant strain. BCSS closure results in a reduction of workforce. However, it is expected that most former BCSS workers will continue to reside within the ROI.

As shown in Table 2.4-3, population growth within the ROI is expected to continue, and the additional population associated with RFFAs is anticipated to align with or slightly accelerate these existing trends. Therefore, the cumulative demographic impacts of these RFFAs are considered minor.

The cumulative demographic impact of building and operating activities from the Project, when considered alongside the effects of past, present, and RFFAs (including projected population growth within population centers within the ROI) is SMALL. This is primarily due to the relatively large existing population in the ROI and the comparatively small size of the Project's workforce during building and operation. As a result, the Project is a minor contributor to the SMALL cumulative impact on demography.

7.2.4.3 Economic Impacts

The description of the affected environment is Section 2.4.2 serves as a baseline for assessing cumulative economic impacts. Section 4.4.3 details the impacts during the building phase, projecting that the Project will introduce millions of dollars into the economy and generate both

direct and indirect employment. These positive economic impacts are primarily realized within the ROI. Minor increases in local tax revenues are expected through individual income taxes, sale of electricity tax, and sales and use taxes. Therefore, impacts on the economy during the building phase are MODERATE and beneficial.

Section 5.4.3 addresses economic impacts during the operation of the Project. Similar to the building phase, operations are expected to contribute millions of dollars into the economy and create both direct and indirect jobs. However, the scale of economic activity during operations is smaller, and therefore, the overall impact during operations is SMALL and beneficial.

The GAI for economic impacts includes four counties that comprise the ROI where economic effects are expected based on the direct and indirect Project expenditures associated with the workforce. Many of the past, present, and RFFA projects listed in Table 7.1-2 are located outside of the GAI or are of a scale (such as local park improvements) that do not appreciably influence economic conditions within the ROI. Several of the RFFAs are linear projects across the GAI (transmission, roadway and rail improvements, greenway developments) that are identified within the Project Vicinity, including:

- Enbridge – T-15 Reliability Project
- Mountain Valley Pipeline (MVP) Southgate Project
- NCTPC 2023-2033 Collaborative Transmission Plan
- Dan River State Trail
- Mountains-to-Sea State Trail
- Transportation projects
- Greenway Improvements/developments
- Water and wastewater improvements

The above actions are generally expected to have a positive economic impact through workforce-related expenditures. However, because the effect is dispersed across a broad geographic area, the overall beneficial impact is minor.

Many of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in economic effects that are primarily realized within the GAI. These include:

- BCSS closure
- BCSS Deconstruction
- WAGABOX RNG Plant
- Bear Branch Solar Project
- Windsor Chavis Nocho Community Complex
- Marshall Aerospace Maintenance and Engineering Facility
- GTCC Aviation Training Center
- Toyota Battery Manufacturing North Carolina

The construction and operation of these actions involve capital expenditures, create employment opportunities, and contribute to overall economic benefits. Although these actions are located within the ROI, project-specific spending and potential increases in local tax revenues are not anticipated to significantly influence the regional economy. BCSS closure results in a reduction of workforce. However, it is expected that most workers are otherwise employed within the ROI.

As noted in Section 7.1.1, the closure of the BCSS may result in loss of local employment opportunities, with approximately 150 current BCSS employees potentially facing temporary unemployment. However, as identified in Section 2.4.2, unemployment rates for all four of the counties in the ROI ranged from 5.2 percent to 6.5 percent. Given the size of the regional labor force, the relatively small number of affected workers, and the addition of in-migrating Project workers the adverse impact of these job losses is negligible.

The cumulative economic impact of the Project, in combination with other past, present, and RFFAs within the GAI, is considered MODERATE and beneficial. The Project is a noticeable contributor to this cumulative impact, particularly through job creation and increased local spending.

7.2.4.4 Community Infrastructure Impacts

The description of the affected environment in Section 2.4.2 serves as a baseline assessing cumulative impacts to infrastructure and community services. Sections 4.4.3 and 5.4.4 describes impacts to infrastructure and community services during the building phase as SMALL within the ROI, with the exception of traffic impacts. Impacts to transportation due to workforce traffic are SMALL within the broader transportation network, but MODERATE on two-lane segments and intersections that provide access to the Project site. Impacts on recreational resources during operations are described in Section 5.4.4.2 and are considered SMALL under conditions in which Belews Lake water levels are stabilized and consumptive losses are offset by MWIS pumping. Operational impacts to recreation are considered MODERATE in conjunction with the effects of increased drought intensity and visual intrusion from the new structures within the Plant Complex areas and the associated plumes.

The GAI for analyzing infrastructure and community service impacts is the ROI, where impacts to infrastructure and demands on community services are expected to increase due to changes associated with the workforce population. As described in Section 2.4.2.6 the ROI contains many opportunities for recreation including natural areas, community parks, golf courses, hiking trails, a campground, and opportunities for boating, fishing, hunting, and bicycling. Many of the past, present, and RFFA projects listed in Table 7.1-2 are located outside of the GAI and do not affect infrastructure or the demand on community services within the ROI.

Several RFFAs within the GAI are primarily construction projects (pipelines, solar projects, transmission, roadway and rail improvements, greenway developments, water treatment plant improvements, water tower construction) and do not require a substantial workforce that would result in notable impacts on the local transportation network or the demand for community services. Additionally, projects involving park and recreational facility improvements primarily attract transient populations, rather than permanent residents, and therefore do result in notable impacts to infrastructure or demand for community services.

Among the RFFAs the following actions listed in Table 7.1-2 are considered to have the potential to contribute to cumulative impacts on infrastructure and community services:

- BCSS Closure
- WAGABOX RNG Plant
- Bear Creek Solar Project
- Marshall Aerospace Maintenance and Engineering Facility
- GTCC Aviation Training Center
- Toyota Battery Manufacturing North Carolina

As described in Section 7.1.2, in conjunction with BCSS closure, potential recreational effects of both water-level changes and changes in water temperature within Belews Lake after closure of BCSS may include the following:

- Belews Lake water levels are no longer influenced by BCSS consumptive water uses (see Section 5.2.1).
- Aquatic ecological communities that reflect a lake lacking significant thermal input from power generation including recreationally important sport fish (Section 5.3.2).
- Depending on the frequency of drought conditions and related water-level fluctuation, corresponding effects may also be evident in the condition of recreationally important sport fish (i.e., smaller fish, changes in community structure, and other factors) that may be sought after by anglers (Section 5.3.2).
- The number of fishing tournaments held at Belews Lake (as described in Section 2.4.2.6.2) and the related benefits to local businesses that depend on such recreators may also be correspondingly reduced.
- Restricted access to several small coves that fall within the EAB as described in Section 5.4.1.1.

Other than the BCSS closure action, these future actions create jobs and are likely to bring in-migrating workers to the ROI. The scale of which varies from relatively minor (solar projects, RNG plant) to potentially large (Toyota Battery Manufacturing North Carolina). As discussed in Section 2.4.1, the population within the ROI is projected to grow at an average annual rate of approximately 0.8 percent, with the most significant growth occurring in Guilford and Forsyth Counties. Urban centers such as Kernersville, Winston-Salem, and High Point already possess the infrastructure, housing, schools, healthcare, and other services needed to accommodate these population increases without significant strain.

The cumulative effect of the Project on infrastructure and community services, when combined with past, present, and RFFAs within the GAI is considered SMALL based on the broader opportunities for recreation within the ROI. While the Project has noticeable effects on traffic and recreation at Belews Lake (as described in Section 5.4.4.2), the Project is a minor contributor to this overall cumulative impact.

7.2.5 NOT USED

Deleted (Executive Order, 2025a, 2025b)

7.2.6 HISTORIC AND CULTURAL PROPERTIES

The description of the affected environment in Section 2.6 of this document serves as a baseline for the cumulative impacts assessment for historic and cultural resources. The area of potential effects (APE) means “the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist.” The determination of the APE is based on the potential for both direct and indirect effects. Direct effects are defined as those that result from activities that could damage or destroy the physical integrity of a cultural resource. Direct effects are typically associated with building activities. Indirect effects are those that do not directly destroy the physical integrity of a cultural resource but would adversely affect contributing elements of the cultural resource. For historic structures, this typically consists of visual effects to the viewshed of the cultural resource that may diminish its overall context. The APE includes a contiguous area on the Project site and a wastewater discharge pipeline corridor to the Dan River. Both are located on land owned by Duke Energy as indicated in Section 2.1.1.3. As described in Section 2.6, a Phase I cultural resource survey identified nine sites potentially eligible for listing on the National Register of Historic Places (NRHP). The Branson Cemetery is also located within the APE, but it is not eligible for NRHP listing. A subsequent Phase II cultural resource survey was conducted and recommended that four of the nine sites are eligible for NRHP listing.

As described in Sections 4.6, the impacts on historic and cultural resources from building the Project are characterized as SMALL to MODERATE. Duke Energy seeks to avoid all sites in conjunction with detailed site development and design activities following technology selection. As such, impacts of building activities are SMALL. However, if site avoidance is not possible, Duke Energy will conduct Phase III data recovery investigations in consultation with NCSHPO. If sites are not avoidable, impacts of building activities are MODERATE. As described in Section 5.6, the impacts on historic and cultural resources from operation are characterized as SMALL. Ground disturbing activities during building may also have the potential to discover previously unknown archaeological resources or human remains. If an inadvertent discovery of a cultural resource (e.g., graves or grave sites, archaeological sites, historical artifacts, etc.) is made during the building phase, then appropriate mitigative measures to address potential effects to these previously unknown cultural resources will be developed in consultation with the tribes, the North Carolina State Historic Preservation Office, and the North Carolina Office of State Archaeology. The Catawba Indian Nation, the only federally recognized tribe with interest in the project area, requested to be notified if Native American artifacts or human remains are discovered.

Based on consultation with and written confirmation from the North Carolina State Historic Preservation Office, an architectural viewshed survey was not required; therefore, an indirect APE beyond the archaeological APE was not established. No portions of the APE include federal, state, or tribal-owned lands. Therefore, as indicated in Table 7.1-1, the GAI for historic and cultural resources is the same as the APE.

RFFAs identified as part of this cumulative effects analysis are identified in Table 7.1-2. Each of the RFFAs are considered in the cumulative effects analysis for impacts to historic properties. Among the projects listed in Table 7.1-2, no new or updated actions within the GAI (i.e., the APE) have the potential to contribute to cumulative impacts on historic and cultural resources.

In summary, the cumulative impacts of building and operating activities on historic and cultural resources, added to the effects associated with past, present, and RFFAs within the GAI on historic and cultural resources is SMALL to MODERATE. Because no other RFFAs are

identified within the APE, the impact of building activities is a SMALL to MODERATE contributor to the cumulative impact on historic and cultural resources.

7.2.7 AIR QUALITY

Section 2.7 provides a description of the affected environment and a baseline for the cumulative impact assessment for air quality. The Project site is in Stokes and Forsyth Counties, North Carolina, and is bordered by Rockingham County to the east and Guilford County to the southeast. The Project site, in addition to all of Stokes, Forsyth, Rockingham, and Guilford Counties are in attainment for all of the National Ambient Air Quality Standard criteria pollutants (NCDEQ, 2024). In addition, these counties are part of the Northern Piedmont Intrastate Air Quality Control Region.

As described in Section 4.4.1.2, air emissions from building activities are minor. Emissions are controlled using minimization measures and by maintaining established regulatory limits. Fugitive dust and fine particulate matter are generated during earth-moving activities, concrete batch plant operation, and movement of vehicular traffic over recently disturbed or cleared areas or unpaved roads. Vehicles and engine-driven equipment (e.g., generators and compressors) generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and to a lesser extent, sulfur dioxides. Painting, coating, and similar operations produce emissions of volatile organic compounds.

As described in Section 5.7, the number of vehicles on roadways associated with operations is smaller than during construction and the Project is a de minimis contributor to air emissions, as expected for a clean energy source. Air emission sources during operation at the Project site are managed in accordance with federal, state, and local air quality control laws and regulations. A new plant at the Project site will comply with all regulatory requirements of the Clean Air Act (CAA), and NCDEQ Division of Air Quality (DAQ) requirements to minimize impacts on state and regional air quality.

More detailed facility-wide assessments will be prepared during the facility's air permitting phases with the NCDEQ-DAQ after final design; therefore, impacts on air quality during operation are SMALL.

As described in Section 5.7.2.2, the impacts of GHG emissions from the Project site and workforce transportation relative to the impacts on GHG emissions in North Carolina and in the United States are also SMALL.

As described in Section 5.7.3, the impacts of existing transmission lines and additions at the Project site are SMALL.

As shown on Table 7.1-1, the GAI for criteria pollutants includes Stokes, Forsyth, Rockingham, and Guilford counties because air quality designations are made on a county-by-county basis.

Table 7.1-2 identifies past, present, and RFFA projects that have the potential to result in air quality impacts. Among the RFFAs, the following actions are within the GAI for air quality and are considered to have the potential to contribute to cumulative impacts on air quality:

- BCSS Closure
- BCSS Ash Basin Closure and Landfill Construction

- WAGABOX RNG Plant
- Natural Gas Pipeline Projects (Enbridge; Transco, LLC; MVP)
- Electric-solar power plant projects
- Transmission line projects
- Parks and recreation improvement projects
- Transportation projects
- Water and wastewater improvement projects

7.2.7.1 Criteria Pollutants

The air quality of the GAI, currently in attainment, has been impacted by past and ongoing industrial land uses. Existing operations such as the BCSS facility and WAGABOX construction are not expected to contribute to reduced air quality within the GAI and they are expected to continue their operations within the terms of their existing environmental permits. Additionally, building activities associated with transmission line, parks and recreation, electric-solar power plant, transportation, and water and wastewater projects, are expected to implement BMPs to minimize potential air quality impacts during construction. The impacts of their future operation will be limited and controlled in accordance with the applicable state and federal regulations such that they do not adversely affect attainment.

The BCSS closure identified in Table 7.1-2 may contribute to substantial cumulative impacts on air quality through direct impacts within the GAI.

As described in Section 7.1.2.4, the BCSS closure has effects on local and regional air quality that include over 97 percent reduced emissions of all criteria pollutants. The cumulative effects of the BCSS closure, in conjunction with the Project, result in smaller criteria pollutant emissions as shown in Table 7.1-3 and contribute to beneficial effects on the existing attainment status of regional air quality within the GAI.

The cumulative impact of building and operating activities from the Project on criteria pollutants, added to the effects associated with past, present, and RFFAs within the GAI is SMALL (beneficial). The impact of the building and operation of the Project site is not a significant contributor to the cumulative impact on air quality.

7.2.7.2 Greenhouse Gas Emissions

GHG emissions are relevant to global climate change, the GAI for GHG is appropriately worldwide.

As described in Section 5.7.2.2, in 2022, North Carolina emitted 116.6 million metric tons (MMT) of CO_2-eq (EIA, 2025). At the national level, net GHG emissions in the United States in 2022 totaled 6343.2 MMT CO_2-eq after accounting for sequestration from the land sector (USEPA, 2024a). These emission rates are existing and reflect the contributing effects of all past and existing projects that emit GHG within both North Carolina and the United States.

The GHG emissions footprint of a generic 1000-megawatt-electric (MWe) reactor provides a conservative estimate of impacts. The lifetime GHG emissions footprint of a generic 1000-MWe reactor is 10.5 MMT CO_2-eq. (Table A-3. Nuclear Power Plant Lifetime GHG Footprint NRC,

2014). Lifetime GHG emissions from a new power plant are an estimated 9 percent of annual 2022 GHG emission in the state of North Carolina (10.5 to 116.6 MMT) and 0.17 percent of the annual 2022 carbon equivalent emissions in the U.S. (10.5 to 6343.5 MMT). Given the relatively small lifetime GHG emission footprint of a generic reactor, impacts of GHG emissions from the Project site are SMALL. Annual GHG emissions in North Carolina from other RFFAs identified in Table 7.1-2 are not notable contributors at the state level.

Estimated annual GHG emissions from the Project and other RFFA projects are a fraction of national GHG emissions. Because GHG emissions and associated impacts require a global perspective, small incremental changes from individual projects must be evaluated collectively. This is beyond the scope of an individual project and is therefore addressed by the U.S. under the authority of the USEPA at the national scale. However, mitigation measures provide individual projects with the ability to minimize GHG emissions. Further, in 2010 the U.S. Environmental Protection Agency (USEPA) promulgated the Tailoring Rule to address GHG emissions under the CAA permitting programs. As initially promulgated, the Tailoring Rule specified that new sources, as well as existing sources with the potential to emit more than 100,000 tons per year CO_2-eq were subject to USEPA permitting requirements. Modifications of existing facilities that increase GHG emissions by at least 75,000 tons per year are also subject to permitting requirements. Subsequent revisions to the Tailoring Rule have not resulted in different GHG emission thresholds (USEPA, 2024b).

The BCSS closure identified in Table 7.1-2 may contribute to substantial cumulative impacts through direct impacts to GHGs within the GAI.

As described in Section 7.1.2.4, BCSS closure has potential beneficial effects on GHG emissions in the Project Region. Compared to BCSS GHG emissions data in 2022 and 2023 combined (the two most recent years of USEPA flight data), the BCSS has emitted more CO_2-eq than the estimated lifetime emissions of the new nuclear facility. The cumulative effects of the BCSS closure, in conjunction with the Project, result in smaller GHG emissions. However, because the GAI for GHG emissions is worldwide, the effects of reduced GHG emissions is minor.

Therefore, the cumulative impact of building and operating activities from the Project on GHG emissions, added to the effects associated with past, present, and RFFAs within the GAI is SMALL. The impact of the building and operation of the Project site is not a significant contributor to the cumulative impact on GHG emission levels.

7.2.8 NONRADIOLOGICAL HEALTH

The description of the affected environment in Section 2.8 serves as a baseline for the cumulative impacts assessment for nonradiological health. Section 2.8 describes public and occupational health related to occupational injuries, etiological agents, noise, and human health issues associated with transportation and electromagnetic fields (EMFs). The existing environment for public and occupational health is partially characterized by information related to the nearest industrial facility (BCSS), as well as statewide data on injuries and fatalities, exposure to etiological agents, traffic patterns, and crash frequencies. Several existing regulations help protect and minimize impacts to public and occupational health including those set by the Occupational Health and Safety Administration (OSHA), the NRC. Duke Energy maintains Environmental Health and Safety manuals outlining policies, responsibilities, and management systems. Additionally, ambient noise at the Project site is below the USEPA public health and welfare threshold of L_{dn} 55 dBA for outdoor residential areas.

As described in Section 4.8, potential public health risks associated with building activities include exposure to chemical hazards or other physical nonradiological hazards, such as air pollution from engine exhaust and fugitive dust, vibration, and noise. Other potential health hazards include transportation-related impacts associated with an increase in crashes related to the additional vehicular traffic from construction and operations workers and the transport of supplies traveling to and from the Project site. Nonradiological health impacts of building activities are SMALL for all categories.

As stated in Section 5.8, impacts of operation are related to potential exposure to etiological agents associated with cooling system operation, noise emissions from cooling tower operation, hazards associated with electric shock, and potential health and injury effects associated with transportation-related crashes. Other operational effects include those associated with worker related occupational injuries and fatalities. Overall, operations-related impacts on nonradiological occupational health are SMALL.

Most physical, nonradiological effects of construction and operation either diminish rapidly with distance or remain confined to the Project site and its ancillary off-site features (intake and discharge locations). Therefore, the primary GAI for nonradiological occupational health impacts is the Project site and its immediate surroundings for etiological agents, noise, EMFs, and electric shock, and the ROI (Forsyth, Guilford, Rockingham, and Stokes counties)—where the workforce primarily resides—for public- and transportation-related health issues (see Table 7.2-1).

While many of the past, present, and RFFAs listed in Table 7.1-2 have the potential to result in effects on nonradiological health, most RFFA projects potentially affecting etiological agents, noise, and EMFs and electric shock are located outside of the GAI. Relevant RFFAs in Table 7.1-2 potentially contributing to cumulative effects related to etiological agents, noise, EMFs and electric shock are limited to BCSS operation and BCSS deconstruction and closure. The existing operations of BCSS, including baseline effects related to each of these factors, are considered as appropriate in Section 2.8. As advanced reactors are completed and brought online, BCSS operations decrease in parallel to maintain a balanced level of regional power generation. Accordingly, thermal effluents of BCSS are diminished and ultimately ceased, as the advanced reactors become fully operational. Because thermal loading to Belews Lake is substantially reduced with advanced reactor operation relative to baseline conditions (Section 5.2.1), the potential for etiological related health effects is lower than the existing condition. The potential for etiological agents associated with cooling tower operation for the Project is assessed in Section 5.8.1. Additionally, as stated in Section 5.2.3, based on compliance with permitting programs and Duke Energy's Water Chemistry Program, the impact from cooling tower blowdown chemical constituents to the Belews Lake and the Dan River are minor. Future activities associated with BCSS retirement and decommissioning may contribute to some periodic increased noise levels in addition to the noise emissions from cooling towers for the Project. Additionally, because transmission systems on the Project site are essentially integrated into the existing established transmission system associated with BCSS, no substantive expansion would occur. Therefore, no cumulative effects related to EMF or electric shock would occur. Therefore, the cumulative effects of relevant RFFAs related to etiological agents, noise, EMFs and electric shock within the GAI are minor.

Other RFFAs outlined in Table 7.2-1 within the GAI may contribute to public and transportation-related health concerns, depending on the scale and duration of each project. Key influencing factors include workforce size, total hours worked, potential hazards during construction and

operation, emissions from equipment and vehicles, and transportation requirements for personnel and materials.

These cumulative impacts are expected alongside ongoing operations within the ROI. Worker health risks are managed through OSHA regulations and environmental programs, while existing transportation infrastructure and traffic systems help mitigate any effects on crash rates and injuries. As a result, the overall cumulative impact of these RFFAs on occupational and transportation-related health within the ROI are minor.

The cumulative impact of building and operation activities for the Project, combined with the effects associated with past, present, and RFFAs within the GAI (occupational as well as the transportation and public health-related GAI), on nonradiological health is SMALL for all categories.

7.2.9 RADIOLOGICAL HEALTH

The description of the affected environment in Section 2.9, Radiological Environment and Radiological Monitoring, serves as a baseline for the cumulative impacts assessment for radiological environment and radiological monitoring. Section 2.9 also describes potential background radiation exposure from natural sources. As described in Section 4.9, Radiological Health, and Section 5.9, Radiological Health during Normal Operation and Radioactive Waste Management, the radiological impacts on construction workers and members of the public from normal operation of the Project site are SMALL.

As shown on Table 7.1-1, the GAI for radiological health is defined as the 50-mi. (80-km) region of the Project site. Any releases of radioactive gases, particulates and direct radiation shine dose is dispersed, diluted, or otherwise attenuated as a function of the distance from the Project site. Their contribution is essentially indistinguishable from the naturally existing background radiation at distances outside the GAI.

Table 7.1-2 identifies past, present, and RFFAs projects considered in the cumulative effects analysis. While many of the past, present, and RFFAs listed in Table 7.1-2 receive small impacts from the Project site, no projects listed are expected to contribute to the cumulative effects related to radiological impacts.

The cumulative radiological impact of construction and operation activities from the Project, combined with the effects associated with past, present, and RFFAs within the GAI, on radiological health is SMALL for all categories discussed in this subsection.

7.2.10 NONRADIOACTIVE WASTE

Section 4.10 identifies nonradioactive waste generated during building activities and Section 5.10 identifies waste generated during operation. Generation, handling, and disposal of nonradioactive solid waste during building and operational activities are managed in accordance with all applicable state and local requirements and standards. All activities comply with measures outlined in the SPCC plans and regulated practices for managing liquid discharges, including wastewater, as well as the conditions of the NPDES permit with an approved SWPPP. Air emissions are minor and meet the requirements of the NCDEQ. Nonradioactive waste streams during operation of the Project and managed and treated prior to their discharge to the Dan River.

As is described in Sections 4.10.1 and 5.10.1 Project building phase activities and operations result in the generation of various types of solid, hazardous, and mixed wastes. Wastes are managed in accordance with Duke Energy's Environmental Programs and procedures to ensure waste is properly managed in conjunction with appropriate disposal. Winston-Salem/Forsyth County Utilities municipal solid waste landfill has sufficient existing permitted capacity to accommodate wastes generated within the service area for approximately 27 years. Other regional landfills may also be considered to support the waste disposal needs during the operations period. Therefore, because all solid, liquid, and gaseous waste generated at the Project site are handled and properly managed by Duke Energy in compliance with federal, state, and local regulations, the impacts on land, water, and air from building activities and operations is SMALL.

Cumulative effects of liquid wastes and air emissions are addressed in Sections 7.2.2 and 7.2.7, respectively. Therefore, this cumulative effect analysis focuses on land-based waste. As indicated in Table 7.1-1 the GAI for nonradioactive waste is focused on the Project Region.

All of the past, present, and RFFA projects listed in Table 7.1-2 have the potential to result in some generation of nonradiological waste. As listed in Table 7.1-2, the BCSS closure and BCSS deconstruction actions are located immediately adjacent to the Project site, and therefore, have the potential to have localized direct or indirect effects that may affect the same resources as those affected by the Project. The particular effects of the BCSS action on nonradioactive wastes include the deconstruction of all site structures, and the management and disposal of all solid and hazardous wastes within regional landfills in accordance with Duke Energy's Environmental Programs and relevant guidelines and regulations.

Other categories of actions listed in Table 7.1-2 that are expected to be generators of nonradioactive waste include the following:

- Energy projects (coal-fired, natural gas, natural gas pipelines, solar, transmission facilities, battery storage, petroleum)
- Development or improvement of recreational facilities
- Transportation projects
- Industrial projects
- Other projects
- Water and wastewater improvement projects

Each of these projects coupled with existing developments (industrial, commercial, recreational) have an impact on cumulative waste management within the Project Region. The cumulative impacts of nonradioactive waste destined for land-based treatment and disposal are primarily related to amount of waste generated by the Project and other reasonably foreseeable projects and the available capacity of area treatment and disposal facilities. Similar to the Project, nonradioactive waste generation is expected to be generally greater during construction of these projects as compared to operation. However, the individual contribution of nonradioactive waste (both nonhazardous and hazardous) by the Project and other projects in Table 7.1-2 within the GAI is expected to be minor. Other landfills with long-range capacity identified within the Project Region include the following:

- Alamance County Landfill, 65.5 approximate total permitted years remaining as of fiscal year 2022-2023.
- Davidson County Landfill, 34.7 approximate total permitted years remaining as of fiscal year 2022-2023.
- Rowan County Landfill, 61.2 approximate total permitted years remaining as of fiscal year 2022-2023.

Given the existing reported landfill capacity in the region and the scope of the RFFAs, construction and operation of these facilities are not expected to substantially contribute to the loss of waste disposal capacity in the GAI. Based on the availability and expected capacity of existing licensed disposal facilities within the GAI, the cumulative impact of building and operating activities from the Project on nonradioactive waste, added to the effects associated with past, present, and RFFAs within the GAI on nonradioactive waste, is SMALL. The impact of the building and operation of the Project is not a noticeable contributor to the cumulative impact on nonradioactive waste.

7.2.11 POSTULATED ACCIDENTS

As described in Section 5.11, the potential environmental impacts of a postulated accident from the operation of a surrogate reactor technology based on a plant parameter envelope approach would be SMALL. Section 5.11.1 considers DBAs and Section 5.11.2 considers severe accidents. A detailed accident analysis is to be performed at the construction permit or license application phase when the reactor technology is selected and the facility configuration is known.

Off-site doses are conservatively estimated considering a surrogate source term from the selected postulated accident expected to produce the highest post-accident dose at the EAB and low population zone (LPZ). Duke Energy has selected the surrogate source term from a postulated instrument line break accident to demonstrate compliance with the radiological consequence evaluation factors set forth in 10 CFR 52.17(a)(1)(ix) and 10 CFR 50.34(a)(1)(ii)(D). This accident scenario was modeled as the bounding DBA for off-site atmospheric release for comparison against the 25 roentgen equivalent man (rem) total effective dose equivalent (TEDE) limits for an individual located at any point on the boundary of the exclusion area for any two-hour period following the onset of the postulated fission product release and an individual located at any point on the outer boundary of the LPZ, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) specified in 10 CFR 52.17(a)(1)(ix)(A) and (B). As shown in Table 5.11-2, the calculated accident doses from the selected bounding DBA meet the 25 rem TEDE limit specified in 10 CFR 52.17 at the EAB/LPZ.

Environmental impacts from severe accidents with damage to the reactor core and degradation of the containment system are evaluated in Section 5.11.2. Duke Energy requested that each of the potential reactor technology vendors provide information from the probabilistic risk assessment (PRA) for its design to allow the assessment of potential severe accident consequences. However, final PRA information was not available for any vendors at the time of preparation of this application. While information regarding severe accident release categories, source terms, and release frequencies was provided to Duke Energy from some vendors, information was not received from all vendors. Therefore, Duke Energy assessed the potential severe accident consequences of two vendors that provided sufficient information and presented the vendor with the most conservative results for the majority of the evaluated

consequence metrics. The PRA information for severe accidents, along with site-specific characteristics were used to estimate the impacts of severe accidents. Potential environmental consequences of severe accidents at nuclear power plants are evaluated using the MELCOR Accident Consequences Code System (MACCS) computer code along with site-specific meteorology, population, land usage, watershed index, and economic data. Economic costs include short-term relocation of people, decontamination of property and equipment, and interdiction of food supplies. The MACCS modeling provided doses from the air pathway and from water ingestion; other pathways were evaluated qualitatively. As discussed in Section 5.11.2, the dose risk from both surface water and groundwater pathways is expected to be less than the atmospheric pathway. The total calculated dose risk to the 50-mi. (80-km) population is less than the maximum, mean, and median dose risks for current generation reactors. Additionally, the early and latent cancer fatality risks meet the NRC Safety Goals, set by the NRC's Safety Goal Policy Statement (51 FR 30028), and the estimated number of people within 50 mi. (80-km) exceeding the dose limits of 25 rem (0.25 sieverts [Sv]) and 200 rem (2 Sv) is zero. Therefore, the environmental impacts of severe accidents are expected to be SMALL.

The cumulative analysis considers risk from both DBA and potential severe accidents at other existing and proposed nuclear power plants that have the potential to increase risk at any location within the geographic area of interest within 50 mi. (80 km) of the Project site. The 50-mi. (80-km) radius was selected to cover potential risk overlaps from two or more nuclear plants. There are no existing operating nuclear power facilities within a 50-mi. (80-km) radius of the Project site. The closest existing operating nuclear power plants to the Project site are the Shearon Harris Nuclear Power Plant in New Hill, NC, approximately 80 mi. (129 km) southeast, and the McGuire Nuclear Station in Huntersville, NC, approximately 76 mi. (122 km) southwest. Both the Shearon Harris Nuclear Power Plant and the McGuire Nuclear Station are owned and operated by Duke Energy. Based on this, the cumulative risks from both DBAs and potential severe accidents at any location within 50 mi. (80 km) of the Project site would be SMALL.

7.2.12 FUEL CYCLE, TRANSPORTATION, AND DECOMMISSIONING

The cumulative impacts from the fuel cycle, transportation activities, and decommissioning activities for the proposed advanced reactors at the Project site are discussed herein.

7.2.12.1 Fuel Cycle

Impacts from the uranium fuel cycle (UFC) for the Project site include the total of those operations and processes associated with the provision, utilization, and ultimate disposition of fuel. Duke Energy is considering six reactor technologies for potential construction at the Project site. Four of the six technologies under consideration are small modular reactors (SMRs) that are based on traditional light water reactor (LWR) technology and that use conventional fuel (i.e., UO_2 fuel pellets): GE Vernova Hitachi Nuclear Energy's BWRX300, NuScale's VOYGR, Holtec's SMR 300, and Westinghouse's AP300.

To estimate the environmental impacts of the UFC, 10 CFR 51.51 requires use of Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis. As discussed in Section 6.1, Table S-3 environmental impacts (which are estimated for a reference 1000 MWe LWR with a capacity factor of 80 percent) must be scaled to the proposed plant using the effective electric output. Because each SMR listed above has a different power output, different technologies utilize differing numbers of units on the site and produce a different total output. For this analysis, the bounding value of 2250 MWe maximum gross output is used as the total site output (2100 MWe net output). The maximum capacity factor among the SMRs listed above is

the Westinghouse AP300, with a capacity factor of 97 percent or higher, and 97 percent has been used as the bounding value for this analysis. The fifth technology under consideration by Duke Energy for the Project site is the X-energy's Xe-100, which is a gas-cooled SMR using high-assay, low-enriched uranium (HALEU) TRi-structural ISOtropic (TRISO) fuel. The sixth technology under consideration by Duke Energy for the Project site is the TerraPower Natrium reactor, which is a sodium-cooled reactor using HALEU metallic fuel. The analysis considered an identical electric output and similar capacity factor (95 percent). Impacts for all technologies were assessed for land use, water use, fossil fuel impacts, chemical effluents, radiological effluents and waste, occupational dose and transportation dose.

As discussed in Section 6.1.1, the environmental effects from the UFC for any SMR technologies based on LWRs being considered would be SMALL. Additionally, as discussed in Section 6.1.2 and Section 6.1.3, the environmental effects from the UFC for an Xe-100 plant or a TerraPower Natrium plant at the Project site, respectively, are SMALL.

This cumulative analysis considers impacts over the UFC associated with operation of the Project along with impacts from past, present, and RFFAs that may contribute to cumulative impacts within the geographic area of interest. The geographic area of interest for impacts of the UFC is nationwide and with imported uranium, worldwide.

NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel* examines the incremental impacts of continued storage on each resource area analyzed in NUREG-2157 in combination with other past, present, and RFFAs. Section 6.5, Table 6-4 of NUREG-2157 indicates ranges of potential cumulative impacts for multiple resource areas. These ranges are primarily driven by impacts from activities other than the continued storage of spent fuel at the reactor site; the impacts from these other activities would occur regardless of whether spent fuel is stored during the continued storage period. In the short term, which is the most likely time frame for fuel disposal, the potential impacts of continued at-reactor storage are SMALL and, therefore, are not anticipated to be a significant contributor to the cumulative impacts. Because the impacts during the short term are SMALL, continued storage would not be a significant contributor to the cumulative impacts. In the longer time frames for at-reactor storage, or in the less likely case of away-from-reactor storage, some of the impacts from the storage of spent fuel could be greater than SMALL. However, other federal and nonfederal activities occurring during the longer time frames, as noted in NUREG-2157, include uncertainties as well, contributing to the cumulative impacts. These uncertainties lead to the ranges in cumulative impacts as discussed throughout Chapter 6 of NUREG-2157. The overall cumulative impact conclusions would not be changed if the impacts of continued storage were removed. Based on the analysis and impact determination in NUREG-2157 the cumulative impacts from radiological wastes from the fuel cycle (which includes the impacts associated with spent fuel storage during operation and continued storage period) would be SMALL.

As noted, Duke Energy has not selected a reactor technology but is considering a variety of advanced reactors most of which are SMRs based on LWR technology and fuel type. The two non-LWR are based on high-temperature gas-cooled reactor technology using TRISO fuel and a sodium-cooled fast reactor using HALEU metallic fuel. NUREG-2157 was developed for impacts from LWR fuels and the applicability of NUREG-2157 to advanced reactors and their fuel types are under consideration but expected to be applicable to advanced reactor fuels. Furthermore, NUREG-2249, Initial, *Generic Environmental Impact Statement for Advanced Nuclear Reactors – Draft Report for Comment*, was provided to the Commission in November 2021 and offered for public comment in September 2024, evaluates the applicability of NUREG-

2157 and determined that the findings were applicable to non-LWR fuel, provided that the non-LWR fuel is stored in a manner that meets the regulatory requirements for spent fuel storage cask approval and fabrication in accordance with 10 CFR Part 72. Additionally, regarding non-LWR fuel, NUREG-2157 states the spent nuclear fuel from Fort Saint Vrain, a decommissioned high-temperature gas-cooled reactor with a pebble bed design, which is being stored in ISFSI, is within the scope of the generic environmental impact statement. Various non-LWR projects have been approved for construction in recent years including the Kairos Hermes (TRISO fuel) and Abilene Christian University (liquid fueled molten salt) by the Commission. Both environmental assessments found the environmental impacts of fuel storage on-site to be either within scope of NUREG-2157 or bounded by the impacts presented in NUREG-2157. Lastly, NUREG-2249 concludes that advanced nuclear reactor fuel cycles, both LWR and non-LWR, will have SMALL impacts, particularly for once-through fuel cycle options. This conclusion is based on improved fuel cycle technologies, improved reactor technologies, and waste and spent fuel inventories that are significantly different from what has been considered for LWR evaluations (e.g., Continued Storage Rulemaking) with respect to hazardous radionuclides. If a reactor technology using non-LWR fuel is selected, the fuel will be stored in a manner that meets the regulatory requirements in 10 CFR Part 72. Therefore, those conclusions remain valid and applicable in this context.

7.2.12.2 Transportation

Section 6.2 describes the environmental impacts of normal conditions of transport and postulated transportation accidents involving shipment of radioactive materials including unirradiated fuel, irradiate fuel, and radioactive waste to and from the Project site. Probable transportation routes were bounded by shipping unirradiated fuel from the Framatome fuel fabrication facility in Richland, WA because it is the furthest identified licensed fuel fabrication facility to be used from the list of technologies considered. The travel distance is approximately 2600 mi. (4184 km) and detailed shipment route link data was utilized from WebTRAGIS. Transportation routes were considered for both Waste Control Specialists facility near Andrews, TX (approximately 1460 mi. [2350 km]), and EnergySolutions disposal facility in Clive, UT (approximately 2100 mi. [3380 km]). The number of shipments of unirradiated fuel, irradiated fuel, and radioactive waste were modeled to determine impacts from transport after being normalized to the NRC's "reference reactor" using the guidance from Regulatory Guide 4.2. The normalized shipment values were 11 for unirradiated fuel, 16 for irradiated fuel, and 234 for radioactive waste.

This cumulative analysis considers impacts from postulated accidents associated with the transportation of fuel and waste for the Project site along with impacts from past, present, and RFFAs that may contribute to cumulative impacts within the geographic area of interest. The geographic area of interest for impacts of postulated transportation accidents is nationwide.

Nonradiological cumulative impacts of transportation are related to the increased traffic over commercial routes with the attendant increased risk of traffic, accidents, injuries, and fatalities. As described in Section 5.8.6, both surrounding roadway networks and local intersections would see a notable increase in traffic; however, the predicted crash rate increases are minor and not destabilizing to traffic safety. The overall cumulative impacts on traffic routes are SMALL.

Radiological cumulative impacts associated with transportation of fuel and waste from the Project site includes impacts from fuel and waste shipments from the Shearon Harris Nuclear Power Plant, the McGuire Nuclear Station, and the Catawba Nuclear Station, which are all within an approximate 100-mi. radius to the Project site. It is reasonable to assume fuel and

waste shipments will travel along similar transportation routes to and from these facilities along with the Project site. Like the shipments associated with the Project site described in Section 6.2, the impacts from each individual shipment would be minimal and, when combined with the impacts associated with the Project site, the total impact would also be minimal. Therefore, the cumulative impacts of transporting unirradiated fuel, along with irradiated fuel and radioactive waste to and from the Project site would be SMALL.

7.2.12.3 Decommissioning

Section 6.3 discusses the environmental impacts of decommissioning the Project site. Decommissioning the facilities includes removal of system, structures, and components, the management of radioactive materials, final disposal of radioactive waste, and eventual unrestricted property release or release under restricted conditions. The primary environmental impact is the use of land for off-site waste burial. Although the various decommissioning methods and alternatives have different impacts, including impacts from size and transport variations, impacts from decommissioning activities at the Project site are expected to be smaller than those during construction.

This cumulative analysis considers impacts from decommissioning activities at the Project site along with impacts from past, present, and RFFAs that may contribute to cumulative impacts within the geographic area of interest. The geographic area of interest for decommissioning impacts is the 50-mi. (80-km) radius for socioeconomic impacts from workers and nationwide for the final disposal of radioactive waste. There are no other nuclear facilities within a 50-mi. (80-km) radius of the Project site.

In NUREG-0586, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, Supplement 1, the NRC found that the impacts from decommissioning due to radiation dose to workers and the public, waste management, water quality, air quality, ecological resources, and socioeconomics would be SMALL.

Duke Energy compared the activities analyzed in NUREG-0586 on the environmental impacts of decommissioning the existing fleet of domestic nuclear power reactors with those used by the Department of Energy to estimate decommissioning costs for advanced reactor designs and determined that the scope of activities is the same. Projected physical inventories associated with advanced reactor designs are generally less than those for currently operating power reactors due to advances in technology that simplify maintenance and benefit decommissioning. In addition, there are no other nuclear facilities within a 50-mi. (80-km) radius of the Project site to potentially have overlap in decommissioning activities. Therefore, the cumulative impacts from decommissioning the Project site would be SMALL.

Table 7.2-1
Cumulative Impacts on Environmental Resources, Including the Impacts of the Project

Resource Category	Project Impact Level
Land Use	MODERATE
Water-Related	
Hydrology – Surface Water	MODERATE
Hydrology – Groundwater Use	SMALL
Water Use – Surface Water	SMALL
Water Use – Groundwater Use	SMALL
Water Quality – Surface Water	LARGE (beneficial)
Water Quality – Groundwater	SMALL
Ecology	
Terrestrial Ecosystems	MODERATE
Aquatic Ecosystems	MODERATE
Socioeconomic	
Physical Impacts	SMALL to MODERATE (aesthetics)
Demography	SMALL
Economic Impacts	MODERATE (beneficial)
Community Infrastructure Impacts	SMALL
Historic and Cultural Resources	SMALL (with avoidance) to MODERATE (without avoidance, and mitigated)
Air Quality	SMALL (beneficial) for criteria pollutants and SMALL for GHGs
Nonradiological Health	SMALL
Radiological Health	SMALL
Nonradioactive Waste	SMALL
Postulated Accidents	SMALL
Fuel Cycle, Transportation, and Decommissioning	SMALL

7.3 IMPACT ASSESSMENT CONCLUSIONS

Duke Energy considered and assessed the potential cumulative impacts resulting from building, operation, and decommissioning of the Project together with other past, present, and RFFAs. The specific resources that could be affected by the Project and other past, present, and RFFAs in the GAI were assessed. The cumulative impacts are summarized in Table 7.2-1. The cumulative impacts for most of the resource areas are SMALL, although there are MODERATE or LARGE cumulative impacts for some resources, as described in the table.

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NEED FOR POWER

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None.

GLOSSARY

Term	Definition

None.

Chapter 8 Need for Power

8.1 NEED FOR POWER

Assessment of the need for power is not required for an Early Site Permit in accordance with U.S. Nuclear Regulatory Commission regulations Title 10 of the Code of Federal Regulations 51.50(b)(2), and guidance document Regulatory Guide 4.2, Rev. 3*, Preparation of Environmental Reports for Nuclear Power Stations*, Appendix A, Section A1.

8.2 REFERENCES

None.

Chapter 9
ENVIRONMENTAL IMPACTS OF ALTERNATIVES

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GLOSSARY

Term	Definition
ac.	acre
ACS	American Community Survey
BCSS	Belews Creek Steam Station
BMP	best management practice
CAA	Clean Air Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO_2	carbon dioxide
COLA	Combined License Application
CRP	Carolinas Resource Plan
CSXT	CSX Transportation
CWA	Clean Water Act
CWS	circulating water system
DBA	Design-Basis Accident
DEC	Duke Energy Carolinas, LLC
DEP	Duke Energy Progress, LLC
DOT	Department of Transportation
EPRI	Electric Power Research Institute
ESP	Early Site Permit
ft.	feet
GAI	geographic areas of interest
GHGs	greenhouse gases
GIS	Geographic Information System

Term	Definition
gpm	gallons per minute
GWe	gigawatts electric
ha	hectare
IPaC	Information for Planning and Consultation
ITC	Investment Tax Credits
IGCC	Integrated Gasification Combined Cycle
km	kilometer
kph	kilometers per hour
KRDU	Raleigh-Durham International Airport
kV	kilovolt
kW	kilowatt
kWh/m^2	kilowatt-hours per square meter
LOS	Level of Service
LLWR	large light-water reactors
m	meter
MDCT	mechanical draft cooling tower
mi.	mile
mph	miles per hour
MW	megawatt
MWe	megawatts electric
MWh	megawatt hours
MWIS	Makeup Water Intake Structure
NAAQS	National Ambient Air Quality Standards
NC	North Carolina

Term	Definition
NCDEQ	North Carolina Department of Environmental Quality
NCDOT	North Carolina Department of Transportation
NCNHP	North Carolina Natural Heritage Program
NEPA	National Environmental Policy Act
NET	negative emission technology
NGCC	natural gas combined cycle
NHPA	National Historic Preservation Act
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NS	Norfolk Southern Railway
NUREG	NRC Technical Report designation
NWI	National Wetland Inventory
OSHA	U.S. Occupational Safety and Health Administration
PGA	peak ground acceleration
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter 2.5 microns or less
PPE	plant parameter envelope
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc.
Project site	Belews Creek, NC site
PTC	Production Tax Credits
PV	photovoltaic

Term	Definition
rev.	revision
RFFA	reasonably foreseeable future action
SC	South Carolina
sq. mi.	square mile
sq. km	square kilometer
SR	state route
SWPPP	Stormwater Pollution Prevention Plan
U.S.	United States
USC	U.S. Code
USCB	U.S. Census Bureau
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VA	Virginia
vol%	percent by volume

Chapter 9 Environmental Impacts of Alternatives

9.0 INTRODUCTION

This chapter identifies and describes the alternatives to siting, constructing, and operating a new nuclear baseload generation plant, utilizing multiple advanced reactors, at the Belews Creek, North Carolina (NC) site (Project site). This chapter provides a thorough evaluation of the impacts associated with the no-action alternative, energy alternatives, alternative sites, and alternative plant and transmission systems to the proposed advanced reactors at the Project site. The proposed federal action is the issuance of an Early Site Permit (ESP) to Duke Energy under the provisions of Title 10 of the Code of Federal Regulations (CFR) Part 52 (10 CFR 52), approving the Project site as suitable for the deployment of multiple advanced reactors. Chapter 9 is divided into the following four sections:

- No-Action Alternative (Section 9.1)

  Section 9.1 describes the environmental impact if an ESP is not issued.

- Energy Alternatives (Section 9.2)

  Section 9.2 examines the potential environmental impacts associated with alternatives to the construction of a new baseload nuclear generating facility.

- Alternative Sites (Section 9.3)

  Section 9.3 describes and evaluates the alternative sites considered for the new plant.

- Alternative Plant Systems (Section 9.4)

  Section 9.4 describes and evaluates plant and transmission system alternatives to the new plant and transmission system.

9.1 NO-ACTION ALTERNATIVE

This section defines the No-Action Alternative and describes the consequences of adopting the No-Action Alternative. The purpose of the ESP is to approve the site for eventual construction and operation of a nuclear generating facility that utilizes multiple advanced reactors at the Project site. The Project would fill the need for carbon-free power in Duke Energy's Carolinas service territory.

Under the No-Action Alternative, the United States (U.S.) Nuclear Regulatory Commission (NRC) would not issue an ESP. Thus, the no-action would accomplish none of the benefits intended by the ESP process, which includes the following items:

- The resolution of siting and environmental issues before large investments of financial capital and human resources in new plant design and construction are made.
- The ability to reserve the site for future use for construction and operation of a nuclear plant.
- The resolution of issues related to the environmental impacts of construction and operation of new nuclear generation units constrained within the defined plant parameters.
- The facilitation of future decisions about whether to construct new nuclear power generation facilities at the Proposed site.

This No-Action Alternative would avoid no significant environmental impacts, because no such impacts are caused by site suitability determination. The only activities that are permissible under an ESP are limited work activities allowed by 10 CFR 50.10(e)(1), and those activities are permissible only if the final environmental impact statement concludes that the activities will not result in any significant environmental impacts that cannot be redressed. As discussed in Section 1.3.2., Duke Energy has not established a date for preconstruction activities and a limited work authorization application is not being included with this ESP.

Pursuance of new nuclear generation at the Project site provides the following ancillary benefits:

- Supports Duke Energy's ability to meet growing demands for baseload generation.
- Supports greenhouse gas emission reduction requirements established by NC Senate Bill 266 and NC House Bill 951 (NC, 2025).
- Facilitates the reduction of emissions from fossil fuel generation through the retirement of fossil fuel units within the Carolinas service territory.
- Creation of jobs and the associated positive impacts to the local economy.

As a rate-based utility, Duke Energy has a regulatory obligation to provide reliable electrical service within its service territory. A comprehensive analysis for the need for power is presented in the Duke Energy Carolinas Resource Plan (CRP) (Duke Energy, 2023) which demonstrates the need for reliable baseload generation. The NRC regulations [10 CFR 51.50(b)(2)] do not require a need for power to be included in the ESP; however, the extensive information included in the CRP provides confidence that the power generated by the proposed project will be produced and consumed in a manner consistent with the stated purpose of and need for the project. Forecasted load growth, driven by robust economic development, population increases, and electrification of transportation and other sectors, is expected to significantly outpace existing generating capacity, particularly as Duke Energy plans to retire over 8400 megawatts electric (MWe) (8.4 gigawatts electric [GWe]) of coal-fired generation by the mid-2030s. It is reasonable to expect that Duke Energy will act to meet this need for power through alternative generation or alternative sites. A range of alternative sites are evaluated in Section 9.3. If other generating sources were developed, either using alternative generation or at alternative sites, environmental impacts would eventually occur.

In summary, under the No-Action Alternative, the ESP would not be issued, and none of the intended benefits would be realized. Additionally, it is reasonable to expect that Duke Energy would act to meet the need for power by alternative means, and environmental impacts associated with new nuclear power generation or alternative energy sources would not be avoided. Therefore, the issuance of the ESP is preferable to the No-Action Alternative.

9.2 ENERGY ALTERNATIVES

This section is not required for an Early Site Permit Application.

9.3 ALTERNATIVE SITES

As required by 10 CFR 51.45(b)(3), this section provides an evaluation of alternatives to the Belews Creek, NC site for construction and operation of the new nuclear power plant. The National Environmental Policy Act (NEPA) mandates the evaluation of reasonable alternatives to a proposed action. This section summarizes the process used to select the Belews Creek, NC site as the proposed location for the new nuclear power plant and evaluates whether any Alternative Site is "environmentally preferable" to the Belews Creek, NC site, and if so, whether it is "obviously superior" for the eventual construction and operation of the new nuclear power plant.

9.3.1 SITE SELECTION PROCESS

A comprehensive site selection study for this Project was completed in 2024 and 2025. The objective of this study was to select a Proposed Site for the new nuclear power plant using a systematic process that considered relevant factors related to environmental acceptability, site safety engineering, and cost concerns. The study utilized the guidance outlined in Section 9.3 of NRC Regulatory Guide 4.2, Rev. 3, *Preparation of Environmental Reports for Nuclear Power Stations* and NUREG-1555, Initial, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants*. It also followed the site selection procedures described in the Electric Power Research Institute (EPRI) report on site selection (EPRI, 2022), as well as considered the reactor site criteria in NRC Regulatory Guide 4.7, General Site Suitability for Nuclear Power Stations, Rev. 4. The process was consistent with other nuclear power plant siting studies as reported in licensing submittals to the NRC.

The site selection study included the following major tasks, as defined in NUREG-1555:

- Identify the Region of Interest - The Region of Interest is the area to be considered in searching for potential nuclear power plant sites.
- Identify Candidate Areas in the Region of Interest - Candidate Areas were identified by using exclusionary factors to eliminate areas within the Region of Interest.
- Identify Potential Sites - Potential Sites are specific locations within the Candidate Areas that are identified for preliminary assessment in establishing Candidate Sites.
- Screen Potential Sites to Identify Candidate Sites - Candidate Sites are those Potential Sites that are among the best sites that can reasonably be found for the siting of a nuclear power plant.
- Evaluate Candidate Sites - The Candidate Sites were evaluated numerically and ranked according to their overall favorability.
- Select Proposed and Alternative Sites - The preceding evaluations and other relevant factors were considered to select the Proposed and Alternative Sites.

The methods and results of these tasks are summarized in the following subsections.

9.3.1.1 Region of Interest

NUREG-1555 defines the Region of Interest as the area to be considered in searching for potential and candidate power plant sites. NUREG-1555 provides the following guidance on the selection of the Region of Interest:

> The Region of Interest is typically selected based on geographic boundaries (e.g., the state in which the Proposed Site is located) or the relevant service area for the proposed plant. In cases where the proposed plant will not have a service area, the applicant should define a reasonable Region of Interest and provide a justification. The Region of Interest must be more extensive if environmental diversity is substantially improved or if Candidate Sites do not meet initial threshold criteria (including the site criteria in 10 CFR Part 100) and added geographic areas will not increase costs substantially. The Region of Interest may be smaller if sufficient environmental diversity exists, threshold criteria are satisfied, and costs will be exorbitant for considering sites outside the State or relevant service area.

Duke Energy Progress, LLC (DEP) an indirect subsidiary of Duke Energy Corporation and Duke Energy Carolinas, LLC (DEC) (together referred to as "the Companies"), combined, make up the Carolinas service territory, hereby referred to as the Region of Interest. The Region of Interest encompasses a majority of NC and South Carolina (SC). The Region of Interest is shown in Figure 9.3-1.

DEC and DEP are both regulated public utilities primarily engaged in the generation, transmission, distribution, and sale of electricity in portions of NC and SC. The DEC service area covers approximately 24,000 square miles (sq. mi.) (62,160 square kilometers (sq. km)) and supplies electric service to 2,800,000 residential, commercial, and industrial customers. The DEP service area covers approximately 29,000 sq. mi. (75,110 sq. km) and supplies electric service to approximately 1,700,000 residential, commercial, and industrial customers.

The Region of Interest encompasses an area of approximately 53,000 sq. mi. (137,269 sq. km), including water areas. Major cities located within the Region of Interest include Durham, Greensboro, Raleigh, and Charlotte, NC, as well as Greenville, SC. Major waterbodies available as a potential source of cooling water for a nuclear power plant include the Catawba River, Cape Fear River, Dan River, Broad River, and the Yadkin-Pee Dee River. Major highways within the Region of Interest include Interstate Routes 95, 85, 40, 26, and 77. There are two major railroads in the Region of Interest, CSX Transportation (CSXT) and Norfolk Southern Railway (NS). Major land use categories found in the Region of Interest include residential, agricultural, urban, industrial, commercial, public facilities, parks, public and private recreation areas, natural areas, transportation, communications, utilities, government special designation, and education. Topographic features in the Region of Interest range from flat floodplains along rivers and coastal areas to steep bluffs, deep ravines, and mountain ranges. There are numerous military bases in the Region of Interest.

9.3.1.2 Identification of Candidate Areas

Candidate Areas were identified by constructing digitized Geographic Information System (GIS) maps of the entire Region of Interest and applying exclusionary criteria to eliminate areas considered unsuitable for nuclear power plant siting. The purpose of the exclusionary criteria was to narrow-down the region to be considered for power plant siting and allow the study to focus on areas that have the greatest probability of containing desirable sites. The exclusionary criteria covered major factors that make licensing, permitting, or development of a nuclear power plant impractical. Exclusionary criteria included:

- Areas within 25 miles (mi.) (40 kilometers [km]) of capable faults
- Areas more than 10 mi. (16 km) from a river with a mean annual flow of 800 cubic feet per second (cfs) or greater, or a waterbody with an area greater than or equal to 2000 ac. (809 ha)

- Areas within active military bases
- Areas that exceed a peak ground acceleration (PGA) of 0.6 g based on a two percent probability of exceedance within 50 years
- Areas within a 3-mi. (5-km) buffer with a population density of 500 people per sq. mi. or more
- Areas within protected lands
- Areas more than 20-mi. (32-km) from barge or rail transport

The application of the exclusionary criteria to the Region of Interest is illustrated in Figures 9.3-2 through 9.3-8. As illustrated in these figures, distance from barge and railway transport and active military bases eliminated relatively small parts of the Region of Interest, but proximity to water resources and capable faults, and high population density eliminated significant parts of the Region of Interest. Figure 9.3-9 shows the Candidate Areas that resulted from the exclusionary criteria.

9.3.1.3 Identification of Potential Sites

Potential Sites were identified by examining topographic maps and aerial photographs of the Candidate Areas to find specific locations that appeared, on the basis of high-level screening criteria, to be suitable for nuclear power plant siting. Other factors that were considered include:

- Proximity to a cooling water source
- Location in lower seismic risk areas
- Proximity to transmission
- Proximity from high-population and high-population-density areas
- Compatible land use
- Avoidance of ecologically sensitive and special designation areas
- Avoidance of wetlands to the extent practical
- Avoidance of special dedicated land uses (such as national parks, Indigenous lands, historic areas, and cemeteries)
- Proximity to transportation and heavy-haul infrastructure (such as rail lines and barge terminals)

Additionally, properties that were owned by Duke Energy, or partially owned by Duke Energy, which may have sufficient land and water resources available to support a nuclear power plant and were located within the Candidate Areas were identified for review. Prior to the establishment of the Candidate Areas, more than 30 preliminary sites were identified within the Region of Interest. Of those 30 preliminary sites, 21 were within the Candidate Areas. Of those 21 sites, 11 were considered suitable based on the above considerations.

9.3.1.4 Screening of Potential Sites

Candidate Sites were identified by examining the Potential Sites to determine whether they had any significant environmental or other issues that will make them impractical or undesirable for licensing, permitting, or development of a nuclear power plant. Issues considered in this evaluation included the following:

- Site Safety - The sites were reviewed with regard to major site safety issues, such as proximity to population centers, proximity to capable faults, PGA values at the site, and proximity to hazardous land issues.

- Environmental Acceptability - The sites were reviewed with regard to major environmental issues, such as proximity to environmentally sensitive areas, proximity to cultural resources, proximity to species of concern, and proximity to aquatic resources, such as wetlands and streams.
- Engineering and Cost - The sites were reviewed with regard to major engineering and cost issues, such as cooling water availability, drought tolerance, buildability, proximity to heavy haul, proximity to transmission, and if there are existing coal or nuclear facilities located at the site.

Based on the screening of the 11 Potential Sites, six sites, NC-03, NC-07, NC-11, NC-14, NC-18, and SC-06 have a larger number of potentially significant issues than the other sites, including certain issues that could be more problematic than those identified for the other sites. Therefore, these sites were eliminated from further consideration as Candidate Sites.

Five sites were found to have notably fewer potentially significant negative issues than the other sites. In addition, a qualitative evaluation of the potentially negative issues identified at these sites indicated that all of the issues were manageable and could reasonably be expected to be resolved. Each site also had other highly desirable characteristics. Therefore, the sites with significantly more potential negative issues were eliminated from further consideration, and the following sites were retained as Candidate Sites:

- NC-15 site
- Belews Creek, NC site
- NC-17 site
- NC-19 site
- SC-04 site

9.3.1.5 Evaluation of Candidate Sites

The Candidate Sites were evaluated in more detail in order to provide a quantifiable basis for comparison. The primary purpose of the evaluation was to develop numerical scores that will allow the Candidate Sites to be ranked according to their overall suitability for development of a nuclear power plant. The numerical scores covered 42 site characteristics related to Health and Safety Criteria (15 characteristics), Ecological Criteria (10 characteristics), Socioeconomic Criteria (four characteristics), and Engineering and Cost-Related Criteria (13 characteristics).

The site characteristics considered in the numerical scoring are listed in Table 9.3-1. An importance weighting factor was assigned to each site characteristic using the modified Delphi technique. A multidisciplinary team of 10 subject matter experts with expertise in geology, hydrology, ecology, socioeconomics, land use, licensing and engineering participated in an iterative workshop to assign weighting factors to each site characteristic.

The Candidate Sites were ranked according to the numerical scoring developed as described above. Based on total weighted scoring, the Belews Creek, NC site was the highest-ranked site, followed in order by sites NC-15, NC-19, NC-17, and SC-04. Based on total unweighted scoring, the NC-15 site was the highest-ranked site, followed in order by the Belews Creek, NC site, NC-19 site, NC-17 site, and SC-04 site.

9.3.1.6 Selection of Proposed and Alternative Sites

As described in the previous subsections, a standardized process was used to identify Candidate Areas, Potential Sites, and Candidate Sites. A systematic numerical scoring system was developed to provide an objective evaluation of the relative favorability of the Candidate Sites, using consistent criteria. The results of these evaluations indicate that all of the Candidate Sites are potentially licensable for a nuclear power plant, and that the Belews Creek, NC site is the most favorable Candidate Site with regard to the issues considered. The last step in the process was to incorporate business considerations and any other relevant additional factors into the site evaluations and the selection of a Proposed Site. Technical and business considerations were used to evaluate the five Candidate Sites, in addition to the Environmental Acceptability, Site Safety, and Engineering/Cost considerations, as described above. In some cases, these considerations correlate to lower construction or operation costs. A Proposed Site was selected based on the following discussion.

The Internal Revenue Code, 26 U.S.C. §§ 45U, 45Y, and 48E, provides production tax credits (PTC) or investment tax credits (ITC) for certain nuclear or clean electricity plants. The PTC or ITC may be increased by 10 percent (subject to certain limitations) if the facility is in an Energy Community as defined in 26 U.S.C. § 45(b)(11). As an example, a utility may receive an ITC equal to 30 percent of what was invested in building a nuclear plant (i.e., a zero-emissions energy production facility), plus an additional 10 percent for a total of 40 percent of the cost to build the plant if it is in or directly adjoins a census tract of a coal-fired generating facility that was retired after December 31, 2009. For this reason, the five Candidate Sites were screened down to the following three sites that are locations that have had or will have a retired coal-fired generation facility: the Belews Creek, NC site, the NC-17 site, and the NC-19 site.

When considering these three sites, additional comparative advantages can be identified based upon land access and population density in the vicinity of each site. The NC-17 site is comparatively less desirable than either the NC-19 site or the Belews Creek, NC site due to the lack of land ownership needed to develop a nuclear plant. Duke Energy does not currently own all of the land required to develop a nuclear facility at the NC-17 site. Further, the NC-19 site has a higher population density in the vicinity of the site than the Belews Creek, NC site. Based upon the above considerations, the Belews Creek, NC site was selected as the Proposed Site, with the NC-17 and NC-19 sites as Alternative Sites. Figure 9.3-10 shows the locations of the Belews Creek, NC site and the Alternative Sites.

9.3.2 ENVIRONMENTAL ASSESSMENT OF ALTERNATIVE SITES

The site selection process described above resulted in the selection of the Belews Creek, NC site as the Proposed Site. The environmental impacts of the Belews Creek, NC site are evaluated in detail in other sections of this Environmental Report. This subsection evaluates the environmental impacts of the Alternative Sites, using the resource categories suggested in NUREG-1555. The purpose of this evaluation is to determine if any of the Alternative Sites are “environmentally preferable” to the Belews Creek, NC site and, if so, whether any of the sites are “obviously superior” to the Belews Creek, NC site. Regulatory Guide 4.2 states, “An applicant is not expected to conduct detailed environmental studies for potential sites, only preliminary investigations using reconnaissance-level information.” The Alternative Sites are evaluated here based on publicly available information, including GIS mapping, and a review of government agency websites. In order to evaluate the environmental impacts of constructing and operating a nuclear power plant at the Alternative Sites, the general plant design described in Chapter 3 and the building and operation practices described in Chapters 4 and 5 were consistently applied to each site. This allowed for a comprehensive and qualitatively consistent assessment of environmental impacts. The potential impact of plant building activities and

operation on each resource category was assigned a significance level according to the criteria established in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, footnote 3, as follows:

> SMALL - Environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attributes of the resource.
>
> LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For some analyses, it was determined that the additional impact criteria established by the NRC in NUREG-1437, Rev. 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plant*, were appropriate, and those criteria were used to assign a significance level to certain impacts, as noted in the specific subsections below.

The following subsections summarize the evaluation of each Alternative Site, using consistent criteria and assumptions applied to the attributes and features of each Alternate Site. Table 9.3-8 summarizes the impacts to each resource for the Alternative Sites and the Belews Creek, NC site. Table 9.3-9 summarizes the cumulative impacts to each resource for the Alternative Sites and the Belews Creek, NC site.

9.3.2.1 Evaluation of the NC-17 site

The NC-17 site is a greenfield site located approximately 10-mi. (16-km) north of Roxboro, in Person County, NC. This site is located approximately 1-mi. (2-km) east of Hyco Lake which was constructed in the early 1960's by the Carolina Power and Light Company (now Duke Energy). Hyco Lake functions as a cooling reservoir for the Roxboro Steam Station, which is a four-unit, 2422 MW coal-fired plant. Hyco Lake covers approximately 3750 ac. (1518 ha) with 120-mi. (193-km) of shoreline. Duke Energy owns the land within which the reservoir is located and up to the 420-feet ((ft.) [130-m]) mark which is approximately 10 ft. (3 m) above full pool of the reservoir. Duke Energy does not currently own all of the NC-17 site. There is a secondary road, Route 1322 (Edwin Robertson Road), that is maintained by the NC Department of Transportation (DOT) that bisects the site parcel. US Highway 501 is a two lane, asphalt paved highway located 6-mi. (10-km) east of the site. The topography of the NC-17 site is comprised of numerous hills and valleys with some slopes that exceed 30 percent. The conceptual site boundary has an approximate total area of 569 ac. (230 ha).

The NC-17 site will require the following off-site features in order to support a nuclear power plant:

- Road access to the site is provided by existing public roads, but portions of those roads will have to be relocated around plant facilities.
- A NS mainline is adjacent to the site and there is a rail siding at the nearby existing Roxboro Steam Station. A new siding will need to be constructed if there is a need for onsite rail.
- Water for the nuclear power plant will be obtained via a new intake on Hyco Lake.
- The NC-17 site will utilize either the existing 230 kilovolt (kV) switchyard or the 500 kV substation for the Roxboro Steam Station and add improvements.

9.3.2.1.1 Land Use

Existing land use across the NC-17 site is predominately forested land, and pine plantation with some areas of rangeland. Limited infrastructure development and structures are present on the NC-17 site. The NC-17 site is located approximately 1-mi. (2-km) from Hyco Lake in Person County, NC. Duke Energy does not currently own all of this site and land will need to be acquired to construct a nuclear facility. Soils classified as prime or farmland of statewide importance cross much of the site (USDA NRCS, 2025). There are no residences identified within the conceptual site boundaries. The closest residence is approximately 1-mi. (2-km) away from the center point of the conceptual site boundaries. The site is zoned as Rural Conservation (Person County, 2025a).

The closest significant industrial land use to the NC-17 site is the existing Roxboro Steam Station which is approximately 3.5-mi. (6-km) from the center point of the conceptual site boundaries.

The development of a new nuclear plant at the NC-17 site will be sufficient to alter noticeably, but not to destabilize land use within the site and surrounding area as the existing land will be converted from rural conservation to industrial use. Due to this, the impact to land use is MODERATE for building activities. During operation, no new land use impacts will occur beyond those described above for building activities, so land use impact due to operation of the Project will be SMALL.

9.3.2.1.2 Water Resources

The NC-17 site is located within the Hyco Lake After Bay Reservoir-Hyco River watershed. The NC-17 site is 1-mi. (2-km) from Hyco Lake, a reservoir created from the damming of the Hyco River. Hyco Lake, was created as a cooling reservoir for the existing Roxboro Steam Station. Neither Hyco Lake nor the Hyco River are listed as a Section 303(d) impaired water by the U.S. Environmental Protection Agency (USEPA). The Hyco River, from the Hyco Lake dam to the NC, Virginia (VA) state line is classified by the NCDEQ as a Class C water. Class C waters are protected for uses such as aquatic life propagation, survival, and maintenance of biological integrity, wildlife, secondary contact recreation, and agriculture. The Hyco River, including the Hyco Lake from the dam to the source of Hyco Lake is classified as a WS-V-B water, which is defined as suitable for primary recreation. It is also suitable as water supply for use by industry to supply drinking water to their employees, but not to municipalities or counties with a raw drinking water supply source (NCDEQ 1999). The NC-17 site is not located over a sole source aquifer.

A 2023 water resources study was conducted to determine what capacity the NC-17 site could support based on a 15 gallons per minute (gpm) per MWe water consumption demand. It was determined that the NC-17 site will need a pumping station added to mitigate drought concerns for plant water consumption greater than 1200 MWe.

The NC-17 site is located approximately 1-mi. (2-km) east of Hyco Lake, so the only direct impact on the reservoir during building activities will be disturbance of a section of the shoreline and lake bottom for installation of required facilities. At a minimum, the required facilities include a water intake structure, a cooling water discharge structure, and a pumping station which will disturb a relatively small area of the shoreline and lake bottom. There is no commercial barge navigation on Hyco Lake or near the NC-17 site. The majority of the site is outside of the 100-year and 500-year floodplains, except for the southern portion of the NC-17 site that borders Ghent Creek.

Water-related impacts associated with building activities on the site itself are similar to the impacts of any large construction project. Potential impacts include direct physical alteration of local surface water bodies; indirect alteration of nearby surface water bodies due to increased runoff volumes or diversions of runoff; degradation of downstream surface water quality as a result of erosion and sedimentation or discharges of pollutants associated with building activities; and changes in groundwater flow patterns due to dewatering of excavations and soil retention management practices. Some existing streams on the site will be directly disturbed, and some adjacent streams will experience a temporary increase in sediment loading due to increased runoff of disturbed soil.

Groundwater withdrawal would not be mandatory at the NC-17 site, because Hyco Lake is capable of providing fresh water for plant uses. A detailed water study would be performed if development of the NC-17 site was anticipated.

Several federal, state, and local permits govern building activities that have the potential to impact water resources. Water-related impacts will be minimized by implementing best management practices (BMP), including erosion, grading, and sediment control measures; stormwater pollution prevention plans (SWPPP); spill prevention and countermeasure plans; and compliance with federal, state, and local regulations pertaining to disturbance of water bodies and pollution discharges.

Proposed hydrological alterations to the NC-17 site for building activities are minimal in terms of impact to surface water and groundwater. Impacts related to hydrological alterations to surface waters for Project operation are MODERATE because of the need for a pumping station to mitigate drought concerns at Hyco Lake. Impacts as a result of building activities and operation are SMALL for water use and water quality since stormwater and plant discharge leaving the site will follow natural contours using culverts and other water management structures, to maintain hydrologic conditions to the extent practicable.

9.3.2.1.3 Terrestrial Ecology

Any large construction project impacts terrestrial ecology primarily by disturbing natural habitats and making those habitats unavailable to plants and animals. Although building activities may result in direct mortality to some plants and animals, most animal species are able to move away to avoid direct impacts. Even those species, however, may experience population declines due to loss of habitat. In addition, noise, lights, and dust may cause some animals to leave areas near building activities. This is also experienced as a loss of usable habitat.

The evaluations conducted for terrestrial ecology were based on a desktop review of publicly available data. Site specific terrestrial habitat conditions are not generally known without a site survey.

The USEPA defines ecoregions in hierarchical levels from Level I to Level IV, increasing in detail as the level increases. The USEPA maintains the mapping of ecoregions (USEPA, 2025a). The NC-17 site is located within the Piedmont Level III Ecoregion. Additionally, the NC-17 site is located within the Northern Inner Piedmont Level IV Ecoregion, which is detailed as being dominated by pine (mostly loblolly and VA) on old field sites and pine plantations, while mixed oak forest is found in less heavily altered areas (USEPA, 2025b).

National Land Cover Database (NLCD) data indicates that the most prevalent land cover type found within the approximately 569 ac. (230 ha) NC-17 site is hay/pasture (~195 ac. [~79 ha]). Other common land cover types include deciduous forest (~106 ac. [~43 ha]), and mixed forest (~102 ac. [~41 ha]). The land cover within the 50-mi. (80-km) region of the NC-17 site is

primarily deciduous forest (~18,141 ac. [~7341 ha]), followed by hay/pasture (~16,154 ac. [~6537 ha]), mixed forest (~15,821 ac. [~6403 ha]), and evergreen forest (~14,189 ac. [~5742 ha]) (Table 9.3-2) (Dewitz, J. and USGS, 2021).

A review of U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) data was completed to determine on-site aquatic resources for the NC-17 site. Ghent Creek flows across the southern boundary of the NC-17 site. The USFWS NWI designates Ghent Creek as a perennial stream. Multiple intermittent tributaries flow southeast to Ghent Creek within the NC-17 site. Freshwater emergent and freshwater forested/ shrub wetlands border Ghent Creek. Two on-channel ponds are also indicated by the USFWS NWI to be within the NC-17 site. Ghent Creek is a tributary to the Hyco River, which eventually flows to the Dan River. In total, there are approximately 41 ac. (17 ha) and 5500 linear feet of streams within the NC-17 site.

The USFWS Information for Planning and Consultation (IPaC) report for the NC-17 site indicated that two terrestrial species proposed for listing, could be “potentially affected by activities at this location” (USFWS, 2025) (Table 9.3-4):

- Tricolored Bat (*Perimyotis subflavus*); proposed endangered
- Monarch Butterfly (*Danaus plexippus*); proposed threatened

A review of the IPaC report did not indicate that any federally designated or proposed critical habitat for terrestrial species is found on the NC-17 site.

Person County, North Carolina Natural Heritage Program (NCNHP) data for state-listed species was reviewed for the NC-17 site. Person County has eight state listed terrestrial endangered and threatened species (Table 9.3-4), excluding the previously listed species. All the state listed terrestrial species are vascular plants, which will require site specific surveys in order to determine presence within the NC-17 site.

Additionally, the Hyco Game Land, which is land leased by Duke Energy to the NC Wildlife Commission Game Lands Program, directly borders the NC-17 site. Multiple natural heritage natural areas are also within close vicinity of the NC-17 site including the Hyco/Ghent Hardwood Forest, the McGhees Mill Road Rare Plant Site, and the Storys Creek/Marlowe Creek Swamp.

Table 9.3-2 shows that the acreage of each habitat potentially affected by building activities is a relatively small percentage of the total acreage of that habitat available in the site vicinity. In addition, it appears that the NC-17 site has been subject to prior disturbance due to the presence of pine plantations and rangeland on the site. Therefore, habitat at the NC-17 site is considered lower quality relative to adjacent habitat. Detailed field studies are required to determine whether any federally listed or threatened species make significant use of the site, and as reconnaissance level data was used for this evaluation, such studies were not conducted for the NC-17 site. However, based on the relatively minor impacts on natural habitats described above, it is unlikely that any threatened or endangered species are significantly affected by building activities or operation. Disturbance to wetland and streams may occur as a result of building activities. Impacts to wetlands and streams are regulated by several federal, state, and local regulations and will be minimal. Based on the area affected, overall impacts on terrestrial habitats are noticeable. But, because of the availability of similar land cover types within the Project Vicinity, the prevalence of low-quality plant communities, and reduced quality of the existing habitats on the Project site, potential impacts on terrestrial land cover are noticeable but not destabilizing. Impacts to terrestrial ecology for building activities at the NC-17 site are MODERATE. Overall, the impacts of Project operation on terrestrial habitat

are minimized through the use of BMPs during landscape maintenance and transmission line operation and maintenance. Therefore, impacts are SMALL for Project operation.

9.3.2.1.4 Aquatic Ecology

The evaluations conducted for aquatic ecology were based on a desktop review of publicly available data. Site specific aquatic habitat conditions are not generally known without a site survey.

The USFWS IPaC report for the NC-17 site indicated that one aquatic species, the Green Floater, proposed for listing, could be "potentially affected by activities at this location" (USFWS, 2025). The Neuse River Dog, which is a federally threatened species, was not listed by the IPaC report, but was listed in Person County, NC NCNHP data.

- Neuse River Waterdog (*Necturus lewisi*); threatened
- Green Floater (*Lasmigona subviridis*); proposed threatened

A review of the IPaC report did not indicate that any federally designated or proposed critical habitat for aquatic species is found within the NC-17 site.

Person County, NC NCNHP data for state-listed species was reviewed for the NC-17 site. Person County has seven state-listed aquatic endangered and threatened species, excluding the federally listed aquatic species, previously discussed.

Some aquatic organisms that use this area could suffer direct impacts from building activities, but most organisms will move away from the area and be affected primarily by the loss of a limited amount of habitat. In addition, some aquatic species might be affected by increased turbidity and siltation resulting from building activities, but such effects will be temporary and localized. The area that will be subject to disturbance in the Hyco Lake is small, and building activity impacts on the Hyco Lake are regulated under federal, state, and local permits. Therefore, impacts on aquatic ecology due to building activities are SMALL.

Direct impacts of operation on aquatic ecosystems in Hyco Lake are similar to those at the Belews Creek, NC site. Potential impacts include impingement and entrainment associated with the Cooling Water Intake Structure, effects of cooling tower effluent constituents and thermal effluents, and effects of water-level fluctuations within Hyco Lake. Operational impacts to aquatic ecosystems include impacts related to on-site stormwater runoff and incidental spills. Impacts on-site are managed through stormwater management systems and, therefore, are minor. In Hyco Lake, impacts are associated with the intake and discharge structures operations, and changes in water levels. Impacts of the discharge(s) are expected to dissipate rapidly, limiting impacts on aquatic ecosystems. Impacts of intake operation are minimized through compliance with CWA Section 316(b) requirements.

Compliance with thermal discharge limits required under the operational NCDEQ NPDES permit will limit adverse impacts to aquatic biota.

Similarly, to the Belews Creek NC, site with the closure of the Belews Creek Stream Station (BCSS), with the closure of the Roxboro Steam Station adjacent to the NC-17 site, the aquatic ecological community within Hyco Lake will reflect a lake lacking significant thermal input from power generation, including recreationally important sport fish.

Impacts on aquatic species and habitats within Hyco Lake from operations, under normal operational conditions in which water levels are stabilized and consumptive losses are offset by makeup water intake structure pumping are minor. Potential impacts to aquatic species and

habitats from hydrologic alterations associated with increased water-level fluctuation under drought conditions within Hyco Lake relate to effects on aquatic macrophyte communities, benthic macroinvertebrates and mussels, effects on fish communities through alteration of habitats (e.g., spawning habitat, nursery areas, foraging habitat), and increased potential for proliferation of nuisance macrophytes. The balance of fish communities is not expected to shift in such a way that would promote the expansion of nonindigenous fish beyond those already present in Hyco Lake. Therefore, impacts on aquatic ecology due to operation of the Project is SMALL to MODERATE (during drought conditions).

9.3.2.1.5 Socioeconomics

This subsection evaluates the social and economic impacts that could result from building and operating the Project at the NC-17 site. The evaluation includes the impacts of building and operation activities and demands placed by the building and operation workforces on the NC-17 site and the surrounding region.

9.3.2.1.5.1 Physical Impacts

This subsection provides an analysis of physical impacts of building and operation activities associated with noise and vibration, odors, dust and air pollution, transportation, and aesthetics.

9.3.2.1.5.1.1 Noise and Vibration

Based on an examination of aerial photographs, the nearest sensitive receptors to the NC-17 site include a residence approximately 0.1-mi. (0.2-km) to the west and a Saddle Club to the south of the site boundary. The sensitive receptors are more than 50 ft. (15 m) from any area that may be subject to vibration related effects from blasting and are not expected to experience impacts from blasting. Appropriate measures will be taken to minimize noise impacts from building activities and operation of the Project to sensitive receptors. Therefore, building activity impacts from vibration and noise to nearby sensitive receptors are SMALL.

The impacts from operation are similar to those from building activities but somewhat reduced. Operating plant equipment will produce some noise, but the noise levels generally are lower than the levels associated with building activities. Therefore, the noise and vibration impact during operation is SMALL.

9.3.2.1.5.1.2 Odors, Dust, and Air Pollution

Based on a review of aerial photographs, there are no residences within the conceptual site boundary. The nearest sensitive receptors include a residence to the west and a Saddle Club to the south, both of which are approximately 0.1-mi. (0.2-km) from the edge of the conceptual site boundary. Similarly, to the Belews Creek, NC site, as described in Section 4.4.1.2, building activities are localized mostly to the NC-17 site because they are generated from ground-level or near-ground-level activities. Because air emissions from on-site building activities are generally released from near ground-level sources, impacts are potentially greatest at the nearest off-site receptors. The nearest sensitive receptors include residences and a church to the east, and a Saddle Club to the south. To minimize temporary air and dust emissions, BMPs will be implemented during building activities at the site. Additionally, building activities are subject to air permits under state and federal laws that address the impact of air emissions on sensitive receptors. This is further discussed in Section 9.3.2.2.8. The impacts of odor, dust, and air pollution are similar to those at the Belews Creek, NC site, and are SMALL.

The impacts of odors, dust, and air pollution during operation are similar to those of building activities but somewhat reduced. Periodic maintenance is required for both on-site and off-site facilities and the maintenance activities will create some dust, but these impacts are more

localized and of shorter duration than during building activities. Therefore, the impact of operation is SMALL.

9.3.2.1.5.1.3 Transportation

This subsection discusses the physical impacts on off-site roadways resulting from increased traffic during building activities for and operation of the Project.

Similarly, to the Belews Creek, NC site, as described in Section 4.4.1.3, during the building phase, deliveries and commuting construction workers will result in increased vehicle use on off-site roadways that may impact pavement and roadway physical conditions.

Route 1336 (McGhees Mill Road) and Route 1322 (Edwin Robertson Road) are both local roadways that represent points of ingress and egress into the NC-17 site. As a result, increased traffic associated with the Project will accelerate the deterioration of these local roads relative to other roads within the surrounding transportation network. Roadway repairs and improvements on Routes 1336 and 1322 and other roadways in the vicinity of the NC-17 site inadvertently affected by vehicles associated with the Project, may be necessary to reduce safety risks and restore pavement conditions. Any damage to public roads, markings, or signs caused by building activities will be repaired to preexisting conditions or better in accordance with state and local requirements. Therefore, physical impacts from building activities on the transportation network in the vicinity of the NC-17 site are SMALL.

The impacts of operation to transportation are similar to those from building activities, but somewhat reduced. Therefore, the impact of operation is SMALL.

9.3.2.1.5.1.4 Aesthetics

Aesthetics in the vicinity of the new plant could be affected by the visual intrusion of large industrial structures and equipment. During building activities, dust could create additional visual intrusions. During operation, water vapor plumes from the cooling towers will be readily visible at certain times. Given that the NC-17 site vicinity currently has predominantly rural scenery, building activities and operation of the Project will alter the existing visual conditions. However, the severity of visual impacts on the human population will depend primarily on the visibility of the plant and off-site facilities from sensitive viewing areas.

NUREG-1437 establishes the following criteria for judging the severity of aesthetic impacts:

> SMALL - No complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and no measurable impact on socioeconomic institutions and processes.
>
> MODERATE - Some complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes.
>
> LARGE - Continuing and widely shared opposition to the project based on a perceived degradation of the area's sense of place or diminution in enjoyment of the physical environment, and measurable social impacts that perturb the continued functioning of community institutions and processes.

The immediate area around the NC-17 site features several notable visual resources:

- Hyco Lake, a scenic body of water used to support power plant operation and recreation.
- Forested land.

- The Roxboro Steam Station, located to the east of the NC-17 site. The coal fired plant is a significant industrial feature in the area.
- Rural/low density residential lands to the south and west of the NC-17 site.
- A Saddle Club to the south of the NC-17 site.

These elements together create a diverse visual environment around the NC-17 site. Sensitive visual receptors, which are potentially affected by visual intrusions of the Project, include recreators on Hyco Lake, the Saddle Club, and residences south and west of the NC-17 site boundary.

Considering that the power plant and off-site facilities are at the closest 0.1-mi. (0.2-km) from the nearest sensitive viewing areas, and that building and operation activities will alter the existing predominately rural scenery in the immediate area, public complaints related to a changed sense of place and diminished enjoyment of the physical environment may occur but are unlikely to be widespread due to the already industrial nature of the surrounding facilities. It is unlikely that there will be general opposition to the Project based on perceived degradation of sense of place, and the Project will not impact the continued functioning of institutions and processes. Therefore, the aesthetic impact associated with building activities and operations is similar to that of the Belews Creek, NC site and is MODERATE.

9.3.2.1.5.1.5 Summary of Physical Impacts

The physical impacts from noise, odors, dust, and air pollution, and transportation from building and operations-related activities are SMALL. Additionally, new plant structures and related cooling tower plumes at the Project site noticeably affect the aesthetic qualities of the natural landscape for nearby residents and recreators near the NC-17 site. Thus, physical impacts on aesthetic quality from building activities and operation are MODERATE.

9.3.2.1.5.2 Demographic Impacts

Demographic impacts are associated with construction workers and operation workers moving into the region surrounding the NC-17 site, potentially causing changes in off-site land use and development patterns. Construction employment is inherently temporary, but construction workers sometimes move their families into the region, magnifying the population increase.

Per NUREG-1437, demographic impacts are expected to be SMALL if project related population growth represents less than 5 percent of the study area's total population, MODERATE if 5 to 20 percent, and LARGE if more than 20 percent.

As described in Section 4.4.2.1, it is estimated that the total peak workforce for building plus operations is 2676 workers. A conservative assumption that can be made is that the entire peak building phase workforce (2676 people) will move into and bring families into the 50-mi. (80-km) region surrounding the NC-17 site. Applying the average NC household size of 2.48 people per household (Section 4.4.2.2), the total population increase is 6636. Based on USCB American Community Survey (ACS) 5-year data from 2023, the population of the region within a 50-mi. (80-km) radius of the NC-17 site is 1,416,824. Using this population value and a population increase of 6636, population growth due to the building phase workforce is 0.5 percent. Therefore, the building activities related demographic impact in the 50-mi. (80-km) region is SMALL.

The number of operations workers will be less than that for building activities, so operations-related demographic impacts at the NC-17 site are SMALL.

9.3.2.1.5.3 Economic Impacts to the Community

This section describes the economic and tax impacts in the 50-mi. (80-km) Region of Interest around the NC-17 site during building activities and operation.

9.3.2.1.5.3.1 Economy

Impacts on the economy are caused primarily by the jobs provided to construction and operation workers. The wages paid to workers result in additional spending, which tends to stimulate the economy, particularly in the retail and service sectors. This can provide opportunities for new businesses and new jobs. These effects are considered to be beneficial and are expected to occur primarily in the area within which the workers reside.

Per NUREG-1437, economic impacts are considered SMALL if project related employment represents less than 5 percent of the study area's total employment, MODERATE if 5 to 10 percent, and LARGE if more than 10 percent.

It was conservatively estimated in section 9.3.2.1.5.2 that the entire peak workforce of 2676 workers would migrate into the 50-mi. (80-km) Region of Interest if a new plant were to be constructed at the NC-17 site.

Using the USCB ACS 5-year estimates from 2023 for the total employment (728,685) within a 50-mi. (80-km) radius of the NC-17 site and the conservative regional employment increase discussed above (2676), employment due to the building activities workforce is 0.4 percent. Therefore, the building activities related economic impact in the 50-mi. (80-km) region is SMALL**.**

The employment of the workforce over the building phase will have a positive economic effect on the county and surrounding region. Building phase activities on the NC-17 site will introduce millions of dollars into the economy and indirectly create jobs that help reduce unemployment and provide opportunities for service-related industries. These economic impacts are realized primarily within the 50-mi. (80-km) radius; therefore, the impact of building activities on the economy of the 50-mi. (80-km) radius is beneficial and noticeable. Economic impacts during building activities at the NC-17 site are SMALL, and beneficial.

Similarly, to the Belews Creek, NC site, Project operation at the NC-17 site will introduce millions of dollars into the economy annually and indirectly creates employment opportunities. The economic impact of operations is SMALL and beneficial.

9.3.2.1.5.3.2 Taxes

Property taxes, sales taxes, and other taxes paid during building and operation of the new plant will benefit the state and local jurisdictions that collect the taxes. The significance of tax impacts is determined primarily by regional conditions, and those conditions are essentially the same for the NC-17 site as for the Belews Creek, NC site, as both sites are within NC. Therefore, regional tax impacts are essentially the same at both sites.

The analysis summarized in Section 4.4.3.3 indicates that the tax impact of constructing the new plant at the Belews Creek, NC site is expected to be MODERATE and beneficial. The analysis summarized in Section 5.4.3.3 indicates that the tax impact of plant operation at the Belews Creek, NC site is also expected to be SMALL and beneficial. Therefore, the building activities related and operation related tax impact at the NC-17 site is expected to be MODERATE and beneficial during building activities, and SMALL and beneficial during operation.

9.3.2.1.5.3.3 Summary of Economic Impacts to the Community

Building and operational activities at the NC-17 site will introduce millions of dollars into the economy and creates jobs. These positive economic impacts are primarily realized within the 50-mi. (80-km) Region of Interest. Minor tax revenue impacts on local jurisdictions are accrued through increases in revenue generated from individual income taxes, sales and use taxes, and property taxes. Therefore, the economic and tax impacts are SMALL to MODERATE and beneficial during building activities and SMALL and beneficial during operation.

9.3.2.1.5.4 Community Infrastructure Impacts

This subsection provides the estimated impacts on infrastructure and community services, including transportation, recreation, housing, and public services.

9.3.2.1.5.4.1 Transportation

Transportation in the vicinity of the new plant is affected by the increase in vehicle traffic associated with building phase and operation workers commuting to the site and the delivery of materials and equipment to the site. The increase in vehicle traffic could cause delays on local roads. The severity of such impacts will depend primarily on the existing traffic volumes and level of service (LOS) on local roads compared with the expected volume of traffic related to the Project.

Road access to the NC-17 site is provided primarily by secondary public roadways. Route 1322 or Edwin Robertson Road bisects the site parcel. McGhees Mill Road or Route 1336 runs along the northern boundary of the site. Both roads are maintained by the NCDOT and are relatively narrow two-lane roads that appear to be used mostly by local traffic. US Highway 501 is a two lane, asphalt paved highway located 6-mi. (10-km) east of the site (NCDOT, 2025a).

NCDOT data (NCDOT, 2025b) indicates that the average daily traffic volume for all lanes in both directions on SR 1322 (Edwins Robertson Road) is 1400 vehicles and 650 vehicles for SR 1336 (Mcghees Mill Rd). US Highway 501 has an average daily traffic volume of 4800 vehicles.

As stated in Section 4.4.2.1, there is a peak employment period during which two advanced reactor units are being constructed while four advanced reactor units are operating. The assessment of impacts on traffic are based on this bounding condition. It is estimated that during peak employment 2546 vehicles are expected to enter and leave the construction site at the same time.

Considering the nature of the roads in the vicinity of the NC-17 site and the current volume of traffic on those roads, it is likely that the peak building traffic will noticeably alter existing transportation conditions (cause noticeable delays on local roads) but will not be sufficient to destabilize important transportation resources. Therefore, the transportation impacts associated with building activities are MODERATE. While transportation impacts during operation are less than that of building activities, there are LOS degradations on two lane roads and intersections that provide access to the Project site, therefore impacts will be SMALL within the broader transportation network but MODERATE on local roads providing access to the Project site.

9.3.2.1.5.4.2 Recreation

Recreational resources within the vicinity of the NC-17 site are potentially affected by building activities. Impacts may include (1) impaired recreational experience associated with the views of the building activities, (2) increased user demand associated with the projected increase in

population as a result of the in-migrating workforce and their families, and (3) possible access delays associated with increased traffic on local roadways.

Constructing the cooling and makeup water intake and process wastewater discharge structures requires working within Hyco Lake. This work may impact recreators; however, these activities only occur during a small portion of the overall building phase. Once construction of the water intake and process wastewater discharge structures completes, it will no longer hinder recreators. However, if building activities associated with installation of intake or discharge structures impede the use of Hyco Lake or associated features, Duke Energy will coordinate with the North Carolina Wildlife Resources Commission, as appropriate.

Recreation users of Hyco Lake may experience visual discord during building activities due to the presence of large equipment and building lighting. Although these building activities alter the undeveloped nature of the NC-17 site, existing industrial features such as the Roxboro Steam Station and associated infrastructure currently exists within the viewshed of recreators on Hyco Lake.

Recreational areas within the vicinity of the NC-17 site are also impacted by the increase in population associated with in-migrating workers and their families. Workers who relocate within the 50-mi. (80-km) region are expected to use recreational areas and outdoor activities at the same rates as the existing permanent population of the Region of Interest. Although the in-migrating population increases usage of recreational areas within the vicinity of the NC-17 site, the increase is minor compared to the existing population and is not anticipated to impede or disrupt current usage of recreational areas.

Overall, during the building phase, recreators may experience increased noise levels and visual discord from building activities at the NC-17 site. The increased noise levels and visual discord may be noticeable to individual recreators on Hyco Lake in areas adjacent to and north of the NC-17 site; however, it does not reflect an impact that is more broadly evident within the larger reaches of Hyco Lake and does not destabilize the overall recreational experience. Building activities are most noticeable to recreators on the lake while the intake and discharge structures are being built. Due to the minor increase from the in-migrating population, use of recreational facilities in the vicinity of the NC-17 site is anticipated to be similar to existing conditions. Because recreators of Hyco Lake are mobile, and the time frame for building activities is limited, impacts to recreation are SMALL.

Operational use of water from Hyco Lake for the Project will result in water level fluctuation, similarly to the Belews Creek, NC site. Additionally, because, the construction of the Project at the NC-17 site would result in the closure of the existing Roxboro Steam Station, water quality (notably, temperature) within Hyco Lake is normalized to that of other regional lakes that lack thermal inputs from power generation. Impacts from operation off the Project at the NC-17 site will neither destabilize nor noticeably alter any important attribute of the resource and are therefore SMALL to MODERATE.

9.3.2.1.5.4.3 Housing

Impacts on housing could be caused by construction and operation workers moving, either permanently or temporarily, into the region surrounding the NC-17 site. This influx of workers could decrease the availability of unoccupied housing units and increase the cost to buy or rent housing. The severity of such impacts will depend primarily on the existing availability of unoccupied housing units compared with the number of workers who will move into the area.

NUREG-1437 establishes the following criteria for judging the severity of housing impacts:

SMALL - Small and not easily discernible change in housing availability. Increases in rental rates or housing values equal or slightly exceed the statewide inflation rate.

MODERATE - Discernible but short-lived reduction in available housing units. Rental rates and housing values rise slightly faster than the inflation rate, but prices realign quickly once new housing units became available or project related demand diminishes.

LARGE – Project related demand for housing units results in very limited housing availability and increases in rental rates and housing values well above normal inflationary increases in the state.

In Section 4.4.2.1 it was conservatively estimated that the peak workforce for the Project would be 2676 workers. Based on USCB ACS 2023 5-year estimates, the total number of vacant housing units in the 50-mi. (80-km) region surrounding the NC-17 site was 68,036. The conservative estimate of in-migrating construction workers discussed above (2676) represents 3.9 percent of the unoccupied housing units in the region. Because a sizable percentage of the unoccupied housing units will remain available, it is very unlikely that there will be a discernible change in housing availability or increase in housing costs. Therefore, the building activities related housing impact in the 50-mi. (80-km) region is SMALL.

It is estimated in Section 5.4.2 that during operation, that a total number of 818 full-time employees will be needed to staff all units once operational. Using a conservative estimate that all of the workers will in-migrate to the surrounding 50-mi. (80 km) region, approximately 1.2 percent of the available vacant housing in the Region of Interest is expected to be occupied by this increased population. Overall, sufficient housing is available within the Region of Interest to accommodate both operations-related workers and temporary short-term workers. Therefore, impacts on housing due to operation are SMALL.

9.3.2.1.5.4.4 Public Services

Public services include police, fire, and medical services; social services; water supply and wastewater treatment facilities; and recreation facilities. Impacts on public services could be caused by construction and operation workers moving into the region surrounding the NC-17 site. This influx of workers could increase the demand for public services, potentially requiring local governments to add facilities, programs, and/or staff.

Per NUREG-1437, impacts on public services generally are considered to be SMALL if there is little or no need to add facilities, programs, and/or staff because of the influx of workers, and MODERATE or LARGE if additional facilities, programs, and/or staff are required.

As discussed in Section 9.3.2.1.5.2, the number of construction workers estimated to move into Person County and the 50-mi. (80-km) region is SMALL compared with the existing populations. Therefore, the building activities related impact on public services in Person County and the 50-mi. (80-km) region is SMALL. The number of workers needed for operation is less than that for building activities, therefore the impacts of operation on public services is SMALL.

9.3.2.1.5.4.5 Education

Impacts on education could be caused by construction and operation workers moving into and bringing school-aged children into the region surrounding the NC-17 site. This increase in the number of school-aged children could cause crowding of local schools and potentially require school systems to add facilities and/or staff.

NUREG 1437 indicates that impacts to education are:

SMALL – If project related increase in school enrollment represents 3 percent or less of the total school enrollment in affected school systems,

MODERATE – If project related increase in school enrollment represents 4 to 8 percent of the total school enrollment in affected school systems, and

LARGE – If project related increase in school enrollment represents more than 8 percent of the total school enrollment in affected school systems.

The NC-17 site is located within the Person County school district, which contains 2 preschools, 8 elementary schools, 3 middle schools, and 3 high schools. The student-teacher ratio is 15 to 1. As discussed in Section 4.4.4, 19 percent of the population in NC is between 5 to 19 years old (i.e., school age). Using this percentage and applying it to the total in-migrating population of 6636 persons, approximately 1261 persons are of school age. This is 0.42 percent of the current number of school aged children (269,197) within the 50-mi. (80-km) region surrounding the NC-17 site (USCB, 2023). The building activities related education impacts to the surrounding 50-mi. (80-km) region are SMALL.

The number of operational workers who will move into the 50-mi. (80 km) surrounding Region of Interest to the NC-17 site will be less than that of building activities. Impacts to education from operation are SMALL.

9.3.2.1.5.4.6 Summary of Community Infrastructure Impacts

Building and operation related impacts on community infrastructure are SMALL with the exception of MODERATE construction related impacts to transportation and SMALL to MODERATE operations related impacts to recreation.

9.3.2.1.6 NOT USED

Deleted (Executive Order, 2025a, 2025b).

9.3.2.1.7 Historical and Cultural Resources

As defined by the National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S. Code (USC) §306108) and its implementing regulations 36 CFR 800.16(l)(1), historic properties are those properties deemed eligible for listing or that are already listed in the National Register of Historic Places (NRHP).

There are no NRHP listed sites within the conceptual boundary of the NC-17 site or within the immediate vicinity of the site. There are 12 listed NRHP sites within Person County. The closest NRHP listed site is the House on Wagstaff Farm which is approximately 4-mi. (6-km) from the NC-17 site. Due to its distance from the NC-17 site, the House of Wagstaff Farm will likely not be impacted by building activities. There are 19 NRHP listed sites within a 10-mi. (6-km) radius of the site, two of which are historic districts.

The NC Natural Heritage Program Data Explorer indicated that a surveyed feature, and a surveyed feature that is now gone were identified within the NC-17 site. However, these features were not listed on the NRHP. The evaluations conducted for historical and cultural resources were based on a desktop review of publicly available data. Site specific conditions are not generally known without a site survey.

The impact on historical and archaeological resources due to building activities is SMALL due to a lack of resources within the conceptual site boundaries.

The impacts of operation are similar to the impacts of building activities but somewhat reduced. The noise levels of operating plant equipment generally are lower than the levels associated with building activities. No new disturbance of historical and archaeological resources is expected to occur during operation. Therefore, the impact on historical and archaeological resources due to operation is SMALL.

9.3.2.1.8 Air Resources

The Clean Air Act (CAA) was enacted in 1970 to protect public health and welfare and authorizes the USEPA to set National Ambient Air Quality Standards (NAAQS) for six common pollutants, called criteria pollutants. There are also provisions to regulate hazardous air pollutants, which are pollutants that are harmful to human health and/or the environment, as well as greenhouse gases (GHGs), primarily carbon dioxide (CO_2) (42 United States Code §7401 et seq).

The CAA requires the USEPA to set NAAQS for pollutants considered to be harmful to public health and the environment. Primary NAAQS provide public health protection including protecting the health of sensitive populations (asthmatics, children, elderly, etc.). Secondary NAAQS provide public welfare protection against decreased visibility and damage to animals, crops, vegetation, and buildings (USEPA, 2025c).

NC reached full attainment with all NAAQS across the entire state in 2015 (NCDEQ, 2024 and USEPA 2025c). The most recent pollutant to be redesignated was ozone. On July 28, 2015, the USEPA redesignated to attainment the NC-portion of the Charlotte-Rock Hill, NC-SC, nonattainment area for the 2008 8-hour ozone NAAQS, effective August 27, 2015.

The CAA defines Class I areas as national parks greater than 6000 ac. (2428 ha.), wilderness areas greater than 5000 ac. (2023 ha), national memorial parks greater than 5000 ac. (2023 ha), and international parks that were in existence as of August 1977. These areas are potentially sensitive to visibility impairment. The USEPA states that a Class I visibility impact analysis is necessary for a major source within 62-mi. (100-km) of a Class I area (USEPA, 1990).

The USEPA promulgated the Regional Haze Rule to improve visibility in Class I areas in 1999 with the ultimate goal of restoring natural background visibility by 2064 (Federal Register Vol. 64, 1999). This rule was amended in 2005 to require certain industrial facilities to install emission controls to reduce emissions of air pollutants that reduce visibility (USEPA, 2025d; Federal Register Vol. 70, 2005). These pollutants include particulate matter with a diameter 2.5 microns or less ($PM_{2.5}$) and compounds that contribute to $PM_{2.5}$ formation, such as nitrogen oxides, sulfur dioxide, certain volatile organic compounds, and ammonia.

The closest Class I area to the NC-17 site is Shenandoah National Park, approximately 148-mi. (238-km) to the north. There are no Class I areas within 62-mi. (100-km) of the NC-17 site, therefore, no Class I areas are affected (USEPA, 2025d).

The NC-17 site is in an attainment area for all criteria pollutants, similarly to the Belews Creek, NC site. These two sites are similar from an air quality perspective. Sections 4.7 and 5.7 indicated the impacts to air resources from building activities and operation of the Belews Creek, NC site are SMALL. As such, the impacts of building activities on air quality are expected to be SMALL and temporary, and the impacts of facility operations on air resources are also expected to be SMALL for the NC-17 site.

9.3.2.1.9 Nonradiological Health

Non-radiological health impacts on the public and workers from building and operation activities at the NC-17 site are similar to those evaluated in Sections 4.8 and 5.8. They include the impacts of public and occupational health, the impacts of noise and vibration, and the impacts of transporting building materials and personnel to and from the Project site. Additional data required, based on applicable federal and state air quality and noise regulations, are provided during the building phase. The NC-17 site has characteristics that will require site-specific Health and Safety Plans for the building phases. Health impacts to workers from occupational injuries, noise, and electric fields are similar at the NC-17 site to those at the Belews Creek, NC site. The NC-17 site does not have characteristics that are expected to lead to fewer, or more, operational accidents than those expected at the Belews Creek, NC site. Due to the implementation of BMPs and compliance with regulations and permit conditions, non-radiological health impacts from building activities and operation are expected to be SMALL for all categories.

9.3.2.1.10 Radiological Health

This NC-17 site does not currently have operating nuclear facilities. Therefore, potential radiological exposures due to existing facilities are similar to that of the Belews Creek, NC site, and lower than the NC-19 site. Human health impacts are also dependent on population density near the proposed facility. The low population density near the NC-17 site should lessen potential health effects. Radiological health impacts for building activities and operation of the Belews Creek, NC site are discussed in Sections 4.9 and 5.9. Generally, dose rates will be within allowable limits. As such, human health impacts from radiological exposures during building activities and operation at the NC-17 site are expected to be SMALL.

9.3.2.1.11 Nonradioactive Waste Management

The impacts on the environment that could result from the generation, handling, and disposal of nonradioactive waste and mixed waste during building activities and operations at the NC-17 site would be similar to those at the Belews Creek, NC site, which is described in further detail in Sections 4.10 and 5.10. Therefore, impacts to land, water, and air from nonradioactive waste generated, handled, stored, and disposed of during building activities and operations are SMALL.

9.3.2.1.12 Environmental Impacts of Postulated Accidents

The potential environmental impacts from a postulated accident, considering both design-basis accidents (DBAs) and severe accidents, for the Belews Creek, NC site are described in Section 5.11. The DBAs and severe accidents analyzed to-date for the Belews Creek, NC site are applicable to the NC-17 site.

The NC-17 site is located in Person County, NC, and is situated approximately 1-mi. (2-km) east of Hyco Lake. The area is characterized generally as rolling hills, with elevations around 400 to 500 ft. (122 to 152 m) reaching a peak of about 820 ft. (250 m) to the south at a distance of 7-mi. (11-km) from the site. High pressure associated with the Bermuda anticyclonic circulation result in moderate wind speeds in the region (NOAA NCEI, 2022a.).

It is unlikely that differences in local meteorological conditions are sufficient to cause doses from DBAs for multiple advanced reactors at the NC-17 site to exceed regulatory limits or guidelines or the impacts from a similar accident at the Belews Creek, NC site. Therefore, the impacts for postulated accidents at the NC-17 site for operation are SMALL.

9.3.2.2 Evaluation of the NC-19 Site

The NC-19 site is comprised of two parcels located adjacent to the existing Shearon Harris Nuclear Plant approximately 20-mi. (32-km) southwest of Raleigh, in Wake County, NC. This site is located near Harris Lake which is a 4100 ac. (1659 ha) reservoir with a primary purpose of providing cooling water for the Shearon Harris Nuclear Plant, which is a single unit, 928 MW nuclear facility. Duke Energy currently owns all of the NC-19 site. U.S. Highway 1 which is maintained by the NCDOT is directly north of this site. The topography of the site is comprised of numerous hills and valleys with some slopes that exceed 30 percent. The conceptual site boundary has an approximate total area of 976 ac. (395 ha) for both parcels.

The NC-19 site will require the following off-site features in order to support a nuclear power plant:

- Road access to the site is provided by existing public roads. The eastern site will need to have a road extension of approximately 1-mi. (1.6-km) in order to connect to U.S. Highway 1.
- There are two parcels for the NC-19 site, and the east parcel contains a number of on-site rail sidings that serve the existing Shearon Harris Nuclear Plant. This industrial rail is ultimately served by CSXT. The second, west parcel will also be served by the rail siding at the existing Shearon Harris Nuclear Plant which is located 5.5-mi. (8.9-km) from the second parcel.
- A new makeup water pipeline will be constructed that will provide makeup water from the Cape Fear River to Harris Lake. The pipeline will be constructed in an existing right-of-way.
- It was assumed that the NC-19 site will utilize the existing 230 kV switchyard at the Shearon Harris Nuclear Plant.

9.3.2.2.1 Land Use

Existing land use across the western parcel at the NC-19 site is predominately evergreen forested land, with a large portion of planted pine plantation. Limited infrastructure development and structures are present on the western parcel of the NC-19 site. A moderate amount of infrastructure development and structures related to the existing Shearon Harris Nuclear Plant are present on the eastern parcel of the NC-19 site. The NC-19 site is located adjacent to Harris Lake in Wake and Chatham Counties, NC. Duke Energy currently owns this entire site, including the land needed for intake structures (Wake County, 2025a, Chatham County, 2025). Transmission and rail interconnect will primarily occur within the conceptual site boundaries. Soils classified as prime or farmland of statewide importance cross much of the site (USDA NRCS, 2025). There are no residences identified within the conceptual site boundaries, the closest residence is approximately 1.5-mi. (2.4-km) away from the center point of the conceptual site boundaries. The NC-19 site is zoned as industrial in the eastern parcel but is mainly zoned as residential in the western parcel (Wake County, 2025b, Chatham County, 2025).

The closest significant industrial land use to the NC-19 site is the existing Shearon Harris Nuclear Plant which is directly adjacent to the site.

While the eastern parcel related to the NC-19 is currently developed and used for the existing Shearon Harris Nuclear Plant, use of the NC-19 site will convert existing forested land and pine plantation on the western parcel to industrial use. The land use impacts are MODERATE for building activities as the western parcel will be converted to industrial use. During operation, no

new land use impacts will occur beyond those described above for building activities, so land use impact due to operation of the Project will be SMALL.

9.3.2.2.2 Water Resources

Water resources at the NC-19 site are located in the White Oak Creek watershed. The NC-19 site is adjacent to Harris Lake, a reservoir created from the impoundment of Buckhorn Creek, a tributary to the Cape Fear River. There is also an auxiliary reservoir located on Tom Jack Creek. The primary purpose of Harris Lake is to provide cooling water for the Shearon Harris Nuclear Plant and general operational water supply for the nuclear station. Secondary uses of the reservoir include recreational activities including fishing, boating, and hunting (NCDEQ, 2022). Harris Lake is not listed as impaired with the USEPA. However, the Cape Fear River from NC Highway 42 to Buckhorn Creek is listed as impaired for recreation from Chlorophyll a. Harris Lake is classified by the NCDEQ as a WS-V water, which is defined as suitable for water supply for use by industry to supply drinking water to their employees, but not to municipalities or counties with a raw drinking water supply source (NCDEQ 1999). The NC-19 site is not located over a sole source aquifer.

Currently, the site contains one 928 MW nuclear plant with closed cycle cooling. For additional nuclear power plants, Harris Lake will need to be raised beyond the current 220 ft. (67 m) level up to a maximum analyzed level of 240 ft. (73 m). A pumping station on the Cape Fear River will be needed to supplement the reservoir. Different locations are under consideration for an intake structure. The most likely of which would be an area at the retired Cape Fear Coal Plant.

There is no commercial barge navigation on Harris Lake or near the NC-19 site. The entirety of the site is outside of the 100-year and 500-year flood zones, except for the portions of the site that border Harris Lake.

Groundwater withdrawal would not be mandatory at the NC-19 site, because Harris Lake is capable of providing fresh water for plant uses. A detailed water study would be performed if development of the NC-19 site was anticipated.

Water-related impacts associated with building activities on the site itself are similar to the impacts of any large construction project. Potential impacts include direct physical alteration of local surface water bodies; indirect alteration of nearby surface water bodies due to increased runoff volumes or diversions of runoff; degradation of downstream surface water quality as a result of erosion and sedimentation or discharges of pollutants associated with building activities; and changes in groundwater flow patterns due to dewatering of excavations and soil retention management practices. The most potentially significant impact is that some existing streams on the site will be directly disturbed, and some adjacent streams will experience a temporary increase in sediment loading due to increased runoff of disturbed soil.

Several federal, state, and local permits will govern building activities that have the potential to impact water resources. Water-related impacts are minimized by implementing BMPs, including erosion, grading, and sediment control measures; SWPPPs; spill prevention and countermeasure plans; and compliance with federal, state, and local regulations pertaining to disturbance of water bodies and pollution discharges.

Proposed hydrological alterations to the NC-19 site for building activities are minimal in terms of impact to surface water and groundwater. Impacts related to hydrological alterations to surface waters for Project operation are MODERATE because of the need for a pumping station and because Harris Lake will need to be raised to support plant operation. Impacts as a result of building activities and operation are SMALL for water use and water quality since stormwater

and plant discharge leaving the site will follow natural contours using culverts and other water management structures, to maintain hydrologic conditions to the extent practicable.

9.3.2.2.3 Terrestrial Ecology

Any large construction project impacts terrestrial ecology primarily by disturbing natural habitats and making those habitats unavailable to plants and animals. Although building activities may result in direct mortality to some plants and animals, most animal species are able to move away to avoid direct impacts. Even those species, however, may experience population declines due to loss of habitat. In addition, noise, lights, and dust may cause some animals to leave areas near building activities. This is also experienced as a loss of usable habitat.

The evaluations conducted for terrestrial ecology were based on a desktop review of publicly available data. Site specific terrestrial habitat conditions are not generally known without a site survey.

The USEPA defines ecoregions in hierarchical levels from Level I to Level IV, increasing in detail as the level increases. The USEPA maintains the mapping of ecoregions (USEPA, 2025a). The NC-19 site is located within the Piedmont Level III Ecoregion. Additionally, the NC-19 site is located within the Triassic Basins Level IV Ecoregion which is detailed as having a mosaic of mixed and deciduous forest, pasture, cropland, and urban land cover (USEPA, 2025b).

NLCD data indicates that the land cover in the approximately 976 ac. (395 ha) NC-19 site is characterized predominantly by evergreen forest (798 ac. [323 ha]), which is the most prevalent land cover type. Other common land cover types include shrub scrub (42 ac. [17 ha]), developed low intensity (42 ac. [17 ha]) and developed open space (41 ac. [17 ha]). The most prevalent land cover type found within the 6-mi. (10-km) vicinity of the NC-19 site is evergreen forest (40,080 ac. [16,220 ha]), followed by mixed forest (16,039 ac. [6491 ha]), open water (8827 ac. [3572 ha]), and developed open space (5830 ac. [2359 ha]) (Table 9.3-3) (Dewitz, J. and USGS, 2021).

A review of USFWS NWI data was completed to determine on-site aquatic resources for the NC-19 site. Multiple intermittent tributaries flow southwest to the Cape Fear River within the NC-19 site. Multiple unknown perennial tributaries also flow southeast to Harris Lake within the NC-19 site. Freshwater forested/ shrub wetlands were observed to border the tributaries.

The USFWS IPaC report for the NC-19 site indicated that three federally listed species, and one species proposed for listing, could be “potentially affected by activities at this location” (USFWS 2025) (Table 9.3-5):

- Red-cockaded Woodpecker (*Dryobates borealis*); threatened
- Monarch Butterfly (*Danaus plexippus*); proposed threatened
- Harperella (*Ptilimnium nodosum*); endangered
- Michaux's Sumac (*Rhus michauxii*); endangered

A review of the IPaC report did not indicate that any federally designated or proposed critical habitat for terrestrial species is found on the NC-19 site.

State Listed Species

Wake and Chatham counties, NC NCNHP data for state-listed species were reviewed for the NC-19 site. Together, the two counties have 30 state listed threatened and endangered species,

excluding the previously listed federal species (Table 9.3-5). Additionally, the site overlaps with Harris Game Land, which is land leased by Duke Energy to the NC Wildlife Commission Game Lands Program.

Table 9.3-3 shows that the acreage of each habitat potentially affected by building activities is a relatively small percentage of the total acreage of the habitat available in the site vicinity. In addition, it appears that the eastern parcel of the NC-19 site has been subject to prior disturbance due to the presence of facilities related to the existing Shearon Harris Nuclear Plant. The western parcel also appears to be previously disturbed due to the presence of pine plantations on the site. Therefore, habitat at the NC-19 site is considered low quality relative to adjacent habitat. Detailed field studies are required to determine whether any federally listed or threatened species make significant use of the site, and as reconnaissance level data was used for this evaluation, such studies were not conducted for the NC-19 site. Based on the area affected, overall impacts on terrestrial habitats are noticeable. However, because of the availability of similar land cover types within the Project Vicinity, the prevalence of low-quality plant communities, and reduced quality of the existing habitats on the Project site, potential impacts on terrestrial land cover are noticeable but not destabilizing. Impacts to terrestrial ecology for building activities at the NC-19 site are MODERATE. Overall, the impacts of Project operation on terrestrial habitat are minimized through the use of BMPs during landscape maintenance and transmission line operation and maintenance. Therefore, impacts are SMALL. Disturbance to wetland and streams may occur as a result of building activities. However, impacts to wetlands and streams are regulated by several federal, state, and local regulations and are minimal.

9.3.2.2.4 Aquatic Ecology

The evaluations conducted for aquatic ecology were based on a desktop review of publicly available data. Site specific aquatic habitat conditions are not generally known without a site survey.

Federally Listed Species

The USFWS IPaC report for the NC-19 site indicates that one endangered aquatic species, could be “potentially affected by activities at this location” (USFWS, 2025). Additionally, the NCNHP also listed the following endangered, threatened, and candidate aquatic species with potential to be found in Chatham and Wake counties (Table 9.3-5):

- Dwarf Wedgemussel (*Alasmidonta heterodon*); endangered
- Green Floater (*Lasmigona subviridis*); proposed threatened
- Yellow Lance (*Elliptio lanceolata*); threatened
- Neuse River Waterdog (*Necturus lewisi*); threatened
- Caper Fear Shiner (*Notropis mekistocholas*); endangered
- Robust Redhorse (*Moxostoma robustum*); candidate
- Carolina Madtom (*Noturus furiosus*); endangered

A review of the IPaC report did not indicate that any federally designated or proposed critical habitat for aquatic species is found on the NC-19 site.

State Listed Species

Wake and Chatham counties, NCNHP data for state-listed species was reviewed for the NC-19 site. Wake and Chatham counties have 22 state-listed aquatic endangered and threatened species, excluding the previously listed federally listed aquatic species (Table 9.3-5).

Some aquatic organisms that use this area could suffer direct impacts from building activities, including the loss of habitat due to raising the elevation of Harris Lake, but most organisms will move away from the area and be affected primarily by the loss of a limited amount of habitat. In addition, some aquatic species might be affected by increased turbidity and siltation resulting from building activities, but such effects will be temporary and localized. The area that is subject to disturbance in Harris Lake is small and impacts to Harris Lake from building activities are regulated under federal, state, and local permits. Therefore, impacts on aquatic ecology due to building activities are SMALL.

Direct impacts of operation on aquatic ecosystems in Harris Lake include impingement and entrainment associated with the cooling water intake structure, effects of cooling tower effluent constituents and thermal effluents, and effects of water-level fluctuations within Harris Lake. Operational impacts to aquatic ecosystems include impacts related to on-site stormwater runoff and incidental spills. Impacts on-site are managed through stormwater management systems and, therefore, are minor. In Harris Lake, impacts are associated with the intake and discharge structures operations, and changes in water levels. Impacts of the discharge(s) are expected to dissipate rapidly, limiting impacts on aquatic ecosystems. Impacts of intake operation are minimized through compliance with CWA Section 316(b) requirements.

Compliance with thermal discharge limits required under the operational NCDEQ NPDES permit will limit adverse impacts to aquatic biota. In addition, raising the levels of Harris Lake may disrupt the aquatic ecology of streams that would be inundated by this action.

Impacts on aquatic species and habitats within Harris Lake from operations, under normal operational conditions in which water levels are stabilized and consumptive losses are offset by makeup water intake structure pumping are minor. Potential impacts to aquatic species and habitats from hydrologic alterations associated with increased water-level fluctuation under drought conditions within Harris Lake relate to effects on aquatic macrophyte communities, benthic macroinvertebrates and mussels, effects on fish communities through alteration of habitats (e.g., spawning habitat, nursery areas, foraging habitat), and increased potential for proliferation of nuisance macrophytes. The balance of fish communities is not expected to shift in such a way that would promote the expansion of nonindigenous fish beyond those already present in Harris Lake. Therefore, impacts on aquatic ecology due to operation of the Project is SMALL to MODERATE (during drought conditions).

9.3.2.2.5 Socioeconomics

This subsection evaluates the social and economic impacts that could result from constructing and operating the Project at the NC-19 site. The evaluation includes the impacts of building and operation activities and demands placed by the construction and operation workforces on the site and the surrounding region.

9.3.2.2.5.1 Physical Impacts

This subsection provides an analysis of the physical impacts of building activities and operation associated with noise and vibration, odors, dust and air pollution, transportation, and aesthetics.

9.3.2.2.5.1.1 Noise and Vibration

Based on an examination of aerial photographs, the nearest sensitive receptors to the NC-19 site include a residence located approximately 0.4-mi. (0.6-km) to the north of the site and a residence located approximately 0.3-mi. (0.5-km) south of the site. The sensitive receptors are more than 50 ft. (15 m) from any area that may be subject to vibration related effects from blasting and are not expected to experience impacts from blasting. Appropriate measures will be taken to minimize noise impacts from building activities and operation of Project to sensitive receptors. Additionally, a large, forested buffer will remain between the NC-19 site and any sensitive receptors which will further reduce noise impacts. Vibration and noise impacts during building activities to nearby sensitive receptors are SMALL.

The impacts from operation are similar to the impacts of building activities but somewhat reduced. Operating plant equipment will produce some noise, but the noise levels generally are lower than the levels associated with building activities. Therefore, the noise and vibration impact during operation is SMALL.

9.3.2.2.5.1.2 Odors, Dust, and Air Pollution

Based on a review of aerial photographs, there are no residences within the conceptual site boundary of the NC-19 site. The nearest sensitive receptor is a residence located approximately 0.3-mi. (0.5-km) to the south of the site. Similarly, to the Belews Creek, NC site, as described in Section 4.4.1.2, building activities are localized mostly to the NC-19 site because they are generated from ground-level or near-ground-level activities. Because air emissions from on-site building activities are generally released from near ground-level sources, impacts are potentially greatest at the nearest off-site receptors. The nearest sensitive receptors include residences to the north and south. To minimize temporary air and dust emissions, BMPs will be implemented during the construction of the site. Additionally, building activities are subject to air permits under state and federal laws that address the impact of air emissions on sensitive receptors. This is further discussed in Section 9.3.2.2.8. The impacts of odor, dust, and air pollution are similar to the Belews Creek, NC site, and are SMALL.

The impacts of odors, dust, and air pollution during operation are similar to the impacts of building activities but somewhat reduced. Periodic maintenance is required for both on-site and off-site facilities and the maintenance activities will create some dust, but these impacts will be more localized and of shorter duration than during construction. Therefore, the impact of operation is SMALL.

9.3.2.2.5.1.3 Transportation

This subsection discusses the physical impacts on off-site roadways resulting from increased traffic during building activities.

Similarly, to the Belews Creek, NC site, as described in Section 4.4.1.3, during the building phase, deliveries, and commuting construction workers result in vehicle use on off-site roadways that may impact pavement and roadway physical conditions.

Because U.S Highway 1 represents the only point of ingress and egress into the NC-19 site, all traffic is focused on this roadway segment. As a result, increased traffic related to the Project accelerates the deterioration of U.S. Highway 1 relative to other roads within the surrounding transportation network. Roadway repairs and improvements on U.S. Highway 1 and other roadways in the vicinity of the NC-19 site inadvertently affected by vehicles related to the Project, may be necessary to reduce safety risks and restore pavement conditions. Any damage to public roads, markings, or signs caused by building activities is repaired to preexisting

conditions or better in accordance with state and local requirements. Therefore, physical impacts from building and operation activities on the transportation network in the vicinity of the NC-19 site are SMALL.

9.3.2.2.5.1.4 Aesthetics

Aesthetics in the vicinity of the new plant could be affected by the visual intrusion of large industrial structures and equipment. During building activities, dust could create additional visual intrusions. During operation, water vapor plumes from the cooling towers will be readily visible at certain times. Given that the NC-19 site is located adjacent to an existing nuclear power plant, building activities and operation will not significantly alter the existing visual conditions.

NUREG-1437 establishes the following criteria for judging the severity of aesthetic impacts:

> SMALL - No complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and no measurable impact on socioeconomic institutions and processes.
>
> MODERATE - Some complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes.
>
> LARGE - Continuing and widely shared opposition to the project based on a perceived degradation of the area's sense of place or diminution in enjoyment of the physical environment, and measurable social impacts that perturb the continued functioning of community institutions and processes.

The immediate area around the NC-19 site features several notable visual resources:

- Harris Lake, a scenic body of water used to support nuclear power plant operation and recreation.
- Forested land.
- The Shearon Harris Nuclear Plant, located adjacent to the NC-19 site. This is a significant industrial feature in the area.
- Mid-density residential lands to the north and east of the NC-19 site.

These elements together create a diverse visual environment around the NC-19 site. Sensitive visual receptors, which are potentially affected by visual intrusions of the Project, include recreators on Harris Lake and residences north and east of the NC-19 site boundary.

Considering that the NC-19 site is located adjacent to an existing nuclear power plant within land already owned by Duke Energy, it is unlikely that there will be general opposition to the Project based on perceived degradation of sense of place, and the Project will not impact the continued functioning of institutions and processes. However, there will be a noticeable impact to aesthetics due to the conversion of previously vegetated land to industrial use. Therefore, the aesthetic impact associated with building activities and operation is similar to the Belews Creek, NC site and is MODERATE.

9.3.2.2.5.1.5 Summary of Physical Impacts

The physical impacts from noise, odors, dust, and air pollution, and transportation from building and operations-related activities are SMALL. Additionally, because existing vegetated land will be converted to industrial use, NC-19 site impacts to aesthetic quality are MODERATE.

9.3.2.2.5.2 Demographic Impacts

Impacts on demography are associated with construction workers and operation workers moving into the region surrounding the NC-19 site, potentially causing changes in off-site land use and development patterns. Construction employment is inherently temporary, but construction workers sometimes move their families into the region, magnifying the population increase.

Per NUREG-1437, demographic impacts are expected to be SMALL if project related population growth represents less than 5 percent of the study area's total population, MODERATE if 5 to 20 percent, and LARGE if more than 20 percent.

As described in Section 4.4.2.1, it is estimated that the total peak workforce for building plus operations is 2676 workers. A conservative assumption that can be made is that the entire peak building phase workforce (2676 people) will move into and bring families into Wake County, where the majority of the nearby population resides. Applying the average NC household size of 2.48 people per household (Section 4.4.2.2), the total population increase is 6636. Using the year 2020 population (1,129,410) of Wake County and the conservative population increase discussed above, population growth due to the in-migrating workforce is approximately 0.3 percent. Therefore, the building-related demographic impacts in Wake County are SMALL.

The number of in-migrating workers during operation of the plant will be less than that for building, so operations-related demographic impacts at the NC-19 site are also SMALL.

9.3.2.2.5.3 Economic Impacts to the Community

This section describes the economic and tax impacts in the 50-mi. (80-km) Region of Interest around the NC-19 site during building activities and operation.

9.3.2.2.5.3.1 Economy

Impacts on the economy are caused primarily by the jobs provided to construction and operation workers. The wages paid to workers result in additional spending, which tends to stimulate the economy, particularly in the retail and service sectors. This can provide opportunities for new businesses and new jobs. These effects are considered to be beneficial and are expected to occur primarily in the area within which the workers reside.

Per NUREG-1437, economic impacts are considered SMALL if project related employment represents less than 5 percent of the study area's total employment, MODERATE if 5 to 10 percent, and LARGE if more than 10 percent.

The employment of the workforce during building activities and operation of the nuclear plant will have a positive economic effect on both Wake and Chatham counties and the surrounding region. Building and operation activities at the NC-19 site will introduce millions of dollars into the economy and indirectly create jobs that help reduce unemployment and provide opportunities for service-related industries.

For this analysis, it was assumed that the majority of the in-migrating workforce will move to Wake County. According to USCB ACS 5 -Year estimates from 2023, Wake County's civilian labor force totaled 637,987. Of those labor force participants, 611,492 were employed and 26,495 were not, representing an unemployment rate of 3.9 percent. Using the county value for total employment (637,987) and the conservative county employment increase discussed above (2676), employment due to the building workforce is 0.4 percent. Therefore, the building-related economic impact in Wake County is SMALL and beneficial.

Similarly to the Belews Creek, NC site, Project operation at the NC-19 site will introduce millions of dollars into the economy annually and indirectly creates employment opportunities. The economic impact of operations is SMALL and beneficial.

9.3.2.2.5.3.2 Taxes

Property taxes, sales taxes, and other taxes paid during building and operation of the new plant will benefit the state and local jurisdictions that collect the taxes. The significance of tax impacts is determined primarily by regional conditions, and those conditions are essentially the same for the NC-19 site as for the Belews Creek, NC site, as both sites are within NC. Therefore, regional tax impacts are essentially the same at both sites.

The analysis presented in Section 4.4.3 indicates that the tax impact of constructing the new plant at the Belews Creek, NC site is expected to be MODERATE and beneficial. The analysis presented in Section 5.4.3.3 indicates that the tax impact of plant operation at the Belews Creek, NC site is also expected to be SMALL and beneficial. Therefore, the building activities related and operation related tax impact at the NC-19 site is expected to be MODERATE and beneficial during building activities, and SMALL and beneficial during operation.

9.3.2.2.5.3.3 Summary of Economic Impacts to the Community

Building and operational activities at the NC-19 site will introduce millions of dollars into the economy and creates jobs. These positive economic impacts are primarily realized within the Region of Interest, Minor tax revenue impacts on local jurisdictions are accrued through increases in revenue generated from individual income taxes, sales and use taxes, and property taxes. Therefore, the economic and tax impacts are SMALL to MODERATE and beneficial during building activities and SMALL and beneficial during operation.

9.3.2.2.5.4 Community Infrastructure Impacts

This subsection provides the estimated impacts on infrastructure and community services, including transportation, recreation, housing, and public services.

9.3.2.2.5.4.1 Transportation

Transportation in the vicinity of the new plant could be affected by the increase in vehicle traffic associated with construction and operation workers commuting to the site and the delivery of materials and equipment to the site. The increase in vehicle traffic could cause delays on local roads. The severity of such impacts will depend primarily on the existing traffic volumes and LOS on local roads compared with the expected volume of traffic related to the Project.

Road access to the NC-19 site is provided primarily by U.S. Highway 1, which is maintained by the NCDOT. This asphalt highway has two lanes of traffic, traveling east and west (NCDOT, 2025a).

NCDOT data (NCDOT, 2025b) indicates that the average daily traffic volume for all lanes in both directions on U.S. Highway 1 is 36,000 vehicles. As stated in Section 4.4.2.1, there is a peak employment period during which two advanced reactor units are being constructed while four advanced reactor units are operating. It is estimated that during peak employment 2546 vehicles are expected to enter and leave the building site at the same time.

Considering the nature of the roads in the vicinity of the NC-19 site and the current volume of traffic on those roads, it is likely that the peak building traffic will noticeably alter existing transportation conditions (cause noticeable delays on local roads) but will not be sufficient to destabilize important transportation resources. Therefore, the transportation impacts associated

with building activities are MODERATE. Impacts to transportation due to workforce traffic during operations are SMALL within the broader transportation network, but MODERATE on two-lane segments and intersections that provide access to the Project site due to the short duration of daily peak traffic and implementation of planned traffic management measures to reduce congestion and unstable conditions.

9.3.2.2.5.4.2 Recreation

Recreational resources within the vicinity of the NC-19 site are potentially affected by building activities at the NC-19 site. Impacts may include (1) impaired recreational experience associated with the views of the building activities, (2) increased user demand associated with the projected increase in population as a result of the in-migrating workforce and their families, and (3) possible access delays associated with increased traffic on local roadways.

Raising the level of Harris Lake beyond the current 220 ft. (67 m) level up to a maximum analyzed level of 240 ft. (73 m) will impact recreators. Approximately 279 ac. (98 ha) of recreation facilities at Harris Lake County Park and four boat ramps will be displaced by the rise to the Harris Lake water level. Because these areas will be displaced by the change in water level elevation, recreators who might have used these areas will have to relocate to other nearby recreation or related areas. However, these recreation areas will be replaced after building is complete.

Recreational areas within the vicinity of the NC-19 site are also impacted by the increase in population associated with in-migrating workers and their families. Workers who relocate to the Region of Interest are expected to use recreational areas and outdoor activities at the same rates as the existing permanent population of the Region of Interest. Although the in-migrating population increases usage of recreational areas within the vicinity of the NC-19 site, the increase is minor compared to the existing population and is not anticipated to impede or disrupt current usage of recreational areas.

Overall, during the building phase, recreators may experience increased noise levels and visual discord from building activities at the NC-19 site. The increased noise levels and visual discord may be noticeable to individual recreators on Harris Lake in areas adjacent to and north of the NC-19 site; however, it does not reflect an impact that is more broadly evident within the larger reaches of Harris Lake and does not destabilize the overall recreational experience. Recreators will also experience temporary impacts when the water level of Harris Lake is raised, however because these recreational facilities will be replaced, impacts from building activities are anticipated to be MODERATE.

Operational use of water from Harris Lake for the Project will result in water level fluctuation, similarly to the Belews Creek, NC site, and the impact will be SMALL to MODERATE.

9.3.2.2.5.4.3 Housing

Impacts on housing could be caused by construction and operation workers moving, either permanently or temporarily, into the region surrounding the NC-19 site. This influx of workers could decrease the availability of unoccupied housing units and increase the cost to buy or rent housing. The severity of such impacts will depend primarily on the existing availability of unoccupied housing units compared with the number of workers who will move into the area.

NUREG-1437 establishes the following criteria for judging the severity of housing impacts:

> SMALL - Small and not easily discernible change in housing availability. Increases in rental rates or housing values equal or slightly exceed the statewide inflation rate.

MODERATE - Discernible but short-lived reduction in available housing units. Rental rates and housing values rise slightly faster than the inflation rate, but prices realign quickly once new housing units became available, or project related demand diminishes.

LARGE – Project related demand for housing units results in very limited housing availability and increases in rental rates and housing values well above normal inflationary increases in the state.

Based on USCB ACS 2023 5-year estimates (USCB, 2023), the total number of vacant housing units in the 50-mi. (80-km) region surrounding the NC-19 site is 105,442. The conservative estimate of the peak workforce discussed in Section 4.4.2.1 (2676) represents 2.5 percent of the unoccupied housing units in the region. Because a sizable percentage of the unoccupied housing units will remain available, it is unlikely that there will be a discernible change in housing availability or increase in housing costs. Therefore, the building-related housing impact in the 50-mi. (80-km) region is SMALL.

It is estimated in Section 5.4.2 that during operation, a staff of 818 full time Project-related personnel will be utilized once all units are operational. Approximately 0.8 percent of the available vacant housing in the NC-19 site Region of Interest is expected to be occupied by this increased population. Overall, sufficient housing is available within the Region of Interest to accommodate both operations-related workers and temporary short-term workers. Therefore, impacts on housing due to operation are SMALL.

9.3.2.2.5.4.4 Public Services

Public services include police, fire, and medical services; social services; water supply and wastewater treatment facilities; and recreation facilities. Impacts on public services could be caused by building and operation workers moving into the region surrounding the NC-19 site. This influx of workers could increase the demand for public services, potentially requiring local governments to add facilities, programs, and/or staff.

Per NUREG-1437, impacts on public services generally are considered to be SMALL if there is little or no need to add facilities, programs, and/or staff because of the influx of workers, and MODERATE or LARGE if additional facilities, programs, and/or staff are required.

As discussed in Section 9.3.2.2.5.2, the number of construction and operation workers estimated to move into Wake County and the 50-mi. (80-km) region is SMALL compared with the existing populations. Therefore, the building activities and operations related impacts on public services in Wake County and the 50-mi. (80-km) region are SMALL.

9.3.2.2.5.4.5 Education

The NC-19 site is located within the North Central District 3 Wake and Chatham Counties school districts. Wake County School District contains 199 schools, with 120 elementary schools, 38 middle schools, 31 high schools, seven alternative schools, and three K-8, 6-12 schools. The student-teacher ratio is 15 to 1. USCB ACS 5-year estimates from 2023 for Wake County indicate that an estimated 197,361 children from kindergarten to 12th grade are enrolled in school. Chatham County School District contains 20 schools, with one alternative school, one K-4 school, one K-5 school, five K-8 schools, three middle schools, and five high schools. The student-teacher ratio is 15 to 1. USCB ACS 5-year estimates for Chatham County indicate that an estimated 12,133 children from kindergarten to 12th grade are enrolled in school (USCB 2023).

As discussed in Section 4.4.4.4.4, 19 percent of the population in NC is between 5 to 19 years old (i.e., school age). Using this percentage and applying it to the total in-migrating population of

6636 persons, approximately 1261 persons are of school age. As in previous sections, it was assumed that most of the in-migrating workforce will migrate to Wake County. An increase of 1261 school-aged children in Wake County will be 0.6 percent of the current number of school aged children (197,361) enrolled in Wake County (USCB, 2023).

NUREG 1437 indicates that impacts to education are:

> SMALL – If Project related increase in school enrollment represents 3 percent or less of the total school enrollment in affected school systems,
>
> MODERATE – If Project related increase in school enrollment represents 4 to 8 percent of the total school enrollment in affected school systems, and
>
> LARGE – If Project related increase in school enrollment represents more than 8 percent of the total school enrollment in affected school systems.

The increase in school enrollment due to the Project is less than 3 percent of the total school enrollment, therefore education impacts from building activities are SMALL.

The number of operation workers is estimated to be smaller than the number of construction workers, so the amount of corresponding school-aged children will also be less. Therefore, the operation-related education impacts in Wake County are SMALL.

9.3.2.2.5.4.6 Summary of Community Infrastructure Impacts

Operation-related impacts on all infrastructure and community services are SMALL to MODERATE within Wake County and the 50-mi. (80-km) Region of Interest.

9.3.2.2.6 NOT USED

Deleted (Executive Order, 2025a, 2025b).

9.3.2.2.7 Historical and Cultural Resources

As defined by the NHPA of 1966, as amended (54 USC. §306108) and its implementing regulations 36 CFR 800.16(I)(1), historic properties are those properties deemed eligible for listing or that are already listed in the NRHP. Issuance of an early site permit is subject to review and consultation under Section 106 of the NHPA which requires the applicant to “take into account the effect of the undertaking on any historic property” and afford the Advisory Council on Historic Preservation “a reasonable opportunity to comment with regard to the undertaking.” This subsection provides an evaluation of the NC-19 site regarding potential impacts to historic and cultural resources.

There are no NRHP listed sites within the conceptual site boundary or within the immediate vicinity of the site. The closest NRHP listed site is the New Hill Historic District which is approximately 2.5-mi. (4-km) from the NC-19 site. No NRHP listed sites will be impacted by building the Project at the NC-19 site. There are 23 NRHP listed sites within a 10-mi. (16-km) radius of the site, six of which are historic districts.

Siting a nuclear plant at the NC-19 site will require a formal cultural resources survey be conducted so that no archaeological or historic resources will be damaged during plant building activities. Mitigative measures will be performed to prevent permanent damage and ensure that any impacts to cultural resources from building activities or operation at the NC-19 site are SMALL.

9.3.2.2.8 Air Quality

The CAA was enacted in 1970 to protect public health and welfare and authorizes the USEPA to set NAAQs for six common pollutants, called criteria pollutants. There are also provisions to regulate hazardous air pollutants, which are pollutants that are harmful to human health and/or the environment, as well as GHGs, primarily CO_2 (42 United States Code §7401 et seq).

The CAA requires the USEPA to set NAAQS for pollutants considered to be harmful to public health and the environment. Primary NAAQS provide public health protection including protecting the health of sensitive populations (asthmatics, children, elderly, etc.). Secondary NAAQS provide public welfare protection against decreased visibility and damage to animals, crops, vegetation, and buildings (USEPA, 2025a).

NC reached full attainment with all NAAQS across the entire state in 2015 (NCDEQ, 2024, USEPA, 2025c). The most recent pollutant to be redesignated was ozone. On July 28, 2015, the USEPA redesignated to attainment the NC-portion of the Charlotte-Rock Hill, NC-SC, nonattainment area for the 2008 8-hour ozone NAAQS, effective August 27, 2015.

The CAA defines Class I areas as national parks greater than 6000 ac. (2428 ha), wilderness areas greater than 5000 ac. (2023 ha), national memorial parks greater than 5000 ac. (2023 ha), and international parks that were in existence as of August 1977. These areas are potentially sensitive to visibility impairment. The USEPA states that a Class I visibility impact analysis is necessary for a major source within 62-mi. (100-km) of a Class I area (USEPA, 1990).

The USEPA promulgated the Regional Haze Rule to improve visibility in Class I areas in 1999 with the ultimate goal of restoring natural background visibility by 2064 (Federal Register Vol. 64, 1999). This rule was amended in 2005 to require certain industrial facilities to install emission controls to reduce emissions of air pollutants that reduce visibility (USEPA, 2025c; Federal Register Vol. 70, 2005). These pollutants include particulate matter with a diameter 2.5 microns or less ($PM_{2.5}$) and compounds that contribute to $PM_{2.5}$ formation, such as nitrogen oxides, sulfur dioxide, certain volatile organic compounds, and ammonia.

The closest Class I area to the NC-19 site is the Linville Gorge Wilderness Area, approximately 213-mi. (343-km) away. There are no Class I areas within 62-mi. (100-km) of the NC-19 site, therefore, no Class I areas are affected (USEPA, 2025b).

The NC-19 site is an attainment area for all criteria pollutants, similarly to the Belews Creek, NC site. These two sites are similar from an air quality perspective. Sections 4.7 and 5.7 indicated the impacts to Air Quality building activities and operation at the Belews Creek, NC site are SMALL. As such, the impacts of building activities on air quality are expected to be SMALL and temporary, and the impacts of facility operations on air quality are also expected to be SMALL for the NC-19 site.

9.3.2.2.9 Nonradiological Health

Nonradiological health impacts on the public and workers from building and operation activities at the NC-19 site are similar to those evaluated in Sections 4.8 and 5.8. They include the impacts of public and occupational health, the impacts of noise and vibration, and the impacts of transporting building materials and personnel to and from the Project site. Additional data required, based on applicable federal and state air quality and noise regulations, are provided during the building phase. The NC-19 site has characteristics that will require site-specific Health and Safety Plans for the building phases. Health impacts to workers from occupational injuries, noise, and electric fields are similar at the NC-19 site to those at the Belews Creek, NC

site. The NC-19 site does not have characteristics that are expected to lead to fewer, or more, operational accidents than those expected at the Belews Creek, NC site. Due to the implementation of BMPs and compliance with regulations and permit conditions, non-radiological health impacts from building activities and operation are expected to be SMALL for all categories.

9.3.2.2.10 Radiological Health

A detailed evaluation of radiological health impacts requires site specific information (e.g., meteorological data) that is not available for the NC-19 site. This site does have existing operating nuclear facilities, therefore, potential radiological exposures due to existing facilities are higher than for the Belews Creek, NC site and the NC-17 site. Human health impacts are also dependent on population density near the proposed facility. There is a high population density in the vicinity of the NC-19 site which increases the potential for health effects. Radiological health impacts for building activities and operation at the Belews Creek, NC site are discussed in Sections 4.9 and 5.9. Radiological health impacts are expected to be slightly higher at the NC-19 site than at the Belews Creek, NC site, but not significantly so. Generally, dose rates will be within allowable limits and consequences would be SMALL at the NC-19 site.

9.3.2.2.11 Nonradioactive Waste Management

The impacts on the environment that could result from the generation, handling, and disposal of nonradioactive waste and mixed waste during building activities and operations at the NC-19 site would be similar to those at the Belews Creek, NC site, which is described in further detail in Sections 4.10 and 5.10. Therefore, impacts to land, water, and air from nonradioactive waste generated, handled, stored, and disposed of during building activities and operations are SMALL.

9.3.2.2.12 Environmental Impacts of Postulated Accidents

The potential environmental impacts from a postulated accident, considering both DBAs and severe accidents, for the Belews Creek, NC site are described in Section 5.11. The DBAs and severe accidents analyzed to-date for the Belews Creek, NC site are applicable to the NC-19 site.

The NC-19 site is approximately 16-mi. (26-km) southwest of Raleigh, NC. The site is also approximately 15-mi. (24-km) northeast of Sanford, NC. Harris Lake is adjacent to the site. Within a 5-mi. (8-km) radius the land is mostly wooded and within a 50-mi. (80-km) radius the land is mostly used for agricultural production. Meteorological data recorded at the Raleigh-Durham International Airport (KRDU) shows area mean wind speeds are generally moderate with an average annual mean speed of 6.4 mph (10.3 kph) and meteorological characteristics include stable conditions (NOAA NCEI, 2022b).

It is unlikely that differences in local meteorological conditions are sufficient to cause doses from DBAs for multiple advanced reactors at the NC-19 site to exceed regulatory limits or guidelines or the impacts from a similar accident at the Belews Creek, NC site. Therefore, the impacts from postulated accidents at the NC-19 site are SMALL.

9.3.2.3 Evaluation of Cumulative Impacts for the NC-17 Site

The NRC regulations in 10 CFR Part 51 implementing NEPA of 1969, as amended (42 U.S. Code § 4321 et seq.), require that the NRC consider the cumulative impacts of proposals under its review (10 CFR 51.71(d)). Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with past, present, and reasonably foreseeable future actions (RFFAs).

Cumulative impacts are defined as “significant effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and RFFAs regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from actions with individually minor but collectively significant effects taking place over a period of time.”

The purpose of this subsection is to identify any past, present, and RFFAs within the geographic area of interest (GAI) of each resource that could have cumulative impacts in conjunction with the Proposed Action. Potential impacts will include substantial changes to any of the analyzed resources which will not occur if the Project is not constructed. Table 9.3-6 lists the projects within the GAI for the NC-17 site.

9.3.2.3.1 Land Use

The GAI for land use impacts encompasses the site, the vicinity, and extent of offsite areas. The projects listed on Table 9.3-6 that are within the GAI include the Roxboro Steam Station, the Person County Energy Complex, the Enbridge – T-15 Reliability Project, and the Person County Mega Park. The Multi Resolution Land Characteristics Consortium, National Landcover Database report for Person County indicates that from 1985 to 2023 there was a 31 percent change in land cover within the county. The biggest change in land cover is the loss of deciduous forest (MRLC, 2025). Prior to construction of the Roxboro Steam Station and the impoundment of the Hyco River to form Hyco Lake, the approximately 6095-ac. (2467-ha) parcel of land the existing Roxboro Steam Station is located on, was converted from primarily agricultural land, rural residential, and woodlands to industrial use. The Enbridge – T-15 Reliability Project will predominantly parallel existing rights-of-way, which will result in minimal impacts to existing land use. The Person County Mega Park will permanently disturb approximately 175 ac. (71 ha) of land. The land where the Person County Mega Park is planned to be constructed is currently forested with some areas of rangeland and was rezoned from rural conservation to general industrial. Given the permanent conversion of forested, agricultural, and rural land to industrial use from the construction and operation of past, present and RFFAs in the GAI, the environmental effects from cumulative land use are sufficient to alter noticeably, but not to destabilize, any important attributes of land use within the GAI. In summary, the cumulative impact of building and operating activities from the Project on land use, added to the effects associated with past, present, and RFFAs within the GAI on land use is noticeable but not destabilizing and therefore MODERATE. Because of extensive past and present modification of land use within the GAI, and the Project site’s proximity to the adjacent existing industrial Roxboro Steam Station, the impact of building the Project is a noticeable, but not a destabilizing contributor to the cumulative impact on land use.

9.3.2.3.2 Water Resources

The GAI for water resources encompasses a 50-mi. (80-km) radius surrounding the NC-17 site. Any past, present, and RFFAs within a 50-mi. (80-km) radius of the NC-17 site are subject to federal, state, and local laws and regulations, which will limit impacts to surface waters and wetlands. One stream, Powells Creek is listed as impaired within the After Bay Reservoir-Hyco

River watershed. Powells Creek is listed as impaired for recreation, due to the presence of E. coli. Additionally, a review of the NLCD report for Person County indicated that 1.3 percent of Person County is wetland, and 0.09 sq. mi. of wetlands were lost between 1985 and 2023. The Roxboro Steam Station currently uses Hyco Lake as a cooling reservoir, however four coal-fired units at the existing Roxboro Stream Station are proposed to be replaced with two hydrogen capable natural gas units by 2030 which will use less water than the coal-fired units. Peak water use at Hyco Lake will occur between 2028 and 2033, when the natural gas units will be operational before the coal-fired units are retired. If the Project is to be operational around this same time, additional strain will be placed on Hyco Lake. Mayo Reservoir is a reservoir formed from the impoundment of Mayo Creek, a tributary to the Hyco River. Mayo Reservoir functions as the cooling water source for the Mayo Plant. Neither Mayo Reservoir nor Hyco Lake are listed as impaired by the USEPA. The Moriah Energy Center will use groundwater for employee facilities; however, groundwater will not be used for plant processes or natural gas liquefaction. Groundwater use will be minimal at this facility. Potential adverse impacts associated with building activities of the past, present, and RFFAs listed in Table 9.3-8 include construction-related discharges. However, these will be managed in accordance with an approved SWPPP, National Pollutant Discharge Elimination System (NPDES) permits for stormwater discharges, and BMPs will be implemented during construction activities. The incremental contribution of pre-construction and construction activities on surface water quality will be minimal.

Overall, the environmental effects from cumulative impacts to hydrology from past, present, and RFFAs are sufficient to alter noticeably, but not to destabilize, any important attributes to hydrology within the GAI. The cumulative impacts to hydrology are SMALL to MODERATE.

9.3.2.2.3.3 Terrestrial Ecology

The GAI for terrestrial ecology is 6 mi. (10 km). Most of the projects in Table 9.3-8 are further than 6 mi. (10 km) and will not contribute to cumulative impacts. As stated in Section 9.3.2.3.1, the construction of Roxboro Stream Station converted approximately 6095 ac. (2467 ha) of agricultural land, rural residential land, and woodlands to industrial use. This conversion resulted in the decrease of habitat for terrestrial species that rely on woodland habitat. Most of the work for the Person County Energy Complex will take place in previously developed or disturbed areas. Disturbance to wildlife will generally be related to noise, and movement, which will be confined to the immediate vicinity of the project. A review of aerial photographs indicated that the CertainTeed Roxboro Wallboard facility converted approximately 38 ac. (15 ha) of rangeland and forested areas to industrial use. None of the previously mentioned projects will impact any critical habitat, and all are subject to the Endangered Species Act of 1973. Construction and operation of the Project at the NC-17 site will contribute incrementally to the conversion of forest to other land uses and the fragmentation of forest habitats that have already occurred and are likely to continue due to other development in the GAI. The impact of building and operation activities on terrestrial ecosystems and wetlands results in degradation of quality habitat that is persistent. Because of habitat loss on the NC-17 site and associated impacts with wildlife, the impact of the building and operation of the Project would be a noticeable contributor to the MODERATE cumulative impact on terrestrial ecology.

9.3.2.2.3.4 Aquatic Ecology

Similar to the Belews Creek, NC site, the cooling system used at the NC-17 site will be a closed-cycle recirculating cooling system, which is considered to be the best available technology to minimize impingement mortality and entrainment. The Roxboro Steam Station will retire four coal-fired boilers and replace them with two new natural gas-fired combined cycle turbines as part of the Person County Energy Complex project. All four units are planned to be retired by the mid-2030s. If the Project were to be built and operated at the NC-17 site, it will

obtain its makeup water from Hyco Lake, which supplies water to the Roxboro Steam Station. This will decrease the amount of water withdrawn from Hyco Lake, and subsequently decrease the amount of impingement mortality and entrainment. Closure of the Roxboro Steam Station may also result in cooler water temperatures within Hyco Lake that reflect a natural condition, similarly to the Belews Creek, NC site. The cooler lake temperatures may affect the timing of spawning and will result in a shorter growth season that is expected to result in decreased fish condition that may also affect sport fish abundance and condition. In summary, the cumulative impact of building and operating activities from the Project on aquatic ecology, added to effects associated with past, present, and RFFAs within the GAI on aquatic ecology is noticeable but not destabilizing for Hyco Lake and the NC-17 site. Overall cumulative impacts on aquatic ecosystems are MODERATE. The impact of building the Project is a noticeable but not destabilizing contributor to the cumulative impact on aquatic ecosystems; the impact of operation of the Project is a noticeable contributor to the cumulative impact on aquatic ecology.

9.3.2.3.5 Socioeconomics

9.3.2.3.5.1 Physical Impacts

This subsection provides an analysis of cumulative physical impacts associated with noise and vibration, odors, dust and air pollution, transportation, and aesthetics.

9.3.2.3.5.1.1 Noise and Vibration

Cumulative noise impacts may occur if several large projects are under construction at the same time in close proximity. Construction of the Person County Energy Complex may occur at the same time as construction of the Project at the NC-17 site. Noise and vibration impacts will be additive but with proper mitigation measures, will not be noticeable. Cumulative impacts related to noise and vibration are SMALL.

9.3.2.3.5.1.2 Odors, Dust, and Air Pollution

All past, present, and RFFAs, will implement BMPs to minimize temporary air and dust emissions during building activities. Additionally, building activities are subject to air permits under state and federal laws that address the impact of air emissions on sensitive receptors. Cumulative impacts related to odors, dust, and air pollution are SMALL for building activities and operation.

9.3.2.3.5.1.3 Transportation

Building activities and operation of the Project at the NC-17 site in addition to past, present, and RFFAs will result in an increased usage of Routes 1336 and 1322 and other roadways in the vicinity of the NC-17 site. Roadway repairs and improvements on Routes 1336 and 1322 and other roadways in the vicinity of the NC-17 site inadvertently affected by vehicles related to the Project, may be necessary to reduce safety risks and restore pavement conditions. Any damage to public roads, markings, or signs caused by building activities will be repaired to preexisting conditions or better in accordance with state and local requirements.

Therefore, cumulative physical impacts from building and operation activities on the transportation network in the vicinity of the NC-17 site are SMALL for building activities and operation.

9.3.2.3.5.1.4 Aesthetics

The GAI for visual resources includes the 2-mi. (3-km) radius surrounding the NC-17 site. Within the 2-mi. (3-km) GAI, are the existing Roxboro Steam Station and CertainTeed Roxboro Wallboard Facility. Construction and operation of the Project at the NC-17 site will align with the

industrial nature of the beforementioned sites, however, the surrounding 2-mi. (3-km) is largely rural and forested, and the visual change will be noticeable. Cumulative impacts to aesthetics are MODERATE.

9.3.2.3.5.1.5 Summary of Physical Impacts

The cumulative physical impacts from noise and vibration, odors, dust, and air pollution, and transportation from building and operations-related activities are SMALL. Cumulative physical impacts on aesthetic quality from building activities and operations are MODERATE.

9.3.2.3.5.2 Demographic Impacts

The Moriah Energy Center is expected to bring in 300 specialized construction jobs and 12 specialized operator jobs.

It is unknown how many workers will be needed for the construction and operation of the Microsoft facility at the Person County Mega Park and for the construction of the Enbridge – T-15 Reliability Project.

The MVP Southgate Project will result in 220 jobs in NC, including direct, indirect, and induced jobs, however, not all of the workers will reside in Person County, and the 50-mi. (80-km) vicinity.

Transco's Southeast Supply Enhancement Project will result in 3000 direct and indirect jobs and 1300 full-time equivalent construction jobs. However, because this project extends from VA to NC, it is not anticipated that the majority of workers needed for this project will reside in Person County and the 50-mi. (80-km) vicinity.

The cumulative demographic impact of building and operating activities from the Project, when considered alongside the effects of past, present, and RFFAs is SMALL. This is primarily due to the relatively large existing population in the vicinity of the NC-17 site and the comparatively small size of the Project's workforce during building and operation. As a result, the Project is a minor contributor to the SMALL cumulative impact on demography.

9.3.2.3.5.3 Economic Impacts to the Community

As discussed in Section 9.3.2.3.5.2, there are multiple RFFAs within the vicinity of the NC-17 site. The economic stimulus created by the Project will be added to the economic stimulus created by the other projects in the area, increasing business opportunities and revenues, creating new jobs, and reducing unemployment in the economic region.

Cumulative impacts to the economy are MODERATE and beneficial during building activities and operation.

9.3.2.3.5.3.1 Taxes

The Moriah Energy Center is expected to bring in $1,000,000 in local and state tax revenue.

It is unknown how much local and state tax revenue will be generated by the Microsoft facility at the Person County Mega Park and the Enbridge – T-15 Reliability Project.

The MVP Southgate Project is expected to bring in $2,000,000 in state and local taxes to NC during building and $328,000 during operation.

Transco's Southeast Supply Enhancement Project will result in $63,500,000 in state taxes and $9,600,000 in local taxes.

Cumulative tax impacts are MODERATE, and beneficial during building and operation.

9.3.2.3.5.3.2 Summary of Economic Impacts to the Community

The cumulative economic impacts to the community are MODERATE and beneficial during building and operation activities.

9.3.2.3.6 Community Infrastructure Impacts

This subsection provides the estimated cumulative impacts on infrastructure and community services, including transportation, recreation, housing, and public services.

9.3.2.3.6.1 Transportation

Congestion at U.S. Highway 501 on and off ramps and along NC Highway 119, and Routes 1336 and 1322 will increase due to the similar construction time frames of the Person County Energy Complex, Enbridge – T-15 Reliability Project, and the Person County Mega Park. Additionally, SR-1333 from the intersection with Edwin Robertson Road south for approximately 3800 ft. will be abandoned as part of the Person County Mega Park Project. This will increase traffic on Edwin Robertson Road. Cumulative impacts will be MODERATE during building activities and SMALL during operation.

9.3.2.3.6.2 Recreation

Cumulative impacts related to recreation will mainly occur as a result from past, present, and RFFAs on Hyco Lake. Because recreators of Hyco Lake are mobile, and the construction time frame is limited, cumulative impacts to recreation from building activities are SMALL. Operations related impacts will be smaller than that of building activities, as such, operations related cumulative impacts are SMALL.

9.3.2.3.6.3 Housing

There are the 68,036 vacant housing units within the 50-mi. (80-km) region surrounding the NC-17 site. As previously discussed in Section 9.3.2.3.5.2, an influx of workers related to the construction and operation of past, present, and RFFAs is expected. The majority of these workers are not anticipated to relocate permanently to Person County or the surrounding 50-mi. (80-km) vicinity. Therefore, the cumulative impacts to housing will be SMALL.

9.3.2.3.6.4 Public Services

The listed RFFAs create jobs and are likely to bring in-migrating workers to the vicinity of the NC-17 site. The scale of which varies from relatively minor to potentially large Projects. Urban centers such as Durham, Greensboro, and Raleigh already possess the infrastructure, housing, schools, healthcare, and other services needed to accommodate these population increases without significant strain. Cumulative impacts to public services are SMALL.

9.3.2.3.6.5 Education

As described in Section 9.3.2.4.5.2, there are many RFFAs that will increase the population, and subsequently the number of school-aged children in Person County and the surrounding 50-mi. (80-km) region. Economic region school enrollment will increase when these children are added. These students will increase the economic region's enrollment. In any event, NC's education equalization programs, will mitigate capacity issues and personnel shortages in schools and districts. Cumulative impacts to education are SMALL.

9.3.2.3.6.6 Summary of Community Infrastructure Impacts

Cumulative community infrastructure impacts at the NC-17 site range from SMALL to MODERATE for building and operation activities.

9.3.2.3.7 NOT USED

Deleted (Executive Order, 2025a, 2025b).

9.3.2.3.8 Historical and Cultural Resources

As discussed in Section 9.3.2.1.7 there are no NRHP sites within the NC-17 site boundary. The GAI is a 0.5-mi. (0.8-km) radius around the NC-17 site. There are no listed projects on Table 9.3-8 within the 0.5-mi. (0.8-km) radius. Additionally, all projects will have to comply with Section 106 of the NHPA and will avoid impacts to NRHP listed sites to the extent feasible. Cumulative impacts on historic and cultural resources are SMALL for building activities and operation.

9.3.2.3.9 Air Quality

The GAI for cumulative impacts to air quality is Person County. Past, present, and RFFAs within Person County were considered in the cumulative impacts analysis. As discussed in Section 9.3.2.1.8, Person County is in attainment for all NAAQS, indicating small impacts from past projects. Any present or RFFAs will be subject to permitting and will not be expected to contribute to the exceedance of a NAAQS. Additionally, Duke Energy plans to retire coal-fired boilers at the existing Roxboro Steam Station in Person County. These units will be replaced with new natural gas-fired turbines. The transition away from burning coal at this facility will reduce overall air emissions, particularly nitrogen oxides and sulfur dioxide (NCDEQ, 2025a). Emissions from other projects in Person County that are listed in Table 9.3-8, will comply with Title V and any non-Title V permitting requirements. Standard control measures will be used to mitigate fugitive dust releases. It is, therefore, anticipated that the cumulative impacts to air quality from building activities and operations of any past, present, and RFFAs within Person County will be SMALL.

9.3.2.3.10 Nonradiological Health

Building activities and operation of the Project will contribute to cumulative non-radiological human health impacts when combined with the other projects in Person County. Effects to workers at nearby industries will be managed through compliance with Occupational Safety and Health Administration standards and implementation of industry safety programs. Therefore, cumulative impacts due to physical effects and occupational injuries are SMALL. The increased traffic congestion could increase the potential for a vehicle crash. The combination of occupational and traffic injuries from the nuclear plant and the other projects along with the increase in population in Person County from the projects will put additional pressure on medical services in Person County. The generation of non-radiological waste is also expected to be similar to the non-radiological waste generated at the Belews Creek, NC site for both building activities and plant operations. Building activities and operation of the Project at the NC-17 site will contribute to cumulative non-radiological waste impacts when combined with the other projects identified in Person County. It is expected that each industrial facility identified in Table 9.3-8 will comply with applicable Federal, State, and local regulations to ensure proper disposal of non-radiological waste. Non-radiological waste impacts from liquid, gaseous, and solid wastes will be SMALL, and mitigation will not be warranted for releases during normal activities. The implementation of adequate training and management practices are also expected to minimize the potential for accidental releases and the environmental impact of accidental releases. Cumulative impacts to non-radiological health during building and operation are SMALL.

9.3.2.3.11 Radiological Health

For the analysis of cumulative radiological impacts for the NC-17 site (which is similar to the analysis for the Belews Creek, NC site), the GAI is considered to be the area that has the potential to increase radiological exposure at any location within a 50-mi. (80-km) radius of the plant. As described in Section 5.9, the NRC historically has used 50-mi. (80-km) as the radius bounding the geographic area for evaluating doses to the public from routine releases from nuclear power plants. There are no nuclear power plants within 50-mi. (80-km) of the NC-17 site. Therefore, the cumulative impacts to radiological health at any location within 50-mi. (80-km) of the NC-17 site during building activities and operation are anticipated to be SMALL.

9.3.2.3.12 Nonradiological Waste

All of the past, present, and RFFA projects listed in Table 9.3-8 have the potential to result in generation of nonradiological waste. As listed in Table 9.3.8, the Person County Energy Complex project is located immediately adjacent to the NC-17 site and therefore, has the potential to have localized direct or indirect effects that may affect the same resources as those affected by the NC-17 site. However, the deconstruction of all site structures, and the management and disposal of all solid and hazardous wastes within regional landfills for the Person County Energy Complex project will occur in accordance with Duke Energy's Environmental Programs and relevant guidelines and regulations.

Each of the past, present, and RFFA projects coupled with existing developments (industrial, commercial, recreational) have an impact on cumulative waste management within the GAI. The cumulative impacts of nonradioactive waste destined for land-based treatment and disposal are primarily related to amount of waste generated by the Project and other RFFAs and the available capacity of area treatment and disposal facilities. Similar to the Belews Creek, NC site, nonradiological waste generation is expected to be generally greater during building activities as compared to operation. However, the individual contribution of nonradioactive waste (both nonhazardous and hazardous) by the Project and other projects in Table 9.3-8 within the GAI is expected to be minor. Other landfills with long range capacity identified within the GAI include the following:

- Upper Piedmont Regional Landfill, 34.2 approximate total permitted years remaining as of fiscal year 2022-2023.
- Orange County CDLF, 22.0 approximate total permitted years remaining as of fiscal year 2022-2023.

Given the existing reported landfill capacity in the region and the scope of the RFFAs, construction and operation of these facilities are not expected to substantially contribute to the loss of waste disposal capacity in the GAI. Based on the availability and expected capacity of existing licensed disposal facilities within the GAI, the cumulative impact of building and operating activities from the Project at the NC-17 site on nonradiological waste, added to the effects associated with past, present, and RFFAs within the GAI on nonradiological waste, is SMALL. The impact of the building and operation of the Project is not a noticeable contributor to the cumulative impact on nonradioactive waste.

9.3.2.3.13 Postulated Accidents

The cumulative analysis for the NC-17 site considers DBAs and severe accidents at other existing and proposed nuclear facilities that have the potential to increase risks at any location within the GAI. The GAI for impacts is within a 50-mi. (80-km) radius of the NC-17 site. There are no nuclear facilities within 50-mi. (80-km) of the NC-17 site. Therefore, the cumulative risks

from postulated accidents at any location within 50-mi. (80-km) of the NC-17 site during operation are anticipated to be SMALL.

9.3.2.4 Evaluation of Cumulative Impacts for the NC-19 Site

The purpose of this subsection is to identify any past, present, and RFFAs within the GAI of each resource that could have cumulative impacts in conjunction with the Proposed Action. Potential impacts include substantial changes to any of the analyzed resources which will not occur if the Project is not constructed. Table 9.3-7 lists the projects within the GAI for the NC-19 site.

9.3.2.4.1 Land Use

The GAI for land use impacts encompasses the site, the vicinity, and extent of off-site areas. The projects listed on Table 9.3-7 that are within the GAI include the Shearon Harris Nuclear Plant, the Longleaf Solar Center, Brickhaven Mine #2, Merry Oaks Site #1, and McGill Environmental. There has been a 44 percent change in land cover in Wake County from 1985 to 2023, according to the MRLC NLCD. The largest changes in land cover have occurred to forested land and agricultural lands. Chatham County has experienced a 33 percent change in land cover, with the greatest changes occurring to forested and agricultural land (MRLC, 2025). The prior listed projects have and will convert land from rural, agricultural, or forested land use to other uses. In summary, the cumulative impact of building and operating activities from the Project on land use, added to the effects associated with past, present, and RFFAs within the GAI on land use is noticeable but not destabilizing and therefore MODERATE. Because of extensive past and present modification of land use within the GAI, and the Project site's proximity to the adjacent existing industrial Shearon Harris Nuclear Plant, the impact of building the Project is a noticeable, but not a destabilizing contributor to the cumulative impact on land use.

9.3.2.4.2 Water Resources

The GAI for hydrology encompasses a 50-mi. (80-km) radius surrounding the NC-19 site. Any past, present, and RFFAs within a 50-mi. (80-km) radius of the NC-19 site will be subject to federal, state, and local laws and regulations, which will limit impacts to surface waters and wetlands. No waters are listed as impaired within the White Oak Creek Watershed. However, the Cape Fear River from NC Highway 42 to Buckhorn Dam is listed as impaired for aquatic life due to the presence of Chlorophyll a. Additionally, a review of the MRLC report for Wake County indicated that 4.4 percent of the land cover in Wake County is wetlands and 1.13 sq. mi. of wetlands were lost between 1985 and 2023 (MRLC, 2025). 1.6 percent of the land cover in Chatham County is wetlands and 0.32 sq. mi. of wetlands were lost between 1985 and 2023 (MRLC,2025). The Shearon Harris Nuclear Plant currently uses Harris Lake as a cooling reservoir. Potential adverse impacts associated with building activities of the other past, present, and RFFAs listed in Table 9.3-9 include construction related discharges. However, these are managed in accordance with an approved SWPPP, NPDES permits for stormwater discharges, and implementing BMPs during building. The incremental contribution of prebuilding and building activities on surface water quality will be minimal.

Overall, the environmental effects from cumulative impacts to hydrology from past, present, and RFFAs are sufficient to alter noticeably, but not to destabilize, any important attributes to hydrology within the GAI. The cumulative impacts to hydrology during building activities are MODERATE. The cumulative impacts to hydrology from operation are less than that of building activities as the projects listed in Table 9.3-7 will not cause a noticeable impact to hydrology in the GAI. Cumulative impacts for operation are SMALL.

9.3.2.4.3 Terrestrial Ecology

The GAI for terrestrial ecology is 6 mi. (10 km). Most of the projects in Table 9.3-7 are further than 6 mi. (10 km) and will not contribute to cumulative impacts. As stated in Section 9.3.2.2.3, the construction of the Shearon Harris Nuclear Plant converted primarily agricultural land, rural residential, and woodlands to industrial use. This conversion resulted in the decrease of habitat for terrestrial species that rely on woodland habitat. Disturbance to wildlife from operation will generally be related to noise, and movement, which are confined to the immediate vicinity of the Shearon Harris Nuclear Plant. The Longleaf Solar Center will also convert forested land to an industrial use. None of the projects listed in Table 9.3-9 will impact any critical habitat, and all are subject to the Endangered Species Act of 1973. The construction and operation of the NC-19 site will contribute incrementally to the conversion of forest to other land uses and the fragmentation of forest habitats that have already occurred and are likely to continue due to other development in the GAI. Cumulative impacts on terrestrial ecology are sufficient to alter noticeably, but not to destabilize, any important attributes of the resource and will be MODERATE.

9.3.2.4.4 Aquatic Ecology

Similar to the Belews Creek, NC site, a closed-cycle recirculating cooling system will be used at the NC-19 site. Closed-cycle recirculating cooling is considered the best available technology to minimize impingement mortality and entrainment. If the Project were to be built and operated at the NC-19 site, it will obtain its makeup water from Harris Lake, which also supplies water to the Shearon Harris Nuclear Plant. This will increase the amount of water withdrawn from Harris Lake, and a pumping station will need to be constructed on the Cape Fear River to supplement the reservoir. In addition, raising the level of Harris Lake may disrupt the aquatic ecology of streams that would be inundated by this action. In summary, the cumulative impact of building and operating activities from the Project on aquatic ecology, added to effects associated with past, present, and RFFAs within the GAI on aquatic ecology is noticeable but not destabilizing for Harris Lake and the NC-19 site. Overall cumulative impacts on aquatic ecosystems are MODERATE. The impact of building the Project is a noticeable but not destabilizing contributor to the cumulative impact on aquatic ecosystems; the impact of operation of the Project is a noticeable contributor to the cumulative impact on aquatic ecology.

9.3.2.4.5 Socioeconomics

9.3.2.4.5.1 Physical Impacts

This subsection provides an analysis of cumulative physical impacts associated with noise and vibration, odors, dust and air pollution, transportation, and aesthetics.

9.3.2.4.5.1.1 Noise and Vibration

Cumulative noise impacts may occur if several large projects were under construction at the same time in close proximity. No projects listed in Table 9.3-9 that are in close proximity to the NC-19 site will be constructed during a similar time frame. Cumulative impacts related to noise and vibration are SMALL for building activities and operation.

9.3.2.4.5.1.2 Odors, Dust, and Air Pollution

All past, present, and RFFAs, will implement BMPs to minimize temporary air and dust emissions during building activities. Additionally, building activities are subject to air permits under state and federal laws that address the impact of air emissions on sensitive receptors. Cumulative impacts related to odors, dust, and air pollution are SMALL for building activities and operation.

9.3.2.4.5.1.3 Transportation

Construction and operation of the Project at the NC-19 site and past, present, and RFFAs will result in an increased usage of U.S. Highway 1 and other roadways in the vicinity of the NC-19 site. Roadway repairs and improvements on U.S. Highway 1 and other roadways in the vicinity of the NC-19 site inadvertently affected by vehicles related to the Project, may be necessary to reduce safety risks and restore pavement conditions. Any damage to public roads, markings, or signs caused by building activities will be repaired to preexisting conditions or better in accordance with state and local requirements.

Therefore, cumulative physical impacts from building and operation activities on the transportation network in the vicinity of the NC-19 site are SMALL.

9.3.2.4.5.1.4 Aesthetics

The GAI for visual resources includes the 2-mi. (3-km) radius surrounding the NC-19 site. Within the 2-mi. (3-km) GAI, is the Shearon Harris Nuclear Plant, Brickhaven Mine No. 2, Merry Oaks Site #1, and the McGill Environmental composting facility. Building activities and operation of a nuclear plant at the NC-19 site will align with the industrial nature of the beforementioned sites. Additionally, an existing nuclear power plant is already located adjacent to the NC-19 site, which will further community acceptance. However, the Project will convert previously rural and undeveloped land to industrial use, which will cause a noticeable change to aesthetics. Cumulative impacts to aesthetics are MODERATE for building activities and operation.

9.3.2.4.5.1.5 Summary of Physical Impacts

The cumulative physical impacts from noise, odors, dust, and air pollution, and transportation from building and operations-related activities are SMALL. Cumulative physical impacts on aesthetic quality from building activities and operations are MODERATE.

9.3.2.4.5.2 Demography

As Wake County contains a large population center, it is unlikely that any noticeable impacts related to an influx of workers related to past, present, and RFFAs will be seen in Wake and Chatham counties and the surrounding 50-mi. (80-km) vicinity. Cumulative impacts to demography are SMALL for building activities and operation.

9.3.2.4.5.3 Economic Impacts to the Community

The economic stimulus created by the Project will be added to the economic stimulus created by the other projects in the area, increasing business opportunities and revenues, creating new jobs, and reducing unemployment in the economic region. As the surrounding 50-mi. (80-km) area to the NC-19 site already has a thriving economy associated with the nearby city of Raleigh, a noticeable impact to the economy is not anticipated for past, present and RFFAs. Cumulative impacts to the economy are SMALL and beneficial for building activities and operation.

9.3.2.4.5.3.1 Taxes

The NC-19 site property tax payment impacts for building activities and operation are anticipated to be MODERATE and beneficial and will be combined with the other project property taxes that will be paid in Wake and Chatham Counties. The cumulative impacts are also anticipated to be MODERATE and beneficial for Wake and Chatham Counties property taxing authorities.

9.3.2.4.5.3.2 Summary of Economic Impacts to the Community

The cumulative economic impacts to the community are SMALL to MODERATE and beneficial during building and operation activities.

9.3.2.4.5.4 Community Infrastructure Impacts

This subsection provides the estimated cumulative impacts on infrastructure and community services, including transportation, recreation, housing, and public services.

9.3.2.4.5.4.1 Transportation

Temporary increased traffic volumes on U.S. Highway 1 may result from building activities. Traffic congestion will increase from the combined workforces of the Shearon Harris Nuclear Plant and building activities at the NC-19 site and at the Longleaf Solar Center, which is also located off of U.S. Highway 1. During building, approximately 175 vehicles are anticipated to access the Longleaf Solar Center using U.S. Highway 1. At peak construction, the Project will employ approximately 150 workers. This will increase the number of vehicular traffic on U.S. Highway 1 by 325. As discussed in Section 9.3.2.2.5.4.1, the average daily traffic volume for all lanes in both directions on U.S. Highway 1 is 36,000 vehicles The increase in vehicles at peak construction is 0.9 percent of the average daily traffic volume. As a major highway, U.S. Highway 1 is more readily available to accommodate this influx in traffic. Cumulative impacts to transportation are SMALL.

9.3.2.4.5.4.2 Recreation

Cumulative impacts related to recreation will mainly occur as a result from past, present, and RFFAs on Harris Lake. Because recreators of Harris Lake are mobile, and the construction time frame is limited, cumulative impacts to recreation from building activities are SMALL. Operations related impacts are smaller than that of building activities, as such, operations-related cumulative impacts are SMALL.

9.3.2.4.5.4.3 Housing

Wake County has more available housing than Chatham County with 25,539 vacant and available housing units, including permanent and temporary housing, in the economic region. This level of vacant and available housing is sufficient to accommodate workers from the cumulative projects. Therefore, the cumulative impacts to housing and land use patterns in the economic region are SMALL for building activities and operation.

9.3.2.4.5.4.4 Public Services

The increased population is not anticipated to cause additional pressure on community services and infrastructure, as the increase in population will be a small percentage of the existing population. Water and wastewater resources in the economic region are anticipated to be sufficient to accommodate the cumulative in-migrating workforce populations. Same as for cumulative adverse impacts to police, fire, and medical services. Cumulative impacts to public services are SMALL during building activities and operation.

9.3.2.4.5.4.5 Education

Cumulative in-migration associated with the Project will not increase the number of school-age children by a substantial percentage. Wake County enrollment is 197,361 and Chatham County enrollment is 12,133 (USCB, 2023). As a county with a large population, Wake County has the capacity to mitigate any personnel shortages in schools and districts. Cumulative impacts to education are SMALL for building activities and operation.

9.3.2.4.5.4.6 Summary of Community Infrastructure Impacts

Cumulative community infrastructure impacts at the NC-19 site are SMALL for building and operation activities.

9.3.2.4.6 NOT USED

Deleted (Executive Order, 2025a, 2025b).

9.3.2.4.7 Historical and Cultural Resources

As discussed in Section 9.3.2.2.7 there are no NRHP sites within the NC-19 site boundary. The GAI is a 0.5-mi. (0.8-km) radius around the NC-19 site. The existing Shearon Harris Nuclear Plant is within the 0.5-mi. (0.8-km) radius. A review of the NC Natural Heritage Program Data Explorer did not indicate that any NRHP sites or surveyed sites have been removed previously from the Shearon Harris Nuclear Plant site boundary. Additionally, all projects will have to comply with Section 106 of the NHPA and will avoid impacts to NRHP listed sites to the extent feasible. Cumulative impacts on cultural resources are judged to be SMALL during building activities and operation.

9.3.2.4.8 Air Quality

The GAI for cumulative impacts to air quality are Wake and Chatham Counties. Past, present, and RFFAs within Wake and Chatham Counties were considered in the cumulative impacts analysis. As discussed in Section 9.3.2.2.8, all counties in NC are in attainment for all NAAQS, indicating small impacts from past projects. Any present or RFFAs are subject to permitting and will not be expected to contribute to the exceedance of a NAAQS. Emissions from other projects in Wake and Chatham Counties that are listed in Table 9.3-9, will comply with Title V and any non-Title V permitting requirements. Standard control measures will be used to mitigate fugitive dust releases. It is, therefore, anticipated that the cumulative impacts to air quality from building activities and operation of any past, present, and RFFAs within Wake and Chatham Counties are SMALL.

9.3.2.4.9 Nonradiological Health

Building activities and operation of the Project will contribute to cumulative non-radiological human health impacts when combined with the other projects in Wake and Chatham counties. Non-radiological health impacts will be managed through compliance with applicable U.S. Occupational Safety and Health Administration (OSHA) standards and implementation of industry safety programs. Therefore, cumulative impacts due to physical effects and occupational injuries will be SMALL. Increase traffic congestion from the Project and other RFFAs will increase the potential for a vehicle crash. The combination of occupational and traffic injuries from the nuclear plant and the other projects along with the increase in population in Wake and Chatham Counties from the projects will put additional pressure on medical services in the counties; however, given the existing infrastructure within the counties, cumulative impacts will be expected to be SMALL.

The generation of non-radiological waste is also expected to be similar to the non-radiological waste generated at the Belews Creek, NC site for both building activities and plant operations. Building activities and operation of the Project at the NC-19 site will contribute to cumulative nonradiological waste impacts when combined with the other projects identified in Wake and Chatham Counties. It is expected that each industrial facility in the surrounding area identified in Table 9.3-9 will comply with applicable federal, state, and local regulations to ensure proper disposal of non-radiological waste. Non-radiological waste impacts from liquid, gaseous, and solid wastes will be SMALL, and mitigation will not be warranted for releases during normal

activities. The implementation of adequate training and management practices are also expected to minimize the potential for accidental releases and the environmental impact of accidental releases. Cumulative impacts to non-radiological health are SMALL during building activities and operation.

9.3.2.4.10 Radiological Health

A detailed evaluation of radiological health impacts requires site specific information (e.g., meteorological data) that is not available for the NC-19 site. This site does have existing operating nuclear facilities, therefore, potential radiological exposures due to existing facilities will be higher than for the Belews Creek, NC site and the NC-17 site. Human health impacts are also dependent on population density near the proposed facility. There is a high population density in the vicinity of the NC-19 site which increases the potential for health effects. Radiological health impacts for the building and operation of the Belews Creek, NC site are discussed in Sections 4.9 and 5.9. As site specific information is not available for the NC-19 site it was assumed that radiological health impacts will be slightly higher than that of the Belews Creek, NC site, due to the previous discussion, but not significantly so. As such, cumulative human health impacts from radiological exposures during building and operation at the NC-19 site are expected to be SMALL.

9.3.2.4.11 Nonradiological Waste

Each of the past, present, and RFFA projects coupled with existing developments (industrial, commercial, recreational) have an impact on cumulative waste management within the GAI. The cumulative impacts of nonradioactive waste destined for land-based treatment and disposal are primarily related to amount of waste generated by the Project and other RFFAs and the available capacity of area treatment and disposal facilities. Similar to the Belews Creek, NC site, nonradiological waste generation is expected to be generally greater during building activities as compared to operation. However, the individual contribution of nonradioactive waste (both nonhazardous and hazardous) by the Project and other projects in Table 9.3-9 within the GAI is expected to be minor. Other landfills with long range capacity identified within the GAI include the following:

- Shotwell Landfill, Inc, 33.5 approximate total permitted years remaining as of fiscal year 2022-2023.
- Red Rock Disposal C&D Landfill, 51.2 approximate total permitted years remaining as of fiscal year 2022-2023.
- Greenway Waste Solutions of Apex, LLC, 51.2 approximate total permitted years remaining as of fiscal year 2022-2023.

Given the existing reported landfill capacity in the region and the scope of the RFFAs, construction and operation of these facilities are not expected to substantially contribute to the loss of waste disposal capacity in the GAI. Based on the availability and expected capacity of existing licensed disposal facilities within the GAI, the cumulative impact of building and operating activities from the Project at the NC-19 site on nonradiological waste, added to the effects associated with past, present, and RFFAs within the GAI on nonradiological waste, is SMALL. The impact of the building and operation of the Project is not a noticeable contributor to the cumulative impact on nonradioactive waste.

9.3.2.4.12 Postulated Accidents

The cumulative analysis for the NC-19 site considers DBAs and severe accidents at other existing and proposed nuclear facilities that have the potential to increase risks at any location within the GAI. The GAI for cumulative impacts is within a 50-mi. (80-km) radius of the NC-19 site. Located adjacent to the NC-19 site is the existing Shearon Harris Nuclear Plant. Potential postulated accidents at this facility have been evaluated, most recently as part of a 2008 license renewal, and a combined license application (COLA). The NRC specifically evaluated the Shearon Harris Nuclear Plant for severe accident impacts for license renewal considerations and concluded that the environmental impacts were of SMALL significance. The consequences could be severe, but because of their low likelihood of occurrence, the risk impact is classified as SMALL significance. Specifically, the following conclusions are found to remain valid for an advanced reactor design (i.e., AP1000) located at the Shearon Harris Nuclear Plant:

- The Shearon Harris plant risks for the atmospheric exposure pathway will be within the range of those considered as SMALL significance in Supplement 33 of NUREG-1437.
- The consequences of atmospheric fallout onto open bodies of water are of SMALL significance for the Shearon Harris Nuclear Plant.
- The consequences of releases to groundwater are of SMALL significance for the Shearon Harris Nuclear Plant.

The Shearon Harris Nuclear Plant site-specific MACCS2 analysis of severe accidents for the AP1000 reactor design shows that the 50-mi. (80-km) population dose risk of 2.20E-03 person-Sv/yr. (2.20E-01 person-rem/yr.) is significantly lower than that for current reactor designs and is less than 1 percent of that associated with the current Shearon Harris Nuclear Plant.

Therefore, the cumulative risks from postulated accidents at any location within 50-mi. (80-km) of the NC-19 site are anticipated to be SMALL during operation.

9.3.3 CONCLUSION

The Belews Creek, NC site was selected on the basis of a comprehensive site selection study, as described in Section 9.3.1. The numerical scores for the Candidate Sites and other objective evaluations indicate that, while multiple sites are suited for the construction of a new nuclear power plant, there are no other environmentally preferrable alternatives to the Belews Creek, NC site. A separate assessment of the environmental impacts for two potentially feasible Alternative Sites, as described in Section 9.3.2, determined that the Proposed and Alternative Sites are all suited for the construction of a new nuclear power plant. As indicated by Tables 9.3-8 and 9.3-9, there is not a substantive difference in impacts from the Proposed and Alternative Sites to indicate that any of the Alternative Sites are environmentally preferable and obviously superior to the Belews Creek, NC site.

Table 9.3-1
Candidate Site Criteria and Weight Factors
(Sheet 1 of 2)

Criteria	Sub-Criteria	Sub-Sub-Criteria	Weight Factor
Health and Safety Criteria	Accident Cause-Related	Geology/Seismology	9.15
		Cooling Water Requirement - Cooling Water Supply	9.00
		Cooling Water Requirement - Ambient Air Requirements	5.10
		Flooding	7.90
		Nearby Hazardous Land Uses	5.90
		Extreme Weather Conditions	4.00
	Accident Effect-Related	Population	6.00
		Emergency Planning	5.30
		Atmospheric Dispersion	5.00
	Operational Effects-Related	Surface Water: Radionuclide Pathway	4.80
		Groundwater: Radionuclide Pathway	4.90
		Air: Radionuclide Pathway	4.30
		Air: Food Ingestion Pathway	4.10
		Surface Water: Food Radionuclide Pathway	4.90
		Transportation Safety	4.10
Ecological Criteria	Building-Related Effects on Aquatic Ecology	Disruption of Important Species/Habitats	5.90
		Bottom Sediment Disruption Effects	3.70
	Building-Related Effects on Terrestrial Ecology	Disruption of Important Species/Habitats – Plant Site	6.00
		Disruption of Important Species/Habitats – Transmission Corridor	5.50
		Disruption of Wetlands	6.10
		Dewatering Effects on Adjacent Wetlands	4.80
	Operations-Related Effects on Aquatic Ecology	Thermal Discharge Effects	5.70
		Entrainment/Impingement Effects	4.60
		Dredging/Disposal effects	4.40
	Operations-Related Effects on Terrestrial Ecology	Drift Effects on Surrounding Areas	4.50

Table 9.3-1
Candidate Site Criteria and Weight Factors
(Sheet 2 of 2)

Criteria	Sub-Criteria	Sub-Sub-Criteria	Weight Factor
Socioeconomic	Socioeconomic Criteria	Socioeconomics – Building-Related Effects	5.30
		Socioeconomics – Operations-Related Effects	5.10
		Environmental Justice[(a)]	5.40
		Land Use	5.70
Engineering and Cost-Related Criteria	Health and Safety-Related Criteria	Water Supply	8.40
		Pumping Distance	6.50
		Flooding	7.10
		Vibratory Ground Motion	7.90
		Civil Works	6.30
		Industrial Site Remediation	6.10
	Transportation and Transmission-Related Criteria	Railroad Access	7.20
		Highway Access	5.70
		Barge Access	6.30
		Transmission Cost and Market Price Differentials	7.60
	Land Use and Site Preparation-Related Criteria	Topography	7.00
		Land Rights	7.10
		Labor Rates	6.00

Note:
(a) The Site Selection Process was completed prior to Executive Order, 2025a, 2025b

Table 9.3-2
Land Cover within the NC-17 Site and Vicinity

Land Cover Class	NC-17 Site Area (ac.)	6-mi. Vicinity (ac.)
Open Water	1	4,022
Developed, Open Space	35	5,427
Developed, Low Intensity	6	2,257
Developed, Medium Intensity	0	605
Developed, High Intensity	0	202
Deciduous Forest	106	18,141
Evergreen Forest	76	14,189
Mixed Forest	102	15,821
Grassland/Herbaceous	3	4,511
Scrub Shrub	1	3,383
Hay/Pasture	195	16,154
Woody Wetlands	44	2,130
Cultivated Crops	0	1,774
Emergent Herbaceous Wetlands	0	56
Barren Land (Rock/Sand/Clay)	0	552
Total	**569**	**89,224**

Table 9.3-3
Land Cover within the NC-19 Site and Vicinity

Land Cover Class	NC-19 Site Area (ac.)	6-mi. Vicinity (ac.)
Open Water	4	8,827
Developed, Open Space	41	5,830
Developed, Low Intensity	42	5,096
Developed, Medium Intensity	5	2,665
Developed, High Intensity	<1	312
Deciduous Forest	6	8,119
Evergreen Forest	798	40,080
Mixed Forest	15	16,039
Grassland/Herbaceous	17	4,391
Scrub Shrub	42	3, 574
Hay/Pasture	4	4,821
Woody Wetlands	2	4,619
Cultivated Crops	0	1,061
Emergent Herbaceous Wetlands	0	118
Barren Land (Rock/Sand/Clay)	0	795
Total	**976**	**102,773**

Table 9.3-4
State and Federal Threatened Endangered and Rare Species Recorded for the NC-17 Site

Common Name	Scientific Name	Federal Status	State Status
Mammals			
Tricolored Bat	*Perimyotis subflavus*	Proposed Endangered	Endangered
Freshwater Bivalve			
Green Floater	*Lasmigona subviridis*	Proposed Threatened	Endangered
Yellow Lampmussel	*Lampsilis cariosa*	None	Endangered
Triangle Floater	*Alasmidonta undulata*	None	Threatened
Atlantic Pigtoe	*Fusconaia masoni*	None	Threatened
Eastern Lampmussel	*Lampsilis radiata*	None	Threatened
Notched Rainbow	*Venustaconcha constricta*	None	Threatened
Creeper	*Strophitus undulatus*	None	Threatened
Amphibian			
Neuse River Waterdog	*Necturus lewisi*	Threatened	Threatened
Fish			
Mimic Shiner	*Paranotropis volucellus*	None	Threatened
Insects			
Monarch Butterfly	*Danaus plexippus*	Proposed Threatened	None
Vascular Plant			
Prairie Blue Wild Indigo	*Baptisia aberrans*	None	Endangered
Ringed Witch Grass	*Dichanthelium annulum*	None	Endangered
Mudbank Crown Grass	*Paspalum dissectum*	None	Endangered
Heller's Rabbit-Tobacco	*Pseudognaphalium helleri*	None	Endangered
Veined Skullcap	*Scutellaria nervosa*	None	Endangered
Carolina Birdfoot-trefoil	*Acmispon helleri*	None	Threatened
Tall Larkspur	*Delphinium exaltatum*	None	Threatened
Indian Physic	*Gillenia stipulata*	None	Threatened

Table 9.3-5
State and Federal Threatened Endangered and Rare Species Recorded for the NC-19 Site
(Sheet 1 of 2)

Common Name	Scientific Name	Federal Status	State Status
Mammals			
Tricolored Bat	*Perimyotis subflavus*	Proposed Endangered	Endangered
Little Brown Bat	*Myotis lucifugus*	None	Endangered
Birds			
Red-cockaded Woodpecker	*Picoides borealis*	Endangered	Endangered
Henslow's Sparrow	*Ammodramus henslowii*	None	Endangered
American Peregrine Falcon	*Falco peregrinus anatum*	None	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Bald and Golden Eagle Protection Act	Threatened
Freshwater Bivalve			
Brook Floater	*Alasmidonta varicosa*	None	Endangered
Yellow Lampmussel	*Lampsilis cariosa*	None	Endangered
Carolina Creekshell	*Sagittunio vaughanianus*	None	Endangered
Savannah Lilliput	*Toxolasma pullus*	None	Endangered
Dwarf Wedgemussel	*Alasmidonta heterodon*	Endangered	Endangered
Green Floater	*Lasmigona subviridis*	Proposed Threatened	Endangered
Triangle Floater	*Alasmidonta undulata*	None	Threatened
Atlantic Pigtoe	*Fusconaia masoni*	None	Threatened
Eastern Lampmussel	*Lampsilis radiata*	None	Threatened
Eastern Pondmussel	*Sagittunio nasutus*	None	Threatened
Creeper	*Strophitus undulatus*	None	Threatened
Notched Rainbow	*Venustaconcha constricta*	None	Threatened
Yellow Lance	*Elliptio lanceolata*	Threatened	Threatened
Amphibian			
Eastern Tiger Salamander	*Ambystoma tigrinum*	None	Threatened
Neuse River Waterdog	*Necturus lewisi*	Threatened	Threatened
Reptile			
Southern Hognose Snake	*Heterodon simus*	None	Threatened
Vascular Plants			
Harperella	*Ptilimnium nodosum*	Endangered	Endangered
Michaux's Sumac	*Rhus michauxii*	Endangered	Endangered

Table 9.3-5
State and Federal Threatened Endangered and Rare Species Recorded for the NC-19 Site
(Sheet 2 of 2)

Common Name	Scientific Name	Federal Status	State Status
American Bluehearts	*Buchnera americana*	None	Endangered
Mead's Sedge	*Carex meadii*	None	Endangered
Carolina Thistle	*Cirsium carolinianum*	None	Endangered
Ringed Witch Grass	*Dichanthelium annulum*	None	Endangered
Veined Skullcap	*Scutellaria nervosa*	None	Endangered
Littleleaf Sneezeweed	*Helenium brevifolium*	None	Endangered
Swamp Saxifrage	*Micranthes pensylvanica*	None	Endangered
Heller's Rabbit-Tobacco	*Pseudognaphalium helleri*	None	Endangered
Grassleaf Arrowhead	*Sagittaria weatherbiana*	None	Endangered
Shale-barren Skullcap	*Scutellaria leonardii*	None	Endangered
Western Rough Goldenrod	*Solidago radula*	None	Endangered
Narrow-leaved Smooth Aster	*Symphyotrichum concinnum*	None	Endangered
Indian Physic	*Gillenia stipulata*	None	Threatened
Buffalo Clover	*Trifolium reflexum*	None	Threatened
Carolina Birdfoot-trefoil	*Acmispon helleri*	None	Threatened
Kidney Sedge	*Carex reniformis*	None	Threatened
Granite Flatsedge	*Cyperus granitophilus*	None	Threatened
Piedmont Quillwort	*Isoetes piedmontana*	None	Threatened
Small's Portulaca	*Portulaca smallii*	None	Threatened
Low Wild petunia	*Ruellia humilis*	None	Threatened
Fishes			
Caper Fear Shiner	*Notropis mekistocholas*	Endangered	Endangered
Robust Redhorse	*Moxostoma robustum*	Candidate	Endangered
Carolina Madtom	*Noturus furiosus*	Endangered	Endangered
Carolina Redhorse	*Moxostoma* sp.	None	Threatened
Ironcolor Shiner	*Alburnops chalybaeus*	None	Threatened
Least Brook Lamprey	*Lampetra aepyptera*	None	Threatened
Mimic Shiner	*Paranotropis volucellus*	None	Threatened
Insects			
Monarch Butterfly	*Danaus plexippus*	Proposed Threatened	None

Table 9.3-6
Past, Present, and RFFAs Considered in the Cumulative Analysis of the NC-17 Site
(Sheet 1 of 2)

Project Name	Description	Approximate Distance from the Site	Status
Other Energy Projects			
Roxboro Plant	A four-unit, 2462-MW coal-fired power plant. Expected to retire in 2033.	4 mi. (6 km) W	Past, present, and RFFA. This power plant began operation in 1966, with additions in 1973 and 1980. (Duke Energy, 2025a)
Mayo Plant	A single-unit, 713-MW coal-fired power plant.	7 mi. (11 km) NE	Past, present, and RFFA. Operational as of 1983. (Duke Energy, 2025b)
Woodsdale Solar Farm	3-MW capacity solar farm.	9 mi. (14 km) SE	Past, present, and RFFA. Operational as of 2018. (Monarch Private Capital, 2025)
Natural Gas Projects			
Enbridge – T-15 Reliability Project	A proposed 45-mi. (72 km) natural gas pipeline along mostly existing rights-of-way from Eden to Roxboro.	4 mi. (6 km) W	RFFA. Proposed to begin building in 2025, with the majority of building taking place in 2026 (Enbridge, 2025b)
MVP Southgate	A proposed 30-in. diameter underground pipe that will span approximately 31 mi. (50 km) to deliver natural gas into Rockingham County, NC.	42 mi. (68 km) SW	RFFA. Target in-service date of mid-2028 (MVP Southgate, 2025).
Transco's Southeast Supply Enhancement Project	A proposed approximately 55-mi. (89-km) pipeline from Virgina to NC. The NC scope of work would include a total of 28 mi. (45 km) of pipeline looping adjacent to existing Transco corridors located in Rockingham, Guilford, Forsyth, and Davidson Counties and additional compressor units in Cleveland, Iredell, and Davidson Counties.	46 mi. (74 km) SW	RFFA. Target building start date of fall 2026, target in service date of the end of 2027 (Williams, 2025).

Table 9.3-6
Past, Present, and RFFAs Considered in the Cumulative Analysis of the NC-17 Site
(Sheet 2 of 2)

Project Name	Description	Approximate Distance from the Site	Status
Person County Energy Complex	The replacement of four coal-fired units at the existing Roxboro Steam Station with two hydrogen-capable natural gas units.	4 mi. (6 km) W	RFFA. The units will enter service by 2028 and 2030. (Duke Energy. 2024)
Moriah Energy Center	A proposed 25-million-gallon Liquified Natural Gas storage facility.	22 mi. (35 km) SE	Present and RFFA. Building began in early 2024. The facility will enter service by 2027. (Enbridge, 2025a)
Transportation Projects			
Raleigh Regional Airport	Public airport in Person County.	15 mi. (24 km) S	Past, present, and RFFA. Operational as of 1987. (AirNav, 2025a)
Other Actions/ Projects			
Person County Mega Park	A 1350-ac. (546 ha) Mega Park, acquired by Microsoft. The plans for development are not yet known.	6 mi. (10 km) SE	RFFA. Proposed. (Person County, 2025b)
CertainTeed Roxboro Wallboard Facility	Gypsum manufacturing plant.	3 mi. (5 km) SW	Past, present, and RFFA. Operational as of 2012. (Person County, 2025c)

Table 9.3-7
Past, Present, and RFFAs Considered in the Cumulative Analysis of the NC-19 Site
(Sheet 1 of 2)

Project Name	Description	Approximate Distance from the Site	Status
Nuclear Projects			
Shearon Harris Nuclear Plant	A single-unit, 928-MW nuclear power plant located near New Hill, N.C.	Adjacent to the NC-19 site	Past, present, and RFFA. Operational as of 1987. (Duke Energy, 2025c)
Other Energy Projects			
Jordan Hydroelectric Project	Hydroelectric plant with two hydroelectric generators; combined, the generating modules produce about 16,900 MW annually.	7 mi. (11 km) NW	Past, present, and RFFA. Operational as of January 2012. (USACE, 2025).
Siler Solar	4.5-MW, 30-ac. (12-ha) solar facility in Chatham County, NC.	40 mi. (64 km) NW	Past, present, and RFFA. Operational as of December 2018. (Global Energy Monitor, 2025)
Longleaf Solar Center	Proposed 100-MW facility with 215,000 fixed-tilt solar panels.	4 mi. (6 km) E	RFFA. Building to begin 2026-2027. Project completion estimated in 2028. (Duke Energy, 2025d)
Transmission Projects			
Pittsboro Hanks Chapel 230 kV Substation	Grid improvement project to add a new substation and power line.	12 mi. (19 km) NW	Present and RFFA. Project building end date of October 2024. (Duke Energy, 2025e)
Lee-Milburnie Transmission line rebuild.	Project to upgrade and rebuild 40 mi. (64 km) of the existing Lee-Milburnie 230-kV transmission line.	24 mi. (39 km) NE	RFFA. Planned in-service date of 2031. (Center for Climate and Energy Solutions, 2025)
Mining Projects			
Brickhaven Mine No. 2 (Cherokee Sanford Group)	Former clay mine, that now functions as a coal ash landfill in Chatham County.	2 mi. (3 km) SW	Past, present, and RFFA. Functioning as a coal ash landfill since 2015. (NCDEQ, 2025b)

Table 9.3-7
Past, Present, and RFFAs Considered in the Cumulative Analysis of the NC-19 Site
(Sheet 2 of 2)

Project Name	Description	Approximate Distance from the Site	Status
Holly Springs Quarry (Heidelberg Materials, Aggregates)	Quarry in Wake County.	5-mi. (8-km) SE	Past, present, and RFFA. Unknown. (NCDEQ, 2025b)
Merry Oaks Site #1 (Triangle Brick Company)	Brick plant in Chatham County, with an annual capacity of 50 million bricks.	2-mi. (3-km) NW	Past, present, and RFFA. Operational as of 1991. (NCDEQ, 2025b)
Transportation Projects			
KRDU	International airport in Wake County, NC that spans across approximately 4800 ac. (1942 ha) of land.	20-mi. (32-km) NE	Past, present, and RFFA. Operational as of 1943. (AirNav, 2025b)
Sanford-Lee County Regional Airport	Public airport in Lee County, NC that spans across approximately 1250 ac. (506 ha) of land.	8-mi. (13-km) SW	Past, present, and RFFA. Operational as of 1999. (AirNav, 2025c)
Southern Wake Regional Airport	Public airport in Wake County, NC.	15-mi. (24-km) SE	Past, present, and RFFA. Operational as of 1975. (AirNav, 2025d)
Other Actions/ Projects			
MetOx International Inc. Production Facility	A proposed high-temperature superconducting wire major production facility in Chatham County, NC.	Unknown	RFFA. Building scheduled to begin in 2025. (MetOx, 2025)
Fred Smith Company - Holly Springs Plant	Asphalt mixing plant.	6-mi. (10-km) SE	Past, present, and RFFA. Unknown (Fred Smith Company, 2025)
Cape Fear Power Station	Retired coal-fired facility with five ash ponds, located in Moncure, NC.	4-mi. (6-km) SW	Past. Began operation in 1923, the last units retired began operating in 1956 and 1958. Retired in 2012. (Duke Energy, 2015)
McGill Environmental	Composting facility in Chatham County.	2-mi. (3-km) NW	Past, Present, and RFFA. Operational as of 2002. (McGill, 2025)

Table 9.3-8
Summary of the Comparative Impact Analysis from Building Activities and Operation at the Proposed and Alternative Sites
(Sheet 1 of 2)

	Belews Creek, NC Site		NC-17 Site		NC-19 Site	
	Building Activities	**Operation**	**Building Activities**	**Operation**	**Building Activities**	**Operation**
Land Use	MODERATE	SMALL	MODERATE	SMALL	MODERATE	SMALL
Water-Related						
Surface Water	SMALL	SMALL (MODERATE under drought conditions)	SMALL	SMALL (MODERATE under drought conditions)	SMALL	SMALL to MODERATE
Ground Water	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Ecology						
Terrestrial Ecology	MODERATE	SMALL	MODERATE	SMALL	MODERATE	SMALL
Aquatic Ecology	SMALL	SMALL (MODERATE under drought conditions)	SMALL	SMALL (MODERATE under drought conditions)	SMALL	SMALL (MODERATE under drought conditions)
Socioeconomics						
Physical Impacts	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Economic Impacts to the Community	MODERATE and beneficial	SMALL and beneficial	SMALL to MODERATE and beneficial	SMALL and beneficial	SMALL to MODERATE and beneficial	SMALL and beneficial
Demographic Impacts	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Community Infrastructure Impacts	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE

Table 9.3-8
Summary of the Comparative Impact Analysis from Building Activities and Operation at the Proposed and Alternative Sites
(Sheet 2 of 2)

	Belews Creek, NC Site		NC-17 Site		NC-19 Site	
	Building Activities	**Operation**	**Building Activities**	**Operation**	**Building Activities**	**Operation**
Historic and Cultural Resources	SMALL to MODERATE (if any eligible site cannot be avoided)	SMALL	SMALL	SMALL	SMALL	SMALL
Air Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Nonradiological Health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Radiological Health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Nonradioactive Waste Management	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental Impacts of Postulated Accidents	N/A	SMALL	N/A	SMALL	N/A	SMALL

Table 9.3-9
Summary of the Comparative Cumulative Impact Analysis at the Proposed and Alternative Sites

Resource Category	Site		
	Belews Creek, NC Site	**NC-17 Site**	**NC-19 Site**
Land Use	MODERATE	MODERATE	MODERATE
Water-Related			
Surface Water	SMALL to MODERATE to LARGE (beneficial)	SMALL to MODERATE	SMALL to MODERATE
Ground Water	SMALL	SMALL	SMALL
Ecology			
Terrestrial Ecology	MODERATE	MODERATE	MODERATE
Aquatic Ecology	MODERATE	MODERATE	MODERATE
Socioeconomics			
Physical Impacts	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Demographic Impacts	SMALL	SMALL	SMALL
Economic Impacts to the Community	MODERATE (beneficial)	MODERATE (beneficial)	SMALL to MODERATE (beneficial)
Community Infrastructure Impacts	SMALL	SMALL to MODERATE	SMALL
Historic and Cultural Resources	SMALL to MODERATE (if any eligible site cannot be avoided)	SMALL	SMALL
Air Quality	SMALL	SMALL	SMALL
Nonradiological Health	SMALL	SMALL	SMALL
Radiological Health	SMALL	SMALL	SMALL
Nonradioactive Waste	SMALL	SMALL	SMALL
Postulated Accidents	SMALL	SMALL	SMALL

9.4 SYSTEM ALTERNATIVES

This section discusses system design alternatives for the heat-dissipation and circulating-water systems for the proposed Project site. This information is provided to enable a comparison of the environmental impacts of the proposed system to that of the select alternatives. Because a final reactor selection has not been made, a plant parameter envelope (PPE) approach to defining the various plant systems has been utilized. The cooling technology that is used in developing the PPE is mechanical draft cooling towers (MDCT). The proposed heat dissipation and circulating water systems for the new facility were initially presented in Chapter 3. Section 9.4.1 presents alternatives to the facility heat dissipation system, and Section 9.4.2 presents alternatives to the circulating water system. The evaluation of alternatives to plant systems is applicable to all technologies that were considered in the PPE.

9.4.1 HEAT DISSIPATION

There are multiple heat dissipation system alternatives, each having varying energy transfer mechanisms and, therefore, varying potential environmental impacts. This subsection utilizes the methodology presented in NUREG-1555 to perform an initial screening and eliminate technologies that are unsuitable for the Project site. Following the initial screening any remaining alternatives are reviewed to determine if they are environmentally preferable, equivalent, or inferior to the proposed heat dissipation system. The following subsections describe the proposed heat dissipation system and evaluate comparable alternatives.

9.4.1.1 Proposed Heat Dissipation System

The purpose of a heat dissipation system is to dissipate heat energy to the environment. To meet cooling requirements of the proposed advanced reactor units at the Project site and at the same time to provide environmental protection for the waters of Belews Lake, a closed system consisting of MDCT was selected as the preferred primary method of heat dissipation.

In this closed-loop tower system, the main circulating water pumps circulate water through the condenser, where waste heat is transferred from the turbine exhaust to the circulating water system and to the towers where the heat is transferred to the air. Air flow through the cooling tower is assisted by large fans. Water returning from the towers flows back to the circulating water pumps. Makeup is provided from Belews Lake to the circulating water system to account for water loss through evaporation, drift, and blowdown, as well as other miscellaneous plant systems. Blowdown flow is returned to Belews Lake through the Belews Lake discharge or sent to the Dan River based on operational determinations. Potential atmospheric effects from the operation of MDCT would include fogging and/or icing, as well as deposition or particulate matter (PM) release in the cooling tower plume.

9.4.1.2 Screening Alternatives to the Proposed Heat Dissipation System

The various heat dissipation system alternatives can be classified as one of two types of systems: once-through cooling system or closed-cycle cooling system. The following classes of heat dissipation systems were considered based on the recommendation of NUREG-1555:

- Once-through systems
- Closed-cycle systems
  - Natural draft cooling towers
  - Dry cooling towers
  - Wet-dry cooling towers (hybrid towers)

- Cooling ponds
- Spray ponds

In the following subsections, these alternative systems are evaluated for use at the Project site. Because all of these alternatives were either not feasible or environmentally desirable, detailed costs, operation and maintenance comparisons are not provided.

Belews Lake is a closed cooling water system supporting Belews Creek Steam Station (BCSS) operation. Duke Energy Carolinas, LLC intends to maintain that designation for future generation at the Project site. There are no planned alterations or increases in permitted capacity to the Makeup Water Intake Structure (MWIS) to support advanced nuclear being classified as new generation at an existing site.

9.4.1.2.1 Once-Through Cooling Systems

Once-through cooling systems involve the use of a large quantity of water which is withdrawn from a nearby water body, circulated through the condenser to absorb heat, and then discharged back into a water body. The water requirements for a once-through system are approximately 25,000 to 60,000 gallons of water per megawatt hour (MWh) of electricity produced (Macknick, 2012). Comparatively, the water used by the proposed closed-cycle cooling system is a maximum 43,131 gpm or approximately 1300 gallons/MWh, which is significantly less than once-through cooling.

Once-through cooling in support of nuclear development at the Project site is not viable since the CWA Section 316(b) compliance point is the Dan River and the MWIS that provides makeup water to the Belews Lake. This point does not have the capacity, nor the permitting allowed to support once-through cooling technology for the nuclear development. Therefore, once-through cooling technology is not a viable solution to heat dissipation and was eliminated from further consideration.

9.4.1.2.2 Closed-Cycle Cooling Systems

Closed-cycle cooling systems utilize much less water than once-through cooling systems, using only 500 to 13,000 gallons per MWh (Macknick, 2012). The water performing the cooling is recirculated through the main condenser, and the only additional water required is makeup water to account for expected system losses such as evaporation, blowdown, and drift. Examples of closed-cycle cooling systems include cooling towers (wet, dry, and wet-dry hybrid), cooling ponds, and spray ponds.

The following subsections describe the alternative closed-cycle cooling systems considered. Duke Energy conducted a feasibility study on different closed-cycle cooling technologies, from conventional wet-type to various hybrid type (mixture of dry and wet type) cooling towers. The focus of the study was on water savings capabilities within the confines of the site footprint and comparing cost estimation with each level of water savings. Various alternatives are discussed below.

9.4.1.2.3 Natural Draft Cooling Towers

Natural draft towers are essentially large chimneys designed to move air up through the structure by convection without the use of fans. As hot water is pumped into a natural draft cooling tower, it is distributed through packing or fill material inside the tower. The fill material provides an interface for evaporation of the water and heating of the air to take place. As the water is being distributed, the exposed, lower portion of the tower allows ambient air to pass over the cold-water basin at the bottom of the tower. This passing of ambient air over the cold-

water basin at the bottom of the tower and the evaporation/air heating taking place at the top of the tower create a temperature and density differential which results in a natural draft as less dense warmer air rises to the top. As this differential is being produced, the hyperbolic shape of the cooling tower itself facilitates the upward flow of air.

Natural draft cooling towers have very high construction costs but low operating costs, low auxiliary power requirements, and low noise impacts because there is no mechanical equipment needed to move the air. Therefore, they can be very practical and cost-effective for locations with access to very large water volumes where consistent cooling is required over an extended time period. Potential environmental impacts resulting from the operation of natural draft cooling towers include cloud development and plume shadowing. Ground level fogging and icing are generally not a problem with larger natural draft cooling towers.

Because Belews Lake provides an adequate water source, a natural draft cooling tower could be appropriate for consideration at the Project site. However, natural draft cooling towers require tall stacks to generate the airflow necessary for cooling. Natural draft towers are typically higher than 500 ft. tall and mechanical draft towers are typically 100 ft. tall (NRC, 2024). Due to the increased visual impact and the comparatively high construction cost, a natural draft tower is not preferable to a MDCT.

9.4.1.2.4 Dry Cooling Towers

Dry cooling towers utilize conduction and/or convection to dissipate heat to the atmosphere. The condenser coolant is enclosed within a piping network that has no direct air-to-water interface. The heat transfer process is based on the thermal transport properties of the piping material and the dry bulb temperature of the air. Either natural or mechanical draft techniques can be used to move the air. Because there are no evaporative or drift losses in this type of system, water loss for dry cooling towers is lower than for wet cooling towers, but some makeup water is required. Additionally, many of the problems associated with wet cooling systems, such as blowdown disposal, water availability, fogging and/or icing, are not applicable. Dry towers do have inherent technical obstacles, such as high turbine backpressure and possible freezing in cooling coils during periods of light load and startup.

Dry cooling technologies also have disadvantages related to reduced plant efficiency and lower power output, increased consumptive power use for fans, and increased footprint for the site layout. Boiling water reactor technology requires an indirect dry cooling design which further reduces efficiency. Given the limited areas available for a plant, the location of dry cooling towers within the existing site boundary would be challenging and require significant distance between the turbine building and the dry cooling towers. This would result in longer lengths of piping for turbine exhaust steam and higher turbine backpressure due to pressure loss in the exhaust lines. Dry cooling increases the overall cost by approximately three times compared to mechanical draft cooling towers and would result in the production of less power in a less reliable manner. This is consistent with evaluation by the USEPA that dry cooling was not the best available technology for minimizing adverse environmental impacts based on high capital, operating, and maintenance costs for dry cooling, the detrimental effects of dry cooling causes on electricity production, and no significant reduction in impingement and entrainment beyond the regulatory approach selected to offset these drawbacks (USEPA, 2001a). As a result, dry cooling is not considered a feasible alternative cooling solution.

9.4.1.2.5 Wet / Dry Cooling Towers (Hybrid Towers)

A wet/dry cooling tower, also referred to as a hybrid cooling tower, is composed of a wet section and a dry section. Consumptive water use for the hybrid wet/dry cooling alternative is bounded by the water use of the wet section.

Compared to full wet cooling towers, hybrid cooling towers reduce water-related impacts with less evaporation, makeup water, and blowdown while also reducing the visible plume associated with wet cooling towers. The advantages of the hybrid system are that it conserves water where water is limited and/or expensive.

The hybrid tower generally functions as a wet cooling tower, but has a dry section installed in the upper part of the tower. This upper section heats wet air coming from the lower wet zone, thereby reducing or eliminating the visible water vapor plumes typically associated with wet cooling towers. Thus, the additional heat transfer in the dry section reduces the heat transfer required in the wet section which reduces the overall evaporative loss and results in a variable degree of water consumption reduction.

In a hybrid cooling tower, fans may be located in the wet section as well as the dry section of the tower and may incorporate a hyperbolic shell which produces a natural draft effect that reduces power consumption. Water consumption for a hybrid tower is based on the water use of the wet section, which for the Project site results in a maximum water savings range of approximately 10-20 percent based on available construction space for hybrid towers. This design has a higher capital cost when compared to wet-type towers, although less capital cost when compared to dry cooling towers.

With hybrid towers, water use is inversely related to cost and power consumption (along with footprint). The cost increase for the hybrid systems versus the wet cooling systems does not overcome water use savings (USEPA, 2001b). The dry cooling portion of the hybrid tower is not as efficient as the wet cooling process because it requires the movement of a large amount of air through the heat exchangers to achieve the necessary cooling. This results in less net electrical power for distribution. Because water availability is not a primary issue at the Project site, a hybrid cooling tower is not a preferred heat dissipation technology for use at this site due to the increased cost for the level of water savings achieved.

9.4.1.2.6 Cooling Ponds

A cooling pond is a shallow reservoir with a large surface area used for removing heat from process water. Cooling ponds can be used to reduce the heat load to natural bodies of water from power plant discharge without the construction and operation costs associated with cooling towers. The natural body of water is not relied on for heat dissipation but is used as a source of makeup water to replace water lost to evaporation and as a receiving stream for blowdown from the cooling pond.

A cooling pond is typically used at locations where land is relatively inexpensive, cooling water is scarce or expensive, and/or where there are strict thermal loading restrictions. Impacts resulting from the discharge of heated water into a cooling pond include thermal impacts such as altered stratification and atmospheric impacts such as steam fogging and/or icing. Once cooled, water in the cooling pond can be reused, thereby reducing the overall quantity of water utilized.

While Belews Lake was originally constructed as a cooling water system to support the BCSS, Belews Lake currently supports many recreational activities, including fishing, boating, etc. In order to reduce heat transferred to the aquatic ecosystem and reduce intake flow velocity and

fish entrainment, direct cooling from Belews Lake is not considered. Cooling from MDCT is considered to reduce lake intake flows and reduce the heat discharged to the lake during plant operation.

9.4.1.2.7 Spray Ponds

Spray pond cooling technology utilizes a series of spray nozzles located in a relatively long and narrow pond. Water from the condenser is sprayed into the air, where it is cooled by evaporation, and then allowed to fall into the pond where it is drawn into the intake structure to be pumped back to the condenser. Water lost in spray ponds through the evaporation process requires makeup from a nearby source. Spray ponds require considerably less land use to dissipate the same amount of heat versus conventional cooling ponds. In general, land use as a function of plant output at power plants utilizing spray ponds is approximately 1 ac. per 15 MWe generated; therefore, approximately 150 ac. would be required at the Project site for a spray pond (U.S. AEC, 1973).

The evaporative heat transfer associated with spray ponds is less efficient than the proposed MDCT. Using the Belews Lake cooling water system to support a spray pond would result in increased heat transferred to the aquatic ecosystems and increased intake to offset evaporation that would affect currently supported recreational activities. Therefore, a spray pond heat dissipation system is not preferable to the proposed MDCT for the Project site.

9.4.1.3 Conclusions

As discussed in the above subsections, all of the alternative heat dissipation systems considered are either not feasible or not an environmentally preferable alternative to MDCT for the Project site. Once-through cooling is not a suitable alternative, and the alternative closed-system cooling technologies are not preferable to MDCT technology.

9.4.2 CIRCULATING WATER SYSTEM ALTERNATIVES

This subsection presents a discussion of alternatives to the following components of the circulating water system (CWS): intake systems, discharge systems, water supply and water treatment processes. This review only considers those alternatives that are applicable to the Project site and are compatible with the proposed heat dissipation system discussed in Section 3.4.

9.4.2.1 Proposed Circulating Water System

This subsection summarizes the components of the CWS proposed for the facility.

9.4.2.1.1 Intake System

The proposed water intake is described in Section 3.2.2.4.1. The two potential locations for the intake are shown in Figure 3.1-1. A single intake structure will service all plant complexes on the Project site. Figure 3.2-1 shows the section and plan views of the conceptual intake design.

The intake structure is designed to meet the bounding makeup water requirements of the heat dissipation system by drawing water directly from Belews Lake. As shown on Figure 3.2-1, the intake structure is constructed with the front face located at the existing lake shoreline. This common intake accommodates pumps and appropriate water screen technology. The design of the intake structure will comply with the CWA 316(b) regulations. The maximum water velocity at the intake and water screens will be less than 0.5 ft. per second, as required by the CWA, Section 316(b) Phase I requirements specified in 40 CFR 125.84.

9.4.2.1.2 Discharge

Conceptual discharge designs being considered are described in Section 3.2.2.4.4 and shown in Figure 3.1-1 and Figure 3.2-2. The proposed Project includes both a discharge to Belews Lake and a discharge to the Dan River. For the discharge to Belews Lake, the blowdown from the CWS is transported from the MDCT to the discharge through a pipeline. Discharge piping entering the lake is submerged and routed to the appropriate location and depth to mix with the bulk waters of the lake.

The discharge design routes cooling tower blowdown to the Dan River in an existing wastewater pipeline corridor adjacent to existing Outfall 006 as needed to serve as dilution flow for treated liquid radwaste. Additionally, operational flexibility is provided to divert blowdown flow to the Dan River to support water quality strategies.

The facility's discharges will be regulated by an NPDES permit. The NPDES permit will include discharge limits established to protect receiving waters and monitoring to ensure compliance with those limits. Temperatures and chemical concentrations for all discharges will be in compliance with the terms and conditions of the NPDES permit.

9.4.2.1.3 Water Supply

The proposed cooling water supply for operation of the Project site is described in Sections 3.2.2.3 and 3.4.1.1. The proposed water source is Belews Lake with supplemental makeup from the Dan River to Belews Lake available through the MWIS.

A water-use diagram for the conceptual facility is provided in Figure 3.2-4 Makeup from Belews Lake and discharge to both Belews Lake and the Dan River is shown in the water balance diagram. Makeup flow from the MWIS to Belews Lake will be performed as necessary based on lake level and operated in accordance with the limitations outlined in the existing NPDES permit. The intake withdraws a normal flow of 30,709 gpm, and a maximum of 43,131 gpm. The MDCT consumes some of this water through evaporation and drift. The drift rate is 1 gpm (normal) and 21 gpm (maximum), and the evaporation rate is 26,256 gpm (normal) and 32,580 gpm (maximum).

9.4.2.1.4 Water Treatment

The proposed treatment of the water for operation of the Project site is described in Section 3.2.3.2. Duke Energy uses a common, open cooling water chemistry program that describes the implementation for treatments, maintenance and testing best suited for the site-specific design and environment. Procedures specific to the Project site will be defined at the construction permit or license application stage once reactor technology is selected, water quality studies are completed, and NC NPDES permitting requirements are established.

9.4.2.2 Screening Alternatives to the Proposed Circulating Water System

The purpose of this subsection is to identify and analyze reasonable alternatives to the proposed CWS. The analysis of each alternative system is covered in separate subsections for the intake system, discharge system, water supply, and water treatment system.

Given the operation of BCSS is projected to overlap with operation of advanced reactor plant development for a period of time prior to planned BCSS retirement, options for intakes and discharges were evaluated based on both overlapping and separate operation of the two generation sources. With heat dissipation technology focused on evaporative cooling, the intake and discharge flows and discharge temperature effects on Belews Lake are far less than once-through cooling. Therefore, the placement of intakes and discharges had very broad options.

9.4.2.2.1 Intake System

The intake location was selected such that it is centrally located between the three plant complex locations and there is easy access to relatively deep water. Driving factors for placement of the intake were to centralize it to the three plant complexes to simplify piping and pumping efforts, proximity to reliable and multiple power sources, favorable topography at a shoreline location that has access to deep water within a short distance of the shoreline. Simplifying piping and pumping distance and ensuring access to deep water minimizes environmental impacts to the landscape and indigenous community.

9.4.2.2.2 Discharge

The driving factors for determining discharge locations, focused on simplification of operation by use of gravity flow of blowdown returned to Belews Lake, resulting in multiple discharges specific to each plant complex. Common discharge locations or potential holding ponds were evaluated although are less desired given the added infrastructure and operational impact to achieve these options.

The preferred discharge option is to have three separate discharges, one for each of the plant complexes, with blowdown being gravity fed to Belews Lake. The three locations were selected based on favorable topography, access to deeper water for mixing, and close proximity to support gravity feed with no discharge pump required. This preferred design minimizes environmental impact by limiting disturbances to the land and natural habitats as well as decreasing the impact of thermal discharge.

A second option considered for discharge is for a common discharge to Belews Lake for all three Plant Complexes. For this option, water is pumped to a single discharge point near the northern central part of the lake with access to deep water for mixing. While this is a less desired option, a holding pond with a common discharge was removed from consideration for the discharge location.

Due to the thermal discharge associated with the cooling tower blowdown discharge to the Dan River, the discharge to the Dan River will be a new submerged discharge to promote thermal mixing. The Dan River Outfall is to be located within the existing discharge pipe corridor and adjacent to Outfall 006 to limit the impacts on land and natural habitat disturbance.

9.4.2.2.3 Water Supply

CWS makeup water is to be withdrawn from Belews Lake. Water used is discussed in Section 3.2 and is summarized in Section 9.4.2.1.3. Alternative water supply sources, including groundwater, municipal water supply, and wastewater flows, were considered. Given that the expected water needs for plant operation range from an average of 30,709 gpm, and a maximum of approximately 43,131 gpm (or 44.2 to 62.1 million gallons per day), none of the alternative water supply sources considered have the capacity to support plant operations, and no further evaluation of these options was considered.

9.4.2.2.4 Water Treatment

Concentration of dissolved salts in makeup water resulting from evaporative water losses requires the discharge of a certain percentage of the mineral-rich stream (blowdown) and its replacement with fresh water (makeup). Nuclear power plants are required to obtain an NPDES permit to discharge effluents. These permits are renewed every five years by the state's water quality permitting agency. The periodic NPDES permit renewals provide the opportunity to require modification of power plant discharges or to alter discharge monitoring in response to water quality concerns. Effects of cooling tower discharges are considered to be of small

significance when water quality criteria (e.g., NPDES permits) are met. In considering the effects of closed-cycle cooling systems on water quality, the NRC evaluated the same issues that were evaluated for open-cycle systems. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft Generic Environmental Impact Statement for License -Renewal of Nuclear Plants, discharge of cooling tower effluents has not been a problem at existing nuclear plants.

As discussed in Section 9.4.2.1.4, specific anti-fouling methods are to be defined at the construction permit or license application stage, when a final plant technology is selected. The quantities and concentrations of chemicals to be used are to be in accordance with the NPDES permit application. Therefore, no alternative water treatment methods have been evaluated.

9.4.2.3 Conclusions

As discussed in the above subsections, alternative circulating water system components considered were either not able to support plant operation or were not an environmentally preferable alternative to the proposed design.

9.4.3 OTHER SYSTEM ALTERNATIVES

There was no consideration of alternative designs for other systems. Therefore, no proposed system alternatives are discussed in this subsection.

9.5 REFERENCES

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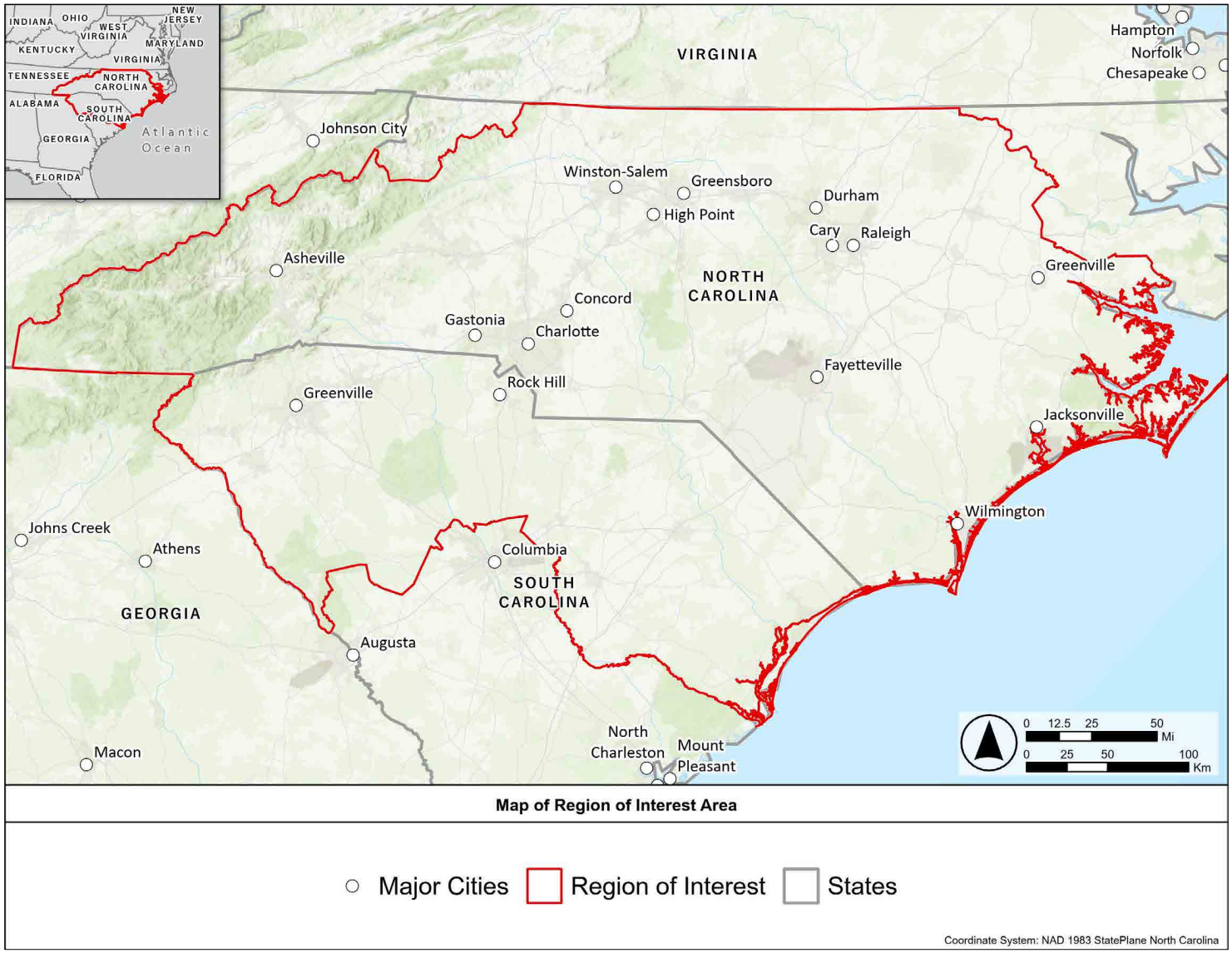

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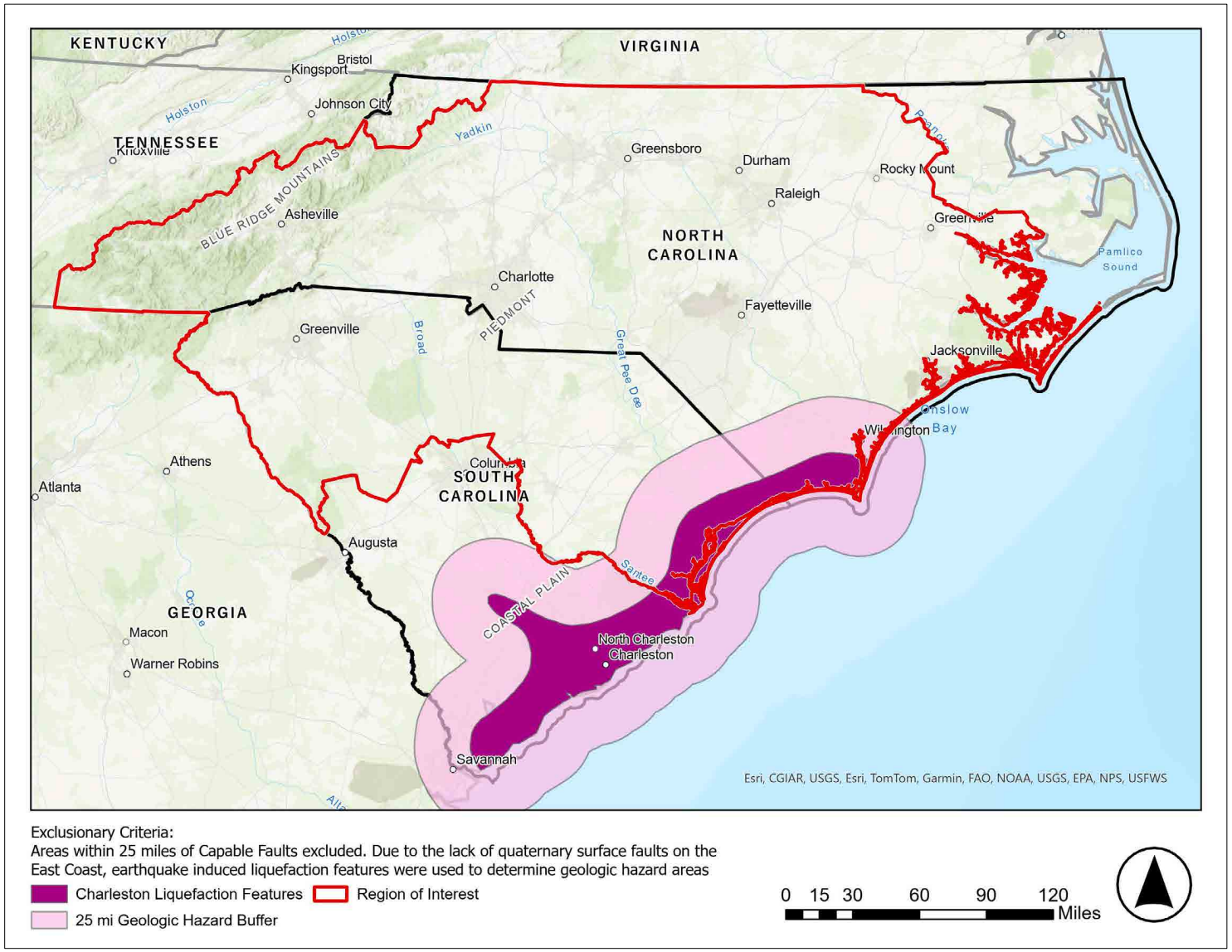

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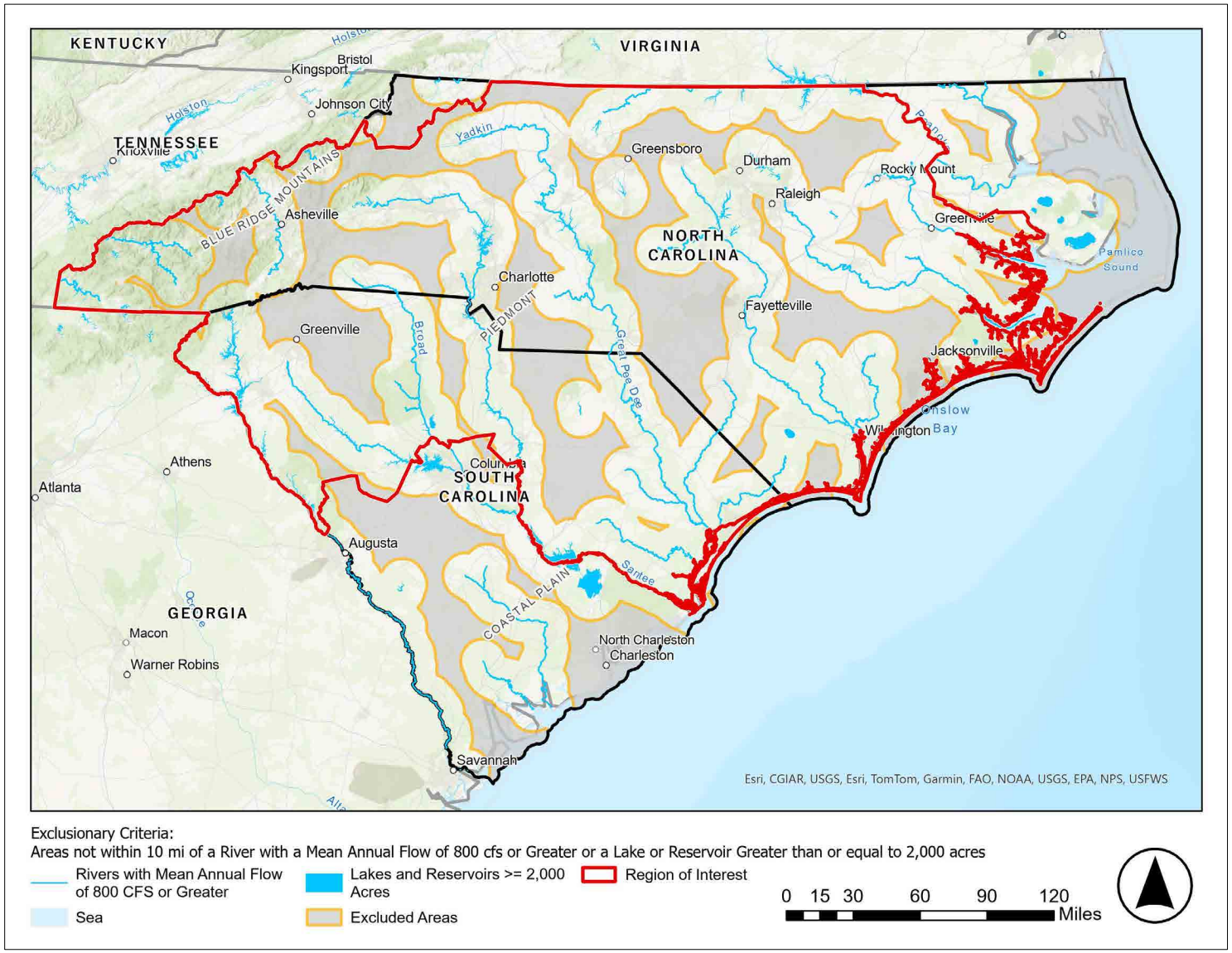

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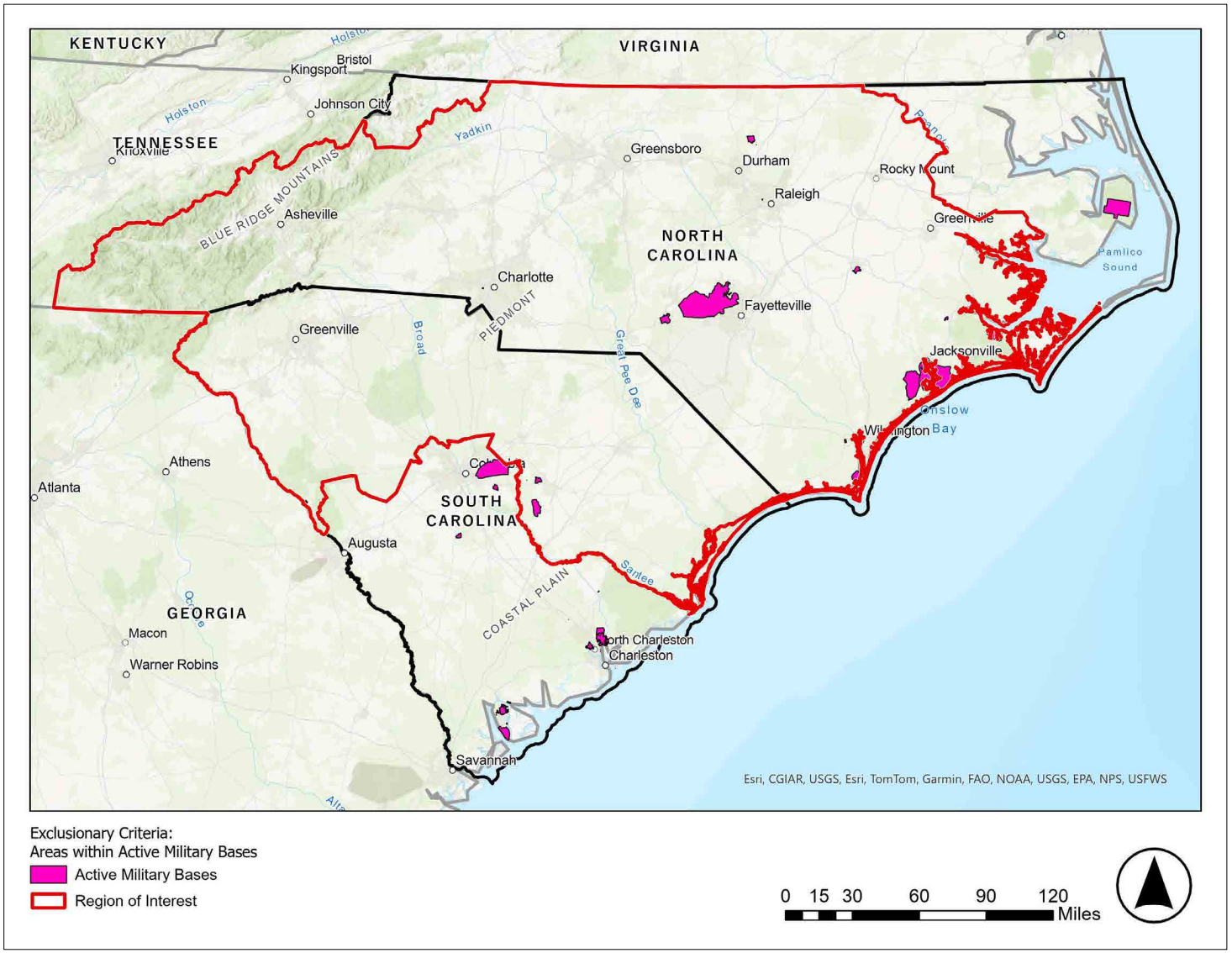

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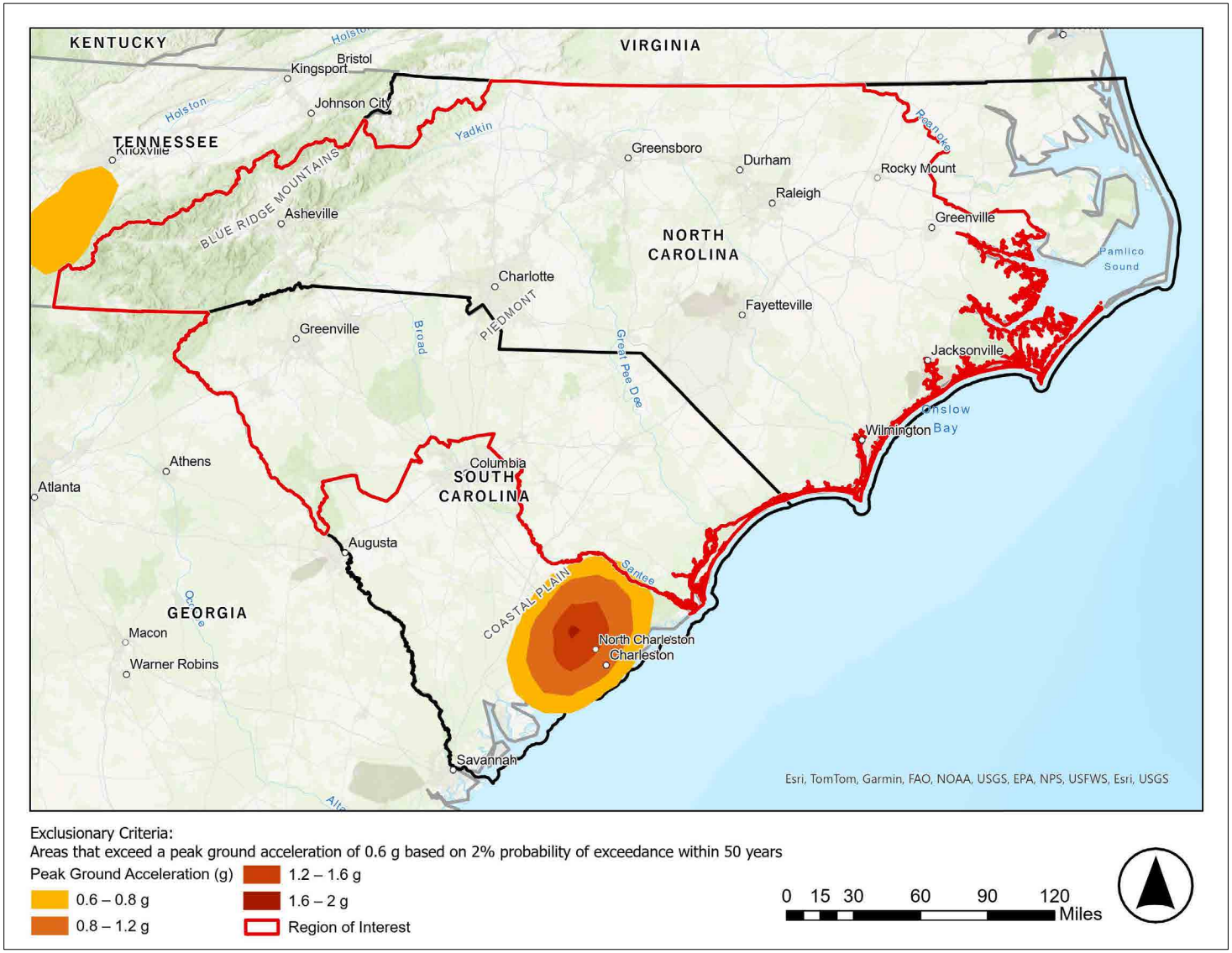

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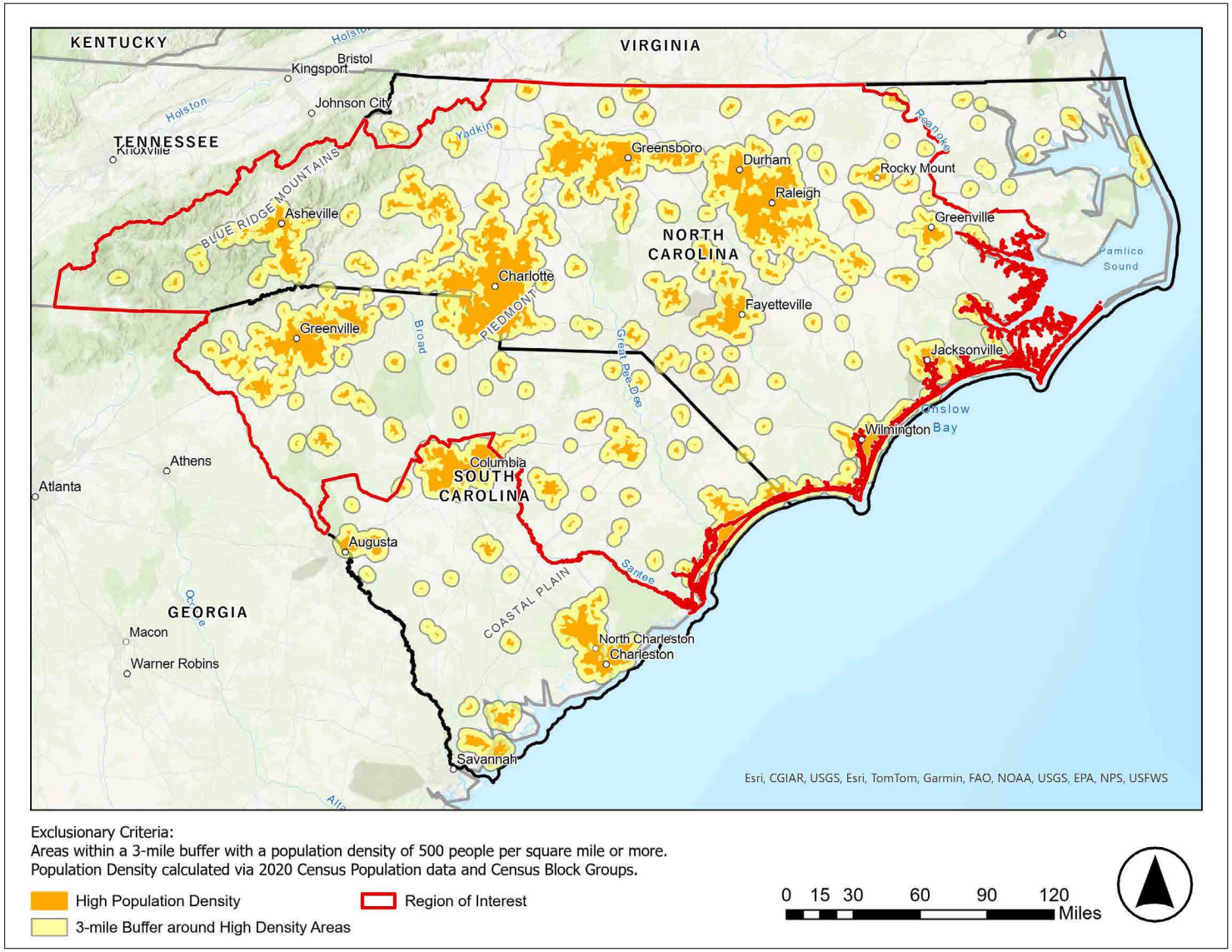

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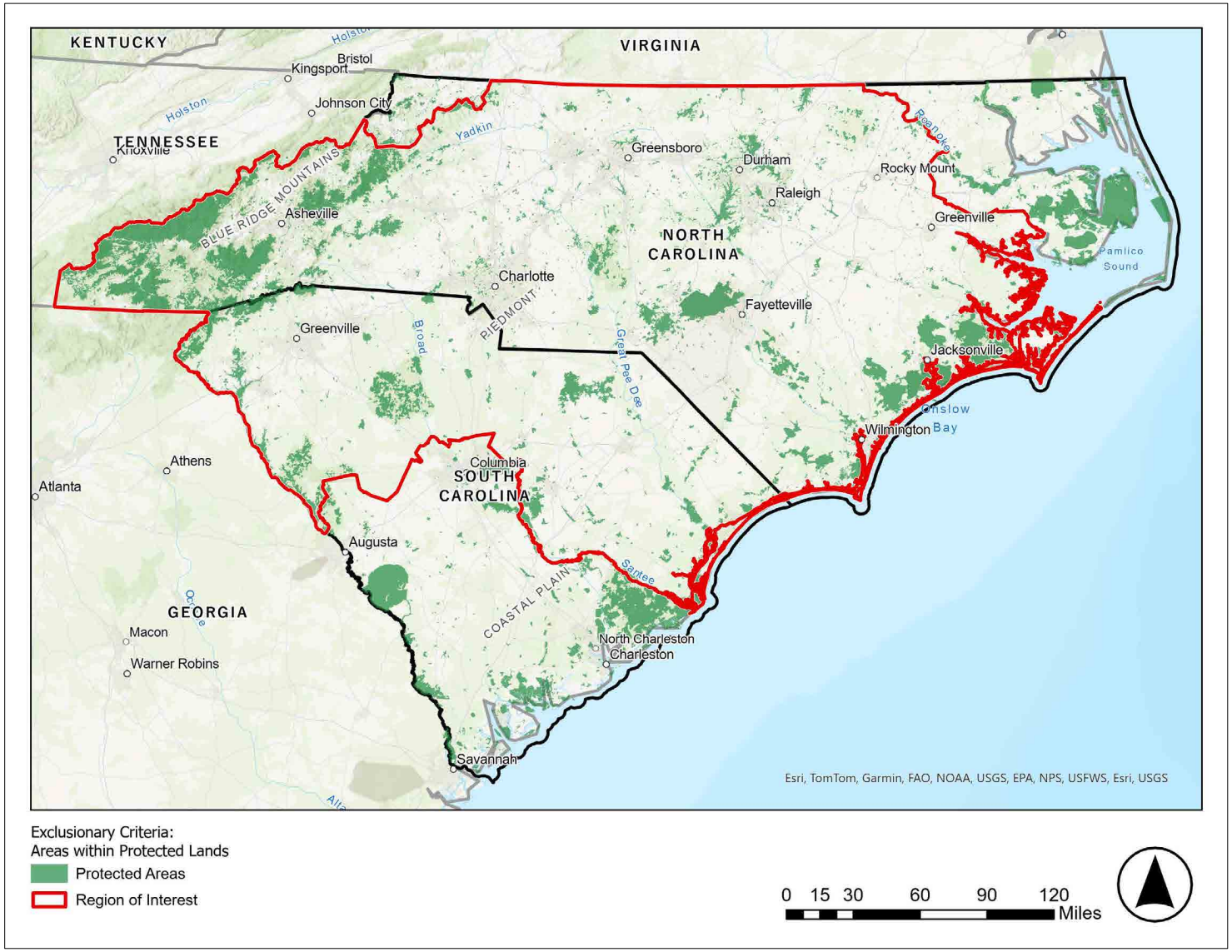

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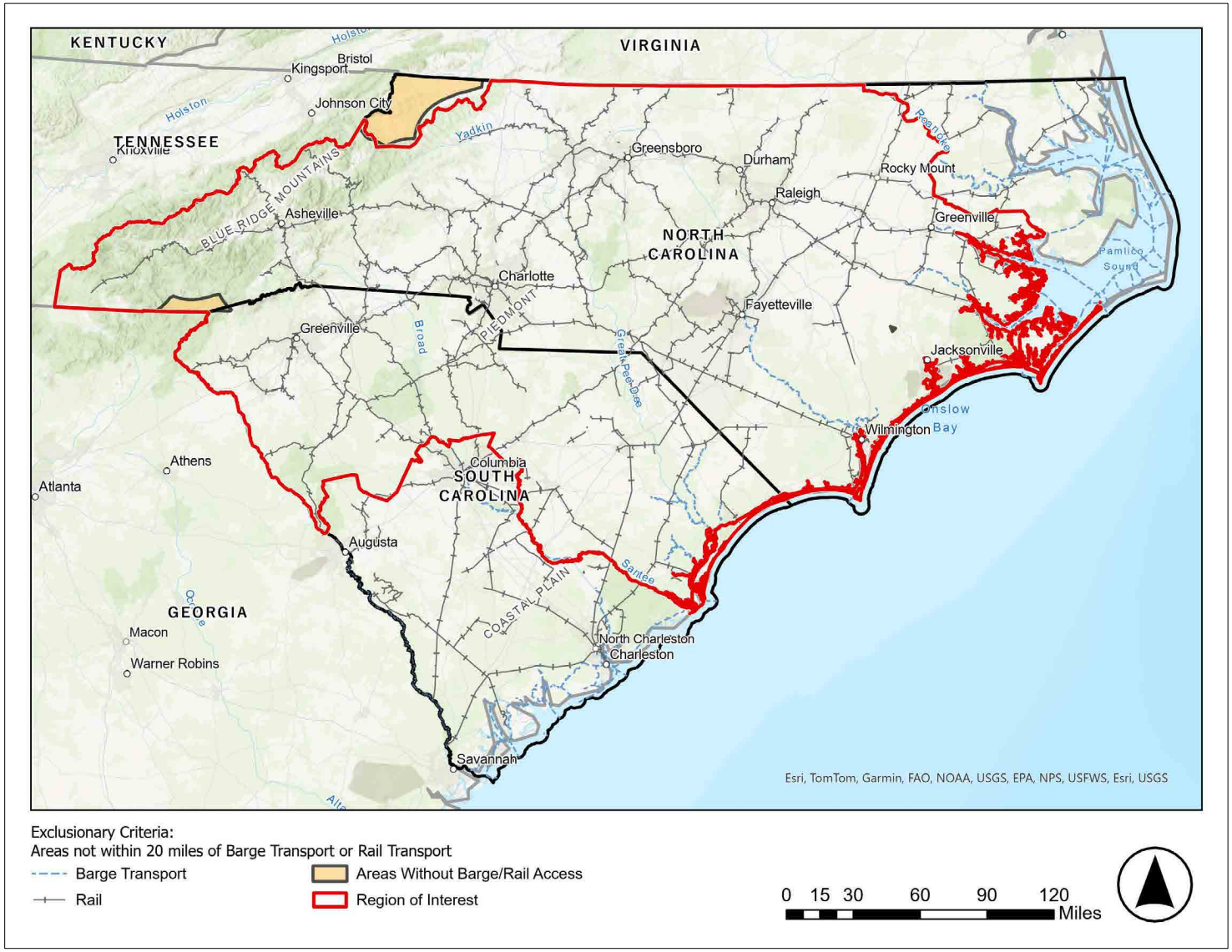

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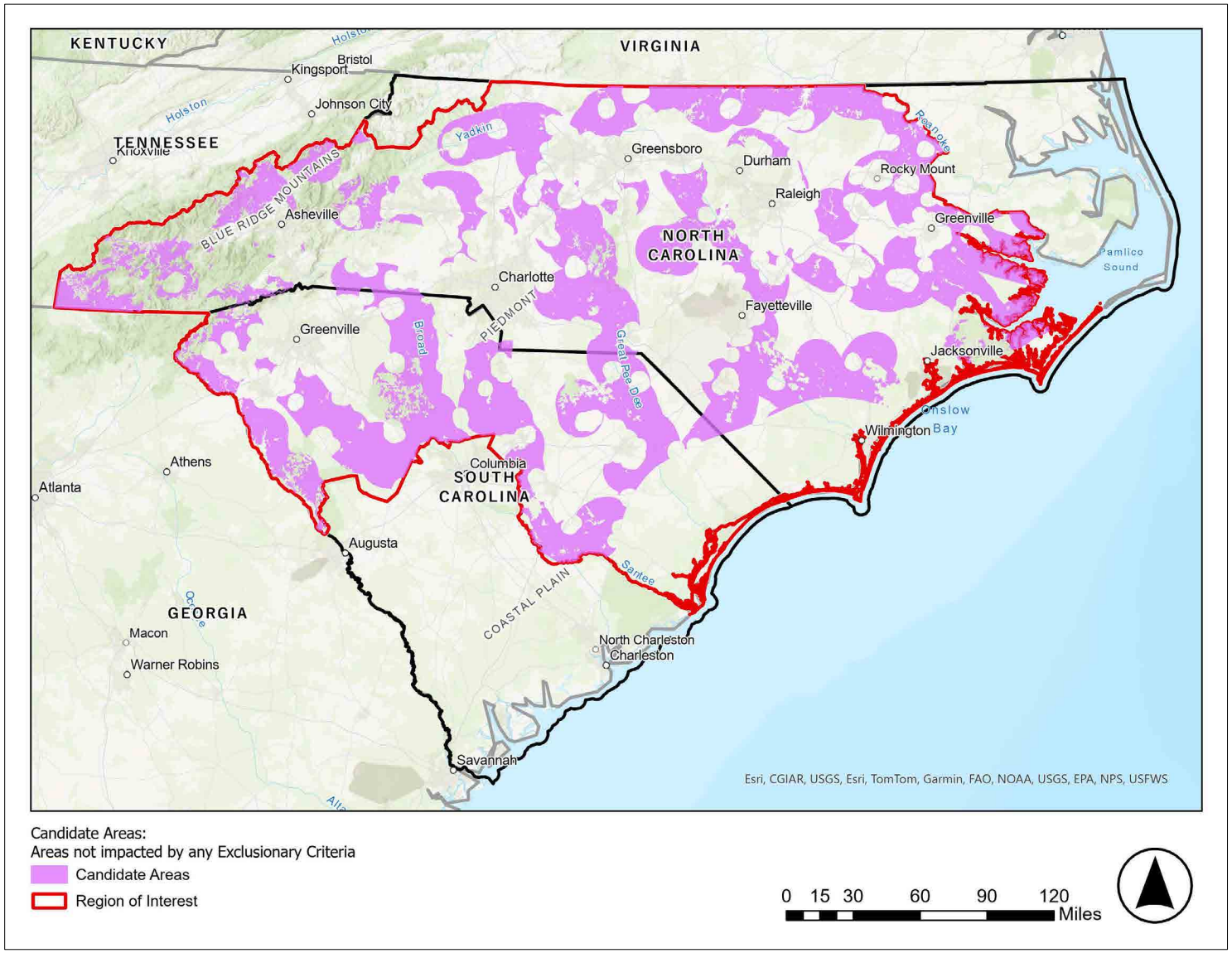

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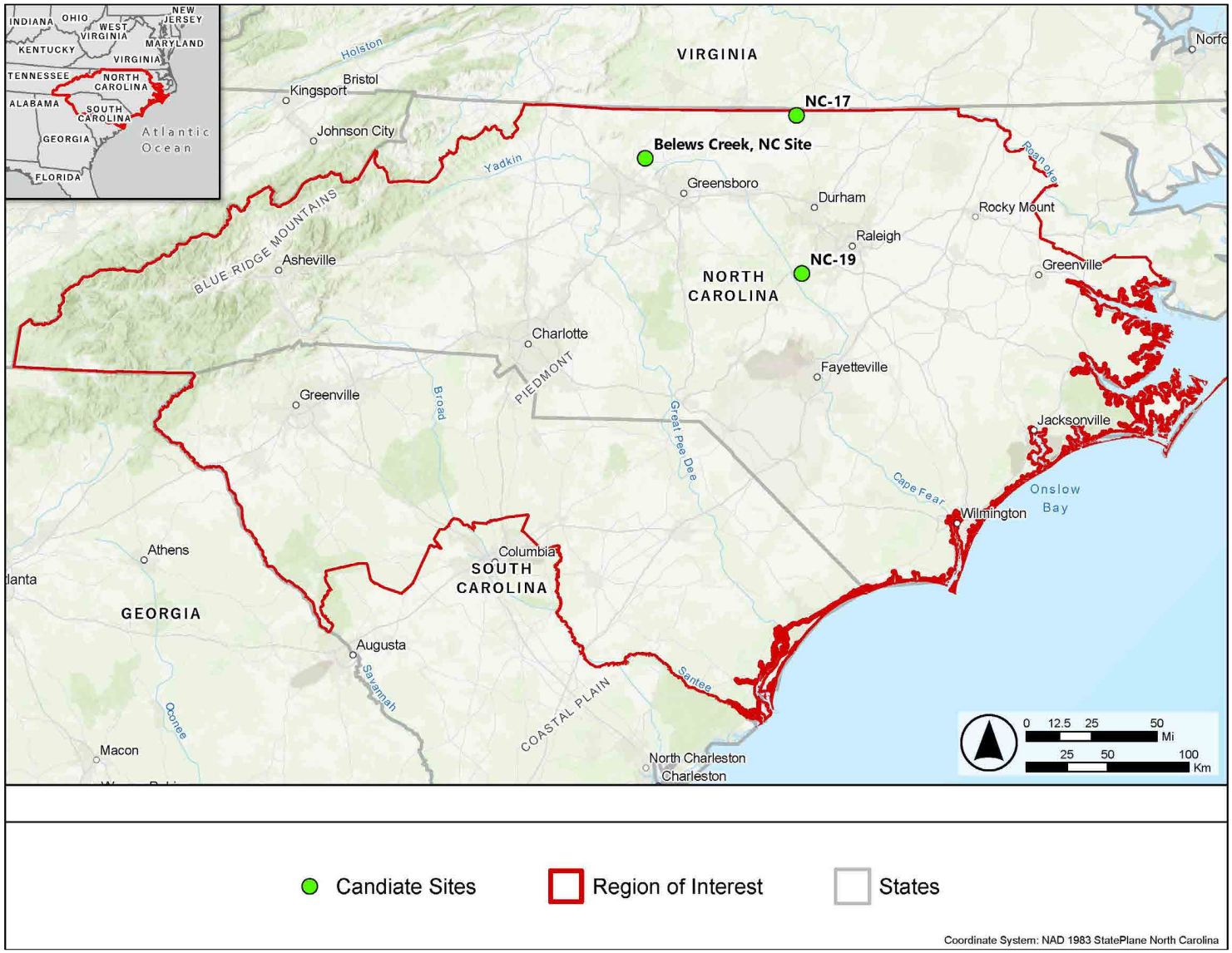

CHAPTER 10
CONCLUSIONS

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None.

GLOSSARY

Term	Definition
ac.	acre
ALARA	as low as is reasonably achievable
cfs	cubic feet per second
CWA	Clean Water Act
BCSS	Belews Creek Steam Station
BEA	U.S. Bureau of Economic Analysis
BMP	best management practice
CFR	Code of Federal Regulations
CRP	Carolinas Resource Plan
DOE	U.S. Department of Energy
ESP	Early Site Permit
ft.	feet
GAI	geographic area of interest
GHG	greenhouse gases
gpd	gallons per day

Term	Definition
GW	gigawatts
INL	Idaho National Laboratory
ISFSI	independent spent fuel storage installation
LLC	Limited Liability Company
lpd	liters per day
m	meter
MACCS	MELCOR Accident Consequences Code System
MDCT	mechanical draft cooling tower
MEI	maximally exposed individual
mrad	millirad
mrem	millirem
mrem/yr	millirem per year
MW	megawatt
MWe	megawatts electric
MWIS	makeup water intake structure
MWt	megawatts thermal

Term	Definition
NAAQS	National Ambient Air Quality Standards
NC	North Carolina
NCDEQ	North Carolina Department of Environmental Quality
NCOSA	North Carolina Office of State Archaeology
NCSHPO	North Carolina State Historic Preservation Office
NCWRC	North Carolina Wildlife Resources Commission
NDA	net disturbance area
NEPA	National Environmental Policy Act
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NUREG	NRC Technical Report designation
OSHA	U.S. Occupational Safety and Health Administration

Term	Definition
Project	All nuclear site development proposed by the applicant including transmission lines, access roads, utility corridors supporting the facility, etc.
PRA	Probabilistic Risk Assessment
Project site	Belews Creek, NC site
rem	roentgen equivalent man
RFFA	reasonably foreseeable future action
RIMS II	Regional Input-Output Modeling System
ROI	Region of Influence
ROW	right-of-way
SMR	small modular reactor
SO_x	sulfur oxides
SPCC	spill prevention, control, and countermeasure
SWPPP	stormwater pollution prevention plan
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

Chapter 10 Conclusions

10.0 INTRODUCTION

Section 101 of the National Environmental Policy Act of 1969 (NEPA) requires federal agencies to assess the environmental effects of proposed major federal actions prior to making decisions. Section 102 of NEPA establishes procedural requirements, applying that national policy to proposals for major federal actions significantly affecting the quality of the human environment by requiring federal agencies to prepare a detailed statement on: (1) the environmental impact of the proposed action; (2) any adverse effects that cannot be avoided; (3) alternatives to the proposed action; (4) the relationship between the proposed action's short-term use of environmental resources and the maintenance and enhancement of long-term productivity; and (5) any irreversible and irretrievable commitments of resources that would be involved in the proposed action.

The environmental consequences of construction and operation of advanced reactors at the Belews Creek, North Carolina (NC) site (Project site) are summarized in the following sections:

- Section 10.1: Impacts of the Proposed Action
- Section 10.2: Unavoidable Adverse Impacts
- Section 10.3: Relationship of Short-term Use of the Environment and Long-term Productivity
- Section 10.4: Irreversible and Irretrievable Commitments of Resources
- Section 10.5: Alternatives to the Proposed Action
- Section 10.6: Benefits and Costs

10.1 IMPACTS OF THE PROPOSED ACTION

The relative magnitude of impacts associated with building activities are discussed in Chapter 4 and summarized in Table 4.11-1. Impacts associated with operating the Project are discussed in Chapter 5 and summarized in Table 5.12-1. Chapter 7 describes the cumulative impacts associated with building activities, operations, and decommissioning of facilities when considered along with other past, present, and reasonably foreseeable future actions (RFFAs) in the geographic area of interest (GAI) for each resource.

The following sections provide a summary of the impacts from building activities, operations, and cumulative impacts associated with the Project.

10.1.1 LAND-USE IMPACTS

The anticipated on-site and off-site impacts to land use due to construction and operation are discussed in Sections 4.1 and 5.1, along with Section 7.2.1.

Land-use impacts from building activities associated with the Project result from permanent conversion of undeveloped forested land and developed land to industrial use, loss of prime farmland soils, and discontinuation of hunting leases on the Project site. As described in Section 4.1.1, noticeable land-use impacts from building activities are primarily due to the conversion of up to approximately 696 acres (ac.) (282 hectares [ha]) of forested land within the Project site to developed land for industrial use. Development of the Project site would be compatible with Belews Creek Steam Station (BCSS) on the adjacent property and is in compliance with current zoning in Stokes and Forsyth counties. Land-use impacts also result from construction within portions of the existing associated off-site wastewater pipeline corridor. Although building activities within the corridor disturb existing land cover, the overall use of the corridor for the pipeline does not change. No new off-site transmission corridors are needed for the Project.

In accordance with the Farmland Protection Policy Act, Duke Energy Carolinas, a limited liability company (LLC) (Duke Energy), coordinated with the United States (U.S.) Department of Agriculture's Natural Resources Conservation Service (NRCS) regarding impacts on prime and unique farmlands. Based on the Farmland Conversion Impact Rating (Form AD-1006) completed for the Project, impacts to prime and unique farmlands are expected to be minor, and no further consultation with the NRCS is required. Building activities affect recreational uses on the Project site because of the discontinuation of hunting leases. Hunting remains prohibited throughout operations. Because of the acreage of land that is converted from forest to industrial use, impacts from building activities noticeably alter, but do not destabilize, land use. Therefore, impacts on land use from building activities are MODERATE.

Approximately 906 ac. (367 ha) are disturbed during the operational life of the Project. Operation of the Project is consistent with applicable land-use planning and zoning, and no additional land is expected to be required to support operations. Operating the mechanical draft cooling towers (MDCTs) has the potential to affect nearby land through fogging, icing, and salt drift. However, the Seasonal and Annual Cooling Tower Impact analysis predicts no occurrences of fogging or plume rime icing, low rates of salt deposition, limited visual impacts, and insignificant levels of plume water deposition. In addition, development of an independent spent fuel storage installation (ISFSI) is being considered at the Project site to store spent fuel. The size and location of the ISFSI is currently undetermined. The facility will meet the requirements set forth in Title 10 Code of Federal Regulations (CFR) Part 72. The off-site wastewater pipeline corridor would continue to be managed as it is currently. Therefore, impacts on land use during operations are SMALL.

The cumulative impact of building and operating activities from the Project on land use, added to the effects associated with past, present, and RFFAs within the GAI on land use, is noticeable but not destabilizing and therefore MODERATE. Because of extensive past and present modification of land use within the GAI and the Project site's proximity to the adjacent existing industrial BCSS site, the impact of building the Project is a noticeable, but not a destabilizing contributor to the cumulative impact on land use. The impact of operating the Project is a minor contributor to the cumulative impact on land use.

10.1.2 WATER RESOURCES

10.1.2.1 Hydrologic Alterations

Impacts on surface waters and groundwater from hydrologic alterations are discussed in Sections 4.2.1, 5.2.1, and 7.2.2.

10.1.2.1.1 Surface Water

Building activities result in direct impacts of up to approximately 16,875 linear feet (ft.) (5144 linear meters [m]) of streams within the net disturbance area (NDA) and approximately 100 linear ft. (30.5 linear m) within the associated off-site wastewater pipeline. An additional approximately 1256 linear ft. (383 linear m) of streams on the Project site are indirectly impacted by building activities. Impacts within Belews Lake are localized to the intake, discharge, and associated lakebed piping structures. Stormwater runoff patterns across the NDA are affected, resulting in changes in stormwater runoff rates across the Project site.

Impacts to on-site aquatic habitats are mitigated in accordance with Sections 404, 401, and 402 of the Clean Water Act (CWA) and associated permits administered by the U.S. Army Corps of Engineers (USACE) and the North Carolina Department of Environmental Quality (NCDEQ). Implementation of design measures and best management practices (BMPs) during building activities, coupled with adherence to federal, state, and local permit conditions related to Sections 404, 401, and 402 of the CWA, reduce direct and indirect impacts on Belews Lake, Dan River, and stormwater runoff rates. For impacts that result from activities subject to permitting under Section 404 of the CWA and that cannot be reduced, Duke Energy implements specific compensatory mitigation measures in accordance with 33 CFR Part 332 "Compensatory Mitigation for Losses of Aquatic Resources." A National Pollutant Discharge Elimination System (NPDES) general construction permit with site-specific stormwater pollution prevention plan (SWPPP) is required and includes strategies to reduce erosion and control sedimentation at the Project site. The overall impacts of hydrologic alterations to surface waters are mitigated and are, therefore, SMALL.

The effects of Project operations on flow patterns within Belews Lake from intake, discharge, and makeup water intake structure (MWIS) operation are localized and minor. Additionally, the potential impacts of sediment transport into Belews Lake from the MWIS operation are negligible. Discharge into the Dan River results in localized changes in flow patterns and currents; however, total flow and discharge flow rates are regulated in conjunction with NCDEQ NPDES permitting requirements and are expected to be similar to the existing Outfall 006 wastewater discharge. Therefore, the hydrological impacts of discharge are minor. Pumping by the MWIS results in minor hydrologic alterations on the Dan River during higher flow conditions or when natural discharge is less than 110 cubic feet per second (cfs) (3.11 m^3/s), which are the most probable flow conditions.

Additionally, Project operations result in predicted water-level variations in Belews Lake resulting from increased consumptive use. Supplemental pumping by MWIS is a mitigating measure for Belews Creek level impacts. The predicted pattern of water-level variations during Project operations is similar to the BCSS Continuous Maximum Generation Condition, but operation of the Project results in somewhat greater drawdowns and an extended critical drought duration relative to the BCSS Continuous Maximum Generation Condition. Impacts on

water levels from Project operations are noticeable during periods of increased drought severity, but are not considered to be destabilizing. Lake hydrologic function and features are generally maintained by operation of the MWIS that mitigates the reduction in lake levels from the increased consumptive use.

The overall operational impacts from hydrologic alterations to surface waters are SMALL on the Dan River and Belews Lake for all Project operations except for the effects associated with consumptive use, including that on Belews Lake and MWIS operations on the Dan River. Under conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping, impacts on Belews Lake hydrology are SMALL. During periods of increased drought intensity, the impacts on Belews Lake hydrology are MODERATE. Pumping by the MWIS results in minor hydrologic alterations on the Dan River during higher flow conditions or when natural discharge is less than 110 cfs (3.11 m^3/s).

Because of extensive past and present modification of Belews Creek and its tributaries as a result of the impoundment of Belews Lake, the cumulative impact of building and operating the Project on surface water hydrology, added to the effects associated with past, present, and RFFAs within the GAI on surface water hydrology is MODERATE. The impact of building the Project is a minor contributor to the cumulative impact on surface water hydrology due to the mitigation of impacts to low-quality streams on-site, impacts to Belews Lake, and stormwater runoff changes. The impact of operation of the Project is a noticeable contributor to the cumulative impact on surface water hydrology in conjunction with periods of increased drought intensity.

10.1.2.1.2 Groundwater

Localized changes (decreases) in groundwater elevations may occur from dewatering during building activities. Once building activities are completed, dewatering is no longer needed, and the water table is returned to the static baseline conditions that Section 2.2.1 describes. Structure foundation development does not result in long-term impacts on groundwater levels, availability, or flow patterns. Development of new impervious surfaces on the Project site results in reduced infiltration and groundwater recharge in the immediate area of these structures and surfaces. In locations where groundwater recharge is affected, corresponding reductions in groundwater levels may occur; however, other lands within the NDA are expected to allow for varying degrees of groundwater infiltration and recharge. Therefore, impacts of hydrologic alteration of groundwater during building activities are SMALL.

During operations, there are few hydrologic alterations that affect groundwater availability. No groundwater use or dewatering occurs during operations that may affect local aquifers. Impervious surfaces from development of areas within the NDA results in reduced infiltration and groundwater recharge in the immediate area of new structures and pavement. In locations where groundwater recharge is affected, corresponding reductions in groundwater levels may occur. Other lands within the NDA are expected to allow for varying degrees of groundwater infiltration and recharge. Therefore, impacts on groundwater from hydrologic alterations during operations are SMALL.

The cumulative impact of the Project on groundwater hydrology, added to the effects associated with past, present, and RFFAs within the GAI, is minor and therefore SMALL. Because groundwater use by the Project is limited to the building phase and only results in localized

alterations from dewatering and reductions in infiltration because of the construction of new impervious surfaces, the impact of building and operation of the Project is not a significant contributor to the cumulative impact on groundwater hydrology.

10.1.2.2 Water Use Impacts

Impacts on surface water and groundwater from water use are discussed in Sections 4.2.2, 5.2.2, and 7.2.2.

10.1.2.2.1 Surface Water

During building activities, surface water is used for dust suppression, potable water, and concrete-batch plant operation. An estimated maximum of 500,000 gallons per day (gpd) (1,892,706 liters per day [lpd]) is drawn from Belews Lake for dust suppression and concrete-batch plant operation. This amount is negligible compared to the current volume of the lake. Potable water for building is obtained from either an existing or new water line connection with Winston-Salem/Forsyth County Utilities, and the maximum expected daily potable water usage is 61,622 gpd (233,264 lpd), which is within the capacity of the water supplier. Therefore, the impacts from surface water use during the building phase are SMALL.

During operations, Belews Lake consumptive water use increases. However, this increased use is supplemented by MWIS operation, and consumptive use in conjunction with Project operations does not adversely affect the availability of water for Project intake systems. Impacts on water use in Belews Lake are therefore SMALL. Although MWIS operation reduces the water available to downstream water users, this reduction does not compromise the overall availability or reliability of surface water to users downstream of the Project. Impacts of MWIS operation on downstream water use by communities are SMALL.

The cumulative impact of the Project on surface water use, added to the effects associated with past, present, and RFFAs within the GAI on surface water use is minor and therefore SMALL. Water used for dust suppression and potable water usage during building activities is minor, and the impact during operations is low due to the available capacity. The impact of both building and operation of the Project is a minor contributor to the cumulative impact on surface water use.

10.1.2.2.2 Groundwater

Groundwater is not used as a source of water for building activities. Therefore, the impacts from groundwater use are SMALL.

Likewise, groundwater is not used during operation of the Project, and no permanent dewatering system is planned for use during operations. Therefore, impacts of groundwater use from operations are SMALL.

The cumulative impact of the Project on groundwater use, added to the effects associated with past, present, and RFFAs within the GAI on groundwater use, is minor and therefore SMALL. Because groundwater is not used during building activities or operations, the impact of building and operation of the Project is negligible and not a significant contributor to the cumulative impact on groundwater use.

10.1.2.3 Water Quality Impacts

Impacts on surface water and groundwater quality are discussed in Sections 4.2.3, 5.2.3, and 7.2.2.

10.1.2.3.1 Surface Water

During building activities, impacts to surface water quality are controlled, localized, and temporary because of implementation of mitigative measures and engineering controls (e.g., BMPs, SWPPP, and Spill Prevention, Control, and Countermeasures [SPCC]). Therefore, impacts on surface water quality are SMALL.

Effects of operation on water quality within Belews Lake include the addition of cooling tower blowdown wastewater constituents, reduced thermal load, and supplemental pumping from the Dan River. The additional wastewater discharges are not expected to accumulate and will meet NPDES permitting limits and requirements with a regulatory mixing zone. Monitoring programs will be implemented to ensure regulatory compliance. Therefore, the overall impacts on surface water quality are considered SMALL.

The direct effects of operation on surface water quality in the Dan River include nonradioactive liquid discharges and the addition of cooling tower blowdown wastewater constituents and thermal load. Operational impacts to Dan River water quality are mitigated through engineering and administrative controls and monitoring programs. The additional wastewater discharges are managed within Section 402 NPDES permitting limits and requirements; therefore, overall impacts on surface water quality are SMALL.

The cumulative effects on surface water quality of BCSS closure in conjunction with the proposed Project are generally beneficial. Cessation of the inputs and discharges from natural gas and coal-fired electricity generation at BCSS and implementation of the Project reduce thermal inputs to Belews Lake and discharge of constituents to the Dan River compared to existing conditions, while remaining within federal and state permitted conditions. Added to the effects of all past, present, and RFFAs within the GAI, the cumulative impact of building and operating activities from the Project on surface water quality is noticeable and stabilizing, primarily due to the beneficial effects of BCSS closure. Because of adherence to regulations and permits by the NCDEQ and USACE, use of BMPs, and implementation of the SPCC plan and SWPPP, the impact of building and operation of the Project is minor and not a significant contributor to the cumulative impact on surface water quality. Overall impacts, therefore, are LARGE and beneficial.

10.1.2.3.2 Groundwater

In the unlikely event small amounts of oil-related substances are released into the environment during building activities, they would have a small, localized, temporary impact on groundwater. Because engineering controls (e.g., BMPs and SPCC) prevent or minimize the release of harmful effluents, and effluent concentrations are maintained at levels below permitted threshold limits that are established to be protective of water quality, impacts to groundwater quality are SMALL.

Likewise, during operations, engineering controls prevent or minimize the release of harmful effluents. Additionally, because concentrations of constituents in surface water are maintained at levels below permitted limits, any impacts to groundwater quality are SMALL.

The cumulative impact of the Project on groundwater quality, added to the effects associated with past, present, and RFFAs within the GAI on groundwater quality, is minor and therefore SMALL. Because engineering controls (e.g., BMPs and SPCC) prevent or minimize the release of harmful effluents, and effluent concentrations are maintained at levels below permitted limits that are established to be protective of water quality, the impact of building and operation of the Project is negligible and not a significant contributor to the cumulative impact on groundwater quality.

10.1.3 ECOLOGICAL RESOURCES

10.1.3.1 Terrestrial and Wetland Impacts

Impacts to terrestrial ecosystems and wetlands are discussed in Sections 4.3.1, 5.3.1, and 7.2.3.

Impacts of building activities on plant communities and terrestrial habitats are the result of alterations to existing habitats within the NDA. Although much of the habitat on-site is of low quality, there is suitable habitat within the Project Vicinity. However, higher-quality habitats on-site are also permanently impacted, and the composition of wildlife within the Project site is altered to naturalized communities. Impacts on wildlife are limited because of mitigation measures, BMPs, and the short duration of building activities. The only important habitat on the Project site consists of wetlands, as defined by U.S. Nuclear Regulatory Commission (NRC) guidance and discussed in Section 2.3.1.6. Impacts on wetland habitats are mitigated by BMPs and required federal or state mitigation. Impacts on important terrestrial species are mostly limited because many of these species are not found on the Project site, or there is limited impact on habitats and populations found within the Project Vicinity and Project Region. Consultation with the U.S. Fish and Wildlife Service (USFWS) and implementing appropriate conservation measures and other mitigative measures reduces impacts on terrestrial species found on the Project site or in adjacent areas. Overall, impacts on terrestrial ecology and wetlands from building activities are MODERATE due to the noticeable but not destabilizing impacts from the conversion of terrestrial ecosystems within the Project site.

Impacts to terrestrial ecology during operations are limited by the lack of habitat on-site because most of the Project site is developed, and wildlife communities are limited to small areas on the Project site such as the vegetated buffer areas around Belews Lake. Impacts associated with landscape maintenance activities, potential for invasive species establishment, noise emissions, cooling tower salt deposition, and potential for bird collisions with tall structures are minor and mitigated using BMPs and general landscape maintenance activities. Control methods limit impacts of invasive species to vegetation and native wildlife. Compliance with the Migratory Bird Treaty Act reduces impacts to birds during transmission or other maintenance activities. Impacts to important terrestrial species and habitats are also minor. Overall, impacts to terrestrial ecology and wetlands from operation are SMALL.

The cumulative impact of building and operating activities on terrestrial ecology and wetlands, added to the effects associated with past, present, and RFFAs within the GAI, is noticeable but

not destabilizing and therefore MODERATE. Because of extensive forest habitat loss on the Project site and associated impacts on wildlife, the impact of building and operation of the Project would be a noticeable contributor to this MODERATE cumulative impact.

10.1.3.2 Aquatic Impacts

Impacts to aquatic resources are discussed in Sections 4.3.2, 5.3.2, and 7.2.3.

Building activities result in direct impacts on up to approximately 16,875 linear ft. (5144 m) of streams within the NDA and 100 linear ft. (30.5 m) within the associated off-site wastewater pipeline. An additional approximately 1256 linear ft. (323 linear m) of streams on the Project site are indirectly impacted by building activities. The impacted streams are primarily first order, relatively small streams which are mostly intermittent in nature and do not demonstrate high quality habitat. Impacts on aquatic habitats in Belews Lake are minor based on the lack of high quality or unique habitats in the locations in which building activities are to occur. Impacts on most streams or other aquatic ecosystems are mitigated in accordance with permitting requirements. Impacts within Belews Lake are temporary and localized to the intake and discharge structures on the Project site.

Building activities have no direct impacts on important aquatic habitats (e.g., natural areas, managed areas, or other designated areas). Indirect impacts on aquatic communities from sedimentation, erosion, and incidental releases resulting from building activities are minimized under permitting and SWPPP requirements and through use of BMPs. In addition, Duke Energy will consult with USFWS and the State of NC regarding avoidance, minimization, and appropriate conservation measures to limit potential effects on proposed critical habitats within the Dan River. The overall impacts of building activities on aquatic resources are therefore SMALL.

Impacts of Project operations on aquatic species and habitats from impingement and entrainment associated with the cooling water intake structure and MWIS, cooling tower effluent constituents and thermal effluents in Belews Lake, and wastewater discharge in the Dan River, are SMALL. Impacts on aquatic species and habitats within Belews Lake from operations, under normal operational conditions in which water levels are stabilized and consumptive losses are offset by MWIS pumping, likewise are minor; however, impacts from reductions in water levels under drought conditions are MODERATE. Supplemental pumping from the MWIS in accordance with the limits established in the NCDEQ NPDES permit mitigates the reduction in lake levels and associated effects on near shore aquatic habitats and minimizes potential effects related to water-level fluctuations. The NCDEQ NPDES permit limits adverse impacts to aquatic ecology within the Dan River by maintaining river flow and habitat availability and minimizing entrainment and impingement.

The cumulative impact of building and operating the Project on aquatic ecology, added to effects associated with past, present, and RFFAs within the GAI is MODERATE. This conclusion accounts for the cumulative effects of past impoundment of Belews Creek and its resultant effects on the aquatic ecosystem within Belews Creek and its tributaries. The incremental contribution of building and operation of the Project is a minor contributor to the cumulative impact on aquatic ecosystems under normal conditions and noticeable in conjunction with the effects of increased drought intensity.

10.1.4 SOCIOECONOMICS

10.1.4.1 Physical Impacts

Physical impacts are discussed in Sections 4.4.1, 5.4.1, and 7.2.4.1.

Building-related noise and vibration impacts to off-site structures are minimal because of the distance from the closest residence to the areas where the activities causing noise and vibration take place. The nearest residence may be disrupted from the use of heavy machinery and vehicles; however, the use of this mobile equipment is intermittent. Emissions from building-related activities are controlled using minimization measures and by maintaining established regulatory limits. Any damage to public roads, markings, or signs caused by building activities is repaired to preexisting conditions or better, in accordance with state and local requirements. Impacts to aesthetics from building activities, including the introduction of new structures, use of equipment, and increased traffic in the Project Vicinity that impact viewsheds, are noticeable for nearby residents and recreators on Belews Lake but are not destabilizing. Therefore, physical impacts of building activities are SMALL for most factors, but MODERATE for aesthetics.

During operations, odors, dust and air pollution, thermal emissions, noise, and transportation have a SMALL physical impact. New plant structures and related cooling tower plumes at the Project site noticeably affect the aesthetic qualities of the natural landscape for nearby residents and recreators on Belews Lake. Thus, physical impacts on aesthetic quality from operations are MODERATE.

The cumulative physical impact of building and operation of the Project, added to the impacts associated with past, present, and RFFAs within the GAI on the physical environment is SMALL for all categories except for aesthetics which is MODERATE. The impact of building and operation of the Project is a noticeable contributor to the cumulative impact on aesthetics, whereas the remaining physical impacts from building and operation of the Project are minor contributors to the cumulative impact.

10.1.4.2 Demographic Impacts

Demographic impacts are discussed in Sections 4.4.2, 5.4.2, and 7.2.4.2.

The building-related population increases associated with the in-migration of workers and their families account for less than 1 percent of the Region of Influence's (ROI's) projected total population in 2030. Therefore, impacts to demographics associated with building activities are SMALL.

The operations-related population increases associated with the in-migration of operations workforce, together with the construction workforce that remain within the ROI, and their families, account for less than 1 percent of the ROI's projected total population in 2040. Therefore, impacts to demographics within the ROI associated with operation are SMALL.

The cumulative impact of building and operation of the Project on demography, added to the impacts of past, present, and RFFAs (including projected population growth within population centers in the ROI) within the GAI for demography is SMALL. Because of the much larger population within the ROI and the comparatively smaller workforces required during building and

operation of the Project, the impact of building and operation is a minor contributor to the cumulative impact on demography.

10.1.4.3 Economic Impacts to the Community

Economic impacts to the community are discussed in Sections 4.4.3, 5.4.3, and 7.2.4.3.

Building activities associated with the Project introduce millions of dollars into the economy and create both direct and indirect jobs. These positive economic impacts are primarily realized within the ROI. Minor tax revenue impacts on local jurisdictions are accrued through increases in individual income tax, sale of electricity tax, and sales and use tax. Therefore, the economic impacts are MODERATE and beneficial.

Operational activity introduces millions of dollars into the economy and creates jobs. These positive economic impacts are primarily realized within the ROI. Minor tax revenue impacts on local jurisdictions are accrued through increases in revenue generated from individual income tax, sales and use tax, and property tax. Therefore, the economic and tax impacts are SMALL and beneficial.

The cumulative economic impact of building and operation of the Project on the economy, added to the economic effects associated with past, present, and RFFAs in the GAI on the economy, is MODERATE and beneficial. The impact of the building and operation of the Project is a noticeable contributor to the cumulative impact on the economy in the GAI, primarily through job creation and increased local spending.

10.1.4.4 Community Infrastructure Impacts

Community infrastructure impacts are discussed in Sections 4.4.4, 5.4.4 and 7.2.4.4.

Building-related impacts on all infrastructure and community services are SMALL within the ROI, with the exception of traffic impacts due to increased commuters on roadways near the Project site at the beginning and end of their shifts. Impacts to transportation due to workforce traffic are SMALL within the broader transportation network, but MODERATE on two-lane segments and intersections that provide access to the Project site during daily peak traffic periods. Implementation of planned traffic management measures reduces congestion and unstable conditions.

Operations-related impacts on all infrastructure and community services are SMALL within the ROI, with the exception of impacts to traffic and recreation. Impacts to transportation due to operations traffic are SMALL within the broader transportation network, but MODERATE on two-lane segments and intersections that provide access to the Project site. Impacts on recreation are SMALL to MODERATE. Under conditions in which water levels in Belews Lake are stabilized and consumptive losses are offset by MWIS pumping, impacts on Belews Lake recreation are SMALL. However, impacts on Belews Lake recreation are MODERATE in conjunction with the effects of increased drought intensity and visual intrusion.

The cumulative effect on infrastructure and community services, when combined with past, present, and RFFAs within the GAI is considered SMALL based on the broader opportunities for recreation within the ROI. While the Project has noticeable effects on traffic and recreation at

Belews Lake (as described in Section 5.4.4.2), the Project is a minor contributor to the overall cumulative impact.

10.1.5 NOT USED

Deleted (Executive Order, 2025a, 2025b)

10.1.6 HISTORIC AND CULTURAL RESOURCES

Impacts on historic and cultural resources are discussed in Sections 4.6 and 5.6, along with Section 7.2.6.

Duke Energy has determined that based on the extent of the NDA indicated in Figure 3.3-1, and the location of archaeological sites as indicated in Figure 2.6-3, potential effects to archaeological sites [[ ]]^{CRI} can likely be avoided. If avoidance is not possible, archaeological mitigation including Phase III data recovery investigations will be developed in coordination with NCSHPO to address adverse effects to archaeological sites eligible for the NRHP under Criterion D. Avoidance of Branson Cemetery, ineligible for inclusion to the NRHP but protected under NC statute, is not possible. Accordingly, provisions regarding exhumation and repatriation provided by NC General Statute Chapter 65-106 will be followed as appropriate. Duke Energy plans to remove all graves in Branson Cemetery and relocate them to a new burial ground in accordance with an approved cemetery removal plan that includes delineation of the cemetery boundaries, generation of cemetery maps, and completion of historical and genealogical research. The plan will be developed in consultation with NCSHPO and in accordance with NC General Statute 65-106. Therefore, impacts on historic and cultural resources as a result of building activities are SMALL where avoidance of archaeological sites is possible and MODERATE with mitigation if sites cannot be avoided.

Operations have no impacts on historic structures. Operation of the advanced reactor units and supporting facilities occurs in areas that are disturbed during the building phase. Nonetheless, if ground-disturbing activities are undertaken beyond the NDA during operations, the potential exists for affecting undiscovered resources within the Project site. Mitigative measures developed in consultation with the NCSHPO and the NC Office of State Archaeology (OSA) are proposed for addressing previously undiscovered resources, and internal procedures will be followed for such discoveries. Therefore, impacts to archaeological sites during operations are SMALL. All cemetery relocation activities will be undertaken in advance of or during the building phase. Therefore, no cemetery will be present on the Project site during operations, and there are no impacts to cemeteries during operations.

The cumulative impacts of building and operating activities on historic and cultural resources, added to the effects associated with past, present, and RFFAs within the GAI, on historic and cultural resources are SMALL to MODERATE. The impact of building activities is a minor contributor to the cumulative impact on historic and cultural resources.

10.1.7 AIR RESOURCES

Impacts on local meteorology and air resources are discussed in Sections 4.7 and 5.7, along with Section 7.2.7.

The primary impacts on air quality during building activities are from dust generated by land clearing and construction, emissions from heavy equipment and machinery, concrete-batch plant operations, and emissions from vehicles used to transport workers and deliver materials to and from the site. Duke Energy develops and implements strategies to reduce emissions to ensure compliance with federal, state, and local regulations, including a dust control program. With implementation of these strategies, impacts on air quality from emissions of criteria pollutants and greenhouse gases are SMALL.

Operational impacts result from releases of heat and moisture from MDCTs, operation of auxiliary equipment (e.g., generators and auxiliary boilers), and mobile emissions from vehicles. No hours of ground fogging or plume rime icing are predicted from operation of the MDCTs, and salt drift deposition is predicted to be low and occur within the Project site. Visual impacts from operation of all MDCTs are limited and occur primarily on the Project site. Operation of the advanced reactors increases gaseous and particulate emissions to the air, primarily from cooling towers, auxiliary boilers, emergency equipment, and emergency power supply system diesel generators and gas turbines. The diesel generators/gas turbines and engine-driven emergency equipment are used intermittently and for brief durations. Nominal localized increases in emissions occur due to the increased numbers of cars, trucks, and delivery vehicles that travel to and from the Project site. Air emission sources during operations are managed in accordance with federal, state, and local air quality controls laws and regulations. The greenhouse gas emission footprint of a generic reactor are expected to be minor, an estimated 0.17 percent of the annual 2022 carbon equivalent emissions in the U.S. Accordingly, impacts to air resources from operation of the Project are SMALL.

Operation of the Project and BCSS closure result in a beneficial cumulative impact to air quality on the existing attainment status of regional air quality because emissions of criteria pollutants from the BCSS facility would cease. Additionally, the relatively small lifetime greenhouse gas emissions from the Project are offset by closure of the BCSS facility and replacement of natural gas and coal-fired electricity generated by this facility with electricity generated by the Project. In conjunction with the effects associated with all past, present, and RFFAs within the GAI, the cumulative impacts of building and operating activities on criteria pollutant and greenhouse gas emissions are SMALL. The impacts of building and operation of the Project are not significant contributors to the cumulative impact because air emissions are controlled through implementation of BMPs and in accordance with applicable federal and state regulations and permitting requirements.

10.1.8 NONRADIOLOGICAL HEALTH

Nonradiological health impacts on the public and workers are discussed in Sections 4.8 and 5.8, along with Section 7.2.8.

During building activities, nonradiological health and safety impacts are minimized through compliance with all applicable state and federal regulations. Based on a conservative analysis (see Section 4.8.2.1), noise levels at residences closest to the Project site are higher than 65 A-weighted decibels during building activities. However, noise levels attenuate rapidly with distance and decrease as equipment moves away from a receptor. For any particular receptor at or along the Project site boundary, exposure to high noise levels is variable and short term. As such, noise impacts from building activities are minor. The impact of building-related vibration on public health is minor. The addition of vehicles during the building phase on local

roads accessing the Project site results in a minor increase in crashes. Based on these impact determinations, the nonradiological health impacts of building activities are SMALL.

During operations, water temperatures in Belews Lake do not support conditions favorable to etiological agent establishment and growth. Therefore, potential effects associated with the development of etiological agents within Belews Lake resulting from operation of advanced reactors at the Project site are minor. Sanitary wastewater discharged to the Dan River complies with NPDES permit requirements. Because the on-site transmission lines comply with the National Electrical Safety Code and Duke Energy safety standards, impacts associated with potential electrical shock and impacts to the public attributable to electromagnetic frequency exposure from transmission system operations are minor. Operations result in cooling tower noise emissions that attenuate with distance; however, overall effects of noise are minor. The additional vehicles associated with operational traffic result in a minor increase in the risk of traffic accidents on the surrounding roadway network relative to the base condition. Therefore, impacts on nonradiological health are SMALL.

The cumulative nonradiological health impact of building and operation of the Project, combined with the effects associated with past, present, and RFFAs within the GAI is SMALL.

10.1.9 RADIOLOGICAL HEALTH DURING NORMAL OPERATIONS

Radiological health impacts on the public and workers are discussed in Sections 4.9 and 5.9, along with Section 7.2.9.

During building activities, construction workers may be exposed to direct radiation sources from plant buildings and facilities of operating units and radioactive gaseous effluents released through a controlled and monitored release point. As discussed in Section 4.9.3, construction workers are not expected to be exposed to radioactive liquid effluents. The annual radiation dose to construction workers is within the limits set in 10 CFR 20.1301 and 10 CFR 20.1302, which establish dose limits for individual members of the public, as noted in Section 4.9.4. As a result, construction workers are classified as members of the public and do not require additional monitoring. Therefore, impacts to construction workers from radiation exposure would be SMALL.

During normal operation of the Project, radiation and radiological effluents could be transmitted to plant workers and members of the public and biota occupying areas near the Project site. Radioactive effluent pathways to humans and nonhuman biota during normal operating conditions consist of:

- Small quantities of treated and diluted radioactive liquid effluent into the Dan River (i.e., liquid effluent)
- Radioactive gaseous effluent releases through a controlled and monitored release point
- Direct radiation from plant buildings of operating reactors.

While man and biota may be exposed to direct radiation from plant buildings of operating reactors, it is assumed that there is no significant direct radiation from plant buildings of operating reactors. This is a reasonable assumption considering that the annual direct radiation

dose contribution at the site boundary of a typical commercial nuclear pressurized water reactor power plant is the range of natural background radiation.

The exposure pathways for members of the public include liquid and gaseous effluents. Based on the doses for the maximally exposed individual (MEI) (i.e., a member of the public located at the Project site boundary) from liquid and gaseous effluents, the collective population dose resulting from normal operations is less than the estimated person-rem/yr exposure from natural background radiation, as discussed in Section 5.9.3. Therefore, impacts to members of the public from normal operation of the Project are SMALL.

The annual occupational dose to operational workers, including workers involved with major maintenance and outage activities, will be provided in the construction permit or license application. This dose will be maintained as low as is reasonably achievable (ALARA) in compliance with 10 CFR 20.1101.

Exposure of nonhuman biota near the Project site can occur through liquid or gaseous effluent exposure pathways. The calculated maximum biota dose, discussed in Section 5.9.5.3 and presented in Table 5.9-17, is 148 millirems per year (mrem/yr), which is above the 25 mrem/yr whole-body limit prescribed by 40 CFR Part 190. Use of exposure guidelines, such as 40 CFR Part 190, which apply to members of the public, in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. When actions taken to protect humans from radiation and radioactive materials are not adequate to protect biota in accordance with 4.j(2)(b) of the Department of Energy (DOE) Order 458.1 (DOE, 2011), an alternative approach may be used to demonstrate that the dose rates to representative biota populations do not exceed the dose rate criteria in Table 2.2 of DOE-STD-1153-2002 (DOE, 2022). The dose rate criteria in Table 2.2 of DOE-STD-1153-2002 are 1 rad/day for aquatic biota and 0.1 rad/day for terrestrial biota. As indicated in Table 5.9-17, all biota analyzed for the Project site are within the dose limits of 1 rad/day (1000 mrad/day) for aquatic biota and 0.1 rad/day (100 mrad/day) for terrestrial biota.

Although many of the past, present, and RFFAs identified in Table 7.1-2 are affected by the Project site, none of these projects are expected to contribute to cumulative effects related to radiological health impacts. Therefore, based on the impacts analysis in Sections 4.9 and 5.9, the cumulative impact of construction and operation activities on radiological health, in consideration with past, present, and RFFAs in the GAI, is SMALL.

10.1.10 NONRADIOACTIVE WASTE MANAGEMENT

Impacts that may result from the generation, handling, and disposal of nonradioactive waste are discussed in Sections 4.10 and 5.10, along with Section 7.2.10.

During building activities, management of solid wastes complies with all applicable federal, state, and local requirements and standards. BMPs minimize the generation of solid waste and decrease potential impacts on downstream water quality. The potential for spills of petroleum or industrial chemicals are managed through SPCC plans. Air emissions are managed in compliance with applicable regulatory limits defined by the National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50). Duke Energy implements a dust control program and develops strategies to reduce emissions to ensure compliance with federal, state,

and local regulations. Therefore, the impacts on land, water, and air from nonradioactive waste during building activities are SMALL.

Although the reactor technology has not been selected, Duke Energy uses site-specific operational procedures and administrative guidelines to manage all solid, hazardous, and mixed waste generated from the site during operation in accordance with federal and state regulations. The impacts of sanitary wastes and liquid effluents on water quality in the Dan River and Belews Lake are managed through engineering controls in accordance with an NPDES permit. Impacts of discharge of small quantities of treated and diluted radioactive liquid effluent to the Dan River are discussed in Section 10.1.9. Stormwater discharges are managed through a separate NPDES stormwater permit and controlled and minimized using BMPs. Air emissions are intermittent during operations and managed to adhere to prevention of significant deterioration standards and other federal, state, and local air quality control regulations. Therefore, impacts on land, water, and air from nonradioactive waste during operations are SMALL.

The cumulative impact of building and operating activities from the Project on nonradiological waste based on the availability and expected capacity of existing licensed disposal facilities within the GAI, added to the effects associated with past, present, and RFFAs within the GAI on nonradiological waste, is SMALL. The impact of the building and operation of the Project is not a noticeable contributor to the cumulative impact on nonradioactive waste. Given the existing reported landfill capacity in the Project Region and the scope of the RFFAs, construction and operation of these facilities are not expected to substantially contribute to the loss of waste disposal capacity in the GAI.

10.1.11 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

As discussed in Section 5.11, the environmental impacts from a postulated accident at the Project site, considering both design basis and severe accidents, are anticipated to be SMALL.

Off-site radiological consequences of design basis accidents are assessed based on a surrogate accident source term associated with one of the potential advanced reactor technologies. The design basis accident source term is shown in Table 5.11-1. The resulting doses shown in Table 5.11-2 are within the acceptance criteria in 10 CFR 50.34. Therefore, the environmental impacts of design basis accidents at the Project site are anticipated to be SMALL.

The environmental risks of severe accidents are evaluated based on source terms and probabilities determined from the Probabilistic Risk Assessment (PRA). The MELCOR Accident Consequences Code System (MACCS) computer code is used to estimate severe accident risks based on-site-specific meteorology, population, and land-use data. The doses for the applicable environmental exposure pathways demonstrate that the individual prompt and latent cancer fatality risks meet the NRC's Safety Goals. The calculated population dose risk is less than the maximum, median, and mean dose risk for current operating reactors. Therefore, the environmental impacts of postulated severe accidents for the Project site are anticipated to be SMALL.

10.2 UNAVOIDABLE ADVERSE IMPACTS

The direct, indirect, and cumulative impacts of building and operating the Project are summarized in Section 10.1. This section and Tables 10.2-1 and 10.2-2 summarize the unavoidable adverse impacts of building and operating the Project. Unavoidable impacts are those adverse impacts that cannot be avoided or for which there are no practical means of further mitigation.

Mitigation measures and controls that are required as part of regulatory compliance, NPDES permits, or SPCC plans or implemented separately by Duke Energy are designed to reduce, manage, or eliminate the negative effect of building and operational activities. When properly implemented, BMPs can effectively control pollutants, manage stormwater, prevent erosion, and protect natural habitats. Tables 10.2-1 and 10.2-2 discuss residual unavoidable building and operational impacts that occur after mitigation or for which no mitigation measures or controls have been identified.

10.2.1 UNAVOIDABLE ADVERSE IMPACTS OF BUILDING

Impacts from building activities are described in Chapter 4. Table 4.11-1 summarizes those impacts and identifies the mitigation measures and controls that may be implemented to reduce or eliminate impacts. As noted in Table 4.11-1, most of the impacts are SMALL because they are either not detectable or do not destabilize or noticeably alter any important attribute of the resource. Table 10.2-1 summarizes the building-related impact determination for each resource, the mitigation and control measures available to avoid or reduce those impacts, and the remaining unavoidable adverse impacts after mitigation and control measures are applied.

As noted in Table 10.2-1, building activities result in the conversion of up to approximately 696 ac. (282 ha) of forested land within the Project site to industrial use. This conversion is necessary to support building of permanent structures, including the power block, switchyard and transmission system, cooling tower areas, water systems, access roads and parking areas, and other plant facilities, as well as temporary changes to support building activities (such as stormwater management features, material laydown, and parking areas). Public access to the Project site for hunting is discontinued during building activities and throughout operation of the Project.

Building activities result in unavoidable adverse impacts to natural and cultural resources within the Project site, including:

- Direct effects on up to approximately 16,875 linear ft. (5144 linear m) of streams and associated functions on the Project site and 100 linear ft. (30.5 m) of streams within the off-site wastewater pipeline.

- Indirect impacts to the function of up to approximately 1256 linear ft. (323 linear m) of connected streams extending outside the NDA.

- Localized alteration of the Belews Lake shoreline and lakebed and the Dan River associated with construction of in-water structures.

- Localized changes in groundwater levels from dewatering during excavation and reduced infiltration and groundwater recharge near new impervious surfaces.
- Displacement of wildlife and loss of less mobile fauna due to land clearing, grading, excavation, filling, and loss of habitat.
- Direct impacts of up to approximately 2.45 ac. (0.99 ha) of wetlands within the Project site and 0.26 ac. (0.11 ha) within the off-site wastewater pipeline area.
- Impacts to tricolored bat foraging and roosting habitat and monarch butterfly foraging habitat. These species are proposed for federal listing as endangered and threatened, respectively.
- Direct and indirect impacts on aquatic biota and habitats in Project site streams, Belews Lake, and the Dan River associated with the placement of fill material, flow alteration, and increased sedimentation.
- Potential non-avoidance of any NRHP-eligible archaeological site.
- Relocation of Branson Cemetery.

Building activities also impact nearby residential and recreational receptors, community infrastructure and waste management. Building activities result in variable and short-term noise levels above 65 dBA, disruptive vibration levels, air emissions of gaseous pollutants and particulate matter, and visual intrusions for nearby sensitive receptors. Throughout the building period, there is increased traffic on the roads and intersections that provide access to the Project site. The commuting workforce and deliveries that cause the increased traffic also reduce the level of service. Building activities also result in a minor reduction in landfill capacity from the disposal of construction debris, general waste, metal waste, and equipment waste.

10.2.2 UNAVOIDABLE ADVERSE IMPACTS OF OPERATION

Operational impacts are discussed in detail in Chapter 5. Table 5.12-1 summarizes operational impacts and identifies measures and controls available to reduce or eliminate those impacts. As noted above for building-related impacts, most impacts from operations are considered SMALL and minimized through compliance with permit requirements and implementation of BMPs. Table 10.2-2 summarizes the operations-related impact determination for each resource, the mitigation and control measures available to reduce these impacts, and the remaining adverse impacts after mitigation and control measures are applied.

As noted in Table 10.2-2, seasonal fluctuations in water level resulting from operational use of cooling water from Belews Lake impact water recreators and aquatic biota along nearshore areas of the lake. Increased consumptive use of lake water results in a predicted minimum water level that is lower than that under modeled BCSS operational scenarios. Lake water-level drawdowns are noticeable during periods of increased drought severity but are not considered to be destabilizing. However, increased consumptive use of water extends the critical drought duration compared to the BCSS full generation scenario. Consumption of surface water from Belews Lake does not preclude the capacity of the lake to continue to provide a reliable source of cooling water in support of thermoelectric power generation.

Discharge flows in the Dan River adjacent to existing Outfall 006 result in localized changes in flow patterns, currents, and total flow, and operation of the MWIS results in minor effects to river discharge downstream. Unavoidable adverse effects on recreation in the Dan River are minor and localized. Hydrologic alterations in the river result in minor impacts to water availability for downstream water users. However, the capacity of these users, including the Town of Madison, to obtain water is not diminished provided they have implemented water supply systems capable of withdrawing water during minimum 7Q10 low flow conditions in compliance with 15A NCAC 18C.0403, as discussed in Section 5.2.2.1.2.1. Other unavoidable adverse impacts of operations on surface waters identified in Table 10.2-2 are localized and minimized through compliance with permit requirements and use of BMPs. Operation of the Project results in unavoidable physical impacts, impacts to community infrastructure, and air quality that are minimized through compliance with permit requirements and use of BMPs, where appropriate. These impacts include air emissions, an increase in noise levels from cooling tower operation, minimal physical deterioration of roadways providing access to the Project site, and noticeable visual intrusions from the presence of plant structures and cooling tower plumes. Commuting workers and operational traffic increase traffic on roadways and intersections providing access to the Project site. Fluctuating water levels, noise, and visual intrusions affect recreation on Belews Lake, and operation of the MWIS results in limited effects on recreation in the Dan River.

Radiological exposure to the occupational workforce and the public from the release of gaseous and liquid effluents is within regulatory limits. Exposure to terrestrial and aquatic ecosystems from effluent releases is within the 0.1 rad/day (100 mrad/day) and 1 rad/day (1000 mrad/day) whole-body dose rate criteria from Table 2.2 of DOE-STD-1153-2002. Monitoring programs are implemented for the occupational workforce to maintain the annual occupational dose ALARA in compliance with 10 CFR 20.1101, and off-site monitoring is conducted to evaluate off-site exposure for members of the public and nonhuman biota.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 1 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.1 Land-Use Impacts			
4.1.1 On-site Impacts	MODERATE	• Grade each Plant Complex area to balance earthwork cut and fill quantities to the greatest extent practical. • Dispose of all building material in accordance with federal, state, and local regulatory requirements. • BMPs for erosion and sedimentation control are developed and installed prior to building activities and will be maintained throughout construction. • Obtain appropriate county approvals for zoning as per Table 1.4-2. • Public access to Duke Energy-owned docks, landings, and launch ramps on Belews Lake will be restored after building activities are complete.	• Conversion of up to approximately 696 ac. (282 ha) of forested land to an industrial use. • Disturbance of approximately 906 ac. (367 ha). • Generation of general waste, metal waste, and equipment waste. • Conversion of prime farmland. • Discontinuation of hunting on the Project site. • Temporary disruption of public access to Duke Energy-owned docks, landings, and launch ramps on Belews Lake during building activities.
4.1.2 Off-site Impacts	SMALL	• BMPs for erosion and sedimentation control are developed and installed prior to building activities and will be maintained throughout construction.	• None.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 2 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.2 Water Resources			
4.2.1 Hydrologic Alterations			
Surface Water	SMALL	• Implement avoidance, minimization, and mitigation measures in accordance with CWA Section 402 and 404 permitting by NCDEQ and U.S. Army Corps of Engineers (USACE), respectively. • Implement BMPs to stabilize soils, control sedimentation and stormwater flows, and remove construction debris to minimize indirect impacts to streams outside the NDA. • Implement a stormwater management system that complies with regulatory requirements for site design. • Comply with NCDEQ permit for land disturbance and stormwater management. Implement BMPs and USACE 404 permit at completion of building activities. • Use temporary features to facilitate building and/or protect water quality during construction. These features will comply with relevant regulations, agency approvals, and typical standards for construction related to erosion control and sedimentation. • Use erosion control measures (such as riprap) placed in proximity to the building area.	• Direct effects on up to approximately 16,875 linear ft. (5144 linear m) of streams and associated functions on the Project site and 100 linear ft. (30.5 m) within the associated off-site wastewater pipeline. • Indirect effects to the function of up to approximately 1256 linear ft. (323 linear m) of portions of streams that extend outside the NDA to the confluence with Belews Lake. • Effects to local stormwater drainage patterns from building activities within the NDA. • Localized and short-term increases in turbidity and sediment deposition and alteration of the Belews Lake shoreline and bottom associated with building intake and discharge structures. • Localized sediment disturbance and alteration of the Dan River associated with building outfall in discharge wastewater pipeline corridor. • Alteration of floodplains from installation of the wastewater pipeline.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 3 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
		• Obtain and comply with site-specific terms of USACE permit for placement of fill. • Use BMPs to minimize impacts from use of heavy equipment in the floodplain and revegetate or rehabilitate the floodplain after installation of the wastewater pipeline.	
Groundwater	SMALL	• No mitigation measures or controls needed.	• Localized changes in groundwater levels from dewatering during excavation. • Reduced infiltration and groundwater recharge in the immediate area of new impervious surfaces.
4.2.2 Water Use Impacts			
Surface Water	SMALL	• Specific measures and controls are not needed.	• Use of surface water for concrete mixing, dust suppression, and other building-related activities.
Groundwater	SMALL	• No mitigation measures or controls needed.	• None.
4.2.3 Water Quality Impacts			
Surface Water	SMALL	• Use BMPs in addition to compliance with conditions in an NCDEQ-issued CWA Section 402 permit and other controls to protect affected water bodies. • Use BMPs to minimize erosion and sedimentation and establish and implement a SWPPP. • Comply with NCDEQ NPDES general construction permit requirements to discharge stormwater associated with building activities and implement an SWPPP.	• Erosion and sedimentation associated with impacts to and alteration of on-site streams, Belews Lake, and the Dan River from building activities. • Stormwater runoff from building activities.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 4 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
		• Establish and implement an SPCC Plan for construction practices. • Use best construction practices to maintain equipment and prevent spills and leaks.	
Groundwater	SMALL	• Comply with NCDEQ NPDES permit to discharge water from groundwater dewatering associated with building activities. • Establish and implement an SPCC Plan for construction practices.	• None.
4.3 Ecological Resources			
4.3.1 Terrestrial Ecosystems and Wetlands	MODERATE	• Use erosion controls and follow BMPs to control erosion from disturbed land and reduce impacts to nearby waters. • Conduct periodic monitoring and control measures. • Minimize or avoid tree clearing during nesting season from April to July or use Duke Energy compliance recommendations. • Minimize the amount of nighttime light, using downshielding, avoiding landscape lighting features, and using only low-pressure sodium, high-pressure sodium, or light-emitting diode light sources. • Comply with NCDEQ and USACE 404 permit mitigation measures to achieve no net loss objectives.	• Direct impacts to terrestrial flora and fauna and habitat loss due to building activities including land clearing, grading, excavation, and filling; displacement of wildlife and loss of less mobile fauna. • Direct impacts to 2.45 ac. (0.99 ha) of wetlands within the Project site and 0.26 ac. (0.11 ha) within the associated off-site wastewater pipeline area. • Indirect impacts to wetlands outside of the NDA associated with hydrologic alterations, erosion and sedimentation, encroachment of invasive species, and habitat function.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 5 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
		• Implement BMPs, such as erosion and sedimentation controls that limit the transport of sediment to wetlands via stormwater, compliance with 33 CFR Part 332 Compensatory Mitigation for Losses of Aquatic Resources, which promotes the national goal of "no net loss" of wetland acreage and functions. • Implement tree-clearing restrictions or consult with USFWS and conduct surveys. Conduct culvert surveys. • Consult with USFWS regarding potential effects to the monarch butterfly if this species becomes federally listed. • Avoid disturbance within 660 ft. (201 m) of bald eagle nest during nesting season. Coordinate with the USFWS prior to construction and implement applicable conservation measures.	• Direct impacts to tricolored bat (proposed for federal listing as endangered) and foraging and roosting habitat due to clearing during building activities. • Impacts to foraging habitat on the Project site for the monarch butterfly (proposed for federal listing as threatened).

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 6 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.3.2 Aquatic Ecosystems	SMALL	• Comply with NCDEQ and USACE 404 permit guidelines. Use BMPs to control erosion and limit the amount of soil and sediment entering surface waters. Develop and implement a SWPPP for collection, mitigation, and control of stormwater runoff in accordance with state and federal regulations and permit requirements. • Designate storage areas for fuel and lubricants on the Project site that are equipped with appropriate spill containment measures in accordance with SPCC plans. • Use BMPs such as cofferdams, silt curtains, wattles, or turbidity curtains to contain and control sedimentation. Maintain approximate 100-ft. (30.5-m) vegetated buffer around Belews Lake. Shoreline stabilization and buffer zones are protective of native aquatic species and habitats. • Consult with USFWS and NCWRC regarding avoidance, minimization, and appropriate conservation measures.	• Direct impacts on aquatic biota in Project site streams as well as indirect impacts by flow alteration and increased sedimentation and turbidity from building activities. • Impacts to aquatic habitats and biota in Belews Lake due to dredging, increases in turbidity and sediment deposition during installation of intake and discharge structures and associated pipelines. • Impacts to Dan River habitat due to physical habitat alteration, direct effects to or avoidance of aquatic biota.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 7 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.4 Socioeconomic Impacts			
4.4.1 Physical Impacts (includes noise, odors, dust, air pollution, physical transportation impacts, and visual intrusions)	SMALL to MODERATE	• Comply with Clean Air Act National Ambient Air Quality Standards and regulatory limits. • Use BMPs and properly maintain construction equipment and vehicles to control emissions. • Use BMPs to minimize dust generation and implement dust control measures by watering roadways and exposed areas. • Repair damage to public roads, markings, or signs caused by building activities to preexisting conditions or better in accordance with state and local requirements. • Maintain natural existing buffers to screen views of the Project site, including an approximately 100-ft. (30.5-m) wide vegetated buffer zone along the edge of the Project site. • Implement light shielding to the extent practicable.	• Vibration effects to off-site residences and structures from building-related blasting and equipment use below the threshold for risk of minor cosmetic damage to fragile buildings. • Increase in emissions of on-site gaseous and particulate pollutants from construction vehicles and equipment, delivery vehicles, and personal vehicles. • Increase in emissions of fugitive dust and fine particulate matter from earth-moving activities, concrete-batch plant operation, and vehicular traffic on recently disturbed areas or unpaved roads. • Deterioration of public roads used by Project-related traffic while building activities are ongoing. • Visual and aesthetic effects during building activities, including lighting for nighttime building and security.
4.4.2 Demographic Impacts	SMALL	• None.	• Potential effects related to in-migration of workers and their families.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 8 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.4.3 Economic Impacts to the Community	MODERATE (Beneficial)	• None.	• None.
4.4.4 Community Infrastructure (includes transportation, housing, and public services)	SMALL to MODERATE	• Implement traffic management measures, including a traffic control mitigation plan. • Coordinate with the NCWRC, as appropriate, if construction of the cooling water intake and discharge structures impede use of Belews Lake or associated facilities, including marinas. • Maintain natural existing buffers to screen views of the Project site. • Implement light shielding to the extent practicable. • Access disruptions are mitigated by traffic management measures and a traffic control mitigation plan and restored when building activities are completed.	• Increased traffic on roads and intersections providing access to the Project site. • Disruption of recreational experience from building activities, including visual intrusions. • Increased user demand for recreational resources from in-migrating workforce and their families. • Possible access delays or disruptions because of increased traffic on local roadways and building activities. • Discontinuation of hunting on the Project site. • Increase in demand for public services from in-migrating individuals and their families.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 9 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.5 Not Used[(a)]	N/A	• N/A	• N/A
4.6 Historic and Cultural Resources	SMALL to MODERATE	• Implement procedures for addressing inadvertent cultural resource discoveries per Duke Energy Cultural Resources Procedure. • Implement avoidance measures for any NRHP-eligible archaeological sites as required. • If required, develop Phase III data recovery investigations in coordination with NCSHPO for any NRHP-eligible archaeological site that cannot be avoided. • Consult with the NCSHPO, NCOSA, and Catawba Indian Nation and implement mitigative measures as appropriate, if previously unknown archaeological resources or human remains are discovered during any building activities. Human remains would be treated in accordance with all state and federal laws. • Conduct archival research on the cemetery, including its history and associated records. • Follow provisions regarding exhumation and repatriation provided by NC General Statute Chapter 65-106 as appropriate. • Develop cemetery relocation plan in consultation with NCSHPO that includes delineation of the cemetery boundaries, generation of cemetery maps, and completion of historical and genealogical research.	• Impacts to archaeological sites eligible for listing on the NRHP if avoidance is not possible. • Relocation of Branson Cemetery.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 10 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.7 Air Resources	SMALL	• No further mitigation would be warranted beyond the mitigation strategies discussed for air emissions in Section 4.4.1 and row 4.4 of this table.	• Impacts from dust generated by land-clearing and building activities, emissions from heavy equipment and machinery, concrete-batch plant operations, and emissions from vehicles used to transport workers and deliver materials to and from the site.
4.8 Nonradiological Health	SMALL	• Implement the SPCC plan; conduct equipment maintenance and stabilize roads and soil stockpiles to minimize fugitive dust. • Adhere to NRC, OSHA, state, and Duke Energy safety standards and provisions for worker safety. • Implement worker safety training and require use of personal protective equipment. • Use common practices to mitigate noise, including noise reduction devices on heavy equipment and limiting driving speeds. • Implement traffic management measures including a traffic control mitigation plan.	• Noise levels above 65 dBA at nearby sensitive residential and recreational receptors. • Short-term and intermittent disruptive vibration levels. • Increased traffic on roads and intersections providing access to the Project site.
4.9 Radiological Health	SMALL	• None.	• Exposure to construction workers is within established regulatory limits.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 11 of 12)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
4.10 Nonradioactive Waste Management			
4.10.1 Impacts to Land	SMALL	• Implement policies and procedures under Duke Energy's Environmental Programs to properly manage waste to ensure safe handling and minimize environmental impacts. • Properly dispose of waste in accordance with federal, state, and local regulatory requirements. • Recycle metal waste and other materials to the fullest extent possible to reduce impacts on local municipal solid waste landfills and facilities. • Implement BMPs to minimize waste generation from on-site construction vehicles.	• Minor reduction in landfill capacity.
4.10.2 Impacts to Water	SMALL	• Implement an SPCC Plan and associated BMPs to minimize the occurrence of spills and limit their effects on surface water. • Adhere to the NCDEQ NPDES Construction Stormwater Permit requirements to minimize impacts from stormwater runoff into receiving water bodies. • Maintain portable sanitary facilities on-site and properly dispose of sanitary waste until a permanent connection to the sanitary waste treatment facility is functional.	• None.
4.10.3 Impacts to Air	SMALL	• Building-related emissions are typically limited to the vicinity. • Implement air emissions mitigation measures to ensure compliance with applicable regulatory limits defined by the National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50) and state and local regulations.	• Air emissions from building activities including gaseous pollutants and particulate matter.

Table 10.2-1
Unavoidable Adverse Environmental Impacts from Construction of the Project
(Sheet 12 of 12)

Note:

(a) Deleted (Executive Order, 2025a, 2025b).

Key: BMP = best management practice; CFR = Code of Federal Regulations; NCDEQ = North Carolina Department of Environmental Quality; NCOSA = North Carolina Office of State Archeology; NCWRC = North Carolina Wildlife Resources Commission; NDA = net disturbance area; NPDES = National Pollutant Discharge Elimination System; NRC = Nuclear Regulatory Commission; NRHP = National Register of Historic Places; OSHA = U.S Occupational Safety and Health Administration; NCSHPO = North Carolina State Historic Preservation Office; SPCC = Spill Prevention, Control, and Countermeasures; SWPPP = stormwater pollution prevention plan; USACE = U.S. Army Corps of Engineers; USFWS = U.S. Fish and Wildlife Service

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 1 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
5.1 Land-Use Impacts			
5.1.1 On-site Impacts	SMALL	• No mitigation measures or controls are needed.	• None.
5.1.2 Off-site Impacts	SMALL	• No mitigation measures or controls are needed.	• None.
5.2 Water Resources			
5.2.1 Hydrologic Alterations			
Surface Water	SMALL (MODERATE under drought conditions)	• Manage stormwater and minimize discharge of sediment and site runoff to Belews Lake through an engineered stormwater collection system and sediment and erosion control measures. • Comply with the requirements of the NCDEQ NPDES permit for discharge of stormwater associated with industrial activity. • Comply with the monitoring and BMP requirements from 15A NCAC 02H.1017 and incorporate these into future permitting and stormwater management operational programs as applicable. • Regulate supplemental pumping from the Dan River in conjunction with NCDEQ NPDES permitting requirements consistent with existing BCSS permitted conditions. • Regulate discharge flows in conjunction with NCDEQ NPDES permitting requirements.	• Minor hydrologic alterations, including flow patterns and sedimentation, where stormwater is discharged to Belews Lake. • Variable lake water levels and a lower predicted minimum level during operations compared to modeled BCSS operational scenarios as a result of increased consumptive use. Lake water-level drawdowns are noticeable during periods of increased drought severity but are not considered to be destabilizing. • Extended critical drought duration compared to the BCSS full generation scenario.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 2 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
		• Install cautionary signage to mark outfall and intake locations in the Dan River for watercraft awareness.	• Localized and minor effects on flow and circulation patterns in Belews Lake as a result of intake, discharge, and MWIS operations. • Negligible sedimentation impacts on Belews Lake from sediment entrainment from the Dan River during MWIS operations. • Localized changes in flow patterns, currents, and total flow in the Dan River due to discharge adjacent to existing Outfall 006. • Minor hydrologic alterations in the Dan River from MWIS operations that affect river discharge downstream.
Groundwater	SMALL	• No mitigation measures or controls are identified due to limited affects.	• Reduced infiltration and groundwater recharge in immediate area of new structures and impervious surfaces.
5.2.2 Water Use Impacts			
Surface Water	SMALL	• Regulate intermittent discharge flows to the Dan River in conjunction with NCDEQ NPDES permitting requirements. • Comply with NPDES permit limits for water withdrawals from the Dan River.	• Belews Lake water use as supplemented by MWIS operation is increased compared to the BCSS Continuous Maximum Generation Condition. While water use is noticeable during periods of increased drought severity this water use

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 3 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
			does not preclude the capacity for Belews Lake to continue to provide a reliable source for cooling water in support of thermoelectric power generation; therefore, impacts on water use are minor. • Minor impacts to water availability and reliability for downstream water users along the Dan River.
Groundwater	SMALL	• No mitigation measures or controls are needed.	• None.
5.2.3 Water Quality Impacts			
Surface Water	SMALL	• Manage stormwater through an engineered stormwater collection system and sediment and erosion control measures. • Comply with NPDES permit requirements, maintain an operational SWPPP and SPCC, and implement stormwater BMPs. • Conduct thermal and chemical monitoring programs, as applicable, for surface water at the Project site and Dan River. • Mitigate water quality impacts by rapid mixing and adherence to NPDES permitting requirements in Belews Lake and by administrative and engineering controls as needed to meet NPDES requirements, monitoring programs, dilution effects, and mixing within the pipeline prior to mixing within the Dan River.	• Minor impacts to water quality in on-site streams from industrial stormwater. • Minor water quality impacts on Belews Lake from cooling tower blowdown, including temperature changes and constituents. • Localized, temporary impact on Belews Lake water quality from MWIS operation. • Minor water quality impacts in the Dan River from cooling tower blowdown and wastewater discharge, including temperature changes, nonradioactive liquid waste discharges, and radwaste.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 4 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
Groundwater	SMALL	• Minimize potential for accidental spills by containment systems and established procedures in SPCC plan pursuant to Title 40 CFR Part 112 to minimize the release of constituents associated with accidental spills.	• None.
5.3 Ecological Resources			
5.3.1 Terrestrial and Wetland Impacts	SMALL	• Use BMPs including following the label-recommended pesticide/herbicide usage and application method and rates, only using licensed herbicide/pesticide applicators, maintaining ground cover in corridors, prohibiting herbicide usage around wetlands, and avoiding mowing and other heavy equipment operation within wetlands. • Monitor disturbed lands to identify and control areas that are dominated by invasive species. Control methods may include using pesticides/herbicides, hand-pulling, or mechanical treatment as applicable. • Implement an SPCC plan pursuant to 40 CFR Part 112 to minimize the release of constituents associated with accidental spills on wetlands. • Comply with the Migratory Bird Treaty Act. May use bird diverters and avian safe insulator assemblies to reduce the frequency of bird collisions and ensure reliable transmission system operation. • Schedule transmission line activities to minimize harm to pollinators when possible by limiting mowing to the fall or winter when flowers are not blooming. Incorporate mitigation measures to limit artificial light impact.	• Impacts to plant communities and wetlands from landscape maintenance activities such as pesticide/herbicide use and mowing within the Project site and off-site wastewater pipeline corridor. • Impacts to wildlife from operational noise. Noise sensitive wildlife are expected to avoid areas within the NDA and other habitats characterized by elevated noise levels. • Occasional bird collisions with tall structures. Bird collisions with nuclear power plant structures occur at rates that are unlikely to affect local or migratory bird populations. • Minor impacts to wildlife from transmission line maintenance due to the limited frequency of maintenance activities. Bird collisions with transmission lines may occur during operations.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 5 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
		• Conduct mowing in the fall or winter when pollinator foraging habitat (flowers) are not blooming, controlling invasive species, and following the label-recommended pesticide/herbicide usage. • Update the Project site's existing Bald Eagle Nest Management Plan as appropriate.	• Minor impacts to wildlife from EMFs. • Limited impacts to pollinators from mowing, pesticide use, and artificial lighting. • Limited impacts on tricolored bat (*Perimyotis subflavus,* proposed for federal listing as endangered) from reduced habitat suitability, noise levels from cooling tower operations, and low risk of collision with tall structures. • Limited impacts on habitats that may be used as foraging habitats by monarch butterfly (*Danaus plexippus*, proposed for federal listing as threatened) and other pollinators. • Limited impacts to bald eagle (*Haliaeetus leucocephalus*) from behavioral effects associated with avoidance of developed high-activity areas and infrequent collisions with structures or powerlines.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 6 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
5.3.2 Aquatic Impacts	SMALL (MODERATE under drought conditions)	• Comply with requirements of the site-specific NPDES permit for stormwater discharges and relevant federal, state, and local stormwater regulations. Implement stormwater BMPs. • Implement an SPCC plan pursuant to 40 CFR Part 112 to minimize the release of constituents associated with accidental spills. • Intake structure is designed to meet the impingement requirements in regulations adopted to implement Section 316(b) of the CWA. • Increase supplemental pumping from the MWIS in accordance with the limits established in the NCDEQ NPDES permit to mitigate the reduction in lake levels and near shore aquatic habitats and minimize potential effects related to water-level fluctuations. • Comply with thermal discharge limits required under the operational NCDEQ NPDES permit to limit adverse impacts to aquatic ecology. • Comply with NPDES permit requirements and use technologies and design features to minimize impacts of the MWIS and discharge operations. • Operate the intake structure in compliance with Section 316(b) of the CWA in regard to impingement and entrainment. • Comply with regulatory stipulations required under the operational NPDES permit to limit adverse impacts to aquatic ecology.	• Limited impacts to aquatic ecosystems in on-site streams from stormwater runoff. • Impingement and entrainment of organisms by the intake structure on Belews Lake and MWIS at the confluence of Belews Creek and the Dan River. A relatively small proportion of eggs, larvae, or adults of aquatic species are impacted. Minor proportions of populations are affected. • Impacts to aquatic biota along nearshore areas of Belews Lake from seasonal fluctuations in surface water levels and changes in water circulation patterns. Effects of lake water-level drawdowns are increased under modeled extreme drought conditions. • Minor, localized impacts to aquatic ecosystems in Belews Lake from thermal discharges. • Limited direct impacts to aquatic species in the Dan River from operation of the MWIS and wastewater discharge.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 7 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
		• Design liquid waste processing systems and apply administrative and engineering controls to manage concentrations of constituents within effluents in compliance with the site-specific NCDEQ NPDES permit. • Consult with the USFWS, State of NC, and USACE and implement appropriate avoidance, minimization, and conservation measures to limit potential effects on proposed critical habitat for green floater for any activities related to maintenance or material removals at the MWIS.	• Localized loss of benthic habitat and loss of less mobile organisms during maintenance activities at the Dan River MWIS. • Minor water quality impacts on aquatic biota in Belews Lake and the Dan River associated with operational effluents. • Limited impacts to proposed critical habitat for green floater from maintenance activities at the MWIS that affect benthic habitat.
5.4 Socioeconomics			
5.4.1 Physical Impacts (includes noise, odors, dust, air pollution, physical transportation impacts, and visual intrusions)	SMALL to MODERATE (AESTHETICS)	• Manage air emission sources in accordance with federal, state, and local air quality control laws and regulations. • Maintain an approximate 100-ft. (30.5-m) vegetative buffer along most of the shoreline of Belews Lake.	• Minor effects from increase in noise level from cooling tower operation. • Air emissions, including dust, during operations do not exceed the NAAQS for criteria pollutants. • Minimal operations-related impacts on road conditions from physical deterioration.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 8 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
			• Minor to noticeable, but not destabilizing, visual intrusions of structures and cooling tower plumes depending on the location of the observer and atmospheric conditions.
5.4.2 Demographic Impacts	SMALL	• None.	• None.
5.4.3 Economic Impacts to the Community	SMALL (beneficial)	• None.	• None.
5.4.4 Community Infrastructure Impacts (includes transportation, recreation, housing, and public services)	SMALL to MODERATE (RECREATION under drought conditions, AESTHETICS, and TRANSPORTATION)	• Implement relevant traffic management measures from building phase. • Regulate supplemental pumping from the Dan River in conjunction with NCDEQ NPDES permitting requirements consistent with existing BCSS permitted condition. • Work with the North Carolina Water Resources Commission to extend public boat ramps during low water conditions as necessary. • Post cautionary signage to minimize impacts on recreators. • Design discharge structure to be low profile to limit effects on recreators.	• Increased traffic on roadways and intersections providing access to the Project site. • Impacts to recreation on Belews Lake from fluctuating water levels, and visual intrusions. • Limited effects of the discharge structure on paddlers or recreators in the Dan River. • Limited effects on recreation in the Dan River during MWIS operations.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 9 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
5.5 Not Used[(a)]	N/A	N/A	N/A
5.6 Historic and Cultural Resources	SMALL	• Comply with mitigative measures developed in consultation with the NCSHPO and NCOSA.	• Potential effects to undiscovered archaeological resources within the Project site if ground-disturbing activities occur outside of the NDA.
5.7 Air Resources	SMALL	• Conduct air dispersion modeling, if required, to demonstrate that Project emissions do not result in exceedances of the NAAQS. • Stagger work shifts, require delivery vehicles to shut down engines while off-loading, restrict idling times of on-site vehicles, use electric and hybrid vehicles, and support and promote van/carpooling and other commuter programs.	• Particulate emissions and plumes from MDCT. • Emissions from operation of auxiliary equipment (e.g., generators and auxiliary boilers), and mobile emissions from operations-related traffic. • Nominal localized increases in vehicular emissions. • Small lifetime GHG emissions footprint compared to annual GHG emissions in the state of NC. • Small emissions of ozone and smaller amounts of nitrogen oxides produced by transmission lines during corona discharges.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 10 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
5.8 Nonradiological Health	SMALL	• Comply with discharge limitations established in the site-specific NPDES permit. • Comply with National Electrical Safety Code standards for transmission lines. • Adhere to Duke Energy's robust safety culture, established internal safety guides and procedures, and NRC requirements and Occupational Safety and Health Administration safety standards. • Implement traffic management mitigation measures identified in Section 4.4.4.1.	• Low potential for impacts from etiological agents. • Minor water quality impacts from operational and sanitary wastewater discharges. • Minor effects from the increase in noise level from cooling tower operation. • Minor human health effects from predicted increases in vehicle crash rates at intersections providing access to the Project site.
5.9 Radiological Health			
5.9.1 Exposure Pathways	SMALL	• None.	• Releases to the environment from gaseous and liquid effluents are within regulatory limits. • Exposure from direct radiation is negligible.
5.9.2 Radiation Doses to Members of the Public	N/A	• N/A	• N/A

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 11 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
5.9.3 Impacts to Members of the Public	SMALL	• Implement off-site monitoring in accordance with the radiological environmental monitoring program to evaluate off-site exposure.	• Exposure to the public from the release of gaseous and liquid effluents are within design objective of Title 10 CFR Part 50 Appendix I and within the regulatory limits of Title 40 CFR Part 190.
5.9.4 Occupational Doses to Workers	SMALL	• Develop monitoring programs for the occupational workforce to maintain the annual occupational dose ALARA in compliance with 10 CFR 20.1101.	• Occupational workforce exposure is within regulatory limits.
5.9.5 Impacts to Biota Other than Members of the Public	SMALL	• Implement off-site monitoring in accordance with the radiological environmental monitoring program to evaluate off-site exposure.	• Exposure to terrestrial and aquatic ecosystems from the release of gaseous and liquid effluents is within the 25 millirem per year whole-body limit prescribed by Title 40 CFR Part 190 and less than 100 mrad/day (threshold cited in NUREG-1555 per scientific literature).
5.10 Nonradioactive Waste Management			
5.10.1 Impacts to Land	SMALL	• Manage wastes in accordance with all applicable federal, state, and local requirements and standards and Duke Energy Environmental Programs' policies and procedures and dispose of wastes within landfills having sufficient capacity.	• Minor reduction in landfill capacity.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 12 of 13)

Resource Area	Summary Impact Determination	Mitigation Measures and Controls	Unavoidable Adverse Impact
5.10.2 Impacts to Water	SMALL	• Control and monitor discharges associated with all liquid discharges (sanitary waste and liquid effluents) in accordance with NPDES permit requirements. • Manage stormwater discharges in accordance NPDES stormwater permit requirements and minimize discharges using BMPs.	• Discharge of sanitary wastewater to the Dan River. • Discharge of nonradioactive liquid effluent waste streams to Belews Lake or the Dan River. • Increased discharge of stormwater runoff from the Project site.
5.10.3 Impacts to Air	SMALL	• Manage and dispose of hazardous waste in accordance with the Resource Conservation and Recovery Act to minimize air emissions.	• Gaseous emissions from equipment associated with auxiliary systems such as diesel generators and auxiliary boilers would be within the NAAQS for criteria pollutants. • Particulate matter emissions from cooling towers. • Minimal air emissions from hazardous wastes.
5.11 Environmental Impacts of Postulated Accidents	SMALL	• The calculated dose consequences of design basis accidents at the Project site were found to be within regulatory limits. • The calculated probability-weighted dose risk of severe accidents at the Project site were found to be less than the maximum, median, and mean dose risk for current operating reactors and the individual prompt and latent cancer fatality risks are below the NRC safety goals.	• Radioactive releases and doses comply with regulatory limits.

Table 10.2-2
Unavoidable Adverse Environmental Impacts from Operation of the Project
(Sheet 13 of 13)

Note:

(a) Deleted (Executive Order, 2025a, 2025b).

Key: ac. = acre; ALARA = as low as is reasonably achievable; BMP = best management practice; CFR = Code of Federal Regulations; CWA = Clean Water Act; ft. = feet; GHG = greenhouse gases; ha = hectare; m = meter; NAAQS = National Ambient Air Quality Standards; NCSHPO = North Carolina State Historic Preservation Office; NDA = net disturbance area; NPDES = National Pollutant Discharge Elimination System; NRC = U.S. Nuclear Regulatory Commission; NCOSA = North Carolina Office of State Archaeology; ROW = right-of-way; SPCC = spill prevention, control, and countermeasures; USACE = U.S. Army Corps of Engineers; USFWS = U.S. Fish and Wildlife Service

10.3 RELATIONSHIP OF SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

This section examines the relationship between the short-term use of environmental resources and the maintenance and enhancement of long-term environmental productivity. It compares the short-term benefits and uses of these resources for the generation of electricity with their potential long-term impacts on environmental productivity. For purposes of this analysis, the environmental impacts associated with the construction, operation, and timely decommissioning of the Project are considered short-term uses of the environment and long-term productivity is that which occurs beyond decommissioning.

Impacts that cease or could be reversed following decommissioning of the Project are considered short term because the affected resources would be restored to their role in supporting long-term productivity. These include short-term impacts to water resources; ecological resources; socioeconomics; air resources; and nonradiological health. Additionally, once the Project is decommissioned, use of radioactive materials ceases. Therefore, radiological health impacts also are considered short-term impacts.

Impacts that cannot be reversed or impacts that continue past decommissioning are considered long term. Long-term impacts associated with the Project consist of unavoidable adverse impacts or irreversible and irretrievable commitments of resources during building and operations. Such impacts include long-term impacts to land use, water resources, historic properties, and nonradioactive waste management, and commitment of materials, water, energy, and uranium fuel, as discussed in Section 10.4.

Production of carbon-free power in the Carolinas' service territory is the principal short-term benefit resulting from building and operation of the Project. As noted in Section 1.2.2, Duke Energy is responding to the requirements of North Carolina's House Bill 951 (HB951), which mandates net-zero emissions by 2050 (NCGA, 2021). The Project serves as a demonstration of advanced reactor technology as a viable option for production of carbon-free electricity in NC and elsewhere. In addition to the benefits to the electrical grid associated with reliable, carbon-free electricity generation, building and operation of the Project results in short-term economic benefits to households, other businesses, and local governments in the local area and Project Region through employment, expenditures, and tax revenues. These short-term benefits offset the long-term impacts to the environment from building and operation of the Project. Furthermore, the economic productivity of the Project site, when used for electricity generation, would be considerably larger than the economic productivity from other probable long-term uses for the site, including forested open space, agriculture/forestry, recreational use, and rural residential use (see Section 5.4.3.1).

10.4 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The predicted irreversible and irretrievable commitment of resources that will be involved with the construction and operation of the reactor units and associated facilities are described in this section. The phrase “irreversible commitments of resources” refers to environmental resources that are irreparably changed by building or operation activities and could not be restored to their present status by practical means at some later time. “Irretrievable commitments of resources” applies to material resources that, when used by construction or operation, cannot by practical means be recycled or restored for other uses. The commitment of resources summarized in this section are discussed in Chapters 4, 5, and 6.

10.4.1 IRREVERSIBLE COMMITMENTS OF RESOURCES

In the building and operation of any electric-generating station, few environmental resources are irreversibly committed to the facility beyond its operational life. Most commitments of environmental resources at or in proximity to the Project site that were identified for the building, operating, and decommissioning phases could be restored after the closure and decommissioning. No irreversible commitments of environmental resources were identified for the following resource areas discussed in Chapters 4, 5, and 6: terrestrial ecosystems and wetlands; aquatic ecosystems; socioeconomic resources (including physical impacts, demographic impacts, economic impacts to the community, and community infrastructure); air resources; nonradiological health; and radiological health. Impacts to these resources during building activities and operations are within regulatory or permitted thresholds, as applicable. Following closure and decommissioning, impacts to these resources cease, and the resource could be restored or used for other uses, as appropriate.

The irreversible commitments of resources resulting from the building and operation of the Project are discussed below.

10.4.1.1 Land-Use Impacts

Up to approximately 906 ac. (367 ha) of primarily forested land is disturbed and in industrial use during the operational life of the Project radioactive and nonradioactive wastes. Once the Project is decommissioned, the majority of the Project site could be used for future industrial or nonindustrial land use. However, construction of the Project results in irreversible commitment of on-site prime farmland soils. The Project site is not currently used for farming and, based on the Farmland Conversion Impact Rating form completed in consultation with the NRCS, impacts to prime farmland are expected to be minor. Land committed to the disposal of radioactive and nonradioactive wastes is committed to that use and cannot be used for other purposes.

Development of an ISFSI is being considered at the Project site to store spent fuel, which requires the irreversible commitment of land resources on the Project site. The size and location of the ISFSI is currently undetermined; however, this facility remains in place and operational following decommissioning, resulting in the irreversible commitment of land resources at the Project site. The ISFSI is governed by applicable regulations for regulated waste disposal facilities.

10.4.1.2 Water Related Impacts

Construction of the Project causes direct effects on up to approximately 16,875 linear ft. (5144 linear m) of streams on the Project site and 100 linear ft. (30.5 m) within the off-site wastewater pipeline, resulting in loss of these stream segments and functions. Construction also causes indirect effects to approximately 1256 linear ft. (323 linear m) of streams between the Project site and the confluence with Belews Lake. Avoidance, minimization, and mitigation measures, including compensatory mitigation, are implemented during building activities in accordance with Section 402 and 404 permitting issued by the NCDEQ and USACE, respectively. Additionally, following decommissioning, Project site topography and stormwater drainage patterns are restored to the degree practicable. However, this analysis assumes that streams on the Project site and their functions are irreversibly committed as a result of construction of the Project.

10.4.1.3 Historic Properties

Five sites within the APE were recommended as ineligible for listing on the NRHP and received concurrence from the NCSHPO. Four sites remain in consultation with the NCSHPO. Impacts to any NRHP-eligible archaeological site resulting from building activities are minimized through avoidance. If avoidance is not possible, archaeological mitigation including Phase III data recovery investigations will be developed in coordination with NCSHPO to address adverse effects to archaeological sites eligible or listed under Criterion D. Building activities result in impacts to Branson Cemetery which is determined to be ineligible for NRHP inclusion. Duke Energy has undertaken work to conduct archival research with respect to Branson Cemetery, including its history and associated records. Duke Energy plans to remove all graves in Branson Cemetery and relocate them to a new burial ground in accordance with an approved cemetery relocation plan that includes delineation of the cemetery boundaries, generation of cemetery maps, and completion of historical and genealogical research. Provisions regarding exhumation and repatriation of human remains provided by North Carolina General Statute Chapter 65-106 will be followed as appropriate.

Building activities at the Project site and operation of the Project may result in irreversible commitment of undiscovered archaeological resources as a result of ground-disturbing activities. Consistent with Duke Energy Cultural Resources Procedures, if an inadvertent discovery of a cultural resource (e.g., graves or grave sites, archaeological sites, historical artifacts, etc.) is made, then appropriate mitigative measures to address potential effects to these previously unknown cultural resources will be developed in consultation with the Catawba Indian Nation, NCSHPO, and NCOSA. Mitigation could include Phase III data recovery and repatriation of any Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony. Any remaining in situ cultural resources associated with previously undiscovered archaeological sites could be irreversibly committed during construction or operation of the Project if those sites cannot be avoided.

10.4.1.4 Nonradioactive Waste Management

Nonradioactive wastes generated by the building, operation, and decommissioning of the Project require the irreversible commitment of disposal capacity at off-site disposal facilities. Solid, hazardous, and mixed waste generated during all phases of the Project that cannot be recycled is disposed of in licensed landfills having sufficient capacity, resulting in the irreversible

commitment of disposal space at these facilities. Disposal facilities used for nonradioactive wastes are governed by applicable regulations.

10.4.2 IRRETRIEVABLE COMMITMENTS OF RESOURCES

Construction of multiple advanced reactors on the Project site requires use of building materials that are considered irretrievable commitments of resources unless they are recycled when the plant is decommissioned. Construction materials used for the plant are expected to be similar to previous nuclear projects and similar to those required for any major, multiyear construction project. However, the actual commitment of construction resources (e.g., concrete, steel, and other building materials) depends on the reactor design selected by Duke Energy in the application for a construction permit or combined license for the facility.

Irretrievable environmental commitments resulting from the Project include:

- Construction materials and irradiated materials
- Consumption of energy
- Consumption of uranium fuel

10.4.2.1 Construction and Irradiated Materials

Building activities require materials such as concrete, rebar, steel, cables, and piping. Because some of this material may be reused or recycled (if uncontaminated) or decontaminated for future use at decommissioning, the reused or recycled portion does not constitute an irretrievable commitment of resources. However, throughout the operational life of the Project, some materials may become contaminated or irradiated, and therefore, cannot be reused or recycled. Radioactive waste created during the operation and decommissioning of the Project is routinely collected and shipped off-site and is not considered an irretrievable environmental commitment. The types of construction materials used for most of the building of the Project are similar to those used for any major new construction project. The amount of such materials accounts for a relatively small incremental increase in the overall availability of such materials; therefore, even if this material is eventually disposed, use of these construction materials in such quantities is small with respect to availability of these resources on a larger scale.

10.4.2.2 Consumption of Fossil Fuels

During building, nonrenewable energy in the form of fossil fuels (i.e., gas, oil, and diesel) and electricity generated from fossil fuels is consumed to power vehicles and equipment. Fossil fuels are required during operation for ancillary equipment and vehicle use. The total energy consumed during building and operation is minimal compared to total fossil fuel consumption in the United States.

10.4.2.3 Consumption of Uranium

As described in Chapter 6, operation of the Project requires the mining and refining of uranium ores to produce and supply fuel for the nuclear reactors. Uranium fuel cycle impacts include irretrievable water and fuel consumption. At the end of its operational use, uranium fuel is

placed in long-term storage pending a decision by the U.S. government regarding recycling. This Environmental Report assumes that no recycling option is available, and that stored fuel is ultimately disposed of as spent fuel. Final disposal of spent fuel is an irretrievable commitment of resources; therefore, the depletion of uranium ores from operation of the Project is an irretrievable commitment of resources.

As of August 2023, the United States had 93 operating commercial nuclear reactors at 54 nuclear power plants (EIA, 2023a). Owners and operators of these plants purchased a total of 55.9 million pounds (25,800 tons) of uranium from U.S. and foreign suppliers in 2024(EIA, 2024). Uranium, the most commonly used fuel in nuclear power plants, is a common metal with economically recoverable reserves in the western United States, Canada, Central Asia, Africa, and South America (EIA, 2023b). The maximum anticipated market requirements for uranium, including contracted purchases of uranium and unfilled demand, for 2024 through 2033 are 433 million pounds of uranium (EIA, 2024). The availability of uranium ore and existing stockpiles of uranium combined with the availability of U.S. and foreign suppliers suggests that the addition of the Project as a consumer of uranium resources by itself does not result in a significant commitment of worldwide uranium resources.

10.5 ALTERNATIVES TO THE PROPOSED ACTION

Chapter 9 describes the alternatives considered for the Project site. This section provides a high-level summary of those alternatives.

10.5.1 NO-ACTION ALTERNATIVE

The No-Action Alternative, whereby the NRC does not issue an Early Site Permit (ESP) for the Project site is evaluated in Section 9.1. The No-Action Alternative would avoid no significant environmental impacts, because no such impacts are caused by site suitability determination. The No-Action Alternative would also prevent the following benefits:

- The resolution of siting and environmental issues before large investments of financial capital and human resources in new plant design and construction are made.
- The ability to bank a site on which a nuclear plant may be located.
- The resolution of issues related to the environmental impacts of construction and operation of new nuclear generation units constrained within the defined plant parameters.
- The facilitation of future decisions about whether to construct new nuclear power generation facilities at the proposed site.

Thus, the issuance of the ESP for the Project is preferrable to the No-Action Alternative. Given the planned retirement of the BCSS discussed in Chapter 1, Duke Energy would reasonably be expected to replace the power through other means and environmental impacts associated with new nuclear generation would not be avoided.

10.5.2 ENERGY ALTERNATIVES

This section is not required for an Early Site Permit Application.

10.5.3 ALTERNATIVE SITES

Alternative sites and the site selection process are discussed in Section 9.3. The Project site was selected on the basis of a standardized and comprehensive site selection study which considered relevant factors related to environmental acceptability, site safety engineering, and cost concerns. Five Candidate Sites were screened down to three locations that had or will have retiring coal-fired generation facility: the Project site, the NC-17 site, and the NC-19 site. The Project site was selected as the proposed site and the NC-17 site and the NC-19 site were selected as Alternative Sites. A separate Environmental Assessment was completed for the two Alternative Sites.

- The NC-17 site is an approximately 569 ac. greenfield site located in Person County, NC. The site is located near Hyco Lake, which functions as a cooling reservoir for the Roxboro Steam Station. The site is comprised of numerous hills and valleys with some slopes that exceed 30 percent grade. The site is comparatively less desirable to the

Project site because Duke Energy does not own all of the land required for a new nuclear generation plant.

- The NC-19 site is an approximately 976 ac. greenfield site located in Wake County, NC. The site is located near Harris Lake, which provides cooling water for Shearon Harris Nuclear Plant. The site is comprised of numerous hills and valleys with some slopes that exceed 30 percent grade. Duke Energy owns all of the NC-19 site. The NC-19 site has a higher population density in the vicinity of the site compared to the Project site.

The Project site was selected based on the comprehensive evaluation of the siting study. Multiple sites met the criteria for suitability; however, quantitative scoring and objective analysis indicated that the Project site was the most suitable for the new nuclear plant and therefore selected as the proposed site. Additionally, a separate environmental impact assessment was conducted for two potentially feasible Alternative Sites, which concluded that neither site is environmentally preferable to the Project site. Therefore, the Alternative Sites are not obviously superior to the Project site.

10.5.4 SYSTEM ALTERNATIVES

Alternatives to heat-dissipation systems and circulating water systems are evaluated in Section 9.4 in order to compare the environmental impacts of the proposed system to that of the selected alternatives.

10.5.4.1 Heat Dissipation

Once-through systems and closed-cycle systems, including natural draft cooling towers, dry cooling towers, wet-cooling towers, cooling pounds, and spray pods, were considered in the systems alternatives analysis. The alternative heat-dissipation systems considered are either not feasible or not an environmentally preferable alternative to MDCT for the Project site. Once-through cooling is not a suitable alternative, and the alternative closed-system cooling technologies are not preferable to MDCT technology.

10.5.4.2 Circulating Water System Alternatives

Only alternatives that are applicable to the Project site and are compatible with the proposed heat-dissipation system were considered in the circulating water system alternatives analysis. Alternative circulating water system components considered were either not able to support plant operation or were not an environmentally preferable alternative to the proposed design.

10.6 BENEFITS AND COSTS

10.6.1 BENEFITS

10.6.1.1 Power Supply Benefits

The deployment of advanced nuclear reactors at the Project site supports Duke Energy's strategy to meet growing energy needs while transitioning to carbon-free generation. This section summarizes the benefits related to the regional power supply.

Chapter 1 states that the Project site has a bounding gross electrical output of 2250 megawatts electric (MWe) with a total bounding thermal output of 6250 megawatts thermal (MWt).

As Section 1.2.2 notes, Duke Energy plans to retire over 8400 megawatts (MW) (8.4 gigawatts [GW]) of dispatchable coal-fired generation in the coming decades. This includes the BCSS, a 2220 MWe dual-fuel power generation facility capable of operating on both coal and natural gas. The Duke Energy 2023 Carolinas Resource Plan (CRP), as well as the 2025 Carolinas Resource Plan that was most recently submitted in October 2025, outlines the company's strategy to achieve carbon reduction and resource planning goals while meeting demand. The CRP is the framework for replacing aging coal plants in a manner that ensures economic benefits for the Carolinas, while meeting growing demand for clean energy. Over the next 15 years, Duke Energy projects a 35,000-gigawatt hours increase in electricity demand within North and South Carolina, further underscoring the need for reliable, carbon-free power.

The addition of baseload energy from advanced reactors at the Project site replaces baseload coal-fired generation from the BCSS with clean, reliable, carbon-free generation and helps maintain system reliability by providing baseload power in the Carolinas service territory.

10.6.1.2 Emission Reduction Benefits

Given concerns regarding climate change and carbon emissions, as well as emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulates, nuclear power generation provides an important environmental benefit by reducing emissions of carbon and other pollutants, when compared to coal-fired and natural gas-fired plants. The operation of advanced reactor units at the Project site does not result in direct emissions of air pollutants associated with global warming and climate change (e.g., NO_x, SO_x, carbon dioxide) or methyl mercury. As described in Section 5.7.2, emissions associated with the Project are limited to relatively small amounts of criteria pollutants from auxiliary systems (including auxiliary boilers, diesel generators/gas turbines, and engine-driven emergency equipment) and workforce transportation, as well as particulate emissions from cooling towers.

Thus, the Project represents substantial emission reduction benefits compared to fossil fuel alternative power sources. As Section 1.2.2 describes the purpose and need of the Project includes replacing the existing coal and natural gas generation capacity with multiple advanced reactors, which will be integrated into the existing power grid. This transition to carbon-free energy will help meet growing demand for reliable, baseload power in the region of interest, while also addressing the critical need for reduced carbon emissions. The Duke Energy CRP is the framework for replacing aging coal plants in a manner that ensures economic benefits for the Carolinas, while meeting growing demand for clean energy. Duke Energy is also responding

to the requirements of HB951, which mandates net-zero carbon emissions by the year 2050 (NCGA, 2021).

10.6.1.3 Economic Benefits

Additional important benefits from the building and operation of the Project include socioeconomic effects such as increases in purchases of local and regional goods and services, local and regional direct and indirect employment, and tax revenues to local taxing jurisdictions.

As detailed in Section 4.4.3.1, economic benefits associated with building are linked to both direct expenditures, such as costs for materials, equipment, and labor, and indirect effects arising from the spending and purchases of goods and services by the workforce. The Economics and Statistics Division of the U.S. Bureau of Economic Analysis (BEA) provides Regional Input-Output Modeling System (RIMS II) regional multipliers for industry employment and earnings. The BEA RIMS II multipliers were obtained for the ROI (Rockingham, Stokes, Forsyth, and Guilford counties) and used to evaluate impacts on employment and economic output based on total employment and total expenditure for a single Plant Complex.

Based on the workforce needed for a single Plant Complex (2096 workers), building the Project results in the creation of approximately 1437 indirect jobs within the ROI. Most indirect jobs are service-related, and those jobs are filled by the existing workforce in the ROI. Some of these indirect jobs could benefit unemployed or underemployed workers in the ROI. Overall, based on Bureau of Labor Statistics labor force data, the combined approximately 3533 jobs (direct and indirect employment) represent 0.7 percent of the total labor force in the ROI.

As Section 4.4.3.1.2 notes, total building expenditures for the single Plant Complex are estimated to be approximately $5 billion. Applying the RIMS II multiplier for construction industry output to building expenditures results in a total economic output of approximately $9.3 billion across local industries. This includes goods and services produced in the ROI during the building phase and indirect effects related to worker spending. The economic impacts during building are conservatively analyzed based on a single Plant Complex (two advanced reactor units). However, as Duke Energy is evaluating reactor technologies that could lead to deploying multiple reactor units across three Plant Complexes, substantially greater economic effects within the ROI and Project Region are possible. While specialized nuclear materials are likely to be sourced from outside the Project Region, portions of the generic building material expenditures can be obtained in the ROI. These expenditures are primarily realized within the ROI, introducing billions of dollars into the economy and indirectly creating jobs that help reduce unemployment and provide opportunities for service-related industries.

Likewise, as described in Section 5.4.3.1.2, employment and purchases associated with the Project during operations also support employment in other sectors of the local economy. Based on the operations workforce needed for a single Plant Complex (339 workers), approximately 935 indirect jobs are created within the ROI. The combined approximately 1274 jobs (direct and indirect employment) represent 0.2 percent of the total labor force within the ROI.

Capital expenditures, the purchase of goods and services, and payment of wages and salaries to the operations workforce has a multiplier effect through an increase in business activity, particularly in retail and service industries. The in-migrating operations workforce and their families purchase goods and services from within the ROI, thereby creating an expanded

economic effect that results in an increase in business activity. For a single Plant Complex (two reactor units) payroll is estimated to be approximately $30.5 million annually, resulting in a total economic output of approximately $62.4 million across local industries annually. During the operations phase, the construction-related workforce that remains within the ROI is expected to earn salaries comparable to those received during the building phase, resulting in additional spending within the ROI.

As detailed in Sections 4.4.3.2 and 5.4.3.2, building and operations-related activities, purchases, and labor force expenditures generate tax revenues. The in-migrating building and operations workforces for one Plant Complex generate a minor increase in income tax revenue of $2.2 million during building and $1.2 million during operations, annually, compared to the revenue from the existing employed population in the ROI. Project activities have a multiplier effect on spending within the ROI that may result in new business developments. Therefore, there may be a minor increase in franchise taxes due to the indirect spending. Expenditures by the in-migrating workforce and their families on items subject to sales and use taxes lead to further increases in sales tax revenues in the ROI. Additionally, improvements made to the Project site suggest a potential increase in future property tax obligations; however, the exact amount of these obligations is currently unknown.

10.6.2 COSTS

The costs associated with new plant building and operation are broken down into internal and external costs. Internal costs are those expended by the applicant in support of the building and operation of a new plant and are generally expressed in monetary values. External costs are the environmental costs that result from the building and operation of the new plant, and are expressed in terms of monetary, quantitative, and qualitative values.

10.6.2.1 Internal (Monetary) Costs

10.6.2.1.1 Building Costs

Based on the methodology published in the Idaho National Laboratory (INL)'s Meta-Analysis of Advanced Nuclear Reactor Cost Estimations (INL, 2024), the capital cost for building a single Plant Complex is estimated to be approximately $5.1 billion, while the cost for a full build out of multiple reactor units across three Plant Complexes is estimated to be approximately $15.2 billion. This capital cost estimate includes pre-construction costs (e.g., land and land rights, permits and licensing, plant studies and reports), direct costs (e.g., structures and improvements, reactor systems, electrical equipment, initial fuel inventory), indirect services costs (e.g., factory and field indirect costs, factory and construction supervision, shipping and transportation, engineering services), and supplementary costs (e.g., taxes, insurance, fees).

10.6.2.1.2 Operation Costs

Based on the INL methodology (INL, 2024), annualized operational costs for a single Plant Complex are estimated to be approximately $148 million, while the estimate for operation of a full build out of multiple reactor units across three Plant Complexes is approximately $443 million annually. These estimates include nuclear fuel costs as well as non-fuel operation and maintenance costs such as plant staff salaries, insurance, regulatory fees, and

decommissioning and decontamination funding. All values are annual estimates in 2022 dollars and are not escalated for the anticipated start of operations.

10.6.2.2 External Costs

External costs are those environmental and societal costs that remain after mitigation and controls have been considered. The environmental impacts of building and operation of advanced reactors at the Project site are described in Chapters 4 and 5, respectively. Section 10.2 identifies unavoidable adverse impacts of the proposed action (i.e., impacts after consideration of proposed mitigation actions) and Section 10.4 identifies irreversible and irretrievable commitments of resources and materials. Table 10.6-2 summarizes these costs.

10.6.3 BENEFIT-COST BALANCE

Tables 10.6-1 and 10.6-2 summarize benefits and costs of the Project which are described in Section 10.1. As detailed in Sections 10.2 and 10.4, the external costs of plant building and operation are reduced by continuing efforts to avoid and minimize impacts to environmental resources. Design features, BMPs, permitting, controls, and mitigation measures reduce environmental impacts to SMALL or MODERATE. The benefits of the Project are significant with respect to power generation, carbon emission reduction, and economic benefits in the long-term of the licensing period. Therefore, the benefits of the Project are greater than the economic and environmental costs.

Table 10.6-1
Monetary and Nonmonetary Benefits of the Project

Category of Benefit	Description of Benefit
Power Supply	• Generates a bounding gross electrical output of 2250 MWe, with a total bounding thermal output of 6250 MWt.
Emission Reduction	• Reduced emissions of criteria pollutants such as SO_x, NO_x, and particulates when compared to coal-fired and natural gas-fired plants.
Economics	
Construction Workers	• Creation of approximately 3533 direct and indirect jobs over the building period.
Building Expenditure	• The total building expenditure results in an estimated total economic value added of approximately $9.3 billion across all local industries.
Operations Workers	• 339 full-time operations workers for one Plant Complex create an incremental increase of approximately 935 indirect jobs within the ROI for at least 40 years of plant operations.
Operations Earnings	• Payroll for operations workers for one Plant Complex results in a total economic output of approximately $62.4 million across local industries annually.
Taxes	• Increased tax revenue from individual income taxes ($2.2 million during building and $1.2 million during operations, annually), franchise taxes, sales and use taxes, and property taxes support improvements to public infrastructure and social services.

Table 10.6-2
Internal and External Costs of the Project
(Sheet 1 of 5)

Category of Cost	Description of Cost
Internal/Monetary Costs	
Building Costs	• Capital cost of approximately $5.1 billion for a single Plant Complex or approximately $15.2 billion for a full build out across three Plant Complexes.
Operation Costs	• Annualized operational costs of approximately $148 million for a single Plant Complex, or approximately $443 million for a full build out across three Plant Complexes.
External Costs	
Land Use	• Disturbance of approximately 906 ac. (367 ha) during building and conversion of up to approximately 696 ac. (282 ha) of forested land to industrial use. • Conversion of prime farmland. • Discontinuation of hunting on the Project site. • Temporary disruption of public access to Duke Energy-owned docks, landings, and launch ramps on Belews Lake during building activities.
Surface Water Alterations	• Loss of up to approximately 16,875 linear ft. (5144 linear m) of streams and associated functions on the Project site from fill activities and 100 linear ft. (30.5 m) within the associated off-site wastewater pipeline. • Indirect impacts to the function of up to approximately 1256 linear ft. (383 linear m) of portions of streams that extend outside the net disturbance area to the confluence with Belews Lake. • Effects to local stormwater drainage patterns from building activities within the NDA. • Minor hydrologic alterations, including flow patterns and sedimentation, where stormwater is discharged to Belews Lake. • Localized and short-term increases in turbidity and sediment deposition and alteration of the Belews Lake shoreline and bottom associated with building intake and discharge structures, and localized and minor effects on flow and circulation patterns in Belews Lake as a result of intake, discharge, and MWIS operations.

Table 10.6-2
Internal and External Costs of the Project
(Sheet 2 of 5)

Category of Cost	Description of Cost
	• Variable lake water levels and a lower predicted minimum level during operations compared to modeled BCSS operational scenarios as a result of increased consumptive use. Lake water-level drawdowns are noticeable during periods of increased drought severity but are not considered to be destabilizing. • Extended critical drought duration compared to the BCSS full generation scenario. • Negligible sedimentation impacts on Belews Lake from sediment entrainment from the Dan River during MWIS operations. • Localized sediment disturbance and alteration of the Dan River associated with building outfall in discharge wastewater pipeline corridor, and changes in flow patterns, currents, and total flow in the Dan River due to discharge adjacent to existing Outfall 006. • Minor hydrologic alterations in the Dan River from MWIS operations that affect river discharge downstream.
Groundwater Alterations	• Localized changes in groundwater levels from dewatering during excavation. • Reduced infiltration and groundwater recharge in the immediate area of new impervious surfaces.
Water Use	• Use of surface water for concrete mixing, dust suppression, and other building-related activities. • Increased cooling water use from Belews Lake, as supplemented by MWIS operation, compared to the BCSS Continuous Maximum Generation Condition. • Minor, localized effects on recreational use of the Dan River due to MWIS operation and discharge from wastewater pipeline. • Minor impacts to water availability and reliability for downstream water users along the Dan River.
Water Quality	• Erosion and sedimentation associated with impacts to and alteration of on-site streams, Belews Lake, and the Dan River from building activities. • Minor impacts to water quality from building activities and from industrial stormwater. • Minor water quality impacts on Belews Lake from cooling tower blowdown, including temperature changes and chemical constituents. • Localized, temporary impact on Belews Lake water quality from MWIS operation. • Minor water quality impacts in the Dan River from cooling tower blowdown and wastewater discharge, including temperature changes, nonradioactive liquid waste discharges, and radwaste.

Table 10.6-2
Internal and External Costs of the Project
(Sheet 3 of 5)

Category of Cost	Description of Cost
Terrestrial Ecology	• Direct impacts to terrestrial flora and fauna and habitat loss due to building activities including land clearing, grading, excavation, and filling; displacement of wildlife and loss of less mobile fauna. • Direct impacts to 2.45 ac. (0.99 ha) of wetlands within the Project site and 0.26 ac. (0.11 ha) within the associated off-site wastewater pipeline area. • Indirect impacts to wetlands outside of the NDA associated with hydrologic alterations, erosion and sedimentation, encroachment of invasive species, and habitat function. • Impacts to plant communities and wetlands from landscape maintenance activities such as pesticide/herbicide use and mowing within the Project site and off-site wastewater pipeline corridor. • Minor impacts to wildlife from operational noise; transmission line maintenance; electromagnetic fields; mowing, pesticide use, and artificial lighting, and occasional bird collisions with tall structures. • Direct impacts to tricolored bat (proposed for federal listing as endangered) and foraging and roosting habitat due to clearing during building activities, as well as limited impacts relating to reduced habitat suitability, noise levels from cooling tower operations, and low risk of collision with tall structures. • Impacts foraging habitat on the Project site for the monarch butterfly (proposed for federal listing as threatened). • Limited impacts to bald eagle from behavioral effects associated with avoidance of developed high-activity areas and infrequent collisions with structures or powerlines.
Aquatic Ecology	• Direct impacts on aquatic biota in Project site streams as well as indirect impacts by flow alteration and increased sedimentation and turbidity from building activities. • Impacts to aquatic habitats and biota in Belews Lake due to dredging, increases in turbidity and sediment deposition during installation of intake and discharge structures and associated pipelines. • Limited impacts to aquatic ecosystems in on-site streams from stormwater runoff. • Impacts to aquatic biota along nearshore areas of Belews Lake from seasonal fluctuations in surface water levels and changes in water circulation patterns during operation. Effects of lake water-level drawdowns are increased under modeled extreme drought conditions. • Impingement and entrainment of organisms by the intake structure on Belews Lake and MWIS at the confluence of Belews Creek and the Dan River. • Minor, localized impacts to aquatic ecosystems in Belews Lake from thermal discharges.

Table 10.6-2
Internal and External Costs of the Project
(Sheet 4 of 5)

Category of Cost	Description of Cost
	• Minor water quality impacts on aquatic biota in Belews Lake and the Dan River associated with operational effluents. • Impacts to aquatic species and benthic habitat in the Dan River from physical alteration during building or maintenance activities, operation of the MWIS, and wastewater discharge. • Limited impacts to proposed critical habitat for green floater from maintenance activities at the MWIS that affect benthic habitat.
Socioeconomics and Community Infrastructure	• Potential effects related to in-migration of workers and their families including increase in demand for public services and recreational resources. • Visual and aesthetic effects, including lighting for nighttime building activities and security, and visual intrusions of structures and cooling tower plumes. • Deterioration of public roads used by Project-related traffic. • Increased traffic on roads and intersections providing access to the Project site during building and operation. • Impacts to recreation on Belews Lake from fluctuating water levels, noise, and visual intrusions, as well as limited effects to recreation on the Dan River from the discharge structure and MWIS operations.
Historic and Cultural Resources	• Unavoidable impacts to Branson Cemetery. • Impacts to any NRHP-eligible archaeological sites if avoidance is not possible. • Potential effects to undiscovered archaeological resources within the Project site if ground-disturbing activities occur outside of the NDA.
Air Resources	• Impacts from dust generated by land-clearing and building activities, emissions from heavy equipment and machinery, concrete-batch plant operations, and emissions from vehicles used to transport workers and deliver materials to and from the site during building activities. • Particulate emissions and plumes from MDCT. • Emissions from operation of auxiliary equipment (e.g., generators and auxiliary boilers), and vehicular emissions. • Small lifetime GHG emissions footprint. • Small emissions of ozone and smaller amounts of nitrogen oxides produced by transmission lines during corona discharges.

Table 10.6-2
Internal and External Costs of the Project
(Sheet 5 of 5)

Category of Cost	Description of Cost
Nonradiological Health	• Noise levels above 65 dBA at nearby sensitive residential and recreational receptors during building activities. • Short-term and intermittent disruptive vibration levels during building activities. • Minor effects from the increase in noise level from cooling tower operation. • Low potential for impacts from etiological agents. • Minor water quality impacts from operational and sanitary wastewater discharges. • Predicted increases in vehicle crash rates at intersections providing access to the Project site.
Radiological Health	• Releases to the environment from gaseous and liquid effluents are within regulatory limits. • Exposure to the public, to occupational workforce, and to terrestrial and aquatic biota are within regulatory limits.
Nonradioactive Waste	• Minor reduction in landfill capacity during building. • Discharge of sanitary wastewater to the Dan River and of nonradioactive liquid effluent waste streams to Belews Lake or the Dan River.

10.7 REFERENCES

1 **NCGA, 2021.** North Carolina General Assembly of North Carolina Session 2021 House Bill 951 Ratified Bill, *H951-V-5*, *An Act to Authorize the Utilities Commission to (I) Take all Reasonable Steps to Achieve a Seventy Percent Reduction in Emissions of Carbon Dioxide from Electric Public Utilities from 2005 Levels by the Year 2030 and Carbon Neutrality by the Year 2050, (II) Authorize Performance-Based Regulation of Electric Public Utilities, (III) proceed with Rulemaking on Securitization of Certain Costs and Other Matters, and (IV) Allow Potential Modification of Certain Existing Power Purchase Agreements with Eligible Small Power Producers*.

2 **DOE, 2011.** Radiation Protection of the Public and the Environment, U.S. DOE Order 458.1, U.S. Department of Energy, 2011.

3 **DOE, 2022.** DOE Standard: A graded Approach for Evaluating Radiation Does to Aquatic and Terrestrial Biota, US DOE-STD-1153-2002, U.S. Department of Energy, 2022.

4 **EIA, 2023a.** *Nuclear explained: U.S. nuclear industry*, U.S. Energy Information Administration, Website: https://www.eia.gov/energyexplained/nuclear/us-nuclear-industry.php. Date accessed: June 10, 2025.

5 **EIA, 2023b.** *Nuclear explained: Where our uranium comes from*, U.S. Energy Information Administration, Website: https://www.eia.gov/energyexplained/nuclear/where-our-uranium-comes-from.php. Date accessed: June 10, 2025.

6 **EIA, 2024.** *Uranium Marketing Annual Report*. U.S. Energy Information Administration. Website: https://www.eia.gov/uranium/marketing/. Date accessed: October 22, 2025.

7 **Executive Order, 2025a**. Executive Order 14148, *Initial Rescissions of Harmful Executive Orders and Actions*, (90 FR 8237) issued January 20, 2025.

8 **Executive Order, 2025b**. Executive Order 14173, *Ending Illegal Discrimination and Restoring Merit-Based Opportunity*, (90 FR 8633-TN11607) issued January 21, 2025.

9 **INL, 2024.** *Meta-Analysis of Advanced Nuclear Reactor Cost Estimations*, Revision 2, INL/RPT-24-77048, Idaho National Laboratory Gateway for Accelerated Innovation in Nuclear, Prepared for the U.S. Department of Energy, Office of Nuclear Energy, July 2024.

Duke Energy Carolinas, LLC
Belews Creek, North Carolina Site
Early Site Permit Application

Part 5

Emergency Plan

Revision 0

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I. INTRODUCTION

A. PURPOSE

The purpose of this Emergency Plan is to describe the provisions established by Duke Energy for responding to a radiological emergency at the Belews Creek, North Carolina (NC) site (Project site) and addresses emergency preparedness in support of the Duke Energy Early Site Permit Application (ESPA).

This Plan establishes the concepts, evaluation and assessment criteria, and protective actions that are necessary to limit and mitigate the consequences of potential or actual radiological emergencies. It has been prepared to establish the procedures and practices for management control over unplanned or emergency events that may occur at the Project site and considers the consequences of non-radiological emergencies such as security threats or breaches, fires, electrical system disturbances, and severe weather events.

To maintain consistency throughout the Duke Energy fleet, this Plan references applicable emergency preparedness processes that are described in EP-ALL-EPLAN, Duke Energy Common Emergency Plan, Revision 5. The Duke Energy Common Emergency Plan has been approved by the U.S. Nuclear Regulatory Commission (NRC) to support all the Duke Energy operating nuclear facilities in Safety Evaluation Report (SER) dated August 26, 2021 (NRC, 2021).

In accordance with 10 CFR Part 52 (b)(2)(i), this Plan provides major features of the emergency plan. This Plan describes a performance-based emergency preparedness program and addresses pertinent requirements and associated guidance contained in 10 CFR 50.160, “Emergency Preparedness for Small Modular Reactors, Non-Light Water Reactors, and Non-Power Production or Utilization Facilities” and Regulatory Guide 1.242, “Performance-Based Emergency Preparedness For Small Modular Reactors, Non Light-Water Reactors, and Non-Power Production Or Utilization Facilities”. 10 CFR 50.160 and guidance contained in Regulatory Guide 1.242 provide a technology-inclusive, risk-informed, and consequence-oriented emergency preparedness approach for SMRs and non-light water reactors (non-LWRs). This Plan has been developed based on design and site-specific information; and provides sufficient information to ensure compatibility of the proposed emergency plan for on-site areas with facility design features, site layout, and site features. A glossary with a list of abbreviations, acronyms, and definitions to support this Plan is located in Appendix 1.

In the development of this Plan, Duke Energy has considered the applicable guidance provided in the following documents:

- Regulatory Guide 1.242, Revision 0, “Performance-Based Emergency Preparedness For Small Modular Reactors, Non-Light Water Reactors, And Non-Power Production Or Utilization Facilities” (RG 1.242).
- Regulatory Guide 1.101, Revision 6, “Emergency Planning and Preparedness for Nuclear Power Reactors” (RG 1.101).
- NUREG-0654/FEMA-REP-1, Revision 2, “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants” (NUREG-0654).
- Section 13.3 of Regulatory Guide 1.70, Revision 3, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants” (RG 1.70).
- Section 13.3 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants” (NUREG-0800).

Additional references to support development of this Plan are described in Appendix 2.

The NRC requires a level of emergency preparedness commensurate with the potential consequences to public health, safety, common defense, and security at the Project site.

The Project site Radiological Emergency Preparedness Program consists of the Emergency Plan, Emergency Plan Implementing Procedures (EPIPs), and associated program administrative documents. The Plan outlines the basis for response actions that would be implemented in an emergency. The EPIPs are maintained separately and are used to guide those responsible for implementing emergency response actions. They are designed to ensure emergencies are properly evaluated, notifications are made, and assessment of on-site protective actions is performed. Plant operating procedures for abnormal and emergency operation and control are in place and are designed to ensure implementation of the EPIPs but are not included in the EPIPs. A typical list of EPIPs and supporting procedures is provided in Appendix 3. Specific EPIPs will be developed to support implementation of the Emergency Plan when Duke Energy determines a design technology for the site.

B. SCOPE

As discussed in Site Safety Analysis Report (SSAR), Section 13.3 of this ESPA, when Duke Energy makes its technology selection for the Project site, the selected reactor technology vendor will be required to provide a confirmatory acceptance analysis at the permit or license application stage. This analysis will confirm that the public dose, as defined in 10 CFR 20.1003, does not exceed the limit of 10 mSv (1 rem) total effective dose equivalent (TEDE) over 96 hours from the release of radioactive materials from the facility considering accident likelihood and source term, timing of the accident sequence, and meteorology per 10 CFR 50.33(g)(2). This will result in the plume exposure pathway Emergency Planning Zone (EPZ) being within the aggregate of the three-plant complex Exclusion Area Boundaries (EABs) identified in Figure I-1. The analysis will be performed in accordance with the methodology described in Regulatory Guide 1.242, Appendices A and B. With the plume exposure pathway EPZ located within the EABs, evacuation of the public during the first 96 hours of the accident is not required. The overall scope of this Plan delineates the actions necessary to safeguard on-site personnel (within the EABs) and minimize damage to property.

This Plan provides information regarding emergency preparedness and response planning and describes organizational responsibilities, capabilities, actions, and guidelines for Duke Energy during a radiological emergency. This Plan describes facility features, capabilities, equipment, and responsibilities and the processes Duke Energy will use to:

- Detect an emergency condition.
- Evaluate the severity of the problems.
- Notify applicable off-site agencies of the emergency condition.
- Activate emergency organizations.
- Evaluate possible off-site consequences, if applicable.
- Mitigate the consequences of the emergency.

Because Duke Energy's authority is limited to Duke Energy owned and controlled property, the state and county agencies are responsible for ordering and implementing actions off-site to protect the health and safety of the public, as necessary. As addressed in the Federal Emergency Management Agency (FEMA) Comprehensive Preparedness Guide 101, "Developing and Maintaining Emergency Operations Plans" (CPG-101), if determined appropriate, government officials may utilize a Comprehensive Emergency Management Plan (CEMP) approach to emergency planning to implement ad hoc protective actions to protect the public beyond the Duke Energy owned and controlled property. The FEMA all hazards approach combines emergency management, technical assistance, and resources for both radiological and non-radiological emergencies (FEMA, 2021).

This Plan serves to limit damage to facilities and property and provides for the restoration of facilities in the event of an emergency. This Plan does not provide guidance for actual plant equipment manipulations. These instructions are contained in site-specific normal and emergency operating procedures, as required by technical specifications and other regulatory guidance. This Plan provides for maintenance of performance, identification and evaluation of emergency situations, protective measures, communications, command and control, emergency response facility staffing and operations, radiological assessment, public information, coordination with the safeguards contingency plan, drills and exercises, and training of emergency response personnel. A process for reentry from a declared emergency is also described in this Plan.

C. PLANNING BASIS

As described earlier, this Emergency Plan addresses pertinent requirements and associated guidance in 10 CFR 50.160 "Emergency Preparedness for Small Modular Reactors, Non-Light Water Reactors, and Non-Power Production or Utilization Facilities" and Regulatory Guide 1.242, "Performance-Based Emergency Preparedness for Small Modular Reactors, Non-Light Water Reactors, and Non-Power Production or Utilization Facilities."

This Plan has been written following a format similar to Regulatory Guide 1.242 to minimize the need for cross-referencing and to aid in the review process. Appendix 4 provides a cross-reference between information contained in the Plan and 10 CFR 50.160 requirements and Regulatory Guide 1.242 evaluation criteria.

This Plan provides information which is generic for six proposed design technologies.

D. SITE LOCATION AND DESCRIPTION

The Project site is located primarily in Sauratown Township, in the southeastern corner of Stokes County, NC, with a small portion in Belews Creek Township, Forsyth County, NC. All proposed nuclear units will be in Stokes County. The Belews Creek, NC Site, adjacent to Belews Lake, is approximately 14 miles (mi.) northeast of Winston-Salem, NC, and approximately 19 mi. northwest of Greensboro, NC. The total site is approximately 1187 acres (ac). Access to the project site is available by road using the Duke Power Steam Plant Rd, via Pine Hall Rd or Craig Rd, via State Highway 65.

The SSAR, Section 2, provides additional information regarding the physical characteristics of the proposed site, including the preliminary site layout, population distribution, and potential hazards in the site vicinity. The Environmental Report provides detailed information addressing land use and other features of the proposed site and surrounding area.

Figure I-1 provides a site layout map of the Project site depicting the proposed design technologies and site access.

E. PLUME EXPOSURE PATHWAY EMERGENCY PLANNING ZONE (EPZ) BOUNDARY

Duke Energy is developing a performance-based emergency preparedness program using 10 CFR 50.160 and applying for an Early Site Permit under 10 CFR Part 52. For SMR and Non-LWR applicants seeking an early site permit under 10 CFR Part 52 and complying with the performance-based approach in 10 CFR 50.160, the criteria for defining the plume exposure pathway EPZ are specified in 10 CFR 50.33(g)(2). Specifically, the plume exposure pathway EPZ is the area in which public dose is projected to exceed 1 rem TEDE over the first 96 hours from the release of radioactive materials from the facility, considering accident likelihood and source term, timing of the accident sequence, and meteorology. In addition, the plume exposure pathway EPZ is the area in which predetermined, prompt protective measures are necessary. Due to the state of the reactor designs of the technologies being considered in this ESPA, the analysis used to determine whether the criteria in 10 CFR 50.33(g)(2)(i)(A) and (B) are met, and if they are met, the size of the plume exposure pathway EPZ, is not available from the reactor technology vendors. When Duke Energy makes its technology selection for the Project site, the selected reactor technology vendor will be required to provide a confirmatory acceptance analysis at the permit or license application stage. This analysis will confirm that the public dose, as defined in 10 CFR 20.1003, does not exceed the limit of 10 mSv (1 rem) total effective dose equivalent over 96 hours from the release of radioactive materials from the facility considering accident likelihood and source term, timing of the accident sequence, and meteorology per 10 CFR 50.33(g)(2). This will result in the plume exposure pathway EPZ being within the aggregate of the

three-plant complex EABs identified in Figure I-1. The analysis will be performed in accordance with the methodology described in Regulatory Guide 1.242, Appendices A and B. With the plume exposure pathway EPZ located within the EABs, evacuation of the public during the first 96 hours of the accident is not required.

Figure I-1 identifies the EABs as the Plume Exposure Pathway EPZ for all proposed technologies.

F. INGESTION RESPONSE PLANNING

Although the Project site plume exposure pathway EPZ is bounded by the exclusion area boundaries, ingestion response planning is required to safeguard the food ingestion pathway in the unlikely event of a radiological release at the site. Due to the technological enhancements inherent in SMRs and Non-LWRs and stringent NRC operational guidelines, the probability of such a release is considered very low. In the event of a radiological release, the principal exposure sources would include contaminated water and food products such as milk or fresh vegetables.

While ingestion response is not required in the early phase of an emergency, longer-term concerns necessitate planning for intermediate and late-phase responses. Local, state, and federal resources support monitoring, analysis, interdiction, and embargo efforts when necessary to protect the food and water supply. As described earlier, state, and local governmental agencies in areas affected by a radiological release may implement a CEMP and rely on all- hazards planning frameworks for ingestion response (FEMA, 2021).

1. State of North Carolina and Counties

   Under the North Carolina Radiological Emergency Preparedness Plan (NCREP), the State assumes direction and control during the transition from early to intermediate phases of a radiological emergency. This shift is due to the complexity of recovery efforts, multiple affected jurisdictions, significant federal involvement, and broader economic consequences. County officials, as applicable depending on location of the radiological release, will actively participate in decision-making and provide local leadership and coordination. The State Emergency Response Team (SERT) will oversee the coordination of federal response.

   The NC Department of Agriculture and Consumer Services (NCDA&CS) is the lead agency for food safety, and the North Carolina Department of Environmental Quality (NCDEQ) is the lead agency for water safety with federal agencies supporting both.

   NCDA&CS has the authority to embargo contaminated food products to protect public health. As a part of the SERT, NCDA&CS will work with the state Radiation Protection Section (RPS) to identify areas requiring an embargo or restrictions. Areas subject to embargoes will initially be based on projected contamination and refined following sampling and analysis. Restrictions may be applied to crops in the field and processing plants in or serving potentially contaminated areas. County public health agencies from the affected county or counties will oversee restaurant and grocery store safety.

The Cooperative Extension Service (CES) from the affected county or counties will coordinate with the NCDA&CS and other state agencies to assess contamination risks to livestock, milk, feed, and crops. The CES will work with local farmers and NCDA&CS to determine processes for agricultural remediation and disposition of food/feed products with radioactive contamination identified above safe levels. A coordinated response among farmers, CES, and state agencies is essential to mitigate impacts on agricultural production.

The NCDEQ, Division of Water Resources, ensures public water system safety by working with local authorities to prevent radiologically contaminated source water from entering supplies. Public works departments will assess radiation levels in source water and determine if water treatment intakes require closure.

Other state agencies, including the Division of Marine Fisheries, Department of Game and Inland Fisheries, North Carolina Wildlife Resources Commission, and Food and Drug Protection Division will support ingestion response planning as needed.

2. Commonwealth of Virginia

Under the Commonwealth of Virginia Radiological Emergency Response Plan (COVRERP) and Emergency Operations Plan, the State of Virginia may provide similar ingestion response planning support if required.

The Department of Agriculture and Consumer Services obtains milk samples from dairy farms, meat samples from packing firms, and food samples from retail and wholesale establishments as requested and submits them for laboratory analysis. This agency also coordinates the control and disposition of radiologically contaminated food, milk, and animal feed and the disposition of farm animals affected by radiological contamination; and provides advice on and coordinates the disposition or use of farm crops, lands, and equipment that have been radiologically contaminated.

Additional State of Virginia agencies will provide ingestion response support as required.

3. Federal Resources

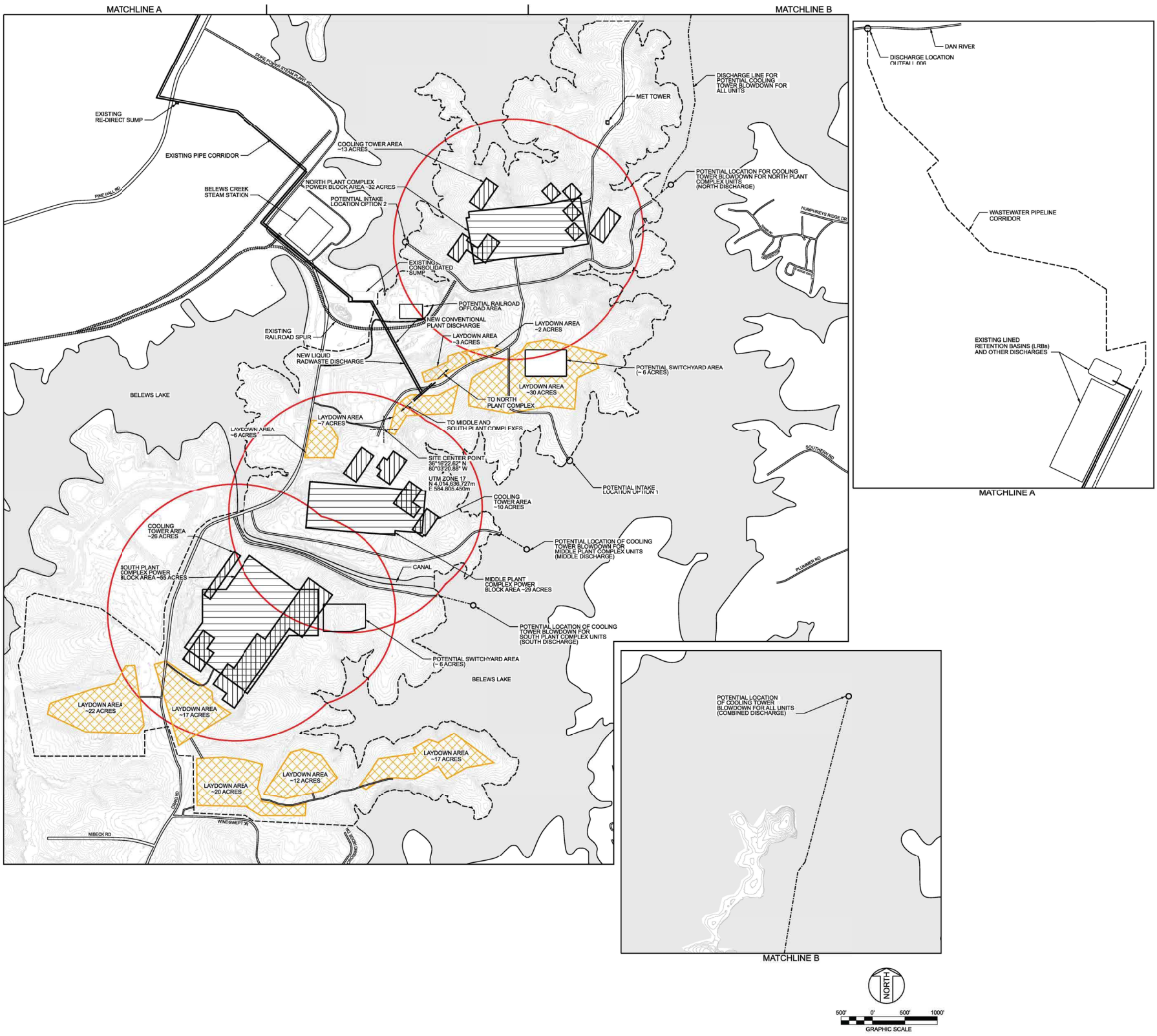
Federal resources are available to support radiological emergency event response, including events that may impact ingestion response planning. Federal resources include the Federal Radiological Monitoring and Assessment Center (FRMAC) and

the Advisory Team for Environment, Food and Health, as well as sampling and testing laboratories.

The FRMAC will assist the state lead agencies in efforts to preserve food and water safety and includes:

- U.S. Department of Agriculture.
- U.S. Environmental Protection Agency (USEPA).
- U.S. Food and Drug Administration (FDA).
- FEMA.

Figure I-1. Project Site Layout - Proposed Design Technologies



Legend:

- EXCLUSION AREA BOUNDARY (EAB)
- SITE BOUNDARY (NOTE 1)
- LAKEBED PIPING
- PROPOSED LAYDOWN AREA

Note 1: Total of the Site Boundary is approximately 1187 acres.

Note 2: Exclusion Area Boundaries (EABs) are also the location of the Plume Exposure Pathway Emergency Planning Zone (EPZ).

II. EMERGENCY MANAGEMENT ORGANIZATION / CONCEPT OF OPERATIONS

A. ASSIGNMENT OF RESPONSIBILITY

Under normal conditions, the Project site Vice President is in charge of activities at the site; and the Plant Manager is responsible for safe efficient operation of the plant.

In the event of an emergency or accident situation at the site, the Control Room shift crew under the direction of the Shift Manager coordinates emergency response activities. When an abnormal situation occurs, the Shift Manager using operating and emergency procedures and based on his/her background, training, and experience, determines whether the emergency conditions result in an Emergency Classification Level (ECL) of an Unusual Event, Alert, or Site Area Emergency (SAE). The Shift Manager assumes the role of Emergency Coordinator (EC) and directs emergency response from the Control Room. At an Alert or SAE classification, the Shift Manager augments the Emergency Response Organization (ERO) with on call personnel and initiate activation of the On-site Emergency Response Facility (OERF). When the OERF is staffed and declared operational, ERO members in the OERF relieve shift personnel of emergency response functions which are not directly associated with plant operations and provide technical support to the Control Room.

Staffing and primary responsibilities of Control Room and OERF personnel for emergency response functions are further described in Section III.G.

B. OFF-SITE AGENCY SUPPORT

In the event of a declared emergency at the Project site, the Federal, State, and local organizations described below can provide support as needed.

1. Federal

   Control, responsibility, and interface of federal organizations is governed by the National Response Framework (NRF) and the Nuclear/Radiological Incident Annex to the NRF when they are called to respond to an event at a nuclear power plant.

   The NRF provides the federal government's concept of operations for responding to radiological emergencies, outlines federal policies and planning assumptions, and specifies authorities and responsibilities of each federal agency that may have a significant role in emergency response.

   a. Nuclear Regulatory Commission (NRC)

      The NRC acts as primary authority for radiological events involving NRC licensed facilities and is the technical lead for the federal government's response to the event. The NRC maintains an Incident Response Plan (IRP) with objectives to provide for protection of the public health and safety, property, and the

environment from effects of radiological incidents that may occur at licensed facilities. The objectives of the agency plan set forth the organizational and management concepts and responsibilities needed to ensure that the NRC has an effective emergency response program. The NRC is prepared to recommend appropriate protective actions for the public and technical actions to the licensee. FEMA acts as the lead federal agency for off-site non-technical concerns.

During an incident, the Chairman of the Commission is the senior NRC authority for all aspects of a response. The Chairman transfers control of the emergency response activities to the Director of Site Operations when deemed appropriate.

All NRC Regions as well as Headquarters are prepared to respond to potential emergencies and have developed plans and procedures for responding to radiological incidents involving NRC licensees. Each Region and Headquarters has established and maintains an Incident Response Center designed to centralize and coordinate emergency response functions. Each Region is prepared to send a team of qualified specialists to the scene; and all necessary supplies and equipment needed for emergency response will be provided and maintained by the NRC. Adequate communications are established to link the licensee, Headquarters, and the Region. There are established lines of communications with state and local government and other federal agencies.

b. FEMA

Per the Federal Response Plan (FRP), FEMA is responsible for the overall coordination of a multi-agency federal response to a significant radiological incident. The primary role of FEMA is to support the state by coordinating delivery of federal non-technical assistance. FEMA coordinates state requests for federal assistance, identifying which federal agency can best address specific needs. If deemed necessary, FEMA will establish a Federal Response Center where it will manage assistance activities.

c. Department of Homeland Security (DHS)

DHS coordinates preparedness activities within the United States to respond to and recover from terrorist attacks, major disasters, and other emergencies. As part of these responsibilities, the Secretary coordinates with federal agencies to provide for federal unity of effort for domestic incident management.

d. U.S. Department of Energy (DOE)

In response to an event at a nuclear power plant and in cooperation with other federal and state agencies, DOE will manage the FRMAC to provide monitoring data and interpretations, including exposure rate controls, dose projections, and other requested radiological assessments to the primary authority and the states. DOE arranges consultation and support services through appropriate federal agencies to all other entities (e.g., private contractors). In cooperation with other federal and state agencies, DOE also provides personnel and equipment to perform radiological monitoring in support of other response activities, support for treatment of radiologically injured or contaminated personnel, and modeling for atmospheric dispersion.

If Duke Energy, the NRC, or the affected state(s) deem that assistance from DOE is necessary or desirable, the affected state(s) would notify the appropriate DOE operations office.

e. Federal Bureau of Investigation (FBI)

The FBI can provide support through its statutory responsibility based in Public Law and the U.S. code, and through a memorandum of understanding for cooperation with the NRC. Notification to the FBI of emergencies in which they would have an interest will be through provisions in the Project site's security plan, or by the NRC.

f. National Weather Service (NWS)

The NWS provides meteorological information during emergency situations, if required. Data available will include existing and forecasted surface wind directions, wind speed with azimuth variability, and ambient surface air temperature. There are NWS offices located in Greensboro, NC and Raleigh, NC.

g. U.S. Geological Survey (USGS)

The USGS maintains the National Earthquake Information Center (NEIC) which can be reached on the USGS website. The NEIC rapidly determines the location and size of all destructive earthquakes worldwide and immediately disseminates this information to concerned national and international agencies, scientists, and the general public. The NEIC is used as one of several sources to evaluate seismic events that may impact the site.

h. USEPA

The USEPA assists with field radiological monitoring/sampling and non-plant related recovery and reentry guidance.

2. State Organizations

If deemed necessary, Duke Energy coordinates emergency response actions with North Carolina state emergency response organizations. These organizations employ the National Incident Management System (NIMS) and the Incident Command System (ICS). Control, responsibility, and interface of the state organizations is governed by their respective emergency plans and emergency operating procedures. State organizations may become involved in ingestion response activities in the event of a radiological release at the site as described earlier in Section I.F.

The Governor has the authority to direct and control the state emergency management program which includes the responsibility for planning and ordering appropriate protective actions if applicable. During a declared state of disaster, the Governor has the authority to use all available state resources reasonably necessary to cope with emergencies. The Governor's representatives coordinate as necessary with Duke Energy and with county government officials.

The Department of Public Safety (DPS) functions as the state Emergency Management Coordinator and has overall management responsibility for radiological emergency response planning and development; updating the North Carolina Radiological Emergency Response Plan; and coordinating activities with Duke Energy. The Department coordinates emergency response activities for the State and other government response agencies. The Department through the State Highway Patrol, in conjunction with the North Carolina Division of Emergency Management, provides the initial 24-hour emergency notification point for the state.

The North Carolina Division of Emergency Management (NCEM) is the responsible organization within the DPS to prepare and maintain a State Radiological Emergency Response Plan for Duke Energy sites in coordination with the Departments of Environmental Quality (NCDEQ), NCDA&CS and NCDHHS and other interested agencies. The NCEM is the lead response agency with the state government and coordinates activities of the SERT at the State Emergency Operations Center (SEOC) in Raleigh. Personnel in the SEOC will confer with Duke Energy during an emergency event to determine appropriate emergency response activities if required.

The RPS is located within the NCDHHS and is the lead state agency for the collection and analysis of radiation monitoring reports and of environmental air, foliage, food, and water samples. The DPS is responsible for dose assessments and

projections and personnel radiological monitoring outside a Duke Energy site and other functions described in the state plan.

3. County Organizations

   County organizations may provide support during an emergency using their all hazards plans and/or emergency operations plans, including support for ingestion response planning (FEMA, 2021). The counties coordinate assistance and cooperation with related agencies in other counties, Duke Energy, state, and federal agencies. If deemed necessary, county Emergency Operations Centers (EOCs) may be activated to serve as the primary coordinating center for local government response within the county's jurisdiction and for coordination between counties.

   Off-site emergency response agencies may be called to the site for events requiring firefighting, medical, or law enforcement support as needed. If an emergency is due to a hostile action-based event, a near site Incident Command Post (ICP) may need to be established. Section IV.B of this Plan describes the set-up of an ICP and coordination between the site and off-site agencies.

4. Private Sector Organizations

   Contractor and private organizations may be requested to provide technical assistance during an emergency but are not used to provide additional personnel for positions on the ERO or perform an operational role.

   Duke Energy may obtain technical support from the reactor design technology vendor during emergencies and may procure other vendor support as needed.

III. PERFORMANCE BASED FRAMEWORK

A. MAINTENANCE OF PERFORMANCE

Duke Energy is required to demonstrate effective response in drills and exercises for emergency and accident conditions at the Project site and ensures this by assigning and training individuals at the site on their specific emergency response functions. Additional information describing the ERO Training Program is located in Section III.G.2. Drills and exercises provide opportunities to develop and maintain skills and test the effectiveness of the ERO to respond to events ranging from minor to severe accidents. Additional discussion on the drill and exercise program is in Section III.G.3.

B. PERFORMANCE MONITORING

A process is in place at Duke Energy for maintaining a performance monitoring program to demonstrate the effectiveness of the implementation of the Project site Emergency Plan to carry out effective response to emergency and accident conditions. Drills and exercises are used to train and to evaluate performance of the ERO. The Duke Energy Drill and Exercise Program identifies all objectives and evaluation criteria that may be used for a drill or exercise. Specific performance metrics and objectives for each of the emergency response functions have been developed and are used for evaluation to demonstrate capabilities to maintain and perform the emergency response functions described in 10 CFR 50.160 and Regulatory Guide 1.242 as described below:

- Event Classification and Mitigation - This metric measures the ability to assess, classify, monitor, and repair facility malfunctions in accordance with the emergency plan to return the facility to safe conditions.
- Protective Actions - This metric measures the ability to implement and maintain protective actions for on-site personnel for emergency conditions and recommend protective actions to off-site authorities as conditions warrant.
- Communications - This metric measures the ability to establish and maintain effective communications with the ERO and make notifications to response personnel and organizations who may have responsibilities for responding during emergencies.
- Command and Control - This metric measures the ability to establish and maintain effective command and control for emergencies by using a supporting organizational structure with defined roles, responsibilities, and authorities for directing and performing emergency response functions.

- Staffing and Operations - This metric measures the ability to establish staffing for the facility necessary to implement the roles and responsibilities defined in the emergency plan.
- Radiological Assessment - This metric measures the ability to assess radiological conditions in and around the facility during emergencies, including radiological conditions, protective equipment, core or vessel damage, and releases.
- Reentry - This metric measures the ability to develop and implement reentry plans for accessing the facility after emergencies.
- Critique and Corrective Actions - This metric measures the ability to evaluate drills and exercises (or responses to actual emergencies) to identify weaknesses or deficiencies in ERO performance and the EP program.

The objectives are scheduled for demonstration at no greater than 12-month intervals, and there are at least two demonstration attempts for the objective in an 8-quarter period. Types of activities in which objectives can be demonstrated; evaluation criteria and performance thresholds; guidance for determining acceptable performance; and a description of performance metrics (including updating and maintenance of metrics) are described in an emergency plan administrative procedure.

Duke Energy conducts post-activity critiques to identify performance weaknesses and deficiencies and captures these in a corrective action process. If a performance metric requires corrective action, Duke Energy conducts an activity to demonstrate the effectiveness of the corrective actions taken to improve performance as described in an emergency plan administrative procedure.

More discussion on the drill and exercise program is described in Section III.G.3.

C. EVENT CLASSIFICATION AND MITIGATION

Duke Energy has established the following three (3) ECLs at the Project site:

- Notification of Unusual Event (NOUE).
- Alert.
- SAE.

The emergency classifications are graded according to severity, and immediate actions are taken to cope with the situation. If conditions warrant, escalation to a higher class, or termination occurs during the course of an emergency.

Duke Energy uses a variety of methods to identify emergency situations and to categorize them. As indicated in the Project site EPIPs, emergencies can be caused by natural disasters such as tornadoes or floods, hazards such as aircraft crashes, releases of toxic gases or breaches of plant security, as well as conditions involving plant systems directly. An off-site chemical hazards survey has been performed to identify any hazardous materials stored or shipped near the site and is described in SSAR, Section 2.2.

Recognition of the emergency classification is primarily a judgement matter for plant personnel. The Initiating Conditions (ICs) used for recognizing and declaring the emergency classification are based on specific measurable values or observable conditions defined as Emergency Action Levels (EALs). These can be combinations of specific instrument readings (including their rate of change), annunciator warnings, time periods certain conditions exist, etc. Duke Energy uses EALs as thresholds for determining the emergency classifications.

To adequately assess the emergency condition, the Control Room and OERF have the necessary equipment and instrumentation installed to make available essential plant information on a continuous basis. Evaluation of plant conditions is accomplished through the monitoring of plant parameters both from indication in the Control Room and within the plant. The resources available to provide initial and continuing information for accident assessment throughout the course of an event include plant parameter display systems, chemistry monitoring systems, area and process radiation monitoring systems, meteorological displays, fire detection panels, and emergency response personnel.

Additional actions to prevent or mitigate the consequences of an emergency are addressed in the Abnormal Operating Procedures (AOPs) and Emergency Operating Procedures (EOPs).

NOTE: When Duke Energy determines a design technology for the Project site, a set of EALs describing plant-specific ICs and specific instrument readings as appropriate for the various ECLs will be developed similar to NEI-99-01, “Development of Emergency Action Levels for Non-Passive Reactors” which has been approved by the NRC. At that time, examples of plant conditions, instrument readings, and parameters required for determination of the EALs, and their recommended emergency classes will be described in an EPIP. This procedure will also specify notifications and information to be provided to off-site organizations, as required. The EAL scheme is design specific and is documented in an EAL Technical Basis Document. If an EAL scheme is ever changed, the new EALs will be submitted to the NRC for approval before implementation.

The three (3) ECLs are described as follows**:**

1. NOUE

   Events are in progress or have occurred which indicate a potential degradation of the level of safety of the plant or indicate a security threat to facility protection has been initiated. No releases of radioactive material requiring off-site response or monitoring are expected unless further degradation of safety systems occurs.

2. Alert

   Events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant or a security event that involves probable life-threatening risk to site personnel or damage to site equipment because of HOSTILE ACTION. Any releases are expected to be limited to small fractions of the USEPA PAG exposure levels.

3. Site Area Emergency

   Events are in progress or have occurred which involve actual or likely major failures of plant functions needed for protection of the public or HOSTILE ACTION that results in intentional damage or malicious acts: 1) toward site personnel or equipment that could lead to the likely failure of or 2) that prevent effective access to equipment needed for the protection of the public. Any releases are not expected to result in exposure levels which exceed USEPA PAG exposure levels beyond the EAB.

Duke Energy has and maintains the capability to assess, classify, and declare an emergency condition within 15 minutes after the availability of indications to plant operators that an EAL threshold has been met or exceeded in accordance with an EPIP. The 15-minute time requirement to declare events will not be construed as a grace period to attempt to restore conditions to avoid declarations.

An emergency classification may be downgraded to a lower classification in accordance with guidelines and criteria as described in EPIPs. Reduction of an emergency classification level is not a requirement, and direct entry into recovery is desirable. However, there may be some occasions when it is more appropriate to reduce the classification level. The NRC should be advised of the decision to downgrade the emergency.

Termination of the emergency is authorized and conducted in accordance with the EPIPs. Considerations for entry into recovery must be performed before exiting the emergency event. When a classified event is terminated, a reentry and recovery phase will be entered which is discussed in Section III.I.

Duke Energy maintains procedures that include immediate actions to be taken that are consistent for any declared ECL. These procedures describe, in detail, required actions, activation of the ERO (if required), notification to the NRC, and notification to other off-site agencies if required. Additional notifications to plant management, corporate communications staff, and supporting agencies are described in procedures.

D. PROTECTIVE ACTIONS

1. Radiological Exposure Control /Protective Measures

The Radiation Protection Section at the Project site is responsible for on-site radiation protection activities. Procedures are in place to implement the requirements of Title 10 Code of Federal Regulations, Part 20, and other required standards as well as requirements and policies in Duke Energy radiological control procedures. Radiation Protection personnel provide surveillance during normal plant operation as well as emergency situations and advise key plant personnel on radiological matters for routine and emergency conditions.

The limiting doses to occupational workers during routine plant operations are located in Duke Energy radiological control procedures. If possible, Duke Energy maintains these limits during emergency operations. If these standards cannot be met during emergencies, on-site exposure guidelines for emergency workers are consistent with USEPA-400/R-17/001 PAG Manual: Protective Action Guidelines and Planning Guidance for Radiological Incidents and are further described in an EPIP.

The EC is responsible for authorizing exposures in excess of 10 CFR 20 limits in accordance with EPIPs and radiation protection procedures. Authorizations are documented as part of the emergency exposure controls process. Any personnel dose in excess of five (5) rem TEDE shall be handled in accordance with the Duke Energy radiological protection plan.

If individuals are expected to receive an exposure in excess of normal occupational limits, then dose extensions are determined and approved on a task basis. Approval is required before emergency workers are allowed to exceed normal occupational radiation dose limits.

All efforts should be made to utilize respiratory protective equipment by qualified workers to minimize ingestion and/or inhalation of radionuclides and to maintain internal exposure below the limits specified in 10 CFR 20, Appendix B. However, if an unplanned incident involves the accidental or potential ingestion or inhalation of radioactive iodine, potassium iodide (KI) is maintained and available for distribution. The process for administration of KI to Duke Energy and vendor employees is described in EPIPs. Ingestion of stable iodine will be recommended for emergency

workers if a dose of 5 rem Committed Dose Equivalent (CDE)-thyroid from radioiodine is expected.

Personnel monitoring equipment (such as direct reading dosimeters, wrist dosimetry, and/or finger dosimetry) is issued to and worn by Duke Energy radiation worker qualified personnel who may be required to work in Radiological Controlled Areas (RCAs) (as described in 10 CFR 20 and radiation protection procedures) as a record of radiation exposure. Other radiation detection devices are available for use by emergency workers as described in radiation protection procedures.

Duke Energy implements adequate protective measures so that dose, considering both internal and external pathways, is maintained As Low As Reasonably Achievable (ALARA) in accordance with specific plant procedures, including issuing respiratory protection equipment and protective clothing to personnel. Internal dose is minimized by using respiratory protection equipment consistent with maintaining the TEDE.

Personnel are not permitted to enter any area where dose rates are unknown or unmeasurable with either instruments or dosimetry.

Personnel dose records are documented and managed in accordance with radiation protection procedures.

Radiation Protection personnel in the OERF have the responsibility to monitor and assess the radiation doses received by ERO personnel on a 24-hour per day basis throughout a declared event.

Radiation safety controls are established 24 hours per day to contain the spread of loose surface radioactive contamination. Contamination control limits and contamination on personnel; action levels for decontamination of personnel and equipment; and disposal of contaminated waste are described in radiation protection procedures.

Under emergency conditions when a release of activity has occurred, eating, drinking, smoking, and chewing will be not permitted until the EC, with input from Radiation Protection, has determined that it is safe to do so based on habitability surveys.

Emergency teams that must enter areas where they might be expected to receive higher than normal doses will be briefed on the task assigned; the planned route to the destination; allowed dose and dose rates; and other instructions in accordance with radiation protection procedures. During dispatch, if the monitored dose or dose rates, or stay times exceed the limits set for the task, the team will communicate with the Control Room or OERF for further direction or will return to the area from where

they were dispatched. Once their task has been completed, team personnel will follow monitoring and personnel decontamination procedures as specified by Radiation Protection.

Non-Duke Energy emergency workers supporting on-site activities will be issued dosimetry and/or be monitored by radiation protection personnel when responding to areas where a dose of radiation may be received. This process will be implemented by ERO radiation protection and site security personnel.

2. Protective Action Notification

The Project site assembly alarm and Public Address (PA) system is used to alert and notify on-site personnel of an emergency condition within 15 minutes. Security personnel with portable loudspeakers may be used, as available, to augment the PA system and check evacuation of outlying areas for other individuals, including those who may be on or passing through the Owner Controlled Area (OCA). The PA system is supplemented by using normal and emergency communications systems.

Notification of individuals who are in public access areas, on or passing through the site, or within the OCA, is performed by site Security in accordance with EPIPs. Visitors within the Protected Area are escorted by a permanently badged individual. The escort is responsible for informing the visitors of what to do in the event of an emergency and for taking action to evacuate the visitors from the site, as necessary.

3. Site Evacuation and Accountability

A site evacuation of all non-essential personnel inside the Protected Area is conducted at a SAE classification level unless delayed due to safety issues. Non-essential personnel inside the Protected Area will typically exit to the OCA by following normal Radiation Protection and Security processes; be accounted for as they exit; and evacuate the site.

Note: A process is in place controlled by Security to perform a rapid evacuation of the Protected Area without monitoring and assembly if conditions warrant.

Site personnel evacuating the Protected Area will be monitored for contamination and typically decontaminated, if necessary, as they leave the Protected Area. If conditions do not allow for decontamination of personnel prior to exiting the Protected Area, they will be directed to an off-site location designated by Duke Energy.

Personnel evacuating the site from outside the Protected Area will be monitored at a location designated by Duke Energy as required by event conditions.

All personnel within the Protected Area will be accounted for within 30 minutes of the declaration of a SAE classification (or lower classification if deemed appropriate by the EC), in accordance with EPIPs. After accountability of personnel is initially completed by Security, accountability will be maintained continuously for the duration of the emergency.

A range of protective actions to protect on-site personnel during a Hostile Action event is developed to ensure continued availability to safely shut down the reactor(s) and perform functions described in this Plan. The range of protective actions is contained in the Project site abnormal procedures which are classified security sensitive. Accountability may be delayed during a Hostile Action event if the EC, in consultation with Security, determines that performing accountability could be detrimental to the safety of plant personnel. If accountability is delayed, then accountability should be performed as soon as conditions permit.

During the accountability process, any missing individuals will be identified by Security, and search and rescue procedures will be implemented to locate unaccounted for persons in accordance with plant procedures.

4. Medical Support

Facilities, equipment, medical supplies, and trained personnel are available for first aid and emergency medical treatment of ill or injured individuals on-site.

Guidance for medical assistance is located in a Project site plant procedure, and a process is in place to coordinate the care, disposition, and reporting of injuries known or suspected to be associated with excess levels of radiation exposure or contamination. Immediate lifesaving and disability-limiting procedures take precedence over noncritical decontamination and dosimetry assessment measures. Emergency treatment of injured personnel will normally be performed on the scene.

The on-shift Medical Emergency Response Team (MERT) (assisted by Radiation Protection personnel) is available to:

- Provide first aid/emergency medical treatment for ill or injured individuals on-site, including those who may have been exposed to or contaminated with radioactive material.
- Minimize injury during the rescue, treatment, and transport of injured individuals, while minimizing radiological hazards and exposure to the victim.
- Advise and protect attending personnel from unacceptable and unnecessary radiological hazards and exposures.

- Identify, document, and control radiation exposure and contamination hazards associated with the emergency.

a. Transportation of Injured Personnel

When transportation of an injured person by ambulance is indicated, transport may be provided by a local ambulance service. The MERT leader coordinates the request for off-site ambulance assistance through the Shift Manager or the EC if the OERF is activated**.**

Radiation monitoring services are provided by Duke Energy personnel whenever it becomes necessary to use an ambulance service for the transportation of contaminated individuals. Injured personnel are evaluated for radiological contamination and packaged to control contamination prior to transport to a medical facility in accordance with radiation protection procedures. Duke Energy personnel will assist with decontamination of transport vehicles if necessary.

b. Off-site Medical Facilities

The ESPA E. Plan will be revised when Duke Energy moves forward with a Construction Permit or Operating License application. At that time, arrangements will be made with off-site medical facilities for the medical treatment of contaminated, injured personnel, and contact information will be described in procedures.

Duke Energy personnel may be available to assist medical personnel with decontamination, radiation exposure, and contamination control. Hospitals will be equipped, and hospital personnel may be trained to address contaminated, injured individuals. Training of medical support personnel may be conducted to include basic training on the nature of radiological emergencies, diagnosis and treatment, and follow-up medical care with support from Duke Energy if requested. Radiological controls capability, including isolation of contamination, assessment of contamination levels, radiation exposure monitoring for medical facility staff, collection of contaminated waste, and decontamination of treatment areas will be described in radiation protection and hospital procedures.

5. Off-site Protective Actions

As addressed in FEMA Comprehensive Preparedness Guide 101, “Developing and Maintaining Emergency Operations Plans” (CPG-101), if determined appropriate, off-site government officials may utilize a CEMP approach to emergency planning to implement ad hoc protective actions to protect the public (FEMA, 2021).

E. COMMUNICATIONS

The Project site has the capability to establish prompt communications and maintain communications between the emergency response facilities, ERO personnel, and principal response organizations (federal and state and county if required). EPIPs describe the use of communications systems during an emergency; and emergency plan administrative procedures provide additional details describing testing and maintenance of communications systems.

Communication systems are available to facilitate normal and emergency communications within the plant; between the plant and emergency response facilities; between the plant and the NRC; and between the plant and off-site emergency response organizations, if required.,

Redundant systems are provided to ensure continuous communication between entities and personnel.

Voice communications systems are available and include:

- Private Branch Exchange (PBX).
- Satellite Telephones.
- Cellular Telephones.
- Radios (on-site).
- PA System.

Provisions exist for communications with the NRC, other Duke Energy sites, and state/county governments (if required). The Project site has the following voice communication systems available for use by the ERO for performing emergency communications:

1. Private Branch Exchange (PBX)

   A PBX is a full-featured telephone system that provides internal calling services for one or more locations. The PBX terminates commercial phone lines from a carrier (e.g., AT&T, Verizon, CenturyLink, etc.) to provide inbound and outbound calling capabilities between Duke Energy and external parties. PBX systems have a number of mechanisms which make them resistant to failure including redundant power connections, redundant network connections, and server hardware installed in geographically diverse locations. PBX is the generic terminology used in the

Emergency Plan to describe the normal telephone systems used throughout Duke Energy.

PBX is the primary means of communication between the Control Room, OERF, and Security. PBX lines may be used for notifications to Off-site Response Organizations (OROs), if required. PBX lines may also be used to request support from off-site emergency response agencies (i.e., local law enforcement, fire departments, ambulance companies, and medical facilities).

2. NRC Communication Links

PBX is the primary means of communication with the NRC. Alternate communication methods are available from the Control Room and OERF if needed. Additional information describing NRC communications is located in Section IV.C. The following communication methods (or equivalent communication methods that are compatible with NRC communication systems) include:

a. NRC Emergency Notification System (ENS) - This communications line provides a communications link to the NRC Operations Center in Rockville, Maryland, and is used for notifications and communications during a classified emergency. This link is available in the Control Room and OERF.

b. NRC Health Physics Network (HPN) – This communications line provides a communications link with the NRC to provide radiological information and is normally available in the OERF.

c. NRC Reactor Safety Counterpart Link (RSCL) – This communications line provides a communications link for the NRC to conduct internal NRC discussions on plant equipment conditions separate from Duke Energy.

d. Protective Measures Counterpart Link (PMCL – This communications line provides a communications link for the NRC to conduct internal NRC discussions on radiological releases, meteorological conditions, and the need for protective actions.

e. Management Counterpart Link (MCPL) (Executive Bridge Line) – This communications line provides a communications link for any NRC internal discussions between the NRC Executive Team Director or Executive Team members and the NRC response team leader or top-level Duke Energy management at the site.

3. Satellite Telephones

   A satellite phone is any fixed or mobile telephone capable of sending and receiving phone calls through orbiting satellites. A satellite phone provides an alternate means of communication between:

   a. Control Room and OERF.
   b. Control Room and OERF when contacting the NRC.
   c. Control Room and OERF for contacting OROs (if required).

4. Cellular Telephones

   A cellular telephone is any mobile telephone (non-Duke Energy or Duke Energy provided) capable of sending and receiving calls through ground-based cell sites.

   Cellular telephones are an alternate means of communication between:

   a. Control Room and OERF.
   b. Control Room and OERF when contacting the NRC.
   c. Control Room and OERF for contacting OROs (if required).

5. Radios (On-site)

   Radios are standard fixed and mobile transceivers that allow point-to-point communications on-site. Radios are an alternate means of communication between the Control Room, OERF, and Security.

6. Plant PA System

   The on-site PA system can broadcast a message via speakers located throughout the site and is used to alert and notify on-site personnel of an emergency condition. It is used to notify site personnel of emergency declarations, provide additional means to notify the ERO, and facilitate on-site protective actions for personnel.

7. ERO Notification

The Project site uses a dedicated notification system to rapidly notify the ERO simultaneously using several methods. The vendor supplied notification system is designed with redundant power and geographic separation. Activation of the ERO notification system is performed by on-shift personnel in accordance with an EPIP. Alternate methods to activate the ERO are in place using an automated dial out system, or individual callouts of needed personnel using any of the calling methods that are available. All ERO members assigned to the Project site are notified and expected to respond on an All Call - All Come basis.

ERO members will be notified at an Unusual Event classification or higher and given plant status and emergency event information. The ERO may be instructed to standby or report to the plant for an Unusual Event emergency declaration if warranted by the EC. At an Alert classification or higher, the ERO is instructed to report to the OERF and begin facility activation.

Testing of communications equipment at the Project site is conducted on a frequency and documented in accordance with emergency plan administrative procedures, and includes the following:

- Systems used to communicate from the Control Room and OERF to NRC Headquarters will be tested monthly. This testing may be performed as part of a drill or exercise.
- Cellular telephones and satellite telephones will be tested on a designated frequency.
- The Emergency Response Data System (ERDS) (or equivalent data transmission system that is compatible with NRC data transmission systems) will be verified to be connected and transmitting data on a quarterly basis.

F. COMMAND AND CONTROL

1. Authority Over the Emergency Response Organization (ERO)

The EC in command and control is the designated Duke Energy individual who has overall authority and responsibility, management ability, and technical knowledge for coordinating all emergency response activities at the Project site.

During an emergency, the Shift Manager in the Control Room initially assumes the function of EC and is in overall command and control of Duke Energy's response to the emergency including all emergency response functions. If the OERF is activated and operational, another individual qualified as EC relieves the Shift Manager and assumes command and control of the emergency.

Command and control involve management of emergency response functions through leadership, use of authority, and concise, effective communication techniques. Command and control during an emergency require reflective, objective, and knowledgeable decision-making abilities to achieve optimum results. Control during an event involves verification and assurance that actions occur in conformity with a predetermined plan, and in accordance with established principles based on available information and feedback and must be viewed from a “big picture” perspective.

2. Criteria for Assuming Command and Control

The transition of command and control and non-delegable responsibilities from the Shift Manager (EC in the Control Room) to the EC in the OERF should occur simultaneously. However, this process may occur separately depending on the readiness of the OERF to activate and the and status of events in progress (e.g., hostile action-based events or natural disasters).

The Shift Manager acting as EC is relieved of command and control as soon as possible after the declaration of an Alert or higher classification (or Unusual Event if requested by the Shift Manager). Command and control of the emergency does not transfer until the following criteria have been met:

- Adequate staffing levels are present in support of the following non-delegable responsibilities:
    - Event classification, reclassification, or termination.
    - Authorization of emergency exposure controls in excess of 5 rem TEDE and the issuance of KI for Duke Energy emergency workers per USEPA-400.
    - On-site protective actions.
    - Notification of the NRC and state/county emergency management (if required).
    - Approval of information that may be released to the public.
- The staff has been fully briefed on the status of the event and the currently proposed plan of action.
- A formal turnover between the EC relinquishing Command and Control and the EC in the OERF assuming Command and Control has been made.

The EC provides leadership and direction to ERO members in performance of their emergency response functions using formal communication techniques and protocols to ensure effective and accurate information is transmitted.

The EC maintains an awareness of the emergency situation continuously and throughout the event and through termination of the emergency in accordance with EPIPs and supporting procedures.

G. STAFFING AND OPERATIONS

1. Staffing

In the event of an emergency at the Project site, the activation of the on-site ERO is required. The overall ERO is comprised of the Shift Manager in the Control Room, Emergency Coordinator located in the OERF, a Control Room staff of Operations personnel, and additional support staff located in the OERF. The ERO is responsible for on-site response to an emergency condition and augments the shift operations crew. The Shift Manager directs on-site activities including the functions of Control Room operations, technical assessment, emergency mitigation analysis, on-site radiation surveys, and dose tracking for site personnel. The on-site organization is assisted by Duke Energy corporate personnel for public information activities and other support if needed.

Initially the on-duty Shift Manager (SM) assumes the emergency response position of EC and directs emergency response from the Control Room. The EC position and responsibilities are transferred to another qualified EC in the OERF if the facility is activated. Upon OERF activation, the EC and the OERF staff provide technical support to the Control Room as part of their overall response to the emergency.

The on-shift staff is continually present on a 24-hour per day basis.

The requirements for on-shift operations staff, security force staff, and fire brigade/first aid staff are controlled by site licensing and administrative documents. Positions from these departments are described in the Emergency Plan only when assigned an emergency preparedness function that is performed during an event. Site procedures provide details of the normal site organization, including reporting relationships.

The normal on-shift complement is trained to handle emergency situations (e.g., initiate implementation of the Plan; perform initial accident assessment and emergency classification, notifications, and communications; and initiate protective actions) until the augmented ERO arrives. The ERO is composed of a broad spectrum of personnel with specialties in operations, maintenance, engineering, health physics, material control, fire protection, security, and emergency preparedness and are available and trained to augment on-shift personnel in an emergency.

The normal shift complement is described in site licensing and administrative documents. Deviation from the normal shift complement is allowed as long as the minimum shift complement, as described, is maintained and appropriate action is taken.

Duke Energy maintains a depth to the ERO that is capable of providing continuous 24-hour per day operation over an extended period of time. Key functions will be maintained throughout a declared emergency by providing relief of on-shift and augmented ERO positions by qualified individuals. Shift rotations for a protracted period will be designated by an assigned ERO member during an event.

The proposed minimum ERO staffing and primary responsibilities for the Project site are described below.

Note: The proposed ERO may change after Duke Energy determines the specific design technology for the site and an on-shift staffing analysis is performed in accordance with NEI 10-05, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities (NEI, 2011), or a similar staffing assessment.

a. Control Room

1) Shift Manager

- Provide overall ERO command and control until relieved.
- Evaluate plant conditions and approve EAL classifications until relieved.
- Authorize personnel dose extensions for Duke Energy emergency workers until relieved.
- Evaluate and assess plant data and on-site radiological data in the development of on-site protective actions (as required) until relieved.
- Direct all radiation protection activities, including on-site monitoring team activities until relieved.
- Approve information that may be released to the public until relieved.

2) Shift Communicator

- Perform ENS communications to the NRC including emergency classification status and plant information until relieved.
- Activate or confirm activation of ERDS or equivalent data transmission system that is compatible with NRC data transmission systems.
- Perform other off-site notifications as required.

3) Shift Radiation Protection (RP) Qualified Individual

- Provide RP coverage for responders accessing potentially unknown radiological environments.
- Provide in-plant and on-site surveys as directed.
- Control dosimetry and radiologically controlled area (RCA) access.

4) Security Supervisor / Alarm Station Operator (ASO)

- Coordinate security-related activities and information with the Shift Manager.
- Perform site accountability.
- Coordinate response activities with Local Law Enforcement Agencies (LLEA) as needed.

b. On-site Emergency Response Facility (OERF)

1) Emergency Coordinator (EC)

- Provide overall ERO command and control.
- Evaluate plant conditions and approve EAL classifications until relieved.
- Authorize personnel dose extensions for Duke Energy emergency workers.
- Evaluate and assess plant data and on-site radiological data in the development of on-site protective actions as required.
- Approve information that may be released to the public.

2) Emergency Communicator

- Perform ENS communications to the NRC including emergency classification status and plant information.
- Activate or confirm activation of ERDS, or equivalent data transmission system that is compatible with NRC data transmission systems.
- Perform other off-site notifications if required.

3) Security Coordinator

- Coordinate security-related activities and information with the EC.
- Perform site accountability.
- Coordinate response activities with LLEA as needed.

4) Plant Engineer
    - Provide engineering coverage for Core/Thermal Hydraulics, electrical and Instrumentation and Control equipment, and mechanical equipment.
5) Radiological Assessment Manager (RAM)
    - Evaluate and assess on-site radiological data in the development of on-site protective actions and recommend on-site protective actions to the EC.
    - Direct all on-site radiation protection activities, including on-site field monitoring team activities if required.
    - Monitor and determine the magnitude of any radioactive releases and initiate dose assessment/projections if conditions warrant.
6) Damage Control Supervisor
    - Supervise OERF activities related to electrical and Instrumentation and Control (I&C) equipment and to mechanical equipment.
7) RP Qualified Individual
    - Provide RP coverage for responders accessing potentially unknown radiological environments.
    - Provide in-plant and on-site surveys.
    - Control dosimetry and radiologically controlled area (RCA) access.
8) Maintenance Technicians (2)
    - Provide mechanical and electrical support for ECCS equipment, event mitigation, and equipment repair as directed.
9) Public Information Officer (PIO)
    - Provide site event and response information to public information staff.
    - Provide technical assistance for the development of information to be released to the public.
    - Serve as the primary communications path to the Joint Information System (JIS).

Other support during an emergency is coordinated on an as-needed basis and as requested by the EC. The Public Information Officer (PIO) can support media relations during an emergency remotely. Information Technology (IT) personnel are also located remotely and can be requested as required.

The ERO is comprised of on-shift personnel who are always located at the site, or augmenting personnel located either on-site or off-site who are on duty at all times.

Table III.G-1 provides a description of proposed ERO positions required to meet minimum staffing and full augmentation of the on-shift complement at an Alert or higher classification, and the major tasks assigned to each position. The full augmentation staffing levels are used as a planning basis to cover a wide range of possible events. As stated earlier, the proposed ERO may change after Duke Energy determines the specific design technology for the site and an on-shift staffing analysis is performed in accordance with NEI 10-05, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities (NEI, 2011), or similar staffing assessment.

2. Emergency Response Organization (ERO) Training

Radiological emergency response training is provided to personnel who may be called on to assist in an emergency as described in emergency plan administrative procedures. Initial training and periodic retraining is conducted for members of the ERO. Training is also offered to off-site organizations that may be called upon to assist the site in the event of an emergency.

Responsibilities for implementing the training program reside with site or corporate training departments, depending on the position or type of training needed. Training is conducted by qualified training personnel or Subject Matter Experts (SMEs). Administration of the training program includes student registration, or attendance records, to track training participation for both initial and requalification for each member of the ERO. ERO training participation is tracked utilizing a database to ensure responding members are properly trained and qualified to respond in the event of an emergency and to notify individuals of training that is coming due and expired training.

ERO personnel who are responsible for responding to an emergency receive the appropriate level of plant access training, training on basic emergency response procedures, communication, evacuation, as well as specialized training specific to their role in the organization. The training program for ERO personnel is developed based on position-specific responsibilities.

The ERO Training Program ensures a consistent program is in place to support the training, qualification, continuing training, and requalification of individuals who may be called on for assistance during an emergency. Specific emergency response task training prepared for response positions is described in lesson plans and position specific guides. Job task analyses are used to develop learning objectives, create

lesson plans, and position-specific guides. The lesson plans, position-specific guides, and written tests (if applicable) are contained in the ERO Training Program.

Requalification training for on-site ERO members consists of periodic ERO update/refresher training and periodic participation in drills. In addition to Duke Energy periodic ERO update/refresher training, personnel assigned to selected on-site ERO positions will receive training specific to their position if a decline in performance is noted in drills or to maintain proficiency.

Members of the ERO receive periodic performance-based emergency response training which is generally provided by participation in a performance drill. Drills allow individuals an opportunity to demonstrate the ability to perform their assigned emergency response functions. During drills, on-the-spot correction of erroneous performance may be made, and a demonstration of the proper performance offered by the drill Controller.

Training is evaluated in accordance with the principles of Systematic Approach to Training (SAT) practices when applicable to ensure effectiveness and to identify areas that need improvement or correction.

Revisions to the training program are identified with feedback from trainees undergoing training and critique items during drills. ERO training is also reviewed during EP assessments at the Duke Energy sites. During assessments, ERO and EP staff performance is reviewed and appropriate revisions to the training program are made using the principles of the SAT process.

Training sessions (e.g., drills) providing performance-enhancing opportunities for key positions must be critiqued in order to identify weak or deficient areas that need correction for the key skills demonstrated. Critiques are documented such that the adequacy and evaluation of key skills demonstrated is sufficiently justified.

3. General Employee Training

All personnel with unescorted plant access are provided with initial orientation training on the notification and instruction methods used in the event of an emergency including the method of notification (for example plant evacuation alarm) and instructions sufficient for proper evacuation of the site. Additionally, all badged individuals receive initial orientation on the basic principles of radiological safety including the effects of radiation and, as appropriate, the use of protective clothing, equipment, and devices.

4. Drills and Exercises

The Duke Energy drill and exercise program is described in emergency plan administrative procedures and serves the following three purposes to ensure the effectiveness of the Emergency Preparedness program to protect the health and safety of site personnel and the public:

- Develop and maintain the skills of emergency responders.
- Test the effectiveness of emergency plans and procedures, facilities and equipment, and training.
- Demonstrate the adequacy of emergency plans and procedures to respond to events ranging from minor to severe accidents**.**

The program provides direction for the scheduling, preparation, conduct, evaluation, and critique of Duke Energy Emergency Preparedness drills and exercises. Drills are used to provide performance enhancing opportunities to train and retrain facility personnel in emergency responsibilities. A variety of drills are performed including:

- Integrated facility drills – Drills incorporating multiple facilities or with any off-site organization that may be used for training or instruction.
- Communication drills – Activities that drill the use of communication equipment and procedures to communicate facility status and emergency conditions and that may be used to verify contact information, protocols, and reliability.
- Fire drills – Drills conducted in accordance with the Fire Protection Program (evaluated outside the EP program).
- Medical emergency drills – Activities that drill the use of first aid and emergency medical response for contaminated individuals or other industrial accidents.
- Radiological monitoring drills – Activities that drill the use of equipment and procedures to determine the adequacy of equipment, training, and procedures for radiological monitoring of processes, effluents, releases, samples, contamination, and dose assessments.

Evaluated exercises are used to demonstrate proficiency in the major portions of the emergency plan and, as such, cannot be used for training and instruction. Participation in an evaluated exercise is not required before assignment to an ERO role.

All drills and exercises are critiqued to identify weak or deficient areas that need correction for the key skills demonstrated. Critiques are documented such that the adequacy and evaluation of key skills demonstrated is sufficiently justified. The critique process is further described in Section III.J.

The drill and exercise program provides key metrics to be included in the performance monitoring metrics as discussed in Section III.B.

Table III.G-1. Project Site Proposed Emergency Response Organization (ERO) Staffing and Augmentation Plan

Emergency Preparedness Function	On-Shift	On-site Emergency Response Facility (OERF) Alert or Greater Augment within 120 minutes [2]
Command and Control	Shift Manager (1)	Emergency Coordinator (1)
Communications	Shift Communicator (1)	Emergency Communicator (1)
Radiation Protection	Radiation Protection Technician (1)	RP Qualified Individual (1) (In addition to on-shift RP)
Supervision of RP Staff and Site Radiation Protection	Shift Manager [1]	Radiological Assessment Manager (1)
Dose Assessment/Projections	Shift Manager [1]	Radiological Assessment Manager [1]
Emergency Classifications	Shift Manager [1]	Emergency Coordinator [1]
Engineering	Shift Manager [1]	Plant Engineer (1)
Security	Security Supervisor (1) Security Staff [3]	Security Coordinator (1)
Repair Team Activities	Not applicable	Maintenance Technicians (2)
Supervision of Repair Team Activities	Not applicable	Damage Control Supervisor (1)
Media Information	Not applicable	Public Information Officer (1) [4]
Information Technology (IT) [5]	Not applicable	Not applicable

[1] Assigned as a collateral function.

[2] Specified On-site ERF personnel should be capable of performing their required functions within 120 minutes of an Alert or higher EAL classification. Emergency response facility activation timing is not the concern: instead, it is whether the facility staff is performing the stated function(s) within the time specified.

[3] Per the site security plan.

[4] Remote responder - not required to respond to OERF.

[5] IT personnel monitor critical digital assets remotely and respond any time an issue is identified.

H. RADIOLOGICAL ASSESSMENT

1. Radiological Conditions

   Process Radiation Monitors (PRMs) are used for the measurement of radioactive noble gas, iodine, and particulate concentrations in gaseous effluent pathways and for gross radioactivity in other gaseous and fluid streams. Some PRMs have local alarms to notify individuals in the surrounding area of changing conditions.

   Area Radiation Monitors (ARMs) are used for the direct measurement of in-plant dose rates and allow in-plant dose rate determinations to be made remotely without requiring local hand-held meter surveys. This information may be used initially to aid in the determination of plant area accessibility. ARMs have local alarms to notify individuals in the surrounding area of changing radiological conditions. When an alarm occurs, personnel are trained to exit the area.

   Process and area radiation monitor data and alarm status is available in the Control Room and OERF.

   Portable radiation monitoring equipment is available for uses such as area monitoring, sampling, personnel surveys, and continued accident assessment and is maintained in accordance with radiation protection procedures.

   Air samples will be collected and analyzed in accordance with radiation protection procedures.

   Major changes in radiological conditions or radiation monitor alarms will be communicated to site personnel, including any protective actions, in accordance with Operations procedures.

2. Protective Equipment

   Individuals entering a Radiologically Controlled Area (RCA) are issued personnel monitoring devices capable of measuring the dose received from external sources of ionizing radiation. The official and permanent record of accumulated deep dose equivalent is normally obtained from a DLR badge. Personnel are also assigned self-reading dosimeters to provide a day-to-day indication of deep dose equivalent. Self-reading dosimeters have alarms with the setpoints determined based on the task to be performed and the areas to be entered. The alarms notify the individual of a dose or dose rate condition that is unexpected and may be set higher during emergencies based on the conditions, and in accordance with radiation protection procedures.

   Protective clothing is a normal use item for work in a contaminated area. Radiation Protection will determine protective clothing requirements for responders in accordance with radiation protection procedures. Sets of protective clothing are

available at the normal RCA dress out area and in emergency kits located in various areas of the plant.

Respiratory protection devices may be required in any situation arising from plant operations where an airborne radioactivity condition exists or potentially exists. In such cases, the air is monitored, and the necessary protective devices specified according to the concentration and type of airborne contaminants present and estimated radiation dose following ALARA principles. During an emergency, monitoring is conducted in accordance with radiation protection procedures. Precautions are taken to keep airborne contamination to a minimum by using proper ventilation and prior decontamination of equipment or work areas. Respiratory protection equipment is maintained by Radiation Protection.

Radiological monitoring kits are emergency kits located in various areas of the plant. Radiation Protection periodically inventories, inspects, and replenishes the kits in accordance with radiation protection procedures.

Radioprotective drugs in the form of KI tablets are available on-site. If the EC, with support from Radiation Protection, determines that consumption of KI is necessary, tablets will be issued to impacted individuals. The approval, issuance, and use of KI is described in EPIPs.

Fire-fighting equipment on-site includes portable extinguishers, hose stations, sprinkler systems, deluge systems, and fire hydrants. The Fire Protection System is described in detail in the Project site Fire Hazards Analysis. Training and use of equipment is performed in accordance with the Fire Protection Program.

3. Core or Vessel Damage

The Project site ERO monitors plant parameters using information provided by plant data transmittal systems to assess the status of reactor fuel using core damage assessment procedures.

The extent of core damage is continually monitored to determine what state the core is in:

- No damage
- Clad failure
- Fuel melt

If clad failure or fuel melt is indicated, the Plant Engineer in the OERF can coordinate performance of a detailed analysis assisted by other engineering personnel as needed. This data is used to:

- Evaluate the risk and possible consequences of the accident.

- Support prioritization of mitigation activities.
- Determine the potential quality (type) and/or quantity (%) of source term available for release in support of projected off-site doses and protective action recommendations.
- Support the determination of radiological protective action for ongoing activities.
- Support the determination of radiological protective actions that should be considered for long term recovery activities.

The ERO also monitors plant data transmittal systems to evaluate the status of containment integrity, systems used to mitigate the release of radioactive material to the environment, and to identify leakage of radioactive material from plant systems, structures, and components.

4. Releases

During normal operations the Control Room has access to all Process Radiation Monitors (PRMs) which are used for the measurement of radioactive noble gas, iodine, and particulate concentrations in gaseous effluent pathways and for gross radioactivity in other gaseous and fluid streams. Process and radiation monitor data and alarm status are available in the Control Room and OERF. For some events, Operations procedures require monitoring certain process monitors and may be required to trend those due to the possibility of a radioactive release occurring. Radiation Protection may be requested to perform surveys.

If an alarm is received or the Control Room is notified by Radiation Protection of an unmonitored radiological release, Operations personnel will respond based on conditions in accordance with appropriate procedure(s).

Meteorological data is collected at the Project site and includes wind speed, wind direction, and a measure of atmospheric stability. The data is directly available in the Control Room and OERF. The National Weather Service (NWS) serves as a backup for obtaining meteorological information if requested.

Monitor indications, sampling results, meteorological data, and certain plant parameters are used to assess the radioactivity released to the environs as described in EPIPs.

When manual sampling is performed, collected samples are obtained in accordance with procedures and transported promptly to the Project site laboratory/counting room which is the primary location for radiological sampling analysis activities. The site laboratory is the central point for receipt and analysis of on-site samples; includes equipment for chemical and radiological analyses; and has the capability of

quantitative analysis of liquid and air samples and qualitative analysis of terrestrial samples.

Additional facilities for counting and analyzing samples are available at unaffected Duke Energy nuclear sites or state and federal laboratory services. These laboratories can act as backup facilities if the Project site's counting room and laboratory become unusable or the capacity or capability of the plant's laboratory is exceeded.

The ERO performs long-term or continuing accident assessment; formulates protective responses; and implements long-term on-site monitoring. Radiological data gathered from the release is analyzed and communicated to the ERO for further projected actual and integrated dose assessment, planning recovery efforts, and on-site protective actions.

In addition to contamination and dose rate measurements, the change out of TLDs and air sampler cartridges can be performed. Other actions may include soil, water, and vegetation sampling.

I. REENTRY

Once the EC has declared that an emergency condition has passed, general plans and procedures are established at the Project site for reentry and recovery which consider existing and potential conditions.

Actions prior to reentry include a review of available radiation survey data and determination of site areas affected by radiological hazards; review of radiation dose history of personnel scheduled for recovery operations; review of available survey equipment and other activities as described in plant procedures.

If the emergency condition is due to a security threat, including hostile action, the EC will coordinate reentry of ERO personnel into the site through Site Security and discussions with the Incident Commander located at the ICP. The IC will then notify and coordinate site access with local law enforcement. Reentry of personnel to the site is coordinated via communications between the plant (EC and Security Coordinator); the ICP Incident Commander, and the FBI.

When the EC, in consultation with other Duke Energy personnel, has determined that the thresholds of an emergency declaration are no longer met, steps will be taken to terminate directly from the event and transition to a state of recovery operations in accordance with an EPIP.

An example recovery organization is described in an EPIP and may be modified or supplemented as necessary to fit the particular emergency situation. Recovery activities would be managed similar to an outage, except that certain activities unique to the post-

accident situation may be managed by the recovery organization. The organization would function as a matrix management organization to coordinate activities with the normal company organization and may be located at the OERF or some other location, as appropriate.

Typical primary positions in the Recovery Organization include the following:

- Recovery Director- Overall management of recovery activities and high-level coordination with federal and state/county governments (if needed).
- On-site Recovery Manager – Directs recovery activities on-site to restore the plant to pre-accident conditions.
- Company Spokesperson or Public Information Officer – Directs the public information program during the recovery process.
- Other support – Other individuals or groups assigned specific tasks to support activities during the Recovery Phase as applicable.

Other site management and supervisory personnel will interface with recovery operations as necessary and as warranted.

The recovery organization, under the direction of the Recovery Director, will develop a recovery plan; assess and determine overall damage; identify resources and equipment needed to complete needed repairs; and perform other activities to support recovery as described in an EPIP.

The EC will inform members of the OERF, site organization, and off-site agencies (as applicable) that recovery operations are being initiated and that activities associated with bringing the plant to a safe shutdown condition are completed.

J. CRITIQUE AND CORRECTIVE ACTIONS

During conduct of a drill or exercise, qualified Duke Energy evaluators who have the skills and knowledge to effectively evaluate the participants evaluate drill/exercise performance objectives against measurable demonstration criteria in accordance with drill/exercise emergency plan administrative procedures.

As soon as possible following the conclusion of drills and exercises, or an actual emergency event, a critique is conducted by participants and qualified evaluators to evaluate the ability of the ERO to implement the Emergency Plan and demonstrate emergency response functions. Areas evaluated include ERO performance, response to procedures, and adequacy of facilities and equipment. The written critique documents the ability of the ERO to respond to an emergency or sequence of events and may identify the need for changes to the Plan, procedures, equipment, facilities, or other

components of the Emergency Preparedness (EP) program. The goal is to identify any issues and follow up with corrective actions as required.

The EP staff prepares a written critique report following a drill, exercise, or actual event to document whether the objectives were successfully demonstrated. Failed or degraded performance objectives are entered into the Corrective Action Program (CAP). Failed or degraded demonstration criteria, improvement items, and recommendations for improvement are dispositioned within the critique report and may be entered into the CAP. The EP Manager or designee then approves the critique reports.

Objectives and demonstration criteria that are not adequately accomplished are described in the critique report and entered into the CAP for trend tracking and/or corrective action. The significance of any identified issue; the action(s) taken to resolve the issue; and the schedule for issue closure are determined by the EP Manager through the CAP process. The EP staff is responsible for initiating changes to the Plan or supporting procedures resulting from drill/exercise critiques or from an actual emergency.

If issues affect departments other than EP, then the EP manager or designee coordinates with the respective department heads for assignment of corrective actions and due dates, as appropriate.

If the Plan is not satisfactorily tested during an exercise to determine that the ERO has maintained key skills specific to emergency response, then a remedial exercise may be requested.

The EP group maintains critique reports as documentation for the completion of performance objectives in accordance with emergency plan administrative procedures.

In addition to identification during drills and exercises, emergency response capabilities associated with facilities, equipment, processes, and ERO staffing are monitored via tests, inventories, and inspections. These activities are controlled in accordance with site procedures. Discrepancies are entered into the CAP as required by procedures. In some cases, immediate compensatory actions may be necessary to maintain the emergency response capability.

IV. ON-SITE PLANNING ACTIVITIES

A. PUBLIC INFORMATION

In response to an emergency at the Project site, Duke Energy has established a process for coordinating and disseminating information to the public and media through a JIS in accordance with EPIPs and company procedures.

The JIS is activated at an Alert level emergency classification or higher by Duke Energy Corporate Communications personnel to ensure that emergency event information is coordinated with State, and affected county public information staff for dissemination to the media and general public. The JIS may be activated, if deemed necessary, at an Unusual Event declaration. The JIS provides the necessary structure and mechanism for organizing, developing, integrating, and delivering coordinated messages using established plans, procedures, and strategies.

A Public Information Officer (PIO) is assigned to the ERO as the primary communications link from the plant to the JIS. The PIO provides emergency event status and technical input to the public information staff in Corporate Communications to support development of information to be released to the news media and general public.

News releases are designed to be a written confirmation of an event at the site and are public information. Information is developed and released as clearly, concisely, and quickly as possible using various methods, including media briefings, news conferences, and social media posts.

During the initial stages of an emergency, responses to media questions relating to plant status are handled by the Corporate Communications team; and the normal Duke Energy media interaction and news release process is followed. When the OERF is activated, Corporate Communications response procedures are implemented for gathering and disseminating information. Duke Energy, State and affected county representatives (as applicable) coordinate and agree on information to be released to the media prior to news conferences. News releases are approved by the Company Spokesperson or the site EC if the Company Spokesperson is not available. Once approved and shared within the JIS, news releases are distributed to the media.

When news conferences and media briefings are scheduled, a designated Company Spokesperson (assisted by Corporate Communications/Nuclear Communications representatives, as needed) updates the media with plant and event status and company information, and State and county Public Information Officers (PIOs) address public response and actions, as applicable.

Interactions with the media may occur at various locations and with various agencies depending on the extent of response. News conferences/media briefings are conducted to keep the media informed with the most current and up to date information about events and response to the incident. PIOs from all agencies responding to the emergency are encouraged to participate in news conferences/media briefings to discuss their activities.

Traditional social media and customer response lines are monitored through the JIS to identify and address public concerns and rumors or inaccurate information. A Corporate Communications liaison works with PIOs from all agencies responding to the emergency via the JIS to acknowledge and determine the origin of rumors and coordinates a response to address rumors or correct any misinformation.

B. COORDINATION WITH SAFEGUARDS CONTINGENCY PLAN

The Project site safeguards contingency plan describes how the site will implement the physical protection program to defend against threats to the facility, up to and including the design basis threat of radiological sabotage. The safeguards contingency plan is intended to maintain effectiveness during the implementation of the Emergency Plan.

If Security is initially notified of a security threat (e.g., waterborne, land, or aircraft), Security personnel refer to security procedures to analyze the type of threat and immediate actions including notifications to the Control Room and other required agencies including the FBI (if applicable). If the security threat indicates a Hostile Action at the site, the Shift Manager (or EC in the OERF if applicable) refers to the emergency classification EPIP and supporting documents, classifies the emergency, and initiates notifications as required including the NRC.

If an ICP is established by the OROs, the EC selects individuals, normally from Operations, Security, and Radiation Protection, to act as ICP Liaison(s) to coordinate response efforts and provide communications, logistics, and site-specific information to/from the ICP in accordance with an EPIP.

A range of protective actions to protect on-site personnel during a Hostile Action event is developed to ensure the continued ability to safely shut down the reactor(s) and perform the functions in the Emergency Plan. This range of protective actions is described in the Project site abnormal procedures which are classified security sensitive.

An Alternate Emergency Facility (AEF) is a facility dedicated for use by Duke Energy and accessible to ERO personnel in the event of a security or hostile action threat when access to the Project site is restricted. When the ERO is notified of a security event, personnel responding from off-site may be requested to report to the AEF until access to the site is deemed safe. The AEF provides a location for the ERO to assist the plant in the management and control of emergency response activities. When event conditions indicate it is safe to access the site, reentry to the site will be coordinated by site personnel with Security and off-site law enforcement agencies. Duke Energy has not yet identified an AEF for locating ERO personnel to support an emergency at the site. The specific location of the AEF and capabilities to support emergency response functions will be described in an update to the Plan when Duke Energy moves forward for a Construction Permit or Operating License application as applicable.

During a security or hostile action event at the site, the general public and news media are kept informed of the emergency status using the Duke Energy JIS as described in Section IV.A, and via off-site agency public information officers.

C. COMMUNICATIONS WITH THE NRC

As described in Section III.E, communication systems are available to facilitate normal and emergency communications between the plant and the NRC, including redundant systems to ensure continuous communications capability if required. Notifications to the NRC are made in accordance with 10 CFR 50.72 and described in EPIPs.

Notifications from the site to the NRC are performed using the ENS telephone system (or equivalent system that is compatible with NRC communications systems) as soon as possible and not later than one hour after declaration of an emergency. If this system is inoperable, an alternate method such as commercial telephone line, cellular, or satellite telephone is available.

The Control Room and OERF is staffed and capable of maintaining continuous communication with the NRC, if requested, and on a case-by-case basis. Open communication lines can be staffed by knowledgeable personnel (for example, personnel with operations background and radiological knowledge) to ensure efficient and effective information flow.

The ERDS system (or equivalent system that is compatible with NRC data transmission systems) is continuously operated. When an event occurs, personnel verify system operation as soon as possible but not later than one hour after declaration of an Alert classification or higher in accordance with 10 CFR 50.72(a)(4). This system is always activated and can supply the NRC with selected meteorological data points on a near real time basis.

As described in Section III.E, there are other communication systems that link the plant to the NRC, including links for the NRC to conduct internal discussions on plant equipment issues separate from Duke Energy and for internal discussions on radiological releases, meteorological conditions, and the need for protective actions. There may also be a link available for NRC internal discussions between the NRC Executive Team Director or Executive Team members and the NRC response team leader or top-level Duke Energy management at the site.

D. EMERGENCY FACILITY OR FACILITIES

1. On-site Emergency Response Facility (OERF)

The OERF provides a location for personnel who are responsible for management and technical support of plant operations during emergency conditions. The OERF also functions to relieve the on-shift personnel of peripheral duties and communications not directly related to reactor system manipulations and to prevent congestion in the Control Room. The Project site has a dedicated OERF for use during emergency situations to implement emergency actions and analyze and mitigate accident conditions. The OERF is sized to accommodate ERO personnel and NRC representatives. State and county emergency management personnel are not expected to report to the OERF.

The OERF is required to be activated within 120 minutes following the declaration of an Alert or higher classification. The OERF may be activated for an Unusual Event classification, if deemed necessary. When activated, the primary functions of the OERF include:

- Prompt relief of the on-shift ERO emergency response activities.
- Coordination of site emergency response actions.
- Assessment of plant status and potential off-site impact.
- Dose assessment and projections, if applicable.
- Continued evaluation of event classification.
- Communications with the NRC and OROs (if required).

The OERF has display, print out, or trend records of comprehensive data necessary to monitor reactor system status and to evaluate plant system abnormalities. In-plant radiological parameters and meteorological parameters are also available.

The OERF has access to drawings and other records, including general arrangement diagrams, piping and instrumentation diagrams, electrical schematics, and plant procedures.

The OERF has communication capabilities that provide reliable voice communications to the Control Room, NRC, and OROs (if required). Additional information describing OERF communications systems is provided in Section III.E and IV.C.

In order to minimize congestion in the Control Room during emergencies, the OERF also provides a location separate from the Control Room where plant maintenance, operations, radiation protection, and other plant emergency support personnel will assemble and stand by to assist as needed.

When the OERF is activated, dosimetry, radiation survey equipment, and Radiation Work Permits (RWPs) will be provided to response personnel as required. In the event of personnel contamination, decontamination will be performed in the area normally designated for this purpose.

Emergency supplies are provided in the OERF or another accessible location to OERF personnel. Additional supplies and Duke Energy resources can be obtained from other unaffected plants upon request.

If the OERF is deemed uninhabitable, the OERF may be relocated to other locations as determined by the EC.

Site-specific location and other details associated with the OERF will be described in an update to the Emergency Plan when Duke Energy determines the design technology for the proposed plant.

2. Alternate Emergency Facility (AEF)

   The AEF is a facility dedicated for use by Duke Energy and designed to be accessible to ERO personnel in the event the OERF becomes uninhabitable or in the event of a Security or Hostile Action threat or severe weather event (such as a flood or tornado) if access to the site is deemed unsafe. The AEF provides a location for the ERO to assist the plant in the management and control of emergency response activities. Duke Energy has not yet identified an AEF for locating ERO personnel to support an emergency at the site. The specific location of the AEF and capabilities to support emergency response functions will be described in an update to the Plan when Duke Energy moves forward for a Construction Permit or Operating License application as applicable.

3. Decontamination Facility

   The Project site has facilities available for decontamination of personnel including those with minor injuries. The specific location of the decontamination facility(s) will

be described in an update to the Plan when Duke Energy determines the design technology for the proposed plant.

4. Laboratories

The Project site laboratory/counting room is the primary location for radiological sampling analysis activities. The site laboratory is the central point for receipt and analysis of on-site samples and includes equipment for chemical and radiological analyses. The site laboratory has the capability of quantitative analysis of liquid and air samples, and qualitative analysis of terrestrial samples. The specific location of the site laboratory/counting room will be described in an update to the Plan when Duke Energy determines the design technology for the proposed plant.

Additional facilities for counting and analyzing samples are available at unaffected Duke Energy nuclear sites or State and federal laboratory services and can act as backup facilities if the Project site counting room and laboratory become unusable, or the capacity or capability of the plant's laboratory is exceeded.

5. Processes, Equipment, and Supplies

Systems and equipment are available on-site to allow continuing assessment and monitoring of unusual or emergency situations. The following geophysical phenomena monitors are available:

- Seismic monitoring for earthquake detection.
- Meteorological tower equipped with thermometers, anemometers, wind vanes, etc., for assessment of weather conditions.
- Indicators for monitoring hydrologic conditions at Belews Lake.

Area, process, and effluent radiological monitors are provided in the plant for continuing assessment of radiological levels. These devices can be used to recognize emergency situations; perform continuing assessment; and may be supplemented by portable radiological monitoring devices and periodic sampling and laboratory analysis. Process instrumentation (based on the plant design) may be used to monitor the status of the plant and detect unusual conditions. A more detailed description of this instrumentation will be described in an update to the Plan when Duke Energy determines the design technology for the proposed plant.

The fire detection system is designed to quickly detect visible or invisible smoke (or other products of combustion) and/or heat in designated areas of the plant. The fire alarm communication systems and subsystems are located at strategic points throughout the plant to warn personnel of a nuclear incident or emergency conditions. Existing plant alarm systems are sufficiently audible to alert personnel in

the event of a fire or need for assembly. Fire-fighting equipment on-site includes portable extinguishers, hose stations, sprinkler systems, deluge systems, and fire hydrants. Fire detection system and equipment will be described in detail in the Fire Protection Program.

The Project site will have sufficient equipment and supplies for the operation of the site emergency facilities. In addition, emergency kits are maintained at the site; and routine inventories are performed to verify contents, inspect, and operationally check equipment/instruments in accordance with plant procedures. Sufficient reserves of instruments and equipment are maintained to replace those removed from emergency kits or lockers for calibration or repair. Sufficient portable radiation monitoring equipment is available for uses such as area monitoring, sampling, personnel surveys, and continued accident assessment. The Radiation Protection section is responsible for the maintenance, calibration, and storage of radiological equipment and instruments.

E. SITE FAMILIARIZATION TRAINING

Duke Energy supports initial training and annual retraining for off-site organizations that may be called upon to assist in an emergency at the Project site, if requested. These agencies include law enforcement personnel, fire department personnel, ambulance company, and hospital personnel.

Training of off-site organizations and agencies includes:

- Site familiarization and general layout of the plant.
- An overview of Emergency Preparedness.
- The notification process for the off-site organization, if required.
- The identity of the individual in the on-site ERO who will control off-site support activities.
- Basic radiation protection principles.
- The expected role of the off-site organization during emergency response activities.
- Site access procedures (as applicable).

Security will support site walkdowns for local law enforcement agencies (LLEAs) to familiarize them with relevant capabilities and the locations of key resources. Fire Protection will support walkdowns for fire departments to familiarize them with site capabilities and location of key equipment and resources.

F. EMERGENCY PLAN MAINTENANCE

Duke Energy has a process in place for maintaining and making changes to the Project site Emergency Plan and EPIPs, including methods to account for facility changes and methods used to conduct independent reviews of the program.

Project site EP personnel and management are responsible for the development, maintenance, review, and updating of the site Emergency Plan.

All Duke Energy EP staff members are provided formal professional development training or activities commensurate with their duties and experience and are required to take initial and periodic retraining to qualify for their positions. Initial training consists of classroom training, reading for awareness, and reading with discussion. Periodic retraining is performed at least biennially through related training, workshops, information exchange meetings with other licensees, and conferences held by industry and government agencies, as available, to maintain current knowledge of the overall planning effort. Other continuing training opportunities include observing exercises at other sites or attending courses, such as Duke Energy technical training, which will enhance plant operational working knowledge. In addition to the above training, EP staff members should complete training on the Applicability Determination process and 10 CFR 50.54(q) process per fleet procedures, as directed by supervision. All EP staff member training is documented in accordance with fleet procedures and training files, as appropriate.

Any changes that are made to the Project site Emergency Plan and EPIPs are evaluated and made in accordance with the change process described in 10 CFR 50.54(q) and Regulatory Guide 1.219, Guidance on Making Changes to Emergency Plans for Nuclear Power Reactors (RG 1.219).

The Project site Plan and procedures required to maintain and implement the Plan are reviewed and certified to be current on an annual basis and updated if necessary. Any changes due to regulatory revisions, issues identified by drills and exercises or actual events, or other updates are incorporated into the Plan. Changes are processed in accordance with 10 CFR 50.54(q) requirements and fleet document control/records management procedures.

Approved changes to the Plan and EPIPs are transmitted in accordance with the distribution list maintained in an electronic document management system. Changes to the Plan and EPIPs are submitted to the NRC in accordance with 10 CFR 50.4.

Appendix 3 provides a typical list of procedures required to maintain and implement the Plan that are considered part of the Plan but are maintained separately.

An independent review is performed for the Project site Emergency Preparedness program, as required in accordance with 10 CFR 50.54(t) and the Duke Energy Quality Assurance Program.

All program elements are reviewed by individuals who have no direct responsibility for the implementation of the emergency preparedness program either:

- At intervals not to exceed 12 months or,
- As necessary, based on an assessment by the licensee against performance indicators, and as soon as reasonably practicable after a change occurs in personnel, procedures, equipment, or facilities that potentially could adversely affect emergency preparedness, but no longer than 12 months after the change. In any case, all elements of the emergency preparedness program must be reviewed at least once every 24 months.

This review must include an evaluation for adequacy of interfaces with State and local governments (as required) and of licensee drills, exercises, capabilities, and procedures. The results of the review, along with recommendations for improvement, must be documented, reported to the licensee's corporate and plant management, and retained for a period of 5 years.

An emergency telephone directory containing contact numbers for the emergency response facilities and support organizations that are identified in the Plan and supporting procedures is reviewed routinely as described in procedures and updated as needed. Personnel use a document revision request process to identify changes needed to the emergency telephone directory.

ERO personnel are contacted quarterly and requested to validate and update their contact information as necessary in the Duke Energy human resources database. EP staff members update call out information in the dedicated ERO callout system at least quarterly using data from the Duke Energy human resources database.

The Duke Energy Corrective Action Program (CAP) is used to capture all events that do not meet program regulations, requirements, or are otherwise conditions adverse to quality. Changes in plant configuration are evaluated for their impact on the effectiveness of the Plan through the Applicability Determination process specified in Regulatory Affairs procedures and, if required, the 10 CFR 50.54(q) process specified in emergency plan administrative procedures.

V. HAZARD ANALYSIS OF CONTIGUOUS OR NEARBY FACILITIES

A hazard analysis survey has been performed to determine if there are any credible hazards from contiguous or nearby facilities that would adversely impact the implementation of the Project site Emergency Plan. This survey was performed using the guidance contained in NRC Regulatory Guide 1.78, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release,” Revision 2, December 2021.

This survey considered all sources within a five-mile radius and chemicals stored in a radius larger than five miles at large facilities or along major roadways as these may be transported within five miles of the site. The survey looked at:

- Facilities
- Roadways
- Railways
- Pipelines
- Waterways

Research was conducted to identify planned industrial facilities that, when completed, could become a potential hazard to the site.

The survey revealed locations, types of hazardous material, amount of hazardous material stored which if released to the environment could impact plant operations, prevent egress from the site, or prevent access to the site.

This survey will be used not only in evaluating Control Room habitability but the development of the EAL Scheme, EPIPs and site procedures. Site protective actions for the hazard will be included within the procedures. Any special protective clothing or equipment to be stored on-site will be identified.

Further discussion on this survey and other hazards that may impact safe operation of the proposed plant can be found in the SSAR, Section 2.2.

DUKE ENERGY
EMERGENCY PLAN

APPENDIX 1

GLOSSARY

GLOSSARY

Term	Definition
Abnormal Operating Procedures (AOPs)	Specific procedures that provide step-by-step instructions to guide plant operations during potential or actual emergency situations.
Accident	Any unforeseen, or unintentional occurrence or mishap resulting in, or potentially resulting in, physical injury or injury due to radiation exposure or excessive exposure to radioactive materials.
Activated (ERO)	The ERO has been notified of a declared event and instructed to respond to an emergency facility/location.
Activated (Facility)	The facility has met minimum staffing requirements, key systems and equipment is verified operational, and the ERO personnel are performing their assigned emergency response functions.
Alert	Events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant or a security event that involves probable life-threatening risk to site personnel or damage to site equipment because of HOSTILE ACTION. Any releases are expected to be limited to small fractions of the USEPA PAG exposure levels.
Alternate Emergency Facility (AEF)	The AEF is a facility dedicated for use by Duke Energy and designed to be accessible to ERO personnel in the event the OERF becomes uninhabitable or in the event of a Security or Hostile Action threat or severe weather event (such as a flood or tornado) if access to the site is deemed unsafe. The AEF provides a location for the ERO to assist the plant in the management and control of emergency response activities.

Annual or annually	Occurring once per calendar year.
Augmented (ERO)	The ERO is divided into two categories – on-shift and augmented. The augmented ERO relieves the shift personnel of emergency response functions.
Biennial or biennially	Once per two calendar years.
Calendar Year	Period beginning January 1 and ending December 31.
CEMP (Comprehensive Emergency Management Plan)	Beyond the EABs, ad hoc actions following a release are addressed using a CEMP. Also referred to as an emergency operations plan (EOP), CEMP is addressed in FEMA Comprehensive Preparedness Guide (CPG) 101, “Developing and Maintaining Emergency Operations Plans”. CPG 101 is the foundation for State, territorial, Tribal, and local emergency planning in the United States. It promotes a common understanding of the fundamentals of risk-informed planning and decision making and helps planners at all levels of government in their efforts to develop and maintain viable, all-hazards, all-threats emergency plans. An EOP is flexible enough for use in all emergencies. It describes how people and property will be protected; details who is responsible for carrying out specific actions; identifies the personnel, equipment, facilities, supplies, and other resources available; and outlines how actions will be coordinated. A CEMP is often referred to as a synonym for “all-hazards emergency planning” (FEMA, 2021).
Command and Control	Management of emergency response functions within a particular context (e.g., an ERF) through leadership and use of authority.
Concept of Operations	Delineation of an organization’s roles and responsibilities and how the organization will function to accomplish those responsibilities.

Containment	A physical structure surrounding a reactor that is designed to prevent or control the release of radioactive material.
Containment Closure	The procedurally defined actions taken to secure containment and its associated structures, systems, and components as a functional barrier to fission product release under shutdown conditions.
Contamination	Undesirable radioactive material (with a potentially harmful effect) that is either airborne or deposited in (or on the surface of) structures, objects, soil, water, or living organisms (people, animals, or plants) in a concentration that may harm people, equipment, or the environment.
Control Room	The area in a nuclear power plant from which most of the plant power production and emergency safety equipment can be operated remotely.
Corrective Action (Non-Emergency)	A concrete, actionable step that is intended to resolve EP program gaps and shortcomings experienced in drills, exercises, or actual events.
Decontamination	A process used to reduce, remove, or neutralize radiological, chemical, or biological contamination to reduce the risk of exposure.
DHS	U.S. Department of Homeland Security.
DOE	U.S. Department of Energy
Dose Rate	The radiation dose delivered per unit of time, measured for example in rem per hour.
Dosimeter	A small portable instrument (such as a film badge, thermoluminescent dosimeter, or electronic dosimeter) used to measure and record the total accumulated personal dose of ionizing radiation.

Dosimetry	The theory and application of the principles and techniques involved in measuring and recording doses of ionizing radiation.
Drill	A coordinated, supervised activity usually employed to validate a specific operation or function in a single agency or organization. Drills are commonly used to provide training on new equipment, develop or validate new policies or procedures, or practice and maintain current skills.
EAB	Exclusion Area Boundary.
EC	Emergency Coordinator
Emergency Action Level (EAL)	A predetermined, site-specific, observable threshold for an initiating condition that, when met or exceeded, places the plant in a given Emergency Classification Level (ECL).
Emergency Classification Level (ECL)	One of a set of names or titles established by the NRC for grouping off-normal events or conditions according to potential or actual effects or consequences and resulting in on-site and off-site response actions. The three (3) ECLs in ascending order of severity, are: Notification of an Unusual Event (NOUE), Alert, and Site Area Emergency (SAE).
Emergency Operating Procedures (EOPs)	Step-by-step procedures for direct actions taken by licensed reactor operators to mitigate and/or correct an off-normal plant condition through the control of plant systems.

Emergency Plan Implementing Procedures (EPIPs)	The set of specific, step-by-step instructions that define how the Emergency Plan is activated and executed during an emergency. EPIPs provide a systematic process for handling emergencies including assurance that emergencies are properly evaluated and classified; notifications are performed; and protective actions are assessed and implemented as needed.
Emergency Release	An unplanned, quantifiable airborne radiological release to the environment attributed to the emergency event.
Emergency Response Data System (ERDS)	A direct, near-real-time electronic data link between the licensee's on-site computer system and the NRC Operations Center that provides for the automated transmission of a limited data set of selected plant parameters.
Emergency Response Organization (ERO)	The personnel assigned to perform tasks and activities associated with implementation of the licensee's emergency plan for coping with emergencies.
Environmental Protection Agency (USEPA)	The mission of the USEPA is to protect human health and the environment. The USEPA is responsible for coordinating Federal environmental response and cleanup for nuclear/radiological accidents.
Evaluation	The process of observing exercise performance to identify strengths and opportunities for improvement in a plant's emergency preparedness and response capabilities.
Exclusion Area	An Exclusion Area is an area specified for the purpose of reactor site evaluation in accordance with 10 CFR 100. It is an area of such size that an individual located at any point on its boundary for two hours immediately following onset of the postulated release would not receive a total radiation dose to the whole body in excess of 25 rem or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure.

Exercise	An instrument to train for. assess, practice, and improve performance in prevention, protection, mitigation, response, and recovery capabilities. Exercises can be used for testing and validating policies, plans, procedures, training, equipment, and interagency agreements; clarifying and training personnel in roles and responsibilities; improving interagency coordination and communications; improving individual performance; identifying gaps in resources; and identifying opportunities for improvement.
Exposure Rate	The rate of charge production from ionizing radiation per unit mass of air (e.g., the amount of gamma radiation that an individual would be exposed to in one hour as measured in air), commonly expressed in roentgens per hour (R/h) or milliroentgens per hour (mR/h).
FBI	Federal Bureau of Investigation
Federal Emergency Management Agency (FEMA)	The agency responsible for establishing Federal policies for and coordinating emergency planning, management, mitigation, and assistance functions of executive agencies. FEMA assists state, local, and tribal government agencies in emergency planning. Its primary role is coordinating Federal, state, local, and tribal governments, and volunteer response actions. FEMA is part of DHS.
Federal Organization	An agency or department of the U.S. Federal Government, or its component(s), having a role in emergency planning and preparedness.
FRMAC	Federal Radiological Monitoring and Assessment Center

Hostile Action	An act directed toward a nuclear power plant or its personnel that includes the use of violent force to destroy equipment, take hostages, and/or intimidate the licensee to achieve an end. This includes attack by air, land, or water using guns, explosives, projectiles, vehicles, or other devices to deliver destructive force.
Incident Command Post (ICP)	The physical location at or near the incident site where primary tactical command functions are performed and led by the Incident Commander and staff. The ICP serves as the central point for managing direct, on-scene control of tactical operations, planning, and communications for the incident.
Initiating Condition (IC)	A plant state or situation that indicates a radiological emergency, or event(s) that could lead to a radiological emergency, has occurred.
Joint Information System (JIS)	A structured approach to organizing, integrating, and delivering information which ensures that timely, accurate, accessible, and consistent messages can be delivered across multiple jurisdictions and/or disciplines to the media, nongovernmental organizations, and the private sector. Critical supporting elements of the JIS include plans, protocols, procedures, and structures used to provide public information.
Key Skill	A capability necessary for implementing emergency response functions to protect public health and safety. A listing of key skills is provided in NSIR-DPR-ISG-01, Interim Staff Guidance, Emergency Planning for Nuclear Power Plants.

Licensee	The utility or organization that has received from the NRC (1) a license to construct or operate a commercial NPP, (2) an ESP for a commercial NPP, (3) a combined license for a commercial NPP, or (4) any other NRC license that is now or may become subject to requirements for radiological emergency planning and preparedness activities.
Monthly	Once per calendar month.
National Incident Management System (NIMS)	A systematic, proactive approach to guide all levels of government, non-governmental organizations, and the private sector to work together to prevent, protect against, mitigate, respond to, and recover from the effects of incidents. NIMS provides stakeholders across the whole community with a shared vocabulary, systems, and processes to successfully deliver the capabilities described in the National Preparedness System. NIMS provides a consistent foundation for dealing with all incidents, ranging from daily occurrences to incidents requiring a coordinated federal response.
National Response Framework (NRF)	The guiding principles, roles, and structures that enable all domestic incident response partners to prepare for and provide a unified national response to disasters and emergencies. It describes how the Federal government, states, tribal governments, communities, and private sector work together to coordinate a national response. The framework builds upon the scalable, flexible, and adaptable concepts identified in NIMS, which provides a template for managing incidents.
Non-Essential Personnel	Those personnel that are not required to fill ERO positions and are not needed for ERO functions.
NC	North Carolina
NCDA&CS	North Carolina Department of Agriculture and Consumer Services

Notification of Unusual Event (NOUE)	Events are in progress or have occurred which indicate a potential degradation of the level of safety of the plant or indicate a security threat to facility protection has been initiated. No releases of radioactive material requiring off-site response nor monitoring are expected unless further degradation of safety systems occurs.
U.S. Nuclear Regulatory Commission (NRC)	U. S. Nuclear Regulatory Commission, the federal agency that regulates commercial nuclear power plants and other uses of nuclear materials, such as nuclear medicine, through licensing, inspection, and enforcement of its requirements.
NRC Site Team	NRC regional personnel who may be activated for on-site assessment and face-to-face coordination with licensee, state, local, and tribal governments, and Federal responders.
Off-site	Outside the boundaries of the Owner Controlled Area (OCA).
On-site	Inside the Protected Area of a nuclear power plant.
On-site Emergency Response Facility (OERF)	An on-site facility that provides plant management and technical support to the reactor operating personnel located in the control room during emergency conditions; and provides a location for maintenance and other support personnel to gather as a ready resource to support emergency response actions.
Owner Controlled Area (OCA)	All areas contiguous to the commercial nuclear power plant that are owned or leased by the licensee (of by any of its associated business units) over which the licensee exercises control. The OCA is usually larger than, and encompasses, the exclusion area.
PA	Public Address

Performance-Based	A regulatory approach that focuses on desired, measurable outcomes rather than prescriptive processes, techniques, or procedures. For EP, the performance-based approach focuses on licensee demonstration of required emergency response functions.
Plume Exposure Pathway Emergency Planning Zone (EPZ)	The area in which public dose as defined in Title 10 of the Code of Federal Regulations,10 CFR) 20.1003, “Definitions”, is projected to exceed 10 mSv (1 rem) TEDE over 4 days (96 hours) from the release of radioactive materials from the facility, considering accident likelihood and source term, timing of the release sequence, and meteorology. It is also the area in which predetermined, prompt protective measures are necessary.
Potassium Iodide (KI)	A prophylactic compound containing a stable (i.e., non-radioactive) form of iodine that can be used effectively to block the uptake of radioactive iodine by the thyroid gland in a human being.
Procedures	An organization’s documented implementing instructions for managing its internal response to emergencies and coordinating its external response with other organizations. The term “procedures” as used in this document, included implementing procedures, standard operating procedures, administrative procedures, maintenance procedures, and testing procedures.
Projected Dose	The prediction of the dose that a population or individual could receive.
Protected Area	The nuclear power plant area under continuous access monitoring and control by the licensee, and armed protection as described in the site security plan.
Protective Action	An action taken to avoid or reduce projected dose.
Protective Action Guide (PAG)	A projected dose to an individual in the general population that warrants the implementation of a protective action.

Quarterly	Once per calendar quarter. Calendar quarters are defined as January-March, April-June, July-September, and October-December.
Rad	Radiation absorbed dose, the basic unit of absorbed radiation dose.
Radiation Protection	The protection of people from the effects of exposure to ionizing radiation, and the means for achieving this.
Recovery	The post-emergency activities in which the plant conditions are assessed, and the plant is returned to an operational mode.
Re-entry	Workers going into relocation or radiologically contaminated areas on a temporary basis under controlled conditions.
Roentgen (r)	A unit of exposure of gamma (or X-ray) radiation in field dosimetry. One roentgen is essentially equal to one rad (see “rad”). A unit for measuring the amount of radiation energy imparted to a volume of air. The roentgen can be used only to measure X-rays of gamma rays.
Roentgen Equivalent Man (rem)	The quantity of ionizing radiation of any type which, when absorbed by man or other mammals, produces a physiological effect equivalent to that produced by the absorption of 1 roentgen of X-ray or gamma radiation.
RPS	Radiation Protection Section
Semi-Annual or semiannually	Twice per calendar year. Twice defined as once in the first six months of the calendar year, and again, once in the second 6 months of the calendar year.
SERT	State Emergency Response Team

Site Area Emergency (SAE)	Events are in progress or have occurred which involve actual or likely major failures of plant functions needed for protection of the public or HOSTILE ACTION that results in intentional damage or malicious acts:1) toward site personnel or equipment that could lead to the likely failure of or 2) that prevent effective access to, equipment needed for the protection of the public. Any releases are not expected to result in exposure levels which exceed USEPA Protective Action Guide (PAG) exposure levels beyond the EAB.
Site Boundary	The line that encompasses the Project site where Duke Energy proposes to construct and operate multiple advanced reactors on one or more of three plant complexes as identified on Figure I-1. The Project site is owned by Duke Energy and is bounded on the north, east, and west by Belews Lake, also owned by Duke Energy. It should be noted that in addition to Belews Lake, Duke Energy owns land beyond the Site Boundary which includes the Belews Creek Steam Station, a two-unit, 2220 megawatts electric (MWe) fossil fuel plant.
Site Safety Analysis Report (SSAR)	The report required by 10 CFR 52.17(a)(1) to be included in each application for an Early Site Permit. The SSAR includes a description of the facility, the maximum levels of thermal and radiological effluents, and a description of seismic, meteorological, hydrologic, and geologic characteristics of the proposed site.
Total Effective Dose Equivalent (TEDE)	The sum of deep dose equivalent (for external exposures) and committed effective dose equivalent (for internal exposures)
Weekly	Once per calendar week, defined as Monday through Sunday.

DUKE ENERGY
EMERGENCY PLAN

APPENDIX 2

REFERENCES

REFERENCES

FEMA, 2021. Federal Emergency Management Agency. Comprehensive Preparedness Guide 101 (CPG 101). Developing and Maintaining Emergency Operations Plans, Version 3, September 2021.

NEI, 2011. Nuclear Energy Institute. NEI 10-05, Revision 0, “Assessment of On-Shift Emergency Response Organization Staffing and Capabilities”, June 2011.

NRC, 2021. U.S. Nuclear Regulatory Commission, “Catawba Nuclear Station, Units 1 and 2; McGuire Nuclear Station, Units 1 and 2; Oconee Nuclear Station, Units 1, 2, and 3; Brunswick Steam Electric Plant, Units 1 and 2; Shearon Harris Nuclear Power Plant, Unit 1; and H.B. Robinson Steam Electric Plant, Unit No. 2 – Issuance of Amendments for Common Emergency Plan Consistent with NUREG-0654, Revision 2,” ML21155A213, August 26, 2021.

DUKE ENERGY
EMERGENCY PLAN

APPENDIX 3

EMERGENCY PLAN IMPLEMENTING PROCEDURES AND SUPPORTING PROCEDURES

(TYPICAL LIST)

EMERGENCY PLAN IMPLEMENTING PROCEDURES AND SUPPORTING PROCEDURES (TYPICAL LIST)

Emergency Plan Administrative Procedures

Administration and Maintenance of the Emergency Plan

Emergency Response Organization

Emergency Preparedness Training Program

Drill and Exercise Program

Emergency Response Facilities and Equipment

Equipment Important to Emergency Preparedness

Emergency Preparedness Performance Metrics

Emergency Plan Implementing Procedures

Classification of Emergencies

Emergency Notifications

Activation and Operation of the On-site Emergency Response Facility (OERF)

Core Damage Assessment

Conduct of Evacuations and Accountability

Emergency Personnel Exposure Controls

Off-site Dose Assessment

Re-entry, Termination and Recovery

Supporting Abnormal Operating Procedures (AOPs)

Probable Aircraft Threat

Response to Hostile Action

Security Event Response

Medical Emergency

Radiological Release

Response to Hazardous Material Release

Severe Weather and Other Natural Hazards

EMERGENCY PLAN

APPENDIX 4

CROSS REFERENCE TO REGULATIONS AND GUIDANCE

CROSS REFERENCE TO REGULATIONS AND GUIDANCE

10 CFR 50.160	R.G. 1.242	Emergency Plan Location
50.160(b)(iv)(2)(3)	C.2.d	Part I, Section E
50.160(b)(iv)(2)(4)	C.3	Part I, Section F
50.160(b)(1)(i)	C.6.a	Part III, Section A
----------	C.6.a(1)	Part I, Section D; Figure I-1
----------	C.6.a(2)	Part IV, Section F
50.160(b)(1)(ii) (A)	C.6.b	Part III, Section B
50.160(b)(1)(ii) (B)	C.6.b	Part III, Section B
50.160(b)(1)(iii)	C.6.b(3)	Part III, Section B
50.160(b)(1)(iii)(A)	C.6.c	Part III, Section C
50.160(b)(1)(iii)(B)	C.6.d	Part III, Section D
50.160(b)(1)(iii)(C)	C.6.e	Part III, Section E
50.160(b)(1)(iii)(D)	C.6.f	Part III, Section F
50.160(b)(1)(iii)(E)	C.6.g	Part III, Section G; Table III.G-1
50.160(b)(1)(iii)(F)	C.6.h	Part III, Section H
50.160(b)(1)(iii)(F)(*1*)	C.6.h(1)	Part III, Section H.1
50.160(b)(1)(iii)(F)(*2*)	C.6.h(2)	Part III, Section H.2
50.160(b)(1)(iii)(F)(*3*)	C.6.h(3)	Part III, Section H.3
50.160(b)(1)(iii)(F)(*4*)	C.6.h(4)	Part III, Section H.4
50.160(b)(1)(iii)(G)	C.6.i	Part III, Section I

CROSS REFERENCE TO REGULATIONS AND GUIDANCE
(Continued)

10 CFR 50.160	R. G. 1.242	Emergency Plan Location
50.160(b)(1)(iii)(H)	C.6.j	Part III, Section J
50.160(b)(1)(iv)(A)(*1*)	C.7.a	Part IV, Section A
50.160(b)(1)(iv)(A)(*2*)	C.7.b	Part IV, Section B
50.160(b)(1)(iv)(A)(*3*)	C.7.c	Part IV, Section C
50.160(b)(1)(iv)(A)(*4*)	C.7.d	Part IV, Section D
50.160(b)(1)(iv)(A)(*5*)	C.7.e	Part IV, Section E
50.160(b)(1)(iv)(A)(*6*)	C.7.f	Part IV, Section F
50.160 (b)(2)	C.9.a – C.9.c	Part V

Duke Energy Carolinas, LLC
Belews Creek, North Carolina Site
Early Site Permit Application

Part 7

Exemptions, Departures, and Variances

Revision 0

PART 7
EXEMPTIONS, DEPARTURES AND VARIANCES

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GLOSSARY

Term	Definition
CFR	Code of Federal Regulations
DEC	Duke Energy Carolinas, LLC
DEP	Duke Energy Progress, LLC
ESP	Early Site Permit
LLC	Limited Liability Company
NRC	U.S. Nuclear Regulatory Commission

Section 1 Introduction and Background

Duke Energy Carolinas, LLC (DEC), referred to herein as “Duke Energy,” a wholly-owned subsidiary of Duke Energy Corporation, is submitting this application for an Early Site Permit (ESP) for the Belews Creek, North Carolina site to the U.S. Nuclear Regulatory Commission (NRC) in accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR) Part 52 (10 CFR Part 52) Subpart A, “Early Site Permits.” Duke Energy is the applicant for this ESP. Duke Energy Progress, LLC (DEP) an indirect subsidiary of Duke Energy Corporation, and DEC (together referred to as “the Companies”) combined make up the Carolinas service territory within the region of interest.

Part 7 of this application identifies any exemptions requested under 10 CFR 52.7, “Specific Exemptions.” In accordance with 10 CFR Part 52, an applicant for an ESP may request exemptions from applicable requirements of Part 52. Exemptions from the requirements of other parts of the regulations that apply by virtue of 10 CFR Part 52 are governed by the exemption requirements of those parts (e.g., 10 CFR 50.12, “Specific Exemptions,” governs exemptions from 10 CFR Part 50 requirements). Variances under 10 CFR 52.93 and departures under 10 CFR 52.63 are not applicable to this ESP application.

As described in Section C.1.7 of Regulatory Guide 1.206, any such exemption request, if applicable, would clearly state its scope and purpose, include justification based on applicable regulatory requirements and guidance, and provide a technical and regulatory evaluation addressing safety significance and acceptance criteria. If an exemption request were submitted, it would be evaluated against the specific exemption criteria in 10 CFR 50.12 and would identify whether NRC approval or an exemption is required.

Section 2 Exemptions

The ESP application submitted herein has been reviewed, and it has been determined that no exemptions from the applicable requirements of 10 CFR are necessary for consideration by the NRC under the provisions of 10 CFR 52.7 and the exemption criteria set forth in 10 CFR 50.12. Variances under 10 CFR 52.93 and departures under 10 CFR 52.63 are not applicable to this ESP application. No NRC approval is required in this regard.

Duke Energy Carolinas, LLC

Belews Creek, North Carolina Site

Early Site Permit Application

Part 8

License Conditions; Inspections, Tests, Analyses and Acceptance Criteria

- Revision 0

PART 8

LICENSE CONDITIONS;

INSPECTIONS, TESTS, ANALYSES AND ACCEPTANCE CRITERIA

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GLOSSARY

Term	Definition
CFR	Code of Federal Regulations
DEC	Duke Energy Carolinas, LLC
DEP	Duke Energy Progress, LLC
ESP	Early Site Permit
ITAAC	Inspections, Tests, Analyses and Acceptance Criteria
LLC	Limited Liability Company
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Section 1 Introduction and Background

Duke Energy Carolinas, LLC (DEC), referred to herein as “Duke Energy,” a wholly-owned subsidiary of Duke Energy Corporation, is submitting this application for an Early Site Permit (ESP) to the U.S. Nuclear Regulatory Commission (NRC) in accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR) Part 52 (10 CFR 52) Subpart A, “Early Site Permits.” Duke Energy is the applicant for this ESP. Duke Energy Progress, LLC (DEP), an indirect subsidiary of Duke Energy Corporation, and DEC (together referred to as “the Companies”) combined make up the Carolinas service territory within the region of interest.

Section 2 License Conditions; Inspections, Tests, Analyses and Acceptance Criteria

No License Conditions or Inspections, Tests, Analyses and Acceptance Criteria (ITAAC) are required for this ESP application. Therefore, the ESP application submitted herein does not propose or contain any license conditions or any ITAAC.

Duke Energy Carolinas, LLC
Belews Creek, North Carolina Site
Early Site Permit Application

Part 10

Quality Assurance Program Description

Revision 0

PART 10
QUALITY ASSURANCE PROGRAM DESCRIPTION

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GLOSSARY

Term	Definition
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CNO	Chief Nuclear Officer
DEC	Duke Energy Carolinas, LLC
DEP	Duke Energy Progress, LLC
ESP	Early Site Permit
ESPA	Early Site Permit Application
GL	NRC Generic Letters
NC	North Carolina
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
Project site	Belews Creek, NC site
QA	quality assurance
QAPD	Quality Assurance Program Description
RG	Regulatory Guide
SRP	Standard Review Plan
SSCs	structures, systems, and components

Section 1 Introduction and Background

Duke Energy Carolinas, LLC (DEC), referred to herein as "Duke Energy," a wholly-owned subsidiary of Duke Energy Corporation, is submitting this application for an Early Site Permit (ESP) for the Belews Creek, North Carolina (NC) site (Project site) to the U.S. Nuclear Regulatory Commission (NRC) in accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR) Part 52 (10 CFR Part 52) Subpart A, "Early Site Permits." Duke Energy is the applicant for this ESP. Duke Energy Progress, LLC (DEP) an indirect subsidiary of Duke Energy Corporation, and DEC (together referred to as "the Companies") combined make up the Carolinas service territory within the region of interest.

Part 10 of this application provides information related to Duke's Quality Assurance Program. The applicable Duke Energy Topical Report is: DUKE-QAPD-001, *Quality Assurance Program Description Operating Fleet* (hereby referred to as QAPD). The QAPD and associated procedures provide for control of Duke Energy's activities that have the potential to affect the quality of safety-related structures, systems, and components (SSCs) of the proposed advanced reactors at the Project site. Requirements for an ESP QAPD are set forth in 10 CFR 52.17(a)(1). The current revision of the Duke QAPD has been previously submitted to the NRC and assigned the Accession number of ML24319A007.

Section 2 Quality Assurance Program Description

The QAPD is the top-level Quality Assurance (QA) document that applies to Duke Energy's fleet and that defines the quality policy and assigns major functional responsibilities. The QAPD applies to Duke Energy's personnel, organizations, and contractors performing activities within the scope of the QAPD that could affect the quality of safety-related SSCs. The QAPD also addresses the site-related activities associated with the preparation of the Early Site Permit Application (ESPA).

The QAPD applies to site suitability quality assurance activities associated with the ESPA, including designing, procuring, handling, testing, siting, inspecting, storing, training, and shipping. The QAPD is based on American National Standards Institute (ANSI) N18.7 and the ANSI N45.2 series standards in lieu of ANSI / American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1.

The QAPD has been evaluated in relationship to NUREG-0800, Section 17.5 and found to be in compliance with the Standard Review Plan (SRP) with following two exceptions:

- Section S, Items 2 and 3 – Per the QAPD, the Chief Nuclear Officer (CNO) is responsible for quality assurance and is the highest level of management responsible for establishing Duke Energy Corporation's nuclear policies, goals, and objectives. The qualifications of the CNO meet the intent of Section S, Item 2 qualifications for management of the implementation of the QA plan. Section S, Item 3 individuals responsible for planning, implementing, and maintaining the QA plan are qualified in accordance with the QAPD and are the same personnel for the operating plants. These qualifications meet the intent of Section S, Item 3 of the SRP.

- Section V, Item 1e – The QAPD does not commit to NRC Generic Letter (GL) 91-05, *Licensee Commercial-Grade Dedication Programs*. The QAPD commits to other dedication guidelines, such as GL 89-02, *Actions to Improve the Detection of Counterfeit and Fraudulently Marked Products*, and Regulatory Guide (RG) 1.164, *Dedication of*

Commercial-Grade Items for Use in Nuclear Power Plants. The current QAPD meets the intent of Section V, Item 1e of the SRP.

Duke Energy Carolinas, LLC
Belews Creek, North Carolina Site
Early Site Permit Application

Part 11

Supplemental Information

Revision 0

PART 11
SUPPLEMENTAL INFORMATION

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Part 11 is a placeholder for supplemental information that may be identified during the review and preparation of the ESP application. This supplemental information, if needed, will supplement the standard information identified in Parts 1 through 10.

The supplemental information may include additional information on specific regulatory issues and other information deemed appropriate by Duke Energy or requested by the NRC to facilitate their review and approval of this ESP application.

Section 2 Supplemental Information

The ESP application submitted herein has been reviewed, and it has been determined that no supplemental information is currently needed to support the application.