NUREG-1811

Draft Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site

Draft Report for Comment

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

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Office of Nuclear Reactor Regulation
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Washington, DC 20555-0001

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Electronic comments may be submitted to the NRC by the Internet at NorthAnna_ESP@nrc.gov.

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Abstract

This draft environmental impact statement (EIS) has been prepared in response to an application submitted to the U.S. Nuclear Regulatory Commission (NRC) by Dominion Nuclear North Anna, LLC (Dominion), for an early site permit (ESP). The proposed action requested in Dominion's application is for the NRC to (1) approve a site within the existing North Anna Power Station (NAPS) boundaries as suitable for the construction, and operation, of new nuclear power generating facilities, and (2) issue an ESP for the proposed site located at NAPS. The proposed action does not include any decision or approval to construct or operate one or more units; these are matters that would be considered only upon the filing of applications for a construction permit and an operating license, or an application for a combined license. The application does propose a plan for redressing the environmental effects of certain site preparation and preliminary construction activities (*i.e.*, those activities allowed by 10 CFR 50.10(e)(1)) performed by an ESP holder under 10 CFR 52.25. In accordance with the plan, the site would be redressed if the NRC issues the requested ESP (containing the site redress plan), the ESP holder performs these site preparation and preliminary construction activities, the ESP is not referenced in an application for a construction permit or combined license, and no alternative use is found for the site. This draft EIS includes the NRC staff's analysis that considers and weighs the environmental impacts of constructing and operating two nuclear units at the North Anna ESP site, or at alternative sites, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's preliminary recommendation to the Commission regarding the proposed action.

The staff's preliminary recommendation is that the ESP should be issued. This preliminary recommendation is based on (1) the Environmental Report submitted by Dominion, as revised; (2) consultation with Federal, State, Tribal and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments received during the public scoping process and; (5) the assessments summarized in this draft EIS, including the potential mitigation measures identified in the ER and in the EIS. In addition, in making its preliminary recommendation, the staff has concluded that there are no environmentally preferable or obviously superior sites. Finally, the staff has preliminarily concluded that the site preparation and preliminary construction activities allowed by 10 CFR 50.10(e)(1) will not result in any significant adverse environmental impact that cannot be redressed.

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Executive Summary

On September 25, 2003, the U.S. Nuclear Regulatory Commission (NRC) received an application from Dominion Nuclear North Anna, LLC (Dominion) for an early site permit (ESP) for a location adjacent to the North Anna Power Station (NAPS), Units 1 and 2. Dominion submitted revisions to the environmental report (ER) on October 2, 2003, July 15, 2004, and September 7, 2004. Any reference in this draft environmental impact statement (EIS) to the ER refers to Revision 3, unless otherwise stated. The North Anna ESP site is located in Louisa County, Virginia, approximately 10 km (6 mi) northeast of the town of Mineral. An ESP is a Commission approval of a location for siting one or more nuclear power facilities and is a separate action from the filing of an application for a construction permit (CP) or a combined construction permit and operating license (combined license or COL) for such a facility. An ESP application may refer to a reactor's or reactors' characteristics or a plant parameter envelope, which is a set of postulated design parameters that bound the characteristics of a reactor or reactors that might be built at a selected site; alternatively an ESP may refer to a detailed reactor design. The ESP is not a license to build a nuclear power plant; rather, the application for an ESP initiates a process undertaken to assess whether a proposed site is suitable should the applicant decide to pursue a CP or COL.

Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321) directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. Subpart A of Title 10 of the Code of Federal Regulations (CFR) Part 52 contains the NRC regulations related to ESPs. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. As set forth in 10 CFR 52.18, the Commission has determined that an EIS will be prepared during the review of an application for an ESP. The purpose of Dominion's requested action, issuance of the ESP, is for the NRC to determine whether the North Anna ESP site is suitable for new nuclear units by resolving certain safety and environmental issues before Dominion incurs the substantial additional time and expense of designing and seeking approval to construct such facilities at the site. Part 52 of Title 10 describes the ESP as a "partial construction permit." An applicant for a CP or COL for a nuclear power plant or plants to be located at the site for which an ESP was issued can reference the ESP, thus reducing the review of siting issues at that stage of the licensing process. However, a CP or COL to construct and operate a nuclear power plant is a major federal action that requires its own environmental review in accordance with 10 CFR Part 51.

Three primary issues – site safety, environmental impacts, and emergency planning – must be addressed in the ESP application. Likewise, in its review of the application, the NRC assesses the applicant's proposal in relation to these issues and determines if the application meets the requirements of the Atomic Energy Act and NRC regulations. This draft environmental impact statement addresses the environmental impacts of the proposed action.

Dominion requested in its application authorization to perform certain site preparation activities after the ESP is issued. The application, therefore, included a site redress plan that specifies how the applicant would stabilize and restore the site to its preconstruction condition (or conditions consistent with an alternative use) in the event a nuclear power plant is not constructed on the approved site. Pursuant to 10 CFR 52.17(a)(2), the applicant did not address the benefits of the proposed action (e.g., the need for power). In accordance with 10 CFR 52.18, the EIS is focused on the environmental effects of construction and operation of a reactor, or reactors, which have characteristics that fall within the postulated site parameters.

Upon acceptance of the Dominion ESP application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing in the *Federal Register* a Notice of Intent (68 FR 65961) to prepare an EIS and conduct scoping. The staff visited the North Anna ESP site during December 2003 and held a public scoping meeting on December 8, 2003, in Mineral, Virginia. Subsequent to the site visit and the scoping meeting and in accordance with NEPA and 10 CFR Part 51, the staff has determined and evaluated the potential environmental impacts of constructing and operating two nuclear power plants at the North Anna ESP site. Included in this draft EIS are (1) the results of the NRC staff's preliminary analyses, which consider and weigh the environmental effects of the proposed action (issuance of the ESP) and of constructing and operating two nuclear units at the ESP site; (2) mitigation measures for reducing or avoiding adverse effects; (3) the environmental impacts of alternatives, and (4) the staff's preliminary recommendation regarding the proposed action.

During the course of preparing this draft EIS, the staff reviewed the Environmental Report submitted by Dominion, consulted with Federal, State, Tribal and local agencies, and followed the guidance set forth in review standard RS-002, *Processing Applications for Early Site Permits,* to conduct an independent review of the issues. The review standard draws from the previously published NUREG-0800, *Standard Review Plans for the Review of Safety Analysis for Nuclear Power Plants*, and NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants.* In addition, the staff considered the public comments related to the environmental review received during the scoping process. These comments are provided in Appendix D of this draft EIS.

In following the precedent of the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437) and supplemental license renewal EISs, environmental issues are evaluated using a three-level standard of significance – SMALL, MODERATE, or LARGE – developed by NRC using guidelines from the Council on Environmental Quality. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels:

SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

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.

Mitigation measures were considered for each environmental issue and are presented in the appropriate sections.

The staff plans to conduct a public meeting near the ESP site to describe the preliminary results of the NRC environmental review, answer questions and to provide members of the public with information to assist them in formulating comments on this draft EIS. After the comment period, the staff will consider and disposition all comments received. These comments will be addressed in Appendix E of the final EIS.

The staff's preliminary recommendation is that the ESP should be issued. This preliminary recommendation is based on (1) the Environmental Report submitted by Dominion, as revised; (2) consultation with Federal, State, Tribal and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments received during the public scoping process and; (5) the assessments summarized in this draft EIS, including the potential mitigation measures identified in the ER and in the EIS. In addition, in making its preliminary recommendation, the staff has concluded that there are no environmentally preferable or obviously superior sites. Finally, the staff has preliminarily concluded that the site preparation and preliminary construction activities allowed by 10 CFR 50.10(e)(1) will not result in any significant adverse environmental impact that cannot be redressed.

Abbreviations/Acronyms

ABWR	advanced boiling water reactor
ac	acre(s)
ACE	U.S. Army Corps of Engineers
ACR-700	Advanced CANDU Reactor
AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ALWR	advanced light-water reactor
ATWS	anticipated transient without scram
BEA	Bureau of Economic Analysis
Bq	becquerel(s)
Btu	British thermal unit(s)
BWR	boiling water reactor
C	Celsius
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	curie(s)
cm	centimeter(s)
COL	combined license
CP	construction permit
CWA	Clean Water Act of 1977 (also known as the Federal Water Pollution Control Act)
CWIS	cooling water intake system
CZMA	Coastal Zone Management Act
d	day
DBA	design-basis accident
DOE	U.S. Department of Energy
EAB	exclusion area boundary
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ER	environmental report
ESBWR	economic simplified boiling water reactor
ESE	east-southeast
ESP	early site permit

F	Fahrenheit
FR	Federal Register
ft	foot/feet
FWPCA	Federal Water Pollution Control Act (also known as the Clean Water Act of 1977)
FWS	U.S. Fish and Wildlife Service
gal	gallon(s)
GEIS	generic environmental impact statement
gpd	gallons per day
gpm	gallons per minute
GT-MHR	gas turbine-modular helium reactor
ha	hectare(s)
HLW	high-level waste
HPS	Health Physics Society
hr	hour(s)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers, Inc.
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
IRIS	international reactor innovative and secure
ISFSI	independent spent fuel storage installation
kg	kilogram(s)
km	kilometer(s)
kV	kilovolt(s)
kWh	kilowatt hour(s)
L	liter(s)
LAAC	Lake Anna Advisory Committee
lb	pound(s)
LLW	low-level waste
LOCA	loss-of-coolant accident
LOS	level-of-service
LPZ	low population zone
LWR	light-water reactor

m	meter(s)
m/sec	meter(s) per second
m^3/d	cubic meter(s) per day
m^3/s	cubic meter(s) per second
MBq	megaBecquerel(s)
mGy/yr	milligray per year
MGD	million gallons per day
mi	mile(s)
MIT	Massachusetts Institute of Technology
mL	milliliter(s)
mph	miles per hour
mrad	millirad(s)
mrem	millirem(s)
MSL	mean sea level
mSv	millisievert(s)
MT	metric ton(s) (or tonne[s])
MTU	metric ton(s)-uranium
MW	megawatt(s)
MWd/MTU	megawatt-days per metric ton of uranium
MW(e)	megawatt(s)-electric
MW(t)	megawatt(s)-thermal
MWh	megawatt hour(s)
NA	not applicable
NAPS	North Anna Power Station
NCDC	National Climatic Data Center
NCHS	National Center for Health Statistics
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act of 1969
NESC	National Electric Safety Code
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NNE	north-northeast
NOAA	National Oceanographic and Atmospheric Administration
NO_x	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
OL	operating license
OSHA	Occupational Safety and Health Administration

PBMR	pebble bed modular reactor
PCB	polychlorinated biphenyl
PPE	plant parameter envelope
PWR	pressurized water reactor
RCIC	reactor core isolation cooling
REMP	radiological environmental monitoring program
rms	root mean square
ROI	region of interest
RRY	reference reactor-year
RSA	Rapidan Service Authority
Ryr^{-1}	per reactor year
s	second
SAIC	Science Applications International Corporation
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SER	safety evaluation report
SHPO	State Historic Preservation Officer
SODI	Southern Ohio Diversification Initiative
SO_x	sulfur oxide(s)
SPCC	Spill Prevention Control and Countermeasure
SR	State Route
SSAR	Site Safety Analysis Report
SSE	south-southeast
Sv	sievert(s)
SWR	Service Water Reservoir
SWU	separative work units
TEDE	total effective dose equivalent
TRU	transuranic (waste)
TVA	Tennessee Valley Authority
UCO	uranium oxycarbide
UFSAR	Updated Final Safety Analysis Report
UHS	ultimate heat sink
U.S.	United States
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USEC	United States Enrichment Corporation, Inc.
USGS	U.S. Geological Survey

VAC	Virginia Administrative Code
VDCR	Virginia Department of Conservation and Recreation
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDOT	Virginia Department of Transportation
VDSS	Virginia Department of Social Services
VEC	Virginia Employment Commission
VEPCo	Virginia Electric and Power Company
VNHP	Virginia Natural Heritage Program
VPDES	Virginia Pollutant Discharge Elimination System
yd	yard(s)
yr	year(s)
WHTF	Waste Heat Treatment Facility

1.0 Introduction

On September 25, 2003, the U.S. Nuclear Regulatory Commission (NRC) received an application from Dominion Nuclear North Anna, LLC (Dominion) for an early site permit (ESP) for an ESP site (the North Anna ESP site) located within the existing North Anna Power Station (NAPS) site near Mineral, Virginia. The September 25, 2003, Environmental Report (ER) of this application was revised by letters dated October 2, 2003 (Revision 1), July 15, 2004 (Revision 2), and September 7, 2004 (Revision 3). Any reference in this draft environmental impact statement (EIS) to the ER refers to Revision 3 (Dominion 2004a), unless otherwise stated. Under the NRC regulations in Title 10 of the Code of Federal Regulations (CFR) Part 52 and in accordance with the applicable provisions of 10 CFR Part 51, which are the NRC regulations implementing the National Environmental Policy Act of 1969 (NEPA), the NRC is required to prepare an EIS as part of its review of an ESP application. In preparing the EIS, the NRC staff is required to publish in the *Federal Register* a Notice of Intent (68 FR 65961) to prepare an EIS, conduct scoping, and publish a draft EIS for public comment. The final EIS will be issued after considering public comments on the draft. A separate safety evaluation report will also be prepared in accordance with 10 CFR Part 52.

1.1 Background

An ESP is a Commission approval of a site or sites for one or more nuclear power facilities. The filing of an application for an ESP is a process that is separate from the filing of an application for a construction permit (CP) and a operating license (OL) or a combined license (COL) for such a facility. The ESP application and review process makes it possible to evaluate and resolve safety and environmental issues related to siting before the applicant makes large commitments of resources. If the ESP is approved, the applicant can "bank" the site for up to 20 years for future reactor siting. In addition, if the ESP includes a site redress plan, the ESP holder can conduct certain site preparation and preliminary construction activities allowed by 10 CFR 50.10 (e)(1). An ESP does not authorize construction or operation of a nuclear power plant. To construct or operate a nuclear power plant, an ESP holder must obtain a CP and an OL, or a COL.

As part of its evaluation of the environmental aspects of the action proposed in an ESP application, NRC prepares an EIS in accordance with 10 CFR 52.18. Because site suitability encompasses construction and operational parameters, the EIS addresses impacts of both construction and operation of reactors and associated facilities. In a review separate from the EIS process, NRC analyzes the safety characteristics of the proposed site and emergency planning information. These latter two analyses are documented in a safety evaluation report that presents the conclusions reached by NRC regarding whether there is reasonable assurance that a reactor or reactors, having characteristics that fall within the parameters for the site can be constructed and operated without undue risk to the health and safety of the public, whether there are significant impediments to the development of emergency plans, and whether site characteristics are such that adequate security plans and measures can be developed. In addition, if the applicant proposes major features of emergency plans, or complete and integrated emergency plans, the safety evaluation report will document whether such major features are acceptable, or whether the complete and integrated emergency plans provide reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. The applicant has chosen to propose major features of emergency plans.

Plant Parameter Envelope

The applicant for an ESP need not provide a detailed design of a reactor or reactors and the associated facilities but should provide sufficient bounding parameters and characteristics of the reactor or reactors and the associated facilities so that an assessment of site suitability can be made. Consequently, the ESP application may refer to a plant parameter envelope (PPE) as a surrogate for a nuclear power plant and its associated facilities.

A PPE is a set of values of plant design parameters that an ESP applicant expects will bound the design characteristics of the reactor or reactors that might be constructed at a given site. The PPE values are a surrogate for actual reactor design information. Analysis of environmental impacts based on a PPE approach permits an ESP applicant to defer the selection of a reactor design until the CP or COL stage. The PPE reflects upper bounds of the values for each parameter that it encompasses rather than the characteristics of any specific reactor design. The PPE is discussed in more detail in section 3.2 of this report.

Site Preparation and Preliminary Construction Activities

The holder of an ESP, or an applicant for a CP (10 CFR Part 50) or a COL (Subpart C of 10 CFR Part 52) that references an ESP with an approved site redress plan, may in accordance with 10 CFR 52.25(a) perform the site preparation and preliminary construction activities allowed by 10 CFR 50.10(e)(1), provided that the final ESP EIS concluded that the activities will not result in any significant adverse environmental impacts which cannot be redressed. Dominion provided a site redress plan as part of its ESP application (Dominion 2004b). Activities permitted under an ESP include preparation of the site for construction of the facility, installation of temporary construction support facilities, excavation for facility structures, construction of service facilities, and construction of certain structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents (10 CFR 50.10(e)(1)).

ESP Application and Review

In accordance with 10 CFR 52.17(a)(2), Dominion submitted an ER as part of its ESP application (Dominion 2004a). The ER focused on the environmental effects of construction and operation of reactors with characteristics that fall within the PPE. The ER also includes an evaluation of alternative sites to determine whether there is an obviously superior alternative to the proposed site. The ER is not required to include, nor did it include, an assessment of the benefits of the proposed action (e.g., the need for power) or a discussion of energy alternatives.

The NRC standards for review of the ESP application are outlined in 10 CFR 52.18. As with the ER, this draft EIS focuses on the environmental effects of construction and operation of reactors that have characteristics that fall within the PPE developed by Dominion and includes an evaluation of alternative sites to determine whether there is an obviously superior alternative to the proposed North Anna ESP site. The EIS does not include an assessment of the benefits of the proposed action or an assessment of energy alternatives.

The NRC staff conducts its reviews of ESP applications in accordance with guidance set forth in review standard RS-002, *Processing Applications for Early Site Permits* (NRC 2004). The review standard draws from the previously published NUREG-0800, *Standard Review Plans for the Review of Safety Analysis for Nuclear Power Plants* (NRC 1987), and NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants* (ESRP), (NRC 1999). RS-002 provides guidance to NRC staff reviewers to help ensure a thorough, consistent, and disciplined review of any ESP application. As stated in RS-002, an applicant may elect to use a PPE approach instead of supplying specific design information. The staff's June 23, 2003, responses to comments received on draft RS-002 (ML031710698) provide additional insights on the staff's expectations and potential approach to the review of an application employing the PPE approach (NRC 2003). Specifically, the NRC staff and its contractor tasked to perform the environmental review have been trained on using the guidance in the ESRP and RS-002, and on incorporating the PPE concept into their review. The reviewers understood the need to adapt the ESRP review guidance to the PPE concept. The findings in this EIS reflect the adaptation of the ESRP guidance to the PPE approach.

During the review of any future COL application referencing an ESP, the staff will assess the environmental impacts of the construction and operation of a specific plant design. If the environmental impacts addressed in the EIS written at the ESP stage are found to be bounding by the staff, no additional analysis of these impacts is required, even if the ESP applicant employed the PPE approach. However, environmental impacts not considered or not bounded at the ESP stage will be assessed at the CP or COL stage. In addition, measures and controls to limit adverse impacts should be identified and evaluated for feasibility and adequacy in limiting adverse impacts at the ESP stage, where possible, and at the CP or COL stage. As a result of the staff's environmental review of the ESP application, the staff may determine that conditions or limitations on the ESP may be necessary in specific areas, as set forth in 10 CFR 52.24. Therefore, the staff has identified in the EIS when and how assumptions and bounding values limit its conclusions on the environmental impacts to a particular resource.

Following requirements set forth in 10 CFR Part 51 and the guidance in RS-002, the NRC environmental staff (and technical experts from Pacific Northwest National Laboratory retained to assist the staff) visited the North Anna ESP site during December 2003 to gather information and to become familiar with the site and its environs. During the site visits, the staff and its contractors met with Dominion staff, public officials, and with members of the public. A scoping meeting was held on December 8, 2003, to obtain public input on the scope of the environmental review. The staff reviewed the comments received during the scoping meeting and also contacted Federal, State, Tribal, regional, and local agencies to solicit comments. A list of the organizations contacted is provided in Appendix B. Other documents related to the North Anna ESP site were reviewed and are listed as references where appropriate.

To guide its assessment of environmental impacts of a proposed action or alternative actions, NRC has established a standard of significance for impacts using Council on Environmental Quality (CEQ) guidance (40 CFR 1508.27). Using this approach, NRC has established three significance levels – SMALL, MODERATE, or LARGE – which are defined below:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> 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.

This draft EIS presents the staff's analysis that considers and weighs the environmental impacts of the proposed action at the North Anna ESP site, including the environmental impacts associated with construction and operation of reactors at the site, the impacts of constructing and operating reactors at alternative sites, the environmental impacts of alternatives to granting the ESP, and mitigation measures available for reducing or avoiding adverse environmental effects. This draft EIS also provides the NRC staff's preliminary recommendation to the Commission regarding the suitability of the North Anna ESP site for construction and operation of reactors with characteristics that fall within the PPE.

A 75-day comment period will commence on the date of publication of the U.S. Environmental Protection Agency Notice of Filing of EIS to allow members of the public to comment on the results of the NRC staff's review. A public meeting will be held near the site during the public comment period. During this public meeting, the staff will describe the results of the NRC environmental review, answer questions related to the review, and provide members of the public with information to assist them in formulating their comments.

1.2 The Proposed Federal Action

The proposed Federal action is the issuance, under the provisions of 10 CFR Part 52, of an ESP for the North Anna ESP site for additional nuclear power facilities with characteristics that fall within the PPE. In addition, the application proposes a plan for redressing the environmental effects of certain site preparation and preliminary construction activities (*i.e.*, those activities allowed by 10 CFR 50.10(e)(1)) performed by an ESP holder under 10 CFR 52.25. In accordance with the plan, the site would be redressed if the NRC issues the requested ESP (containing the site redress plan), the ESP holder performs these site preparation and preliminary construction activities, the ESP is not referenced in an application for a construction permit or combined license, and no alternative use is found for the site. While the applicant is not currently proposing construction and operation of new units, this EIS analyzes the environmental impacts that could result from the construction and operation of two new nuclear units at the North Anna ESP site, or at three alternative sites. These impacts are analyzed to determine whether the proposed ESP site is suitable for the addition of new units and whether there is an alternative site that is obviously superior to the proposed site.

The North Anna ESP site proposed by Dominion is located in Louisa County in central Virginia, near the town of Mineral. It is completely within the confines of the current NAPS site, which is located on a peninsula on the southern shore of Lake Anna approximately 8 km (5 mi) upstream of the North Anna Dam. Lake Anna is approximately 27 km (17 mi) long with 435 km (272 mi) of shoreline. The lake was created in 1971 by the construction of a dam on the main stem of the North Anna River. Virginia Electric and Power Company, a subsidiary of Dominion Resources, Inc., owns the land above and below the lake surface and around the lake up to the expected high-water mark.

No specific plant design has been selected by Dominion for the ESP site; instead, a set of bounding plant parameters has been specified to envelope future site development. This plant parameter envelope (PPE) is based on the addition of power generation from two distinct units, to be designated as North Anna Units 3 and 4. Each unit represents a portion of the total generation capacity to be added and would consist of one or more reactors or reactor modules. These multiple reactors or modules (the number of which may vary depending on the reactor type selected) would be grouped into distinct operating units. The total nuclear generating capacity to be added would not exceed 4300 MW(t) per unit. This draft EIS documents the staff's evaluation of the proposed ESP site for construction and operation of North Anna Units 3 and 4. Cooling water for Unit 3, the first of the proposed new units, would be provided by Lake Anna. Unit 4 would use dry cooling towers.

1.3 The Purpose and Need for the Proposed Action

The purpose and need for the proposed action (ESP issuance) is to provide stability in the licensing process by addressing safety and environmental issues before the plants are built, rather than after construction is completed. The ESP process allows for early resolution of many safety and environmental issues that may be identified for the ESP site. In the absence of an ESP, safety and environmental reviews of applications for operating licenses under 10 CFR Part 50 continue during plant construction. Alternatively, all safety and environmental issues would have to be addressed at the time of the staff's review of a combined license submitted under 10 CFR Part 52 if no ESP for the site were referenced. Although actual construction and operation of the facility would not take place until a COL is granted, certain lead-time activities, such as ordering and procuring certain components and materials necessary to construct the plant, may begin before the COL is granted. As a result, without the ESP review process, there could be a considerable expenditure of funds, commitment of resources, and passage of time before site safety and environmental issues are finally resolved.

1.4 Alternatives to the Proposed Action

Section 102(2)(C)(iii) of NEPA states that EISs will include a detailed statement on alternatives to the proposed action. The NRC regulations for implementing Section 102(2) of NEPA provide for inclusion of a chapter in an EIS that discusses the environmental impacts of the proposed action and the alternatives (10 CFR Part 51, Subpart A, Appendix A). Chapter 8 of this draft EIS discusses the environmental impacts of three categories of alternatives: (1) alternative sites, (2) system design alternatives, and (3) the no-action alternative. The Commission determined that evaluation of energy alternatives is not required for an ESP.

The three alternative sites that are considered in detail in this draft EIS include lands within Dominion's Surry Power Station in Virginia, the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant in Ohio, and the U.S. Department of Energy Savannah River Site in South Carolina. Chapter 8 also includes sections discussing (1) Dominion's region of interest for identification of alternative plant sites, (2) the methodology used by Dominion to select the proposed ESP site and alternative sites, and (3) generic issues that are consistent among the alternative sites. Chapter 9 compares the environmental impacts at the North Anna ESP site to the alternative sites and to the no-action alternative, and qualitatively determines whether an obviously superior alternative site to the proposed site exists.

1.5 Compliance and Consultations

Prior to construction and operation of a new reactor or reactors, Dominion is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, Dominion provided a list of environmental approvals and consultations associated with the North Anna ESP. Because an ESP is limited to establishing the acceptability of the proposed site for future development, the authorizations Dominion will need from Federal, State, and local authorities for construction and operation are, with the exception of the Coastal Zone Management Act (CZMA) certification, not yet necessary; therefore, they have not been obtained. Dominion plans to submit its request for CZMA certification after the issuance of this draft EIS (Dominion 2004c). Dominion will need to obtain the necessary authorizations in order to conduct the site preparation and preliminary construction activities allowed by 10 CFR 50.10(e)(1). Authorizations and consultations potentially relevant to the proposed ESP are included in Appendix H. The information provided is based on guidance from NUREG-1555.

The staff reviewed the list and contacted the appropriate Federal, State, and local agencies to identify any compliance, permit, or significant environmental issues of concern to the reviewing agencies that may impact the suitability of the North Anna ESP site for the construction and operation of the reactors that fall within the PPE.

1.6 Report Contents

The subsequent chapters of this draft EIS are organized as follows. Chapter 2 describes the proposed site and discusses the environment that would be affected by the addition of new reactor units. Chapter 3 examines the power plant characteristics to be used as the basis for evaluation of the environmental impacts. Chapters 4 and 5 examine site suitability by analyzing the environmental impacts of construction (Chapter 4) and operation (Chapter 5) of the proposed new units. Chapter 6 analyzes the environmental impacts of the fuel cycle, transportation of radioactive materials, and decommissioning, while Chapter 7 discusses the cumulative impacts of the proposed action as defined in 40 CFR Part 1508. Chapter 8 explains how the alternative sites were selected, and analyzes the alternative sites and systems. Chapter 9 compares the proposed action with the alternatives, Chapter 10 summarizes the findings of the preceding chapters, and presents the staff's preliminary recommendation with respect to (1) the Commission's approval of the proposed site for an ESP based on the staff's evaluation of environmental impacts and (2) the site redress plan.

The appendices to the EIS provide the following additional information.

- Appendix A – Contributors to the Environmental Impact Statement
- Appendix B – Organizations Contacted
- Appendix C – Chronology of NRC Staff Environmental Review Correspondence Related to Dominion Nuclear North Anna, LLC's Application for Early Site Permit at North Anna Nuclear Plant Site
- Appendix D – Scoping Comments and Responses
- Appendix E – Draft Environmental Impact Statement Comments and Responses
- Appendix F – Key Correspondence
- Appendix G – Data and Information to Support Specific Analyses
- Appendix H – Authorizations and Consultations
- Appendix I – Plant Parameter Envelope Values

1.7 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy,* Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy,* Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 1508, "Terminology and Index."

Dominion Nuclear North Anna, LLC (Dominion). 2004a. *North Anna Early Site Permit Application – Part 3 – Environmental Report.* Revision 3, Richmond, Virginia.

Dominion Nuclear North Anna, LLC (Dominion). 2004b. *North Anna Early Site Permit Application – Part 4 – Programs and Plans.* Revision 3, Richmond, Virginia.

Dominion Nuclear North Anna, LLC (Dominion). 2004c. Response to Virginia Department of Environmental Quality Comment Letter. June 28, 2004.

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

U.S. Nuclear Regulatory Commission (NRC). 1987. *Standard Review Plans for the Review of Safety Analysis Reports for Nuclear Power Plants.* NUREG-0800, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants.* NUREG-1555, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2003. Response to comments on Draft RS-002 *Processing Applications for Early Site Permits* (ML031710698).

U.S. Nuclear Regulatory Commission (NRC). 2004. *Processing Applications for Early Site Permits.* RS-002, Washington, D.C.

2.0 Affected Environment

The site proposed by Dominion Nuclear North Anna, LLC (Dominion) for an early site permit (ESP) is located in Louisa County, Virginia, within the existing boundaries of the currently operating North Anna Power Station (NAPS) (Dominion 2004a). Virginia Electric and Power Company (referred to as Virginia Power or VEPCo) and Dominion are wholly owned subsidiaries of Dominion Resources, Inc. The site is on the shore of Lake Anna approximately 64 km (40 mi) north-northwest of Richmond. Two operating nuclear generating units, Units 1 and 2, are currently located on the NAPS site, and a small hydroelectric power plant is located at the base of the North Anna Dam. The station location is described in Section 2.1, followed by a description of associated land, meteorology and air quality, geology, radiological environment, hydrology, ecology, socioeconomics, historic and cultural resources, and environmental justice in Sections 2.2 through 2.10, respectively. Section 2.11 examines related Federal projects, and references are presented in Section 2.12.

2.1 Site Location

Dominion's proposed ESP location is wholly within the NAPS site and is west of and adjacent to the existing facilities of NAPS Units 1 and 2 (see Figure 2-1). The NAPS site is located in rural Louisa County, which had a population of about 25,000 in 2000. The plant is located within a triangle formed by the cities of Richmond, Charlottesville, and Fredericksburg. Figure 2-2 shows the location of NAPS in relation to the counties and important cities and towns within an 80-km (50-mi) radius. Interstate 95 passes within 26 km (16 mi) of the NAPS site, and Interstate 64 passes within 29 km (18 mi). The nearest incorporated community is the town of Mineral, which is approximately 10 km (6 mi) southwest of NAPS. Louisa, the county seat, is 19 km (12 mi) west of the site. NAPS is situated on a peninsula on the southern shore of Lake Anna, approximately 8 km (5 mi) upstream from North Anna Dam. The normal surface elevation of Lake Anna is about 76 m (250 ft) above mean sea level (MSL). NAPS occupies approximately 422 ha (1043 ac) of land. In addition, the waste heat treatment lagoons cover approximately 1400 ha (3400 ac), as shown in Figure 2-3. All site land, subsurface lands, and mineral rights are owned by Virginia Power, a subsidiary of Dominion Resources, Inc. No public or commercial highways, railroads, or waterways traverse the site. Virginia Power also owns and operates the North Anna Hydroelectric Project, an 855-kW-capacity hydroelectric power plant at the base of North Anna Dam.

Lake Anna, which was created as a source of cooling water for NAPS, has become a popular recreation area, and the dam provides downstream flood control. The lake is not used as a source of potable or industrial water, except for the NAPS Units 1 and 2. Virginia Power owns the land below the surface and around the lake up to the 78-m (255-ft) high-water mark above MSL. Since its completion, recreational, residential, and retirement development has grown significantly around Lake Anna.

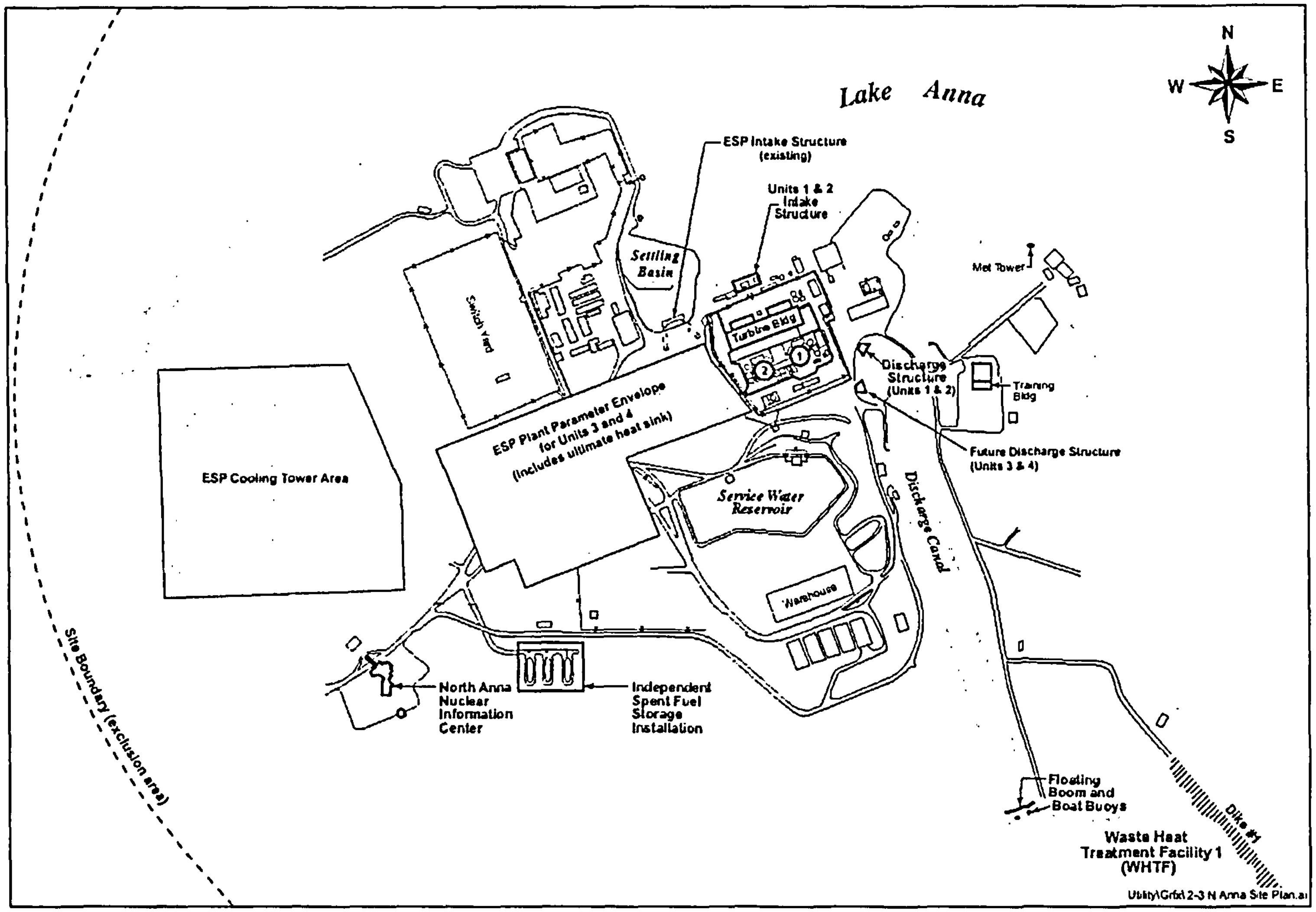
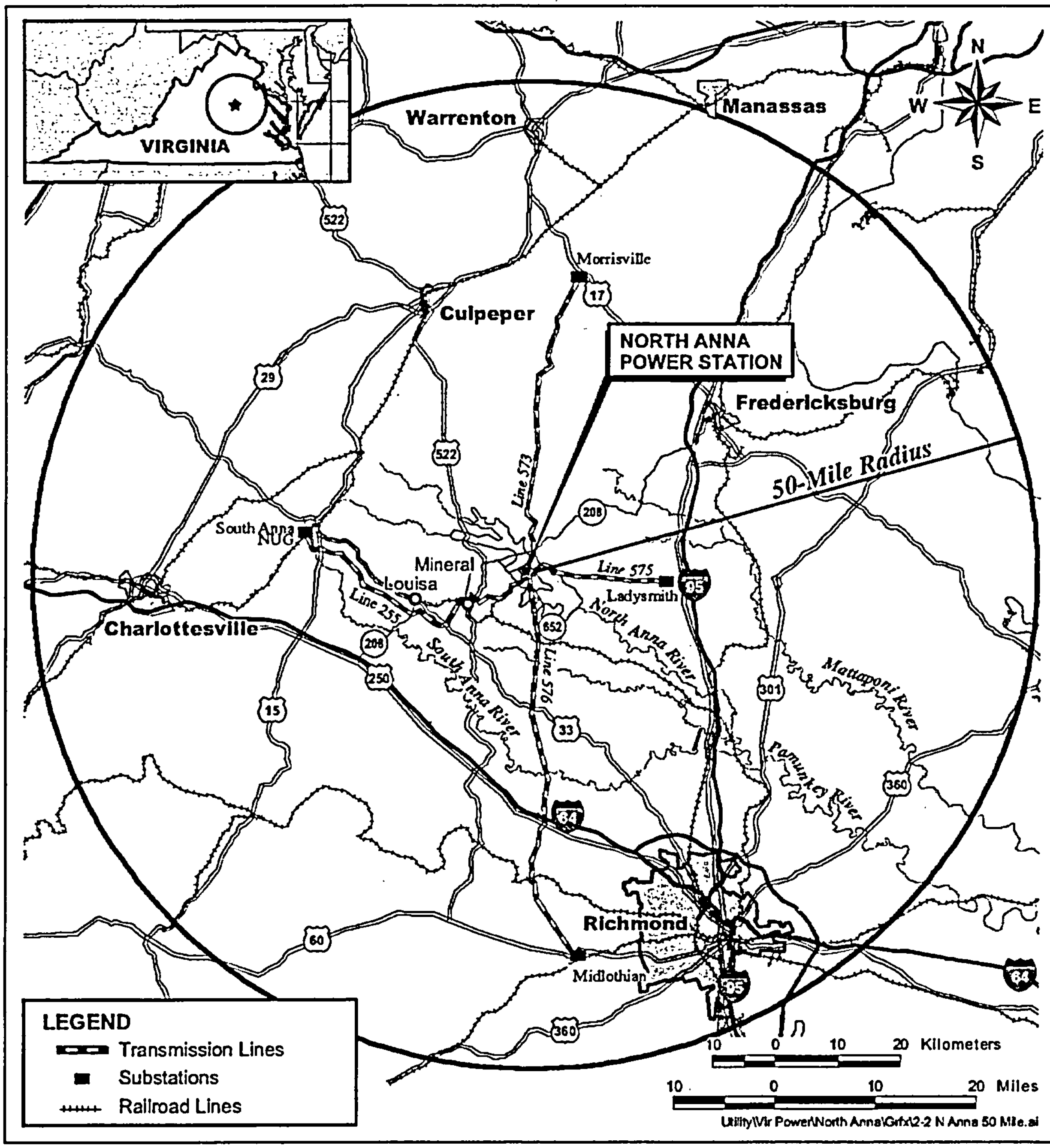
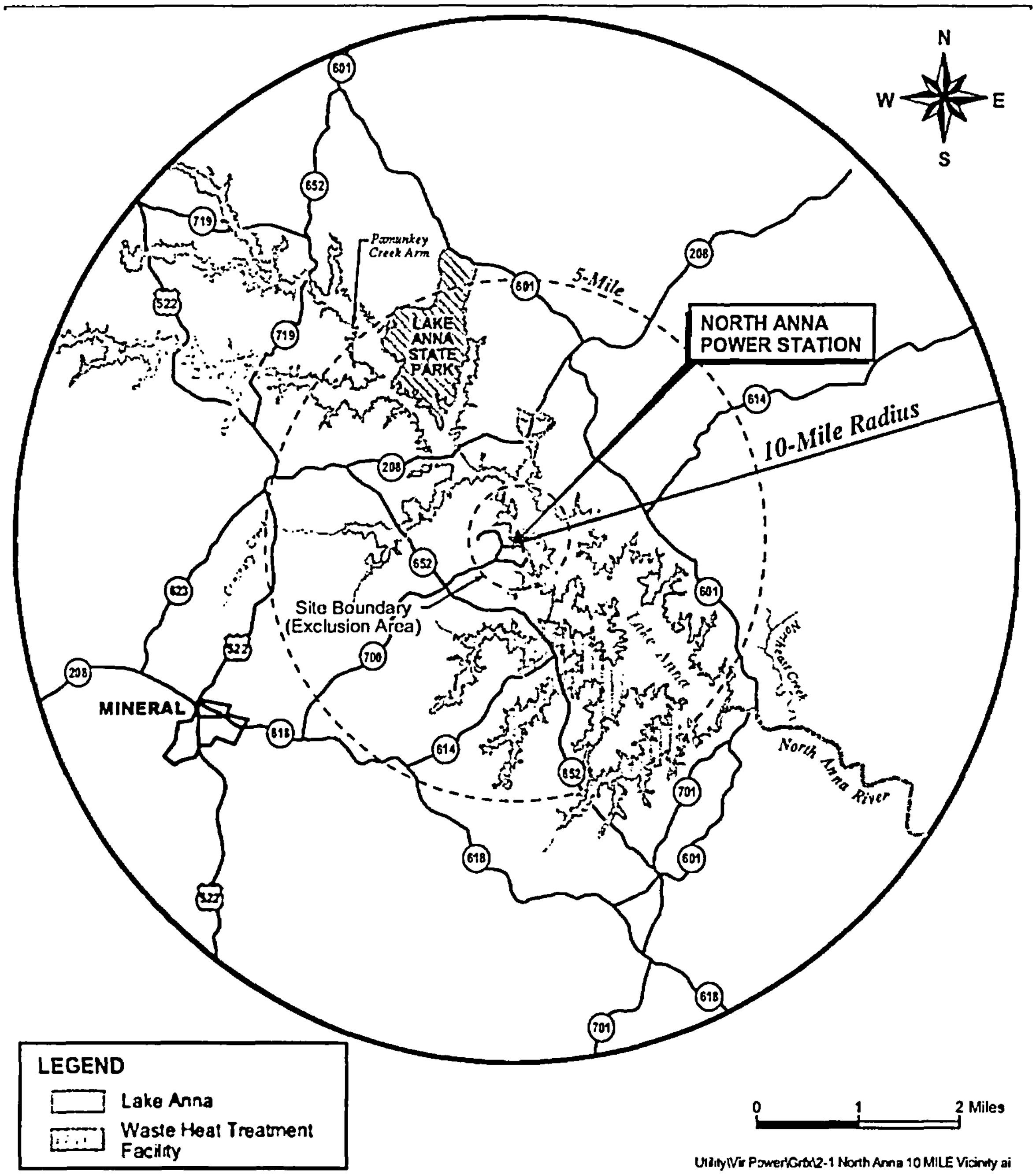


Figure 2-1. North Anna ESP Site Boundaries within the Existing NAPS Site



1 **Figure 2-2.** Location of North Anna Power Station, 80-km (50-mi) Region



1 **Figure 2-3.** North Anna Power Station Vicinity Map, 16-km (10-mi) Region

A final Lake Anna Special Area Plan was developed by local jurisdictions to coordinate planning efforts by Louisa, Orange, and Spotsylvania Counties for the Lake Anna region and watershed. The plan was released in March 2000 (Lake Anna Special Area Plan Committee 2000).

2.2 Land

This section discusses land-related issues for the North Anna ESP site. Section 2.2.1 describes the site and the vicinity around the site. Section 2.2.2 discusses the existing electric power transmission line rights-of-way and offsite areas. Section 2.2.3 discusses the region, defined as the area within 80 km (50 mi) of the NAPS boundary.

2.2.1 The Site and Vicinity

The plant site proposed by Dominion in its ESP application is located in Louisa County in north-eastern Virginia. The proposed site is wholly within the existing boundaries of the NAPS site. The proposed Units 3 and 4 would be sited adjacent to Dominion's existing Units 1 and 2.

The NAPS site is situated on a peninsula of Lake Anna's southern shore at the end of State Route (SR) 700. Lake Anna, an artificial reservoir, was created in 1971 by Virginia Power by erecting a dam on the main stem of the North Anna River. The reservoir was filled by December 1972. Downstream of the dam, the North Anna River flows southeasterly, joining the South Anna River to form the Pamunkey River about 43 km (27 mi) southeast of the site. The earthen dam that creates Lake Anna is about 8 km (5 mi) southeast of NAPS.

Lake Anna is divided into two distinct bodies of water, the reservoir and the Waste Heat Treatment Facility (WHTF), which is composed of three waste heat treatment lagoons (Figure 2-4). The lagoons have a total surface area of approximately 1400 ha (3400 ac) and are separated from the rest of Lake Anna by a series of dikes. The main body of the lake is approximately 27 km (17 mi) long with 435 km (272 mi) of irregular shoreline and approximately 3900 ha (9600 ac) of water surface. The land adjacent to Lake Anna is becoming increasingly residential as the area is developed. No new transportation routes (roads or railroad lines) or new industrial activities are currently planned in the vicinity of NAPS.

Virginia Power and Old Dominion Electric Cooperative own, and Virginia Power controls, all of the land within the NAPS boundary, both above and beneath the water surface, including those portions of Lake Anna and the waste heat treatment lagoons that lie within the site boundary. The NAPS property comprises 729 ha (1803 ac), about 307 ha (760 ac) of which are covered by water. Virginia Power and Old Dominion Electric Cooperative also own all the land outside the NAPS boundary that forms Lake Anna, up to the expected high-water mark (i.e., elevation 78 m [255 ft] above MSL). The NAPS site and all supporting facilities, including Lake Anna and the waste heat treatment lagoons, the earthen dam that forms Lake Anna, dikes, railroad spur,

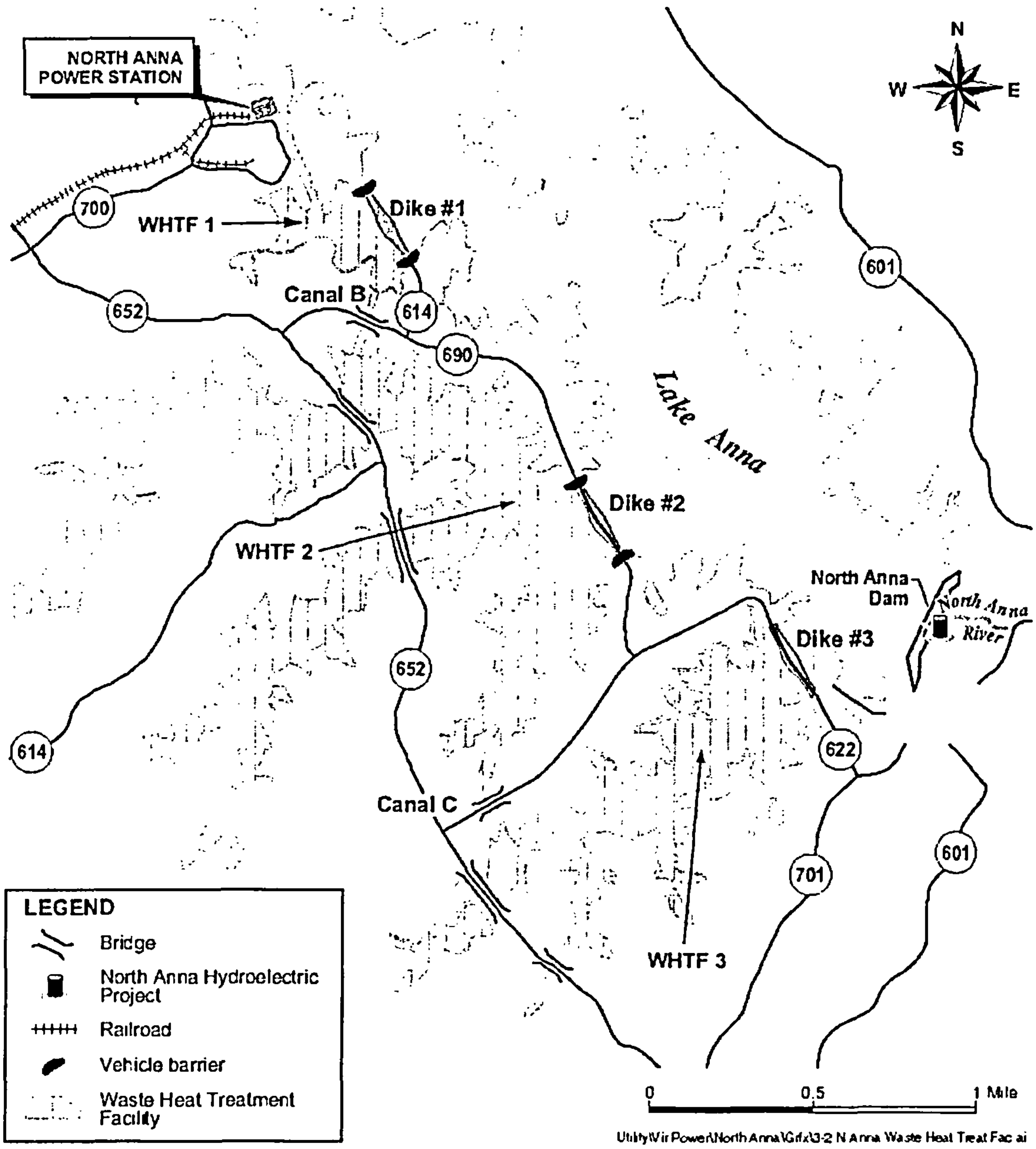


Figure 2-4. Lake Anna and the North Anna Power Station Waste Heat Treatment Facility

and roads constitute approximately 7544 ha (18,643 ac). Virginia Power also owns and operates the North Anna Hydroelectric Project, an 855-kW(e)-capacity hydroelectric power plant at the base of the dam that forms Lake Anna.

The primary land cover on the NAPS site is pine and pine-hardwood mixed forest (70 percent). Approximately 20 percent of the site is used for nuclear power station facilities and activities including electricity generation, maintenance and distribution facilities, warehouses, training and administration buildings, lagoons and settling basin, parking lots, roads, a railroad line, information center, and the independent spent fuel storage installation (ISFSI). About 10 percent of the site is cleared area that includes the landscaped ground, open areas, laydown areas, three historic cemeteries, a weapons range used for security training, and a recreation and picnic area used by employees of Dominion Resources, Inc., and its subsidiaries.

Geographically, NAPS is located within the central Piedmont Plateau Physiographic Province. The topography of the site is characterized as a gently undulating surface that varies from 60 m (200 ft) to 152 m (500 ft) above MSL. The Blue Ridge Mountains lie approximately 73 km (45 mi) northwest of the site.

Louisa County has two incorporated towns, Louisa and Mineral. Louisa is the county seat and has a population of approximately 1400. Mineral has a population of approximately 425 and is the largest community within 16 km (10 mi) of NAPS. The county is largely rural with a population density of about 43 people/mi^2. About 10 percent of the county is developed as urban, residential, or industrial; 71 percent is natural and planted forest lands; 16 percent is crop, pasture, and open land; and 3 percent is covered by water (Louisa County 2003).

Each Virginia county is required to have a comprehensive plan for the physical development of the territory within its jurisdiction by Section §15.2-2223 of the Code of Virginia. The comprehensive plan for Louisa County was issued in September 2001 (Louisa County 2001); the Spotsylvania County Plan was issued in February 2002 (Spotsylvania County 2002); and the Orange County comprehensive plan was issued September 1999 (Orange County 1999). The Lake Anna Special Area Plan was issued in March 2000 (Lake Anna Special Area Plan Committee 2000).

Louisa County's comprehensive plan identifies two existing mining activities in the county (Louisa County 2001). Virginia Vermiculite Ltd. operates a vermiculite facility at the western end of the county (between the town of Louisa and the community of Boswells Tavern). A granite mining activity exists west of U.S. Highway 522 at the north end of the county. Various other mining activities have been proposed (Louisa County 2001).

Section 307(c)(3)(A) of the Coastal Zone Management Act (16 USC 1456(c)(3)(A)) requires applicants for Federal permits to conduct an activity in a coastal zone area to provide to the permitting agency a certification that the proposed activity complies with the enforceable policies of the state's coastal zone program. The Virginia Department of Environmental Quality (VDEQ) oversees this program for the Chesapeake Bay Coastal Zone Management Area. NAPS is not within Virginia's coastal zone for purposes of the Coastal Zone Management Act (VDEQ 2004a). However, Spotsylvania County and the associated portion of Lake Anna within Spotsylvania County are included within the Virginia coastal zone (VDEQ 2004a). Therefore, Dominion is required to provide a Coastal Zone Management Act certification to the Commonwealth of Virginia (VDEQ 2004b).

Dominion submitted a certification to the VDEQ in November 2003 stating that issuance of an ESP for the NAPS site would be consistent with Virginia's Federally approved coastal zone management program and requested the Department's concurrence with this determination. VDEQ requested that Dominion withdraw the certification and resubmit it after the draft U.S. Nuclear Regulatory Commission (NRC) environmental impact statement (EIS) is issued so that the State can more fully evaluate the certification with the benefit of the NRC staff's impact assessment. Accordingly, on January 12, 2004, Dominion withdrew its certification request and is expected to resubmit the certification around the time the draft EIS is issued by NRC.

2.2.2 Transmission Line Rights-of-Way and Offsite Areas

One 230-kV transmission line and three 500-kV transmission lines leave the NAPS site switch-yard. Each transmission line occupies a separate right-of-way, which ranges in width from 37 to 84 m (120 to 275 ft) and 24 to 66 km (15 to 41 mi) in length, covering a total of approximately 1174 ha (2900 ac) (Dominion 2004a). The transmission line rights-of-way extend from NAPS to the north, south, east and west, terminating in Morrisville, Midlothian, Ladysmith, and at the South Anna non-utility generator, respectively, as shown in Figure 2-2.

The NAPS transmission line rights-of-way were constructed between 1973 and 1984, and pass through typical north-central Virginia land, such as row crops, pastures, forests and old fields, hardwood forests, and shrub bogs. No areas designated by the U.S. Fish and Wildlife Service (FWS) or VDEQ as "critical habitat" for endangered species exist at the ESP site or in any of the associated transmission line rights-of-way. The rights-of-way do not cross any State or Federal parks, wildlife refuges, or wildlife management areas.

Virginia Power maintains rights-of-way in timberlands and in the vicinity of road crossings on a 3-year mowing cycle. In areas inaccessible to mowers, non-restricted herbicides are used. In areas of dense vegetation or wetlands, maintenance by hand treatments may be used.

Areas of rare or sensitive plant species are identified and avoided, or modified treatment practices are used to avoid adverse impacts. Vegetation treatments have been developed in cooperation with the Virginia Department of Conservation and Recreation (VDCR) Natural Heritage Program.

Initial evaluation by Dominion shows that any two of the 500-kV transmission lines together with the 230-kV line would have sufficient capacity to carry the total output of the proposed power capacity of the new units in addition to the existing units. If Dominion were to decide to proceed with development of the proposed ESP units, a system study (load flow) modeling these lines, including the additional power from the proposed new units, would be performed.

2.2.3 The Region

Regionally, NAPS is approximately 64 km (40 mi) north-northwest of Richmond, Virginia; 58 km (36 mi) east of Charlottesville, Virginia; 35 km (22 mi) southwest of Fredericksburg, Virginia; and 112 km (70 mi) southwest of Washington, D.C. Interstate Highways 95 and 64 pass within 26 km (16 mi) to the east and 29 km (18 mi) to the south of the site, respectively. U.S. Route 1 is 24 km (15 mi) east of the site.

The region, defined as up to 80 km (50 mi) beyond the NAPS boundary, includes all or portions of the following counties in Virginia: Amelia, Albemarle, Buckingham, Caroline, Chesterfield, Culpeper, Cumberland, Essex, Fauquier, Fluvanna, Goochland, Greene, Hanover, Henrico, King and Queen, King George, King William, Louisa, Madison, New Kent, Orange, Page, Powhatan, Prince William, Rappahannock, Richmond, Rockingham, Spotsylvania, Stafford, and Westmoreland. The region also includes a portion of Charles County in Maryland. Major waterways, highways, roads, railroads, and other transportation routes in the region are shown in Figures 2-2 and 2-3.

Land use within the region varies with distance from major population centers and high-use transportation corridors. The metropolitan areas of Richmond, Fredericksburg, and Charlottesville, and the transportation corridors associated with I-95 and I-64 contain the highest density of residential, commercial, and industrial land-use. Land use in the immediate vicinity of NAPS and the areas outside the noted metropolitan areas and transportation corridors is primarily forest and agriculture. The region, comprising about 20 percent of the total area of Virginia, encompasses four main land-use classes: to the north are mainly urban areas surrounding Washington, D.C., and cropland; to the east is primarily cropland; to the south is a mixture of cropland and pasture; and to the west is a mixture of forests and pasture.

Land uses for the three counties that border on Lake Anna – Louisa, Orange, Spotsylvania and nearby Henrico county – are provided in Table 2-1.

Table 2-1. Land Use in Henrico, Louisa, Orange, and Spotsylvania Counties[(a)]

County and Land Use	Hectares	Acres	Percent of Total
Henrico			
Residential	14,865	36,732	23.5
Commercial	2094	5175	3.3
Industrial	1451	3586	2.3
Undeveloped[(b)]	27,744	68,554	43.9
Water	1757	4341	2.8
Other[(c))]	15,303	37,812	24.2
Total Henrico	63,214	156,200	100.0
Louisa			
Residential	7322	17,655	5.0
Agriculture	31,979	79,019	23.5
Forest	92,474	228,500	68.0
Water	3994	9868	3.0
Other[(d)]	649	1604	0.5
Total Louisa	136,418	336,646	100.0[(e)]
Orange			
Developed land[(f)]	4597	11,360	5.0
Agriculture	34,021	84,064	37.0
Forest	53,330	131,776	58.0
Water	N/A	N/A	
Total Orange	91,948	227,200	100.0[(e)]
Spotsylvania			
Residential	22,793	56,320	22.0
Developed land[(g)]	3108	7680	3.0
Agriculture	18,649	46,080	18.0
Forest	53,874	133,120	52.0
Other	5180	12,800	5.0
Total Spotsylvania	103,604	256,000	100.0

(a) The City of Richmond is heavily developed. For this reason, the land use of this jurisdiction is not discussed.
(b) Includes land being used for agricultural purposes.
(c)) Includes public and semi-public (churches, schools, parks, etc.) and miscellaneous land classifications (rights-of-way, utilities, transportation and communications facilities).
(d) Includes commercial and industrial lands.
(e) Numbers have been adjusted to achieve a total of 100 percent.
(f) Developed land is defined to include residential, commercial, industrial, and public use.
(g) Developed land is defined to include industrial and commercial.
N/A not available
Source: NRC 2002.

Two major airports operate within the region: Richmond International Airport and Charlottesville-Albemarle County Airport, approximately 72 km (45 mi) southeast and 64 km (40 mi) west of NAPS, respectively. Three smaller airports are located within 24 km (15 mi) of NAPS: Lake Anna Airport, Louisa County Airport, and Cub Field. The airports are located 11 km (7 mi) south-southwest, 18 km (11 mi) west-southwest, and 16 km (10 mi) southwest of the site, respectively.

2.3 Meteorology and Air Quality

Section 2.3 describes the general climate of the proposed ESP site and the regional meteorological conditions that were used as the basis for evaluating design and operational conditions for the prospective new units at the NAPS site, and to evaluate construction and operational impacts. General climate information was obtained from data published through the National Climatic Center in Asheville, North Carolina. Information for onsite meteorological conditions was obtained from the meteorological stations that serve NAPS.

The onsite primary meteorological tower is located about 530 m (1750 ft) east-northeast from the NAPS Unit 1 containment building (Dominion 2004a). The wind speed, wind direction, ambient and dew point temperatures, and atmospheric stability data are collected from sensors located on the tower. These data are considered representative of the ESP site.

2.3.1 Climate

The site is located in the Piedmont region of Virginia. The climate in this region is considered continental. Summers are generally warm and humid, while winters are generally mild. Temperatures in the region rarely exceed 37.8°C (100°F) or fall below -18°C (0°F). The Blue Ridge Mountains located west of NAPS act as a partial barrier to episodes of cold, continental air in the winter. These mountains also tend to channel regional wind flow along a general north-south orientation.

Data from Richmond Airport are considered representative of long-term climate conditions at the site (NOAA 2001). Based on data presented in the ER (Dominion 2004a), Richmond receives an annual average rainfall of 109.6 cm (43.16 in.). Normal monthly rainfall is equally distributed throughout the year with maximum amounts of 12.8 cm (5.03 in.) and 11.2 cm (4.40 in.) occurring in July and August, respectively, and the minimum of 7.5 cm (2.96 in.) during April. The maximum monthly rainfall amounting to 47.9 cm (18.87 in.) occurred in July 1945, and the minimum amounting to 0.03 cm (0.01 in.) occurred in October 2000.

Richmond averages about 41.4 cm (16.3 in.) of snowfall annually with the majority occurring in January and February. The maximum monthly snowfall was 71.9 cm (28.3 in.), which occurred in January 1940. The maximum snow depth recorded from a single event was 51 cm (20 in.) in February 1922.

The annual average temperature for the Richmond airport is 14.3°C (57.7°F). July has the highest annual average monthly temperature of 25.6°C (78.0°F). The highest recorded temperature is 40.6°C (105.0°F), which occurred in July 1977, while the lowest recorded temperature is -24.4°C (-12°F), which occurred in January 1940 (NOAA 2001).

2.3.1.1 Wind

Based on data collected from the onsite meteorological station starting as early as 1974, the prevailing winds are from the south-southwest at both the 10- and 48.4-m levels (Dominion 2004a). On a seasonal basis, the prevailing winds are from the south-southwest at both levels in the summer. During the winter, the prevailing winds are from the northwest for the lowest level, and north for the upper level. For the spring and fall, the prevailing winds at the two observation levels vary, with the lower-level winds from the north or northwest, while the upper-level winds are from the south-southwest. This information is consistent with local topography and regional climatic activities.

The mean annual wind speeds at the North Anna ESP site are 2.8 m/s (6.3 mph) and 3.8 m/s (8.6 mph) at the lower- and upper-tower levels, respectively (Dominion 2004a). The mean wind speed varies seasonally. For both levels, the highest wind speeds occur during the spring while the lowest occur during the summer. The annual frequency of calm wind speed conditions are 0.4 and 0.8 percent for the lower- and upper-tower levels, respectively (Dominion 2004a).

Wind persistence is defined as a continuous flow from a given direction or range of directions. This is determined by grouping continuous hourly wind direction readings into one of 16 22.5-degree cardinal range directions, such as north through north-northwest. The longest wind persistence event at the lowest level is 26 hours from the north. However, events of 25 and 24 hours have occurred from the northwest and the north-northwest (Dominion 2004a). For the upper level, the longest wind persistence occurrence was 33 hours from the west-northwest. At this level, three 30-hour wind persistence events have occurred from the north-northwest, north, and south-southwest directions (Dominion 2004a).

2.3.1.2 Atmospheric Stability

Atmospheric stability can be determined by the magnitude of change in the ambient temperature between vertical levels of the atmosphere, known as the delta-T method as defined by NRC. These two measurement levels correspond to the two levels of the onsite meteorological station at NAPS.

On an annual basis, the highest frequency of stability class occurrence is neutral (30.7 percent) followed by slightly unstable (26.1 percent). The mean wind speeds with these two stability classes are 3.1 m/s (7.0 mph) and 2.3 m/s (5.2 mph), respectively. Extremely unstable conditions occur 20 percent of the time with a mean wind speed of 3.2 m/s (7.2 mph), while extremely stable conditions occur only 5.46 percent of the time with a mean wind speed of 1.3 m/s (3.0 mph).

2.3.1.3 Temperature

Temperature measured at the lower level of the onsite meteorological station is considered representative of onsite conditions. The average temperature at this level is 13.2°C (55.8°F), while the normal temperature at the Richmond Airport is 14.3°C (57.7°F) (Dominion 2003a). A difference of several degrees is expected because the site is located in a rural area and onsite temperatures are moderated due to the presence of Lake Anna, while the Richmond Airport is located near a large city impacted by an urban heat-island effect. For comparison, annual average temperatures for the nearby towns of Louisa and Partlow in the vicinity of the NAPS site are 13.4°C (56.1°F) and 12.9°C (55.2°F), respectively.

2.3.1.4 Atmospheric Moisture

The moisture content of the atmosphere can be represented in a variety of ways. The most recognized is relative humidity. However, that parameter is not measured at the NAPS site, therefore data from Richmond is considered to be representative of the site. The normal annual relative humidity for Richmond is 70 percent, with the higher values expected to occur in the morning hours and lower values in the afternoon and evening (Dominion 2004a). Another measured parameter is wet-bulb temperature, which is used for cooling-system modeling studies. Based on a data record of 24 years (1973 to 1996), the 0.4 percent, 1 percent, and 2 percent wet-bulb temperatures measured in Richmond are 26.1°C (79°F), 25.6°C (78°F), and 25.0°C (77°F), respectively.

Fog is another relative indication of atmospheric moisture. Data collected at Richmond, based on 73 years of data, indicate heavy fog will occur on an average of 27.1 days per year (Dominion 2004a). Given the topography of the site compared to that of Richmond and locations near Lake Anna, a higher occurrence of heavy fog at the NAPS site is expected.

2.3.1.5 Severe Weather

The site can experience severe weather in the form of thunderstorms, hail, tornadoes, snow and ice, and hurricanes. Other significant weather events also are associated with several of these events, such as hail and lighting occurring with thunderstorms, and high winds associated with tornadoes. The probability of occurrence of impact from a tropical storm at the site is far greater than a hurricane given the fact that hurricanes lose intensity and degrade into tropical storms soon after they make landfall.

The most representative long-term climatic data for thunderstorm occurrence at the site is data from the Richmond Airport (NOAA 2001). On average, 36 thunderstorms are expected per year. The maximum number (8 or more) is expected to occur in July with the minimum number (much less than 1) occurring during the period from November through February. The site has an expected 100-year return period of 1-hour and 24-hour rainfall total of 8.9 cm (3.5 in.), and 20.3 cm (8.0 in.), respectively (NCDC 2003). For perspective, with the passage of tropical storm Gaston on August 30, 2004, the Richmond, Virginia area received up to 330 mm (13 in.) of rainfall (NCDC 2004).

The occurrence of hail is typically associated with more organized thunderstorms. Recent data from the National Climatic Data Center indicated that 18 hail events have been reported for Louisa County during the period from January 1, 1955, to July 31, 2003 (NCDC 2003). Each occurrence was in either the afternoon or the early evening. In four occurrences, hailstones with diameters of 4.4 cm (1.8 in.) were observed, and in one occurrence, 3.8-cm (1.5-in.) diameter hailstones were reported. The other events produced hailstones typically around 2.5 cm (1.0 in.) in diameter.

For the period of January 1950 through July 31, 2003, the site was not on the path of either a hurricane or tropical storm. This is not unexpected given the inland location of the site and the fact that hurricanes making landfall along the Atlantic coast lose intensity and degrade into tropical storms and then into a system of heavy rainfall before they fully dissipate. However, the site area has experienced the impacts of tropical storms that have passed in its vicinity. The one with the largest impact was Tropical Storm Floyd in September 1999. Rainfall at or exceeding 15 cm (6 in.) from this storm was recorded at two locations near the site. This storm produced a maximum 2-minute wind speed of 18 m/s (40 mph), which was recorded at the Richmond Airport.

The site area is also susceptible to the occurrence of tornadoes and associated high winds. During the period from January 1, 1950, to July 31, 2003, a total of seven tornado sightings were reported for Louisa County (NCDC 2003). The strongest winds were associated with the tornado that occurred on August 9, 1962. Rotational wind speeds were estimated to be between 51 m/sec (113 mph) and 70 m/sec (157 mph). The most recent tornado sighting in Louisa County was on February 17, 1998.

Based on a 30-year data set of tornado occurrences in the United States, on the average, only six tornadoes are expected to occur in Virginia annually (Ramsdell and Andrews 1986). The probability of a tornado striking the NAPS site is estimated to be about 5×10^{-5} per year (NRC 2002).

Louisa County has experienced 30 snow and ice events during the period from December 28, 1993, to July 31, 2003 (NCDC 2003). Of that total, two events are specifically listed as ice storms with the most devastating occurring on December 23, 1998. That storm resulted in $20 million in property damage in the county. The other events are listed as heavy snow, winter storm, and winter weather/mix. The latter two events could have included some degree of icing, but with a much smaller impact compared to those listed as ice storms.

2.3.1.6 Meteorological Monitoring

The meteorological monitoring for the proposed ESP site would consist of the current onsite monitoring program for NAPS provided that the structures that would be constructed are at distance no greater than 10 times its height. The primary meteorological monitoring system consists of a Rohn Model 80 guyed 48.8-m (160-ft) tower instrumented at the 10-m (33-ft) and the 48.4-m (159-ft) levels. Wind speed, wind direction, horizontal wind fluctuation, and ambient temperature are measured at both levels. In addition, at the 10-m (33-ft) level, dew point temperature data is measured. Temperature difference is measured between the two levels with a separate temperature system, and precipitation data are collected at ground level. Data are collected on a digital data recording system that is located in an insulated building at the base of the tower. This system is interfaced with the intelligent remote multiplex system so it can be transmitted into the control room for NAPS and to the utilities operations center in Richmond for processing. The primary system is located approximately 530 m (1750 ft) east of the NAPS Unit 1 containment building.

A backup monitoring system is also operational at the NAPS site. The system consists of a Rohn Model 25 tower, a freestanding 10-m (33-ft) tower located 396 m (1300 ft) northeast of the NAPS Unit 1 containment building. At the top of the tower, wind speed, wind direction, and horizontal wind direction fluctuation data are collected. Data from this system are also collected on a digital data recording system in the insulated building at the base of the tower and transmitted into the control room for NAPS and to the utilities operations center in Richmond for processing.

Data recovery rates for the period from January 1, 1996, to December 31, 2001, for the primary monitoring system, including reliable atmospheric stability information, ranged from 99.30 percent for the upper-level wind data in 1996 to 90.9 percent for the same data set in 1997. For each year in the data set the recovery rate exceeded 90 percent for both levels. The frequency of wind speed, class wind direction, and stability class are available in the updated Final Safety Analysis report for NAPS Unit 1 and 2 (VEPCo 2002a).

The meteorological data for the period of January 1, 1996, to December 31, 1998, were used to generate atmospheric dispersion factors (χ/Q values) used to estimate radiological impacts in the areas surrounding the ESP site.

The NRC staff expects that the current monitoring systems would remain operational during the site preparation and construction phases as well as during the operational phase. Any anticipated modifications to the system would be limited to transmitting appropriate meteorological data to the additional control rooms.

The staff reviewed the available information relative to the onsite meteorological measurements program and the data collected by the program. The staff concludes that the system provides adequate data to represent onsite meteorological conditions as required by Title 10 of the Code of Federal Regulations (CFR) 100.20. The onsite data also provides an acceptable basis for making estimates of atmospheric dispersion for design-basis accidents and routine releases from the plant to meet the requirements of 10 CFR 50.34 and 10 CFR Part 50, Appendix I.

2.3.2 Air Quality

The county in which the ESP site is located, Louisa County, is within the Northeastern Virginia Intrastate Air Quality Control Region. This region is designated as in attainment or unclassified for all criteria pollutants for which National Ambient Air Quality Standards have been established (Dominion 2004a). Attainment areas are areas where the ambient air quality levels are better than designated by the Environmental Protection Agency (EPA).

The Commonwealth of Virginia is also subject to a revised 8-hour ozone standard and a new ambient air-quality standard for particulate matter with an aerodynamic diameter less than or equal to 2.5 nominal micrometers (designated as $PM_{2.5}$). The EPA has promulgated the new 8-hour ozone standard, and Louisa County is classified as in attainment (Dominion 2004a). However, the EPA has yet to promulgate the standard for $PM_{2.5}$.

Within the Commonwealth of Virginia, the EPA has designated two Class 1 areas where visibility is an important issue (40 CFR 81.433) – James River Face Wilderness and Shenandoah National Park. The boundary of the closer of these areas, Shenandoah National Park, is within 76 km (42 mi) of NAPS (NRC 2002).

VDEQ would regulate airborne emissions at the North Anna ESP site during construction activities and for routine non-radiological emissions during operation. Currently, the applicant holds an Exclusionary General Permit from VDEQ under Title 9 of the Virginia Administrative Code for all non-radiological airborne emissions resulting from current plant operations. Under this permit, no air emission or air quality monitoring is performed at the site. Compliance is based on estimated emissions using fuel sulfur content and fuel consumption records with a limit on the hours of operation for boilers and diesel generators. If Dominion anticipates that the facility will exceed the emission limits specified as part of the permit, then it would be required to apply for a permit application under Title V of Virginia's Administrative Code and maintain more stringent recordkeeping and reporting requirements.

Under the permit for the existing units, the site provides VDEQ with the necessary records and a compliance certification on an annual basis. Based on the 2000 emission statement filed by Dominion with VDEQ, estimated emissions were well below the limits established in the Exclusionary Permit. Any emissions from the operation of the proposed units are not expected to jeopardize compliance with requirements set forth under the current permit. However, additional records would have to be submitted along with a certification for all emission sources at the North Anna ESP site. The additional emissions are expected to be limited to a short test period.

2.4 Geology

A description of the geological, seismological, and geotechnical conditions at the proposed site is provided in Section 2.6 of the Environmental Report (ER) submitted by Dominion (Dominion 2004a). This description was based on earlier reports prepared for the two existing units at the site (VEPCo 2002; Dames and Moore 1969), the two units proposed but never constructed (Dames and Moore 1971), and the independent spent fuel storage installation (ISFSI) constructed for the two existing units (VEPCo 2002b). Additionally, results of subsurface investigations performed in 2002 as part of the ESP application provided further basis for this description. The staff's description of site and vicinity geological features and the detailed analyses and evaluation of geological, seismological, and geotechnical data as required for an assessment of the site-safety issues related to the specific proposed ESP site will be included in the staff's safety evaluation report.

The North Anna ESP site lies within the Piedmont Physiographic Province (Trapp and Horn 2000). The Piedmont Province is bounded on the west by the Blue Ridge Province and on the east by the Coastal Province. The boundary between the Coastal Province and the Piedmont Province is the Fall Line. The Fall Line is a low east-facing cliff paralleling the Atlantic coastline from New Jersey to the Carolinas. It separates hard Paleozoic metamorphic rocks of the Appalachian Piedmont to the west from the softer, gently dipping Mesozoic and Tertiary sedimentary rocks of the Coastal Plain. This erosional scarp, the site of many waterfalls, often represents an obstruction to upstream passage of migratory fish.

The ESP site is underlain by rocks of the Ta River Metamorphic Suite, which extend thousands of feet below the surface. The crystalline metamorphic rocks near the surface have undergone extensive weathering to create a layer of saprolite about 30 m (100 ft) thick beneath the site. Unconfined aquifer systems exist in the saprolite and in fractures within the crystalline bedrock. The water table around the ESP site is a slightly subdued version of the topography, which is characterized by a gently undulating surface varying in elevation from about 60 to 150 m (200 to 500 ft) above MSL.

Sulfide and gold deposits have been mined in the vicinity of the NAPS ESP site. Mining operations have resulted in significant degradation of Contrary Creek, which drains into Lake Anna. The low pH and high metal concentrations in Contrary Creek are quickly buffered and diluted as Contrary Creek enters Lake Anna. The applicant states that the ESP site has not been, nor would be expected in the future, to be affected by such mining activities.

The geotechnical properties of the saprolite beneath the site are unsuitable for use as a fill material for plant construction. Therefore, fill material will need to be imported to the ESP site during construction and excavated material will have to be removed to another location.

Given Dominion's proposed use of best management construction practices, the gently rolling terrain and geotechnical properties of the saprolite render landslides in the region of the site unlikely. This conclusion is supported by a study of historical hillslope failures including field reconnaissance, air-photo interpretation, a literature search for available information on landslides, review of existing literature, and discussions with researchers familiar with the site region (Dominion 2004b).

2.5 Radiological Environment

A radiological environmental monitoring program (REMP) has been conducted around the NAPS site since 1976 (NRC 1977). The REMP includes monitoring of the airborne exposure pathway, direct exposure pathway, water exposure pathway, aquatic exposure pathway from Lake Anna and the North Anna River, and ingestion exposure pathway in a 40-km (25-mi) radius of NAPS. The preoperational environmental radiation monitoring program sampled various media in the environment to establish a baseline to determine the magnitude and fluctuation of radioactivity in the environment once the units began operation (AEC 1973). The preoperational monitoring program included collection and analysis of samples of air particulates, precipitation, milk, crops, soil, well water, surface water, fish, and silt as well as measurement of ambient gamma radiation. After operation of NAPS Units 1 and 2 began, the monitoring program continued to assess the radiological impacts to workers, the public, and the environment. Modifications to the monitoring program are made based on changes in the area, such as milk production, agricultural uses, changes in lake use, etc. Radiological releases are summarized in the reports entitled *Radiological Environmental Operating Program* and *Annual Radioactive Effluent Release Report* (Dominion 2004a); reports are issued annually. The limits for all radiological releases for Units 1 and 2 are specified in the Offsite Dose Calculation Manual (ODCM) (Dominion 2003).

The NRC staff reviewed historical data on releases and estimated occupational and population doses. The data showed that doses to the maximally exposed individuals around NAPS were a small fraction of the limits specified in Federal environmental radiation standards, 10 CFR Part 20; 10 CFR Part 50, Appendix I; and 40 CFR Part 190.

2.6 Water

This section describes the hydrologic processes governing the movement and distribution of water in the existing environment at the ESP site. The most limiting scenarios of the existing environment with the current units in operation, was used throughout this analysis.

2.6.1 Hydrology

This section describes the site-specific and regional hydrological features of the existing environment that could be altered by the construction, operation, or decommissioning of the proposed Units 3 and 4. A description of the site's hydrological features was presented in Section 2.3.1 of the ER (Dominion 2004a). The hydrological features of the site related to site safety (e.g., probable maximum flood) are described by Dominion in the Site Safety Analysis Report (SSAR) portion (Part 2) of the application.

2.6.1.1 Surface Water Hydrology

The dominant hydrological feature of the NAPS site is Lake Anna. The site is located on Lake Anna's southern shore. Lake Anna was created by impounding the North Anna River behind the North Anna Dam. The pool formed behind Lake Anna Dam has a volume of 3.76×10^8 m^3 (3.05×10^5 acre-ft) at the normal pool level elevation of 76.2 m (250 ft) above MSL. An additional 3.02×10^8 m^3 (2.45 10^5 acre-ft) are available for flood control storage up to the crest of the dam at elevation 80.8 m (265 ft) above MSL. A spillway with three radial gates is capable of regulating large releases from the pool and two skimmer gates are able to regulate small releases. Generally, the gates are operated to maintain a steady pool elevation of 76.2 m (250 ft) above MSL. The staff independently determined the stage-storage relationship of Lake Anna using GIS methods and determined the values presented by Dominion within 2 percent (Dominion 2004a, b).

The lake is divided into two sections by a series of three dikes that separate the WHTF from the remainder of the lake. The WHTF receives the heated discharges from the existing units and, because of time of travel and exposure to the atmosphere, dissipates some of the excess heat to the atmosphere before the water is returned to the main body of the lake. The main body of the lake is 3900 ha (9600 acres), whereas the WHTF is 1400 ha (3400 acres).

The watershed above Lake Anna drains 888 km^3 (343 mi^2) of the eastern slopes of the southwestern mountains in the Appalachian Range. Water released from Lake Anna Dam continues to flow down the North Anna River until it joins the South Anna River, to form the Pamunkey River. Further downstream, the Pamunkey River joins the Mattaponi River to form the York River. The York River enters Chesapeake Bay approximately 24 km (15 mi) north of Hampton, Virginia. Virginia currently requires a minimum release of 1.1 m^3/s (40 cfs) from the North Anna Dam, except under drought conditions. During a drought when the lake surface falls below elevation 75.6 m (248 ft) MSL, a flow of 0.57 m^3/s (20 cfs) must be released (VDEQ 2001).

In an average year at the site, precipitation exceeds evaporation. Evaporation from the large surface area of Lake Anna reduces the total amount of water available to flow downstream of the dam. An approximation of the natural mean monthly and annual evaporation was obtained from van der Leeden et al. (1990) for an unnamed reservoir in nearby Richmond, Virginia [40 mi (64 km) SSE of the site] in which the climate would be similar. The Van der Leeden et al. report identified this reservoir as having an average evaporation rate of 99 cm (39 in.) per year with a maximum average monthly evaporation of 15 cm (5.9 in.) in July. In addition to this natural evaporation, Lake Anna experiences induced evaporation resulting from the heat added to the lake from the once-through heat dissipation systems for NAPS Units 1 and 2. These two components (presence of the lake plus waste reactor heat) combine to produce evaporation rates that likely exceed the historical pre-impoundment evapotranspiration rates that would have occurred in the area that the lake has inundated. Therefore, the presence of the lake and the discharge of heat to the lake from Units 1 and 2 have increased evaporation and reduced the total quantity of water available for release downstream of the dam. In drought years, the decrease in precipitation is often paired with an increase in evaporation, resulting in significant water deficits. It should be noted, however, that the dam provides a beneficial flow stabilization impact, and the historical pre-dam minimum flows were less than the current post-dam minimum discharges released from the dam, usually less than 0.14 m^3/s (5 cfs) during dry summer months.

Seasonal patterns of precipitation and evaporation also impact water availability. While monthly averages of precipitation are relatively constant, ranging from a maximum of 13.0 cm (5.14 in.) in July to a minimum of 7.4 cm (2.9 in.) in April, monthly averages of evaporation from Richmond, Virginia range from a maximum of 14 cm (5.6 in.) in July to a minimum of 3.3 cm (1.3 in.) in January. Over an annual cycle this seasonal variability tends to result in a water deficit during July, August, and September.

2.6.1.2 Groundwater Hydrology

The North Anna ESP site lies within the Piedmont Physiographic Province. Aquifers occur in both the shallow saprolite layer and the deeper fractured crystalline rocks. Recharge of the aquifers in this region is predominately from local infiltration. The water table is considered a subdued reflection of the ground surface; therefore, the groundwater generally flows from ridges to valleys.

The hydraulic connection between Lake Anna and nearby aquifers results in a rise of the water table for those aquifers in proximity of the lake. Given the relatively small fluctuations of lake water surface elevation, it is not expected that the water table in these aquifers would vary significantly. No aquifers in the Piedmont Province of Virginia have been designated as sole source aquifers by the EPA (2003).

2.6.1.3 Hydrological Monitoring

This section describes the pre-application hydrological monitoring programs. Thermal and chemical monitoring programs are discussed in Sections 2.6.3.3 and 2.6.3.4, respectively.

As a result of ongoing monitoring associated with the two existing units, Dominion was able to consider this existing monitoring program as part of the pre-application monitoring program for the ESP site. Many of these same monitoring activities would likely be continued, if the new units were built, and would become part of the operational monitoring for the new units (Dominion 2004a). Dominion collects the existing flow measurements directly associated with the current site operation that are required under the terms of the applicant's existing VPDES permit. Dominion also records lake level elevations at the dam and water elevations in 19 groundwater observation wells. Nine of the groundwater observation wells are maintained to detect seepage from the service water reservoir for NAPS Units 1 and 2; one was installed near the ISFSI, and nine pre-ESP-application wells were installed in 2002.

At various times in the past, the U.S. Geological Survey (USGS) has maintained four streamflow gauges in the vicinity of the plant. Two gauges measured streamflows of tributaries draining into Lake Anna and two measured streamflows downstream of the Lake Anna Dam. The longest streamflow record exists for the North Anna River gauge near Doswell, Virginia. This gauge reflects the release from Lake Anna and runoff from an additional 250 km^2 (97 mi^2) of watershed downstream of the Lake Anna Dam. This gauge was recorded from April 1929 through October 1988. A streamflow gauge immediately downstream from the Lake Anna Dam (North Anna River near Partlow, Virginia) was recorded from October 1978 to October 1995. The gauge on Contrary Creek, which drains into Lake Anna, reflects only 14 km^2 (5.53 mi^2) of the watershed and has a record from October 1975 to January 1987. Another stream gauge upstream of Lake Anna (Pamunkey Creek at Lahore, Virginia) records runoff from 105 km^2 (40.5 mi^2) of the Pamunkey Creek drainage for the period from August 1989 to July 1993. The two upstream gauges on Contrary Creek and Pamunkey Creek, record flows representative of 120 km^2 (46 mi^2) or approximately 13 percent of the total upstream area contributing flow to Lake Anna. Because of the limited inflow data, it is not possible to create a reliable water budget for Lake Anna directly from inflow and discharge measurements.

Dominion records sufficient information to calculate discharge released through the dam by providing lake elevation and release structure settings (e.g., skimmer gate and radial gate openings). Such records are the only available discharge measurements for the North Anna River immediately downstream of Lake Anna Dam since the Partlow gauge has been discontinued.

No water velocity measurements within the WHTF or Lake Anna have been recorded. When North Anna Dam was constructed, instruments for reliably measuring the relatively low current velocities in lakes, such as Lake Anna, were unavailable. The only practical methods at that time to measure currents were drogue or dye experiments. Velocity measurements are important for both understanding of the hydrodynamics of the lake and to calibrate numerical models of fluid and heat transport process in the lake. Velocity flow measurements will be used in the hydrological evaluation at the CP/COL stage.

2.6.2 Water Use

Consideration of water use requires estimating the magnitude and timing of consumptive and non-consumptive water use. Non-consumptive water use does not result in a reduction in the water supply available. For instance, water used to rinse fish impinged on intake screens off the screens would result in no change in the water supply, as the same volume of water pumped from the lake would eventually be returned to the lake. Consumptive water use results in a reduction of the water supply available. For instance, lake evaporation results in a transfer of water from the lake to the atmosphere, thereby reducing the lake volume. The following two sections describe the existing consumptive and non-consumptive uses of surface water and groundwater.

2.6.2.1 Surface Water Use

The existing NAPS units are the largest users of water in the region. When both Units 1 and 2 are operating, eight circulating water pumps draw water from Lake Anna at a rate of 120 m^3/s (4246 cfs). The large volume of water withdrawn from Lake Anna for condenser cooling is entirely returned to the lake. While there is no consumptive use of water between the intake and discharge, the elevated temperature of the discharged water does result in induced evaporative losses from the WHTF and the remainder of Lake Anna.

In Section 2.3 of the ER, Dominion identifies surface water users within the North Anna River drainage whose average daily withdrawal during any single month exceeds 38,000 L/d (10,000 gpd). Dominion identified these users from the water-use database maintained by VDEQ. Users include the NAPS existing units, Bear Island Paper Company, the Doswell Water Treatment Plant, and St. Laurent Paper Products Corporation.

In Section 4.2.3 of the ER, Dominion discusses the upstream land-use changes that might alter the inflow to Lake Anna and downstream development that may increase the downstream demand for water. These projections are based on comprehensive plans for the three upstream counties (Louisa, Spotsylvania, and Orange Counties) and the four downstream counties (Hanover, Caroline, New Kent, and King William Counties).

Increases in development generally result in increased areas of impervious surfaces. Impervious surface result in less groundwater recharge and higher fractions of surface water runoff. Due to the limited projected development in the three upstream counties and policies promoting the use of storm water management practices that limit the impact of impervious surfaces, upstream land-use changes are not expected to appreciably alter the patterns of inflow to Lake Anna. One of the three counties is relying on obtaining water from the North Anna River drainage to satisfy their water demands.

Growth in downstream demands for water withdrawals could result in increased water conflicts, particularly during drought periods. The Doswell Water Treatment Plant in Hanover County has a capacity of 15,000 m^3/d (4 MGD), which is the equivalent to a streamflow of 0.17 m^3/s (6.1 cfs). One of the alternatives proposed by Hanover County to meet its projected water supply needs would require an additional withdrawal of 1.3 m^3/s (46 cfs) from the North Anna River. The minimum release from Lake Anna prescribed by VDEQ for normal conditions is 1.1 m^3/s (40 cfs). During drought conditions the release prescribed by VDEQ can be reduced to 0.57 m^3/s (20 cfs). Three of the downstream counties are considering using the North Anna River or Pamunkey River as future water sources to meet projected growth.

The Virginia Surface Water Management Act of 1989 and associated regulations (9 VAC 25-220-10, et seq.) impose legal restrictions on surface water withdrawals where surface water resources have a history of low-flow conditions that threaten important in-stream and off-stream uses. The purposes of these regulations are to maintain surface water flow at minimum levels during periods of drought, ensure assimilation of treated waste water, and support of aquatic and other water-dependent wildlife. In an area designated by the State Water Control Board as a surface water management area, water withdrawals of 3,000,000 L (300,000 gallons) per month or more are required to have a surface water withdrawal permit. Permits and certificates must include a conservation plan that is activated during low-flow surface water conditions. As of October 2004, the Virginia State Water Control Board had not designated any surface water management areas in the State.

2.6.2.2 Groundwater Use

Dominion describes groundwater use in the vicinity of the ESP site in Section 2.3.2.2 of the ER (Dominion 2004a). Groundwater is primarily obtained from springs and wells in either the saprolite or underlying crystalline bedrock. Most wells completed in the saprolite have been excavated either by hand digging or augering. These wells are susceptible to becoming dry because of seasonal fluctuations in the water table. Drilled wells generally extend through the saprolite into the underlying bedrock. The production of groundwater in the vicinity of the ESP site is generally not sufficient to satisfy large water demands because of the relatively low yield of the aquifers. The majority of groundwater development in the area is for domestic and agricultural use, with some public, light industrial, and commercial use.

2.6.3 Water Quality

The following sections describe the water quality of surface water and groundwater resources in the vicinity of the ESP site. Pre-application monitoring programs for thermal and chemical water quality are also described.

2.6.3.1 Surface Water Quality

This section describes the water quality of Lake Anna, the tributaries draining into Lake Anna, and the North Anna River downstream of the lake. Dominion presents a discussion of the water quality conditions in Section 2.3.3.1 of the ER (Dominion 2004a). The thermal load discharged into the lake from the two operating units results in localized elevated temperatures in the lake. These elevated temperatures are the most significant water-quality concern associated with both the existing and the proposed ESP units. Operational impacts of proposed Unit 3 on Lake Anna water quality are discussed in Section 5.2.2 of this draft EIS. Monitoring programs for thermal and chemical water quality are discussed in Sections 2.6.3.3 and 2.6.3.4, respectively.

Eight of the tributaries draining into Lake Anna are on the Virginia Draft 2004 303(d) list as impaired for one or more of the following attributes: fecal coliform bacteria, pH, and dissolved oxygen. The source of impairment for one of the tributaries, Contrary Creek, is known to be an abandoned mining operation. The specific source of the impairment for the other tributaries is unknown. The lower portion of Lake Anna is listed as impaired due to polychlorinated biphenyl (PCB) levels in fish tissues; a public health advisory has been issued regarding the consumption of certain fish. The source of the PCBs is unknown at this time. Downstream of Lake Anna, the discharge is not listed as impaired until it reaches the Chesapeake Bay estuary, after first entering the Pamunkey River and then the York River.

Units 1 and 2 have a Virginia Pollutant Discharge Elimination System (VPDES) permit from the VDEQ (VDEQ 2001b). Before Units 3 and 4 could begin to operate, Dominion would be required to obtain a VPDES permit for discharges from these units. Dominion would also be required to demonstrate to VDEQ that the thermal effluent limitations for Unit 3 is adequate to ensure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife through a Clean Water Act 316(a) demonstration. Unit 4 is expected to use dry cooling towers which discharges the heat directly to the air.

2.6.3.2 Groundwater Quality

There are no site-specific data available for the chemistry of the groundwater underlying the ESP site. In the Section 2.3.3.2 of the ER and in response to a Request for Additional Information, Dominion provided a summary of published studies that characterize the water quality of crystalline aquifers in the Piedmont Province (Dominion 2004a, b). The Piedmont region aquifers provide good quality water (USGS 2000). As with most crystalline rocks, the rocks of the Piedmont Province contribute relatively high levels of naturally occurring radioactivity to the groundwater. Pursuant to 10 CFR 100.20(3), site-specific groundwater chemistry data would be required as part of a construction permit (CP) application or in a combined license (COL) application. Groundwater sampling undertaken in 1992 as part of the Louisa County Water Testing Program has identified coliform contamination in aquifers near the ESP site. This coliform contamination is likely attributable to private septic systems in the area.

2.6.3.3 Thermal Monitoring

This section describes pre-application and pre-operational thermal monitoring programs. The applicant is able to consider an ongoing monitoring program associated with the existing Units 1 and 2 as part of the pre-application and pre-operational monitoring program at the ESP site. Many of the same monitoring activities would be continued if the ESP units were completed and would become part of the operational monitoring for the ESP units. In Section 6.1 of the ER, Dominion describes the existing lake temperature measurements directly associated with the current site operation that are required under terms of its existing VPDES permit (Dominion 2004a; VDEQ 2001a).

The current temperature monitoring program includes both continuous fixed-location temperature stations and temperature profile locations that are sampled twice per year. Ten fixed-location temperature stations are located around Lake Anna, seven within the main body of the lake, one at the discharge canal, and two within the WHTF. An additional fixed-location station is located downstream of the Lake Anna Dam. The temperature profiling is conducted during at least two quarters per year, such that one measurement quarter is always during the July-to-September quarter, and the remaining quarter is alternated every year. All of the spot profile locations are located in the main body of the lake.

2.6.3.4 Chemical Monitoring

This section describes the pre-application and operational chemical monitoring programs. As a result of ongoing monitoring associated with the existing two units, the applicant is able to consider this operational monitoring program as part of the pre-application and pre-operational monitoring program for the ESP site. Many of these same monitoring activities would be continued if Units 3 and 4 were completed and would likely become part of the operational monitoring. In Section 6.6 of the ER, Dominion describes the chemical monitoring that is required under terms of the applicant's existing VPDES permit (Dominion 2004a).

The NAPS Units 1 and 2, VPDES permit establishes chemical discharge limits at a variety of locations internal to the NAPS facility and at the discharge from the WHTF into Lake Anna at Dike 3. Chemical monitoring of a variety of constituents is required including pH, chlorine, copper, nickel, chromium, zinc, suspended solids, oil and grease, and biological oxygen demand. While temperature is monitored both inside and outside the WHTF, no chemical monitoring is required outside the WHTF.

The Commonwealth of Virginia monitors Lake Anna, Lake Anna's tributaries, and the North Anna River downstream from Lake Anna. Results from this monitoring program provide the basis for the Virginia 303(d) list of impaired waters. Recent sampling by the State has resulted in a public health advisory regarding the consumption of certain fish in Lake Anna and its tributaries. The advisory was triggered by detecting PCBs in the tissue of certain fish.

Community-based monitoring of Lake Anna and WHTF water quality has been performed by volunteers from the Lake Anna Civic Association. Water samples are collected and analyzed for several standard water-quality metrics, such as *Escherichia coli* (*E. coli*) bacteria and dissolved oxygen. Results from this monitoring program are provided to Virginia and EPA.

2.7 Ecology

Much of the proposed North Anna ESP site construction area consists of dirt roads, cleared areas, parking lots, buildings, and early succession habitats. The western portion of the current and proposed laydown area can be classified as "old-field" habitat. None of the current or proposed laydown area is forested. The area proposed for temporary offices is an existing office complex; thus, undisturbed habitats are absent from this area. Approximately 32 ha (80 ac) of the 729-ha (1803 ac) proposed site is currently forested; most of the forested portion of the site is within the area where cooling towers would be constructed. Generally, wildlife species found in the forested portions of the ESP site and surrounding areas are those typically found in the forested portions of the North Anna site and in upland Piedmont forests of north-central Virginia. Wildlife species in the old-field habitat of the laydown area and in the transmission line rights-of-way within the ESP site would include most of those found in the adjacent wooded areas. A few small wetland areas and two intermittent streams exist on the ESP site (Dominion 2004a).

Sections 2.7.1 through 2.7.6 provide general descriptions of the terrestrial and aquatic environments near the ESP site. They provide detailed descriptions, where needed, to support the analysis of potential environmental impacts of construction, operation, and decommissioning of new nuclear power generating facilities. The descriptions are provided to support mitigation activities identified to avoid, minimize, rectify, reduce, or compensate for potential impacts during the assessment. Descriptions are provided to facilitate comparison of the alternatives identified to the North Anna ESP site. Also included are descriptions of monitoring programs for terrestrial and aquatic environments.

2.7.1 Terrestrial Ecology

The ESP site is located within the Piedmont Physiographic Province as described by Omernik (1987). Although forests in the Piedmont Province are nominally characterized by oak-hickory-pine forest (Woods et al. 1999), this portion of north-central Virginia has been settled since the colonial era, and therefore no longer contains virgin forests. Vegetative cover surrounding the ESP site is an irregular patchwork of row crops, pastures, pine plantations, abandoned (old) fields, and second growth forests of hardwoods and mixed pine-hardwoods (Dominion 2004a).

2.7.1.1 Biological Communities of the North Anna Site

Approximately 30 percent of the North Anna site consists of generation and maintenance facilities, parking lots, roads, cleared areas, and mowed grass. Hardwood forests and planted pines exist on the approximately 70 percent of the site that has not been cleared for the construction or operation of the existing units. These wooded areas are remnants of forests that were used for timber production prior to acquisition by Virginia Power and are dominated by a variety of oaks (*Quercus* spp.), yellow poplar (*Liriodendron tulipifera*), sweet gum (*Liquidambar styraciflua*), and red maple (*Acer rubrum*) trees. Scattered loblolly pines (*Pinus taeda*), Virginia pines *(P. virginiana*), and short-leaf pines *(P. echinata*) exist in some wooded areas (Dominion 2004a).

The Piedmont region of Virginia is characterized as an irregular plain with low rounded ridges and shallow ravines (Woods et al. 1999). There are no steep ridges on the ESP site. The rolling terrain at the site extends down slope to the waters of Lake Anna, resulting in essentially no marsh habitat along the shoreline at the site. Hydrophytic vegetation, such as cattail (*Typha* spp.) and rushes (*Juncus* spp.), are typically absent or extend only to approximately 0.3 m to 1 m (1 to 3 ft) beyond the shoreline (Dominion 2004a). Two intermittent streams flowing north into an unnamed arm of Lake Anna, just northwest of the power-block area, bisect the area where cooling towers would be located. A narrow band of wetlands is associated with each of these streams. A small isolated wetland is located within the ESP site.

Wildlife species found in the forested portions of the North Anna site are those typically found in upland Piedmont forests of north-central Virginia. Frequently observed mammals, such as the white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), gray squirrel (*Sciurus carolinensis*), and gray fox (*Urocyon cinereoagenteus*), exist at the site, as do smaller mammals such as moles (Talpidae), shrews (Soricidae), and a variety of mice (Muridae) and voles (*Microtus* spp.). Woodchucks (*Marmota monax*) live in the grassy areas near forest edges at the site, and beavers (*Castor canadensis*) occur in Lake Anna and its tributaries. Various birds and herpifauna (e.g., snakes, turtles, lizards, and toads) live in the uplands and along the edge of Lake Anna (Dominion 2004a).

Virginia Power has cooperated with the National Audubon Society in conducting periodic "Christmas Bird Counts" during December or January. Common bird species recorded in upland areas on and near the North Anna site during these surveys include the American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), Carolina chickadee (*Poecile carolinensis*), mourning dove (*Zenaida macroura*), black vulture (*Coragyps atratus*), turkey vulture (*Cathartes aura*), European starling (*Sturnus vulgaris*), song sparrow (*Melospiza melodia*), white-throated sparrow (*Zonotrichia albicollis*), dark-eyed junco (*Junco hyemalis*), northern cardinal (*Cardinalis cardinalis*), house finch (*Carpodacus mexicanus*), tufted titmouse (*Baeolophus bicolor*), red-bellied woodpecker (*Melanerpes carolinus*), downy woodpecker (*Picoides pubescens*), and northern flicker (*Colaptes auratus*) (Audubon Society 2004). Species known to nest within forested areas at the North Anna site, along forested edges, and in open areas (for example, northern cardinal, Carolina chickadee, blue jay) are those that commonly nest in upland Virginia habitats. Virginia Power has placed bluebird nest boxes in suitable habitats at the North Anna site and has constructed roofed structures for swallows in some locations. Eastern bluebirds (*Sialia sialis*) annually use the nest boxes, and barn swallows (*Hirundo rustica*) nest beneath the roofed structures (Dominion 2004a).

Several species of residential and migratory wading birds and waterfowl use Lake Anna. Numerous gulls, ducks, and geese were noted during Christmas bird counts (Audubon Society 2004), as were great blue herons (*Ardea herodias*). Virginia Power biologists have documented breeding at Lake Anna by mallards (*Anas platyrhynchos*), wood ducks (*Aix sponsa*), and Canada geese (*Branta canadensis*) (VEPCo 1986). Virginia Power, in association with the Louisa County Chapter of Ducks Unlimited, has placed wood duck nest boxes on Lake Anna, and wood ducks have used several of these nest boxes (VEPCo 1986). Belted kingfishers (*Ceryle alcyon*), great blue herons, and green-backed herons (*Butorides virescens*) are present at Lake Anna throughout the year, and kingfishers and green-backed herons presumably nest on or near the Lake Anna shoreline. Great blue herons typically nest in rookeries, and because there are no known rookeries at Lake Anna (Dominion 2004a), it is unlikely that great blue herons nest on the lake. Waterfowl are typically most abundant at Lake Anna during the winter. Lake Anna provides important habitat for migratory waterfowl on the Atlantic flyway, especially during extremely cold winters when the elevated water temperature from station operation maintains a large ice-free body of water. The most common ducks observed during winter are mallard, American black duck (*Anas rubripes*), bufflehead (*Bucephala albeola*), and greater scaup (*Aythya marila*). The Canada goose, American coot (*Fulica americana*), ringed-billed gull (*Larus delawarensis*), and herring gull (*L. argentatus*) are also abundant on Lake Anna during the winter (Audubon Society 2004; VEPCo 1986).

2.7.1.2 Threatened and Endangered Terrestrial Species

This section describes the threatened and endangered terrestrial animal and plant species that exist within the ESP site, vicinity, and corresponding transmission line rights-of-way, and examines the potential impacts of the construction and operation of the potential new units on these resources. The U.S. Fish and Wildlife Service (FWS) maintains current lists of threatened or endangered species at its website (FWS 2004a). The Virginia Department of Game and Inland Fisheries (VDGIF 2004a) and Virginia Natural Heritage Program (VNHP 2004) also maintain lists of State-protected species at their websites. Terrestrial species potentially occurring near the North Anna site that are listed as threatened or endangered by these agencies are listed in Table 2-2.

Animals

Bald eagles (*Haliaeetus leucocephalus*) are occasionally observed along Lake Anna (six were observed during the 2003 Christmas Bird Count) (Audubon Society 2004). However, there are no known eagle nests at the ESP site (NRC 2002). The nearest known bald eagle nest is near the north end of Lake Anna, approximately 16 km (10 mi) upstream of the existing units. Dominion is not aware of any eagle nests along North Anna-associated transmission line rights-of-way. Loggerhead shrikes (*Lanius ludoviciana*) occasionally have been observed in the vicinity of NAPS during Christmas Bird Counts (Audubon Society 2004). They are known to breed in Central Virginia (VDGIF 2004a), but breeding loggerhead shrikes have not been recorded at the North Anna site or along the transmission line rights-of-way (Dominion 2004a). Loggerhead shrikes inhabit mowed or grazed grassy areas and margins of wooded areas.

With the exception of the bald eagle and loggerhead shrike, no other Federally and/or State-listed endangered or threatened terrestrial animals are known to exist at the North Anna site or along the transmission line rights-of-way, although the upland sandpiper (*Bartramia longicauda*) and the cerulean warbler (*Dendroica cerulea*) may occasionally migrate through the area (VDGIF 2004a). The regal fritillary butterfly (*Speyeria idalia*) has been reported in Orange and Spotsylvania Counties, but has not been reported in Louisa County (VDGIF 2004a). The eastern big-eared bat (*Plecotus rafinesquii macrotis*) has been reported in Hanover County, downstream from Lake Anna. Several species, including the red-cockaded woodpecker (*Picoides borealis*), Bachman's sparrow (*Aimophila aestivalis*), dismal swamp southeastern shrew (*Sorex longirostris fisheri*), and tiger salamander (*Ambystoma tigrinum*) have been reported in Caroline County (VDGIF 2004a), which is downstream from the North Anna site. However, the presence of these species in this area appears doubtful, and reported observation sites are well away from the transmission lines, or portions of the North Anna River potentially affected by construction and operation of new reactors at the North Anna site.

Table 2-2. Terrestrial Species Known or Likely to Occur in Countries Adjacent or Downstream from the North Anna Reservoir (Louisa, Orange, Spotsylvania, Caroline, and Hanover Counties)

Scientific Name	Species	Counties	Status*	Source
Birds				
Haliaeetus leucocephalus	bald eagle	Louisa, Orange, Spotsylvania, Caroline, Hanover	FT/ST	VDGIF 2004a, FWS 2004a, VDCR 2004, FWS 2004b
Picoides borealis	red-cockaded woodpecker	Caroline	FE/SE	VDGIF 2004a
Lanius ludovicianus migrans	migrant loggerhead shrike	Louisa, Orange, Spotsylvania, Caroline, Hanover	FS/ST	VDGIF 2004a
Dendroica cerulea	cerulean warbler	Louisa, Orange, Spotsylvania, Caroline, Hanover	FS	VDGIF 2004a
Aimophila aestivalis	Bachman's sparrow	Caroline	FS/ST	VDGIF 2004a, FWS 2004, VDCR 2004
Bartramia longicauda	upland sandpiper	Louisa, Orange, Spotsylvania, Caroline, Hanover	ST	VDGIF 2004a
Mammals				
Plecotus rafinesquii macrotis	eastern big-eared bat	Hanover	SE	VDGIF 2004a
Sorex longirostris fisheri	Dismal Swamp southeastern shrew	Caroline	ST	VDGIF 2004a
Amphibians				
Ambystoma tigrinum	tiger salamander	Hanover	SE	VDCR 2004
Insects				
Speyeria idalia	regal fritillary	Orange, Spotsylvania	FS	FWS 2004a,b VDGIF 2004a
Vascular Plants				
Isotria medeoloides	small whorled pogonia	Spotsylvania, Hanover, Caroline	FT/SE	VDGIF 2004a, FWS 2004 a,b VDCR 2004
Helonias bullata	swamp pink	Caroline, Hanover, Spotsylvania	FT/SE	VDGIF 2004a, VDCR 2004, FWS 2004b
Aeschynomene virginica	sensitive joint-vetch	Caroline	FT	FWS 2004a, b
Juncus caesariensis	New Jersey rush	Caroline	FS/ST	VDCR 2004

*FE = Federal endangered, FT = Federal threatened, FS = Federal species of concern, SE = State endangered, ST = State threatened.

Plants

There are no known populations of any plants species listed as threatened or endangered by the FWS or the State on the North Anna site (Dominion 2004a; NRC 2002). Additionally, there are no known populations of such species in Louisa County (VNHP 2004; FWS 2004a).

The supplemental environmental impact statement prepared for the license renewal of NAPS Units 1 and 2 (NRC 2002) described three Federally listed plant species that could potentially occur in the North Anna transmission line rights-of-way: the small whorled pogonia (*Isotria medeoloides*), swamp pink (*Helonias bullata*), and the sensitive joint-vetch (*Aeschynomene virginica*). The previous evaluation determined that continued operation and maintenance of the transmission line rights-of-way would have no effect on these species. Because the existing rights-of-way would not be altered, and no additional rights-of-way would be required, no additional species are likely to be affected. The New Jersey rush (*Juncus caesariensis*) occurs in shaded stream banks and other wet areas, and has been reported to occur in Caroline county (VDCR 2004).

The transmission line rights-of-way are managed to prevent woody growth from reaching the transmission lines. The removal of woody species can provide grassland and bog-like habitat for many rare plant species dependent on open conditions. Virginia Power has cooperated with the VDCR's Natural Heritage Program in rare plant surveys within transmission line rights-of-way. The Natural Heritage Program prepared reports on the results of the rare plant species surveys. Although several rare plant species have been located along other Virginia Power transmission line rights-of-way, no endangered or threatened plants were noted along the rights-of-way associated with the North Anna ESP site (Dominion 2004a).

2.7.1.3 Terrestrial Ecological Monitoring

Dominion currently performs no terrestrial ecological monitoring (Dominion 2004a). However, Dominion does cooperate with private organizations such as Ducks Unlimited and the Audubon Society to allow informal monitoring of selected resources at and near NAPS. The NRC expects Dominion to work with the State on development and implementation of any required monitoring programs.

2.7.2 Aquatic Ecology

The aquatic resources in the vicinity of the North Anna ESP site are associated with Lake Anna, the WHTF, and the North Anna River (VEPCo 2001a). Lake Anna was created to serve as the cooling water source for NAPS. The lake was made during 1971 by erecting a dam on the main stem of the North Anna River, just upstream of the confluence of the North Anna River and Northeast Creek (Figure 2-5).

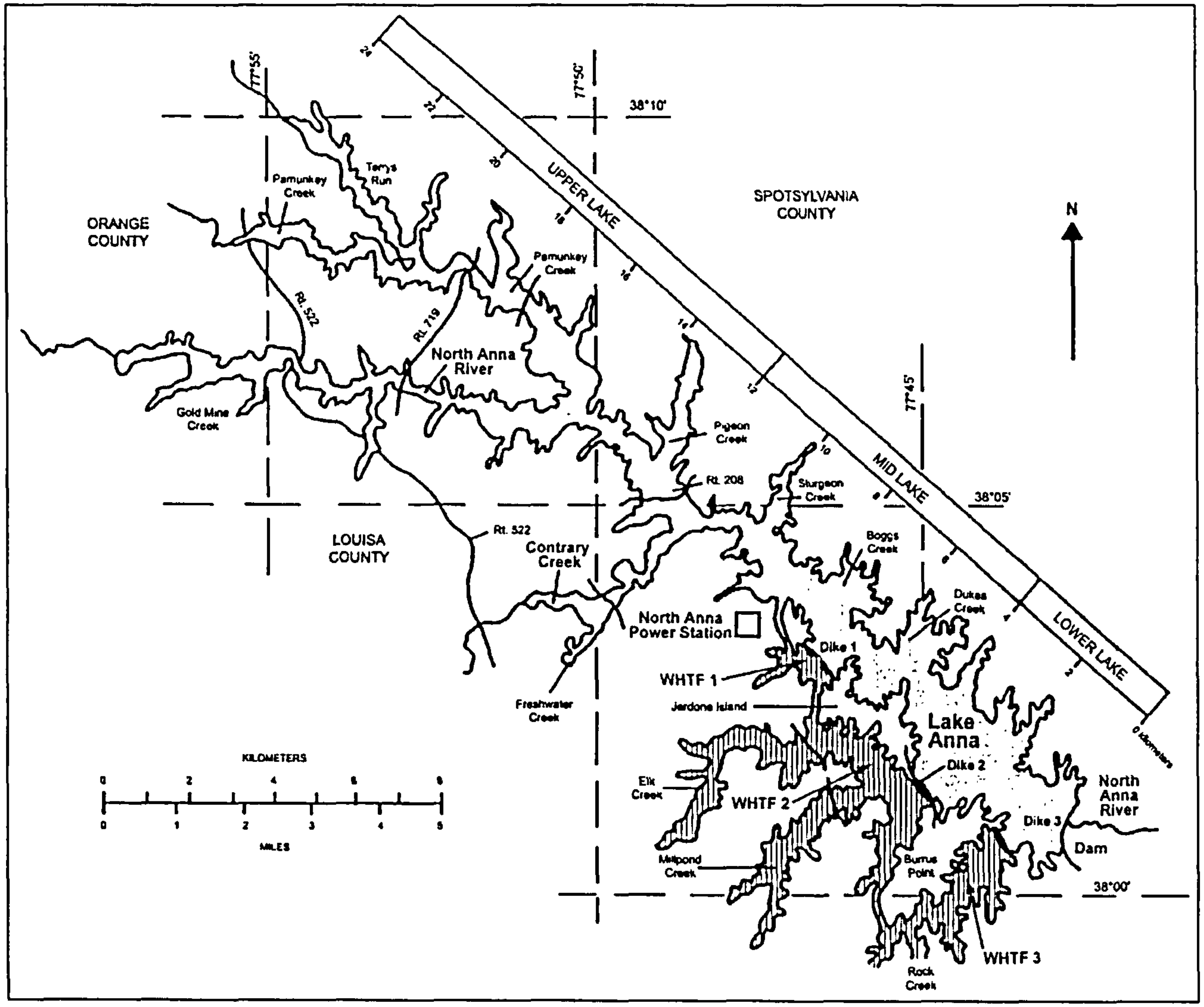


Figure 2-5. Diagram of Lake Anna Showing the Upper and Lower Reach of the North Anna River, Contrary Creek, the North Anna Waste Heat Treatment Facility (sections 1, 2, and 3), and the North Anna Dam

Lake Anna drains an area of 888 km^2 (343 mi^2) (VDEQ 1986). The dam is approximately 27 m (90 ft) high and 1500 m (5000 ft) long and contains 700,000 m^3 (900,000 yd^3) of earth and rock (AEC 1973). Lake Anna began filling during January 1972 and reached full pool in December of that year (AEC 1973). Lake Anna is approximately 27 km (17 mi) long, with 435 km (272 mi) of shoreline. It is relatively shallow (maximum depth 27 m [90 ft]; average depth approximately 8 m [25 ft] at full pool), with a surface area of 5300 ha (13,000 ac) (AEC 1973). The normal elevation of the reservoir is 76 m (250 ft) above MSL, at which stage it holds 376,000,000 m^3 (305,000 acre-feet) of water (AEC 1973). Lake Anna is used extensively for recreation and fishing. The aquatic resources of Lake Anna are managed cooperatively by Virginia Power and State natural resource agencies including VDGIF and VDCR.

Lake Anna is divided into two distinct bodies of water: the WHTF and the reservoir. The reservoir is the larger body of water and is physically separated from the WHTF by three dikes. The WHTF is the smaller body of water into which the waste heat from existing North Anna Units 1 and 2 is discharged via a discharge canal. The total surface area of the WHTF is 1400 ha (3400 ac). The surface area of the reservoir is 3900 ha (9600 ac). The WHTF was formed by diking off the three southernmost arms of Lake Anna. These arms are the three cooling lagoons of the WHTF; all three lagoons are interconnected by canals.

The North Anna River headwaters are in Louisa and Orange Counties, Virginia, and flow eastward for about 97 km (60 mi) before joining the South Anna River to form the Pamunkey River (Figure 2-2). The Pamunkey River flows to the southeast, joining with the Mattaponi River to form the York River, which flows into the Chesapeake Bay north of the Hampton Roads area of Virginia. The entire North Anna River watershed is approximately 1550 km^2 (600 mi^2) (AEC 1973).

2.7.2.1 Biological Communities of Lake Anna

Lake Anna is typical of many shallow reservoirs found in the south and mid-Atlantic states. Since impoundment, Lake Anna has gone through the typical ecological succession of reservoirs. The initial biotic community was highly productive because initial nutrient levels were high. Productivity subsequently decreased and ultimately stabilized (Paterson and Fernando 1970; Voshell and Simmons 1978). Aquatic communities in Lake Anna experienced gradual post-impoundment changes from riverine to lake communities. Some of these communities had stabilized in Lake Anna by 1975 (VEPCo 1986), and all have been relatively stable since 1985 (VEPCo 1986; VEPCo 2002b).

Lake Anna contains numerous phytoplankton, zooplankton, and benthic macroinvertebrate communities. Seventy-seven genera of phytoplankton have been identified, and diatoms, green algae, blue-green algae (Cyanobacteria), and cryptomonads are the dominant forms. The zooplankton are dominated by small-bodied forms (rotifers and copepods). This has been attributed to selective predation upon larger-bodied zooplankton by landlocked schooling clupeids such as various shad species (Brooks and Dodson 1965). A total of 124 benthic taxa have been identified from Lake Anna (VEPCo 1986). Three bivalve species were collected in the North Anna basin prior to impoundment: *Elliptio complanatus*, *E. productus*, and *Sphaerium striatum* (AEC 1973).

In more recent years, the introduced Asiatic clam (*Corbicula* spp.) has dominated collections from both Lake Anna and the lower North Anna River. The Asiatic clam has spread rapidly throughout the United States since its first discovery in 1938 (VEPCo 1986). Its populations expand rapidly when they invade a new habitat, and densities stabilize as the species reach carrying capacity of the habitat. Asiatic clams are present throughout Lake Anna with the greatest population densities found at mid-lake (VEPCo 1989a). After its initial invasion of Lake Anna, densities increased sharply from 1979 to 1981. Populations remained relatively stable between 1984 and 1988 (VEPCo 1989a). Virginia Power received approval from VDEQ to discontinue Asiatic clam sampling in 1989.

Small numbers of unionid mussels (*Elliptio* spp.) and fingernail clams (Sphaeriidae) have also been collected. Acid drainage and sediment from the Contrary Creek mine site historically depressed freshwater mussel populations downstream from the Contrary Creek-North Anna River confluence; the first major mussel beds prior to the inpoundment of Lake Anna did not occur until 100 m downstream of the confluence of the North and South Anna Rivers (Reed and Simmons 1972). There are indications that mussel populations (*Elliptio* spp.) are recovering in the lower North Anna River (VEPCo 1986).

Approximately 39 species of fish (representing 12 families) have been identified in Lake Anna (VEPCo 1986) (Table 2-3). Species include those historically found in the North Anna River, those that had been in local farm ponds inundated by the new reservoir, and species introduced by the Virginia Department of Game and Inland Fisheries (VDGIF) . Recreational species include largemouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilis*), walleye (*Stizostedion vitreum*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), white perch (*Morone americana*), pumpkinseed (*L. gibbosus*), redear sunfish (*L. microlophus*), redbreast (*L. auritus*), channel catfish (*Ictalurus punctatus*), and white catfish (*Ameiurus catus*). Forage species include threadfin shad (*Dorosoma petenense*) and gizzard shad (*D. cepedianum).* Striped bass and walleye are stocked annually by VDGIF. Sterile triploid herbivorous grass carp (*Ctenopharyngodon idella*) was stocked by Virginia Power.

Because of the importance of recreational fishing in Lake Anna, its fish community has been the subject of wide-ranging studies (VEPCo 1986). Abundance and distribution of fish were evaluated over a period from 1975 to 1985, using a variety of sampling methods. Larval fish studies, creel surveys, and a number of special studies focused on the reproduction and growth of important species, such as largemouth bass. Seasonal movement and habitat preferences of striped bass were investigated, using ultrasonic tags.

Table 2-3. Fish Collected from Lake Anna

Scientific Name		Common Name
Anguillidae		
	Anguilla rostrata	American eel
Clupeidae		
	Dorosoma cepedianum	gizzard shad
	D. petenense	threadfin shad
	Alosa aestivalis	blueback herring
Umbridae		
	Umbra pygmaea	eastern mudminnow
Poeciliidae		
	Gambusia affinis	mosquitofish
Catostomidae		
	Catostomus commersoni	white sucker
	Erimyzon oblongus	creek chubsucker
	Moxostoma macrolepidotum	shorthead redhorse
	Hypentelium nigricans	northern hog sucker
Esocidae		
	Esox niger	chain pickerel
	E. lucius	northern pike
Cyprinidae		
	Cyprinus carpio	common carp
	Nocomis leptocephalus	bluehead chub
	N. micropogon	river chub
	Notemigonus crysoleucas	golden shiner
	Notropis analostanus	satinfin shiner
	N. procne	swallowtail shiner
	N. hudsonius	spot tail shiner
Aphredoderidae		
	Aphredoderus sayanus	pirate perch
Ictaluridae		
	Ictalurus catus	white catfish
	I. nebulosus	brown bullhead
	I. natalis	yellow bullhead
	I. punctatus	channel catfish
	Noturus insignis	margined madtom
	Ameiurus catus	white catfish
Centrarchidae		
	Enneacanthus gloriosus	bluespotted sunfish
	Lepomis auritus	redbreast sunfish
	L. gibbosus	pumpkinseed
	L. gulosus	warmouth
	L. macrochirus	bluegill
	L. microlophus	redear sunfish
	Acantharchus pomotis	mud sunfish

Table 2-3. (contd)

Scientific Name		Common Name
	Micropterus salmoides	largemouth bass
	Pomoxis nigromaculatus	black crappie
Percidae		
	Perca flavescens	yellow perch
	Stizostedion vitreum	walleye
	Etheostoma olmstedi	tessellated darter
Percichtyidae		
	Norone americana	white perch
	N. saxatillis	striped bass

The community structure for fish in Lake Anna remained relatively stable during the 1975 to 1985 period, with some year-to-year variation in species composition. These variations were caused by (1) normal population fluctuations, (2) reservoir aging, (3) the introduction of forage species and competing predators, (4) the installation of fish attraction structures and artificial habitat, and (5) the increase in Asiatic clam densities (VEPCo 1986). Post-1975 changes included (1) a decline in relative abundance of yellow perch and black crappie, (2) an increase in the relative abundance of white perch and threadfin shad, and (3) an increase in redear sunfish abundance, with a corresponding decrease in pumpkinseed.

The mean standing crop for fish in Lake Anna ranged between 105 and 134 kg (232 and 296 lb) of fish per 0.4 ha (1 ac) during the 1975 to 1985 period, but it increased substantially in 1985 to 189 kg (417 lbs) per 0.4 ha (1 ac) because of a large increase in introduced threadfin shad and an increase in the abundance of gizzard shad. Both species provide forage for Lake Anna's game fish, which include largemouth bass, walleye, and striped bass. Lake Anna appears to support a standing crop of fish greater than most U.S. reservoirs, with thriving populations of several forage species and game fish species. Standing stocks of largemouth bass, Lake Anna's most popular sport fish, remained stable during the 1975 to 1985 period. During 1985, Lake Anna produced more largemouth bass of "citation" size (3.6 kg [8 lb] or more) than any other lake or reservoir in Virginia. Life history studies of Lake Anna largemouth bass suggest that the reproductive success, feeding ecology, and growth of largemouth bass were similar before and after Units 1 and 2 commenced operation (VEPCo 1986).

Four non-native fish species (striped bass, walleye, threadfin shad, and blueback herring [*Alosa aestivalis*]) have been stocked in Lake Anna by VDGIF since 1972. Striped bass, introduced during 1973, have been stocked annually since 1975. They provide a "put-grow-and-take" recreational fishery. A self-sustaining population is not expected in Lake Anna because the streams, including the North Anna River, that flow into Lake Anna lack the flow, depth, and length to support striped bass spawning runs. Studies show that striped bass grow and provide a substantial recreational fishery, but adults are subject to late-summer habitat restrictions (e.g., may be restricted to cooler-water refuge areas). As a consequence, they may lose weight and show a decline in condition. Walleye are also stocked annually by the VDGIF and are highly sought-after game fish.

Threadfin shad, introduced during 1983 to provide forage for striped bass and other fish, are vulnerable to cold shock and winter kills, and would not be able to survive in Lake Anna if it were not for operation of NAPS. Threadfin shad appear to be thriving and are an important source of food for game fish. Blueback herring, stocked by VDGIF during 1980 as a forage species, have not been as successful. During 1994, grass carp were stocked by Virginia Power (with the approval of the VDGIF) in the WHTF to control the growth of the nuisance submersed aquatic plant hydrilla (*Hydrilla verticillata*).

Commercially Important Fisheries of Lake Anna

There is no commercial fishing on Lake Anna or the North Anna River. Professional fishing guides regularly take clients fishing for largemouth, striped bass, and walleye on Lake Anna, but there are no commercial fishing operations in the sense that fish are netted or trapped and sold at market. Professional fishing guides must adhere to State fishing regulations, and are prohibited by law from selling their catch.

Recreationally Important Fisheries of Lake Anna

Lake Anna is a popular destination for anglers from central and northern Virginia. Lake Anna's proximity to the cities of Washington, D.C., Richmond, and Charlottesville means that the reservoir is heavily fished. The heated effluent that flows into North Anna Reservoir at Dike 3 creates conditions conducive to good fishing during the winter, making the reservoir a popular fishing spot when cold weather slows or shuts down fishing at other ponds and lakes in the region. VDGIF estimated that 42,731 anglers fished Lake Anna for 232,439 hours over a 12-month period during 2000 and 2001. The species most often sought were largemouth bass, striped bass, and crappie, with 69 percent, 15 percent, and 12 percent of anglers, respectively, pursuing these species (VDGIF 2003). Black crappie, not largemouth bass, was the species most often harvested. Depending on the time of year, species such as bluegill, white perch, channel catfish, and walleye are also sought by Lake Anna anglers.

VDGIF manages the fisheries of the North Anna Reservoir, "...with particular emphasis on providing quality largemouth and striped bass fisheries within the capacity of available habitat" (Odenkirk 1999). Thus, the VDGIF focuses on these two species. Other species, such as black crappie and channel catfish, are monitored by the VDGIF but are not as actively managed.

Electro-fishing catch rates for largemouth bass greater than 20 cm (8 in.) long in the North Anna Reservoir have been high in recent years (VDGIF 2003; Odenkirk 2001, 2002). Young-of-the-year catch rates, although lower, have been indicative of consistent recruitment. Structural indices of the largemouth bass population indicate a population dominated by larger, older individuals. Growth of younger (1-to-4 year old) largemouth bass is excellent; however, growth of older bass (5 years and older) is below the district average (Odenkirk 1999). On average (all age classes considered), largemouth bass in the North Anna Reservoir grow more rapidly than largemouth bass in other large Virginia impoundments (Odenkirk 2001). In summary, largemouth bass tend to grow rapidly in their first 4 years of life. Their growth rate levels out at age 5, and then slows. The population of Lake Anna contains a high proportion of harvestable individuals, and provides relatively high catch-per-unit-effort for anglers seeking larger, trophy-sized fish.

Annual stockings of fry and fingerlings sustain the striped bass population in Lake Anna. Normally, between 100,000 and 200,000 fingerlings are stocked annually, which equates to about 25 and 50 fish per ha (10 and 20 fish/acre) (Odenkirk 1999). The VDGIF is experimenting with stocking rates of about 12 fish per ha (5 fish/acre) to determine if the striped bass population is significantly affected. Striped bass growth patterns in Lake Anna vary from year to year, with some of the variability apparently related to the size of fish stocked (dependent on size of fish supplied by hatcheries). Generally speaking, young striped bass grow rapidly, and reach harvestable size (51 cm [20 in.]) in about 30 months (Odenkirk 1999). Estimates of annual mortality range from 35 to 50 percent, depending on the cohort evaluated, with the lower percentage likely more accurate (Odenkirk 1999, 2001, 2002).

Based on experimental gill net catches, black crappie abundance in North Anna Reservoir was very high during 1997 and 1998, but has declined in recent years (Odenkirk 1999, 2001, 2002). Growth of black crappie is good, and is similar to growth observed in other impoundments in the region. There is considerable year-to-year variability in population size structure (i.e., average size of fish captured), but it is unclear if this is an indication of changes in age composition or changes in growth rates. The catch-per-unit-effort of "quality" black crappie declined by 50 percent between 1997 and 1998, an indication that (fishing) mortality is high. Most crappie (92 percent) caught in gill nets were caught in the "upper lake" (Odenkirk 1999).

Channel catfish ranked fifth in abundance in gill nets during 1997 and fourth in abundance during 1998 (Odenkirk 1999). Much higher numbers of channel catfish and white catfish were captured in gill nets during 1998 than during 1997, but this was attributed to low reservoir levels (related to drought) rather than an actual increase in numbers of catfish.

Because threadfin shad abundance is cyclic, gizzard shad serve in most years as North Anna Reservoir's forage base (Odenkirk 1999). Gizzard shad are regarded by fisheries managers as a less-than-ideal forage species, because their rapid growth makes them unavailable to predators in 1 to 2 years. Threadfin shad, while the ideal size for forage, are subject to mass die-offs from low temperatures or sudden temperature changes. During 1997 and 1998, gizzard shad numbered second and first, respectively, in North Anna Reservoir gill net catches.

Threadfin shad were seventh in 1997 and eighth during 1998. Most shad (71 percent during 1997 and 76 percent during 1998) were caught in the upper reservoir (Odenkirk 1999).

Nuisance Species of Lake Anna

Virginia Power first collected Asiatic clams in benthos samples during 1979. Densities increased sharply thereafter, as this species with its high reproductive potential quickly occupied suitable habitat in the reservoir (VEPCo 1986). The total numbers and densities of Asiatic clam at the various locations in the North Anna Reservoir and the WHTF show sizable fluctuations between years, mostly as a result of spawning activity (Willis 1998a, b, 1999a, b, 2000a, b, 2001a; Dominion 2004a). Small "sand-sized" clams less than 2 mm long are sometimes locally abundant immediately after spawning takes place, and inflate numbers and densities found at a particular sampling location. Asiatic clam numbers in the WHTF near the cooling water discharge for Units 1 and 2 show the most dramatic fluctuations. For example, densities of clams at this location declined from 1619 clams per m^2 during spring 1992 to 11 clams per m^2 during fall 1992 (Willis 1992a, b). Clams in this area are subject to "boom and bust" cycles, because under extreme conditions (high plant operating levels, high ambient temperatures, drought), water temperatures can get high enough to cause localized die-offs. Larger (greater than 15 mm in length), older (1 to 3 years old) Asiatic clams (*Corbicula)* are uncommon in North Anna Reservoir samples, generally comprising less than 10 percent of the total collected (Odenkirk 2001; Willis 1998; 1999a, b, 2000a, b, c, 2001, 2002a, b). Larger Asiatic clams are generally uncommon in WHTF samples as well, but sometimes make up a significant percentage (i.e., greater than 50 percent) of the total in the third arm of the WHTF when sample sizes are small (Willis 1999b, 2000a, b). Although Asiatic clam shells have been observed in the service water reservoir, Virginia Power biologists have collected no live clams at this location.

The service water reservoir is treated with algicides and molluscicides, thus preventing Asiatic clams from becoming established in this small reservoir. When Virginia Power compared 1990 to 2002 Asiatic clam survey results to similar surveys conducted during the 1980s, data indicated a decline in the Lake Anna population. The greatest sample totals were recorded during the spring of 1985 and 1988, when 194 and 294 clams, respectively, were collected in replicate samples from a mid-lake location. The greatest sample totals collected during the fall occurred during 1986 and 1987, when 237 and 1227 clams, respectively, were collected from a mid-lake location. The greatest number of clams collected during the 1990 to 2002 period from the mid-lake location was 148, during spring 1994 sampling. Operational experience at Units 1 and 2 provides further evidence of a stable or declining Lake Anna Asiatic clam population; no condenser tube blockages have been reported since Asiatic clams first appeared in Lake Anna during the late 1970s.

In the course of monitoring Asiatic clam populations, Virginia Power also looks for evidence that the zebra mussel (*Dreissena polymorpha*) has invaded Lake Anna. As of the end of 2002, Virginia Power biologists had observed no zebra mussels in the North Anna Reservoir or the WHTF. Dissolved calcium levels in North Anna Reservoir and the WHTF are well below those known to promote shell growth in zebra mussels, which should limit its establishment in those waterbodies. Zebra mussels are known in only one location in the Commonwealth of Virginia: Millbrook Quarry, in Prince William County, Virginia, approximately 100 km (60 mi) north of the site.

2.7.2.2 Biological Communities of the WHTF

The WHTF is the body of water into which waste heat from the existing units is discharged via the discharge canal. It is physically separated from the rest of Lake Anna by a series of dikes. The same aquatic communities occur in the WHTF that occur in the main reservoir. Fish can swim from the main reservoir into the WHTF and back. However, fish are not stocked in the WHTF, and access to this fishery is restricted to the land owners along this part of the shoreline.

2.7.2.3 Biological Communities of the North Anna River

The North Anna River joins the South Anna River 37 km (23 mi) downstream from the North Anna Dam (Figure 2-2), forming the Pamunkey River. Another 56 km (35 mi) downstream, the Pamunkey River joins the Mattaponi River to form the York River. In the North Anna River downstream of the dam, the periphyton community (single-celled, filamentous or colonial algae, and associated microfauna attached to underwater surfaces) is dominated by diatoms, as are many southeastern streams. Caddisflies (Trichoptera) that feed on seston (living and dead plankton, plus particulate matter) from Lake Anna dominate the benthic macroinvertebrate community. Farther downstream, macroinvertebrate communities show more diversity and are similar to those of the South Anna River (VEPCo 2001a).

Before the North Anna River was impounded, the fish community of the river downstream of the Contrary Creek inflow was dominated by pollution-tolerant species. In the years following impoundment (and reclamation of the Contrary Creek mine site), there was a steady increase in measures of abundance and diversity of fish. During 1984 to 1985, 38 species from 10 families were found in the North Anna River, compared to 25 species from 8 families in the control stream, the South Anna River (VEPCo 1986). (Thirtynine species have been identified in North Reservoir.) When species from the North Anna Reservoir were subtracted from the North Anna River totals, the two fish communities (North and South Anna River communities) showed striking similarities, indicating that the operation of the existing units had little or no effect on fish populations downstream from the dam.

During 2000, the number of fish collected at four stations downstream of the North Anna Dam was low but was similar to 1989, 1993, and 1996 collections. High spring flows and canceled surveys in the fall may have contributed to the low fish numbers. Experience has shown that high flows are associated with low electrofishing catch rates, and vice versa. Although the number of fish collected in 2000 was low, the species composition of the catch was similar to previous years, with six species comprising 80 percent of the electrofishing catch by number and six species comprising 83 percent of the electrofishing catch by weight. All indications are that the low catch in 2000 was an anomaly, and the North Anna River continues to support a healthy, well-balanced community of aquatic organisms.

There is no commercial fishing in Lake Anna or the North Anna River. There are no runs of anadromous fish in the North Anna River. The North Anna River is a tributary of the Pamunkey River, which has an annual run of American shad; but these shad do not move into the North Anna River (Jenkins and Burkhead 1994; Bilkovic 2002). The Pamunkey Fish Hatchery in King William County, Virginia, is approximately 121 km (75 mi) downstream of the North Anna Dam. Shad reared at this facility are normally stocked in the Pamunkey River and the James River as fry. Young American eels (*Anguilla rostrata*) are found in the North Anna River, and are not sought by commercial fishermen. The American eel is a catadromous species, meaning that these fish begin their lives in the open ocean and migrate into coastal rivers where they spend more of their lives in fresh water (Rohde et al. 1994). Upon reaching sexual maturity, at age 5 to 7 years, the eels migrate back to the ocean where they spawn and die. Eels in the North Anna River are juveniles, and also are known as "yellow eels."

The lower North Anna River below the North Anna Dam is small, approximately 23 to 46 m (75 to 150 ft) wide, but supports a diverse assemblage of stream fishes. It is a popular fishing spot. Unless stream flow is unusually high, powerboats are impractical. Most anglers fish from shore or from canoes and kayaks. Recreational fishermen generally seek largemouth and smallmouth bass or redbreast sunfish. Bluegill and redear sunfish are present as well, but receive less attention from anglers.

Although the VDGIF periodically surveys the fish of the lower North Anna River and monitors the condition of the recreational fishery, it does not actively manage these populations. VDGIF is most concerned about the largemouth and smallmouth bass populations in the lower river, as these are the species most often sought by anglers and the species most likely to attain harvestable size. Recent VDGIF surveys have indicated that largemouth bass and smallmouth bass populations are healthy, despite the limited supply of forage in the river.

Since 1987, Virginia Power biologists have gathered data on the abundance and distribution of bass species in the lower North Anna River (VEPCo 2001a). Biologists established transects at four locations in the lower river, counting and categorizing (by size) all bass that are observed and noting the type of cover being used by the fish. Historically, largemouth bass have dominated the fish counts at upstream locations, while smallmouth bass have been more prevalent at downstream locations (VEPCo 2001a). In recent years, both species have occupied the entire study area. Density estimates for both largemouth and smallmouth bass at all locations were lower during 2000 than average densities for the entire study period, but dense growth of hydrilla adjacent to stream banks limited the ability of observers to accurately count the fish.

Redbreast were most abundant in North Anna River electrofishing samples during 1998, 1999, and 2000, and are the four most abundant species since 1981 (VEPCo 2001a). The redbreast is found across the coastal plain and Piedmont of Virginia in warm-water creeks and rivers of low-to-moderate gradient (Jenkins and Burkhead 1994). It is an adaptable species, and may also be found in ponds, lakes, reservoirs, and even slightly brackish waters near the coast. The lower North Anna River redbreast population is a typical stream-dwelling population, with unremarkable growth rates, food habits, and spawning habits.

2.7.2.4 Threatened and Endangered Aquatic Species

This section describes the threatened and endangered aquatic animal species that exist within the ESP site, vicinity, and corresponding transmission line rights-of-way, and examines the potential impacts of the construction and operation of the proposed new units upon these resources.

Virginia Power has monitored fish populations in Lake Anna and the North Anna River for more than 25 years. No Federally or State-listed fish species has been collected in any of these monitoring studies, nor has any listed species been observed in creel surveys or occasional special studies conducted by Virginia Power biologists. No Federally or State-listed fish species' range includes Lake Anna or the North Anna River, and none are believed to occur in counties adjacent to Lake Anna or the North Anna River (i.e., Caroline, Hanover, Louisa, Orange, and Spotsylvania Counties). The only aquatic species listed by the FWS as Federally endangered is the dwarf wedgemussel.

Animals

No Federally or State-listed (i.e., endangered or threatened species of concern) fish species or critical habitats are found in Lake Anna or the North Anna River. No Federally or State-listed fish species has been collected in any surveys or operational monitoring studies. While VDGIF ecological databases indicate that there is the potential for one Federally listed mussel species, one State-listed mussel species, and one mussel species that is a candidate for Federal listing that occur in counties that border Lake Anna or the North Anna River, the three Federally or State-listed species – the Commonwealth freshwater mussel species dwarf wedgemussel (*Alasmidonta heterodon*), the Atlantic pigtoe (*Fusconaia masoni*), and James River spiny mussel (*Pleurobema collina*) – could occur in local streams, none have been observed or collected in local streams. A fourth mussel species, the kidney mussel (*Ptychobranchus subtentum*), a candidate for federal listing, has been reported to has been observed in the vicinity of the North Anna ESP site. However, these observations may be in error, because confirmed observations limit this species to more western mountain streams that drain to the

Gulf of Mexico. None of the three Federally or State-listed species have been found in Lake Anna of the North Anna River.

Table 2-4 identifies the aquatic species potentially occurring near the North Anna site listed as threatened or endangered by the FWS, VDGIF and VDCR.

Table 2-4. Federally Listed Threatened or Endangered Aquatic Species Known or Likely to Occur in Counties Adjacent or Downstream from the North Anna Reservoir (Louisa, Orange, Spotsylvania, Caroline, and Hanover Counties)

Scientific Name	Common Name	Counties	Status
Alasmidonta heterdon	dwarf wedgemussel	Hanover, Louisa, Caroline	FE,SE

FE=Federal endangered (FWS 2004 a,b,) SE=State endangered

The dwarf wedgemussel (*Alasmidonta heterodon*) was historically found in Hanover, Louisa, and Spotsylvania Counties (VDCR 2004). It is listed as endangered by both the State and FWS. The FWS Recovery Plan for the species, completed in 1993, indicated that one population survived in the South Anna River in Louisa County (Moser 1993). The VDGIF Fish and Wildlife Information Service database currently lists a "remnant" population in the South Anna River in Louisa County, presumably the same population (VDGIF 2004b).

There are other bivalves listed as species of concern by the Federal and State governments. The VDGIF's Fish and Wildlife Information Service database lists these species as occurring in a stream or streams near NAPS. All confirmed accounts of these species are confined to mountain streams in southwestern Virginia that are tributaries of the Tennessee River. It is unlikely that a disjunct population would occur several hundred miles away in a river system that flows eastward to the Atlantic Ocean.

None of these mussel species were collected in pre-impoundment surveys of the North Anna River, and none have been collected in more recent years during routine monitoring surveys.

Plants

No Federally or State-listed aquatic plant species have been collected in any of the monitoring studies associated with the existing NAPS Units 1 and 2, nor has any listed species been observed in surveys or special studies conducted by Virginia Power biologists. No Federally or State-listed aquatic species' range includes Lake Anna or the North Anna River, and none is believed to occur in counties adjacent to Lake Anna or the North Anna River (i.e., Carolina, Hanover, Louisa, Orange, and Spotsylvania Counties).

2.7.2.5 Aquatic Monitoring

The NRC does not impose conditions of operation, including monitoring requirements, in the area of water quality. Regulation of water quality lies in the National Pollutant Discharge Elimination System (NPDES) under the EPA or the states (Virginia in the case of any new units at North Anna). The NRC's role in water quality is limited to assessing aquatic impacts as part of its NEPA evaluation. To provide the information needed to assess potential aquatic impacts, previous monitoring programs and monitoring programs planned for construction and operation were reviewed. These programs are expected to support any required assessments of aquatic impacts associated with new units.

Virginia Power has monitored fish populations in Lake Anna since the early 1970s. Virginia Power conducts quarterly electro-fishing sampling at nine stations (five stations in the North Anna Reservoir, and four in the WHTF) and at six gill-netting stations (four in the reservoir and two in the WHTF). These surveys are designed to document (1) the types of fish species present in Lake Anna, (2) their relative numbers by species, and (3) their size class distribution. In the North Anna River below the dam, Virginia Power biologists have also gathered abundance and distribution data on largemouth and smallmouth bass by direct (snorkel) observation. The biologists sampled river segments, counted and categorized (by size) all bass that were observed, and noted the type of cover being used. Other fish abundance and distribution information in the North Anna River is collected three times per year by electro-fishing at four stations.

In response to NRC Generic Letter 89-13, Virginia Power initiated a semi-annual sampling program in the fall 1990 to monitor Asiatic clams (*Corbicula flumenia)* in the North Anna Reservoir, the WHTF, and the service water reservoir. Virginia Power continues to collect replicate samples at two North Anna Reservoir stations (i.e., intake and mid-lake), two WHTF stations, and a single station in the service water reservoir; they report the total number and density of clams at the stations and discuss population trends in semiannual reports. In the course of monitoring *Corbicula* populations, Virginia Power assesses the micro-fouling potential of Asiatic clams and looks for evidence that the exotic zebra mussel (*Dreissena polymorpha*) has invaded Lake Anna. As of the end of 2002, Virginia Power had observed no zebra mussels in Lake Anna.

Virginia Power biologists have also conducted studies in the North Anna River in response to reduced flow because of drought conditions. The studies included physical habitat measurements at different flows, dissolved oxygen, temperature, and collection of benthic macro-invertebrates.

Each fall, when warranted, an aerial and ground-based monitoring program that focuses on identifying the presence of a nuisance submerged aquatic macrophyte, *Hydrilla verticillata*, is conducted.

VDGIF also conducts aquatic ecology monitoring as part of their management responsibilities for the fisheries of Lake Anna. VDGIF district biologists monitor and research the fishes of Lake Anna annually, focusing primarily on the largemouth and striped bass. Other species, such as black crappie, walleye, channel catfish, and gizzard and threadfin shad, are also monitored by VDGIF.

2.8 Socioeconomics

This section presents the socioeconomic resources that could be potentially impacted by the construction, operation, and decommissioning of two new nuclear power units. It is organized into two major subsections providing details on demographics and community characteristics. These subsections include discussions on spatial (e.g., regional, vicinity, and site) and temporal (e.g., 10-year increments of population growth) considerations, where appropriate, as referenced.

The potential impact area for the analysis discussed in this section was determined by where the majority of employees of the currently operating NAPS Units 1 and 2 reside. There are approximately 720 employees currently at NAPS. Approximately 79 percent of these employees live in Henrico, Louisa, Orange, and Spotsylvania Counties and the City of Richmond (NRC 2002).

2.8.1 Demographics

The analysis of the population distribution around the ESP site out to an 80-km (50-mi) radius is based on the 2000 census. Table 2-5 presents the population in the concentric rings starting at 16 km (10 mi), 16 to 40 km (10 to 25 mi), 40 to 60 km (25 to 37 mi), and 60 to 80 km (37 to 50 mi), and projected population increases in those rings from 2000 to 2040. Dominion used a formula adopted from the Weldon Cooper Center for Public Service (2004), using the 1990 and 2000 Census as the base. The Weldon Cooper Center for Public Service, located at the University of Virginia, Charlottesville, performed the 2001 provisional population estimates for Virginia. The percent annual growth in population ranges between 1.2 percent (2030 to 2040) and 1.9 percent (2000 to 2010). Total growth in population between 2000 and 2040 is projected at 81 percent. The ESP, if granted, would expire in 2026 assuming an issue date of 2006.

All or parts of 32 counties and five major cities are located within 80 km (50 mi) of the proposed North Anna ESP site. The largest population center within 16 km (10 mi) of the site is the town of Mineral, which is southwest of NAPS. In 2000, the population of Mineral was 424 (USCB 2000a). Lake Anna State Park also lies within the 16-km (10-mi) radius to the northwest of the site.

Table 2-5. Population Distribution from 2000 to 2040 Within 80 km (50 mi) of the ESP Site

Year	0 to 16 km (0 to 10 mi)	16 to 40 km (10 to 24.9 mi)	40 to 60 km (24.9 to 37.3 mi)	60 to 80 km (37.3 to 50 mi)	Total	% Annual Growth
2000	15,511	185,456	487,482	849,347	1,537,796	
2010[a]	20,996	239,444	604,455	984,645	1,849,540	1.9
2020[a]	26,480	293,431	721,067	1,119,943	2,160,921	1.6
2030[a]	31,965	347,419	837,680	1,255,241	2,472,305	1.4
2040[a]	37,449	401,406	954,292	1,390,539	2,783,686	1.2

(a) Estimated population. Source: Dominion (2004a).

The town of Louisa, located west of the ESP site, falls within the 32-km (20-mi) radius. In 2000, its population was 1401 (USCB 2000a). The City of Fredericksburg, population 19,279 (USCB 2000a), is northeast of the site, and the town of Culpeper, population 9664 (USCB 2000a), is north of the site. Fredericksburg and Culpeper fall within or on the edge of the 48-km (30-mi) radius. Charlottesville, population 45,049 (USCB 2000a), is located west of NAPS, and Richmond, population 197,790 (USCB 2000a), is east of the site. Charlottesville and Richmond lie within or on the edge of the 64-km (40-mi) radius.

Table 2-6 lists the age distribution of the population in Henrico, Louisa, Orange, and Spotsylvania Counties and the City of Richmond in 2000 and compares the city populations to the population of Virginia. The counties' age-distributed populations closely track within 2 to 3 percent of each other. The exceptions are Spotsylvania County's under-18 age group (30.0 percent versus 24.6 percent for Virginia) and Orange County's 25-to-44 age group (27.8 percent versus 31.6 percent for Virginia).

Table 2-7 contains data on population, projected population, and annual growth rates for the area of potential impact. Among the counties included in the comparison, Spotsylvania County by far has the fastest growth rate, in terms of percentage growth from 1980 through 2000 (actual) and 2010 projected growth rate. Between 1990 and 2000, the population of Spotsylvania County increased by 57.4 percent. The population in Louisa County for the same 10-year period increased by 26.1 percent. During the same time period, population increases in Henrico and Orange Counties were 20.4 and 20.8 percent, respectively. The population of the City of Richmond decreased 2.6 percent during the same period (Virginia Statistical Abstract 2004). The City of Richmond consistently lost population over the 30-year period from 1970 through 2000 and is projected to continue to do so through 2010. Both Spotsylvania and Louisa Counties are ranked among the fastest growing counties in Virginia.

Table 2-6. Estimated Age Distribution of Population in 2000

	Henrico County		Louisa County		Orange County		City of Richmond		Spotsylvania County		Virginia	
Age Group	People	%	People	%	People	%	People	%	People	%	People	%
Under 18	64,702	24.7	6,255	24.4	5,955	23.0	43,178	21.8	27,108	30.0	1,738,262	24.6
18 to 24	20,553	7.8	1,691	6.6	1,678	6.5	25,932	13.2	6,626	7.3	679,398	9.6
25 to 44	86,166	32.9	7,656	29.9	7,184	27.8	62,712	31.7	29,062	32.2	2,237,655	31.6
45 to 64	58,278	22.2	6,710	26.2	6,620	25.6	39,839	20.1	20,073	22.2	1,630,867	23.0
65 and over	32,601	12.4	3,315	12.9	4,444	17.1	26,129	13.2	7,526	8.3	792,333	11.2
Totals	262,300	100.0	25,627	100.0	25,881	100.0	197,790	100.0	90,395	100.0	7,078,515	100.0

Source: USCB (2000b).

Table 2-7. Population Growth in Henrico, Louisa, Orange, and Spotsylvania Counties, and the City of Richmond–1980 to 2010

	Henrico County		Louisa County		Orange County		City of Richmond		Spotsylvania County	
Year	Population	Annual % Growth	Population	Annual % Growth	Population	Annual % Growth	Population	Annual % Growth	Population	Annual % Growth
1970	154,465		14,004		13,792		249,431		16,424	
1980	180,735	1.6	17,825	2.4	18,063	2.7	219,214	-1.3	34,435	7.7
1990	217,880	1.9	20,325	1.3	21,421	1.7	203,056	-0.8	57,405	5.2
2000	262,300	1.9	25,627	2.3	25,881	1.9	197,790	-0.3	90,395	4.6
2010	301,000[a]	1.4	29,100	1.3	30,000	1.5	191,600	-0.3	25,000	3.3

(a) Projected population for 2010; values for 1970 through 2000 are actual census population numbers.
Sources: Weldon Cooper Center (2004); Virginia Employment Commission (2003); Virginia Statistical Abstract (2004).

2.8.1.1 Transient Population

The area within 16 km (10 mi) of the ESP site is predominately rural and characterized by farmland and wooded tracts. No significant industrial or commercial facilities are in the area, and none are anticipated. As a result, employment is most likely to be out of, rather than into, the area.

Recreational use of Lake Anna, which is the cooling water source for NAPS, is the greatest contributor to a transient population. Numerous recreational sites, consisting of boat ramps, wet slips, camping sites, picnic areas, etc., are located around the reservoir. A central data collection site for recreational use of the lake does not exist. Dominion developed an estimate of lake use on a peak weekend day in mid-summer based on representative usage of recreational facilities (e.g., boating, picnicking, and camping) (Dominion 2004a). Data for the estimate were provided by the VDCR for the recreational facilities at Lake Anna. The estimate does not include use of the lake by local residents with their own private boat docks. Table 2-8 shows the estimated transient population in the vicinity attributed to the lake and to Paramount's Kings Dominion Amusement Park, located 32 km (20 mi) north of Richmond.

The resulting estimated total peak daily transient population on Lake Anna is 5900 for boating and other uses of the lake and 4370 for Lake Anna State Park. The use of the WHTF is limited to residents around the WHTF and their guests; thus, its peak use is less than 1000. Given the conservative assumptions and the potential for double-counting, these numbers may be high (Dominion 2004a).

The annual transient population is less certain because of the dramatic drop in boating during weekdays and the fall, winter, and spring seasons. Based on the Lake Anna State Park data and assuming 180 days of operation, the average daily attendance for the park is less than one quarter of the peak daily attendance. Assuming that the average attendance, excluding the park, is one-half the peak daily figure (Dominion 2004a), the total annual attendance in the vicinity of Lake Anna would be about 808,300, based on a 180-day use period.

An accurate count of the transient population between the 16-km (10-mi) and 80-km (50-mi) radii from the ESP site is difficult to estimate. There are colleges, schools, and hospitals within 80 km (50 mi). However, compared to the resident population within the same area, use of these facilities by the transient population is expected to be insignificant (Dominion 2004a).

Between 16 km (10 mi) and 80 km (50 mi) from the ESP site, Paramount's Kings Dominion Amusement Park is the only major recreational facility that draws a significant amount of transient visitors. Paramount's Kings Dominion Amusement Park is 56 km (35 mi) southeast of the site. The park operates from March to November and hosts about 2 to 2.5 million visitors annually. According to the park's public relations manager, the park could experience slow growth in the future, until it reaches its current maximum capacity of 2.875 million visitors per year (i.e., an additional 15 percent above the current attendance) (Dominion 2004a). On average, the park is open for public use about 138 days per year (Paramount 2004).

Table 2-8. Estimated Transient Population Recreating at Lake Anna Facilities and Paramount's Kings Dominion Amusement Park

Facility	Daily Peak Transient Population	Annual Usage	Comments/Assumptions
Lake Anna – Recreational Facilities and State park			
Lake Anna	5900	531,000	Annual use based on 180 days at 2,950/average day.
Waste Heat Treatment Facility	<1000	90,000	Peak daily use based on doubling the resident population in cooling lagoon sectors (one guest per resident). Annual use based on 180 days at 500/average day.
Lake Anna State Park	4370	187,300	Annual use was 187,300 between July 1, 2001, and June 30, 2002. Park closes in winter. Usage includes occupants of boats launched at the park.
Total Estimated Annual Attendance		808,300	Assumed 180 days of operation. For Lake Anna State Park assumed 25 percent of the peak daily attendance. For Lake Anna (including the WHTF), assumed average attendance is one half the peak daily figure.[a]
Paramount's Kings Dominion Amusement Park			
Total estimated attendance	18,115	2,500,000	Annual use is estimated at between 2.0 to 2.5 million between March and November. Park closes in winter.
Attendance from outside 80-km (50-mi) radius	7246	999,948	Assumes that 40 percent of park visitors come from outside the 80-km (50-mi) radius.[b]
Total estimated transient population		1,808,248	Sum of Lake Anna and Paramount's Kings Dominion Amusement Park transient population

(a) Dominion calculated the annual attendance at 807,300 based on a 180-day season (Dominion 2004a). The NRC staff, using the same numbers and assumptions, derived an estimated annual attendance of 808,300.
(b) Dominion used the maximum capacity of 2.875 million visitors per year to estimate 20,830 average daily park visitors (Dominion 2004a). The NRC staff used the current estimated annual number of visitors at the park as a basis for calculations of the estimated transient population.
Source: Dominion (2004a).

Using the annual number of visitors to the park and the average number of days open, the current average daily park visitor count is conservatively estimated to be 18,115. While there is no official count of visitors that come from areas outside the 80-km (50-mi) radius of the ESP site, the majority of the park visitors are expected to come from the Richmond and Fredericksburg areas because of their proximity to the park. Dominion assumed that 40 percent of the daily park visitors (7246 visitors) come from areas outside the 80-km (50-mi) radius; or 999,948 visitors over the 138 days that the park is open. These park visitors are considered transient population (Dominion 2004a). The total estimated transient population within 80 km (50 mi), therefore, is 1,808,248.

2.8.1.2 Migrant Labor

Migrant workers are typically members of minority or low-income populations. Because migrant workers travel and can temporarily spend a significant amount of time in an area without being an actual resident, they may be unavailable for counting by census takers. If this occurred, migrant workers would be under-represented in the U.S. Census Bureau's (USCB) minority and low-income population counts.

Agriculture in Louisa County is representative of the surrounding region, including Spotsylvania Henrico, and Orange Counties. In 1997, Louisa County had 385 individual farms. The main crops grown within the county are legumes, grass hay, corn for grain, soybeans, corn for silage, and wheat. Beef cattle production is also important, with 71 percent of the farms holding cattle and calf inventories and 71 percent of the farms selling cattle and livestock (Louisa County 2001). Migrant workers do not harvest agricultural crops in Louisa County; however, they do replant forestland that has been harvested (NRC 2002).

Over the past 5 years, most completely harvested forestland in Louisa County has been replanted or allowed to regenerate naturally. From July 1998 to June 2000, approximately 1465 ha (3560 ac) of forest land were thinned or cleared. In 1999, 877 ha (2130 ac) were reforested (Louisa County 2001). Planting takes place from late January through March and is often done under a Virginia Department of Forestry contract, even on private lands. Migrant laborers often plant the trees. Data on the number of migrant workers participating in the planting are not available, but the number is considered to be small. Given the expected small number of migrant workers, and the fact that if they were concentrated at a single location where they would remain only for a short time, migrant workers would not materially change the population characteristics of any particular census tract within Louisa County.

2.8.2 Community Characteristics

2.8.2.1 Economy

The communities potentially impacted socioeconomically by activities at the ESP site are Henrico, Louisa, Orange, Spotsylvania Counties, and the City of Richmond, all in central Virginia. Louisa County, where the NAPS site is located, would see the greatest impact. All these counties, but not the City of Richmond, have experienced steady growth in population and economic activity during the 1990s. Brief discussions of the economy of each of the counties follow.

Some comparative economic statistics for the four counties and Virginia are presented in Tables 2-9, 2-10, 2-11, 2-12, and 2-13. Table 2-9 presents information on the unemployment rate (for December 2003), the percentage of individuals below the poverty line for 2000, and median household income. Table 2-10 presents the major employers in Louisa County.

Table 2-11 presents information on regional employment trends for Henrico, Louisa, Orange, and Spotsylvania Counties; the City of Richmond; and the Commonwealth of Virginia. Table 2-12 contains county and city employment by proprietorship and industry (1990 and 2000) for the four counties and the City of Richmond. Table 2-13 is an aggregation of Table 2-12 and totals employment by industry or business type across the four counties and City of Richmond for 1990 and 2000.

Table 2-9. Percent Unemployment, Individual Poverty, and Median Household Income

	Unemployment (% December 2003)	Poverty (% Estimated 2000)	Median Household Income (2000 $)
Henrico County	3.0	6.2	49,185
Louisa County	4.8	10.2	39,402
Orange County	3.5	9.2	42,889
City of Richmond	5.3	21.4	31,121
Spotsylvania County	1.9	4.7	57,525
Virginia	3.3	9.5	46,677

Sources: USCB (2000c); Virginia Employment Commission (2004).

Table 2-10. Major Employers in Louisa County, Virginia

Employer	Product	Number of Employees
Dominion Virginia Power	Electric Utility	1318+
Kloeckner–Pentaplast	Rigid PVC Products	652
Wal-Mart, Inc.	Distribution Center	525
Louisa County Public Schools	Education	680
Louisa County	Government Services	250[(a)]
AGI Klearfold, Inc.	Plastic Packing	160
Tri-Dim	Filters	120

(a) Inclusive of full- and part-time employees (VEPCo 2001a).
Sources: Louisa County Economic Development (2004), and NRC 2002.

Table 2-11. Regional Employment Trends – 1990 and 2000

County, City, and State	Workers Employed Full-Time and Part-Time 1990	Workers Employed Full-Time and Part-Time 2000	% Change in Workers Employed 1990 - 2000	Unemployment Rate 1990 %	Unemployment Rate 2000 %
Henrico	142,293	194,787	36.9	3.0	1.6
Louisa	8427	11,641	38.1	4.9	3.1
Orange	9955	10,558	6.1	2.5	2.2
Spotsylvania and Fredericksburg	40,402	59,872	48.2	3.8	1.3
City of Richmond	221,241	196,175	-11.3	6.4	2.9
Total for region	422,318	473,033	12.0	-	-
Virginia	3,727,194	4,424,791	18.7	4.5	2.2

Sources: BEA (2000) and County and City Data Books (1994, 2000).

Table 2-12. County and City Employment by Proprietorship and by Industry

Industry	Henrico County		Louisa County		Orange County		Spotsylvania County and Fredericksburg		City of Richmond	
	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000
Proprietors employment	15,789	16,705	2052	5282	2306	2092	6902	9173	14,437	14,033
• Nonfarm proprietor employment	15,628	16,529	1621	4827	1868	1613	6603	8871	14,437	14,033
• Farm proprietor employment	161	176	431	455	438	479	299	302	0	0
By Industry										
Farm employment	234	214	511	476	644	671	373	341	0	0
Agriculture services, fishing, and other	899	1352	146	191	126	164	294	D	539	639
Mining	200	187	76	D	L	D	10	D	161	195
Construction	10,539	12,092	1352	1227	972	913	3916	4497	8842	8513
Manufacturing	13,465	16,514	1548	1548	2058	1689	3215	3420	28,327	19,175

Table 2-12. (contd)

Industry	Henrico County 1990	Henrico County 2000	Louisa County 1990	Louisa County 2000	Orange County 1990	Orange County 2000	Spotsylvania County and Fredericksburg 1990	Spotsylvania County and Fredericksburg 2000	City of Richmond 1990	City of Richmond 2000
Transportation and public utilities	6313	8815	D	D	214	326	1271	2191	12,383	10,965
Wholesale trade	9771	11,757	116	227	212	558	1945	2678	11,697	9048
Retail trade	29,430	38,274	773	1310	1782	1903	10,606	15,513	22,744	18,830
Finance, insurance, and real estate	19,811	32,402	431	1222	601	D	3084	3754	24,320	16,601
Services	39,902	59,016	D	2949	1897	1768	10,424	19,237	61,122	61,735
Government and government enterprises	11,729	14,164	1040	1341	1446	2066	5264	7652	51,106	50,474

D - Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
L - Fewer than 10 jobs, but the estimates for this item are included in the totals.
Source: BEA (2000).

Table 2-13. Aggregated Employment by Industry or Business Type for Henrico, Louisa, Orange, and Spotsylvania Counties and the City of Richmond

Industry or Business Type	1990 Employment	2000 Employment	% Increase (Decrease)
Proprietors employment	41,486	47,285	14.0
• Nonfarm proprietor employment	40,157	45,873	14.2
• Farm proprietor employment	1329	1412	6.2
By Industry			
Farm employment	1762	1702	-3.4
Agriculture services, fishing, and other	2004	2346*	17.1*
Mining	447*	382*	-14.5*
Construction	25,621	27,242	6.3

Table 2-13. (contd)

Industry or Business Type	1990 Employment	2000 Employment	% Increase (Decrease)
Manufacturing	48,613	42,346	-12.9
Transportation and public utilities	20,181*	22,297*	10.5*
Wholesale trade	23,741	24,268	2.2
Retail trade	65,335	78,830	20.7
Finance, insurance, and real estate	48,247	53,979*	11.9*
Services	113,345*	144,705	27.7*
Government and government enterprises	70,585	75,697	7.2

Source: BEA (2000).
*Summations and percentages are for numbers shown in Table 2-12 (i.e., as with Table 2-12, some county data are not reported because of confidentiality issues).

The City of Richmond is part of the Richmond-Petersburg metropolitan statistical area, which is home to approximately 950,000 people. The Richmond-Petersburg area is the primary economic driving force within an 80-km (50-mi) radius of NAPS. The Richmond metropolitan statistical area is located approximately 160 km (100 mi) from Washington, D.C., and has a transportation network of trucking and railroad terminals and interstate highway access to main east-west and north-south routes. It also has an international airport and the western-most inland port in the Commonwealth of Virginia with direct access to the Atlantic Ocean, giving it access to both domestic and international markets (VEPCo 2001a).

The unemployment rate for the City of Richmond at the end of December 2003 was 5.3 percent (Table 2-9), an increase from an annual unemployment rate of 2.9 percent for the year 2000 (Table 2-11). The workforce decreased from approximately 221,241 to 196,175 or about 11.3 percent between 1990 and 2000. Services, government, and manufacturing are the biggest employment sectors for 2000 (see Table 2-12). The City of Richmond leads with the highest poverty rate and lowest median household income of the five jurisdictions evaluated (Table 2-9).

Henrico County is also part of the Richmond-Petersburg metropolitan statistical area. The Richmond area is home to the headquarters of 35 major corporations, including eight Fortune 500 companies and 14 Fortune 1000 corporations. Of those numbers, three Fortune 500 and three Fortune 1000 companies are located in Henrico County (Henrico County 2004a). Services, retail trade and finance, insurance, and real estate are the largest employment sectors in the county (Table 2-12) (Henrico County 2004a). Capital One Financial Corporation is one of the largest private employers in the area (NRC 2002). The unemployment rate in Henrico County was 3.0 percent in December 2003 (Table 2-9) (Virginia Employment Commission 2004), essentially unchanged from 2000. Henrico County's workforce increased from approximately 142,000 in 1990 to 195,000 in 2000, or about 37 percent (see Table 2-11).

Henrico County had the second highest median household income (at $49,185 in 2000) and the second lowest percentage individual poverty in 2000, 6.2 percent of the total population (Table 2-9). The median household income in Henrico County exceeded Virginia's median household income by approximately $2500.

Louisa County is located in the triangle between Richmond, Fredericksburg, and Charlottesville. Interstate Highway 64 (I-64) runs east-west through the county, as does a CSX Corporation rail line. Because NAPS is located in Louisa County, that county has benefitted more economically from the existing Units 1 and 2 than have Henrico, Orange, and Spotsylvania Counties. Table 2-10 shows the top seven employers in Louisa County.

Until the 1990s, Louisa County had been rural and dominated by farming and forestry, which are still economically important. In the 1990s, the county population grew by 26 percent, without a comparable increase in industrial and commercial development (Louisa County 2001). The number of full-time and part-time jobs in the county increased from 8427 in 1990 to 11,641 in 2000, an increase of 38.1 percent (see Table 2-11). During the 1990s, two clothing manufacturers located in the county closed (Louisa County 2001). A positive aspect of the county's economic development was the arrival of a Wal-Mart Regional Distribution Center at Zion Crossroads in the western part of the county. Wal-Mart currently employs approximately 525 people (see Table 2-10). In addition, since 1990 the unemployment rate in Louisa County dropped from 4.9 percent (see Table 2-11) to 3.1 percent in 2000. The unemployment rate has since increased to 4.8 percent for December 2003 (Table 2-9). Services, manufacturing, construction and finance, insurance, and real estate were the top employment sectors in the county in 2000 (Table 2-12). Louisa County had the second highest individual poverty rate and second lowest median household income (for 2000) of the five jurisdictions (see Table 2-9).

More than half the 11,640 resident workers in Louisa County commute to jobs outside the county (Louisa County 2001; VEPCo 2001a). In many respects, Louisa County is a bedroom community for the larger metropolitan regions, particularly Richmond, and to a lesser extent, Fredericksburg, Charlottesville, and Washington, D.C.

Operation of NAPS Units 1 and 2 in Louisa County has kept the property tax assessment rates significantly below those of neighboring counties. It also enabled the county to begin an economic development program in the 1970s with the construction of its industrial park (NRC 2002). While recognizing that NAPS has been economically beneficial, Louisa County would like to lessen its dependence on NAPS through diversification of the local economy. To achieve this diversification, the county hopes that it can attract technology and bio-research firms (NRC 2002) and that Wal-Mart will train and provide employment for workers at the lower end of the pay scale, which is defined as being substantially higher than minimum wage (currently the Federal minimum wage is $5.50 per hour), but generally less than $10 per hour.

The economy in Orange County is dominated by agribusiness, manufacturing, and commercial retail services. The towns of Orange and Gordonsville are the only two incorporated towns in the county. A planned, gated residential community exists at Lake of the Woods (VEPCo 2001a).

Orange County's workforce was approximately 10,560 in 2000 (see Table 2-11), with 45 percent of working adults commuting out of the county to work (Orange County 2004a). The existing employment base in Orange County represents an increase of 6.1 percent over the 1990 level (Table 2-11). The largest employer (600 people) is American Woodmark Corporation. The second largest employer (287 workers) is Von Holtzbrinck Publishing Services, a book distribution center (Orange County 2004b). The unemployment rate in Orange County was 3.5 percent in December 2003 (Table 2-9), an increase from the annual unemployment rate of 2.2 percent in 2000 (Table 2-11). Orange County had the third highest median household income and individual poverty rate of the five jurisdictions studied (Table 2-9). In percentage terms, the fastest growing employment sectors in Orange County during the decade of the 1990s were wholesale trade (163 percent), transportation and public utilities (52.3 percent), and government and government enterprises (42.9 percent) (Table 2-12).

Spotsylvania County is located halfway between Washington, D.C. and Richmond, Virginia. Economically, it is more associated with the Washington, D.C. metropolitan area through the commuting patterns of its residents (NRC 2002). It is estimated that approximately 40 percent of the county's workers commute to jobs outside the county (NRC 2002). Hence, the county is a bedroom community to the Washington, D.C., and Richmond metropolitan areas.

Historically, agriculture and forestry have been important components of the economy for Spotsylvania County. The economic slowdown of 2001 to 2002 did not materially impact Spotsylvania County, as can be seen by the unemployment and other economic factors. The continued building boom, particularly in residential construction, was the most important economic factor (Partridge et al. 2003). The relative economic importance of agricultural and forest activities has declined as the commercial base as the county has grown. The largest employer in Spotsylvania County is Capital One (employment at 1200), which has a call center located in the county. Spotsylvania County government is the next largest employer (at 650 workers), with CVS Pharmacy third (450 workers). CVS Pharmacy has a distribution warehouse located in the county (Spotsylvania County 2004).

The unemployment rate in Spotsylvania County was 1.3 percent for the year 2000 (Table 2-11). This compares with an unemployment rate of 1.9 percent as of December 2003 (Table 2-9).

While there is exceptionally low unemployment in the county, Spotsylvania County lacks resident-based employers that pay higher wages. The prevalent wage paid by a number of resident based employers is under $10 per hour (Partridge et al. 2003). Workers employed full-time and part-time increased by approximately 48.2 percent between 1990 and 2000 (Table 2-11). In percentage terms, the fastest growing employment sectors in Spotsylvania County between 1990 and 2000 were services (84.5 percent); transportation and public utilities (72.4 percent); retail trade (46.3); and government and government enterprises (45.4 percent).

There are no growth restrictions in Spotsylvania County, which had the second highest growth rate in Virginia and the thirteenth highest in the country (Partridge et. al. 2003). Attempts are being made to manage growth through the permit process. One such approach involves down-zoning housing density (for example, where housing density once was one house per acre, now it is one house per 2 acres). Attempts are being made to preserve agricultural land by limiting one house to approximately 10 acres. Also, market forces are limiting entry into the county's housing market. It is currently a seller's market, because houses in Spotsylvania County are more affordable than in Fairfax County and other Northern Virginia locations. The average price of a residential house in Spotsylvania is around $215,000, with more than that price often being offered by potential buyers. This is shifting growth that might have taken place in Spotsylvania County to Louisa and Caroline Counties and beyond (Goss 2003).

Table 2-13 aggregates employment by industry or employment type across Henrico, Louisa, Orange, and Spotsylvania Counties and the City of Richmond between 1990 and 2000. The fastest growing sector was services (27.7 percent). Next was retail trade at 20.7 percent, followed by agricultural services, fishing, and other at 17.1 percent. Proprietor employment increased by 14.0 percent, followed by finance, insurance, and real estate, which increased by 11.9 percent. The construction workforce increased from 25,621 in 1990 to 27,242 in 2000, or 6.3 percent. As can be seen from Table 2-11, the total number of workers increased from 422,318 in 1990 to 473,033 in 2000, or 12.0 percent.

2.8.2.2 Transportation

There are 32 counties within the 80-km (50-mi) radius of the ESP site (see Figure 2-2). One county is in Maryland while the remaining counties are in Virginia. The 31-county Virginia area is served by two major freeways. Interstate Highway 95 (I-95) runs north-south through the region and connects it with Washington, D.C., to the north and Richmond, Virginia, to the south. I-64 connects Richmond to Charlottesville on the west and Norfolk on the east. I-295 serves as a beltway around the City of Richmond.

The area is also traversed by several other State and Federal highways including U.S. Route 15 (U.S. 15) from the vicinity of Warrenton in the north, through Culpeper, and on south. U.S. 29 runs more northeast to southwest from the vicinity of Manassas, through Culpeper, to Charlottesville, and extends on to the southwest. U.S. 33 passes through Louisa and then southeast to Richmond. U.S. 250 runs between Charlottesville and Richmond. Numerous State routes (SRs) traverse the area including SRs 700, 652, 208, and 522.

Road access to North Anna is via SR 700, a narrow, two-lane, paved road. SR 700 intersects SR 652 approximately one-half mile from the North Anna site. The major commuting routes in the immediate vicinity of NAPS are SRs 700, 652, 208, 522, and 618. These roads all carry a level-of-service (LOS) designation "B" (stable flow in which the freedom to select speed is unaffected but the freedom to maneuver is slightly diminished). See Table 2-14 for a description of LOS designations.

General transportation studies have been undertaken of highways in the region. The interchange for SR 606 and I-95 is congested, generally at a LOS D or better. A Virginia Department of Transportation (VDOT) I-95 interchange study has determined that this interchange will become more congested in the future (Dominion 2004a).

The VDOT I-95 study includes an analysis of traffic patterns for the SR 606/I-95 interchange out to year 2025. The study identifies an existing congestion issue and relates it to the ongoing rapid growth in western Spotsylvania County. Upgrading the access to I-95 has been delayed due to lack of funding. The VDOT study also identifies the need for widening the western section of SR 606 to alleviate the existing congestion that affects traffic trying to access I-95 north and south.

I-95 north from Richmond is not as congested. I-64 west from Richmond has a LOS no worse than B (Dominion 2004a). During the December 2003 site visit, the staff noted that even during what would normally be considered rush hour, I-64 leaving Richmond westbound in the evening or returning to Richmond in the morning was moderately traveled, with traffic moving well. SRs 208 or 522 are well maintained, lightly traveled, two-lane roads.

The Louisa-Orange-Spotsylvania Advisory's three-county planning group, the Lake Anna Advisory Committee, has recommended that planners in each of the three counties upgrade their local roads around Lake Anna. The recommended upgrades would provide a circumferential roadway system around the lake with adequate lanes for towed boats and bicycles. Should the upgrade occur, it would alleviate congestion on local roads, such as SRs 608 and 522 (Lake Anna Special Area Plan Committee 2000). The Louisa County Comprehensive Plan of 2001 also recognizes the need to improve the roadways around Lake Anna. The plan recommends improvement to the roads within Louisa County, but provides no information on funding or the timing of the recommended road improvements (Louisa County 2001).

Table 2-14. Level-of-Service Designation Characteristics

Level-of-Service	Conditions
A	Free flow of the traffic stream; users are unaffected by the presence of others.
B	Stable flow in which the freedom to select speed is unaffected, but the freedom to maneuver is slightly diminished.
C	Stable flow that marks the beginning of the range of flow in which the operation of individual users is significantly affected by interactions with the traffic stream.
D	High-density stable flow, in which the freedom to maneuver are severely restricted; small increases in traffic will generally cause operational problems.
E	Operating conditions at or near capacity level, causing low but uniform speeds and extremely difficult maneuvering that is accomplished by forcing another vehicle to give way; small increases in flow or minor perturbation will cause breakdowns.
F	Defines forced or breakdown flow that occurs whenever the amount of traffic approaching a point exceeds the amount that can traverse the point. This situation causes the formation of queues characterized by stop-and-go waves and extreme instability.

Source: VEPCo 2001a.

Spotsylvania County plans to widen SR 606 west of I-95 to four lanes and has included this project in their comprehensive plan (Spotsylvania County 2002). Construction of a SR 208 Bypass around the historic Courthouse District is currently planned to begin in 2006. When completed, the SR 208 Bypass will connect the Spotsylvania Parkway (SR 208 north) with Courthouse Road (SR 208 south) south of its intersection with SR 606. SR 208 south is a minor road with a bridge over the North Anna Reservoir west of the ESP site. Spotsylvania County's plans are to upgrade the two-lane roads around Lake Anna by widening them to include shoulders, which should more easily accommodate larger vehicles such as motor homes. This upgrade is in line with the three-county planning group's plans for the Lake Anna area (Dominion 2004a).

In Hanover County, U.S. 33 links Richmond with Louisa and points to the north and west. This two-lane road in the northern part of the county is currently congested and needs to be widened (Dominion 2004a). A time frame for the widening has not been set because the source of funding has not been identified. Traffic congestion would be considered in developing a county traffic management plan (Hanover County 1998).

2.8.2.3 Property Taxes

Table 2-15 presents information on the total property tax revenues and the amount Dominion paid to Louisa County for NAPS from 1995 to 2003. In addition, the percentage of total property taxes paid and the county's budget is presented. For the period 1995 to 2003, property taxes for NAPS averaged about 46 percent of the total property tax revenue for Louisa County over the 9-year period and averaged approximately 22.5 percent of the county's total annual budget. Dominion projected annual property tax payments for NAPS would continue to increase slightly (absolute amount) through the license renewal term of Units 1 and 2 (VEPCo 2001a). However, the percent such payments represent of the total county taxes paid will probably continue to decline. The potential effects of electric utility deregulation in Virginia on future property tax collections from the units is not fully known at this time.

The significance of this discussion on the economy is that the four-county area around the ESP site is in a state of change. Henrico and Spotsylvania Counties are more economically sound than Orange and Louisa Counties. Spotsylvania County, for at least the last two decades, has been influenced economically by the Washington, D.C., and northern Virginia economies, with many white-collar professionals choosing to live in Spotsylvania County (for the suburban-country lifestyle) and commute to jobs in Washington, D.C, and northern Virginia. Also, over the last two decades, the Richmond area has become economically diversified and has grown significantly. Some of this growth has impacted Spotsylvania County, to the north, and Henrico County, which abuts the City of Richmond.

Table 2-15. Property Tax Revenues Generated in Louisa County; Property Taxes Dominion Paid to Louisa County; and Operating Budgets for Louisa, Orange, and Spotsylvania Counties – 1995 to 2003

Year	Total Property Tax Revenues	Property Tax Paid to County for NAPS	Percent of Total Property Taxes	Total County Operating Budget
		Louisa County		
1995	19,244,309	10,683,585	56	36,121,116
1996	21,452,251	11,131,726	52	44,471,914
1997	22,783,690	11,361,154	50	37,600,195
1998	24,141,313	11,006,924	46	37,651,399
1999	24,094,105	11,145,065	46	43,562,452
2000	24,770,698	10,583,390	43	46,554,387
2001	24,343,887	10,987,610	45	51,944,200
2002	25,861,613	9,931,868	38	56,704,171
2003	26,098,535	10,171,340	39	54,514,969

(a) The total county budget is in some years due to capital construction such as schools.
(b) Source: McLeod, March 16, 2004.

Orange and Louisa Counties have also benefitted from the growth in neighboring Henrico and Spotsylvania Counties. In addition, both Louisa and Spotsylvania Counties have been impacted by Lake Anna and the economic development around Lake Anna. Orange County has been impacted to a lesser extent by this development because it has fewer miles of shoreline. Development around Lake Anna has been oriented toward upscale vacation and retirement homes. Lake Anna is becoming family oriented with more permanent year-round residences (Goss 2003). Land values around the lake have increased significantly. Starter homes are being built on Louisa County's eastern edge, closer to the City of Richmond. Homes and developments for residents with moderate incomes are scattered across Louisa County, and upscale neighborhoods are being built in the western end of the county closer to Charlottesville and around Lake Anna.

Dominion has a significant impact on the economic well-being of Louisa County, paying an average, about 46 percent of the total property taxes between 1995 and 2003. Louisa County schools have benefitted substantially from the taxes Dominion pays for NAPS by being able to upgrade their infrastructure. Over time, the percentage contribution of total NAPS property taxes payable to Louisa County for NAPS Units 1 and 2 will decline, assuming the current rate of economic growth in the county continues. Thus, while the economic importance of NAPS is expected to decline, it may decline even faster if Louisa County experiences substantial economic growth as did Spotsylvania and Henrico Counties during the 1990s.

2.8.2.4 Aesthetics and Recreation

Access to the North Anna site itself is provided by SR 700, a narrow, two-lane road leading up to the plant boundary. The terrain is gently undulating and wooded. Most of the site structures are screened from public view up to the proximity of the plant boundary. Noise from plant operations is not noticeable, particularly from points outside the NAPS plant boundary.

From October 2000 to September 2002,[a] the area around Lake Anna went through a severe drought, the worst in the 108-year history of data collection in the area. The drought had an impact on Lake Anna with the water level dropping to 245 feet above MSL. The normal operating pool level is 250 feet above MSL. As a result of the drop in water levels, most boat ramps could not support launches (Dominion 2004c, d).

An effort was made to determine how the drought affected park attendance and boat launches at Lake Anna State Park. The results are presented in Table 2-16.

(a) October through September is defined as a water year for purposes of measuring precipitation.

Table 2-16. Visitor and Boat Launches at Lake Anna State Park – 1998 to 2003

Year	Annual Park Visitors	Annual Boat Launches
1998	145,500	2792
1999	111,000	2449
2000	158,200	2107
2001	178,300	2447
2002	185,900	2125
2003	159,700	2073

Source: Dominion 2004d.
Note: For annual park visitors, the 2003 data are for 11 months of the year only, from January through November.

With respect to park attendance, it appears the drought had little impact. Annual attendance rates increased through the drought period (2000 to 2002) and then, based on annualizing the attendance from 11 months to 12 months for 2003, declined again.

The impact of the drought on boat launches from the park is more obvious. There was a general downturn in the number of boat launches between 1998 (at 2792 launches) and 2000 (at 2107 boat launches). During 2001, the number of launches increased to 2447 and then declined to 2125 in 2002 (the worst year of the drought), or 13.2 percent. The number of boat launches continued their decline into 2003, declining by 2.4 percent over 2003.

2.8.2.5 Housing

Approximately 720 permanent employees work at NAPS Units 1 and 2 (Dominion 2004a). Approximately 79 percent of these employees live in Henrico, Louisa, Orange, and Spotsylvania Counties and the City of Richmond, the rest live in other locations. Table 2-17 presents the county of residence for the 820 permanent employees for whom addresses were provided during the license renewal review (NRC 2002). The staff expects that the 720 employees currently employed at NAPS Units 1 and 2 are distributed throughout the counties in the same pattern as the 820 employees were at the time of license renewal.

Dominion refuels each nuclear unit at NAPS on an 18-month staggered schedule. During refueling outages, site employment increases by as many as 700 temporary workers for 30 to 40 days. The staff assumed that residences for these temporary workers are similarly dispersed throughout the region as are those of NAPS permanent employees.

Table 2-17. North Anna Power Station – Permanent Employee Residence Information by Four-County Area of Potential Impact

County	Number of Personnel	Percent of Total Personnel
Henrico, including the City of Richmond	104	12.7
Louisa	237	28.9
Orange	120	14.6
Spotsylvania	186	22.7
Other	173	21.1
Total	820	100.0

Source: NRC 2002.

Table 2-18 provides the number of housing units and housing unit vacancies for the area of potential impact for 1990 and 2000. Each county in the area of potential impact has a comprehensive land use plan. Louisa County updated its plan in September 2001 (Louisa County 2001). Louisa County is adding from 350 to 400 homes a year to its housing stock. This rate has been fairly constant over the last 3 to 4 years (NRC 2002).

The county showing the greatest increase in housing units over the decade of the 1990s is Spotsylvania County, which one would expect given its economic growth over the decade. The number of housing units increased by 62.7 percent, and the number of renter-occupied housing units increased by 62.5 percent. The number of vacant units increased by 31.4 percent. The City of Richmond had the largest number of vacant units at 7733 in 2000, representing a decrease of 12.2 percent from 1990.

Table 2-19 presents more detailed 2000 census data on vacant housing units for Henrico, Louisa, Orange, and Spotsylvania Counties and the City of Richmond. Of the total vacant housing units, the City of Richmond, as previously noted, had the highest number at 7733 vacancies of which 3113 (or 40.3 percent of vacant housing) were for rent and another 2659 (or 34.4 percent) were vacant. Henrico County was second with 4449 vacant units of which 1970 (or 44.3 percent of vacant housing) were for rent and another 818 units (or 18.4 percent of vacant housing) were vacant. Louisa and Orange Counties had the smallest number of units for rent at 73 and 116, respectively. Within the counties of interest and the City of Richmond, approximately 5630 units were available for rent.

Table 2-18. Housing Units and Housing Units Vacant (Available) by County – 1990 and 2000

	1990	2000	Approximate Percentage Change
HENRICO COUNTY			
Total Housing Units	94,539	112,570	19.1
Occupied Units	89,138	108,121	21.3
Owner Occupied	56,848	71,089	25.1
Renter Occupied	32,290	37,032	14.7
Vacant Units	5401	4449	-17.6
LOUISA COUNTY			
Housing Units	9080	11,855	30.6
Occupied Units	7427	9945	33.9
Owner Occupied	5932	8110	36.7
Renter Occupied	1495	1835	22.7
Vacant Units	1653	1910	15.5
ORANGE COUNTY			
Housing Units	9038	11,354	25.6
Occupied Units	7930	10,150	28.0
Owner Occupied	6047	7822	29.4
Renter Occupied	1883	2328	23.6
Vacant Units	1108	1204	8.7
Housing Units	20,483	33,329	62.7
	1990	**2000**	**Approximate Percentage Change**
SPOTSYLVANIA COUNTY			
Occupied Units	18,945	31,308	65.3
Owner Occupied	15,516	25,735	65.9
Renter Occupied	3429	5573	62.5
Vacant Units	1538	2021	31.4
CITY OF RICHMOND			
Housing Units	94,141	92,282	-2.0
Occupied Units	85,337	84,549	-0.1
Owner Occupied	39,515	39,008	-1.3
Renter Occupied	45,822	45,541	-0.6
Vacant Units	8804	7733	-12.2

Sources: USCB 1990, 2000d.

Table 2-19. Vacant Housing Units for Henrico, Louisa, and Spotsylvania Counties and the City of Richmond – 2000

	Number	Percent of Vacant Units
Henrico County		
Vacant Housing Units	4449	
For rent	1970	44.3
For sale only	806	18.1
Rented or sold, not occupied	395	8.9
For seasonal, recreational or occasional use	454	10.2
For migratory workers	6	0.1
Other vacant	818	18.4
Louisa County		
Vacant Housing Units	1910	
For rent	73	3.8
For sale only	124	6.5
Rented or sold, not occupied	84	4.4
For seasonal, recreational or occasional use	1226	64.2
For migratory workers	0	0.0
Other vacant	403	21.1
Orange County		
Vacant Housing Units	1204	
For rent	116	9.6
For sale only	170	14.1
Rented or sold, not occupied	66	5.5
For seasonal, recreational or occasional use	484	40.2
For migratory workers	1	0.1
Other vacant	367	30.5
Spotsylvania County		
Vacant Housing Units	2021	
For rent	359	17.8
For sale only	449	22.2
Rented or sold, not occupied	164	8.1
For seasonal, recreational or occasional use	564	27.9
For migratory workers	1	0.0
Other vacant	484	23.9
City of Richmond		
Vacant Housing Units	7733	
For rent	3113	40.3
For sale only	949	12.3
Rented or sold, not occupied	761	9.8
For seasonal, recreational or occasional use	249	3.2
For migratory workers	2	0.0
Other vacant	2,659	34.4

Source: USCB 2000d.

Rental rates for reasonable housing in Louisa County are considered high for a small rural area, and the availability of rental apartments and housing is limited. Rents range from $750 to $800 per month for a moderately priced two-bedroom unit. The presence of the Wal-Mart distribution center at Zion's Crossroads has pushed rents to these levels and they can be held there because of the shortage of housing. There is also shortage of rental housing in Orange and Culpeper Counties and nearby Charlottesville.

2.8.2.6 Public Services

Water Supply

Table 2-20 summarizes the daily water consumption and areas served by each water system within the area of potential impact. Henrico County provides water to approximately 83,411 residential, commercial, and industrial customers (NRC 2002). Currently, the county purchases its water supply from the City of Richmond, which has no restrictions on the amount of water that can be purchased. Henrico County's average daily water use is 130,000 m^3/day (35 MGD). The county also has service agreements to supply limited amounts of water to Hanover and Goochland Counties (NRC 2002). Because of the rapid growth rate in Richmond and surrounding counties, a water supply treatment plant with a capacity of 210,000 m^3/day (55 MGD) was completed and placed in operation in May 2004 for Henrico County. Henrico County has a permit to withdraw 300,000 m^3/day (80 MGD) of water. The plant is expected to be expanded to accommodate the larger withdrawal rate by 2010 (Slater 2004).

Table 2-20. Major Public Water Supply Systems in Henrico, Louisa, Orange, and Spotsylvania Counties

Water System	Source	Daily Capacity (MGD)	Average Daily Use m^3/day (MGD)	Area Served
Henrico County	James River	NA	130,000 (35)	Henrico, Hanover and Goochland Counties
City of Richmond	James River	480,000 (128)	310,000 (83)	Richmond, Chesterfield, Hanover, and Henrico Counties
Louisa County Water Authority	Groundwater/NE Creek Reservoir	3800 (1)	1100 (0.3)	Towns of Louisa, Mineral, and some County residents
Town of Orange	Rapidan River	7600 (2)	5700 (1.5)	Town of Orange
Rapidan Service Authority	Groundwater	NA	75 (0.02)	Town of Grodonsville, plus 50 to 60 homes on Route 20
Wilderness Treatment Plant	Rapidan River	6100 (1.6)	1500 (0.4)	Town of Wilderness/Lake of the Woods
Spotsylvania County	Ni River	23,000 (6)	17,000 (4.5)	Supplies most residential, commercial, and industrial areas in the county

NA = not available.

Richmond's source of water is the James River, which supplies approximately 562,000 people in the City of Richmond and in Chesterfield, Hanover, and Henrico Counties. It has a maximum capacity of 484,000 m^3/day (128 MGD) and an average use of 310,000 m^3/day (83 MGD) (VEPCo 2001a). Richmond is upgrading the plant to treat 570,000 m^3/day (150 MGD).

About 80 percent of the residential drinking water for Louisa County is from groundwater through private wells. Twelve small private water supply systems exist in the county. The major treatment plant in the county is the Northeast Creek water treatment plant that supplies the town of Louisa, part of the town of Mineral, and some county residents. The plant has a capacity of approximately 3800 m^3/day (1 MGD), and average use is 1100 m^3/day (0.3 MGD). To provide water for industrial and other users, five new groundwater wells and a new storage tank were also completed between 2001 and 2004 in the Zion's Crossroads area in the western part of the county (Delk 2004). This is in addition to the existing storage tank.

Ninety percent of Orange County residents obtain their drinking water from private groundwater wells. The town of Orange draws its water directly from the Rapidan River in what is known as a "run-of-the-river" withdrawal.[a] The town of Orange also owns and operates a 7600 m^3/day (2 MGD) capacity water treatment plant that supplies the town (VEPCo 2001a). Average daily use is around 5700 m^3/day (1.5 MGD) (VEPCo 2001a).

Part of the town of Orange's treatment plant production, around 2000 m^3/day (0.5 MGD), is sold to the Rapidan Service Authority (RSA), which supplies the town of Gordonsville (VEPCo 2001a). RSA operates two other Orange County facilities. The source of water for these plants is the Rapidan River and groundwater. RSA's Wilderness Treatment Plant has a 6100 m^3/day (1.6 MGD) treatment capacity and supplies, on average, approximately 1500 m^3/day (0.4 MGD) to Lake of the Woods and the town of Wilderness (VEPCo 2001a).

Spotsylvania County has a public water system supplying most residential, commercial, and industrial areas within the county. Rural areas of the county are served by wells and springs (NRC 2002). The Ni River Treatment Plant, which draws water from the Ni River, has a capacity of 23,000 m^3/day (6 MGD) and average use of 17,000 m^3/day (4.5 MGD). Another larger treatment plant began operating during 2004 (Elam 2004).

Public water supply is not a constraint to growth in the vicinity of NAPS. There are supply concerns in some individual municipalities and in some of the impact counties. In Louisa County, water and sewer infrastructure are a concern now, particularly around the I-64 corridor in the vicinity of Gum Springs. The county is considering a separate system for this area.

(a) A "run of the river" means that there is little or no water storage behind the dam or structure being employed to withdraw water from the river.

Water supply reservoirs are also a concern. The recent drought exacerbated a shortage in the availability of water supplies. Currently there are no growth restrictions in Louisa County (Williams and Buckler 2003).

In Orange County, the Rapidan River is the source of water for several public water supply systems. The Rapidan River is not normally a high flowing river; thus, during the 2000 to 2002 drought, there were some water supply problems. In the corridor that encompasses Gordonsville and the town of Orange, water and sewer services are operating at maximum capacity. Any new growth will require system upgrades. Location is also a problem. The existing water supply system at the eastern end of the county, where many current NAPS employees live, is operating at close to capacity. Shipping water from the west end of the county to the east end would be expensive. Currently there are no growth restrictions in Orange County (Livingood and Kendall 2003).

There are no limitations on new sources of water from groundwater. In addition, many of the treatment plants located in the area of potential impact have reserve treatment capacity, especially in the larger metropolitan areas. In cases where municipal systems are approaching the limits of their reserve capacities, plans are in place to address those limitations by constructing new treatment systems or expanding existing facilities.

Police, Fire, and Medical Facilities

In Orange County, there are two outpatient clinics and no hospitals. The fire departments are made up of volunteers, and rescue services are composed of both volunteer and paid employees. In the future, for new facilities, the county is considering hiring full-time paid staff (Livingood and Kendall 2003). An increase in construction workers locating to the county could put pressure on this infrastructure.

In the town of Louisa and Louisa County, there is no hospital. In Louisa County, general fire, police, and rescue services are considered adequate at present (Lintecum 2003).

Henrico County is home to three hospitals. In total, 12 acute-care hospitals and seven special-care facilities are located in the Richmond area representing nearly 5200 patient beds. Notable in this total is the Medical College of Virginia Hospital, a major research and teaching center (Henrico County 2004b). Spotsylvania County has two hospitals.

Social Services

Social services in the Commonwealth are provided in each county by the Virginia Department of Social Services (VDSS) with offices in each county. The department provides services to children (child care, protective services, foster care and child support enforcement, among other services) and adults (adult protective services, domestic violence prevention, etc.) and financial assistance such as food stamps and Medicaid. The department has 131 local departments located throughout Virginia (VDSS 2004).

2.8.2.7 Education

Louisa County has one high school, one middle school, and three elementary schools. For the school year 2000 to 2001, there were 4232 students in the school system (NRC 2002). All schools currently have higher enrollment than they were designed to accommodate (on the order of 100 to 150 students depending on the school), so overcrowding is a concern. Enrollment is growing at 2 percent a year. Tax rates in the county have not increased in 6 years, so while the schools are being maintained, there has been no new construction to accommodate the increased enrollment. Growth is occurring in the county because of its low tax base when compared to the surrounding counties because Louisa County has NAPS in its tax base (see Table 2-15) (Milton 2003). Property was purchased for a new elementary school in 2004, with construction to start in 2005 (Green 2004). Property also has been purchased for construction of a new middle school. The growth areas in the county are around Lake Anna, Zion Crossroads, and the I-64 corridor (Lintecum 2003).

Orange County schools have a total enrollment of approximately 4200 students spread among five elementary schools, two middle schools, and one high school (Shifslett 2004). Orange County is expanding its school infrastructure. One new middle school has been added, and the high school has been renovated, adding an additional 26,000 square feet of space. Both middle schools currently have 600 students and could accommodate 800. The high school has a current enrollment of 1250 and could expand to 1500 pupils. Growth is taking place in the eastern end of the county, closer to NAPS and Lake Anna. There is one middle school in the eastern end of the county, and if growth continues, a new elementary school will need to be built (Baker 2003).

Spotsylvania County has 26 schools in its system (16 elementary schools, 6 middle schools, and 4 high schools). In addition, the county has one vocational school, and one special high school for intellectually gifted students (NRC 2002). Approximately 20,350 students are enrolled in the county school system, and an additional 350 are in the special high school (NRC 2002). A middle school is being constructed to accommodate growth around Lake Anna (Goss 2003).

Henrico County and the City of Richmond have 41 elementary schools, 10 middle schools, 9 high schools, and 2 technical centers (NRC 2002). Total school enrollment is more than 41,000.

2.9 Historic and Cultural Resources

This section discusses the cultural background and the known and potential historic and cultural resources at the North Anna ESP site and the immediate surrounding area.

2.9.1 Cultural Background

The area around the North Anna ESP site is rich in prehistoric and historic Native American and historic Euro-American resources. A number of recent documents provide adequate background detail for the area's cultural chronology and prehistoric and historic period contexts. Consequently, only a brief summary is provided here. For the ESP site, Ahlman and Mullin (2001) discuss the prehistoric and historic contexts. Another overview document discusses the cultural background at the nearby North Anna State Park (Goode and Dutton 1999), located upriver and north of the plant. Historic period overviews are available for both Louisa County (Thomas Jefferson Planning District 1995), in which the plant is located, and for Spotsylvania County (Traceries 1996), which is situated just across the North Anna River to the east of NAPS. Cooke (1997) also provides a historical overview of Louisa County. The following cultural chronology summaries are extracted from these sources.

Prehistoric Period

The prehistoric Native American occupation of the region including the North Anna site includes three general periods: the Paleo-Indian period (about 10,000 to 8000 B.C.); the Archaic period (about 8000 to 1000 B.C.); and the Woodland period (about 1000 B.C. to A.D. 1600). Toward the end of the Woodland period (A.D. 1500 to 1675), a transitional episode known as the Protohistoric period occurred in which initial contacts with Europeans and cultural changes associated with subsequent white settlement of the area took place.

The prehistoric periods were marked by initial reliance on big game hunting subsistence, followed by increased use of smaller game animals and plant foods in the Archaic era. Major environmental changes in the Archaic period led to an increasingly more sedentary lifestyle, focused primarily in riverine settings. Late in the Archaic, more sedentary villages and an increasing reliance on cultivated crops became the norm and the subsequent Woodland period was characterized by larger base camps in the river valleys, with subsistence based on agriculture, hunting and gathering, and intergroup trade. The latter part of the Woodland period is primarily identified by the added presence of European trade goods.

Historic Period Native American

At the time of European contact and subsequent intrusion into the area surrounding the North Anna site, the lands including the piedmont and mountains of western Virginia were occupied by several Siouan-speaking Indian groups.

One of the Monacan Indian groups, part of the larger Monacan Confederacy, is commonly associated with the area of present-day Louisa County. Between 1607 and 1720, the Monacan were gradually pushed from their homelands through a series of encounters with the encroaching settlers, and by the 1677 "Treaty Between Virginia and the Indians." By 1700, the Monacan had left Louisa County (Cooke 1993). Although some of the Monacan left the area for good, going as far as Pennsylvania and Canada, a remnant group moved to the Bear Mountain area of Amherst County, Virginia, around 1720. Today, the Virginia Monacan Tribe numbers about 900 individuals (Hauck and Maxham 1993). In 1989, the Monacan Tribe was recognized by the Virginia General Assembly as one of the eight indigenous tribes in the state, and became a member of the Virginia Council on Indians (Monacan Indian Nation Website).

Historic Period Euro-American

Similar to the prehistoric period, the historic period in Virginia can be subdivided into sequential time periods that are descriptive in terms of associated events. These include the European Settlement to Society Period (1607 to 1750); Colony to Nation Period (1750 to 1789); Early National Period (1789 to 1830); Antebellum Period (1830 to 1860); Civil War Period (1861 to 1865); Reconstruction and Growth Period (1865 to 1917); World War I to World War II Period (1917 to 1945); and the New Dominion Period (1945 to present).

European settlement of the area around the North Anna site began shortly after 1700, and Louisa County was formed in 1742. The earliest economy of the area was based on cultivation of tobacco in the fertile lands along the North and South Anna River valleys. In the early 1800s, production of tobacco resulted in severe soil exhaustion, and wheat and corn replaced it as staple crops. Although the area remained largely rural and agricultural in nature, at times mining and quarrying also became important to the economy of Louisa County in the 1800s, including mining of iron, copper, sulfur, gold and other ores, and quarrying of whetstone materials. The area just upriver from the North Anna site was the scene of intensive gold mining in the period from about 1830 to 1900.

2.9.2 Historic and Cultural Resources at North Anna Power Station

To assess both known and potential cultural resource sites at the North Anna ESP site, several existing literature and database sources were consulted, along with direct contacts to several organizations (Appendix B). Particularly useful in this regard was the recent cultural resource assessment for the plant site, commissioned by Dominion Resources (The Louis Berger Group 2001a, b).

At the time of the 2001 cultural resource assessment, examination of historic and cultural resource files at the Virginia Department of Historic Resources Archives indicated that no previously recorded cultural resource sites were known to exist at NAPS (Ahlman and Mullen 2001). Similarly, a review of historical documentation at the Louisa County Historical Museum, including historic maps dating between 1751 and 1863, indicate few historic resources in the vicinity of the North Anna site, other than an early road paralleling the south side of the North Anna River that appears to be near the western boundary of the North Anna site. An unpublished map based on county deeds from 1765 to 1815 (Truce undated), shows the presence of the "Jerdones Mill" on the North Anna River bank, just upriver from the North Anna site, along with the associated "Jerdones Mill Road." The same map shows an "Old Mine Road" within the North Anna site area.

Background research undertaken by Ahlman and Mullin (2001) indicate that on undisturbed lands within the larger plant boundary there is potential for both unrecorded prehistoric and historic cultural resources to occur. More recently, a field inspection of the proposed ESP project area was completed (Voigt 2003). This reconnaissance concluded that much of the proposed ESP site lies within previously disturbed areas, particularly in the eastern portion. However, some undisturbed areas in the western sector have some potential for the presence of cultural resources.

As a follow-up to the 2001 assessment, five known historic period cemeteries were recorded, three of which lie within the administrative boundary of the North Anna site and two that are located just down river from the North Anna Dam (Louis Berger Group 2001b). Two of these cemeteries have associated archaeological remains of former structures.

Two of the recorded historic period cemeteries, designated as 44LS221 and 44LS222 in the Virginia Department of Historic Resources site file system, are located in the vicinity of proposed ESP construction or laydown areas. Site 44LS221 is a small cemetery located in the area known as the Northwest Laydown Yard in a lightly wooded area. During construction of NAPS, this area was marked and protected during construction activities. Site 44LS222 is located on the hilltop above the proposed construction area and is protected by a tall chain-link fence.

It should also be noted that reconnaissance-level historic and archaeological investigations were also completed in 1969 and 1970 for both the North Anna site area and the lake bed area with few results (AEC 1973). A few Archaic period artifacts were noted in the area, but the investigator did not deem them worthy of recording and evaluating. In addition, according to records in the Louisa County Historical Society files, a total of 33 historic period cemeteries were identified in the area along the river to be inundated. Many of these were avoided by adjusting project boundaries, although some were "removed" prior to inundation. This total apparently includes at least four of the cemeteries recorded recently at the North Anna site. Finally, cultural resource surveys along transmission line rights-of-way associated with NAPS have largely resulted in negative findings for cultural resources (Saunders 1976; MacCord 1981).

2.9.3 Native American Consultation

Today, there are eight Native American tribes that are recognized by the Commonwealth of Virginia. Six of these tribes have for several years been pursuing federal recognition, but that status has not yet been achieved. Consultation letters were sent to the following tribes in conjunction with the North Anna ESP EIS:

- Chickahominy Indian Tribe
- Chickahominy Indians – Eastern Division
- Mattaponi Indian Tribe
- Monacan Indian Nation
- Nansemond Indian Tribe
- Pamunkey Indian Tribe
- Rappahannock Tribe
- Upper Mattaponi Indian Tribe

Based on information previously received from the Bureau of Indian Affairs, NRC also contacted the Tuscacora Nation concerning the ESP EIS for the proposed Units 3 and 4.

In addition, the Virginia Council on Indians was contacted regarding the project. The Council serves as an integrating office for Virginia's Indian Tribes within the state government.

2.10 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority[(a)] or low-income populations. The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice (CEQ 1997). Although it is not subject to the Executive Order, the Commission has voluntarily committed to undertake environmental justice reviews. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (NRC 2004).

The staff examined the geographic distribution of minority and low-income populations within 80 km (50 mi) of the North Anna site, employing the 2000 Census (USCB 2000e) for low-income populations and the 2000 Census (USCB 2000f) for minority populations. The radius within 80 km (50 mi) of NAPS encompasses counties in Virginia and Maryland. The analysis was also supplemented by field inquiries to the planning departments of Orange, Louisa, and Spotsylvania Counties (Livingood and Kendall 2003, Williams and Buckler 2003, and Goss 2003, respectively); social service agencies in Louisa and Orange Counties (Lingo 2003), and other governmental officials in Spotsylvania County.

For purposes of the staff's review, a minority population is defined to exist if the percentage of any minority or aggregated minority category within the census block groups[(b)] within an 80-km (50-mi) radius of the NAPS site exceeds the corresponding percentage of minorities in the entire States of Virginia and Maryland (for Charles County, Maryland) by 20 percent, or if the corresponding percentage of minorities within the census block group is at least 50 percent. A low-income population is defined to exist if the percentage of low-income population within a census block group exceeds the corresponding percentage of low-income population in the entire States of Virginia and Maryland by 20 percent, or if the corresponding percentage of low-income population within a census block group is at least 50 percent. For counties and census block groups within an 80-km (50-mi) radius of the ESP site, the percentage of minority and

(a) Minority categories are defined as: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; or Black races; or Hispanic ethnicity; "other" may be considered a separate minority category. The 2000 Census included multi-racial data. The staff should consider multi-racial individuals in a separate minority category, in addition to the aggregate minority category when the Census Bureau releases the updated information (69 FR 52040).

(b) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the Census Bureau collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census data users in accordance with Census Bureau guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts (NRC 2002).

low-income populations is compared to the percentage of minority and low-income populations in Virginia or Maryland, as applicable.[a]

Dominion followed the convention of including census tracts in its assessment. It included the census tracts where at least 50 percent of their area lay within 80 km (50 mi) of the ESP site (Dominion 2004a). The "more than 20 percentage points above the comparison area" criterion was used to determine whether a census tract should be counted as containing a minority or low-income population (Dominion 2004a). Because the 20 percentage points is a lower threshold, the 50 percent criteria was not needed.

The staff followed the convention of employing census block groups. Figure 2-6 shows the distribution of minority populations (shaded areas) within the 80-km (50-mi) radius. All census tracts with at least 50 percent of their area within an 80-km (50-mile) radius of the North Anna ESP site are included in the analysis.

(a) Low-income households should be identified using the annual statistical poverty threshold from the Census Bureau.

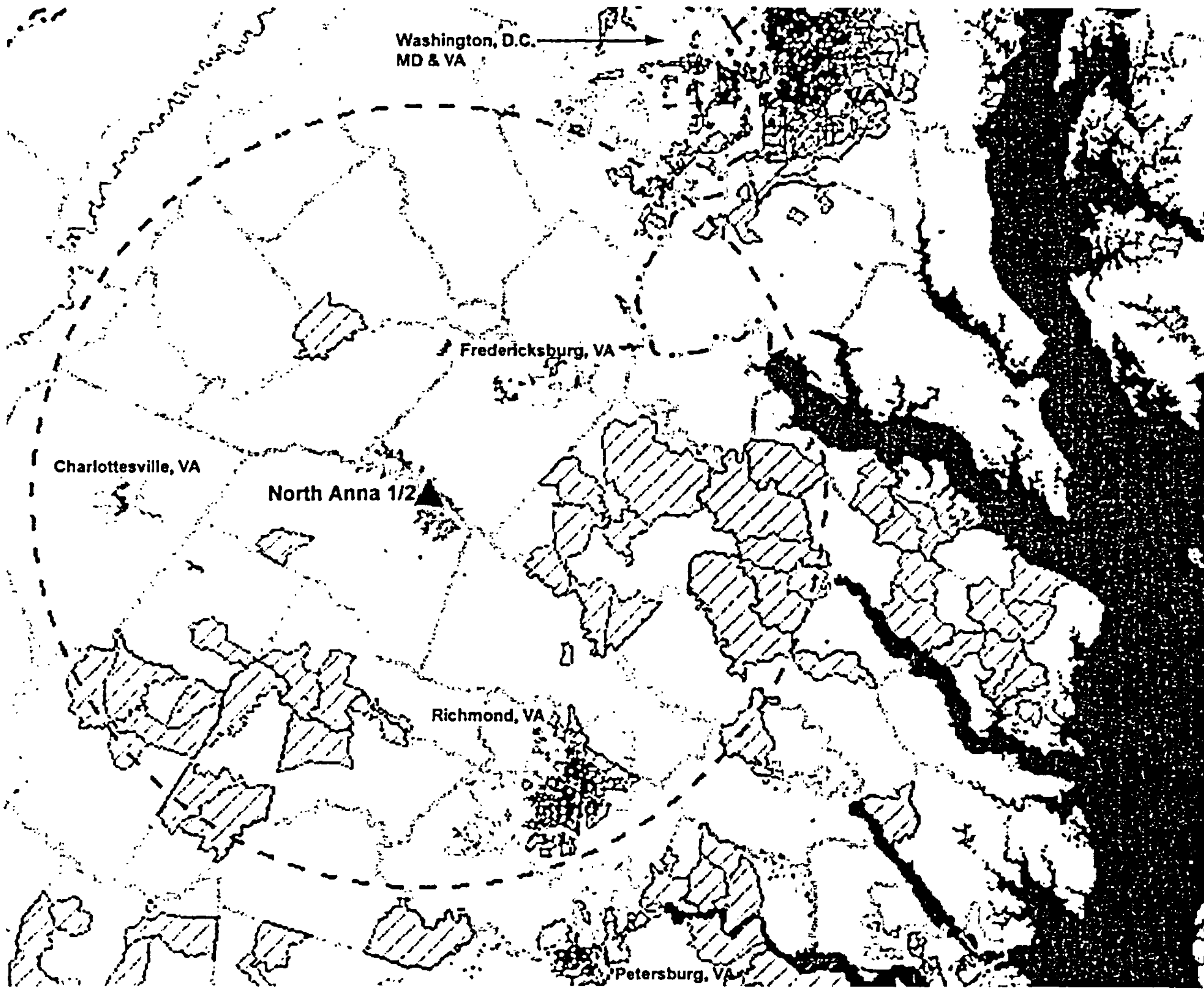


Figure 2-6. North Anna Census 2000 Environmental Justice Minority Within an 80-km (50-mi) Radius of the North Anna ESP Site

Within 32 km (20 mi) of NAPS, a minority population is concentrated to the southwest of the site in Louisa County. Black minority populations exist within approximately 24 km to 48 km (15 mi to 30 mi) east-southeast of the site on Caroline County's boundary with Hanover County and extending to King William County. Between approximately 64 km (40 mi) and 80 km (50 mi) east of the ESP site, minority populations exist in Essex and Westmoreland Counties.

A concentration of minority census block groups exists in Charles County (Maryland) and Prince William County (Virginia), east-northeast of the NAPS site. Between 64 km (40 mi) and 80 km (50 mi) southeast of NAPS, there is a concentration of minority census block groups in the Richmond area, and to the south-southwest a concentration in Buckingham, Fluvanna, Goochland, and Cumberland Counties. Minority populations also appear in Culpeper County northwest of the North Anna site. All minority block groups are more than 16 km (10 mi) from NAPS.

Data from the 2000 census characterize 9.6 percent of Virginia's and 8.5 percent of Maryland's populations as low-income (USCB 2000e). Applying the NRC criterion of "more than 20 percent greater," the census block groups were identified to contain low-income populations and are presented in Figure 2-7. Census block groups containing low-income populations are concentrated in the City of Richmond.

Also, Henrico and Chesterfield Counties, to the southeast between approximately 65 km and 80 km (40 mi and 50 mi) from the North Anna site, have low-income populations. Other areas of low-income populations include Buckingham County southwest of the site and Charlottesville.

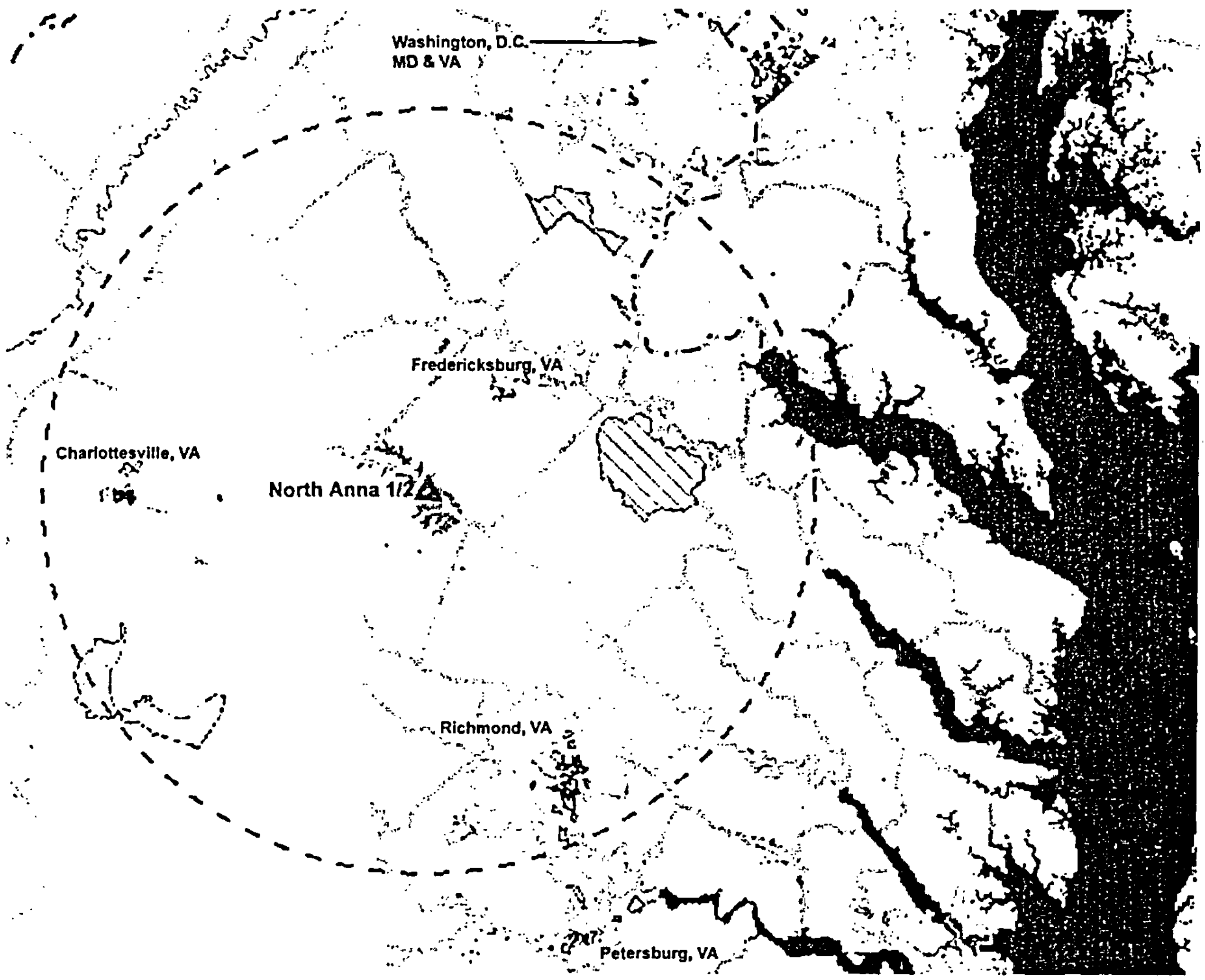


Figure 2-7. North Anna Census 2000 Environmental Justice Low Income Within an 80-km (50-mi) Radius of the North Anna ESP Site

2.11 Related Federal Projects

The staff reviewed the possibility that activities of other Federal agencies might impact the issuance of an ESP to Dominion. Any such activities could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency for preparation of the EIS (10 CFR 51.10(b)(2)).

Federal lands within an 80-km (50-mi) radius of the NAPS site include the George Washington Birthplace National Monument, Fredericksburg and Spotsylvania National Military Park, Richmond National Battlefield, Shenandoah National Park, Featherstone and Rappahannock National Wildlife Refuges, Fort A.P. Hill Military Reservation, Marine Corps Base Quantico, and the Naval Surface Warfare Center, Dahlgren Division. There are no national forests, wilderness areas, or wild and scenic rivers within the region. Several Virginia State Parks exist within the region. The closest park, Lake Anna State Park, is approximately 8 km (5 mi) northwest of the NAPS site. The closest Native American reservations, the Mattaponi and the Pamunkey Tribes, are more than 80 km (50 mi) from the NAPS site. The hydroelectric project operated by Virginia Power at the Lake Anna dam is not licensed by the Federal Energy Regulatory Commission because of its small size.

After reviewing the Federal activities in the vicinity of the NAPS site, the staff determined that there were no Federal project activities that would make it desirable for another Federal agency to become a cooperating agency for preparation of the EIS.

The NRC is required under Section 102(c) of NEPA to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in the subject matter of the EIS. During the course of preparing this draft EIS, NRC consulted with the FWS and the National Marine Fisheries Service. Contact correspondence is included in Appendix F.

2.12 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

40 CFR Part 81. Code of Federal Regulations, Title 40, *Protection of Environmental*, Part 81, "Designation of Areas for Air Quality Planning Purposes."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

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3.0 Site Layout and Plant Parameter Envelope

The site for the proposed North Anna early site permit (ESP) site is located in Louisa County in predominately rural central Virginia, and is within the current North Anna Power Station (NAPS) boundaries. The site is situated approximately 64 km (40 mi) northwest of Richmond, Virginia. This chapter describes the approach Dominion Nuclear North Anna, LLC (Dominion) used to identify the key plant parameters and site characteristics the needed to assess the environmental impacts of the proposed action (Dominion 2004a). The site layout, and existing facilities are discussed in Section 3.1. The plant parameters and power transmission system are discussed in Sections 3.2 and 3.3, respectively, and references for this chapter are documented in Section 3.4.

3.1 External Appearance and Site Layout

The North Anna Power Station consists of two operational pressurized water reactors (PWRs) furnished by Westinghouse Electric Company, a shared turbine building, a switchyard, intake and discharge structures, and support buildings. NAPS is located on the shore of Lake Anna, an impoundment created in 1971 by constructing a dam on the main stem of the North Anna River to create a source of cooling water for NAPS. Lake Anna is divided into the North Anna Reservoir, which serves as the cooling water source for NAPS Units 1 and 2, and the Waste Heat Treatment Facility (WHTF), which receives the heated discharge. The existing units use a spray pond for an ultimate heat sink. A radioactive waste disposal system, a fuel-handling system, an independent spent fuel storage installation, auxiliary structures, and other onsite facilities necessary for a complete operating nuclear power plant also exist on the NAPS site. With the exception of a few support buildings that may be relocated, the existing NAPS site would remain unchanged. The proposed North Anna ESP site, most of which has been previously disturbed, is located in an area adjacent to the existing Units 1 and 2 (Figure 3-1).

A specific plant design has not been selected for the proposed new Units 3 and 4; instead, a set of bounding plant parameters was chosen to envelop the North Anna ESP site development. This plant parameter envelope (PPE) is based on the addition of two new power generating units, each of which would be a stand-alone plant with its own support systems. Dominion states that the new units would share ancillary support structures such as maintenance facilities, office centers, and wastewater and water treatment plants. Each new unit would represent a portion of the total generation capacity to be added, and may consist of one or more reactors or reactor modules. These multiple reactors or modules (the number of which may vary depending on the reactor type selected) would be grouped into distinct operating units. The nuclear generating capacity to be added would not exceed 4300 megawatts-thermal (MW[t]) per unit, or up to a total of 8600 MW(t) for two units. For the cooling systems, Dominion has proposed using once-through cooling for Unit 3 and dry cooling towers for Unit 4.

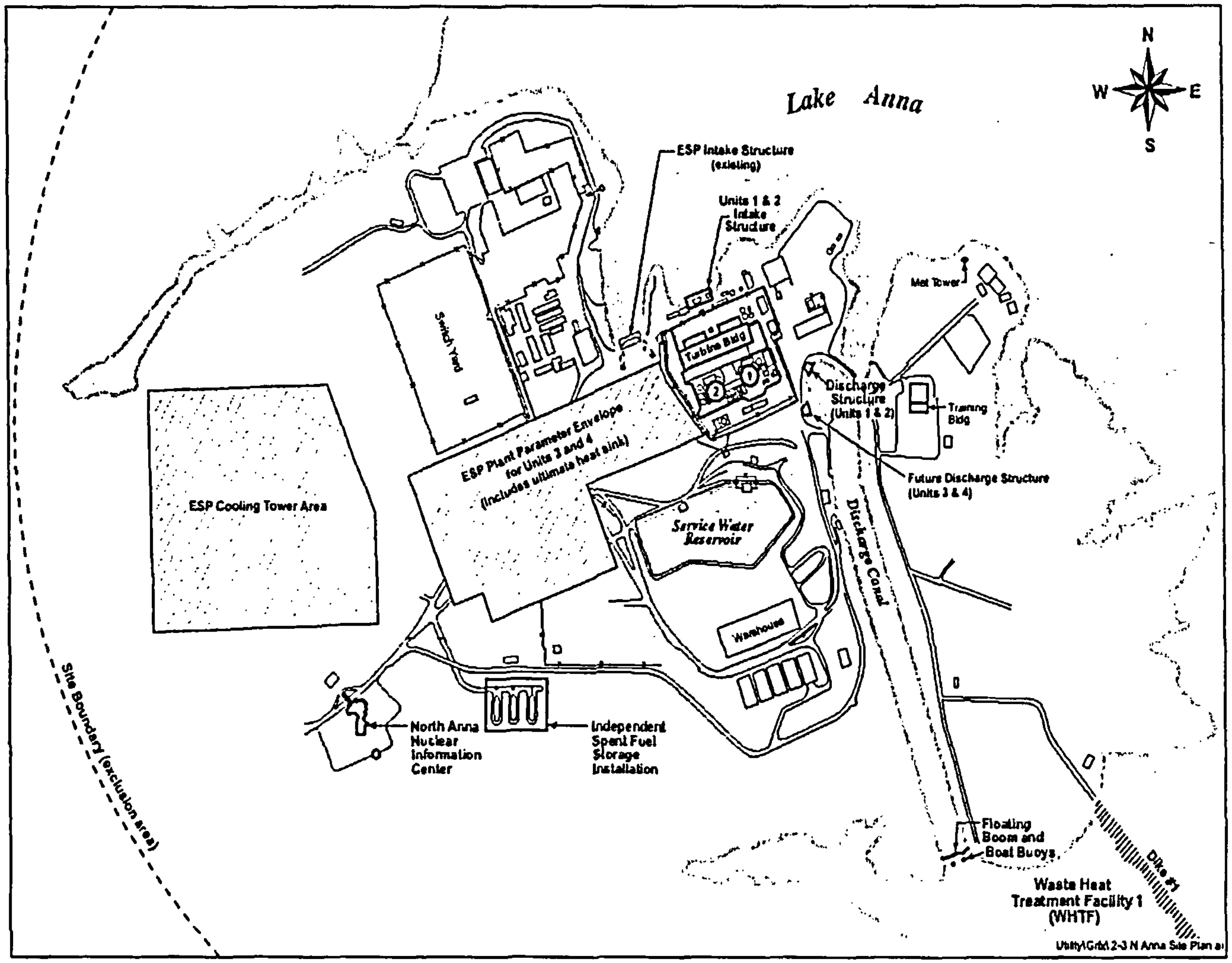


Figure 3-1. Proposed Major ESP Structures (Units 3 and 4) in Relation to Existing Units 1 and 2 Structures

3.2 Plant Parameter Envelope

An applicant for an ESP need not provide a detailed design of a reactor or reactors and the associated facilities but should provide sufficient bounding parameters and characteristics of the reactor or reactors and the associated facilities so that an assessment of site suitability can be made. Consequently, the ESP application may refer to a plant parameter envelope (PPE) as a surrogate for a nuclear power plant and its associated facilities.

A PPE is a set of values of plant design parameters that an ESP applicant expects will bound the design characteristics of the reactor or reactors that might be constructed at a given site. The PPE values are a surrogate for actual reactor design information. Analysis of environmental impacts based on a PPE approach permits an ESP applicant to defer the selection of a reactor design until the construction permit (CP) or combined license (COL) stage. The PPE reflects upper bounds of the values for each parameter that it encompasses rather than the characteristics of any specific reactor design.

In its North Anna ESP application, Dominion used a composite of values from seven reactor designs to develop the PPE for the ESP application. The values used in the environmental review from the seven reactor designs are not necessarily the same values used in the safety review. The values in this report are not design-specific; rather, they are used to determine the environmental impacts of a reactor design that falls within the values used in this report. The reactor designs used to develop the PPE include the following five light-water reactor and two gas-cooled reactor types:

- ACR-700 – This reactor, developed by Atomic Energy Canada Limited, is an evolutionary extension of CANDU 6 plant using very slightly enriched uranium fuel and light-water coolant.

- Advanced Boiling Water Reactor (ABWR) – This reactor, developed by General Electric Company, is a standardized plant that has been certified under the NRC requirements in 10 CFR Part 52. The ABWR is fueled with slightly enriched uranium and has light-water cooling.

- Surrogate AP1000 – Advanced Pressurized Water Reactor (PWR) – This is an earlier version of the AP1000 reactor final design approved by the NRC, and developed by Westinghouse Electric Company, using slightly enriched uranium and light-water cooling. This design is not the AP1000 that has received final design approval from the NRC.

- Economic Simplified Boiling Water Reactor (ESBWR) – This reactor, developed by General Electric Company, is fueled with slightly enriched uranium and has light-water cooling.

- International Reactor Innovative and Secure (IRIS) next generation PWR – This reactor is under development by a consortium led by Westinghouse Electric Company and is a modular light-water reactor.

- Gas Turbine Modular Helium Reactor (GT-MHR) – This reactor, developed by General Atomics, is a modular helium-cooled graphite-moderated reactor.

- Pebble Bed Modular Reactor (PBMR) – This reactor, developed by PBMR (Pty) Ltd., is a modular graphite-moderated helium-cooled gas turbine reactor.

The ABWR design has been certified by NRC in accordance with 10 CFR Part 52. On September 13, 2004, the NRC granted the Final Design Approval for the AP1000. The design certification rulemaking for the AP1000 is scheduled to be completed by the end of 2005.

Dominion would not be required to use any of these designs if it elects to proceed with a CP or COL application, however, the characteristics of the reactor ultimately selected would have to be within the bounds of the PPE for the assessment of a given characteristic contained in this EIS to be applicable.

Not all of the values in the PPE were used in the staff's evaluation. The atmospheric dispersion factors in the PPE were not used in the review. Site specific values were used for the atmospheric dispersion factors. Atmospheric dispersion factors were calculated using site meteorological conditions to determine the dilution capability of the site. At the CP/COL stage, the staff will need to verify that the atmospheric dispersion factors for the selected reactor are bounded by the values specified by the site atmospheric dispersion factors. The ER stated that Unit 3 would use a once-through cooling system and Unit 4 would use a dry tower cooling system. The PPE values of the other types of cooling systems were used in the review for comparison purposes.

In its evaluation of uranium fuel cycle impacts for the North Anna early site permit (ESP) site, Dominion used the plant parameter envelope (PPE) approach for the advanced LWR designs but not for the two gas-cooled reactors. In its evaluation of the impacts from transportation of radioactive materials, Dominion did not use the PPE approach but rather evaluated each reactor design individually. In situations where designs were evaluated individually, Dominion would have to perform a new evaluation if a different design is proposed at the CP or COL stage. In its evaluation of the radiological consequences on the environment of potential design basis accidents, Dominion used the PPE approach focusing on two light-water reactors: the certified ABWR with an uprated power level of 4300 MWt and a surrogate AP1000 reactor design. The PPE does not include source terms for severe accidents; therefore, the applicant used source terms for the ABWR and the surrogate AP1000 reactors instead of PPE values. The staff did not evaluate the design basis or severe accident impacts for gas-cooled reactors. Therefore, at the CP/COL stage, the applicant and the staff will need to evaluate whether the environmental impacts of design basis and severe accidents at the NAPS ESP site remain bounded by the impacts from the surrogate (ABWR and AP1000) designs.

3.2.1 Plant Water Use

This draft EIS assesses the impacts of plant water use bounded by the PPE and site-specific constraints. The following sections describe both the consumptive and non-consumptive water uses of proposed Units 3 and 4 and the associated plant water treatment systems.

The two proposed ESP units involve considerably different cooling systems with vastly different water needs. The proposed Unit 3 would use once-through cooling and the WHTF in the same manner as the existing Units 1 and 2 at NAPS. The proposed Unit 4 would use dry cooling towers. The cooling systems are described in more detail in Section 3.2.3.

3.2.1.1 Plant Water Consumption

The primary water demand for the proposed Unit 3 is for condenser cooling. The PPE value for the proposed Unit 3 would be limited to withdrawing 71,900 L/s (1,140,000 gpm) through the intake structure. The once-through portion of the cooling system would return approximately the same amount of water to the discharge canal and the WHTF. The elevated temperature of the discharged water would result in induced evaporative losses, which would be in addition to the natural (ambient) evaporative losses from the lake. The induced evaporation caused by the cooling system design is not included in the PPE and is a site-specific parameter. Only that volume of the water lost from the lake through induced evaporation is considered a consumptive use. The estimate of the induced evaporation is presented in Section 5.2.2 of the Environmental Report (ER) submitted by Dominion (Dominion 2004a), and the staff's independent estimate of induced evaporation as provided in Section 5.3.1 of this document.

Dry cooling towers are proposed for the Unit 4 cooling system (Dominion 2004a). Whereas wet cooling towers rely primarily on the latent heat of vaporization of water to satisfy cooling demands, dry towers rely solely on the much smaller sensible heat exchange between the air and the water in an enclosed radiator. It should be noted that the consumptive cooling water use for wet cooling towers is approximately 991 L/s [15,720 gpm]), the consumptive water use for dry cooling towers is a negligible 0.06 L/s [1 gpm]).

Units 3 and 4 would have identical demands for potable water, demineralized water, and fire protection water. In Tables 3.3-1 and 3.3-2 of its ER, Dominion estimated these combined water uses to be 41.3 L/s (655 gpm) per unit under normal conditions and 211 L/s (3340 gpm) per unit when the fire protection system is operating at full capacity. Potable water would be provided from groundwater wells, whereas the demineralized water and fire protection water would be supplied from Lake Anna.

For safety-related cooling, the ultimate heat sink for the proposed Units 3 and 4 would provide water to the reactor cooling systems and safety-related components. Dominion proposes to use the same ultimate heat sink system for both plants. This system would be composed of a mechanical draft cooling tower with a 71.6 m wide by 107 m long by 15.2 m deep (235 ft wide by 350 ft long by 50 ft deep) engineered underground basin constructed beneath the tower (Dominion 2004b). The basins will be large enough to store 1.2 x 10^8 L (30,600,000 gal), which is adequate to hold a 30-day supply of emergency cooling water. During periods when the ultimate heat sink cooling towers are in operation, the towers are expected to withdraw an average flow of 25.9 L/s (411 gpm) from the basin, with a maximum flow of 53.6 L/s (850 gpm). During normal operation, a negligible volume of make-up water will maintain the pool level in the basin beneath the cooling tower.

3.2.1.2 Plant Water Treatment

Because no specific design has been selected, the water treatment systems for the proposed Units 3 and 4 are not specified. Currently, raw cooling water from Lake Anna for condenser cooling and service water needs is not treated. Make-up water for the proposed Unit 4 and both ultimate heat sink systems would call for treatment with biocides, antiscalants, and dispersants. Make-up of ultra-pure water systems, such as condensate and primary cooling, would employ technologies such as reverse osmosis and ultra-filtration. The water quality of effluents from any water treatment would be regulated by a Virginia Pollutant Discharge Elimination System (VPDES) permit for the units.

3.2.2 Cooling System

In Section 3.4.1 and 3.4.2 of its ER, Dominion describes the operational modes and components, respectively, for the cooling systems of the proposed Units 3 and 4 (Dominion 2004a). Two very different classes of cooling systems are proposed for the normal cooling needs of Units 3 and 4. Unit 3 would use a once through cooling system and Unit 4 would use dry cooling towers. The proposed cooling systems for emergency/shutdown cooling needs are identical for the new units.

3.2.2.1 Description and Operational Modes

The following sections describe the operating modes for the proposed Units 3 and 4 under normal operating and emergency/shutdown conditions.

Normal Cooling

During normal operation at full power, the primary cooling system for each unit is required to rejects 2800 MW/hr (9.7 x 10^9 BTU/hr) to the environment. Unit 3 will reject this heat load via a once-through cooling system. In that Unit 3 will withdraw water from Lake Anna and discharge the heated effluent to the discharge canal, this design is the same as for the existing NAPS Units 1 and 2. Based on the PPE, the maximum temperature increase between the intake and the discharge will be 10°C (18°F) and the maximum discharge temperature will be 52.8°C (127°F). Dominion specified in the PPE that the flow rate through the condenser will not exceed 71,900 L/s (1,140,000 gpm).

During low water conditions, the existing NAPS Units 1 and 2 are allowed to operate until the surface elevation of the pool reaches a minimum level of 74.4 m (244 ft) above MSL. Dominion states that it is attempting to have the minimum pool elevation allowed for operation of Units 1 and 2 and the proposed new Unit 3 lowered to 73.8 m (242 ft) above MSL (Dominion 2004a).

During normal operation, the proposed new Unit 4 will use dry cooling towers. These towers will not use make-up water for condenser cooling.

Ultimate Heat Sink

Based on the PPE, during shutdown the ultimate heat sink systems for each unit will reject 123 MW/hr (4.2 x 10^8 BTU/hr) of heat to the environment. Make-up water for the mechanical draft ultimate heat sink cooling towers will be withdrawn from an engineered underground basin located beneath the tower. Each basin will maintain an adequate supply of water for 30 days of emergency operation. Based on the PPE, the maximum blowdown discharged to the discharge canal will be 54 L/s (850 gpm).

3.2.2.2 Component Descriptions

The following sections describe the intake, discharge, and heat dissipation systems. Pursuant to the Sections 316(a) and 316(b) provisions of the Clean Water Act, prior to any construction activities, Dominion will be required to obtain approval from the Virginia Department of Environmental Quality by documenting plant design and site-specific analyses regarding the impacts of the thermal discharges and intake systems on the Lake Anna aquatic environment.

Intake System

The proposed location of the intake structure is shown in Figure 3-1 (Dominion 2004a). The location of the intake would be approximately in the same location as the intakes planned for the abandoned Units 3 and 4. The cofferdam, which currently isolates the area of the proposed ESP intake structure from Lake Anna, would be removed, and the approach channel would be dredged so that water can flow from the lake to intake pumps. The intake system for Units 3 and 4 would consist of a structure next to the lake with screens and pump bays.

Discharge System

The proposed location of the discharge structure for the proposed Units 3 and 4 is shown in Figure 3-1 (Dominion 2004a). The discharge from the proposed new Units 3 and 4 would enter the discharge canal near the location where the existing Units 1 and 2 discharges enter the discharge canal. Just as is the case for Units 1 and 2, the discharge from Units 3 and 4 would flow through the WHTF before entering the main body of Lake Anna at Dike 3. Because Unit 4 uses dry cooling towers, it will not discharge circulating water. However, Unit 4 will discharge small amounts of processed water.

Heat Dissipation Systems

The normal cooling needs of Unit 3 will be provided by a once-through cooling design in conjunction with the WHTF. The once-through/WHTF cooling system relies primarily on evaporative heat transfer and long-wave heat transfer to the atmosphere to dissipate the rejected thermal load. This design results in less consumptive use of water than a conventional cooling tower for the same load. Dominion estimates, in the PPE, a maximum evaporative loss of a once-through design to be 738 L/s (11,700 gpm) or 0.738 m^3/s (26 cfs) as compared to 1230 L/s (19,500 gpm) or 1.23 m^3/s (43 cfs) for wet cooling towers. These values are used for the site-specific evaluation in Section 8.2 of this document.

The normal cooling needs of Unit 4 would be provided by a dry cooling tower system. A dry cooling tower system relies entirely on sensible heat transfer between the fluid circulating in the condenser loop and the ambient air. It is a completely closed system and, therefore, uses negligible make-up water and negligible blowdown water. Dry cooling towers uses large fans to keep air flowing over the fins of the cooling tower(s). Dry cooling towers have a very high energy cost that significantly reduces plant efficiency. The efficiency penalty of dry cooling towers is 8.5-11 percent (Dominion 2004a).

For safety-related cooling, the ultimate heat sink for each of the proposed Units 3 and 4 would provide water to the reactor cooling systems and safety-related components. As proposed, both plants would use the same ultimate heat sink system, which would be composed of a mechanical draft cooling tower with a 71.6 m wide by 107 m long by 15.2 m deep (235 ft wide by 350 ft long by 50 ft deep) engineered underground basin constructed beneath the tower (Dominion 2004b). The basin would have a storage capacity of 1.2 x 10^8 L (30,600,000 gal), which is adequate to hold a 30-day supply of emergency cooling water. During periods when the ultimate heat sink cooling towers are operating, the flow rate through the towers is expected to average 27.8 L/s (411 gpm) with a maximum of 53.6 L/s (850 gpm). During normal operating conditions, a negligible volume of water would maintain the pool in the basin beneath the cooling tower.

3.2.3 Radioactive Waste Management System

Liquid, gaseous, and solid radioactive waste management systems will be used to collect and treat the radioactive materials that are produced as a by-product of operating the proposed Units 3 and 4 on the North Anna ESP site. These systems will process radioactive liquid, gaseous, and solid effluents to maintain releases within regulatory limits and to levels as low as reasonably achievable (ALARA) before being released to the environment. Waste processing systems will be designed to meet the design objectives of 10 CFR Part 50, Appendix I (Numerical guide for design objectives and limiting conditions for operation to meet the criterion "As Low as is Reasonably Achievable" for Radiological Material in Light Water-Cooled Nuclear Power Reactor Effluents). Radioactive material in the reactor coolant would be the primary source of gaseous, liquid, and solid radioactive wastes in LWRs. Radioactive fission products build up within the fuel as a consequence of the fission process. These fission products are contained in the sealed fuel rods, but small quantities escape the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system would also contribute to coolant contamination.

Dominion did not identify specific radioactive waste management systems for the North Anna ESP site. The PPE concept was used to provide an upper bound on liquid radioactive effluents, gaseous radioactive effluents, and solid radioactive waste releases (Dominion 2004a).

Adequate design information to estimate liquid and gaseous radioactive effluents was available for three of the seven reactor designs considered in establishing PPE values. The three reactors were LWRs and included the certified ABWR, the (surrogate) AP1000 PWR, and the ACR-700 light-water-cooled, heavy-water moderated reactor. Dominion considered one ABWR reactor (3926 MW[t]), one AP1000 reactor (3400 MW[t]), and two ACR-700 reactors (3964 MW[t]) in developing the liquid and gaseous effluent bounding values for one unit on the North Anna ESP site. Limited information was available for liquid and gaseous effluent releases from the gas-cooled reactor designs. Dominion stated that effluents from the gas-cooled reactors would be bounded by LWR designs (Dominion 2004a). However, this would have to be verified at the CP/COL stage.

Solid radioactive wastes that would be produced for operating the proposed Units 3 and 4 at the North Anna ESP site would be either dry or wet solids. The solid waste management system would receive, collect, and store solid wastes prior to onsite storage or shipment offsite. Dominion indicated that low-level waste storage for the ESP site would be coordinated with storage from the existing NAPS Units 1 and 2. The bounding solid radioactive waste activity was from one ABWR reactor (3926 MW[t]) or one ESBWR reactor (4000 MW[t]) (Dominion 2004a).

3.2.4 Nonradioactive Waste Systems

Dominion describes the nonradioactive waste systems for the proposed Units 3 and 4 in Section 3.6 of its ER (Dominion 2004a). Nonradioactive waste system parameters are not addressed by the PPE; however, effluents from liquid, gaseous, and solid nonradioactive waste systems are regulated by cognizant State and Federal agencies.

Chemicals and biocides may be employed in water treatment for various water uses at the proposed Units 3 and 4. Effluents containing chemicals and/or biocides would be regulated by the VPDES permit. Sanitary effluents would be expected to increase because of the increased workforce, and sanitary effluents would be regulated by the VPDES permit. Dominion states that the sanitary wastes would be treated onsite using a permanent, self-contained sanitary waste treatment system (Dominion 2004a).

Dominion states that gaseous wastes (e.g. diesel backup generators) and solid wastes (e.g. sewage sludge, construction debris, etc.) would be handled in compliance with appropriate State and Federal regulations (Dominion 2004a).

3.3 Power Transmission System

The existing NAPS Units 1 and 2 have three 500-kV transmission lines and one 230-kV transmission line leaving the site from the switchyard. Each transmission line occupies a separate right-of-way. Table 3-1 presents the lengths, widths, and areas of the rights-of-way, which range from 37 to 84 m (120 to 275 ft) in width and from 24 to 66 km (15 to 41 mi) in length and cover a total of approximately 1174 ha (2900 ac) (AEC 1973; NRC 2002). The rights-of-way extend from the NAPS site to the north, south, east, and west terminating in Morrisville, Midlothian, Ladysmith, and at the South Anna non-utility generator (Figure 3-2). The existing transmission lines and rights-of-way were constructed between 1973 and 1984, and no additional construction of transmission lines is expected for Units 3 and 4 (Dominion 2004a).

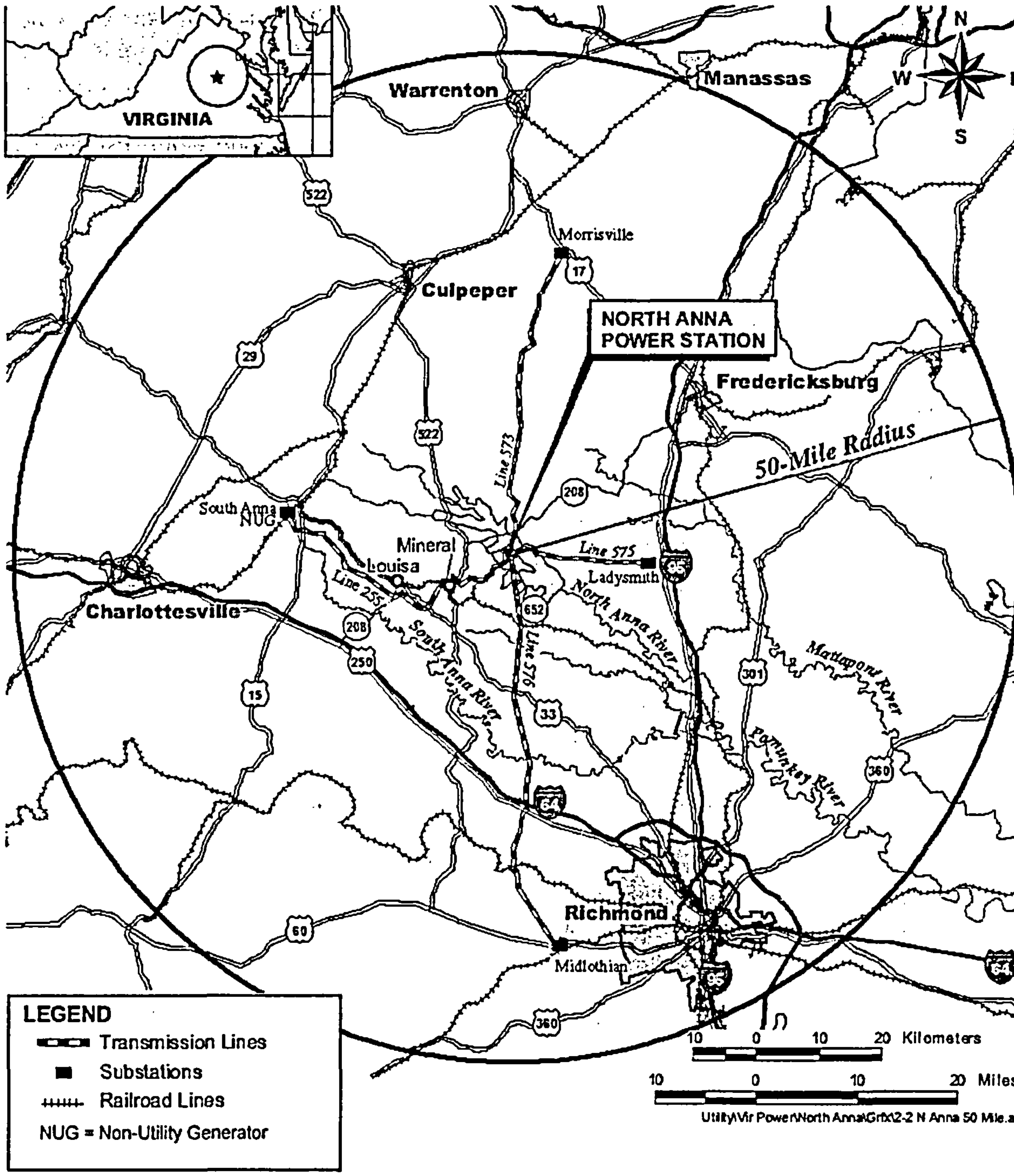
In the ER, Dominion indicates the existing transmission system (three 500-kV lines and one 230-kV line) has the capacity to handle the output from the existing Units 1 and 2 plus the anticipated output from the proposed Units 3 and 4 (Dominion 2004a). Detailed system load studies for the proposed new units would be performed by Dominion once the in-service date for the units has been established, to confirm the current transmission system is capable of handling the output of all units.

Table 3-1. North Anna Power Station Transmission Line Rights-of-Way

Substation	kV	Length km (mi)	Direction from NAPS	Width m (ft)	Area hectares (acres)	Construction Date
Morrisville	500	53 (33)	N	72 (235)	366 (905)	1973
Midlothian[a]	500	66 (41)	S	72 (235)	469 (1160)	1979
Ladysmith	500	24 (15)	E	84 (275)	192 (475)	1976
South Anna non-utility generation	230	50 (31)	W	30 - 37 (100 - 120)	146 (360)	1984
Total		193 (120)			1174 (2900)	

(a) The transmission line to the Midlothian Substation runs an additional 26 km (16 mi) in a shared right-of-way with a non-NAPS line.

Dominion owns approximately 1 percent of the rights-of-way and has easements for the remaining 99 percent (NRC 2002). Dominion has procedures to ensure that all chemical and mechanical vegetation controls are conducted in ways that minimize adverse impacts. Vegetation in the rights-of-way is currently managed through a combination of mechanical and herbicide treatments conducted on a 3-year cycle. Mowing is the primary mechanical treatment, while Accord® and Garlon® are the primary herbicides used in the rights-of-way. In some areas, such as wetlands or dense vegetation, hand-trimming is used. Rare and sensitive plant species areas are identified and avoided, or modified treatment practices are used to avoid adverse impacts. These modified vegetation treatments are developed in cooperation with the Virginia Department of Conservation and Recreation's Natural Heritage Program (NRC 2002). In addition, wildlife food plots and Christmas tree plantations are located along the rights-of-way and are supported through cost sharing by Virginia Power (NRC 2002).



1 **Figure 3-2.** Location of Transmission Lines for North Anna Power Station, Units 1, 2, 3, and 4

3.4 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants."

Clean Water Act also (referred to as the Federal Water Pollution Control Act). 33 USC 1251, et seq.

Dominion Nuclear North Anna, LLC (Dominion). 2004a. *North Anna Early Site Permit Application - Part 3 - Environmental Report.* Revision 3, Glen Allen, Virginia.

Dominion Nuclear North Anna, LLC (Dominion). 2004b. Letter Response to Request for Additional Information Regarding Safety Portion of ESP Application, No. 04-318, Glen Allen, Virginia, August 2, 2004.

Dominion Energy Inc. and Bechtel Power Corporation (Dominion and Bechtel). 2002. *Study of Potential Sites for the Deployment of New Nuclear Plants in the United States.* U.S. Department of Energy Cooperative Agreement No. DE-FC07-021D1431.

U.S. Atomic Energy Commission (AEC). 1973. *Final Environmental Statement Related to the Continuation of Construction and Operation of Units 1 and 2 and the construction of Units 3 and 4, North Anna Power Station.* U.S. AEC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants Regarding North Anna Power Station, Units 1 and 2. NUREG-1437, Supplement 7.* Office of Nuclear Reactor Regulation, U.S. NRC Washington, D.C.

4.0 Construction Impacts at the Proposed Site

This chapter examines the environmental issues associated with the potential site preparation activities and construction of the proposed North Anna Power Station (NAPS), Units 3 and 4 as described in the application for an early site permit (ESP) submitted by Dominion Nuclear North Anna, LLC (Dominion). As part of this application, Dominion submitted an Environmental Report (ER) and a site redress plan (Dominion 2004a, b). The ER provides the plant parameter envelope (PPE) as the basis for the environmental review. The parameters included in the PPE and their values are listed in Appendix I. The site redress plan allows for specific site preparation activities to be conducted with approval of an ESP. The activities evaluated are those permitted by Title 10 of the Code of Federal Regulations (CFR) 52.25(a) and 10 CFR 50.10(e)(1) at the North Anna ESP site. In the event that the ESP is approved and Dominion conducts site preparation activities but does not build the plant(s), Dominion would be required to implement its site redress plan.

This chapter is divided into Sections 4.1 through 4.9 that discuss the potential impacts on land use, meteorology and air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, nonradiological and radiological health effects, and applicable measures and controls that would limit the adverse impacts of station construction. In accordance with 10 CFR Part 51, impacts have been analyzed, and a significance level of potential adverse impacts (i.e., SMALL, MODERATE or LARGE) has been assigned to each analysis. (Negligible impacts and beneficial impacts are listed as SMALL impacts.) Possible mitigation of adverse impacts, where appropriate, is presented in Section 4.10, followed by a description of the site redress plan in Section 4.11. A summary of the construction impacts is presented in Section 4.12. Full citations for the reference cited in this chapter are listed in Section 4.13. Cumulative impacts of construction and operation are discussed in Chapter 7. The technical analyses provided in this chapter support the results, conclusions, and recommendations presented in Chapters 9 and 10.

The staff relied on the mitigation measures and the required Federal, State and local permits and authorizations presented in the ER in reaching its conclusion on the significance level of the adverse impacts. The staff relied on the infrastructure upgrades planned by the counties, cities and towns, such as road and school expansions in assigning significance levels to the impacts. Failure to implement such infrastructure upgrades may result in larger impact level.

4.1 Land-Use Impacts

This section provides information regarding land-use impacts associated with site preparation activities and construction of proposed Units 3 and 4 at the North Anna ESP site. Topics discussed include land-use impacts at the site and in the vicinity of the site and land-use impacts in transmission line rights-of-way and offsite areas.

4.1.1 The Site and Vicinity

The ESP site is located entirely within the existing NAPS site, which is zoned for industrial use by Louisa County. However, construction of Units 3 and 4 at the site would require a conditional use permit from the county.

All construction activities for Units 3 and 4, including ground-disturbing activities, would occur within the existing NAPS site boundary. According to Dominion (2004a), the area that would be affected on a long-term basis as a result of permanent facilities is approximately 52 ha (128 ac). An additional 27.5 ha (67.9 ac) would be disturbed on a short-term basis as a result of temporary activities and facilities and laydown areas. Dominion states that it will conduct any ground distributing activities in accordance with Federal, State and local regulatory requirements (Dominion 2004a). The applicant submitted a site redress plan, which is evaluated in Section 4.11.

No new or highways or railroad lines are planned to support the construction of Units 3 and 4. Clearing and removal of trees growing within the ESP site would be required. No agricultural lands would be directly affected by construction activities.

A few small wetland areas and two intermittent streams exist on the ESP site. Dominion states that it intends to avoid watercourses and wetlands to the extent possible during construction (Dominion 2004a). Any work that has the potential to impact a wetland would be performed in accordance with applicable regulatory requirements.

The floodplain along the Lake Anna shoreline was determined by Dominion using the Federal Emergency Management Agency Flood Insurance Rate Map (Dominion 2004a). Any flooding that might occur during construction of Units 3 and 4 would be limited to areas adjacent to the lake shoreline (i.e., below elevations of 255 feet above mean sea level). Limited construction activity would occur within the lake floodplain for the construction and installation of a new water intake structure.

Some offsite land-use changes as a result of construction activities would be expected. Likely changes are the conversion of some land in surrounding areas to housing developments (e.g., apartment buildings, single family condominiums and homes, manufactured home parks, and recreational vehicle parks) to accommodate construction workers and the addition of new retail developments. All counties surrounding the NAPS site have comprehensive land-use plans in place as required by Section 15.2-2223 of the Code of Virginia.

Based on information provided by Dominion, the county's comprehensive land-use plans for the surrounding vicinity, the applicant's site redress plan, and its own independent review, the staff concludes that there are no significant environmental impacts related to land use that would influence the granting of an ESP to Dominion. The staff concludes that the land-use impacts of construction would be SMALL, and further mitigation is not warranted.

4.1.2 Transmission Line Rights-of-Way and Offsite Areas

Based on the evaluation provided by Dominion, no additional electrical transmission lines or rights-of-way would be required to transmit the power generated by the proposed North Anna Units 3 and 4 to the regional power grid (2004a). Construction would be limited to providing the new units' switchyards and interconnections with the existing operating units. All planned construction activities would occur on the NAPS site. Because construction would be limited to onsite work and no additional land would be needed to connect the new units to the grid, the staff concludes that the construction land-use impacts due to transmission line rights-of-way are expected to be SMALL, and further mitigation is not warranted.

4.2 Meteorological and Air Quality Impacts

During construction activities on the North Anna ESP site, some minor air quality impacts are expected to occur. The likely sources of these air quality impacts are fugitive dust emissions from general construction activities and the potential for elevated ambient air quality levels caused by emissions from the vehicles used by the workforce and from construction equipment. These impacts are discussed further in the following sections.

4.2.1 Construction Activities

The impact of construction activities on local air quality conditions will primarily be governed by the influence of additional building structures on the dispersion of normal effluent releases from either the existing NAPS Units 1 and 2 or from Units 3 and 4 during construction.

Equipment emissions and fugitive dust from operation of earth-moving and material-handling equipment are sources of air pollution from construction activities. In addition, operation of other equipment for hauling debris, equipment, and supplies on unpaved roads will produce fugitive dust emissions. The pollutant emission of concern would be PM_{10} particulate matter (less than 10 microns in diameter), reactive organic gases, oxides of nitrogen and sulfur, and carbon monoxide from construction equipment engines. All activities would be conducted in accordance with Virginia Administrative Codes 9 VAC 5-50 (Visible and Fugitive Dust Emissions) and 9 VAC 5-40-5680 (Emission Standard for Mobile Sources – Vehicles). In addition, if construction activities include burning of construction materials, Dominion would need to obtain a permit from VDEQ and contact Louisa County officials to determine if compliance with local ordinances is required (VDEQ 2004).

The ER identifies additional mitigation including developing a dust control plan to mitigate the impacts of emissions from construction activities (Dominion 2004a). Potential measures to be included in the plan would include the following:

- Limit the speed of construction equipment on unpaved roads.
- Remove dirt spilled onto paved roads on the construction site.
- Cover haul trucks during unloading and loading activities.
- Cease grading and excavation activities during periods of high wind speeds or extreme air pollution episodes.
- Phase construction activities to minimize daily emissions.
- Phase grading to minimize the area of disturbed soils.
- Perform proper maintenance activities on construction vehicles to minimize emissions.
- Revegetate road medians and slopes in according with the site redress plan.

Based on an independent evaluation of the requirements set forth in Virginia Administrative Codes and measures of dust control plans identified in the ER, the staff concludes that air quality impacts from construction, both onsite and beyond the plant boundary, would be temporary and SMALL, and further mitigation beyond the actions stated above is not warranted.

4.2.2 Transportation

In its ER, Dominion estimated that during construction activities, the 5000 workers would be divided between two 10-hour shifts (Dominion 2004a). Using an assumption of 1.8 workers per vehicle, 2800 additional vehicles per day would travel to and from the site (Dominion 2004a). Depending on the actual location of the workers, some of the roadways leading to the site would likely experience congestion unless current plan-recommended upgrades are implemented. This situation would impact the local ambient air quality levels because of emissions from vehicles both during normal operation and during periods of traffic congestion when vehicles are stopped with their engines idling. The overall impact is difficult to estimate at this time because of the timing of construction activities and actual location of the workers that would be employed during construction, but five existing roads are expected to be impacted.

Dominion indicated in the ER, that it would develop and implement a construction traffic management plan to increase the number of workers per vehicle by developing methods for enhancing the use of multi-person vans. They also would attempt to schedule shift changes for operating personnel, outage workers, and construction workers to reduce the number of vehicles on the road at any given time. All of these techniques would mitigate the impact of vehicular traffic on air quality.

Based on the mitigation identified by Dominion in the ER to develop a traffic management plan and its own independent review, the staff concludes that the impact on the local air quality from the increase in vehicular traffic related to construction activities would be temporary and SMALL, and additional mitigation beyond the actions stated above is not warranted.

4.3 Water-Related Impacts

Water-related impacts involved in the construction of a nuclear power plant are similar to impacts that would be associated with any large industrial construction project. Likewise, the applicant must apply for the same permits and follow the same construction best management practices as any other builder of a large industrial facility. Prior to initiating construction, including any site preparation work, the applicant is required to obtain the appropriate permits regulating alterations to the hydrological environment. These permits would likely include:

- Clean Water Act Section 404 permit. This permit would be issued by the ACE and regulates impacts of construction activities on wetlands and management of dredged material.

- Clean Water Act Section 401 certification. This certification would be issued by the Commonwealth of Virginia and ensures that projects do not conflict with State water quality management programs.

- Clean Water Act Section 402(p) VPDES storm water permit. This permit regulates point source storm water discharges. EPA's 1990 Phase 1 Storm Water Regulation established requirements for storm water discharges from various activities including construction activities disturbing an area of at least 2.0 ha (5.0 acres). EPA has delegated the responsibility for administering the VPDES program in Virginia to VDEQ.

- Coastal Zone Management Act (CZMA) Section 307 Consistency Determination (and 15 CFR Part 930). The Federal consistency requirement in CZMA Section 307 provides for the primacy of State decisions regarding coastal uses and resources. While the National Oceanic and Atmospheric Administration administers CZMA, the authority to issue the consistency determination has been delegated to the VDEQ.

4.3.1 Hydrological Alterations

Excavation, fill, and grading operations at the North Anna ESP site will alter two ephemeral streams and possibly one or more wetlands. Removing the cofferdam in Lake Anna would likely result in temporary and localized suspension of sediment. Any dredging of the approach channel leading into the intakes for the New units is also likely to result in some temporary and localized suspension of sediment.

Dominion did not provide information on wetlands in its ER (Dominion 2004a). Wetland delineations and jurisdictional determinations of the upland landscape and submerged lake areas that would be impacted by construction would be required in order to submit an application for a Section 404 Permit to ACE. The ACE permitting process ensures that impacts of construction are limited by requiring the appropriate construction best management practices. The applicant currently has not obtained a Section 401 certification from Virginia for construction activities at the ESP site. The ACE is expected to require the applicant to obtain a Section 401 certification prior to issuing a Section 404 permit.

Many of the possible reactor designs considered in the PPE would require that dewatering systems be installed during construction of the foundation of the reactor and various other buildings. Dewatering systems used during construction would depress the water table in the vicinity and possibly change the direction of groundwater flow and the available capacity of local wells. These impacts would be localized temporary construction impacts. Because the impacts of hydrologic alterations resulting from construction activities would be localized and temporary, and the VDEQ Section 401 and ACE Section 404 Permit process would serve to minimize impacts, the staff concludes that the impacts of hydrologic alterations would be SMALL, and further mitigation beyond the actions stated above is not warranted.

4.3.2 Water-Use Impacts

Water-use requirements for construction activities are similar to other large industrial construction projects. Additional potable water supplies for the construction workforce would be required. Water for various standard construction activities, such as dust abatement, would be provided from Lake Anna. Dewatering systems may preclude existing onsite wells from providing adequate water supply during construction, particularly potable water needs. If additional water is required, water could be imported from offsite during periods when the dewatering system is active. Based on these considerations and their localized and temporary nature, the staff concludes that water-use impacts caused by construction activities would be SMALL, and mitigation is not warranted.

4.3.3 Water-Quality Impacts

Water-quality impacts for the construction activities are similar to other large industrial construction projects. Construction best management practices are generally required to ensure that accidental spills and storm water runoff will have minimal impact on surface and groundwater quality. If Dominion applies for and receives a CP or a COL or conducts site preparation activities, a VPDES permit will be required from VDEQ before construction activities can commence. In view of the VPDES permit requirements and the localized and temporary nature of any impacts, the staff concludes that water-quality impacts caused by construction activities would be SMALL, and that further mitigation is not warranted.

4.4 Ecological Impacts

This section describes the potential impacts of construction on the ecological resources at the North Anna ESP site. The section is divided into three subsections: Terrestrial Ecosystems, Aquatic Ecosystems, and Threatened and Endangered Species.

4.4.1 Terrestrial Ecosystems

The total approximate area of the North Anna ESP site is 81 ha (200 ac). Undisturbed habitats are absent from the approximately 49 ha (120 ac) of industrial/developed land on the site. Construction activities are not expected to have a noticeable impact on ecological resources within these developed portions of the ESP site. Construction of Units 3 and 4 would result in the removal of approximately 32 ha (80 ac) of forested habitat within the site. The ESP site does not contain any old growth timber, unique or sensitive plants, or unique or sensitive plant communities. Therefore, construction activities would not noticeably reduce the local or regional diversity of plants or plant communities.

There are no important animal species or habitats (as defined by NRC 1999) on the North Anna ESP site. No areas designated by the U.S. Fish and Wildlife Service (FWS) as critical habitat for endangered or threatened species exist at or near the site, nor are threatened or endangered plants or animals known to exist at the site. Therefore, construction likely would have no impact on any threatened or endangered species, or other important species or habitats.

A few small wetland areas and two intermittent streams exist on the North Anna ESP site (Dominion 2004a). Watercourses and wetlands would be avoided to the extent possible during any construction. Dominion states that any work it would conduct that has the potential to impact a wetland would be performed in accordance with applicable laws, regulations, permits, and authorizations. Wetland delineations to determine if any of the wetland areas are under the jurisdiction of the ACE under Section 404 of the Clean Water Act would be conducted prior to commencement of construction activities. If the areas are determined to be wetlands under the Clean Water Act, disturbance of the areas would either be avoided or other appropriate mitigation actions would be implemented as required by any applicable permits and regulations.

Land clearing associated with construction would be conducted according to Federal and State regulations, permit conditions, existing procedures, construction best management practices, and other established best management practices (e.g., directed drainage ditches, and silt fencing will be employed). Fugitive dust emissions would be minimized by watering the access roads and construction site as necessary. Thus, impacts from dust on terrestrial ecosystems would be minimal. Emissions from heavy construction equipment would be minimized through scheduled equipment maintenance procedures (Dominion 2004a).

To minimize construction-related impacts to wildlife, Dominion states that it would adhere to State permit conditions that may restrict the timing of certain construction activities (Dominion 2004a). As the site undergoes clearing and grading, disturbance and loss of forested habitat would displace mobile animals such as birds and larger mammals. Species that can adapt to disturbed or developed areas (e.g., raccoon [*Procyon lotor*], opossum [*Didelphis virginiana*], mockingbird [*Mimus polyglottus*], northern cardinal [*Cardinalis cardinalis*]) may recolonize portions of the site where suitable habitat remains or is replanted following construction activities. Species more dependent on forested habitat may be permanently displaced. Clearing and grading activities may directly result in the loss of some individuals, particularly the less mobile animals such as toads, lizards, turtles, snakes, moles, and mice.

Movement of construction workers, materials, and equipment, and the operation of construction equipment (e.g., earth-moving equipment, portable generators, pile drivers, pneumatic equipment, and hand tools) would generate noise. Noise from human activities can affect wildlife by inducing physiological changes, nest or habitat abandonment, and behavioral modifications, or it may disrupt communications required for breeding or defense (Larkin 1996). However, it is not unusual for wildlife to adapt to noise from human activities (Larkin 1996). Although short-term noise levels from construction activities could be as high as approximately 110 decibels (e.g., impulse noise during pile-driving activities), these noise levels would not extend far beyond the boundaries of the ESP site. At a distance of 120 m (400 ft) from the construction site, noise levels would range from approximately 60 to 80 decibels from these activities. These noise levels are below the 80-to-85-decibel threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Thus, noise from construction activities would not be likely to disturb wildlife beyond 120 m from the construction site. Additionally, construction of Units 3 and 4 would occur adjacent to the existing operating Units 1 and 2, where wildlife have presumably become accustomed to typical existing operating facility noise levels of approximately 50 to 60 decibels at the NAPS security fence (Dominion 2004a). Therefore, noise-related impacts during construction would be negligible.

Avian collisions with fabricated structures are a result of numerous factors related to species' characteristics such as flight behavior, age, habitat use, seasonal habits, and diurnal habitats, and to environmental characteristics such as weather, topography, land use, and orientation of the structures. Most authors on the subject of avian collisions with utility structures agree that collisions are not a biologically significant source of mortality for thriving populations of birds with good reproductive potential (EPRI 1993). NRC reviewed monitoring data concerning avian collisions at nuclear power plants with large cooling towers and determined that the overall avian mortality is low (NRC 1996). No avian collisions with existing structures at the NAPS site have been reported (Dominion 2004a). The number of construction-related bird collisions with structures is expected to be negligible.

The construction-related impacts of forested habitat loss to local wildlife populations cannot be quantitatively assessed because population data for species on and adjacent to the NAPS site are not available. However, relatively large tracts of forest to the north, west, and south of the North Anna ESP site are available to displaced wild life. The approximately 32 ha (80 ac) of forested habitat at the ESP site represents a small portion of the available undeveloped land in the vicinity; therefore, the impacts of construction-related mortality and temporary displacement of wildlife are expected to be minimal. In addition, construction activities likely would not reduce the local or regional diversity of plants or plant communities, and would not impact endangered or threatened species.

The ER identified construction mitigation including performing wetland surveys to determine Clean Water Act Section 404 eligibility, instituting construction best management practices for erosion and dust control, noise abatement, proper equipment maintenance, restricting the timing of activities to minimize impacts to resources such as breeding birds, and adherence to applicable permit conditions. The staff reviewed the potential impacts of constructing Units 3 and 4 on terrestrial ecological resources, including loss of habitat, loss of wetlands, noise, dust emissions, and avian collisions. Based on this review and the mitigation identified in the ER, the staff concluded that the overall impact of construction-related activities on terrestrial ecological resources would be SMALL, and further mitigation beyond the actions stated above is not warranted.

4.4.2 Aquatic Ecosystems

Construction of the new cooling water intake structure and channel would be the primary source of construction impacts on the aquatic environment. Construction would involve major modifications to an existing intake structure previously constructed for Units 3 and 4, and deepening and enlarging the existing intake canal. Section 3.2.2 provides a description of the proposed plant cooling water use and structures.

The cooling water intake structure would be approximately 46 m (150 ft) long and 91 m (300 ft) wide and would house the trash racks, traveling screens, and intake pumps (Figures 4-1 and 4-2). The intake channel would extend from the intake structure toward the west slope of the intake cove.

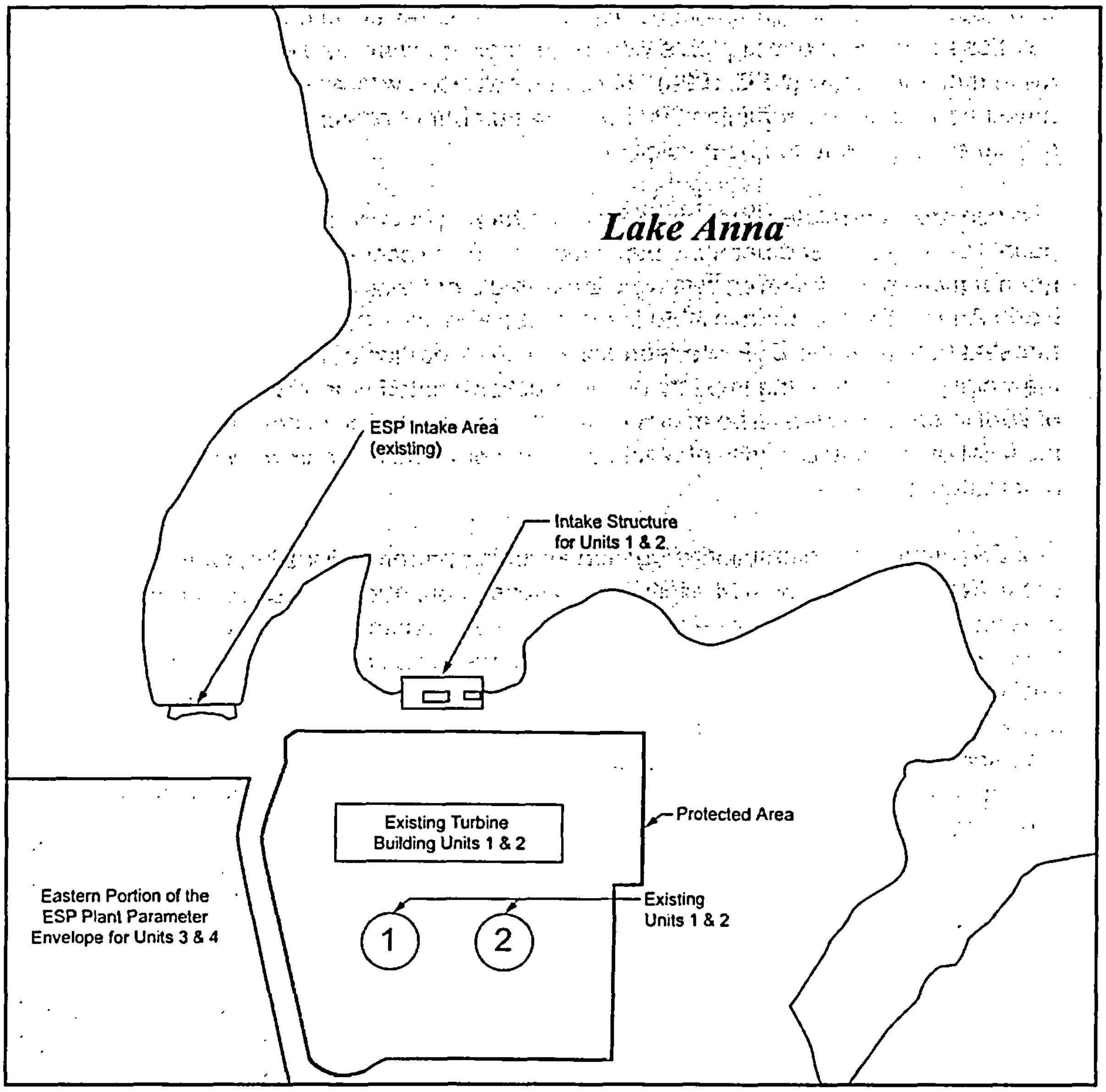


Figure 4-1. Layout of Screenwell/Pump Intake for the ESP Site

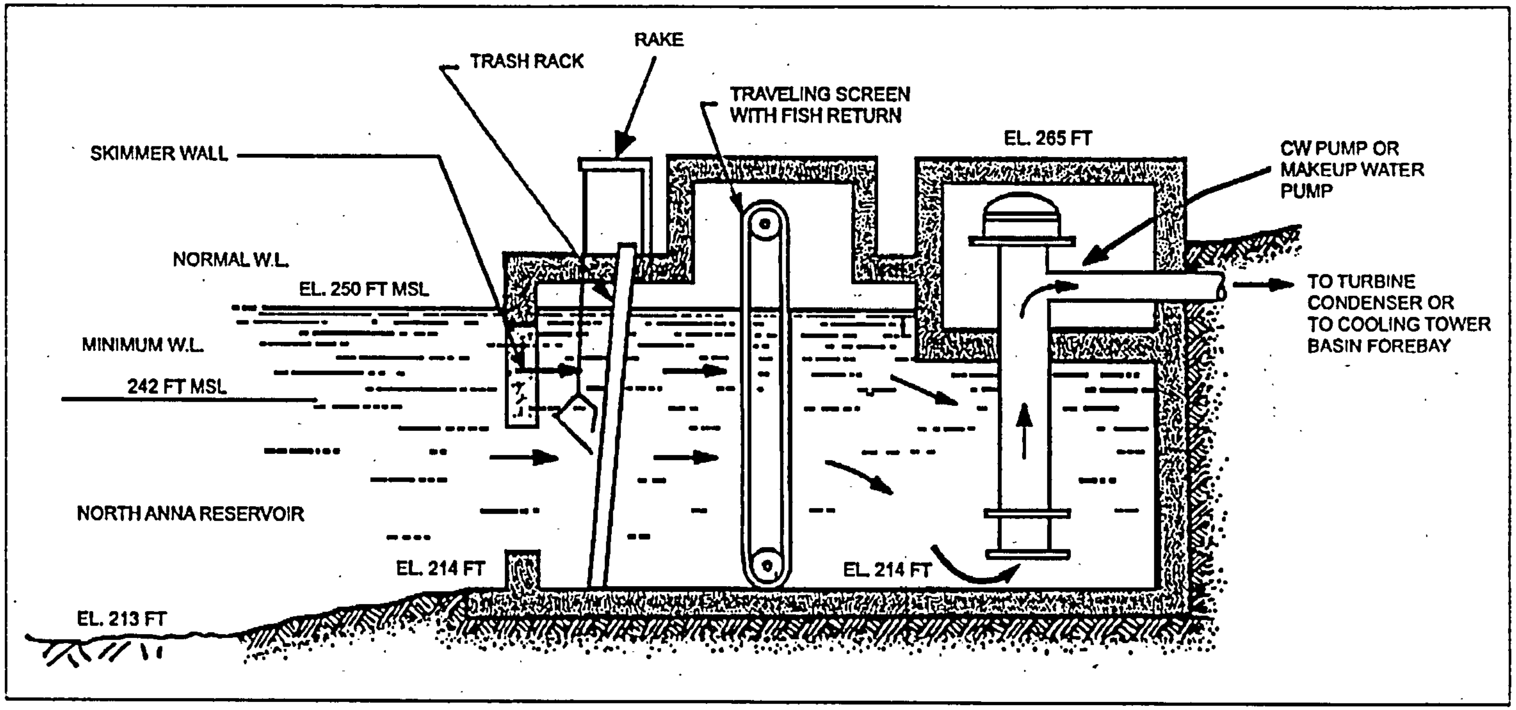


Figure 4-2. Schematic View of Pump Intake

Construction would result in the removal or reshaping of the shoreline to accommodate the intake structure and to meet the intake approach velocity requirements.

As part of the cooling water intake structure and channel modification, the existing cofferdam would be removed. Approximately 64,200 m^3 (84,000 yd^3) of material would be moved from the cofferdam. All the dredged material would be disposed of in accordance with regulatory requirements and permit conditions.

In anticipation of construction, topsoil would be removed from the construction site footprint, stored, rolled, and seeded, if necessary, to minimize erosion. Some disturbed areas may be graveled, paved, or compacted to prevent erosion. These and other soil preparation activities would minimize impacts to the aquatic environment from earth-moving activities. When construction activities are completed, areas that have been temporarily disturbed would be graded and contoured, covered with topsoil, and seeded with native vegetation.

Degraded water quality (i.e., increased turbidity and siltation) resulting from shoreline contouring and dredging would pose the greatest potential for impacts on the Lake Anna ecosystem in the immediate vicinity of the construction activities. This shoreline contouring would result in the temporary loss of benthic habitat and displacement or loss of benthic organisms, which provide food for other animals such as fish and shorebirds. After construction, the intake channel cove and the shoreline substrate near the new intake structure is expected to be recolonized with benthic organisms. To minimize impacts to benthic populations in the reservoir, intake construction and associated mitigation activities would be conducted in accordance with State regulations and permit requirements. The benthic habitat lost would be temporary and a small percentage of the available benthic habitat. The loss of this habitat would not have a long-term impact on the aquatic ecosystem.

Some fishery habitat may be changed as well. Fish inhabiting the intake channel and the lake near the intake channel may leave the area temporarily during construction activities. After construction is completed, fish would be expected to repopulate the area. Temporary habitat loss would be a small percentage of the total fishery habitat available in the reservoir portion of Lake Anna. The area of the reservoir is 3900 ha (9600 ac); the construction area is expected to comprise fewer than 4 ha (10 ac). To minimize impacts to fish populations in the reservoir, intake construction and protection activities would be conducted in accordance with State regulations and permit requirements. Construction impacts on the reservoir's fishery are expected to be small and temporary.

Dredging for the new intake channel could resuspend heavy metals in the bottom sediments from Contrary Creek. Prior to impoundment, water quality in the North Anna River was degraded by sedimentation and acid mine drainage from Contrary Creek, a 14-km (8.5-mi)-long tributary that flowed into the river from the west, near the town of Mineral, Virginia (Figure 4-3). Land adjacent to Contrary Creek had been the site of extensive iron pyrite mining operations during the late 19th and early 20th centuries (VDEQ 1986). When the mines were abandoned (circa 1920), mine shafts and tailings piles were left exposed to the weather. Runoff from the mine area was acidic, with high concentrations of metals. Virtually no aquatic life was found in Contrary Creek downstream of the mine site (AEC 1973). Prior to impoundment, the density and diversity of fish and benthic macroinvertebrates were markedly reduced in the North Anna River immediately downstream of its confluence with Contrary Creek. Subtle changes were evident as far as 24 km (15 mi) downstream, although water quality was generally satisfactory (VDEQ 1986).

In 1976, the Virginia State Water Control Board, in association with EPA, attempted to reclaim previously mined and disturbed areas along Contrary Creek to reduce the impacts of sedimentation and acid mine drainage (VDEQ 1986). The reclamation project reduced, to some extent, erosion and sedimentation in the area. The creation of Lake Anna has mitigated most water-quality impacts from Contrary Creek area runoff. Low-pH creek water is neutralized as it mixes with higher-pH reservoir water. Heavy metals are removed from the water column by adsorption to clay particles and the subsequent settling of those particles. Chemical precipitation (and co-precipitation with iron) may also remove zinc and copper ions from Contrary Creek water when it mixes with Lake Anna water. If dredging were performed to improve access to Units 3 and 4 intake, such dredging could cause these metals, which are present in the resuspended sediments, to potentially impact aquatic biota. Any potential impacts would likely be addressed through the Clean Water Act Section 404 permit and Section 401 verification process.

Dredging could also cause increased turbidity, thus leading to a temporary reduction in primary productivity due to reduced light penetration and smothering of periphyton and aquatic macrophytes in the intake channel. After construction, primary productivity would be expected to return to previous levels, and macrophyte recolonization would occur. Dominion states that the design and operation of the intake bay for Units 3 and 4 would require that a barrier (e.g., a turbidity curtain or sheet piling) or some form of protection be installed between Units 3 and 4 and the lake to reduce the potential for silt and soil entrainment through the existing units to the Waste Heat Treatment Facility (WHTF) (Dominion 2004a). This mitigation measure should reduce the possibility for adversely impacting primary production in the WHTF.

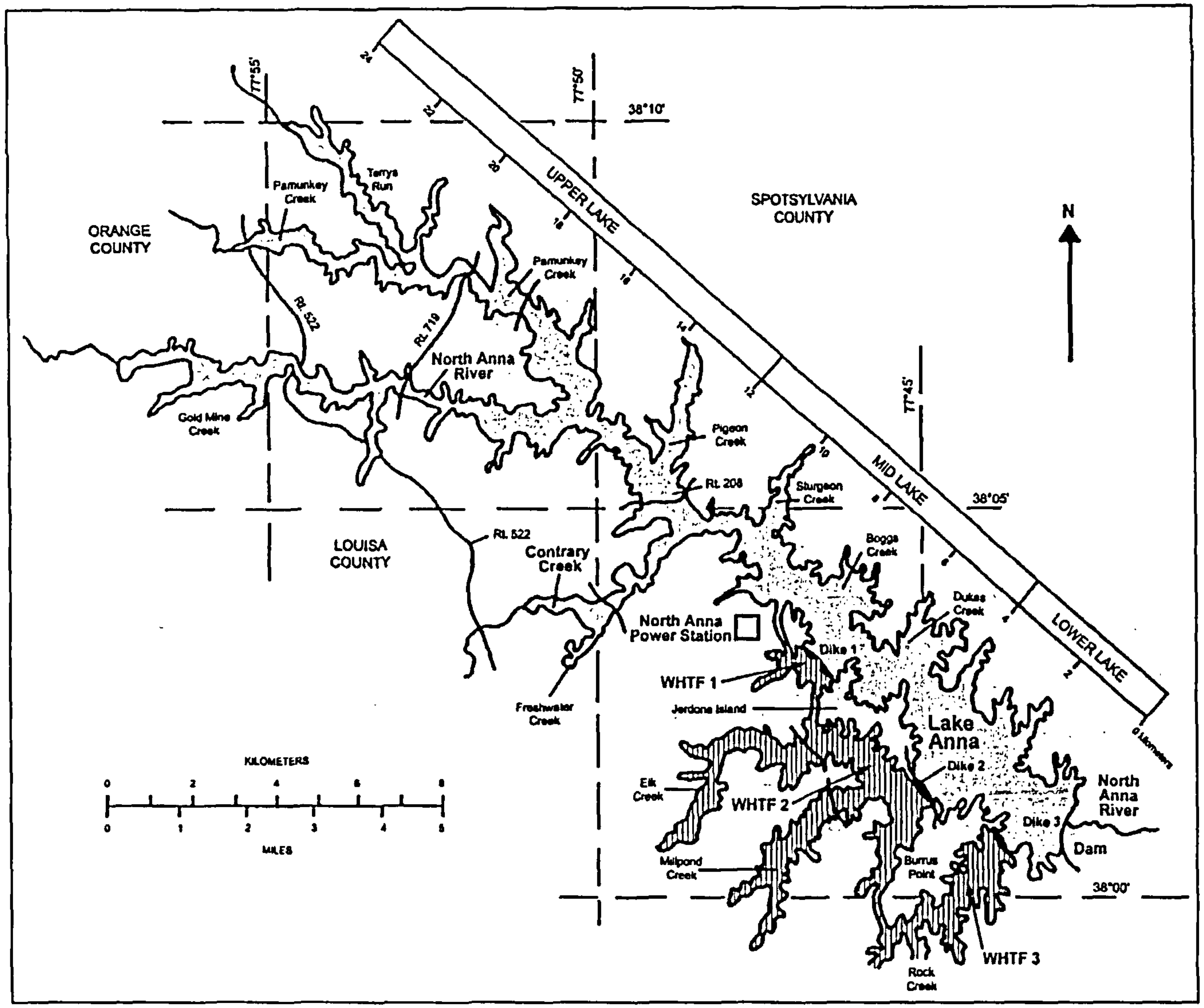


Figure 4-3. Lake Anna and the Rivers and Creeks in the Vicinity of the North Anna Power Station and the WHTF

The potential for fuel or other fluid spills exists throughout the construction phase. The State would likely require that controls to prevent contaminants from entering the aquatic system from spills would be handled according to an approved Spill Prevention Control and Countermeasure Plan.

Construction of dry cooling towers for Unit 4 could be near an intermittent stream. If so, construction of these towers could result in temporary soil erosion and silt entry into the stream.

Renovation of an existing rail spur or construction of a new one also could occur near the stream. Intermittent streams in this area are not known to provide key fishery habitat for any important species. The State would likely require that sedimentation and erosion control best management practices and/or effective storm water management would be used to protect aquatic resources in the construction area.

The ER identified construction mitigation including instituting best management construction practices for erosion control in Lake Anna, the WHTF, and potentially impacted streams. The staff reviewed the potential impacts of construction of Units 3 and 4 on aquatic ecological resources including constructing a new intake structure and channel and the associated loss of benthic and fish habitat, which would be localized and temporary. Based on this review, the staff concluded that the overall impact of construction-related activities on aquatic ecological resources would be SMALL, and further mitigation beyond the actions stated above is not warranted.

4.4.3 Threatened and Endangered Species

As described in Sections 2.7.2 and 2.7.4, no Federally listed threatened or endangered species are known to occur at or near the North Anna ESP site except the bald eagle (*Haliaeetus leucocephalus*), which is occasionally observed perching or foraging on the shore of Lake Anna. However, the closest known bald eagle nesting site is located approximately 16 km (10 mi) upstream from the North Anna ESP site. Site preparation and construction for Units 3 and 4 would have no effect on bald eagle nesting, and are not likely to alter eagle foraging behavior on Lake Anna.

Loggerhead shrike (*Lanius ludoviciana*), which appears as a threatened species on the State list, has been observed near the North Anna ESP site, but have not been reported to nest in the vicinity (Dominion 2004a). Site preparation and construction may result in some habitat loss for this species, but it usually does not use forested areas, preferring forest edges and open areas. Several other State-listed species may occasionally pass through the vicinity, but do not rely on habitat at the North Anna ESP site. No State-listed aquatic species are known to occur at the North Anna ESP site.

Virginia Power has monitored fish populations in Lake Anna and the North Anna River since the early 1970s to evaluate the response of these populations to the operation of NAPS Units 1 and 2. No Federally or State-listed fish species have been collected in any of these monitoring studies, nor have any listed species been observed in creel surveys or occasional special studies conducted by Virginia Power biologists and affiliated researchers. No Federally or State-listed fish species' range includes Lake Anna or the North Anna River, and none are believed to occur in counties adjacent to Lake Anna or the North Anna River (i.e., Caroline, Hanover, Louisa, Orange, and Spotsylvania Counties).

According to the Virginia Department of Conservation and Recreation (VDCR) and the Virginia Department of Game and Inland Fisheries (VDGIF) (Division of Natural Heritage) databases, one Federally listed mussel species, one State-listed mussel species, and one mussel species that is a candidate for Federal listing occur in counties that border Lake Anna or the North Anna River. None of these three species has been found in Lake Anna or the North Anna River.

The staff reviewed the potential impacts of construction of Units 3 and 4 on threatened and endangered species. It is unlikely that any threatened or endangered species exist on the North Anna ESP site. However, Dominion would perform a field survey for such species within all areas that would be disturbed by site preparation or construction activities prior to initiation of such activities. Because there are no Federally listed species in the proposed project area, and the impact to the one State-listed species is minor, the staff concludes that the effect of construction on threatened and endangered species would be SMALL, and mitigation is not warranted.

4.5 Socioeconomic Impacts

This section discusses the socioeconomic impacts of construction activities. It includes impacts that could result from the construction-related activities at the North Anna ESP site, and from the activities and demands of the workforce on the surrounding region. Socioeconomic impacts that were evaluated include potential effects on individual communities, the surrounding region, and minority and low-income populations.

4.5.1 Physical Impacts

Construction activities at the North Anna ESP site may cause temporary and localized physical impacts including, but not limited to, noise, odor, vehicle exhaust emissions, and dust. Dominion does not expect significant vibration and shock impacts during construction because of the strict restriction or control of such activities onsite (Dominion 2004a). This section qualitatively addresses those potential impacts that may affect people, buildings, roads, and recreational facilities (such as Lake Anna).

4.5.1.1 Workers and the Local Public

The NAPS site is located in an area zoned for industrial use. The site is bounded by light industrial and commercial zones to the north and west, a recreational area (Lake Anna) to the east, and residential housing to the south. All construction activities would occur within the NAPS site boundary (Dominion 2004a). Offsite areas supporting construction activities (e.g., borrow pits, quarries, disposal sites) are assumed to be permitted and operational. As such, impacts on those facilities from constructing Units 3 and 4 at NAPS are considered small incremental impacts associated with their normal operation.

The estimated population within 16 km (10 mi) of the ESP site is 15,500 people (Dominion 2004a). The area surrounding the site is predominately rural and is characterized by farmland and wooded tracts. The exception is the residential development surrounding Lake Anna. No other significant industrial or commercial facilities exist around the site, and it is the goal of the Louisa County Board of Supervisors to preserve the rural character of Louisa County (Louisa County 2001).

People who work or live around the NAPS site could be subjected to noise, fugitive dust, and gaseous emissions resulting from construction activities. The staff would expect construction workers and personnel working onsite to be most impacted, followed by individuals working or living immediately adjacent to the site. Least impacted would be transient populations, such as temporary employees, recreational visitors to Lake Anna, and tourists passing through the area.

Onsite impacts to construction workers would be mitigated through adequate training and use of personal protective equipment to minimize the risk of potentially harmful exposures (Dominion 2004a). Emergency first-aid care and regular health and safety monitoring of construction personnel could also be undertaken.

Dominion expects that individuals working onsite or living near the North Anna ESP site would not experience any physical impacts greater than those that would be considered an annoyance or nuisance. In the event of atypical or noisy construction activities (e.g., pile driving), prior public announcements and/or notifications of these activities would be provided. Dominion has stated that these activities would be performed in compliance with Federal, State, and local regulations, and with site-specific permit conditions (Dominion 2004a).

Fugitive dust and odors could be generated as a result of normal construction activities. Various mitigation measures, such as paving disturbed areas, using water to suppress dusts, and reducing material-handling activities, as stated in Section 4.2.1 of the ER, could be undertaken to minimize these impacts. Dominion has indicated it would undertake additional mitigation control measures to address any nuisance issues on a case-by-case basis (Dominion 2004a).

Dominion maintains that noise and exhaust emissions from construction equipment would have no discernable impact on the local noise level and air quality (Dominion 2004a). All equipment would be operated in accordance with Federal, State, and local emission requirements (Dominion 2004a).

The ER identified mitigation measures including worker training, developing a fugitive dust plan, and compliance with State and local permit conditions. Based on its review of this information, the staff concludes that the overall physical impacts to workers and the local population are SMALL, and further mitigation beyond the mitigation actions stated above is not warranted.

4.5.1.2 Buildings

Construction activities are not expected to impact any offsite buildings. The building(s) most exposed to shock and vibration from pile driving are those located on the NAPS site; however, Dominion has constructed the onsite buildings to safely withstand any shock and vibration impacts resulting from construction activities (Dominion 2004a).

Because the nearest offsite building is about 910 m (3000 ft) from the North Anna ESP site, the staff concluded that the overall physical impacts to offsite buildings would be SMALL, and mitigation is not warranted.

4.5.1.3 Roads

The transportation network in Louisa County and at the ESP site is a well-developed system. In 2001, most of the roadways within Louisa County were operating at acceptable levels-of-service (LOS). As shown in Table 2-7, the population in Louisa County, the county most impacted by the presence of the proposed Units 3 and 4, is projected to increase from approximately 25,627 to 29,100 or approximately 13.6 percent between 2000 and 2010 (VEC 2003). It is expected to increase by another 15 percent between 2010 and 2020 (Louisa County 2001) even without the influx of construction workers for Units 3 and 4. While such growth would put pressure on the local road system, it is not expected to overwhelm the system. An adequate transportation system exists, and a number of improvements are planned in Louisa County over the next 15 years for primary and secondary roads to maintain a level of service "C" rating (Louisa County 2001).

Dominion states that no new public roads would be required as a result of construction activities, nor would public roads be altered (e.g., widened) as a result of construction activities.

Dominion anticipates that some minor road repairs and improvements (e.g., patching cracks and potholes, adding turn lanes, reinforcing soft shoulders) would be necessary to enable equipment accessibility and minimize safety risks (Dominion 2004a). Construction site exits onto public roads would be marked clearly with signs and maintained. Any damage to public roads, markings, or signs caused by construction activities would be repaired to pre-existing conditions or better by Dominion (Dominion 2004a).

Dominion states that a new access road on the NAPS site would support construction activities and would be private and fully contained within the existing NAPS site boundary. The road would be maintained by Virginia Power personnel as needed (Dominion 2004a). However, the staff evaluation found that State Route (SR) 700 leading into NAPS from SR 618 is very narrow and paved. It is unlikely that this road could accept heavy construction traffic and the transportation of construction materials without substantial upgrading. There could be congestion at shift changes at the intersection of SR 700 and SR 652, particularly if the construction and operating personnel both leave and enter the plant site at the same time. In addition, construction at the North Anna ESP site could increase traffic loads in and around Lake Anna itself. The roads around Lake Anna are already congested. SR 618 through the town of Mineral would need to be evaluated with respect to potential construction at the NAPS site. Also, the existing rail spur into the site could be employed to bring in heavier equipment and construction materials, thereby taking some of the burden off the local roads. The rail spur may require upgrading to accommodate the heavier loads.

While Dominion stated that no public roads would need to be altered due to construction of new facilities, local officials believe this would need to be evaluated prior to the start of construction. Based on the information provided by Dominion in its ER and its own independent review, the staff concludes that the overall physical impacts to local roadways would be temporary and SMALL, as long as mitigation actions, such as traffic control and possible management measures that Dominion identified, are undertaken.

4.5.1.4 Aesthetics

Lake Anna, created in 1971, is the main source of cooling water for NAPS Units 1 and 2. The lake has seen tremendous residential development over the years with many permanent year-round and part-time residences. The lake is a major economic development resource for Louisa and Spotsylvania counties and, to a lesser extent, Orange County. The lake has public access, and its use by the public includes recreational boating, fishing, camping, and picnicking. Virginia Power and Old Dominion Electric Cooperative own, and Virginia Power controls, the land that forms Lake Anna, both above and beneath the water surface, up to the expected high-water marks. The aquatic resources of Lake Anna are managed cooperatively by Virginia Power and State natural resource agencies, including the Virginia Department of Game and Inland Fisheries (VDGIF) and Virginia Department of Conservation and Recreation (VDCR).

From a visual perspective, construction activities at the ESP site would generally not be visible from points outside the NAPS boundary. The exception is that recreational users of Lake Anna would be able to see some construction activities occurring on the NAPS site. However, such activities would take place on a site zoned "industrial" and containing NAPS Units 1 and 2. Because visual impacts of construction, such as water turbidity from localized dredging and fugitive dust, would be temporary and would be controlled pursuant to State regulations, and the points from which they could be observed from the lake would be limited, , the staff considers the visual impacts of construction on Lake Anna and the surrounding area would be SMALL, and further mitigation is not warranted.

4.5.2 Demography

The population in the region within 80 km (50 mi) of the ESP site is projected to grow at an average annual rate of 1.75 percent between 2000 and 2020 (i.e., from 1,538,156 in 2000 to 2,160,921 in 2020), see Table 2-5. The economy in the region is considered strong and growing.

Eighty percent of the peak 5000-person construction workforce for Units 3 and 4 would be expected to come from within the region and to commute to the NAPS site. The remaining 1000 workers may commute from outside the region to the site or relocate into the region. Thus, increases in population directly attributable to the construction workforce for Units 3 and 4 would be small.

Some new jobs may result from the multiplier effect[a] attributable to the construction workforce. But these increases, when compared to the total population base in the region, would be minimal as well.

Should a larger than expected number of construction workers decide to locate to Louisa or Orange Counties, there could be a noticeable, but not excessive, increase in population. Based on 2000 census data, a 1000-person increase caused by the relocation of construction workers would only represent a 3.9 percent increase in total population. Any multiplier effects resulting from construction worker expenditures would most likely mean that residents of the two counties would obtain new or higher paying jobs as a result of the increased economic activity.

(a) The multiplier effect describes the situation in which each dollar spent on goods and services by a construction worker becomes income to the recipient who saves some but re-spends the rest on consumption. This re-spending becomes income to someone else, who in turn saves part and re-spends the rest. The number of times the final increase in consumption exceeds the initial dollar spent is called the "multiplier."

Based on the expectation that (1) most construction workers would be expected to come from within the region and (2) the number of construction workers who might relocate to the region would be a small percentage of the larger population base, the staff concludes that the impacts of construction on increases in population within the region would be SMALL, and mitigation is not warranted.

4.5.3 Community Characteristics

This section evaluates the social and economic impacts to the surrounding region as a result of constructing Units 3 and 4 at the North Anna ESP site. The evaluation assesses impacts of construction and demands placed by the larger workforce on the surrounding region. Construction activities are assumed to last up to 5 years and employ up to 5000 workers. Dominion expects this size workforce to be maintained for a large part of the construction period (Dominion 2004a). This is in addition to the720 personnel currently employed at the site (Dominion 2004a).

4.5.3.1 Economy

The impacts of construction of the new Units 3 and 4 on the local and regional economy are dependent on the region's current and projected economy and population. The impacts on the economy of constructing Units 3 and 4 would generally be positive within the region. The degree of impact of the benefits would vary throughout the region, with Louisa County being most impacted.

Some insight can be obtained on the projected economy and population by consulting county comprehensive plans and data from the U.S. Census Bureau. The North Anna ESP, if approved, could be in effect for up to 20 years after approval. Within that period, limited site preparation activities allowed under the site redress plan could start at any time. Construction activities require the issuance of CP or a COL. Therefore, the positive economic benefits of construction could begin before the start of major construction activities. The economic impacts, given the 20-year time horizon, are qualitatively discussed.

Dominion projects that up to 5000 workers will be needed to construct Units 3 and 4. The employment of this large workforce for an extended period of time will have economic and social impacts on the surrounding region. Louisa County would be the most impacted. Orange County may be the second most impacted, and otherwise, the impacts become diffuse as a result of interacting with the larger economic base of the surrounding counties and the City of Richmond. Impacts would affect transportation, taxes, aesthetics and recreation, housing, public services, and education, all of which are discussed separately below. The magnitude of the impacts hinge on the percentage of the workforce that would come from within an 80-km

(50-mi) radius of the ESP site and thus commute to the site, and the numbers of workers who might relocate to the area and whether they relocate to Louisa and Orange Counties or Henrico County and the City of Richmond.

The peak construction workforce is expected to be approximately 5000 workers, but many more jobs would be created in the region due to the multiplier effect of direct employment as a result of the expenditures of the construction workforce in the region for food, other products, and services.

Another consideration is whether there would be a sufficient number of construction workers to supply the estimated 5000-person workforce and whether the available workers would have the requisite skills, especially in light of a very tight labor market as evidenced by the very low unemployment rates in the area (see Tables 2-9 and 2-11). In its ER (Dominion 2004a), Dominion refers to a labor study that showed there would be sufficient construction labor from the greater Richmond area to meet its demands.

Through information obtained from the interviews conducted during the December 2003 site visit, the staff confirmed that a sufficient number of construction workers would be available to meet the expected demand. Many construction workers commute from the Fredericksburg area to jobs in Northern Virginia and Washington, D.C.; for example, for the Fredericksburg region, it is estimated that out of a workforce of 122,000, 48,300 workers (almost 40 percent), commute out of the Fredericksburg region to their jobs (Fredericksburg 2003). Also, if workers were given the opportunity to reduce or eliminate their commute by working closer to home, they would do so. As a result, the staff concludes that there would be little or no impediments to recruiting the requisite construction workforce (from the local labor pool and with regional imports) to enable the construction of Units 3 and 4 at the North Anna ESP site.

The staff reviewed the impacts of station construction on the economy of the region and concludes that the magnitude of the economic impacts would be diffused in the larger economic bases of Henrico and Spotsylvania Counties and the City of Richmond, whereas with the smaller economic bases of Orange and Louisa Counties, the economic impacts would be more noticeable. Based on the positive aspects of station construction on the regional economies and the workforce availability, the staff concludes that the impacts on the economy are largely positive. In terms of representing adverse effects, the staff concludes that the impact would be SMALL, and mitigation is not warranted.

4.5.3.2 Transportation

Current transportation patterns, existing road traffic congestion, and planned road upgrades in the region were examined in Section 2.8.2.2 of this draft environmental impact statement (EIS). This section summarizes the potential impacts of construction on the transportation system as a whole.

The main impacts to the transportation system resulting from construction of Units 3 and 4 would be on the roads leading to and from the NAPS site. Several impacts could occur. First there could be the potential congestion on some of the major Federal highways and SRs leading to the NAPS site. Second could be the crowding and congestion at the entrance to NAPS during shift changes. Third, the transport of large pieces of construction equipment and supplies into the site could adversely impact the transportation system, particularly SR 700. This impact could be alleviated by using the existing rail spur to bring in supplies and construction equipment. The rail spur itself may need to be upgraded to accommodate the increased traffic and weight of some of the material being hauled. However, the transport of heavy construction equipment into the site is expected to be an occasional to rare occurrence.

Depending on the routes used, a peak workforce of 5000 construction workers commuting to and from the NAPS site could potentially impact other parts of the transportation system. Not all 5000 workers would be commuting to the site at the same time, and their arrival and departure times would most likely be spread throughout the 24-hour period in two or three shifts.

SR 700 (LOS B) (see Table 2-14 for relevant definitions of LOS) is the only road that leads directly into the North Anna ESP site, and the traffic east of the intersection on SR 652 is normally related to activities at NAPS. This would also be the case during the construction of Units 3 and 4. Construction worker access to the ESP site would be via an access road that would be built on the north side of SR 700 on Virginia Power property. This new access road would intersect with SR 700 several hundred yards west of the access road to the existing units (Dominion 2004a). Dominion indicates that the potential for congestion exists at SRs 700 and 652 if construction and plant shift changes are not managed. To alleviate this potential problem, Dominion plans to develop, in cooperation with the Virginia Department of Transportation, a traffic management plan as a construction mitigation measure (Dominion 2004a). However, this action may not fully alleviate the congestion. Beginning at the intersection of SR 700 and SR 652, the increased construction traffic would begin to disperse onto local roads, but congestion could develop at the intersection of SRs 700 and 652 during construction shift changes even if the shift changes for construction and operation are staggered (Dominion 2004a). Both SRs 700 and 618 into Mineral are of concern to Louisa County officials in light of the additional vehicular traffic placed on the roads as a result of construction.

Accounting for the current permanent workforce of 720 employees, the planned outages that double the workforce (at least four outages would occur during the construction of Units 3 and 4) and 5000 construction workers working two to three shifts per day would place a total of approximately 3900 vehicles per day on the roads (Dominion 2004a). This represents a major increase in traffic at the intersection of SRs 700 and 652, which historically has been able to handle a peak of around 2000 workers without creating a major traffic problem on the local roads (Dominion 2004a). The potential cumulative increase in the number of vehicles during a combined outage, construction, and permanent workforce egress and ingress into the site would require mitigating measures.

Dominion identified in the ER, several mitigating measures that could be undertaken to partially mitigate congestion at the intersection of SRs 700 and 652 and on the local road systems, particularly SR 700, which is a paved country lane (Dominion 2004a). These mitigating actions are described below:

- Develop a traffic management plan for the local road system prior to construction startup to alleviate congestion at the intersection of SRs 700 and 652.

- Encourage the use of car and van pooling to reduce the number of vehicles on the roads leading to the plant.

- Schedule shift changes for all employees so arrivals and departures are staggered over a 24-hour period. Dominion states it plans to do this, but recognizes the need to hand off work from the outgoing to the incoming shift workers may complicate this scheduling effort for construction and when an outage occurs.

- Upgrade the intersection of SRs 700 and 652 by installing turn lanes and traffic lights at the intersection.

Another alternative would be for Virginia Department of Transportation to widen SR 700 at U.S. 522 near the town of Mineral. As previously mentioned, SR 700 is a paved country lane and is not designed to handle large amounts of vehicular traffic or the transport of heavy loads.

The Louisa-Orange-Spotsylvania Advisory's three-county planning group, the Lake Anna Advisory Committee, has recommended that planners in each of the three counties upgrade their local roads around Lake Anna (Lake Anna Special Area Plan Committee 2000). The recommended upgrade would provide a circumferential roadway system around the lake with adequate lanes for towed boats and bicycles. Should the upgrade occur, it would alleviate congestion on local roads, such as SR 608 and U.S. 522, due to the influx of construction workers. Many of the roads around the upper end of Lake Anna have not been upgraded since the 1970s. Transportation choke points in the area now are SRs 700 and 652 at the NAPS site entrance and SR 208 to Fredericksburg.

In Orange County, the transportation system is generally considered to be adequate at present, but with new development, the system would become constrained.

Spotsylvania County plans to widen SR 606 west of I-95 to four lanes and has included this project in its comprehensive plan (Spotsylvania County 2002). This project, if completed, should reduce the additional impacts of a large number of construction workers commuting on SR 606 to the NAPS site. Construction on the SR 208 Bypass around the historic Courthouse District is scheduled to begin in 2006.. When completed, this new road would connect the SR 208 Bypass with the Spotsylvania Parkway (SR 208 north) and with the intersection of Courthouse Road (SR 208 south) with SR 606. SR 208 south is a minor road with a bridge over Lake Anna west of the North Anna ESP site. Spotsylvania County plans to upgrade the two-lane roads around Lake Anna by widening them to include shoulders (Dominion 2004a).

In Hanover County, U.S. 33 currently carries relatively modest volumes of traffic and needs to be widened (Hanover County 2003). A time frame for the widening has not been set because the source of funding has not been identified. If U.S. 33 is not widened before the start of construction of Units 3 and 4, construction workers commuting from the City of Richmond would cause increased congestion (Dominion 2004a). The magnitude of the congestion impacts would depend, to some extent, on the shift schedule for the construction of Units 3 and 4 relative to the normal commuting schedule of other road users (Dominion 2004a).

The most likely commuting routes taken by the construction workers from Richmond would be U.S. 33 through Hanover County or I-64 through northwest Henrico County and along the southern boundary of Louisa County. I-64 west from Richmond has a LOS no worse than B (Dominion 2004a). Dominion states that commuting construction workers from the greater Richmond area using SR 208 or U.S. 522 would not cause congestion problems (Dominion 2004a). While these are well maintained, lightly traveled, two-lane roads at present, adding up to 1900 construction and permanent workers (assuming three shifts in a 24-hour period) could result in congestion. This could be managed by staggering the shift changes, encouraging car pooling, etc., or by upgrading the roads in the future as discussed below.

Construction workers traveling south on I-95 from Spotsylvania County or points further north toward Washington, D.C. would most likely take SR 606 west or the Spotsylvania Turnpike exit to the Route 208 Bypass (construction to begin in 2006), and then south on SR 208 (Courthouse Road) to reach the NAPS site (Dominion 2004a). The SR 606/Interstate 95 interchange is already congested, generally at LOS D or worse. I-95 is not the most direct route to the NAPS site from Richmond, so I-95 north from Richmond through Hanover County would not be as adversely impacted by construction workers commuting from the greater

Richmond area. The capacity of I-95 is generally adequate to serve current and projected needs; however, there are periods of extreme congestion during morning and afternoon weekday hours and during peak weekend travel times (Hanover County 2003).

In conclusion, traffic congestion would be a problem if the road systems are not properly maintained. Ongoing growth in the area and recreation at Lake Anna is currently putting pressure on the roads around Lake Anna. Increased congestion could impact the recreational use of Lake Anna with consequential economic impacts to the area. Adding a construction workforce to an existing permanent workforce plus workers associated with planned outages will further exacerbate traffic congestion unless mitigation measures, as described above, are undertaken. Even then, these mitigation measures may not fully alleviate the congestion, especially on SR 700 leading to the NAPS site and at the intersection of SRs 700 and 652.

Based on this review and the mitigation measures identified in the ER, the staff concluded that if the planned upgrades and improvements to the road systems in the region and Dominion's traffic management mitigation measures are implemented, then the temporary impacts of construction on transportation in the region would be SMALL and further mitigation is not warranted. The staff further notes that impacts could be moderate if the mitigation measures are not taken.

4.5.3.3 Taxes

The type of reactor selected would impact the size of the required workforce and, thus, the amount of taxes paid. Because reactor selection would only occur if Dominion decides to proceed with a CP or a COL, only a qualitative assessment of the impacts to the surrounding area and region can be provided at this time.

There would be several types of taxes generated by the construction of Units 3 and 4 and its workforce: income taxes on wages and salaries paid and corporate profits, sales and use taxes on purchases, and property taxes on the physical facility itself. Each tax type is briefly discussed below.

Income Taxes

Virginia has a personal income tax with a 5.75 percent top marginal rate for taxable income exceeding $17,000. It also has a corporate income tax, which is 6 percent of corporate taxable income. Both the corporate and personal tax return is based on the Federal return, so generally, income that is taxable at the Federal level is also taxed by Virginia Department of Taxation (VDOT 2003). Thus, construction workers and employees of Dominion would pay taxes on their wages and salaries to Virginia if their residence is in Virginia as would corporations based in or doing business in Virginia. While the exact amount of tax payable to

Virginia is not known, the absolute amount could be substantial over a 5-year construction period, but small when considered in relation to total amount of income taxes Virginia would collect over that period.

Sales and Use Taxes

Virginia has two types of sales and use taxes. A 4 percent tax is levied on selected food items with 3 percent of the revenue going to the State and 1 percent going to the local jurisdiction in which it is collected (VDOT 2000). In addition, a 4.5 percent sales tax is levied on other goods and services sold, with the State receiving 3.5 percent of the revenue and local jurisdictions receiving the remaining 1 percent (VDOT 1987). The current combined sales and use tax rate for Louisa County is 4.5 percent: 3.5 percent of the revenue is paid to the State and 1 percent to the local governmental entity where the taxes are collected, such as Louisa County (Dominion 2004a).

Virginia and the counties surrounding the North Anna ESP site would experience an increase in the amount of sales and use taxes collected from construction materials and supplies purchased for the project. Additional sales and use taxes would be generated by retail expenditures of construction workers.

Dominion estimates that about half of the day-to-day expenditures during construction would occur in the region (Dominion 2004a). At this point it is difficult to assess which counties and local jurisdictions would be most impacted by the expenditures and resultant sales and use taxes collected. But, as with income taxes, the total amount of sales and use taxes collected, while large, would be small when compared to the total amount of taxes collected by State and local governments. The exception might be Louisa County where a larger percentage of expenditures that generate sales and use taxes could be expected to take place. Needless to say, the taxes collected would benefit State and local jurisdictions.

Because the absolute amount of sales and use taxes paid to State and local entities would be small when compared to the total amount of sales and use taxes collected, the staff concludes that the overall impacts of construction on sales and use taxes collected would be small and beneficial. In the case of Louisa County, the impacts might be moderate and beneficial because of the preponderance of construction activities in the county.

Property Taxes

Louisa County would benefit from additional property tax revenue associated with the construction of Units 3 and 4. The first source of revenue would be the tangible personal property taxes paid by contractors during construction of the additional units. This tax is based on the value of property owned by the contractors that acquire taxable status in Louisa County during the construction period. Currently, the county calculates the assessed value of the property at 10 percent of the original cost, which is then taxed at the rate of $1.90 per $100 of value (Dominion 2004a).

The second source of revenue would be from the real property taxes levied for the incremental increase in value to the entire site from the additional units. While under construction, the tax would be levied only on the value of the tangible personal property to become part of the additional units. Currently, the Virginia State Corporation Commission is responsible for the valuation of the property both during construction and following completion of the additional units. The current tax rate for this property is $0.67 per $100 of value (Dominion 2004a).

Louisa County is expected to be the primary beneficiary, of the property taxes paid by Dominion during the construction period. For the period 1995 to 2003, property taxes paid by Dominion for NAPS averaged about 46 percent of the total property revenue of Louisa County, and approximately 22.5 percent of the county's total annual budget (see more detailed discussion in Section 2.8.2.3).

The staff considers the overall impacts from real and personal property taxes resulting from construction of Units 3 and 4 to be moderate and beneficial for Louisa County. Construction would take place at the North Anna ESP site, which is in Louisa County. Louisa County receives the preponderance of property tax revenue collected on the existing NAPS Units 1 and 2, which represents a significant portion of the total property tax revenues collected by the county. This would be expected to continue with the construction of Units 3 and 4.

Summary of Impacts on Taxes

The staff reviewed the income taxes generated on wages and salaries of Units 3 and 4 construction workers and Dominion corporate profits as well as sales and use taxes, most of which represent beneficial sources of income for the State and some of which would benefit the counties in the region. Property tax paid by contractors and by Dominion would directly benefit Louisa County. The overall impacts from real and personal property taxes, on the region would be beneficially small to large for Louisa County. Therefore, the adverse impact level would be SMALL, and mitigation is not warranted.

4.5.3.4 Recreation

As discussed previously under physical impacts, construction at the North Anna ESP site would have limited visual impacts on users of Lake Anna or from points outside the site boundaries. Water-quality impacts of construction of a new water intake structure would be subject to applicable Federal and State regulations, and any noticeable effects would be transitory. Impacts on recreational users of Lake Anna as a result of these activities would be minimal.

Congestion on roads around Lake Anna could be exacerbated with the addition of the construction workforce, and recreational use of Lake Anna would increase as a result of expected increased use by the construction workforce, potentially causing temporary overcrowding. The increased congestion on the roads and use of the lake could lessen the recreational experience of current users of the lake and could discourage some recreational users of the lake, particularly those users visiting from outside the region such as Northern Virginia. Recreationalists from outside the area would most likely spend more money (gas for boats, food, and lodging) than resident recreationalists, resulting in economic impacts to local merchants around the lake.

Based on the expectation that mitigative measures, such as traffic management, road improvements, and best construction management practices to minimize water quality impacts, are conducted, the staff concludes that the impacts of construction on the recreational use of Lake Anna would be SMALL, and further mitigation is not warranted. If the mitigation measures described above is not undertaken then the impacts levels could be moderate.

4.5.3.5 Housing

Impacts on housing from the construction workforce are dependent on how many workers come from within the region (80 km [50 mi]) and, thereby, already have housing, and how many might need to relocate to the area and, thus, would require housing. Dominion states in its ER that the majority of the construction workforce would come from within the region (Dominion 2004a). Interviews with local county and economic development officials and data from the U.S. Bureau of Economic Analysis support this assumption. In 2000, there were 473,033 full- and part-time workers in Henrico, Louisa, Orange and Spotsylvania Counties and the City of Richmond, or 10.7 percent of the Virginia workforce (see Table 2-11). Of the total, 27,242 workers were employed in construction across the four counties and the City of Richmond (see Table 2-13). This number does not include construction workers who may commute to jobs outside the area of their residence.

Dominion estimates it would need a construction workforce of up to 5000 over a 5-year period to construct Units 3 and 4 (Dominion 2004a). If the entire workforce is derived from within the 80-km (50-mi) radius, there would be no or little impact on housing. However, Dominion's prior experience on projects of similar size indicates that up to 20 percent of the workforce would come from beyond the 80-km (50-mi) radius (Dominion 2004a). It is not unusual for construction workers to drive 80 km (50 mi) or more from their place of residence to a job site. So, even if 1000 or more workers came from outside the region, all 1000 would not necessarily require housing within the region.

Regardless, if current trends hold into the future, it appears that adequate rental housing is available within the 80-km (50-mi) radius of NAPS, particularly in Henrico County and the City of Richmond (see Tables 2-18 and 2-19) and to a lesser extent Spotsylvania County, given the assumption that approximately 1000 workers would come from outside the region, may need housing in the region, and would be willing to live in Henrico or Spotsylvania Counties or the City of Richmond and commute to the NAPS site. However, if these assumptions prove incorrect, housing availability could be impacted, particularly in Orange and Louisa Counties where there is a shortage of rental housing (see Table 2-19). If too many "imported" workers tried to live in these two counties, there would likely be an upward effect on rents. The staff notes that impacts to Orange and Louisa Counties could be moderate if significantly more workers than expected locate in these counties where a shortage of rental housing currently exists. The building of a significant number of new rental units in anticipation of construction activities at the North Anna ESP site is not expected because of the short period of time over which construction would occur. If rents increase, some low-income populations could be priced out of their rental housing.

Such upward pressures on rents is less likely to occur in larger metropolitan area where there is a greater supply of rental housing. In addition, if a number of construction workers were to bring trailers to live in during their period of employment, they would likely compete with recreational users of Lake Anna for spaces at existing recreational vehicle/trailer parks, again putting upward pressure on the prices or rents charged for such spaces.

Increased demand for recreational vehicle/trailer spaces could result in an increase in the number of spaces being made available. During the construction of NAPS Units 1 and 2, temporary trailer courts were established in Louisa to accommodate some of the workers. Discussions with Louisa County officials indicated that they would consider establishing such temporary courts again if needed. The availability of adequate water and sewer services would be an issue, however, as discussed in the next section.

Because of the overall availability of housing in Henrico and Spotsylvania Counties and the City of Richmond and assuming that the housing pattern follows past experience, the staff concludes that the overall impacts of construction on housing in these areas would be SMALL, and mitigation is not warranted.

4.5.3.6 Public Services

Water Supply and Waste Treatment Facilities

In Louisa County, in light of current growth and without the construction of Units 3 and 4 at the North Anna ESP site, water and sewer infrastructure are a concern now, particularly around the I-64 corridor, in the vicinity of Gum Springs. The county is considering a separate system for this area. Water supply reservoirs are also a concern, because a recent drought has exacerbated a shortage in the availability of water supplies. An influx of construction workers to the county could potentially further exacerbate the current situation. According to the Directors of

Planning and Community Development and Planning and Zoning, Mr. Williams and Buckler respectively, there are currently, no growth restrictions in Louisa County.

In Orange County during the recent drought, there were some water supply problems. Also, in the Gordonsville to town of Orange corridor, water and sewer services are near or at capacity, such that any new population growth will require upgrades of both systems. Moreover, the water and sewer systems at the eastern end of the county, where many current NAPS employees live, are close to capacity. In the event of an influx of construction workers to the eastern end of the county, shipping water from the west end of the county to the east end would be a possible, albeit expensive, solution. Currently there are no growth restrictions in Orange County.

Dominion notes in its ER, there are no public water or sewer systems in the vicinity of the ESP site except those of incorporated towns, where it is unlikely that new recreational vehicle/trailer courts would be allowed. This would require extending services from the incorporated areas to such facilities or locating them closer to Henrico County and the City of Richmond, where public water and sewer systems are available (Dominion 2004a).

As previously discussed, Dominion expects 80 percent, or approximately 4000 of the construction workers to live within an 80-km (50-mi) radius of the NAPS site, with the remaining 1000 workers commuting from outside the area or moving into the area to establish residency. Given the shortage of rental units in Orange and Louisa counties, it is expected that most of those workers moving into the region would locate in the larger population centers of Henrico and Spotsylvania Counties and the City of Richmond. Existing or planned expansions to the infrastructure would mitigate the impacts to Orange and Louisa Counties. However, during an interview on December 8, 2003, officials in Orange and Louisa Counties generally expressed the view that the existing water supply and sewer infrastructure are nearly at capacity.

Because of the overall availability of water supply and treatment facilities in Henrico and Spotsylvania Counties and the City of Richmond, the staff concludes that the overall impacts of construction on water supply and waste treatment facilities for these areas would be small. These governments have either added capacity to the infrastructure recently, or are planning additional upgrades and expansion or both. The staff further concludes that the impacts to Orange and Louisa Counties could be moderate if significantly more workers than expected locate in these counties where there is little available capacity in both water supply and waste treatment facilities.

Police, Fire, and Medical Facilities

In Orange County there are two outpatient clinics but no hospitals. The fire departments are made up of volunteers, and rescue services are composed of both volunteer and paid employees. In the future, as new facilities are established, the county is considering hiring full-time paid staff. An increase in the number of construction workers locating to the county could put pressure on the police, fire, and medical infrastructure.

There is no hospital in the town of Louisa or in Louisa County. In Louisa County, general fire, police, and rescue services are considered adequate to meet current needs. Louisa county staff periodically evaluates the adequacy of services based on growth and would include growth as a result of the construction of Units 3 and 4. It is possible that such growth would require the expansion of the police department and the fire department (currently a volunteer service) in the town of Louisa. The fire department may have to transition to a fully paid, full-time status.

A population increase caused by the construction workforce working at the North Anna ESP site, with some workers potentially relocating to Louisa and Orange Counties, would require some upgrades to existing services in these counties, but these needs are expected to be manageable because of the additional tax dollars available, particularly in Louisa County from the additional property tax revenues and other taxes as a result of construction on the NAPS site.

In the larger metropolitan areas of the City of Richmond and in Henrico and Spotsylvania Counties, police, fire, and medical facilities would not be significantly impacted by any new construction workers relocating to the area for the reasons previously discussed.

Social Services

This section focuses on the potential impacts of construction on the social and related services provided to disadvantaged segments of the population in Louisa and Orange counties, and is distinguished from issues surrounding environmental justice, which is discussed in Section 4.7.

Generally, construction of Units 3 and 4 at NAPS is viewed as economically beneficial to the disadvantaged population segments served by the Department of Social Services for Louisa and Orange Counties. Construction of the new units may enable the disadvantaged population to improve their social and economic position by moving to better-paid construction jobs, potentially lessening the demand for social services by this segment of the population. At a minimum, the expenditures of the construction workforce in the counties for goods and services would have a multiplier effect and increase the number of jobs that could be filled by the disadvantaged population.

There may be an initial increase in demand for social services by construction and other workers newly moving to the area until they establish employment, but this is considered manageable.

Summary of Public Services

Based on the current availability of services and additional taxes that would likely compensate the need for additional services, the staff concludes that the impact on the demand for public and related services as a result of construction would be SMALL, and mitigation is not warranted.

4.5.3.7 Education

Orange County is currently in the process of expanding its school infrastructure and, as a result, could accommodate modest growth increases in student population. Growth is taking place in the eastern end of the county closer to the NAPS site and Lake Anna. One middle school is located in the eastern end of the county and, if growth continues in this area, a new elementary school will be needed. Construction of the two proposed units at the NAPS site would require additional investment in the public school system, particularly given the ongoing growth in the eastern end of the county. At issue is how to accommodate any increased enrollment resulting from construction laborers locating to the county – whether through permanent construction or the use of modular trailer units (Baker 2003).

In an interview on December 10, 2003, the Superintendent for Louisa County schools said that the county schools are currently overcrowded. Enrollment is growing at 2 percent a year. Taxes in the county have not been raised in 6 years, so while the schools are being maintained there has been no new construction to accommodate increased enrollment. Growth is occurring in the county as a result of its low taxes as compared to the surrounding counties (Louisa County has the NAPS facility in its tax base (see Table 2-15). Any increase in student population because of construction workers and their families relocating to the county would most likely be handled with modular units. Louisa County purchased property to build a new elementary school in 2004, and construction is scheduled to begin in 2005. Property has also been purchased for a new middle school.

It is expected that a maximum of 1000 workers would establish new residences within an 80-km (50-mi) radius of the NAPS site and that most of these would locate to the larger population areas because of the existing shortage of available housing in Louisa and Orange Counties. Given that the workers would be scattered throughout the metropolitan region of Henrico and Spotsylvania Counties and the City of Richmond the effects of increased enrollment of students as a result of their relocation on school infrastructure in those areas is expected to be minimal.

Housing is more widely available in Henrico and Spotsylvania Counties and the City of Richmond. As a result, most construction workers are expected to already be located in these areas, and the majority of new construction workers from outside the region would most likely locate to these areas as well. Given this, the impacts of construction on school infrastructure are considered small in Orange County, which has expanded its school infrastructure and currently has excess capacity. The schools in Louisa County currently are overcrowded The county is planning to build new schools, which will alleviate the current crowded conditions. However, if the numbers of construction workers locating in Louisa County is significantly greater than suggested by previous trends, the new capacity would not be sufficient to provide services, and the impact could rise to moderate.

Based on the overall availability of educational facilities in Henrico, Spotsylvania, Orange and Louisa Counties and the City of Richmond and assuming that the housing pattern follows past experience, the staff concludes that any impact of construction on educational resources would be SMALL, and mitigation is not warranted.

4.6 Historic and Cultural Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to take into account the potential effects of their undertakings on historic properties. The review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation at 36 CFR Part 800. Evaluating suitability of a potential ESP site within the existing NAPS site for construction, operation, and decommissioning of new power units is an undertaking that could possibly affect either known or potential historic properties that may be located at the North Anna ESP site. Therefore, in accordance with the provisions of NHPA, NRC is required to make a reasonable effort to identify historic properties in the area of potential effects. If no historic properties are present or affected, NRC is required to notify the State Historic Preservation Officer before proceeding. If it is determined that historic properties are present, NRC is required to assess and resolve possible adverse effects of the undertaking.

In the case of the North Anna ESP site, Dominion has indicated that construction of additional units would involve land disturbance within a designated ESP plant construction area (currently a mostly disturbed area), the ESP cooling tower area, and in a spoils and overflow storage area. Both the cooling tower area and spoils storage areas exhibit less previous ground disturbance than the area where Units 3 and 4 would be constructed. Additionally, temporary parking, module fabrication areas, and laydown zones would involve some ground disturbance. Following construction activities, disturbed support areas would be landscaped and replanted to match the overall site appearance.

Dominion has recently commissioned studies to assist in recording and protecting known cultural resource sites, as in the case of the five historic period cemeteries located on the NAPS site. As part of the cultural resource assessment effort, the entire NAPS site has been classified into one of three categories, based on the potential for presently undiscovered historic properties to be present, including recommendations for responding to inadvertent discovery and preventing possible adverse effects to resources. These include the following:

- *Areas with No Potential for Historic or Cultural Resources.* These areas include lands where past disturbances related to construction of the power station and appurtenant (associated) facilities have taken place to such an extent that once extant cultural resources are no longer present. No further archaeological investigations are recommended for these areas.

- *Areas with Low Potential for Historic or Cultural Resources.* Lands within the ESP site that fall into this category are those that are relatively undisturbed but that possess characteristics that would normally indicate a low possibility for most types of cultural resources to occur. For the most part, these lands have a degree of slope greater than 15 percent. For most of these areas, further archaeological work would not be necessary, although there could be smaller areas within the larger zone where specific ground conditions could require investigation.

- *Areas with Moderate-to-High Potential for Historic or Cultural Resources.* These areas are classified as those that are relatively undisturbed by past activities and have a likelihood for prehistoric and historic archaeological sites according to local models of prehistoric and historic land-use and settlement patterning. Archaeological investigation is recommended prior to undertaking any ground-disturbing activities in these areas.

The eastern part of the proposed project area, where the proposed plant footprint is expected to be located, was extensively altered during ground-disturbing activities related to the original construction of the power plant and associated facilities. Therefore, it is classified as having No Potential for Historic and Cultural resources.

The western sector of the proposed project area, which includes the cooling tower area, spoils and overflow storage areas, and parking and laydown areas, includes lands that have been designated as Low and Moderate-to-High Potential for historical and cultural resources. In the event that future ground-disturbing activities in these areas would occur pursuant to the ESP, Dominion would need to consult with the Virginia Department of Historic Resources concerning the need for additional field inventory of acreage for historic and cultural resources prior to undertaking such activities.

Two known historic cemeteries are located in proximity to the proposed project area. Site 44LS221 is situated in a wooded area just north of the northwest corner of the ESP cooling tower area. The site was marked and avoided during original site construction activities. It would be protected by similar measures during any future site preparation and construction activities and would not be impacted. Site 44LS222 is located near the southeast corner of the cooling tower area, but outside the ESP construction boundary. This cemetery is a known site and would be avoided to prevent construction activities from impacting the site.

To date, literature reviews and consultations with regional Native American tribes have not identified any traditional cultural properties or other culturally significant resources that might occur in the vicinity of the proposed ESP construction area.

In addition to assessing the known and potential occurrence for historic and cultural resources and classifying site lands according to resource potential, Dominion includes cultural resource-specific written directions in its site-wide Excavation and Backfill Work Procedures (North Anna Power Station NSS Work Procedure WP-C01) involving an immediate stop work order should archaeologic, historic, or other cultural resources be discovered during excavation. The construction supervisor is responsible for ensuring the work stoppage and for notifying the Environmental Compliance Coordinator of an inadvertent discovery.

Based on the presence of a well-managed cultural resources program at the NAPS site, which includes the existence of written procedures to provide immediate reaction and notification in the event of inadvertent discovery of historic and cultural resources, and its cultural resource analysis and consultation, the staff concludes that the potential impacts on historic and cultural resources would be SMALL, and mitigation is not warranted.

4.7 Environmental Justice Impacts

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority[(a)] or low-income populations. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (NRC 2004). Figures 2-6 and 2-7 (Section 2.8.4) show the locations of minority and low-income populations around the NAPS site and within an 80-km (50-mi) radius.

(a) The NRC Guidance for performing environmental justice reviews defines "minority" as American Indian or Alaskan Native, Asian or Pacific Islander, Black not of Hispanic Origin, or Hispanic (69 FR 52040, August 24, 2004).

The staff identified the pathways through which the environmental impacts associated with the construction of Units 3 and 4 at the NAPS site could affect human populations. The staff then evaluated whether minority and low-income populations could be disproportionately affected by these impacts. In its December 2003 site audit, the staff interviewed local government officials and the staff of social welfare agencies concerning potentially disproportionate impacts to low income and minority populations. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately impacted by construction of Units 3 and 4 at the North Anna ESP site and that would result in those populations being adversely affected. In addition, the staff did not identify any location-dependent disproportionately high and adverse impacts affecting these minority and low-income populations.

Based on information provided by Dominion and its own independent review, the staff concludes that offsite impacts of construction of Units 3 and 4 at the NAPS site to minority and low-income populations would be SMALL, and mitigation is not warranted.

4.8 Nonradiological Health Impacts

Dominion (2004a) indicated that the physical impacts of construction, including public health, occupational health, and noise, would be small and were discussed qualitatively. The area around the North Anna ESP site is predominantly rural with a population of approximately 15,500 people within 16 km (10 mi) of the site. No significant industrial or commercial facilities are currently located or planned in this area.

4.8.1 Public Health

Dominion expects that individuals living near the North Anna ESP site would not experience any physical impacts greater than those that would be considered an annoyance or nuisance. In the event of atypical or noisy construction activities (e.g., pile driving), prior public announcements and/or notifications of these activities would be provided. Dominion has stated that these activities would be performed in compliance with Federal, State, and local regulations, and with site-specific permit conditions (Dominion 2004a).

Fugitive dust emissions and odors could be generated as a result of normal construction activities. Mitigation measures identified in the ER to minimize fugitive dust and odors include paving disturbed areas, water suppression and reduced material handling. Dominion states that noise and exhaust emissions from construction equipment would have no discernable impact on the local noise level and air quality (Dominion 2004a). All equipment would be operated in accordance with Federal, State, and local emission requirements (Dominion 2004a).

Based on the mitigation measures identified by Dominion in its ER, the required permits and authorization, and its own independent review, the staff concludes that the nonradiological health impacts to the local population would be SMALL, and additional mitigation beyond the actions stated above is not warranted.

4.8.2 Occupational Health

The staff expects that construction workers and personnel working onsite to be most impacted by noise, fugitive dust, and gaseous emissions resulting from construction activities. Onsite impacts to construction workers would be mitigated through training and use of personal protective equipment to minimize the risk of potentially harmful exposures. Emergency first-aid care and regular health and safety monitoring of construction personnel could also be undertaken.

Dominion states that atypical or noisy construction activities would be performed in compliance with applicable Federal, State, and local regulations, and with site-specific permit conditions (Dominion 2004a).

Fugitive dust emissions and odors could also be generated as a result of normal construction activities. Various measures could be undertaken to mitigate these impacts such as paving disturbed areas, using water to suppress dusts, and reducing material-handling activities. Dominion indicates it would undertake additional mitigation control measures to address any nuisance issues on a case-by-case basis.

Dominion states that noise and exhaust emissions from construction equipment would have no discernable impact on the local noise level and air quality (Dominion 2004a). All equipment would be operated in accordance with applicable Federal, State, and local emission requirements (Dominion 2004a).

Based on the mitigation measures identified by Dominion in its ER, the required permits and authorizations, and its own independent review, the staff concludes that the overall nonradiological impacts to workers from construction activities would be SMALL, and additional mitigation beyond the actions stated above is not warranted.

4.8.3 Noise Impacts

Large construction projects involve many noise-generating activities. Regulations governing noise from construction activities are generally limited to worker health and safety. Federal regulations governing construction noise are found in 29 CFR Part 1910 and 40 CFR Part 204. The regulations in 40 CFR Part 204 generally govern the noise levels of air compressors, while the regulations in 29 CFR 1910.95 deal with noise exposure in the construction environment.

The Commonwealth of Virginia does not have noise regulations or guidelines. Louisa and Spotsylvania Counties have general noise regulations, but these regulations do not include specific limits on noise levels, and the Spotsylvania County does not regulate noise from construction activities between 6 a.m. and 10 p.m.

Activities associated with construction of Units 3 and 4 at the North Anna ESP site would generate noise levels typical of larger construction projects. Noise levels for common construction activities are typically about 90 decibels at a distance of 3.5 m (10 ft). At 35 m (100 ft), the noise level would be about 70 decibels, and at a distance of 350 m (1000 ft), the noise level would be 50 decibels. A 10-decibel decrease in noise level is generally perceived as a halving the loudness. A few activities (e.g., jack hammers) have noise levels of about 110 decibels.

Many of the construction activities at the North Anna ESP site would take place near the existing Units 1 and 2. It is unlikely that noise from the location would be discernible at the exclusion area boundary or offsite. Construction activities may take place within 21 m (70 ft) of the western edge of the exclusion area boundary. The land to the west of the site is zoned for light industrial use; however, no uses for it have been established.

The following mitigation measures could be undertaken by Dominion, if necessary to reduce the noise during construction of Units 3 and 4:

- routine inspection and maintenance of equipment to include noise aspects
- restricting loud noise-related activities, such as pile driving or blasting, to daylight hours
- develop and implement a plan to manage and respond to citizen concerns about noise.

Considering the temporary nature of construction activities and the remote location of the North Anna ESP site, the staff concludes that the noise impacts from construction would be SMALL, and additional mitigation beyond the action stated above is not warranted.

4.8.4 Summary of Nonradiological Health Impacts

Based on the mitigating actions identified in the ER including operating the construction equipment within local noise and air quality limits and implementing a dust control plan, and its own independent review, the staff concludes that the impacts of construction on nonradiological health would be SMALL, and further mitigation beyond the above actions is not warranted.

4.9 Radiological Health Impacts

The sources of radiation exposure to site preparation workers (i.e., construction workers) include direct radiation exposure, exposure from gaseous radioactive effluents, and exposure from liquid radioactive waste discharges from routine operations at NAPS Units 1 and 2 during the site preparation and construction phase of additional units. Dominion (2004a) noted that all major construction activities are expected to occur outside of the NAPS Units 1 and 2 protected area boundary but inside the restricted site boundary (exclusion area), as shown in Figure 2-1.

4.9.1 Direct Radiation Exposures

Dominion identified two principal sources of direct radiation exposure from NAPS Units 1 and 2. These sources are (1) the boron recovery tank and (2) the low-level contaminated storage area, both located directly south of the two operating units. Another source of direct radiation is the independent spent fuel storage installation (ISFSI), which is located south of the construction site. The staff did not identify any additional sources of direct radiation.

Dominion estimated direct radiation exposure to site preparation workers by using thermoluminescent dosimeters (TLDs) that measure direct radiation levels at locations in and around the NAPS protected area and by dose rate surveys (Dominion 2004a). The TLDs used for this evaluation are the same ones used for evaluating public dose in controlled areas. The TLD located closest to the proposed site for Units 3 and 4 at the protected area boundary was on the west protected area fence for Units 1 and 2. Dominion used the measurements from this TLD to estimate one component (from the boron recovery tank and the low level contaminated storage area) of the direct radiation exposure to site preparation workers. The maximum measured dose rate for the 7-year period from 1996 through 2002 at this TLD location was 0.74 mSv/yr (74 mrem/yr) and the average annual dose rate for all the TLD readings at this location for the 7 year period was 0.56 mSv/yr (56 mrem/yr),(these dose rates are for continuous exposure at the TLD location). The TLDs were read quarterly. It was assumed that workers involved in site preparations would be west of this protected area fence, several hundred feet farther away from the operating Units 1 and 2 than where the TLDs were located. Using the average annual TLD reading of 0.56 mSv/yr (56 mrem/yr) over the 7-year period, and adjusting the TLD exposure time to 2080 hr/yr, which is the estimated maximum time a worker would be exposed, Dominion calculated an annual worker whole body or total effective dose equivalent (TEDE) dose of 0.13 mSv/yr (13 mrem/yr) from this component of direct radiation. Adjustments for background dose were not made for the assessment of dose to the site preparation workers.

The TLD reading at the west protected area fence of the existing Units 1 and 2 included the ISFSI dose contribution based on the ISFSI loading at the time of the measurements. However, to provide a more conservative dose estimate, Dominion calculated an additional dose component to the site preparation workers assuming a fully loaded ISFSI. Dominion calculated this additional dose to be 4.7×10^{-5} mSv/hr (4.7×10^{-3} mrem/hr). With an occupancy rate of 2080 hr/yr, this is equivalent to an annual worker whole body or TEDE dose of 9.8×10^{-2}

mSv/yr (9.8 mrem/yr). When this ISFSI dose of 9.8×10^{-2} mSv/yr (9.8 mrem/yr) is added to the estimated dose from the boron recovery tank and the contaminated storage area of 0.13 mSv/yr (13 mrem/yr), Dominion calculated a total dose to the site preparation workers of 0.23 mSv/yr (23 mrem/yr).

The staff reviewed the potential locations for exposures and recent records of dose rates, the locations of the TLDs, the method to estimate doses to members of the public in controlled areas, and other recent data. The staff determined that the method used to estimate the dose from direct exposure was acceptable.

4.9.2 Radiation Exposures from Gaseous Effluents

Dominion used data from the Annual Radioactive Effluent Report for 2001 to estimate the whole body dose and dose to the critical organ for a site preparation worker from gaseous effluents. Dominion stated that the annual releases for 2001 are typical for the existing units (VEPCo 2002). For the year 2001, Dominion calculated the whole body dose of 4.62×10^{-4} mSv/yr (4.62×10^{-2} mrem/yr) and 1.5×10^{-3} mSv/yr (1.5×10^{-1} mrem/yr) to the critical organ for the maximally exposed member of the public from release of gaseous effluents from the operating units. These doses are based on continuous occupancy; therefore, for estimating doses to the site preparation worker, the doses were adjusted to an exposure time of 2080 hr/yr. These doses are calculated for the maximally exposed member of the public located at or beyond the plant site boundary.

Because the workers involved in site preparation are located inside the plant boundary and are, therefore, closer to the effluent release point, Dominion assumed that the gaseous effluent dose to these workers would be higher than the dose to the maximally exposed member of the public at or beyond the site boundary. To arrive at a factor of how much larger these doses would be, Dominion took a ratio of the atmospheric dispersion factors (χ/Q) for routine releases from the existing units at the exclusion distance and at a point one-fourth of a mile to the west of the existing units (approximately the same distance from the existing units as the construction site).

On this basis, Dominion conservatively assumed that the gaseous effluent dose to the site preparation worker would be no more than 10 times higher than the dose to the maximally exposed member of the public. Therefore, Dominion multiplied the gaseous effluent dose to the maximally exposed member of the public by a factor of 10 to arrive at the estimated dose to the site preparation worker from gaseous effluents. The resulting doses are 1.1×10^{-3} mSv/yr (1.1×10^{-1} mrem/yr) for the whole body dose and 3.5×10^{-3} mSv/yr (3.5×10^{-1} mrem/yr) for the critical organ. From International Commission on Radiation Protection (ICRP) Publication 30

(ICRP 1979), applying a weighting factor of 0.3 to the organ dose and adding the whole body dose provided a TEDE of 2.1×10^{-3} mSv/yr (2.1×10^{-1} mrem/yr) for the site preparation worker from gaseous effluents (ICRP 1979).

The staff reviewed the data from the Annual Radioactive Effluent Report for 2001 (VEPCo 2002) and for more recent years and determined that the method to estimate dose from gaseous effluents was acceptable.

4.9.3 Radiation Exposures from Liquid Effluents

Dominion used data from the Annual Radioactive Effluent Report for 2001 to estimate the whole body dose and dose to the critical organ for a site preparation worker from liquid effluents (Dominion 2004a). Dominion stated that the annual releases for 2001 are representative of the typical releases for the existing units. For the year 2001, Dominion calculated a whole body dose of 3.08×10^{-3} mSv/yr (3.08×10^{-1} mrem/yr) and 3.52×10^{-3} mSv/yr (3.52×10^{-1} mrem/yr) to the critical organ for the maximally exposed member of the public from release of liquid effluents from the operating units. These doses are based on continuous occupancy; therefore, for estimating doses to the site preparation worker, the doses were adjusted to an exposure time of 2080 hr/yr. Dominion also multiplied this dose by a factor of 10 to account for uncertainty regarding the location of the worker compared to the maximally exposed member of the public. The resulting doses are 7.3×10^{-3} mSv/yr (7.3×10^{-1} mrem/yr) for the whole body dose and 8.4×10^{-3} mSv/yr (8.4×10^{-1} mrem/yr) for the critical organ. From ICRP Publication 30, applying a weighting factor of 0.3 to the organ dose and adding the whole body dose provided a TEDE of 9.8×10^{-3} mSv/yr (9.8×10^{-1} mrem/yr) for the site preparation worker from liquid effluents (ICRP 1979).

The staff reviewed the data from the Annual Radioactive Effluent Report for 2001 and for more recent years and determined that the method to estimate dose from liquid effluents was acceptable.

4.9.4 Total Dose to the Site Preparation Workers

To obtain the dose per year to the site preparation workers, Dominion added the annual dose from the three pathways, direct radiation, gaseous effluents, liquid effluents, and multiplied by the estimated number of workers (5000) to determine an estimated maximum annual collective dose to site preparation workers of 1.20 person-Sv (120 person-rem).

In summary, Dominion has estimated an annual dose to a site preparation worker of 0.24 mSv (24 mrem). The dose is primarily from the direct exposure pathway, with the doses from liquid and gaseous effluents being small. This estimate is well within both the dose limits to individual members of the public found in 10 CFR 20.1301 and occupational dose limits to workers found in 10 CFR 20.1201. The annual dose limit to an individual member of the public is 1 mSv (100 mrem) TEDE. The annual occupational dose limit to workers is 0.05 Sv (5 rems) TEDE.

The staff reviewed the data from the Annual Radioactive Effluent Report for 2001 and for more recent years and determined that the method to estimate the total dose from the three pathways, direct radiation, gaseous effluents, liquid effluents was acceptable.

4.9.5 Summary of Radiological Health Impacts

Based on the Dominion estimate of dose to occupational workers and the public and its own review, the staff found the doses to be well within NRC exposure limits designed to protect the public health, even if workers exceed the 2080 hrs/yr occupancy factor, and concludes that the impacts of radiological exposures to occupational workers and the public would be SMALL, and mitigation is not warranted.

4.10 Measures and Controls to Limit Adverse Impacts During Construction Activities

The staff relied, in its evaluation of environmental impacts during construction activities for the proposed new North Anna units on Dominion's compliance with the following regulatory requirements:

- Compliance 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, storm water management, spill response and cleanup, hazardous material management)

- Compliance with applicable requirements of existing permits and licenses (e.g., VPDES Permit, operating license) for the existing units and other permits or licenses required for construction of the new units (for example, ACE Section 404 Permit, VDEQ wetlands permit)

- A permit from VDEQ and compliance with county ordinances if burning of construction materials is required

- A VPDES permit related to accidental spills and storm water runoff.

Dominion specifically identified the following general plans or specific mitigation measures in its ER (Dominion 2004a) on which the staff relied in its evaluation:

- Incorporation of environmental requirements into construction contracts

- Avoid watercourses and wetlands to the extent possible during any construction (ER Sections 4.1.1.6.2, 4.3.1.2)

- Develop a dust control plan to mitigate the impacts of emissions from construction activities (ER Section 4.4.1.4)

- Develop a construction traffic management plan to include several traffic mitigating measures (ER Section 4.4.2.2.1)

- Determine whether any wetlands are likely to be impacted (ER Section 4.3.1.2; in which case, the staff states that Dominion would have to determine eligibility under the jurisdiction of ACE under Section 404 of the Clean Water Act)

- Minimize emissions from heavy construction equipment by scheduled equipment maintenance procedures (ER Section 4.3.1.2)

- Prevent contaminants from entering the aquatic system through use of a Spill Prevention Control and Countermeasure Plan (ER Section 4.3.2)

- Coordinate with the VDHR regarding the potential presence of historic and cultural resources within planned disturbed areas and notify VDHR in the event of any unanticipated discovery (ER Section 4.1.3).

In addition, the staff relied upon the following Dominion statements:

- Dominion stated it could construct/modify the intake structure in accordance with State and permit regulations. It noted that it may install a barrier between the ESP site and the lake to reduce the potential for silt and soil entrainment through the existing units to the WHTF (ER Section 4.3.2)

- Dominion stated it could institute controls to minimize potential noise impacts including inspection and maintenance of equipment, restrict noise-related activities to daylight hours, and restrict delivery times (ER Section 4.4.1.3)

- Dominion stated it would provide safety training and personal protective equipment to construction workers to minimize the risk of potentially harmful exposures; provide regular health and safety monitoring (ER Section 4.4.1.1.1)

- Dominion stated it would follow construction best management practices for erosion control in Lake Anna, the WHTF, and potentially impacted streams (ER Section 4.2.1).

4.11 Site Redress Plan

Site Preparation and Preliminary Construction Activities

In its ESP application, Dominion requested that it be allowed to conduct site preparation activities at the North Anna ESP site as authorized by 10 CFR 52.17(c), 10 CFR 52.25, and 10 CFR 50.10(e)(1). Dominion included in its application, as required by 10 CFR 52.17©), a site redress plan that would be implemented if site preparation activities were performed, but the ESP expired before the issuance of a construction permit (CP) or combined license (COL) by the U.S. Nuclear Regulatory Commission (NRC) (Dominion 2004a). The objective of the site redress plan is to ensure that the ESP site would be returned to an environmentally stable and aesthetically acceptable condition suitable for non-nuclear uses consistent with Louisa County zoning requirements. Under the site redress plan, locations that are permanently disturbed would be stabilized and contoured to conform with surrounding areas. Revegetation of disturbed lands would be conducted.

Prerequisites to site preparation and preliminary construction activities that must be fulfilled prior to performing such activities include:

- Create a record of the existing site conditions within the proposed ESP site by way of photographs, surveys, listings of existing facilities and structures, or other documentation. This record would serve as the baseline for redressing the site in the event ESP site preparation activities are terminated as a result of project cancellation or expiration of the ESP.

- Obtain an State and local permits and authorizations necessary to perform the site preparation activities.

- Obtain the appropriate regulatory approvals of an agreement between Virginia Power and Dominion. This agreement would authorize Dominion to conduct the pre-construction activities subject to Dominion's obligation to perform such site redress as may be required to comply with the Site Redress Plan approved by the NRC.

- Provide to the NRC a guaranty by Dominion Resources, Inc. (DRI) of $10 million as a financial assurance for Dominion's obligation to comply with the Site Redress Plan. Dominion is an indirect, wholly-owned subsidiary of DRI.

When these prerequisites have been achieved, planned site preparation and preliminary construction activities may proceed and may include none, some, or all of the activities discussed below pursuant to 10 CFR 52.25 and 10 CFR 50.10(e)(1). If the ESP is approved, Dominion may perform the following site preparation activities for the proposed Units 3 and 4 at the North Anna ESP site:

- Prepare the site for construction of the facilities (including such activities as clearing, grading, construction of temporary access roads, and preparation of borrow areas).

- Install temporary construction support facilities (including items such as warehouses, shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings).

- Excavate for facility structures.

- Construct service facilities (including items such as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, switchyard interconnects, and sanitary sewage treatment facilities).

- Drill sample/monitoring wells or additional geophysical borings.

- Construct structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public, including but not limited to:

  - cooling towers
  - intake and discharge structures
  - circulating water lines
  - fire protection equipment
  - switchyard and onsite interconnections
  - microwave towers
  - underground utilities.

The environmental impacts of site preparation activities allowed pursuant to 10 CFR 50.10(e)(1) are bounded by environmental impacts for construction of the entire facility. In many cases, the impacts of both the site preparation activities and construction may be similar, but the impacts resulting solely from site preparation activities would be of a shorter duration. In the preceding sections in this chapter, the staff presented impacts of construction that bound the impacts of site preparation. If the ESP expires before an application for a CP or COL is received under 10 CFR 52, Subpart C, and site preparation and preliminary construction activities have occurred, then the site redress plan would be activated to return the ESP site to an environmentally stable and aesthetically acceptable condition suitable for future alternative use (presumably non-nuclear) that conforms with local zoning laws, thus minimizing the long-term environmental impacts.

Site Redress Plan

Dominion provided a site redress plan as part of its ESP application in the event that site preparation and preliminary construction work did not proceed to full construction (Dominion 2004b). The plan identifies the overall objective as providing "an environmentally stable, self-draining, self-maintaining, esthetically acceptable site that can be left unattended." In its plan, Dominion states that redress activities would reflect applicable land use and zoning requirements and identifies the following five general redress activities for consideration:

1. recontouring, revegetation, and replanting of cleared areas
2. restoration of sensitive water resource features disturbed for intake and/or discharge structures
3. habitat replacement
4. use of constructed facilities for alternative purposes, or their removal
5. remediation of contamination resulting from site preparation and preliminary construction or site redress activities.

The staff reviewed the list of allowed site preparation and preliminary construction activities in the event that the ESP is granted and reviewed the full site redress plan submitted by Dominion. As a result of its own independent review, the staff, in accordance with 10 CFR 52.25(a), preliminarily concludes that the potential site preparation and preliminary construction activities described in the applicant's site redress plan would not result in any significant adverse impacts that could not be redressed.

4.12 Summary of Construction Impacts

Impact level categories are denoted in Table 4-1 as SMALL, MODERATE, or LARGE as a measure of their expected adverse environmental impacts, if any. A brief statement explains the basis for the impact level. Some impacts, such as the addition of tax revenue from Dominion for the local economies, are likely to be beneficial impacts to the community. The beneficial aspect is reflected in the comment. Positive impacts and negligible impacts are shown in the table as SMALL impacts along with those that are predicted to constitute a small adverse impact.

Table 4-1. Characterization of Impacts from Construction of Units 3 and 4 at the North Anna ESP Site

Category	Comments	Impact Level
Land-use impacts		--
The site and vicinity	Construction activities would take place within existing site boundaries.	SMALL
Transmission line rights-of-way	No new transmission line rights-of-way would be needed.	SMALL
Air quality impacts	Construction activities would be conducted in accordance with applicable Virginia administrative codes, and dust and emissions would be minimized through a dust control plan.	SMALL
Water-related impacts		--
Hydrological Alterations	Impacts localized and temporary. VDEQ and ACE permit processes would minimize impacts.	SMALL
Water use	Minimal water usage during construction.	SMALL
Water quality	Construction would be conducted using best management practices to control spills and storm water runoff.	SMALL
Ecological impacts		--
Terrestrial ecosystems	No important terrestrial species would be affected by construction at the NAPS site.	SMALL
Aquatic ecosystems	Construction impacts to benthic habitats would be temporary.	SMALL
Threatened and Endangered Species	There are no Federally listed species in vicinity. Impacts to State-listed species would be minor.	SMALL
Socioeconomic impacts		--
Physical Impacts		--
Workers/local public	Construction takes place within existing plant boundaries, so impacts to the public would be minimal. Impacts to workers would be mitigated with training and protective equipment.	SMALL
Buildings	Construction would not affect any offsite buildings, and onsite buildings were constructed to withstand vibration from construction activities.	SMALL

Table 4.1. (contd)

Category	Comments	Impact Level
Roads	Growth would put pressure on local road systems, but traffic control and management measures would protect any local roads during construction.	SMALL
Aesthetics	Construction activities would be temporary, and observation points would be limited because of site location.	SMALL
Demography	Percentage of construction workers relocating to the region would be small. Most would already live within the region.	SMALL
Community Characteristics		--
Economy	Economic impacts of construction overall are beneficial to local economies, in this case ranging from small to moderately beneficial.	SMALL
Transportation	Planned upgrades and traffic management plans would reduce temporary construction transportation impacts. Impacts could be moderate in some areas without planned upgrades.	SMALL
Taxes	Depends on residence location; generally, impacts are beneficial, especially for property taxes and employment, ranging from small to moderately (Louisa County) beneficial.	SMALL
Recreation	Visual impacts of construction would be limited and temporary. Recreational use of Lake Anna would be expected to increase, and traffic mitigation would keep impacts small. Impacts could be moderate if mitigation measure are not undertaken.	SMALL
Housing	Adequate housing is available in Henrico and Spotsylvania Counties and in the City of Richmond to handle construction workers. If more construction workers than expected locate in Orange and Louisa Counties, the impact could be moderate.	SMALL
Public Services	Public services are adequate for any temporary influx of workers due to construction at the NAPS site.	SMALL

Table 4.1. (contd)

Category	Comments	Impact Level
Education	If Louisa County builds new schools to accommodate the temporary influx of construction workers, then all counties would have room for additional students. If no additional school capacity is added then the impact in Louisa County could be moderate.	SMALL
Historic and cultural resources	Proposed construction area is previously disturbed, and Dominion has a well-managed cultural resource program in place at NAPS.	SMALL
Environmental justice	No unusual resource dependencies in the area.	SMALL
Nonradiological health impacts	Emission controls and remote location of the NAPS site would keep nonradiological health impact small.	SMALL
Radiological health impacts	Exposures would be below annual occupational and public dose limits.	SMALL

4.13 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants."

15 CFR Part 930. Code of Federal Regulations, Title 15, *Commerce and Foreign Trade*, Part 930, "Federal Consistency with Approved Coastal Management Programs."

29 CFR Part 1910. Code of Federal Regulations, Title 29, *Labor*, "Occupational Safety and Health Standards," Subpart G, "Occupational Health and Environmental Control."

29 CFR 1910.95. "Occupational Noise Exposure."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

40 CFR Part 204. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 204, "Noise Emission Standards for Construction Equipment."

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5.0 Station Operation Impacts at the Proposed Site

This chapter examines environmental issues associated with operation of the proposed Units 3 and 4 at the North Anna ESP site, for an initial 40-year period as described in the early site permit (ESP) application submitted by Dominion Nuclear North Anna, LLC (Dominion). As part of this application, Dominion submitted an Environmental Report (ER) that discusses the environmental impacts of station operation (Dominion 2004a). The chapter is divided into 13 sections. Sections 5.1 through 5.11 discuss the potential operational impacts on land use, meteorology and air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, nonradiological and radiological health effects, postulated accidents, and applicable measures and controls that would limit the adverse impacts of station operation during the 40-year operating period. In accordance with Title 10 of the Code of Federal Regulations (CFR) Part 51, impacts have been analyzed, and a significance level of potential adverse impacts (i.e., SMALL, MODERATE or LARGE) has been assigned to each analysis. The staff's determination of significance levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various State, and county governments, such as infrastructure upgrades, as discussed throughout this chapter are implemented. Failure to implement these upgrades may result in a change in significance level. Possible mitigation of adverse impacts is also presented, where appropriate. Negligible impacts and beneficial impacts are categorized as SMALL impacts. A summary of these impacts is presented in Section 5.12. The references cited in this chapter are listed in Section 5.13.

5.1 Land-Use Impacts

Sections 5.1.1 and 5.1.2 contain information regarding land-use impacts associated with operation of the proposed Units 3 and 4 at the North Anna ESP site. Section 5.1.1 discusses land-use impacts at the site and in the vicinity of the site. Section 5.1.2 discusses land-use impacts with respect to transmission line rights-of-way and offsite areas.

5.1.1 The Site and Vicinity

Some offsite land-use changes can be expected as a result of operational activities. Possible changes include the conversion of some land in surrounding areas to housing developments (e.g., apartment buildings, single family condominiums and homes, and manufactured home parks) and retail development to serve plant workers. Property tax revenue from the new plants could also lead to additional growth and land conversions in Louisa County as a result of infrastructure improvements (e.g., new roads and utility services). However, any growth would be managed because all counties surrounding the North Anna ESP site have comprehensive land-use plans in place as required by Section 15.2-2223 of the Code of Virginia.

Based on the existence and projected implementation of land-use plans, the information provided by Dominion, and its own independent review, the staff concludes that the land-use impacts of operation would be SMALL, and further mitigation is not warranted.

5.1.2 Transmission Line Rights-of-Way and Offsite Areas

Dominion stated in the ER, that any two of the three existing 500 Kv transmission lines along with the existing 230 Kv line are expected to have sufficient capacity to carry the total output of the existing units and the new units (Dominion 2004a). Dominion stated that it will, at the COL stage, perform a system study (load flow) modeling these lines with the new units power contribution. The staff based its evaluation on the assumption that the existing transmission lines are adequate and new transmission lines will not be needed. This assumption will need to be verified at the COL stage.

In Supplement 7 to the Generic Environmental Impact Statement Regarding North Anna, NRC determined that the impact of transmission lines was SMALL, and no mitigation was warranted (NRC 2002b). This conclusion would not change with the addition of new units at the North Anna ESP site because the existing transmission lines would be used. Based on the information provided in the ER, that no additional electrical transmission lines or rights-of-way would be needed, and on the staff's evaluation, land-use impacts to other offsite areas would be SMALL, and mitigation is not warranted.

5.2 Meteorological and Air Quality Impacts

The proposed cooling systems include once-through cooling for Unit 3 and dry cooling towers for Unit 4. The meteorological and air quality impacts from operating Units 3 and 4 would be limited to those resulting from operation of the Unit 4 dry cooling towers and periodic pollutant emissions from auxiliary boilers and generators from both units. Unit 4 use dry cooling towers. which dissipates the heat directly to the air. In a dry cooling tower ambient air is drawn across sealed tubes and the heat is transferred directly to the air. The heated air then mixes with the surrounding air. Any increase in air temperature would be localized and not affect the air quality. The meteorological and air quality impacts of the cooling systems and the transmission lines are expected to be negligible.

Air quality impacts from routine releases other than the cooling system would be limited to non-radiological pollutants emitted during the operation of auxiliary boilers and emergency generators, and emissions from onsite services vehicles. These systems would be used on an infrequent basis, and pollutants discharged (i.e., particulates, oxides of sulfur and nitrogen, carbon monoxide, and hydrocarbons) would be handled in accordance with Federal and State regulations. Dominion provided bounding values for these pollutants (Dominion 2004a).

Because these systems are used on an infrequent basis (i.e., typically a few hours per month) and the fact that there is no significant industrial activity within 16 km (10 mi) of the ESP site, the impact of pollutants from these sources would be small. As of January 2004, there were no non-attainment areas in the region surrounding the site for the mandated criteria pollutants (EPA 2004). Therefore, the Virginia Department of Environmental Quality (VDEQ) could decide to incorporate emission limits for the ESP site under the existing Exclusionary Permit for the North Anna site.

Impacts of existing transmission lines on air quality were reviewed in the *Generic Environmental Impact Statement of License Renewal of Nuclear Plants* (NUREG-1437) (NRC 1996). Small amounts of ozone and smaller amounts of oxides of nitrogen are produced by transmission lines. The analysis found the small amounts of these gases to be insignificant for 745-kV lines (the largest lines in operation) and for a prototype 1200-kV line. In addition, it was determined that potential mitigation measures would be very costly and would not be warranted. The largest existing line in the transmission and distribution system servicing the North Anna ESP site is a 500-kV line, which is well within the range of lines considered in NUREG-1437. Given the relatively large distance from the Class I areas and short time duration of any emissions, the resulting impact on local ambient air quality levels or visibility in the Class I areas is estimated to be insignificant. Based on these factors, the staff concludes that the potential impacts of releases from vehicles, auxiliary boilers, emergency generator, cooling systems and transmission lines would be SMALL, and maintenance measures beyond those normally taken in the operation of plant equipment are not warranted.

5.3 Water-Related Impacts

This section discusses the water-related impacts of the new units including the influence of increased heat load to Lake Anna from the once-through cooling of Unit 3. The proposed Unit 4 with its dry cooling system would have negligible impacts on the water supply. Therefore, only Unit 3 is considered in relation to water use.

Use of water resources requires managing and balancing the tradeoffs between various, often conflicting objectives. The objectives of water management at Lake Anna and the North Anna River downstream of Lake Anna include recreation, visual aesthetics, fishery maintenance, and a variety of consumptive uses of water, such as municipal water supplies and industrial uses (e.g., cooling water for power generation). The ultimate responsibility for regulating water use and water quality is delegated to the Virginia Department of Environmental Quality (VDEQ) through both Federal laws and laws of the Commonwealth of Virginia. Water resource management incorporates the uncertainty of projections of the future supply and demand for water that results from natural climate variability and man-made demands. The ability to manipulate the water supply to balance periods of excess water supply with periods of excess water demand is limited by the available water infrastructure. While the water supply is regularly being replenished by precipitation, conflicts over water resources typically grow along with population.

Both Dominion and the staff analyzed changes in Lake Anna's water supply that would result from operating Unit 3 at the North Anna site. The applicant and the staff employed different approaches and relied on different data sources. For a more complete description of the applicant's analysis refer to Sections 5.2.2 and 5.3.2 of the ER.

The staff has reviewed long-term precipitation and evaporation data from Richmond, Virginia, to characterize typical year conditions and critical year conditions. Based on annual values, the data show that precipitation exceeds evaporation in average years. Using average monthly estimates, evaporation exceeds precipitation by more than 20 percent in June. In an average year, runoff from areas draining into Lake Anna offset any deficit in the lake due to natural evaporation. However, even making normal minimum releases of 1.1 m^3/s (40 cfs) from Lake Anna will result in deficits during July, August, and September. Therefore, the lake level will decline in average years during those months. Historical summer flows downstream were much lower than the current minimum release, so it is reasonable that Lake Anna would experience deficits during the summer. While the addition of Unit 3 would cause further declines in Lake Anna, in long-term simulations using the water budget model (discussed below), the staff determined that in normal years, the lake surface elevation would not drop below 75.6 m (248 ft) above mean sea level (MSL).

During the period from October 2001 through December 2002, an extreme drought occurred in the region from Georgia to northern Virginia. As a result of this climatic anomaly, Lake Anna experienced the lowest water surface elevations and lowest estimated inflows in its history. Through the Lake Level Contingency Plan (a condition of the NAPS [Virginia pollution discharge elimination system] VPDES permit issued by VDEQ), releases from Lake Anna Dam were reduced to below the normal minimum of 1.1 m^3/s (40 cfs) to 0.57 m^3/s (20 cfs). Low water conditions were quickly reversed when normal precipitation levels returned to the region. This period of extreme drought was considered as the critical period in the analyses of both the applicant and the staff.

Both the staff's and the applicant's water budget models of Lake Anna were based on a simplified representation of the conservation of mass. The principle of conservation of mass can be restated specifically for water as "the change in storage of water at any time is equal to the water inflow less the water outflow." In both water budget models, changes in lake storage over time were equal to the differences between the inflows and the outflows. Inflows included the drainage from the basin upstream of the lake and the precipitation occurring directly on the lake. Outflows were the natural and induced evaporations and releases from the dam. Groundwater can either flow from the aquifer into Lake Anna or Lake Anna water can recharge the aquifer. Based on groundwater elevation measurements, the only time Lake Anna is expected to recharge the adjacent aquifer would be after refilling the lake following an extended period of very low lake elevations. The change in storage is reflected by a change in the pool elevation.

The staff and Dominion made different assumptions to estimate the inflow to Lake Anna. Because of the limited record of tributary flow measurements, there is no direct way to estimate the total inflow into Lake Anna from its tributaries. The outflow from Lake Anna Dam was estimated by Dominion from the U.S. Geological Survey (USGS) gauge downstream from the dam at Doswell, Virginia, after adjusting for the additional contributing area downstream between the dam and the Doswell gauge. Precipitation data was not used by the applicant in its water budget analysis as it assumed that the sum of precipitation, groundwater, and tributary as the imbalance between the estimated evaporative losses, dam releases, and the change in storage in the lake. The change in storage in the lake was based directly on records of the pool elevation. Evaporation estimates were based on calculations with the applicant's lake temperature model discussed in Section 5.3.2 of the ER. Relatively small errors in the pool elevation measurements can result in significant errors in the combined precipitation, groundwater, and tributary inflow estimate. For example, an error of only 2.5 cm (1 in.) between daily lake elevation measurements translates into an error of about 14 m^3/s (500 cfs); this can result in negative inflow estimates that are physically impossible. The occurrence of negative inflow estimates was reduced by Dominion by using weekly averages instead of daily values. Dominion provided results as the weekly averaged results.

The staff estimated inflows for the drainage upstream of Lake Anna using data from the adjacent Little River drainage basin adjusted for the differences in drainage areas. The reason for using an adjacent drainage basin is that too few of the tributaries flowing into Lake Anna are gauged for the direct data to be useful in constructing an inflow sequence for analysis. The staff also decided that the flows downstream from the Lake Anna Dam cannot be used to estimate the inflows to Lake Anna because they are too heavily influenced by consumptive losses from Units 1 and 2 and the flow regulation resulting from the lake to be used. The Little River drainage is a 277 km^2 (107 mi^2) area adjacent to the North Anna drainage with measurements from October 1961 to the present. Based on a review of streamflow records from the USGS Gauge 01671100 (Little River near Doswell, Virginia), the staff selected the period from June 2000 through April 2003 as the critical water period. The direct precipitation to the lake was based on precipitation records from the meteorological station at the Richmond, Virginia, airport.

The staff estimated outflows from the lake based on the current operating rules for Lake Anna Dam. Releases are generally performed to maintain a water surface elevation of 76.2 m (250 ft) above MSL. When the water surface elevation drops below 76.2 m (250 ft) above MSL because of inadequate inflow to offset the natural and induced evaporative losses, the release is maintained at the normal minimum flow of 1.1 m^3/s (40 cfs). If the water surface elevation declines below 75.6 m (248 ft) above MSL, releases were assumed to decrease to 0.57 m^3/s (20 cfs) immediately. In cases of severe declines in the lake water surface elevation, this assessment took into account the current lake level limit for Units 1 and 2 operation is 74.4 m (244 ft) MSL and for proposed Unit 3 is 73.8 m (242 ft) MSL. Once the water surface elevation rose above the intake threshold, the unit(s) were restarted.

5.3.1 Hydrological Alterations

The only plant operational activity identified by staff that would result in a detectable hydrological alteration is the discharge of waste heat from Unit 3. The additional discharge entering the discharge canal from the Unit 3 will result in shorter times for the water to travel from the discharge back to the intake. Similarly, a decrease of lake volume due to additional induced evaporation from Unit 3 would also reduce the travel time between the discharge and the intake.

During normal operation at full power, based on the PPE, the primary cooling system for each unit is required to reject 2800 MW (9.7 BTU/hr) to the environment. Unit 3 will reject this heat load via a once through cooling system. This design is the same as for NAPS Units 1 and 2 in that Unit 3 will withdraw water from Lake Anna adjacent to the location of the existing intakes and discharge the heated effluent to the discharge canal. The PPE also states that the flow rate through the condenser will not exceed 71,900 L/s (1,140,000 gpm). The once-through portion of the cooling system would return approximately the same amount of water to the discharge canal and the WHTF. The elevated temperature of the discharge would result in induced evaporative water losses, which are in addition to the natural (ambient) evaporative water losses from the lake. The induced evaporation the cooling system design is not included in the PPE and is a site-specific parameter. Only that volume of the water withdrawn from the lake through induced evaporative loss is considered a consumptive use. The staff's bounding analysis used the applicant's PPE estimates of induced evaporation for a once-through system 0.738 m^3/s (11,700 gpm), and evaporation for a wet cooling tower 1.23 m^3/s (19,500 gpm).

Because makeup water for ultimate heat sink (UHS) cooling towers is proposed to be stored in an engineered basin and is much less than the water demand during normal operation, water demand in UHS mode is considered to be bounded by the water demand for normal operation. The PPE provides no information on the seasonal variations on water demand. While it might be expected that the cooling system flow rate could be reduced in response to cooler intake water during the winter months, the staff assumed a constant maximum flow would bound any hydrologic alteration impacts.

During low water conditions, the existing two NAPS units are allowed to operate down to 74.4 m (244 ft) above MSL. The applicant is proposing that Unit 3 be allowed to operate down to 73.8 m (242 ft) above MSL. Given the gradual decline of the lake elevation during periods of drought, the staff concluded that the facility would have adequate time to prepare for any shutdown caused by low lake elevations.

No information on operational practices and procedures were provided in the ESP application. The applicant is deferring this analysis to the CP/COL application at which time the staff will review the operational practices and procedures that might minimize adverse impacts due to hydrological alteration.

While the increased circulation of water within Lake Anna resulting from the increased discharge from the Unit 3 will be detectable, staff conclude it is only an impact inasmuch as it results in a change in the quantity and distribution of heat in the lake. The staff identified no impacts that would be irreversible. The staff concludes that the hydrological impacts would be SMALL. However, at the CP/COL stage, the applicant will provide sufficient temperature and velocity monitoring data and modeling results to ensure that the hydrological impact of the actual discharge design is bounded by this EIS.

5.3.2 Water-Use Impacts

The existing NAPS units are the largest users of water in the region, and the addition of a third unit would add to this use. Other uses include recreation and fishing, and a variety of down-stream consumptive users of water, such as municipal water supplies and industrial uses. Most of the NAPS water usage of water drawn from Lake Anna for condenser cooling is non-consumptive as it is entirely returned to the lake. However, although there is no consumptive use of water between the intake and discharge, the elevated temperature of the discharged water results in additional induced evaporative losses from the remainder of Lake Anna, and a third unit's once-through cooling system would add to this loss.

The impacts on water use are related to the water budget. Discharge of the additional condenser cooling heat from Unit 3 to the lake would increase the heat in the lake and increase evaporation. This additional volume of discharged cooling water would also change the hydro-dynamic circulation of Lake Anna. The increased evaporation from Lake Anna from a third unit's once-through cooling system would increase the duration that the flow rate from the Lake Anna Dam would be 0.57 m^3/s (20 cfs) or less from 5.8 percent to 11.8 percent of the time and the percent of the time the lake level would be less than or equal to 75.6 m (248 ft) above MSL from 5.2 to 11.6 percent of the time. This will increase the time that the lake level or flow rate will be low. This will impact the recreational use of the lake as discussed in section 5.5.

In addition to the differences in inflow estimates mentioned earlier, the staff's assessment of the water budget involved different methods from the applicant's assessment. The staff water budget model, LakeWBT, used a fundamental timestep of six hours, whereas the applicant used a fundamental timestep of one week (NRC 2004b).

Evaporative mass transfer is generally approximated by multiplying a wind function times the difference in vapor pressure between the water surface and the atmosphere. Because vapor pressure is temperature dependent, an accurate temperature measurement of both the water surface and the atmosphere in contact with the water are necessary for an accurate estimation of evaporative mass transfer. Numerous evaporation formulations are available in the technical literature including Bras (1990) and Brutsaert (1982). Two technical studies germane for conditions surrounding Lake Anna are TVA (1972) and Edinger, et al. (1974). Staff applied both of these formulations of evaporation to understand the sensitivity of the Lake Anna water budget model.

LakeWBT included a dynamic representation of evaporation and heat loss. The staff estimated the ambient evaporation based on the TVA formulation with meteorological data (air temperature, relative humidity, and wind speed) obtained from the NOAA weather station at the Richmond, Virginia airport. The TVA formulation also requires data for the ambient lake temperature. For these data, the staff used the equilibrium temperatures estimated in the applicant's MIT model. The staff's bounding analysis used the applicant's PPE estimates of evaporation for a once-through system 0.738 m^3/s (11,700 gpm) and evaporation for a wet cooling tower 1.23 m^3/s (19,500 gpm). The wet cooling tower evaporation estimate is a conservative bounding value of forced evaporation of the once-through system as it includes no heat loss through any mechanism except evaporation. Long-wave and conductive heat loss are both neglected using the wet cooling tower estimate and therefore make the estimate conservative.

Lake temperature estimates used in the staff's estimation of the forced evaporation of the existing units were obtained from the applicant's calibrated and validated MIT model results. The staff used conservative temperature values from the MIT model as input into the staff's estimation of the evaporative loss. By selecting upstream temperatures, conservatism was enforced. The temperature at the end of the discharge canal was used to represent the main portion of the WHTF. The temperature at Burrus Point was used to represent the main body of the lake. The arms of the main body were assumed to be at the equilibrium temperature.

The staff estimated outflows from the lake based on the current operating rules for Lake Anna Dam. Releases are generally performed to maintain a water surface elevation of 76.2 m (250 ft) above MSL. When the water surface elevation drops below 76.2 m (250 ft) above MSL because of inadequate inflow to offset the natural and induced evaporative losses, the release is maintained at the normal minimum flow of 1.1 m^3/s (40 cfs). If the water surface elevation declines below 75.6 m (248 ft) above MSL, releases were assumed to decrease to 0.57 m^3/s (20 cfs) immediately. In cases of severe declines in the lake water surface elevation, this assessment took into account the current lake level limit for Units 1 and 2 operation, 74.4 m (244 ft) MSL, and for proposed Unit 3, 73.8 m (242 ft) MSL. Once the water surface elevation rose above the intake threshold, the unit(s) were restarted.

The staff's water budget modeling analysis assumed both the existing NAPS units and the once-through Unit 3 operated continuously at a 100% load factor except when the lake dropped below the current threshold, at which point the impacted units cease to operate. Four scenarios, including Unit 3 using an alternate cooling system (wet cooling towers), were selected to estimate the minimum water surface elevations: no units operating; Units 1 and 2 operating; Units 1 and 2 and the proposed Unit 3 (once-through system); and Units 1 and 2 and the proposed Unit 3 (wet tower cooling). The last scenario represents a water use upper bound. When modeling water surface elevations during the critical period of record, specifically targeting the minimum elevation occurring during early October (in the 2nd week) of 2002, the model predicts the following minimum water surface elevations for the various scenarios:

- No units operating: 75.53 m (247.8 ft)
- Units 1 and 2 (existing/observed conditions): 74.71 m (245.1 ft)
- Units 1 and 2 plus Unit 3 using once through cooling: 74.19 m (243.4 ft)
- Units 1 and 2 plus Unit 3 using wet cooling tower cooling: 73.88 m (242.4 ft).

These numbers are similar to results provided in the ER, in which Dominion estimated that during the critical period, the water surface elevation would drop an additional 0.6 m (2 ft), from below 75.0 m (246 ft) to below 74.4 m (244 ft), with the addition of Unit 3 (using wet cooling tower cooling).

Based on the results of the staff's independent water budget model, showing that supply exceeds demand, the staff concluded that the water supply provided by Lake Anna is adequate to meet plant and current downstream water demands except during periods of severe drought. Operation of Unit 3 would increase the duration of periods during drought conditions when the Lake Level Contingency Plan would be applied. Hanover County, one of four downstream counties, has identified a need for additional water (Hanover County 2004). The downstream users identified by Hanover County are, the county itself, the Doswell Limited Partnership Power Plant, Paramount's King's Dominion and the Bear Island Paper Company. To meet their future projected demand, Hanover County proposes to withdraw 1.3 m^3/s (46 cfs) from the North Anna River (Dominion 2004a). However, this diversion target withdrawal exceeds the discharges currently specified in the Lake Level Contingency Plan for minimum releases in normal and drought conditions. The Virginia General Assembly passed a bill that mandated that the minimum releases be reduced during drought conditions. This mandate is met by the Lake Level Contingency Plan, which requires the flow to be reduced to a minimum of 1.3 m^3/s (20 cfs) during drought conditions. Any future conflicts over water use fall within the regulatory authority of the Commonwealth of Virginia.

Based on the information provided by Dominion in its ER and its own independent modeling, the staff concludes that during normal water years the water use impacts, including impacts on downstream users, would be SMALL, and mitigation is not warranted. During severe droughts, however, the impact to the water level could be temporarily MODERATE. Given the infrequent and temporary nature of the severe drought conditions, the fact that Units 1 and 2 are currently required to shut down at 74.4 m (244 ft), and that lake level will return to normal with normal precipitation, no mitigation is warranted.

5.3.3 Water-Quality Impacts

Because a specific design has not been selected, the ultimate water treatment systems for proposed Units 3 and 4 are not specified. Currently, raw cooling water from Lake Anna for condenser cooling and service water needs at NAPS Units 1 and 2 is not treated. Makeup water for Unit 4, and the ultimate heat sink systems for both Units 3 and 4 would require treatment with biocides, antiscalants, and dispersants. Makeup of ultrapure water systems, such as condensate and primary cooling, would employ technologies such as reverse osmosis and ultrafiltration.

The United States Environmental Protection Agency (EPA) has delegated the responsibility for regulating water quality to VDEQ. The water quality impact of effluents from Units 1 and 2 is regulated by a VPDES permit which minimizes the impact on Lake Anna's water quality. Units 3 and 4 would also be regulated by a VPDES permit. Therefore, based on the review of the current VPDES permit for Units 1 and 2, the required VPDES permit for Units 3 and 4, Dominion's ER, the environmental monitoring report, and its independent review, the staff concludes that the impact to water quality would be SMALL, and mitigation is not warranted. However, this will have to be verified at the CP/COL stage when a design has been selected.

5.4 Ecological Impacts

This section describes the potential impacts to ecological resources from operation of the proposed Units 3 and 4. This description focuses on the habitats, wildlife, and fish that could be affected by operation of the proposed new units, in addition to transmission line rights-of-way and offsite facilities. Terrestrial and aquatic ecosystems are addressed separately.

5.4.1 Terrestrial Ecosystems

Dominion has indicated that Unit 3 would use a once-through cooling system, and Unit 4 would be cooled using a closed-cycle system with dry towers. Dry towers do not expose the cooling water directly to the air; thus, there would be no evaporative loss from the cooling towers and, therefore, no salt drift, vapor plumes, fogging, or icing. Although dry towers eliminate many of the potential impacts of wet cooling towers on terrestrial ecological resources, there are still potential impacts due to noise and avian collisions with the surface structures. The addition of new operating units also could alter the hydrological regime of Lake Anna, potentially altering the amount and characteristics of the shoreline vegetation and habitats both at Lake Anna and along the downstream portions of the North Anna River. Each of these topics is discussed below.

5.4.1.1 Noise

Maximum noise levels from the operation of the reactors and dry cooling towers would be similar to current noise levels to which local species are adapted. Current noise levels at NAPS are occasionally as high as 100 decibels (measured at the security fence during outages), but they are typically less than 80 to 85 decibels, which is the threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Noise levels from cooling tower operation would be less than 65 decibels (Dominion 2004a). There are no important terrestrial species or important habitats in the vicinity of the site or cooling towers. Thus, noise impacts to terrestrial ecological resources would be minimal.

5.4.1.2 Avian Collisions

Once-through cooling systems, as proposed for Unit 3, require no elevated structures other than the reactor building which could pose a risk of avian collisions. The dry cooling towers proposed for Unit 4 heat dissipation expected to be approximately 46 m (150 ft) tall. No avian collisions with existing NAPS structures have been recorded, and the dry towers would produce operational noise and air movements that would further decrease the potential for bird collisions. It is likely that bird collisions with the new towers would be rare. The North Anna ESP site is not within a major migratory bird concentration area along the Atlantic flyway (VDCR 2004). Dominion maintains a migratory bird protection program, including protection of nests and reporting of bird (especially raptor) strikes and other events (Dominion 2001a). Impacts to birds from collisions with heat dissipation structures at the North Anna ESP site would be minimal.

5.4.1.3 Shoreline Habitat

The increased water use and evaporation caused by the addition of one new unit with a once-through cooling system could increase the amount of shoreline exposed along Lake Anna, or affect the length of time that the additional shoreline is exposed. This increased shoreline exposure could lead to alterations of the shoreline vegetation, or enhance the introduction and/or spread of undesirable vegetation.

Dominion quantified the additional drawdown of Lake Anna caused by Unit 3 operation that could occur during drought years (Dominion 2004a). The staff performed an independent water budget analysis that evaluated effects of Unit 3 operation on the water level in Lake Anna. This analysis is discussed in section 5.3.2. The maximum annual drawdown in most years would not differ greatly from the current operation of the existing units alone. The fraction of time that the lake level would be at or below 74.4 m (244 ft) above MSL would increase from zero to approximately 1.1 percent of the time with the addition of Unit 3. The surface elevation would be at or above 75.6 m (248 ft) above MSL approximately 88 percent of the time with three operating units compared to the current 95 percent of the time with two operating units. The normal pool elevation is 76.2 m (250 ft) above MSL.

During most years, very little change in the shoreline would be evident. During drought years, the number of days of increased shoreline exposure would increase, but because this would be a temporary event, long-term effects resulting from the occasional increased drawdown caused by the addition of Unit 3 are not likely. Therefore, it is expected that the impacts to shoreline vegetation and habitats would be minimal, and additional mitigation is not warranted.

The addition of Unit 3 could cause decreased flows down river. Reduced flows could alter the riparian vegetation and habitat for riparian and wetland species along the North Anna River. Analysis by Dominion indicates that the fraction of time that the outflow from North Anna Dam is equal to or less than 1.1 m^3/sec (40 cfs) would increase from about 44 percent of the time to approximately 52 percent of the time with the addition of Unit 3 (Dominion 2004a). This change is not expected to noticeably change quantity, distribution, or characteristics of the riparian or wetland vegetation and habitats along the North Anna River between North Anna Dam and the confluence with the South Anna River. Therefore, the impact of the additional units on downstream riparian habitats is expected to be minimal.

5.4.1.4 Transmission Line Rights-of-Way

The vegetation in the transmission line rights-of-way is managed through a combination of mechanical and herbicide treatments conducted on a 3-year cycle. Mowing is the primary mechanical treatment, while Accord® and Garlon® are the primary herbicides used in the rights-of-way. In some areas (e.g., wetlands, dense vegetation), hand-cutting is used. Although no rare and sensitive plant species are known to occur within the NAPS transmission line rights-of-way, Dominion has procedures in place to ensure that such species areas be identified and avoided, or modified treatment practices used to avoid adverse impacts. These modified vegetation treatments are developed in cooperation with the Virginia Department of Conservation and Recreation's (VDCR's) Natural Heritage Program (NRC 2002b). In addition, wildlife food plots and Christmas tree plantations located along the rights-of-way are supported through cost sharing by the Virginia Electric and Power Company (also referred to as Virginia Power or VEPCo) (NRC 2002b).

In its analysis for the re-licensing of NAPS Units 1 and 2, the staff determined that continued operation and maintenance of the transmission lines rights-of-way would have a SMALL impact on terrestrial resources (NRC 2002b). Because there would be no new lines or alterations of existing the rights-of-way, no changes to this impact would be expected to occur if additional power from Units 3 and 4 is transmitted through this system.

5.4.1.5 Summary of Terrestrial Ecosystems Impacts

The staff considered the potential impacts to terrestrial ecological resources of operating the proposed Units 3 and 4, including noise, avian collisions, changes to shoreline, and riparian and wetland habitat, and transmission line rights-of-way. Based on the Dominion ER and its own independent review, the staff has determined that the operational impacts of the proposed units 3 and 4 on terrestrial ecological resources would be SMALL, and mitigation is not warranted.

5.4.2 Aquatic Impacts

This section discusses the impacts on the Lake Anna aquatic ecosystem, including striped bass, from the cooling systems associated with operating the new units at the North Anna ESP site. The lake would be the main source of cooling water for Unit 3, which would use a once-through system with cooling water taken from the lake. Unit 4 is expected use a dry cooling system that requires almost no cooling water. As a result, the potential impacts to the aquatic environment are expected to be related to the operation of Unit 3. Therefore, this analysis focuses on Unit 3 operational impacts, along with the impacts of the existing Units 1 and 2.

5.4.2.1 Intake System

The cooling water intake system can potentially impact aquatic communities by either impingement or entrainment. Traveling screens in the front of the cooling water pumps filter the water and provide protection to the cooling water pumps from damage and clogging. Impingement occurs when swimming organisms are not strong enough to escape the cooling water intake flow and are caught or stuck on the screens (i.e., impinged). Impinged organisms are generally fish, but can include other semi-aquatic animals such as amphibians (e.g., frogs, turtles, and salamanders), waterfowl (e.g., ducks and coots), or mammals (e.g., muskrats). The screens are periodically cleaned using a spray wash system from which the impinged organisms are collected and disposed of.

The second mechanism that may cause adverse impact is entrainment (i.e., the intake of organisms into and passage through the cooling water system). Entrained organisms are generally small and include phytoplankton, zooplankton, and fish eggs and larvae. As these entrained organisms pass through the cooling water system, they are subjected to stresses that may result in mortality. Impacts to the entrained organisms include physical damage from contact with pumps, pipes, and condensers; pressure damage from passage through pumps; shear damage from complex water flows; thermal damage from elevated temperatures in the condenser passage; and toxicity damage from the addition of chemicals to the cooling water system.

5.4.2.2 Impingement

In May 1985, Virginia Power published *Impingement and Entrainment Studies for North Anna Power Station, 1978-1983* (VEPCo 1985). This study was conducted in accordance with Section 316(b) of the Clean Water Act and in compliance with the NAPS Environmental Technical Specifications and the existing Virginia Pollutant Discharge Elimination System (VPDES) Permit under Special Conditions: Environmental Studies. The objective of the study was to examine the effects of impingement and entrainment at the cooling water intake system and determine if they adversely affect the fish populations in Lake Anna. When the existing Units 1 and 2 are operating, there is a maximum total withdrawal capacity of 122,000 L/s (1,934,300 gpm), or about 2.8 percent of the total Lake Anna volume per day (3.76×10^8 m^3 at 76 m above MSL [305,000 ac ft at 250 ft above MSL]). In addition, Units 1 and 2 operate in a once-through mode, and all water withdrawn from the lake is returned, but at a higher temperature. Each unit uses four circulating water pumps to withdraw condenser cooling water from Lake Anna. The cooling water is withdrawn through two screen wells (one for each unit) located in a cove north of the station (Figure 5-1). Each screen well contains four individual bays and each bay is equipped with a trash rack, a traveling screen, and a vertical, motor-driven, circulating water pump. The trash racks consist of 1.3-cm-wide by 8.9-cm-thick vertical bars spaced 10.2 cm on center. The flow through the trash racks is about 0.2 meters per second (0.69 fps) (VEPCo 1985). The traveling screens, constructed of 14-gauge wire with 9.5-mm square openings, are designed to rotate once every 24 hours or whenever a predetermined pressure differential exists across the screens. Debris collected at the trash racks is removed by mechanical rakes and collected in hoppers that discharge the debris into wire baskets. Debris and fish collected in the wire baskets are disposed of as solid waste (VEPCo 1985).

Impingement studies were conducted at NAPS from April 1978 to December 1983 in compliance with Section 316(b) of the Clean Water Act (VEPCo 1985). On average, just over 47,400 fish representing 34 species were collected annually during each full year of the study. The year 1978 was not included because sampling was not conducted for that entire year (VEPCo 1985).

To determine the total estimated number of fish impinged over a given time period, daily impingement values (number of fish per liter or gallon withdrawn) were multiplied by the average volume of intake cooling water withdrawn on that sample day, which provides an estimate of the number of fish impinged per day per liter (gallon) of water withdrawn. Period estimates were computed using daily estimates and the number of days in each period. Totaling period estimates by species results in estimates of total fish impinged by month; yearly estimates are the sum of the months.

Six species accounted for 99 percent of all fish impinged during the study. The most commonly impinged fish were gizzard shad (61 percent), followed by black crappie and yellow perch (both at 16 percent), bluegill (4 percent), white perch (1 percent), and striped bass (1 percent). No other species comprised more than 1.0 percent of the total number impinged (VEPCo 1985).

Based on the estimation process outlined above, an average of 182,000 fish were impinged each year from 1979 to 1983 (Table 5-1), 114,000 of which were gizzard shad. These impingement estimates represent a maximum number based on the withdrawal capacity for Units 1 and 2 on the specific sample collection date. A comparison of impingement numbers to standing crop estimates based on cove rotenone data from Lake Anna indicates that the percentage of the fish population affected by impingement is very low. Gizzard shad impingement losses represent 0.38 percent by number and 0.32 percent by weight of the total standing crop for Lake Anna. For black crappie, the percentages were 3.1 percent by number and 3.8 percent by weight. Values for all other species were 1.4 percent or less (VEPCo 1985).

During the study period, total impingement rates declined; the decline appeared to be associated with the reduction in gizzard shad impingement after 1979. On a yearly basis, the majority of the fish impinged were gizzard shad during 1979, 1981, and 1983. However, black crappie were impinged most often in 1980 and 1982 (VEPCo 1985). Most fish were impinged during the winter (75 percent, January to March), followed by spring (13 percent, April to June), fall (9 percent, October to December), and summer (3 percent, July to September). Lower water temperatures during the winter months tend to make fish lethargic and thus more susceptible to impingement. During 1979, gizzard shad accounted for more than 78 percent of the impingement total; 64 percent of these shad (290,000 fish) were impinged between February 20 and March 20. This large gizzard shad impingement occurred when water temperature (1.18°C, February 20, 1979) was the lowest recorded during the study period (VEPCo 1985). Winter kills are common for gizzard shad when water temperatures fall below

3.3°C (Jester and Jensen 1972). This suggests that impingement rates are inflated by winter-killed or cold-stunned shad that float into the intake area and are impinged. During subsequent years of the study, impingement levels for gizzard shad never reached the levels of 1979.

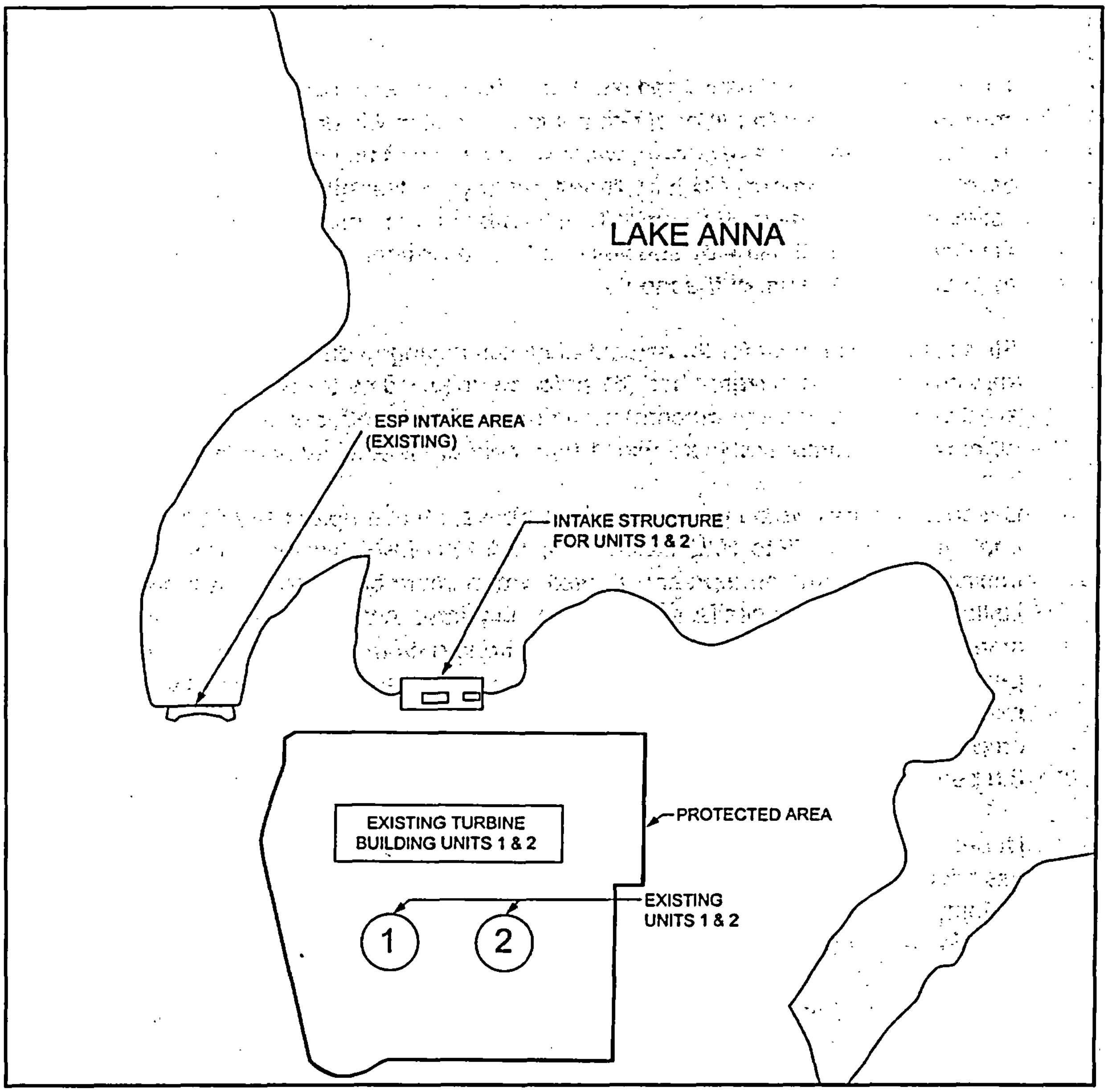


Figure 5-1. Layout of Screenwell/Pump Intake for the Existing NAPS Units 1 and 2 and the ESP Site

Table 5-1. Mean Number of Representative Important Fish Species Estimated Impinged per Month at North Anna Power Station, Units 1 and 2 from 1979 to 1983 (Based on Actual Data Estimates)

Month	Striped Bass	Black Crappie	Bluegill	Gizzard Shad	White Perch	Yellow Perch	Total All Species
January	213	929	134	14,600	92	44	16,012
February	265	2,360	235	26,459	162	1,392	30,873
March	381	9,734	465	58,314	625	24,436	93,955
April	87	4,347	636	8,407	471	1,754	15,702
May	10	1,643	630	1,607	390	84	4,364
June	0	480	839	57	135	49	1,560
July	0	372	392	67	164	39	1,034
August	3	426	985	84	159	23	1,680
September	12	845	644	485	161	19	2,166
October	30	3,449	574	236	160	5	4,454
November	357	2,143	1,944	714	176	26	5,360
December	682	1,211	293	2,827	231	36	5,280
Yearly Totals	2,040	27,939	7,771	113,857	2,926	27,907	182,440

Source: VEPCo 1985.

To estimate the impacts of the addition of a new once-through cooling water intake system with a maximum intake flow of 75,868 L/s (1,202,565 gpm) on the impingement of fish in Lake Anna, data from the 1978 to 1983 sampling study were used (VEPCo 1985). The following assumptions were used to extrapolate fish impingement rates at Unit 3: (1) fish distribution and composition has remained generally the same as in the 1978 to 1983 study, (2) a new once-through cooling water intake system would operate at 100 percent pumping capacity, and (3) the intake screen mesh size and approach flow velocity of Unit 3 would be the same as that of the existing units. Based on the impingement rate for the six representative important fish species from the 1978 to 1983 study and the maximum flow rate for a new once-through cooling system, a worst-case estimate of the total number of fish that would be impinged was calculated. Mean monthly impingement estimates for the six representative important fish species were calculated for the same 5 years of operation (Table 5-2). The staff determined that using the mean of the five representative years would give the most accurate estimate for annual fish impingement.

Table 5-2. Mean Number of Representative Important Fish Species Estimated Impinged Per Month at North Anna Power Station, Unit 3 Using a Once-Through Cooling System (Using Worst-Case Assumptions)

Month	Striped Bass	Black Crapple	Bluegill	Gizzard Shad	White Perch	Yellow Perch	Total All Species
January	269	919	152	12,201	91	43	13,675
February	361	2,514	267	30,634	155	1,754	35,685
March	504	13,386	611	93,500	781	34,701	143,483
April	123	6,622	730	10,250	650	2,741	21,116
May	8	1,724	663	2,022	605	112	5,134
June	0	543	795	70	144	70	1,622
July	0	309	322	68	137	40	876
August	2	323	816	64	128	20	1,353
September	7	648	487	311	148	31	1,632
October	32	3,462	569	197	194	10	4,464
November	367	2,575	1,721	620	121	39	5,443
December	681	1,511	270	2,409	203	30	5,104
Yearly Totals	2,354	34,536	7,403	152,346	3,357	39,591	239,587

As expected, gizzard shad dominated the impingement estimates for the new intake system with an estimated annual impingement of approximately 152,000 fish. This estimate is about 30 percent greater than the yearly estimate for the existing units (Table 5-1), and is primarily due to assuming that the new once-through cooling system would be operating at 100 percent pumping capacity and would withdraw 75,868 L/s (1,202,565 gpm). In reality, the new cooling water intake system would operate at less than 100 percent capacity, but the maximum withdrawal capacity was used in calculating a worst-case estimate. In addition, these estimates for gizzard shad may be unusually high due to increased impingement during the winter of 1979, as discussed earlier.

Estimated impingement for the other representative important species would be proportional to those of the existing units. In addition, seasonal impingement would be highest during the winter and lowest during the summer, trends that reflect those revealed in the 1985 study (Table 5-2).

Cumulatively, based on the worst-case estimate for Unit 3 and actual impingement rates for Units 1 and 2, impingement would more than double with the addition of a new unit with a once-through cooling system. Total estimated impingement for the six representative important species would be approximately 422,000 fish annually. Approximately 94 percent of the annual impingement would be gizzard shad (63 percent), yellow perch (16 percent), and black crappie (15 percent) (Table 5-3).

Table 5-3. Mean Number of Representative Important Fish Species Estimated Impinged per Month with Units 1 and 2 and a New Unit 3 Using a Once-Through Cooling System

Month	Striped Bass	Black Crappie	Bluegill	Gizzard Shad	White Perch	Yellow Perch	Total All Species
January	482	1,848	286	26,801	183	87	29,687
February	626	4,874	502	57,093	317	3,146	66,558
March	885	23,120	1,076	151,814	1,406	59,137	237,438
April	210	10,969	1,366	18,657	1,121	4,495	36,818
May	18	3,367	1,293	3,629	995	196	9,498
June	--	1,023	1,634	127	279	119	3,182
July	--	681	714	135	301	79	1,910
August	5	749	1,801	148	287	43	3,033
September	19	1,493	1,131	796	309	50	3,798
October	62	6,911	1,143	433	354	15	8,918
November	724	4,718	3,665	1,334	297	65	10,803
December	1,363	2,722	563	5,236	434	66	10,384
Yearly Totals	4,394	62,475	15,174	266,203	6,283	67,498	422,027

Gizzard shad are the major forage fish in Lake Anna. Threadfin shad, which were introduced by the Virginia Department of Game and Inland Fisheries (VDGIF) during 1983, were collected in impingement samples only in late summer and fall 1983, and were not included in the impingement estimates because of a lack of data. Threadfin shad contribute to the forage base, but its population is cyclic and subject to die-offs during cold winters.

The percentage of the total reservoir population that is impinged is very low. Based on cove rotenone sampling in Lake Anna, the average annual standing crop of gizzard shad over a 5-year period (1979 to 1983) was 121 kg/ha and the average annual impingement weight of gizzard shad was 2200 kg (VEPCo 1985). Therefore, the average percentage of gizzard shad standing crop in Lake Anna that was removed annually by impingement was 0.32 percent by weight. Similarly, values for black crappie were 3.8 percent, yellow perch 1.4 percent, bluegill 0.02 percent, and white perch 0.1 percent (VEPCo 1985). Using the worst-case scenario and the assumptions presented earlier, the addition of a new once-through cooling system would more than double the number of fish impinged. Therefore, a new once-through cooling system in combination with the current once-through system would remove approximately 0.7 percent by weight of gizzard shad annually, 8 percent of black crappie, 3 percent of yellow perch, 0.04 percent of bluegill, and 0.2 percent of white perch.

Gizzard shad have a high reproductive potential because they grow rapidly, mature quickly, and produce a large number of eggs per female. Gizzard shad can reproduce at 2 years of age and each 2-year-old female can produce from 211,000 to 543,000 eggs (Carlander 1969). The average yearly combined impingement estimates for the existing units, a new once-through cooling system, and new cooling towers using makeup water from Lake Anna, is approximately 270,000 gizzard shad, which is considerably less than the maximum egg production of one average size 2-year-old female gizzard shad. Likewise, black crappie become sexually mature at 2 or 3 years of age, and a mature female can produce from 11,000 to 188,000 eggs annually (Carlander 1977). The average yearly impingement estimates for black crappie from the existing Units 1 and 2 and new Units 3 and 4 combined would be approximately 63,000 fish, well below the maximum egg production of one mature female. These trends hold true for the other representative important species. Growth rate, survival rate, and age at maturity are factors that directly and critically influence recruitment success in fish populations; fish that grow and mature quickly are more likely to be added to the population than those that grow and mature slowly. Growth, survival, and age at maturity are in turn influenced by an array of interrelated factors that include water quality, disease, competition, predator-prey relationships, and genetics. Generally speaking, high mortality rates are associated with low rates of recruitment. Fish can be preyed on by larger fish, by wading birds, and by fishermen. Power plants essentially function as predators and, like predators, tend to be more "successful" as prey populations expand and densities increase. The theory of natural compensation relies on the assumption that fish populations grow when the population density (standing crop) is low and likewise decline when the density is high. In other words, compensation is the capacity of a population to offset, to some extent, reductions in numbers caused by some disturbance. This natural compensation process works to ensure that population size remains relatively stable over time. That the Lake Anna fish population is balanced and has remained balanced is an indication that natural compensation is occurring. Therefore, natural compensation would be expected to be offset fishery losses from impingement in Lake Anna.

Generally, new reservoirs exhibit an initial high level of productivity. This initial high level of productivity is followed by a decline. Ultimately, productivity stabilizes but at a productivity level below the initial level. The initial surge in productivity is primarily related to high nutrient levels from the freshly inundated vegetation and soil. This high nutrient level cannot be maintained so productivity decreases (Kimmel and Groeger 1986; Barwick et al. 1995). Environmental conditions tend to stabilize 5 to10 years after impoundment, and fish biomass stabilization follows. Lake Anna exhibited high initial fish abundance during 1973 and 1974 followed by a decline in succeeding years. Since 1978, the mean standing crop of fish has remained relatively stable, with the exception of 1985 when the standing crop increased significantly because of the introduction of threadfin shad in 1983 concurrently with an excellent year class for gizzard shad.

Lake Anna appears to support a higher standing crop of fish than most reservoirs in the United States, with thriving populations of several forage and game fish species.

The 1985 study at NAPS showed no significant impacts because of impingement, a conclusion validated by more than 20 years of monitoring in Lake Anna. In addition, the Section 316(a) demonstration (VEPCo 1986) and more recent monitoring data and annual reports (VEPCo 2002a) indicate that fish populations in Lake Anna are healthy and diverse. The operation of a Unit 3 using a once-through cooling system would not change this conclusion.

The staff evaluated the overall impact of withdrawing water from Lake Anna and resultant impingement of aquatic ecological resources. Because the fish impinged most frequently are prolific, exhibit a high reproductive potential, and compensatory responses of the fish population occur to offset losses, the staff concludes that the impacts of impingement would be SMALL.

5.4.2.3 Entrainment

During the 1978 to 1983 study, entrainment samples were collected once a week in front of the intake forebays. Sampling was conducted from March through July of each year, which represents the spawning period of the Lake Anna fishery (VEPCo 1985). During this 6-year study, an average of 1318 fish larvae were collected annually in the entrainment samples. No fish eggs were collected. Most of the fish species in Lake Anna produce demersal (sinking), adhesive eggs, which reduces their potential for entrainment. For purposes of the study and as a conservative estimate, 100 percent entrainment and 100 percent mortality were assumed for all larval fish collected (VEPCo 1985). During the study, five larval fish taxa dominated the collections, with gizzard shad (65.7 percent) being the most commonly entrained larvae followed by white perch (15 percent), sunfish (*Lepomis* spp.) (13.3 percent), yellow perch (4.9 percent), and black crappie (1.0 percent). All of the larvae collected were representatives of common, widely distributed species found across Virginia and the southeast (Jenkins and Burkhead 1994; Lee 1980). Seasonal differences in the sample collections of the various species reflected the spawning characteristics of the individual species (VEPCo 1985).

More sunfish (*Lepomis* spp.) and yellow perch larvae were collected in the first year of the study (1978) than in subsequent years. Gizzard shad were collected in relatively greater numbers in 1979 and 1981. White perch exhibited a general increase in samples over the study period. Collections of black crappie were considered too low to make any meaningful comparison between years. With the exception of 1978, when sunfish and yellow perch dominated the collections, trends in total numbers of larvae entrained from year to year were generally reflected in the number of gizzard shad, sunfishes, and white perch collected. The percentage of the total larvae collected represented by gizzard shad remained high (between 43 and 88 percent) and stable each year of the study, whereas the percentage of white perch increased each year from 0.3 percent in 1978 to 31 percent in 1983 (VEPCo 1985).

On a seasonal basis, yellow perch larvae were the first to appear each year in collections, generally in early April when water temperatures approached 12°C (54°F). White perch appeared in April when temperatures approached 14°C (57°F), peaked in numbers in mid-May, and were collected into July. Gizzard shad larvae generally were first collected in late April to early May at water temperatures between 14°C (57°F) and 18°C (64°F) and peaked in numbers in mid-May to early June. Sunfish were the last group to appear in samples (May to June) and were first collected when water temperatures rose to 19°C (66°F). Both gizzard shad and sunfish larvae were collected in relatively fewer numbers in July (VEPCo 1985).

To determine the total estimated number of larvae entrained over a given time period, daily entrainment values for each species expressed as the number of eggs or larvae per gallon withdrawn were multiplied by the average volume of intake cooling water withdrawn on that sample day. Period estimates were computed using daily estimates and the number of days in each period. Dominion's totaling period estimates by species results in estimates of total numbers of larvae entrained by month; yearly estimates are the sum of the months (VEPCo 1985). Based on the estimation method outlined above, an average of 149,400,000 fish larvae was entrained each year from 1978 to 1983 (Table 5-4). During this period, gizzard shad had an average yearly entrainment of approximately 95,500,000 or about 63 percent of the total entrainment, while white perch represented 15.4 percent, sunfish 14.9 percent, yellow perch 4.6 percent, and black crappie 1.2 percent.

Table 5-4. Mean Number of Representative Important Fish Species Estimated Entrained per Month from 1979 to 1983 with Existing North Anna Power Station, Units 1 and 2 Operating

Taxa	March	April	May	June	July	Yearly Totals
black crappie	-	-	1,144,967	598,711	-	1,743,678
Lepomis spp.	-	-	892,255	12,326,144	9,031,991	22,250,390
gizzard shad	-	367,705	51,580,191	41,131,018	2,396,247	95,475,161
white perch	-	3,923,856	17,157,903	1,818,796	92,820	22,993,375
yellow perch	223,513	6,309,313	384,800	10,400	-	6,928,026
Monthly Totals	223,513	10,600,874	71,160,116	55,885,069	11,521,058	149,390,630

Source: VEPCo 1985.

On a seasonal basis, the highest estimated larval fish entrainment occurred in May (47.6 percent) when all representative important species were present (Table 5-4). June estimates were the second highest with collections dropping dramatically in July.

To estimate the impacts of the addition of a new once-through cooling water intake system with a maximum intake flow of 75,868 L/s (1,202,565 gpm) on the entrainment of fish from Lake

Anna, data from the 1978 to 1983 sampling study (VEPCo 1985) were used. The following assumptions were used to extrapolate fish entrainment rates for a proposed new once-through cooling system: (1) fish distribution and composition has remained generally the same as in the 1978 to 1983 study, (2) the new once-through cooling water intake system would operate at 100 percent pumping capacity, and (3) the intake screen mesh size and approach flow velocity of the new unit would remain the same as that of the existing units. Based on the entrainment rate (number per gallon) for the five representative important fish species from the 1978 to 1983 study and the maximum flow rates for the new once-through cooling system, an estimate of the total number of these species' larvae entrained was calculated. As noted earlier in this section, the maximum cooling water withdrawal rate from Lake Anna for a new unit with once-through cooling would be 75,868 L/s (1,202,565 gpm). Combined with current usage of 122,032 L/s (1,934,300 gpm) for the existing units, this would result in 5.7 percent of Lake Anna's volume being used each day. Entrainment rates were calculated for the following representative important species: gizzard shad, sunfish, white perch, yellow perch, and black crappie. Mean monthly and yearly entrainment estimates for the new unit were calculated for the five representative important fish species for each of the six years of the study (Table 5-5).

Because the sampling period was similar in all six years, all data were used and an average yearly estimate was calculated. Entrainment estimates for the new unit averaged approximately 147,700,000 larvae annually, with gizzard shad dominating the estimates.

Table 5-5. Mean Number of Representative Important Fish Species Estimated Entrained per Month with New North Anna, Unit 3 Using a Once-Through Cooling System

Taxa	March	April	May	June	July	Yearly Totals
black crappie	--	--	1,301,138	510,611	--	1,811,749
Lepomis spp.	--	--	1,372,567	11,304,534	7,868,851	20,545,952
gizzard shad	--	299,825	50,802,477	39,808,477	2,196,895	93,107,674
white perch	--	4,439,294	18,444,442	1,399,913	71,976	24,355,625
yellow perch	231,241	7,165,176	478,451	8,751	--	7,883,619
Monthly Totals	231,241	11,904,295	72,399,075	53,032,286	10,137,722	147,704,619

Estimated entrainment for the other representative important species also would be proportional to those of the existing units on an annual and monthly basis. Cumulatively, entrainment would approximately double (Table 5-6) with the addition of a new once-through cooling system. As noted earlier, this is based on a worst-case estimate and is subject to the assumptions presented earlier in this section. Total estimated entrainment with the old and new units operating for the five representative important species would be approximately 297,000,000 fish larvae annually. Once again, gizzard shad would account for approximately 63 percent of all larvae entrained (Table 5-6).

Reproductive strategies vary among fish species. In general, the strategy is to produce large numbers of eggs but provide little protection thereafter. Therefore, mortality rates are extremely high, with generally less than 1 percent of the larvae surviving to 1 year of age (Baker et al. 1993). Survival rates are higher in species (e.g., sunfish, salmonids) that build nests and provide protection until the larvae swim away from the nest, but are still generally 10 percent or less (Baker et al. 1993). To assess the impact of the loss of fish larvae due to entrainment by the existing units on the fisheries of Lake Anna, the adult equivalent model of Goodyear (1978) was used (VEPCo 1985). The following assumptions were used: (1) there is 100 percent mortality of entrained larvae, (2) the stock populations are at equilibrium and the total lifetime fecundity produces two adults, (3) no compensatory mechanisms are operating, and (4) 75 percent of the eggs produced by the entrained species survive to the larval stage.

Table 5-6. Mean Number of Representative Important Fish Species Estimated Entrained per Month with Existing North Anna Power Station, Units 1 and 2 and a New Unit 3 Using a Once-Through Cooling System

Taxa	March	April	May	June	July	Yearly Totals
black crappie	--	--	2,446,105	1,109,322	-	3,555,427
Lepomis spp.	--	--	2,264,822	23,630,678	16,900,842	42,796,342
gizzard shad	--	667,530	102,382,668	80,939,495	4,593,142	188,582,835
white perch	--	8,363,150	35,602,345	3,218,709	164,796	47,349,000
yellow perch	454,754	13,474,489	863,251	19,151	-	14,811,645
Monthly Totals	454,754	22,505,169	143,559,191	108,917,355	21,658,780	297,095,249

This model estimates the number of adult fish that would have resulted from the entrained larvae had they not been lost to entrainment from the two operating units. It also provides an estimate of the potential percent reduction in the adult fish population as a consequence of entrainment. Values ranged from 0.01 percent for black crappie in 1978 and 1979 and sunfish in 1982, to 4.13 percent for gizzard shad in 1980. Percent reductions of this magnitude would not have a significant adverse effect on the Lake Anna fishery, especially when viewed in concert with other population mechanisms such as compensation (VEPCo 1985).

The analysis from the adult equivalent model provided a conservative estimate of entrainment impact by the existing units, primarily as a result of assumptions used in the analysis (VEPCo 1985). Applying the adult equivalent model analysis to a new once-through cooling system and associated entrainment estimates would result in a doubling of the losses estimated for the existing units (VEPCo 1985). Losses of this magnitude would not impact the Lake Anna fishery. Likewise, a new unit using a once-through cooling system would not have a significant adverse effect on the Lake Anna fishery.

The fish population in Lake Anna represents a balanced community. Over the years, the fishery of Lake Anna has matured and changed to meet the demands for public fishing through species additions (threadfin shad) and annual stockings of striped bass. Overall, the abundance and quality of the fishery has remained healthy and balanced despite increased fishing pressure and shoreline development. Because of the thriving populations of game fish in Lake Anna and the forage species that support them, the additional entrainment resulting from the operation of a new once-through unit would have a small impact on the fishery community.

Because the fish entrained most frequently are prolific, exhibit a high reproductive potential, and compensatory responses of the fish population occur to offset losses, the staff concludes that the impacts of entrainment would be SMALL.

5.4.2.4 Aquatic Thermal Impacts

This section discusses the potential thermal impacts to the aquatic resources of Lake Anna from adding heated water from the proposed Unit 3's once-through cooling discharge along with discharge from NAPS Units 1 and 2 into the discharge canal and its influence on the temperatures in Lake Anna. Fish and other aquatic resources are potentially impacted when water temperatures are greater or lower than the plants or animals can tolerate or water temperatures change so quickly that plants and animals cannot adjust. The staff evaluated the aquatic impact on the lake's ecosystem, and describes the water-use impacts of the cooling system for an additional unit. Except where site-specific data were available, the bounding design parameter values from the plant parameter envelope (PPE) were used as the basis for the analysis and evaluation of the Unit 3 discharge system. The staff describes the physical attributes of the new discharge system in Section 5.3.1.

Cold Shock

Cold shock occurs when aquatic organisms that have been acclimated to warm water, such as fish in a power plant's discharge canal, are exposed to a sudden temperature decrease. This sometimes occurs when single-unit power plants shut down suddenly in winter. It is less likely to occur at a multiple-unit plant, because a sudden temperature decrease is moderated by the heated discharge from the unit or units that continue to operate. Cold shock mortalities at U.S. nuclear power plants are "relatively rare" and typically involve small numbers of fish (NRC 1996).

"Winter kills" of fish have occurred in Lake Anna associated with cold weather and unusually cold water temperatures, but plant operations were not a factor. During February and March 1979, large numbers of gizzard shad were killed or stunned when Lake Anna water temperatures fell below 2.2°C (36°F) (Virginia Power 1985). These fish drifted into the existing units' intake, and were observed in impingement samples. The susceptibility of gizzard shad and threadfin shad to winter kills is well known. Limited threadfin shad kills have occurred during severe winters. The threadfin shad is native to the Gulf slope of the United States, peninsular Florida, and Central America, and was introduced to a number of Virginia impoundments in the 1950s, 1960s, and 1970s as a forage fish (Jenkins and Burkhead 1994). Because this species is subject to cold kills when water temperatures drop below 8.9°C (48°F), it is able to overwinter in northern latitude impoundments only when waters are heated by power plant effluents (Olmsted and Clugston 1986).

As noted above, incidents of cold shock in receiving waters of nuclear power plants are infrequent, and even more infrequent at multiple unit sites. The operation of an additional once-through unit would, therefore, reduce the likelihood of a cold shock incident in Lake Anna. Therefore, the staff concludes that the impacts of cold shock from Unit 3's once-through cooling system would be SMALL, and mitigation is not warranted.

Heat Stress

The thermal tolerance for aquatic organisms is defined in different ways. Some definitions relate to the temperature that fish may avoid, other temperatures relate the temperature that fish prefer for spawning, and others relate to the temperatures (upper and lower) that may kill individuals. Some of these tolerances are termed preferred temperatures, upper avoidance temperatures, and lethal temperatures. A list of these tolerances for several important Lake Anna species was compiled in the ER (Dominion 2004a) and is presented in Table 5-7. While study objectives, methods, and definitions vary among the temperatures cited, patterns of temperature preference and temperature tolerance are generally evident for a given species. Critical thermal maxima and chronic lethal maxima values are arrived at experimentally, and are based on different endpoints and acclimation schemes.

Mount Storm Lake, a 490-ha (1200-acre) impoundment in Grant County, West Virginia, was built to provide condenser cooling water for Dominion Energy's Mount Storm Power Station, a large 1600 MW, coal-fired generating station. Maximum (monthly mean) temperatures (one meter depth) in the impoundment ranged from 33.6° to 35.7°C (92.5°F to 96.3°F) over the 1998–2001 period at a location in the vicinity of the station's discharge (Dominion 2002). Annual maximum temperature ranged from 36.6° to 37.5°C (97.9° to 99.5°F) over the same period at the same location. Despite water temperatures that would appear certain to induce thermal stress in fish, Mount Storm Lake supports a recreational fishery dominated by largemouth bass, smallmouth bass, and channel catfish; temperate-zone species that are found in streams, lakes, and impoundments across Virginia and West Virginia. Mount Storm Lake had the third highest "success rate" (i.e., number of fish caught per hour) of 17 West Virginia lakes and impoundments where sanctioned (West Virginia Bass Federation) bass fishing tournaments were held in 2002 (West Virginia Bass Federation 2003). In addition to these species, the impoundment contains hybrid striped bass, walleye, and sunfish (bluegill and green sunfish), with spotfin shiner, emerald shiner, and threadfin shad providing the forage base.

The thermal analysis for Lake Anna described in the ER (Dominion 2004a) predict surface and sub-surface temperatures for the following three locations: Burrus Point, Thurman Island, and the existing intake area based on historical meteorological data (1961 to 2003). Temperatures predicted under historical two-unit operation were compared to field measurements and found to approximate actual temperatures. With a three-unit operation, Dominion predicted a measurable increase in Lake Anna temperatures.

Table 5-7. Temperature Requirements of Important Fish Species of Lake Anna

Species	Preferred Temperature Range		Upper Avoidance		Lethal (Undefined Experimental Method)		Critical Thermal Maximum (Lethal)		Chronic Lethal Maximum (Lethal)	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
Gizzard shad	19-23	69-73	30	86	37	98	--	--	--	--
Channel catfish	25-36	77-87	30-35	90-95	33-35	92-95	35.9-42.1	95.9-107.8[(b)]	--	--
Striped bass	18-21	65-70	25-27	77-81	--	--	31.6	88.9	--	--
Bluegill	28-33	82-91	--	--	--	--	--	--	--	--
	27-32	81-90	30-35	90-95	--	--	36.1-41.4	97-106.5[(c)]	35.9	95.9
Large-mouth bass	27-32	81-90	29-34	84-93	--	--	--	--	--	--
	27-32	81-90	31-33	88-91	--	--	32.3-40.2	97.3-104.4[(d)]	--	--

(a) Blank entries indicate no data was found.
(b) Acclimation temperatures >20°C (68°F).
(c) Acclimation temperatures >28°C (82°F).
(d) Acclimation temperatures >20°C (68°F).

Based on Dominion's modeled results, three-unit operation would increase average daily surface temperatures in the Burrus Point area by approximately 3°C (5°F) and would increase average daily surface temperatures in the Thurman Island and intake areas by approximately 3° and 2°C (5° and 4°F), respectively. Maximum daily surface temperatures predicted for the Burrus Point, Thurman Island, and the existing intake locations over approximately 42 future years of 3-unit operation were 35.6°, 35.1°, and 34.4°C (96.0°F, 95.1°F, and 94.0°F), respectively. The model predicts that 35°C (95°F) would be exceeded at a surface depth in the Burrus Point area only 1 year out of 42 years, and in only 6 days of that year. This translates into less than 0.04 percent of the 42-year period (more than 15,000 days) evaluated. At the Thurman Island location, 32°C (90°F) would be exceeded at a surface depth on an average of 20 days per year, during the June-September period. At the Intake location, 90ºF would be exceeded at a surface depth on an average of 8 days per year during the July-September period. Average annual surface temperatures at these locations would be substantially lower, ranging from 21.4° to 22.8°C (70.5°F to 73.1°F). As discussed in the ER, Dominion's thermal modeling assumes that temperatures at a given location would be uniform from the surface to a depth of 8.5 m (28 ft). This upper layer of warm, well mixed water corresponds with the area of the epilimnion in a thermally stratified body of water. The thermocline, a transitional zone where temperature drops rapidly with increasing depth, lies between the epiliminion and the hypolimnion.

Under the thermocline in the hypolimnion, temperatures are markedly cooler, even at the hottest times of year. Average daily temperatures are predicted for surface and subsurface depths at Burrus Point, Thurman Island, and intake locations during the summer months over a 42-year period.

The applicant's analysis indicates that average daily Lake Anna water temperatures at the surface would be high enough in late summer with three units operating to produce an avoidance response in some resident fish species. Fish could respond by moving up-lake, into tributary streams, or into deeper, cooler water. Temperatures below the warm, well-mixed epilimnion (at the thermocline and below, until dissolved oxygen becomes limiting) would be somewhat lower and acceptable to most Lake Anna fish species. Many non-pelagic fish species in temperate-zone lakes and reservoirs move seasonally in response to changes in temperatures, oxygen levels, and availability of food, even when the lake or reservoir is unaffected by the operation of a power plant (Hall 1977).

The warm water fish species of Lake Anna – those with less stringent temperature requirements that are native to inland waters in the southeast – should not be adversely affected by the operation of a new unit with a once-through cooling system. These include most of the species sought by anglers: largemouth bass, black crappie, bluegill, channel catfish, and white catfish. The two most important forage species, gizzard shad and threadfin shad, also should not be adversely affected.

Overall, the staff determined that additional heat discharged to Lake Anna from the WHTF, would be localized and would not increase water temperature throughout the lake and would not destabilize the native fish populations. During the summer when warmer temperatures accumulate near the discharge, most of the lake is unaffected by operations, and fish will be able to find sufficient inhabitable areas. Additionally, the fish found in the lake most frequently are prolific, exhibit a high reproductive potential, and compensate to offset losses. Based on these factors, the staff concludes the thermal impacts on the fishery community of the discharge of waste heat from Unit 3 into Lake Anna would be SMALL, and mitigation is not warranted.

5.4.2.5 Striped Bass

The striped bass, a non-native species introduced into Lake Anna for recreational fishing, is one of the most thermally-sensitive fish species in Lake Anna, and perhaps the species most vulnerable to thermal stress. Based on its thermal preferences and tolerances, the striped bass would be classified as a cool-water species. The term "cool-water species" is not rigorously defined, but it refers generally to fish species that are distributed by temperature preference between the coldwater salmonid communities of the northern United States and the more diverse centrarchid-dominated warm water assemblages of the southern United States (Trendahl 1978).

Striped bass were, until the 1940s, found only in estuaries along the Atlantic Coast from Nova Scotia to South Carolina and, during their annual spawning runs, in large freshwater rivers that flow into these estuaries. The striped bass's ability to physiologically adapt to freshwater led fisheries managers to stock them in many inland reservoirs, including a number in Virginia (Jenkins and Burkhead 1994).

The Lake Anna striped bass population is sustained by annual stockings and provides a "put-grow-and-take" fishery. Striped bass in reservoirs across the southeast show a preference for deeper, cooler water in late summer and are often found concentrated in the area of the thermocline at these times. If conditions in the area of the thermocline become inhospitable (i.e., too warm or too low in dissolved oxygen), striped bass in some southeastern reservoirs disperse to thermal refuges, areas within the reservoir that are slightly cooler because they are deeper, or cooled by underwater seeps or springs, or influenced by cooler inflowing streams. Coutant and Carroll (1980) found that sub-adult striped bass preferred temperatures of 18° to 24°C (68°F to 75°F) in summer, but frequently made brief "excursions" to warmer and cooler water. Cheek et al. (1985) discovered that striped bass were restricted in summer to riverine areas of the Watts Bar Reservoir where temperatures were less than 24° (75°F) and dissolved oxygen concentrations exceeded 4.0 milligrams per liter. Other researchers have noted a tendency of striped bass to move to deep, downlake areas near dams in late summer in search of cooler water (Combs et al. 1982).

Coutant (1985) theorized that striped bass populations are limited by available summer habitat, which he defined as 18° to 25° C (64°F to 77°F) temperatures and 2.0 to 3.0 milligrams per liter dissolved oxygen concentrations. Mathews et al. (1989) found that in late summer, large adult striped bass moved downlake to deeper, cooler water "just above the anoxic hypolimnion," and that these adults were able to tolerate temperatures somewhat higher than 25°C (77°F). Moss (1985) observed that striped bass in two Alabama reservoirs sought out cool-water refuges in summer when water temperatures approached 27° (81°F). Several researchers, including Coutant and Carroll (1980) and Dudley et al. (1977) have suggested 26° to 27° C (79°F to 81°F) as upper avoidance temperatures for striped bass.

Experience has shown that unusually high air temperatures and low rainfall in summer (e.g., the drought conditions seen over the 1998 to 2002 period) can reduce striped bass habitat in some portions of Lake Anna. This situation could be exacerbated by adding an additional unit with its additional heat load. The impact of the additional heat and water discharged to the WHTF from Unit 3 can be estimated by extending the current impacts to fish that exist in the WHTF into the main body of the lake. Based on the staff's analysis, increasing the heat load and associated flow by approximately 72 percent would increase the portion of the lake experiencing WHTF-like condition. The WHTF contains about 21 percent of the total volume of Lake Anna. Therefore, the conditions currently experienced in 21 percent of the lake would increase by 72 percent. Assuming all of these Unit 3-related WHTF-like conditions occur in the main body of the lake, 19 percent of the main body of the lake would experience WHTF-like conditions with the new unit.

Experience has also shown that even extreme circumstances (e.g., an extended drought) do not eliminate striped bass habitat in the upper lake and mid-lake areas. No striped bass die-offs have been observed in any portion of Lake Anna. Striped bass restricted to a narrow layer of water around the thermocline or to thermal refuges may not be able to move freely and feed normally; thus they may be forced to live on stored energy reserves. As a consequence, they may lose weight or show a decline in condition. This phenomenon has been observed at a number of southeastern reservoirs where striped bass experience a late-summer habitat "squeeze." When surface waters cool in September and October, striped bass are able to move freely in the water column again and resume normal feeding. Weight gain and an improvement in their condition generally follow.

As noted previously in this section, a number of southeastern reservoir populations experience a summer habitat "squeeze," trapped between a too-warm upper layer and an oxygen-deficient lower layer. Because the Lake Anna striped bass population is not native to this portion of the watershed and does not reproduce naturally in the lake, the striped bass fishery is dependent on annual stockings. The section of the river above the Lake Anna Dam lacks the required flow, depth, and length to support striped bass spawning. Thus, reproduction would not be affected by the addition of a new unit.

Based on the available information, the staff determined that waste heat input to Lake Anna from a new unit with a once-through cooling system could affect striped bass in the reservoir by forcing them up-lake into areas that provide suitable habitat, but effects would be limited to a three-to-four month period in summer and early fall. There could be some energetic costs associated with the up-lake movement and there could be a period of "lost" growth, if fish are restricted to relatively small areas with an inadequate supply of forage. When confined in late summer to areas that provide only marginal habitat, striped bass sometimes cease feeding (Siler et al. 1986). Thermal impacts on striped bass may be detectable in that fish take longer to grow to sizes desired by fishermen, fish health may decline during summer months, optimum habitat may be reduced during summer months, and fish may have to congregate in other parts of the lake. In cooler months and non-drought years, "put-grow-and-take" fishing provides optimum fishing opportunities. Maintenance of the striped bass fishery in Lake Anna could warrant mitigation during drought conditions.

Because the Lake Anna striped bass population is a "put-grow-and-take" fishery of a non-indigenous species and because suitable habitat would continue to exist within Lake Anna, the staff concludes that the heat stress impact of Unit 3's once-through cooling system on the striped bass would be SMALL during cooler months and non-drought years. During drought years, the impacts without mitigation may be MODERATE. In such circumstances, mitigation to reduce the impact could be accomplished by stocking more fish, stocking larger fish, or managing the fishery to provide more catch opportunities of larger fish.

5.4.2.6 Shoreline Erosion and Other Physical Impacts

With low flow velocity in Lake Anna, the impacts, such as increased shoreline erosion, lakebed scouring, and increased turbidity levels caused by the operation of the new intake system would not be detectable or destabilizing to the aquatic resources of Lake Anna. The flow velocity in the discharge channel, the connecting canals, and the main ponds of the WHTF would be slightly higher than in the reservoir portion of Lake Anna because of their smaller dimensions. It is assumed that Unit 3 would use a once-through cooling system with a circulating flow rate of up to 71.9 m^3/s (2540 cfs). Including the cooling water discharge of 120 m^3/s (4246 cfs) from the existing units, the total maximum discharge flow to the WHTF would be 192 m^3/s (6795 cfs). At maximum discharge rate and a water level in the WHTF of 76.7 m (251.5 ft) above MSL, corresponding to the design lake level of 76 m (250 ft) above MSL, the flow velocity in the discharge channel and the connecting canals would be approximately 0.5 m/s (1.7 ft/s).

Dominion states that flow velocity in the channel and canals would be 0.88 m/s (2.9 ft/s) during severe drought conditions when the lake pool elevation could decline to 73.8 m (242 ft) above MSL, which would be the proposed minimum operating lake level. With only the existing units are in operation, the channel velocity is estimated to be about 0.33 to 0.55 m/s (1.1 to 1.8 ft/s) at water levels of 76.7 m (251.5 ft) above MSL and 74.2 m (243.5 ft) above MSL, respectively.

The velocity in the WHTF system for the flow from the existing units and future units would be higher than the velocity projected at the intake channel area, but would be low enough not to cause scouring or erosion problems. Banks of the connecting canals are currently protected by rip-rap from 73.8 to 76.2 m (242 to 250 ft) above MSL to protect against erosion. The flow velocity slows substantially in the main ponds of the WHTF beyond the entrance-mixing zone near the end of the connecting canals. At the Dike 3 discharge to the reservoir, the exit velocity is designed to be about 2 m/s (7 ft/s). The bottom of the discharge structure is protected by a concrete apron to minimize local erosion at the discharge.

No adverse impact because of scouring from the existing plant discharge has occurred, and none would likely occur as a result of the future combined operation of three units. There is a limited record of turbidity level measurements in the WHTF, but based on the projected discharge flow velocity, the range of the turbidity level in the WHTF would be approximately the same as current turbidity. Siltation would be minimal, because the medium-to-coarse sediment would settle before reaching the intake approach channel. A small amount of fine, suspended sediment could be entrained into the cooling water intake system and discharged to the WHTF, where the majority of entrained sediment would stay in suspension. The sediment-laden cooling water would return to the Lake Anna reservoir via Dike 3.

Because no adverse impact from the existing plant discharge has occurred nor is expected from the combined operation of the three units, many of the fish species in the lake are fecund, and compensatory responses of the fish population occur to offset losses, the staff concludes that the impacts to aquatic ecological resources from physical changes to Lake Anna from operation of Unit 3 once-through cooling would be SMALL, and mitigation is not warranted.

5.4.2.7 Summary of Aquatic Impacts

The fish population in Lake Anna represents a balanced community. Over the years, the fishery has matured and changed to meet the demands for public fishing through species additions (threadfin shad) and annual stockings of striped bass. Overall, the abundance and quality of the fishery has remained healthy and balanced despite increased fishing pressure shoreline development, and thermal impingement, and entrainment impacts of the existing Units 1 and 2. The additional aquatic impacts, thermal, impingement, entrainment, shoreline erosion and the physical impacts that may occur to Lake Anna from the operation of a third unit would be small on the fishery community. Unit 4, using dry cooling towers, would have negligible aquatic impacts. As a result, the staff concludes that aquatic impacts from the operation of Units 1, 2, 3 and 4 on Lake Anna would be SMALL. The impact on the striped bass would be SMALL during the cooler months and non-drought years. During drought years, impacts may be MODERATE and warrant mitigation. In such circumstances, the impact could be reduced by stocking more and larger fish or managing the fishery to provide more opportunities to catch larger fish.

5.4.3 Threatened and Endangered Species

This section describes the potential impacts that operation of the proposed Units 3 and 4 may have on threatened or endangered species at and in the vicinity of the North Anna ESP site. The terrestrial species potentially occurring in the vicinity of the North Anna ESP site are described in Section 2.7.1, and the potential impacts of operating the new units to terrestrial species are examined in Section 5.4.3.1. The threatened and endangered aquatic species potentially occurring near the ESP site are described in Section 2.7.4, and potential impacts of operating the new units to aquatic species are considered in Section 5.4.3.2.

5.4.3.1 Terrestrial Species

There are no threatened or endangered terrestrial species that are known to inhabit the vicinity of the North Anna ESP site. Bald eagles which are threatened, (*Haliaeetus leucocephalus*) are occasionally observed along Lake Anna; the nearest known nest site is approximately 16 km (10 mi) upstream from the proposed ESP site. Noise generated by the operations of the new units and the Unit 4 dry cooling towers would be well below levels that have been associated with disturbance to wildlife, and would not be likely to adversely affect bald eagles foraging in the vicinity of the plant. Dominion follows the bald eagle protection guidelines for Virginia (FWS and VDGIF 2000), which would prevent or minimize impacts of operation of the proposed new units and the NAPS transmission lines. No other Federally listed terrestrial threatened or endangered animal species has been observed near the proposed ESP site.

There are no Federally listed terrestrial threatened or endangered animal species that are known to occur along the North Anna River downstream from Lake Anna. Therefore, if any changes to the flow regimes in this portion of the river were made, there would not be an effect on Federally listed threatened or endangered terrestrial species.

Three Federally listed threatened or endangered plant species have been identified as potentially occurring within the NAPS transmission line rights-of-way. These include the small whorled pogonia (*Isotria medeoloides*), swamp pink (*Helonias bullata*), and the sensitive joint-vetch (*Aeschynomene virginica*). In its assessment of the potential impacts of continued operation of the existing NAPS Units 1 and 2, the staff concluded that continued operation and maintenance of the transmission lines and rights-of-way would not adversely impact these plant species (NRC 2002b). Because no changes to the transmission lines and rights-of-way are anticipated to result if the proposed Units 3 and 4 are built, there would be no change to the potential impact of operation and maintenance of the transmission lines or rights-of-way on these threatened or endangered plant species.

The staff evaluated the potential impacts of operation of the proposed Units 3 and 4, including operation of the plants, cooling systems, and transmission systems, as well as potential changes to the flows in the North Anna River on terrestrial threatened and endangered species. Based on this evaluation, the staff concludes that the impacts of operating the proposed new units on terrestrial threatened and endangered species would be SMALL, and mitigation is not warranted.

5.4.3.2 Aquatic Species

Virginia Power has monitored fish populations in Lake Anna and the North Anna River for more than 25 years. No Federally listed fish species has been collected in any of these monitoring studies, nor has any listed species been observed in creel surveys or occasional special studies conducted by Virginia Power biologists. No Federally or State-listed fish species' range includes Lake Anna or the North Anna River, and none is believed to occur in counties adjacent to Lake Anna or the North Anna River (i.e., Caroline, Hanover, Louisa, Orange, and Spotsylvania Counties).

According to VDGIF and VDCR (Division of Natural Heritage) databases, one Federally listed mussel species, and one mussel species that is a candidate for Federal listing, occur in counties that border Lake Anna or the North Anna River. None of them has been found in Lake Anna or the North Anna River.

The staff evaluated the potential impacts of operating the proposed new Units 3 and 4, including operating the plants, cooling systems, and transmission systems, as well as potential changes to the flows in the North Anna River, on aquatic threatened and endangered species. Based on this evaluation, the staff concludes that the impacts of operating the proposed new units on aquatic threatened and endangered species would be SMALL, and mitigation is not warranted.

5.5 Socioeconomic Impacts

This section describes the socioeconomic impacts from operating two new nuclear units at the North Anna ESP site, and from the activities and demands of the operating workforce on the surrounding region. Socioeconomic impacts include potential impacts on individual communities, the surrounding region, and minority and low-income populations.

5.5.1 Physical Impacts

This section assesses the potential physical impacts on the nearby communities caused by operation of new nuclear units at the North Anna ESP site. Potential impacts discussed include noise, odors, exhausts, thermal emissions, and visual intrusions. Dominion, as stated in its ER, plans to manage these physical impacts to comply with applicable Federal, State, and local environmental regulations (Dominion 2004a). Dominion does not expect operation of the new units to significantly affect the North Anna ESP site and its vicinity (Dominion 2004a). The staff's evaluation is discussed in the following subsections.

5.5.1.1 Workers and the Local Public

Access to the North Anna ESP site is provided by State Route (SR) 700. The terrain around and into the plant site is undulating and wooded. Most of the site structures are screened from public view up to the proximity of the plant boundary. There are no residential areas located within the North Anna ESP site boundary.

Offsite, the region surrounding Lake Anna and the North Anna ESP site is covered with forest and brushwood interspersed with occasional farmland. The population immediately surrounding the lake ranges from about 980 and 2940 within 4 and 8 km (2.5 and 5 mi), respectively, from the ESP site, (Dominion 2004a). The town of Mineral, located about 10 km (6 mi) from North Anna ESP site, has a population of 424 (USCB 2000).

Because of its distance from the ESP site, residents of Mineral would experience minimal physical impacts from operation of the new units. People who work or live closer to the North Anna ESP site (the nearest residence is about 1000 m [3000 ft] away) could be subjected to some noise (particularly from the dry cooling system on Unit 4), fugitive dust, and gaseous emissions resulting from operation activities. Least impacted by station operations would be transient populations, such as temporary employees, recreational visitors to Lake Anna, and tourists passing through the area. Such effects should be transient and have minimal impact.

Personnel working onsite are most likely to be impacted by station operation. The number of employees at the ESP site would approximately double to 1600-plus employees if both Units 3 and 4 were constructed and placed into operation. Onsite impacts to permanent workers from station operations could be mitigated through adequate training and use of personal protective equipment to minimize the risk of potentially harmful exposures. Standard management practices should minimize such exposures. Emergency first-aid care and regular health and safety monitoring of permanent, operating personnel could also be undertaken.

The staff evaluated the information provided by Dominion and notes that most of the local public is located well away from the North Anna ESP site and onsite impacts to North Anna ESP workers can be mitigated. Based on these considerations and its own independent review, the staff concludes that the overall physical impacts of station operation to workers and the local public are SMALL, and additional mitigation beyond the actions discussed above is not warranted.

5.5.1.2 Buildings

Because operational activities are not expected to impact any offsite buildings, most of which are located well away from the North Anna ESP site boundaries, the staff concludes that any offsite physical impacts from station operation to buildings would be SMALL, and mitigation is not warranted.

5.5.1.3 Roads

In its analysis, the staff assumed that by the time North Anna Units 3 and 4 would begin operation, improvements to the road systems around the North Anna ESP site (as discussed in Section 4.5.1.3 and 4.5.3.2) would have been completed. Construction of Units 3 and 4 would require up to 5000 workers while the operating workforce would number approximately 720, in addition to the 720 permanent workforce at the existing units. Thus, any impacts to the road system by the operating workforce would most likely be significantly less than impacts incurred with the addition of the construction workforce.

There may be some congestion at the entrances to the North Anna ESP site at shift changes. There may also be some ambient dust levels from commuter traffic into and out of the North Anna ESP site, but this is expected to be minimal because commuters to and from the site would be using paved roads.

Based on the assumption that any needed upgrades to the regional road system would have been made in conjunction with, or as a result of, the construction of Units 3 and 4, and that number of operating personnel would be significantly fewer than the number of construction personnel, the staff concludes that the physical impacts of station operation on the road system would be SMALL, and mitigation is not warranted.

5.5.1.4 Aesthetics

The physical aspects of station operation on the aesthetics of Lake Anna and the surrounding area can be viewed from two different perspectives. The first is the visual impacts of the operating units to users of the lake and the surrounding community. Second is the impact of station cooling operations on Lake Anna and the surrounding area. This would include the physical impacts on the water level of the lake of operating the two new units.

Visual Impacts

The turbine building for the existing units is about 30 m (100 ft) above grade, and the containment buildings are about 40 m (130 ft) above grade. The turbine building for the two new units could be approximately 70 m (230 ft) above grade (Dominion 2004a). As previously discussed, once-through cooling, which requires no superstructure, would be used for Unit 3, as is the case with Units 1 and 2. Unit 4 would use dry cooling towers, which would be approximately 46 m (150 feet) high and would consist of a series of modules, each containing air-circulating fans. The dry modules would be expected to cover an area of approximately 9.7 ha (24 ac).

The nearest residential area to the North Anna ESP site is about 1000 m (3000 ft) north and is shielded by forested land. Given this distance and vegetative shielding, most residents near the site would not be expected to have a clear view of the new units. Recreational users on Lake Anna and some residents along the lake would be able to see the new units as well as the existing developed areas at the North Anna ESP site.

Some of the aesthetic impacts of station operation will be determined by the type of design selected for the new units. Based on the selected design, Dominion would undertake a visual impact study to assess the physical layout on the North Anna ESP site of the new reactors and ancillary facilities with respect to the existing facilities to identify whether mitigative actions were needed and could be undertaken to reduce the potential aesthetic impact of the new units on the users of the lake to the extent practicable. The results would be included in the construction permit or combined license (COL) application for the new units (Dominion 2004a).

Cooling System Impacts

The staff also considered the potential atmospheric phenomena resulting from operation of proposed types of heat-dissipation systems and their potential aesthetic impacts in the ESP site vicinity. The once-through cooling water system for Unit 3 would discharge to the existing WHTF for heat dissipation.

The WHTF dissipates the rejected heat from the plant by heat transfer to the atmosphere and through internal mixing within the water body itself. Under extreme humidity conditions during fall, winter, and spring, cool moist air above the WHTF could turn to fog (i.e., steam fog) and drift to adjacent areas. According to Dominion, the impact of steam fog would be small because this type of atmospheric phenomena tends to impact ground-level visibility in a very localized area (Dominion 2004a). Additionally, the results from screening hourly meteorological data collected at Richmond, Virginia, from 1996 to 2000 indicate that there were no hours concurrently having relative humidity greater than 90 percent and ambient temperature below 0°C (32°F), the precursor conditions needed for steam fog formation. Therefore, steam-fog-induced icing conditions have been very infrequent at the North Anna site and, the staff expects the condition to be infrequent in the future.

Unit 4 would use closed-cycle dry cooling towers for heat dissipation. The towers themselves do not allow circulating water to evaporate because the water is fully contained within the tubes. Therefore, it is expected that there would be no impacts from visible plumes (Dominion 2004a).

Because of the severe drought conditions experienced within the Lake Anna area between October 2001 and December 2002, and its impact on reducing the water levels in the lake, the staff evaluated the impacts of the addition of thermal impacts of the Unit 3 discharge in relation to water levels within Lake Anna. Under severe drought conditions, Unit 3 could have an exacerbating effect on the drawdown of Lake Anna, potentially adding to the duration of low water levels, which would affect the visual impact of the amount of shoreline exposed.

Dominion, both in its revised ER and its response to a comment in correspondence with the VDEQ, points out that the 2001 to 2002 water year (October through September) was the driest year on record out of 108 years of record keeping (i.e., it appears to be a rare event). Dominion also points out that the reservoir's low levels occur generally after the end of September, which marks the end of the park recreation season (Dominion 2004a), although use of the lake continues into October and November. Impacts of the Unit 3 cooling system on the lake's water level could be more noticeable in time of drought.

Summary of Aesthetic Impacts

Based on information provided by Dominion and its own independent review, the staff concludes that the overall impacts of station operation of Units 3 and 4 on aesthetics is SMALL because the new units would be located in the existing power station complex and the visual aspects of the site to offsite viewers is limited. However, the staff notes that during severe drought conditions, the operation of Unit 3 would have an impact on the water levels by adding to the duration that shoreline mud flats may be exposed, during which time visual aesthetic impacts could temporarily be moderate. Mitigation is not warranted due to the temporary nature of the impact.

5.5.2 Demography

Population in the region within a 80-km (50-mi) radius of the North Anna ESP site is projected to grow at an average annual rate of 1.7 percent between 2000 and 2020 (i.e., from 1,537,796 in 2000 to 2,160,921 in 2020; see Table 2-5). The economy in the region is considered to be strong and is growing.

There are currently 720 personnel employed at NAPS for Units 1 and 2 (Dominion 2004a). Approximately 720 additional permanent workers would be required for the operation of the proposed Units 3 and 4 (Dominion 2004a). As a conservative measure, the staff assumed that these 720 workers would relocate into the area with their families (i.e., none of the new workers already lived in the area). The 720 additional employees would translate into an increase in population of about 2900 to the region, assuming each new employee represents a family of four (Dominion 2004a). Assuming that the geographic distribution of new employees would be the same as for the existing units when it was evaluated for license renewal (NRC 2002) (see Table 2-17), about 208 new employees would settle in Louisa County, 163 in Spotsylvania County, 105 in Orange County, 91 in Henrico County and the City of Richmond, and 153 in the other counties within an 80-km (50-mi) radius of North Anna ESP site .

The addition of the new employees and their families would equate to the following percentage increase in population (using 2000 census data, see Table 2-7): Louisa County, 3.2 percent; Orange County, 1.6 percent; and Spotsylvania County, 0.7 percent. The potential percentage increase for Henrico County and the City of Richmond would be substantially less than 0.1 percent. Overall, the potential increases in population do not represent a large percentage increase in the total population, even for Louisa County, which is hypothesized to receive the highest percentage of new employees.

Some new jobs may result from employment of the new operating personnel through the multiplier effect attributable to the operations workforce. But these increases, when compared to the total population base in the region, would be expected to be minimal as well. And many of these new jobs would be filled by workers who already reside in the region.

The staff evaluated the impacts of station operation on increases in population and determined that while the new operating personnel are expected to come from outside the region, their small numbers, when considering the population base of each jurisdiction, would not significantly increase the base population within each jurisdiction. Most new jobs created through the multiplier effect are expected to go to workers who already reside in the region. Based on these considerations, the staff concludes that the impacts of station operation on increases in the regional population would be SMALL, and mitigation is not warranted.

5.5.3 Community Characteristics

This section evaluates the social and economic impacts to the surrounding region as a result of operation of Units 3 and 4 at North Anna ESP site. The evaluation assesses impacts of operation and of those demands placed by the workforce on the surrounding region during a 40-year operating license period. Dominion expects to employ up to an additional 720 workers to operate the new units (Dominion 2004a). This is in addition to the 720 personnel currently employed at the site (Dominion 2004a).

5.5.3.1 Economy

The impacts of station operation on the local and regional economy are dependent on the region's current and projected economy and population. Some insight can be obtained on the projected economy and population by consulting county comprehensive plans and data from the U.S. Census Bureau. The economic impacts over a 40-year period of station operation are qualitatively discussed.

Dominion states that most new operating personnel are expected to come from outside the region (Dominion 2004a). Their employment for such an extended period of time would have economic and social impacts on the surrounding region. Louisa County (site of the operating plants) would be the most impacted. Orange County may be the second most impacted. Outside of these areas, the impacts become diffuse as a result of interacting with the larger economic base of the surrounding counties and the City of Richmond. Impacts would affect areas such as transportation, taxes, aesthetics and recreation, housing, public services, and education, which are discussed separately in the following sections. The magnitude of the impacts hinge on (1) the percentage of the workforce that would come from within the region of interest (80 km [50 mi]) and thus commute to the site and (2) those workers who might relocate to the area and whether they relocate to Louisa and Orange Counties or Henrico County and the City of Richmond.

The new jobs, as with the construction workforce, would also create new jobs in the region through the multiplier effect. Any multiplier effect resulting from the operating personnel expenditures in the region would most likely mean that some residents would obtain new or higher paying jobs as a result of the increased economic activity.

The staff reviewed the generally positive impacts of station operation on the economy of the region and concludes that the impacts would be small everywhere except potentially in Louisa and Orange Counties, where the impacts could be moderate. The magnitude of the economic impacts would be diffused in the larger economic bases of Henrico and Spotsylvania Counties and the City of Richmond; whereas, within the smaller economic bases of Orange and Louisa Counties, the economic impacts would be more noticeable. Based on the effects of station operation on the regional economies, the staff concludes that the beneficial impacts would be small to moderate (Louisa and Orange County). In terms of adverse effects, the staff concludes that the impact would be SMALL, and mitigation is not warranted.

5.5.3.2 Transportation

Section 4.5.3.2 discusses a number of permanent changes to the regional and local transportation network that could be made to reduce potential adverse impacts generated by the influx of 5000 construction workers during construction of the new units. These include improvements planned for I-95, U.S. 33, and State roads in Spotsylvania and Louisa Counties, among others. These permanent changes, if implemented, would reduce or eliminate any potential adverse impacts that could be generated by the additional operating workforce of about 720 and their families.

Impacts that might occur include potential congestion on some of the Federal and State routes leading to the North Anna ESP site. In addition, there could be crowding and congestion at the entrance to the plant site during shift changes, as previously discussed. Not all of the new 720 permanent workers for Units 3 and 4 and existing operating labor force for Units 1 and 2 would be commuting to and from the site at the same time and would mostly likely be spread throughout the 24-hour period in two or three shifts.

Should transportation difficulties arise, Dominion could encourage some of the mitigation practices undertaken during the construction phase as part of its traffic management plan, such as promoting car and van pools, to reduce the number of vehicles on the roads leading to the plant.

Based on the assumption that improvements made during the construction phase and the activation of Dominion's travel management plan, as needed, the staff concludes that the overall impacts of station operation on transportation would be SMALL, and mitigation is not warranted.

5.5.3.3 Taxes

Several types of taxes would be applicable to the permanent workforce at North Anna ESP site. These include income taxes on wages and salaries paid and corporate profits, sales and use taxes on purchases, and property taxes on owned, real property. Each is briefly discussed in turn.

Income Taxes

Virginia has both personal and corporate income taxes. Wages and salaries of permanent employees of Dominion's new operating units would pay taxes to Virginia if they reside in Virginia. Dominion would pay a corporate income tax to the state on the profits received from the new units to the Commonwealth. While the exact amount of tax payable to Virginia is not known, it could be substantial over the 40-year life of the operating units. The taxes collected through personal income and corporate tax, while substantial, are nevertheless a small sum when compared to the total amount of income taxes Virginia would collect over that period.

Sales and Use Taxes

Virginia has two types of sales and use taxes. Four percent is levied on certain food items with 3 percent going to the state and 1 percent going to the local jurisdiction in which the tax is collected (VDOT 2000). In addition, Virginia has a 4.5 percent sales tax levied on other goods and services sold, with the state receiving 3.5 percent and local jurisdictions receiving the remaining 1 percent (VDOT 1987). The current combined sales and use tax rate for Louisa County is 4.5 percent; 3.5 percent would be paid to the Commonwealth of Virginia and 1 percent to the locality, such as Louisa County (Dominion 2004a).

The state and the counties surrounding the North Anna ESP site would experience an increase in the amount of sales and use taxes collected from purchases made by the employees of the site. Additional sales and use taxes would be generated by expenditures by the workers at restaurants, hotels, and retail outlets. The taxes paid to any one jurisdiction are a small sum when compared to the total sales and use taxes collected by the region as a whole.

Property Taxes

The counties surrounding the ESP site and the City of Richmond would benefit from additional revenue generated by property taxes collected from new North Anna employees who purchase houses.

Property taxes would be levied on Dominion by Louisa County for the increase in value of the NAPS property because of the new units, as well as continued levies on the existing Units 1 and 2. An average of 46 percent of the property taxes collected in Louisa County between 1995 and 2003 came from Dominion for NAPS. The addition of the new units at the North Anna ESP site could substantially increase the property tax payments. The existing units have enabled the property tax rate assessments in Louisa County to remain substantially below those of neighboring counties. Operation of the new units would help offset the depreciation of the existing units; thus, NAPS could continue to be a major benefit to Louisa County when the new units start operating.

The potential effects of electric utility deregulation within Virginia on Units 3 and 4 are not known at this time (NRC 2002b). However, it is reasonable to conclude that the operation of new units should result in an increase in, or at least the maintenance of, the existing amounts paid in property taxes to Louisa County.

It is not possible to estimate either the real property taxes on housing that would be paid to the regional governments by the new employees locating to the area, or expenditures that the regional governments would incur as a result of the need to provide increased services (e.g., school, recreational, medical, fire and police, and transportation systems) for the new employees at North Anna site. The expenditures by the regional governments would, in part, be related to the number, size, and age distribution of the families of the new employees.

The staff considers the overall impacts of the property taxes collected to be beneficially large for Louisa County and small for the other counties in the vicinity of NAPS. The amount of property taxes collected on the operation of the new units could represent a significant portion of the total property taxes collected by Louisa County.

Summary of the Impact of Taxes

The staff evaluated the effect of taxes from income on wages and salaries of Units 3 and 4 operational workers, and sales, use, and property taxes on these employees and on Dominion's corporate profits, most of which represent beneficial sources of income for the State and some of which would benefit the counties in the region. Property tax paid by Dominion would directly benefit Louisa County. Based on a review of the overall impacts from income, sales and use, and property taxes, the staff concludes that the beneficial impact level would be small on the region to large for Louisa County. Therefore, the adverse impact level would be SMALL, and mitigation is not warranted.

5.5.3.4 Recreation

Lake Anna is a major tourist draw and economic benefit to Louisa, Orange, and Spotsylvania Counties. The social and economic impacts to recreation on and around the lake would most likely be associated with increased congestion on local roads and with reduced lake levels during severe droughts.

The staff assumes that any needed improvements made to the road systems and implementation of Dominion's traffic management program would have occurred before or during the construction phase would be sufficient to handle traffic related to the operation of Units 3 and 4. If for some reason measures to mitigate the congestion are not implemented, such congestion could precipitate less recreational use of the lake, which would have an adverse economic impact on the surrounding counties. To accommodate the increases in population and the demands for recreational facilities, Louisa, Spotsylvania, and Orange Counties may be required to address and fund new recreational areas as they update their comprehensive plans (Dominion 2004a). Also, road improvements undertaken to alleviate congestion during the construction phase of the project could alleviate or minimize any congestion around the lake as a result of new employees and their families.

Most of the 43,000 anglers visiting Lake Anna every year use the boat ramps at Lake Anna State Park and at commercial marinas to launch their boats. Pleasure traffic on the lake exceeds angler traffic by as much as 10 to 15 times. The height of stationary boat docks are impacted when the lake level drops below 76 m (248 ft) above MSL. At these levels and below, the stationary docks become unusable. However, boat ramps would be usable for launching boats until the water level receded below the end of the ramp. During the 2001 to 2002 drought, most boat ramps could not support launches at lake levels below 74.7 (245.1 ft) MSL (Dominion 2004d).

As discussed in Section 2.8.2.4, visitors to the state park actually increased during 2002 above the previous years, while the number of boat launches at the park in 2002 was fewer than launches in 2001 by 13.2 percent. The number of boat launches declined by an additional 2.4 percent in 2003, which was not a drought year.[a] Thus, there appears to have been a decline in the boating during the drought years, but an increase in the use of the park itself There is a concern, as discussed in Section 5.5.1.4, that the operation of Unit 3 with its once-through cooling system, together with Units 1 and 2 and their once-through cooling systems, would exacerbate conditions at the lake during times of drought.

These impacts could have economic consequences to the three counties surrounding the lake. The more immediate impacts would be to the marinas and commercial businesses that earn revenue on a seasonal basis from recreational users of the lake. If drought conditions extend over a long enough time period, property values around the lake could be impacted as well. Particularly impacted would be homeowners with lake-front houses who could have mud-flat views instead of their preferred water views. Minimal recreational impacts to Lake Anna from operation of the units are expected to occur during non-drought conditions.

The staff reviewed the information provided in Dominion's ER, Dominion's response to questions raised by Virginia Department of Environmental Quality (Dominion 2004d), and conducted an independent evaluation. The economic aspects of recreational use of Lake Anna depend on whether traffic congestion around the lake from the operation of Units 3 and 4 is mitigated. The staff expects that this traffic congestion would be mitigated before or during the construction phase. It also depends on the frequency, severity, and duration of severe drought conditions in the future that would make launching boats into the lake difficult. The latter could adversely impact use of the lake, recreational visits to the area by people from outside the region, and enjoyment of the lake by property owners. Based on these considerations, the staff concludes

(a) Note that these numbers do not include boat launches from private marinas.

that the overall potential impacts of station operation on aesthetics and recreation would be SMALL. However, the staff notes that impacts may be moderate if traffic congestion is not managed. In addition, during drought years the impact to recreation could be moderate due to short term low lake level.

5.5.3.5 Housing

Section 2.8.2.5 reviewed the availability of housing in the region and presented tables specifically showing that the availability of housing units for sale and rent in the region could easily accommodate the expected permanent workforce of 720 new employees. Further, the counties in the vicinity of the North Anna ESP site and within the region are addressing the needs of the projected increases in population in their comprehensive plans (Louisa County 2001; Spotsylvania County 2002; Orange County 1999).

Spotsylvania, Louisa, and Orange Counties do not have growth moratoriums. The incomes of the new workforce would generally be expected to be higher than the overall average of incomes in Orange and Louisa Counties and the City of Richmond. The staff also anticipates that the new operating personnel would buy housing in the region rather than renting. It can be expected that the prices paid for housing by these employees would be on the high end of the price range within these counties and the City of Richmond. However, the new workers and their families are a small percentage of the existing and projected populations for the counties and the City of Richmond over the next 10 years (see Table 2-11). Therefore, the impact on housing prices of workers locating to the counties within the larger population areas (Henrico County and the City of Richmond) are expected to be minimal.

In Spotsylvania County, housing prices are already high when compared to the surrounding counties. In Orange and Louisa Counties there could be upward pressure on housing prices at the upper end of the range because there are fewer units available in that range and some new construction may need to take place to meet demand. The staff would expect many of the new employees to locate into existing upscale areas of development in these counties, such as Lake Anna (Orange, Louisa, and Spotsylvania Counties) and Lake of the Woods (Orange County). Should that be the case, there are enough home builders available to meet an increase in demand (Ryan 2003; Waugh 2003), although there are some shortages in the specialty skills such as stone or brick masons (Ryan 2003).

Based on the existence of a sufficient supply of houses in all price ranges within Henrico and Spotsylvania Counties and the City of Richmond, the staff concludes that the impacts of station operation on housing would be SMALL in these areas, and mitigation is not warranted. Because of their proximity to the North Anna ESP site, the housing impacts within Orange and Louisa Counties could experience a temporary shortage that would increase housing prices that could create a moderate impact in the short-term. However, eventually over the 40-year operating life, the supply of housing would increase to meet demand. Therefore, the staff concludes the long-term impacts of station operation in Orange and Louisa Counties would be SMALL, and no mitigation is warranted.

5.5.3.6 Public Services

Water Supply and Waste Treatment Facilities

As discussed in Section 2.8.2.6, Louisa and Orange Counties, in light of current growth, have some concern about water and sewer infrastructure in certain parts of their respective counties, which are currently experiencing growth or are expected to grow. The incorporated areas of the two counties appear to have excess capacity in their sewer treatment facilities, but the recent drought revealed a water-supply issue. Wells and septic tanks are the methods of managing water supply and sewage disposal in residential developments outside the incorporated areas. Louisa County addresses the issue of water supply in its comprehensive plan (Louisa County 2001). Orange County is encouraging development in the existing growth areas to lessen the impact on the rural character of the county (Orange 1999). Spotsylvania and Henrico Counties and the City of Richmond appear to have adequate infrastructure and excess capacities for both water and sewage disposal.

The current water supply and sewage disposal issues in Orange and Louisa Counties would exist whether the two new nuclear units were operated or not, and could be exacerbated with normal, projected population growth. The potential impacts associated with hiring new permanent employees would be contingent on where in the counties the employees locate, whether there are water and sewer issues in those locations, and the extent to which they have been previously addressed.

Police, Fire, and Medical Facilities

In Orange and Louisa Counties there are no hospitals. Most patients requiring hospitalization travel to Charlottesville or Richmond, or to Henrico and Spotsylvania Counties. In Orange County, the fire departments are made up of volunteers, and rescue services are composed of both volunteer and paid employees. Services may need upgrading to account for normal population growth and, if upgraded, could account for any population growth caused by the new employees. In Louisa County, general fire, police, and rescue services are considered presently adequate. In the larger metropolitan area of Richmond and Henrico and Spotsylvania Counties, police, fire, and medical facilities would not be materially impacted by an increase in the permanent workforce at North Anna ESP site. This is because the 720 new employees would be a small fraction of the expected population growth in these areas.

Social Services

This section focuses on the potential impacts of station operation on the social and related services provided to segments of the disadvantaged population in Louisa and Orange Counties. Issues surrounding environmental justice are discussed in Section 5.7.

Operation of the new units at the North Anna ESP site is viewed as beneficial to the economically disadvantaged population segments served by the Departments of Social Services for Louisa and Orange Counties. Operation of the new units may enable members the disadvantaged population to improve their social and economic position by advancing to higher paying jobs created by the multiplier effect of station operation jobs. Based on where the current operating workforce for Units 1 and 2 lives and with the expectation that the new employees would follow similar location patterns, many of these benefits could accrue to Louisa County.

The expected benefits of station operation to Orange County would be, as in Louisa County, the secondary jobs provided by expenditures of the operations workforce in the county. Many of the jobs created through the multiplier effect could be of the type that would go to members of the disadvantaged population.

Summary of Public Services

Based on the information provided by Dominion and the staff's independent review of the local and regional water and wastewater treatment capacities; the police, fire, and medical facilities; and the demand for social and related services, the staff concludes that any increase in demand for these services by an increase in the operations workforce would be SMALL, and mitigation is not warranted. The increase in employment associated with station operation could have beneficial impacts, which could reduce the demand for social services, while the increase in tax revenue could help with the infrastructure and resource requirements from potential increase in demand for other services (police, fire, etc.).

5.5.3.7 Education

As discussed in Section 2.8.2.7, Orange County is currently expanding its school infrastructure and, as a result, could accommodate modest growth in student population. Louisa County schools are currently overcrowded. Enrollment is growing at 2 percent a year. Tax rates in the county have not been increased in six years, so that while the schools are being maintained, there has been no new construction to accommodate the increased enrollment. Property was purchased to build a new elementary school in 2004 with construction to start in 2005. Property has also been purchased for a new middle school (Lintecum 2003). Any increase in student population caused by the newly hired permanent workers relocating to the county could exacerbate the existing situation if the additions to the educational infrastructure do not take place.

A majority of the new workers would be expected to establish residences in the larger population areas such as Henrico, Hanover, and Spotsylvania Counties and the City of Richmond, assuming that the new workers would follow the same location patterns as the current permanent workforce at the NAPS site. Given that the workers would be distributed throughout the metropolitan region, increased enrollment of students on school infrastructure in those areas is expected to be minimal. It is also possible, should crowding continue to exist in Louisa County at the time the new workers are hired, that such conditions could cause fewer new workers to locate in Louisa County than might otherwise.

Orange County currently has excess capacity. Louisa County is addressing its current overcrowding problem through the planned building of new schools. Any new construction undertaken to meet the demands placed on the system by the construction workforce would be available to accommodate the demands of the operation workforce. The infrastructure in Spotsylvania and Henrico Counties and the City of Richmond is considered adequate given the size of the base population vis-a-vis the small increase in that population caused by the new employees relocating to these jurisdictions. Based on the information provided by Dominion and the staff's independent review of the local and regional educational facilities, the staff concludes that the impact on education as a result of station operation would be SMALL, and mitigation is not warranted.

5.6 Historic and Cultural Resource Impacts

The National Historic Preservation Act (NHPA), as amended through 1992, requires Federal agencies to take into account the potential effects of their undertakings on historic properties. The historic review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, as amended. Evaluating the suitability of potential ESP sites for construction, operation, and decommissioning of new power units is an undertaking that could possibly affect either known or potential historic properties that may be located at the plant. Therefore, in accordance with the provisions of NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effects. If no historic properties are present or affected, NRC is required to notify the State Historic Preservation Officer before proceeding. If it is determined that historic properties are present, NRC is required to assess and resolve possible adverse effects of the undertaking. Should an alternate site be selected for an ESP, NRC would also undertake consultation with all potentially affected Native American tribes regarding the possible presence of traditional cultural properties or other culturally sensitive resources at the site. For more specific historic and cultural information on North Anna, see Section 2.9.

In that all ground-disturbing activities that could have an impact on historic or cultural resources would probably occur during the construction phase, there would be limited potential for impacts during operation of additional power units at North Anna. Should archaeological, historic, or other cultural resources be uncovered during site excavation, Dominion would implement its site-wide Excavation and Backfill Work Procedures (NAPS NSS Work Procedure WP-C01) involving an immediate stop work order. Based on the limited potential for historic or cultural resources on site and Dominion's existing mitigation plan should such items be discovered, the staff concludes that the historic and cultural impacts from operations would be SMALL, and mitigation is not warranted.

5.7 Environmental Justice Impacts

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority[a] or low-income populations. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (NRC 2004). Figures 5-2 and 5-3 show the locations of minority and low-income populations around the NAPS site and within an 80-km (50-mi) radius.

The staff identified the pathways through which the environmental impacts associated with the construction of Units 3 and 4 at the NAPS site could affect human populations. The staff then evaluated whether minority and low-income populations could be disproportionately affected by these impacts. In its December 2003 on site review, the staff interviewed local government officials and the staff of social welfare agencies concerning potentially disproportionate impacts to low income and minority populations. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionate impacted by construction of Units 3 and 4 at the NAPS site that would result in those populations being adversely affected. In addition, the staff did not identify any location-dependent disproportionately high and adverse impacts affecting these minority and low-income populations.

(a) The NRC Guidance for performing environmental justice reviews defines "minority" as American Indian or Alaskan Native, Asian or Pacific Islander, Black not of Hispanic Origin, or Hispanic (69 FR 52040, August 24, 2004).

Based on information provided by Dominion and its own independent review, the staff concludes that offsite impacts of operation of Units 3 and 4 at the North Anna ESP site to minority and low-income populations would be SMALL, and mitigation is not warranted.

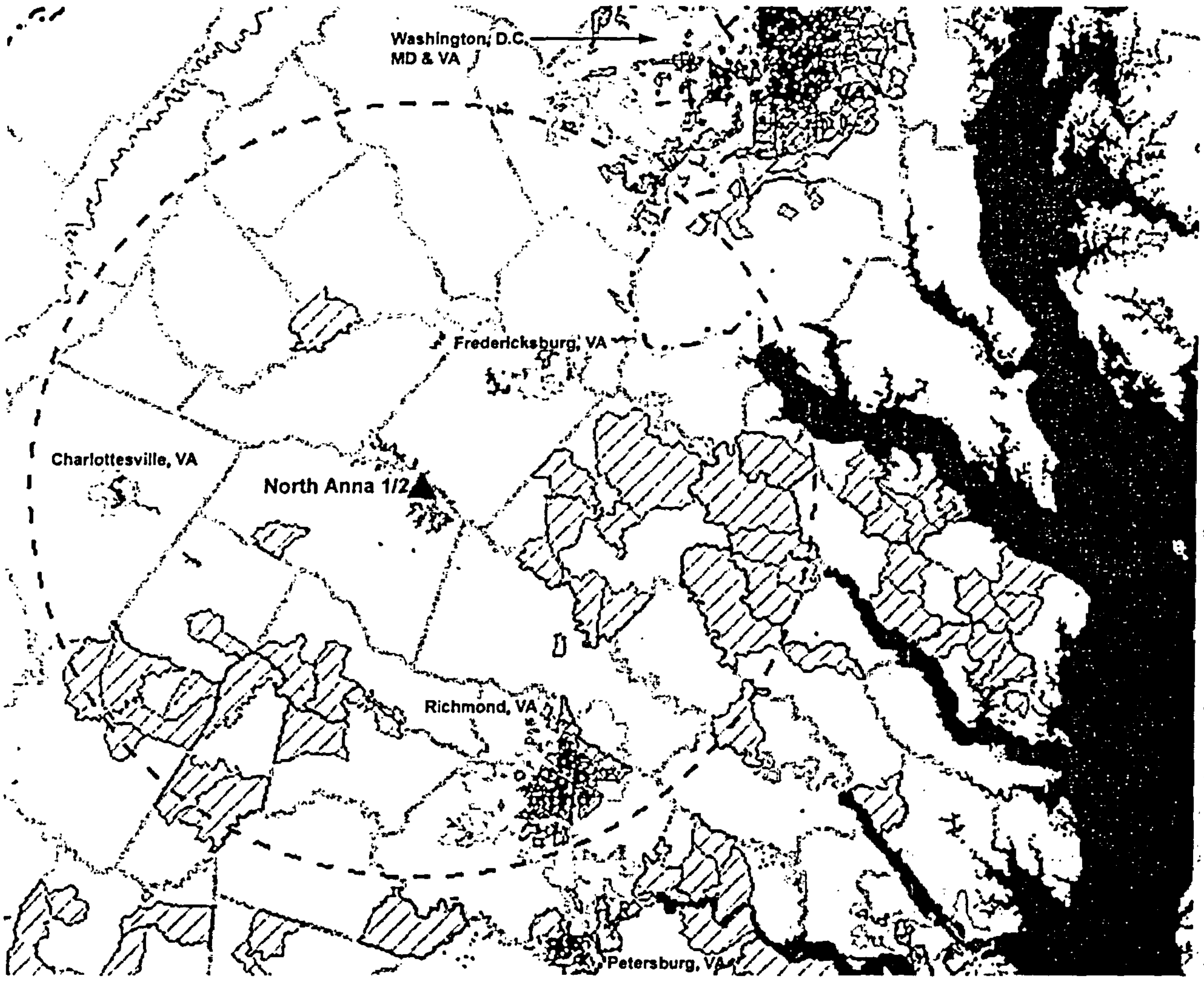


Figure 5-2. North Anna Census 2000 Environmental Justice Minority Populations Within an 80-km (50-mi) Radius of the North Anna ESP Site

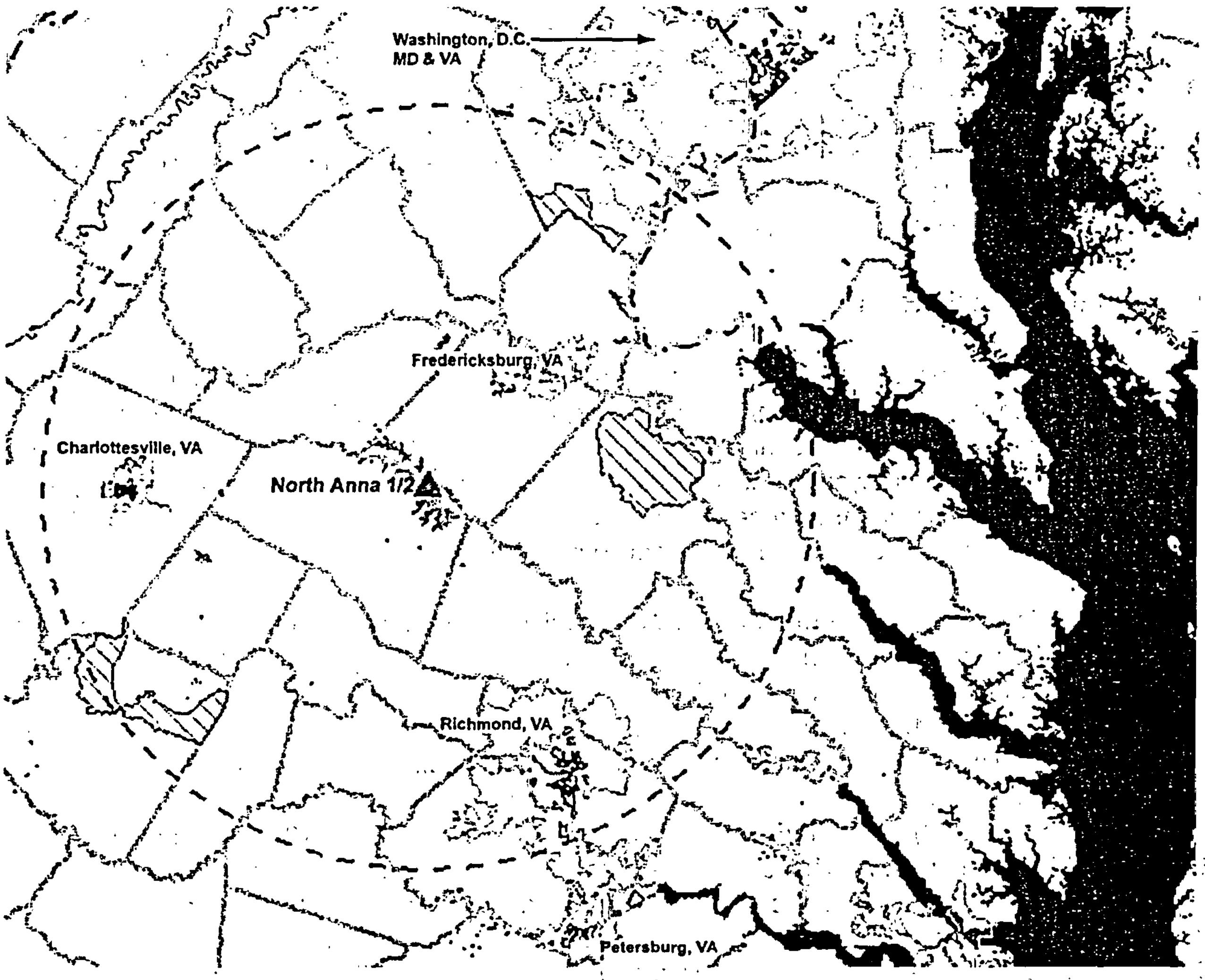


Figure 5-3. North Anna Census 2000 Environmental Justice Low Income Populations Within an 80-km (50-mi) Radius of the North Anna ESP Site

5.8 Nonradiological Health Impacts

This section addresses the health impacts of operating the proposed new units at the North Anna ESP site from nonradiological sources. Health impacts to the public from the cooling system, noise generated by unit operations, and electromagnetic fields are discussed. Health impacts from the same sources are also evaluated for workers at the new units. Health impacts from radiological sources during operations are discussed in Section 5.9.

The potential exists for impacts to members of the public from operation of the transmission system in terms of electrical shock, electromagnetic field exposure, noise, and aesthetics. The current transmission lines that originate from the North Anna ESP site are sized to handle the output from Units 3 and 4. These lines consist of three 500-kV lines that were erected in the late 1970s and one 230-kV line erected in 1984. Both sets were designed and constructed according to National Electrical Safety Code (NESC) requirements and industry guidance that was current at that time (Dominion 2004a).

5.8.1 Public Health

Dominion proposes an open-cycle cooling system (i.e., cooling lake) for Unit 3 and a closed-cycle cooling system (i.e., dry cooling tower) for Unit 4. The NRC concluded in NUREG-1437 that the impacts of thermophilic micro-organisms on public health should be considered for open-cycle cooling systems such as is proposed for Unit 3 because use of a cooling lake may significantly increase the presence and numbers of thermophilic micro-organisms (NRC 1996). These microorganisms could be causative agents of potentially serious human infections.

Dominion noted that thermophilic micro-organisms (e.g., *Naegleria fowleri*) generally exist in water bodies with ambient temperatures between 25°C (77°F) to 80°C (176°F) with maximum growth of such organisms generally occurring when ambient temperatures are maintained between 50°C (122°F) and 60°C (140°F) (Dominion 2001b). Since 1975, Virginia Power has monitored water temperatures at various locations in Lake Anna, the WHTF, and the discharge canal. The highest temperature recorded in (1) the discharge canal was 39°C (102.4°F) in August 2002, (2) the WHTF was 35°C (95.0°F) in July 1993, and (3) Lake Anna was 34°C (92.7°F) in July 1977. These temperatures were hourly average values. While ambient summer water temperatures in the sampled locations were found to be within the range of those known to permit the reproduction and growth of pathogenic micro-organisms, the temperatures measured were below those considered optimal for the growth of thermophilic forms.

Thermophilic micro-organisms can cause primary amoebic encephalitis in man. No cases of primary amoebic encephalitis have been documented in NAPS workers or area residents during the operating history of Units 1 and 2 (Dominion 2004a). The addition of Units 3 and 4 at the ESP site, one of which will use Lake Anna as a cooling source, is not expected to increase the temperature in Lake Anna enough to create an environment conducive to the optimal growth of thermophilic organisms.

Another source of health concern is water-borne pathogens from domestic sewage waste water. Dominion noted in its ER, that Virginia Power recently upgraded the onsite sewage treatment plant to include disinfection processes that reduce coliform bacteria and other micro-organisms to levels that meet State water-quality standards. This upgraded sewage treatment plant would be able to handle waste from the new units (Dominion 2004a).

5.8.2 Occupational Health

Occupational health impacts from thermophilic micro-organisms would be the same as those discussed above for the public. Health impacts to worker from nonradiological emissions and from noise and electromagnetic fields would be monitored and controlled in accordance with the applicable Occupational Safety and Health Administration regulations.

5.8.3 Noise Impacts

In NUREG-1437 the staff discussed the environmental impacts of noise at existing nuclear power plants (NRC 1996). Common sources of noise from plant operation include cooling towers, transformers, and loud speakers with intermittent contributions from auxiliary equipment. These noise sources are generally sufficiently distant from the plant boundaries that the noise generated by the plant diminishes to near ambient levels before reaching critical receptors outside the plant boundary.

The existing Units 1 and 2 at NAPS use an open-cycle cooling system that draws water from North Anna Reservoir and returns water to the WHTF. These systems do not contribute significantly to noise at the plant site or at the plant boundary. In its ER Dominion specifies that the new Unit 3 would be cooled by a open-cycle cooling system using the WHTF, and that Unit 4 would be cooled by dry cooling towers (Dominion 2004a). If the plants are ultimately constructed, the dry towers for cooling Unit 4 would be the primary noise source on the site.

The applicant does not specify the sound intensity for dry cooling towers directly. However, Dominion states that the sound intensity from a dry cooling tower would be less than 65 decibels at 300 m (1000 ft) (Dominion 2004a). In general, the decrease in sound intensity with distance from the source is inversely proportional to the square of the distance. According to Dominion, the closest point of the exclusion area boundary is about 100 m (300 ft) from the cooling tower location, and the closest residence is about 1000 m (3000 ft). Using these distances, the inverse square relationship, and the PPE cooling tower noise specification, the corresponding sound intensities at the exclusion area boundary and nearest residence are estimated to be approximately 75 and 55 decibels, respectively. For context, Tipler (1982) lists the sound intensity of a quiet office as 50 decibels, normal conversation as 60 decibels, busy traffic as 70 decibels, and a noisy office with machines or an average factory as 80 decibels. Construction noise at 3 m (10 ft) is listed as 110 decibels, and the human pain threshold is 120 decibels.

As discussed in NUREG-1437, noise levels below 60 to 65 decibels are considered to be of small significance (NRC 1996). More recently, the impacts of noise were considered in Supplement 1 of NUREG-0586 (NRC 2002a). In that generic environmental impact statement, the criterion for assessing the level of significance was not expressed in terms of sound levels. Rather, the level of significance was based on the effect of noise on human activities and threatened and endangered species. The criterion in NUREG-0586, Supplement 1 is:

> The noise impacts of... are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts ... are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened or endangered species is affected.

Based on the information provided by Dominion and the assessment in NUREG-0586 Supplement 1, the staff concludes that the potential impacts of noise resulting from operation of two additional nuclear power plants with cooling systems meeting the noise criteria of the PPE as defined in the ER would be small.

5.8.4 Acute Effects of Electromagnetic Fields

Currently, the National Electric Safety Code (NESC) requires that, to limit the potential for electric shock, the design of transmission lines be such that electrostatic effects from operation do not create a steady-state current that exceeds 5 mA root mean square (rms). As part of the license renewal application for NAPS Units 1 and 2, the applicant analyzed the potential induced current for all four transmission lines under the limiting case conditions. The computed values ranged from 3.10 to 4.95 mA and were confirmed by field verification (Dominion 2004a). The current NESC requirements for preventing electric shock from induced current were met, and the staff concluded that the impact to the public would be small. And verify the NESC limits at the COL stage for transmission of electricity from Units 3 and 4. At the CP/COL Dominion will have to verify that the transmission lines meet the NESC criteria. Therefore, the staff concludes that the impact from acute effects of electromagnetic fields is small and mitigation is not warranted.

5.8.5 Chronic Effects of Electromagnetic Fields

Research on the potential for chronic effects from 60-Hz electromagnetic fields from energized transmission lines was reviewed and addressed in NUREG-1437 (NRC 1996). At that time, research results were not conclusive. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy. An NIEHS report (1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF (extremely low frequency-electromagnetic field) exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and is exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposure. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the staff to consider the potential impact as significant to the public. However, the staff will continue to follow developments on this issue.

5.8.6 Summary of Nonradiological Health Impacts

The staff evaluated health impacts to the public and the workers from the cooling systems, noise generated by unit operations, and acute and chronic impacts of electromagnetic fields. Based on the information provided by Dominion and its own independent review, the staff concludes that the potential impacts of nonradiological effects resulting from the operation of two additional nuclear power plants with cooling systems meeting the noise criteria of the PPE as defined in the ER would be SMALL, and mitigation is not warranted.

5.9 Radiological Health Impacts

This section addresses the radiological impacts of normal operations of the proposed new Units 3 and 4 including a discussion of the estimated radiation dose to a member of the public and to the biota inhabiting the area around the new units. Estimated doses to workers at the new units are also discussed. Radiological impacts were determined using the PPE approach where the bounding liquid and gaseous radiological effluents were used in the evaluation (see discussion in Section 3.2.4). Direct radiation exposure from the proposed new units was determined to be negligible (Dominion 2004a).

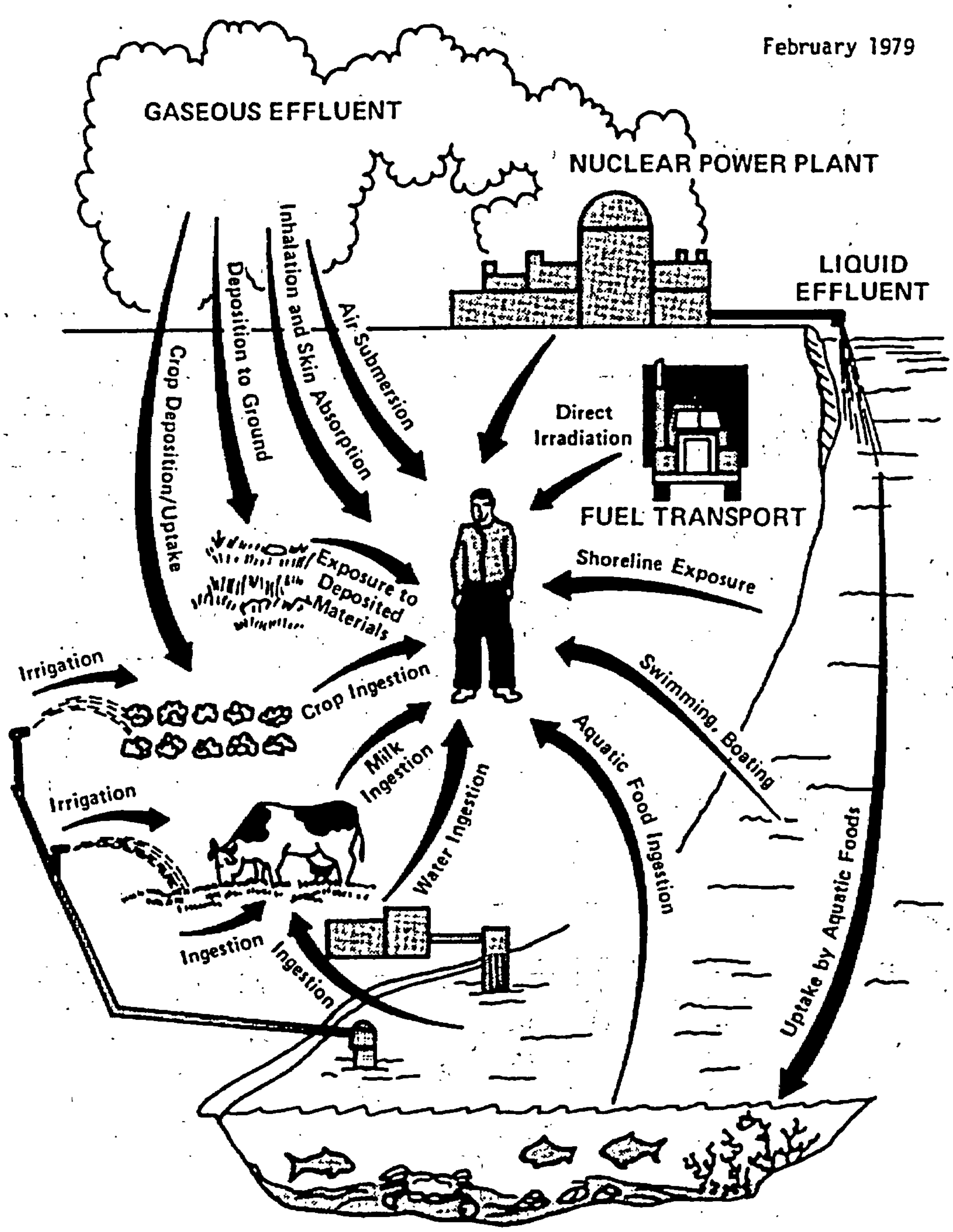
5.9.1 Exposure Pathways

During normal operation, small quantities of radiological materials will be released to the environment through gaseous and liquid effluents from the plant. Dominion stated in its ER that the contribution to direct radiation exposure from new reactor designs would be negligible (Dominion 2004a).

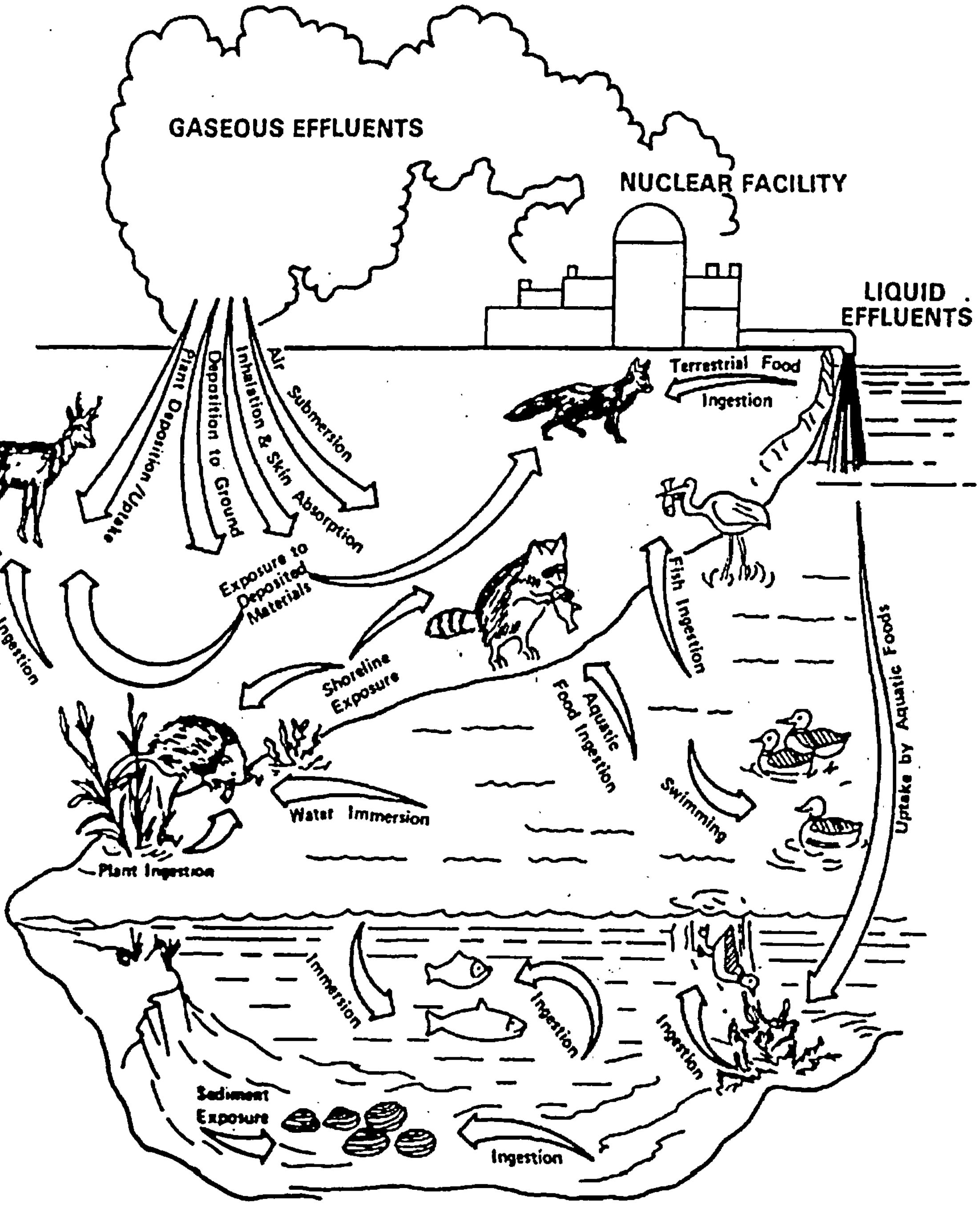
Using the PPE, the ER submitted by Dominion provided a list of fission and activation products that may be released as liquid and gaseous effluents from the new Units 3 and 4 (Dominion 2004a). The impacts from releases and direct radiation were evaluated by considering the probable pathways to individuals, populations, and biota near the proposed new units. The highest dose from the major exposure pathways were evaluated for a given receptor. The exposure pathways, described in Regulatory Guides 1.109 and 1.111 (NRC 1977a,b) are illustrated in Figures 5-4 and 5-5.

The new units at the North Anna ESP site would release liquid effluents into the WHTF through the discharge canals used for the operating units. The liquid pathways considered are ingestion of aquatic food, ingestion of drinking water, exposure to shoreline sediment, and exposure to water through boating, swimming, and other activities (Dominion 2004a).

The gaseous pathways considered by Dominion in its ER were external exposure to the airborne plume; external exposure to contaminated ground, inhalation of airborne activity, and ingestion of contaminated agricultural products (Dominion 2004a).



1
2 Figure 5-4. Exposure Pathways to Humans



1 **Figure 5-5.** Exposure Pathways to Biota Other than Humans

5.9.2 Radiation Doses to Members of the Public

The dose to a maximally exposed individual was calculated from both the liquid and gaseous effluent release pathways (Dominion 2004a), and a collective whole body dose was calculated for the population within 80 km (50 mi) of the North Anna ESP site.

Liquid Effluent Pathway

Liquid pathway doses were calculated using the LADTAPII computer program (Strenge et al. 1986) for the following activities: eating fish and invertebrates caught near the discharge point, drinking water from Lake Anna, and boating, swimming, and using the shoreline for recreational purposes. The liquid effluent releases for one new unit used in the estimate of dose to a maximally exposed individual are found in Table 5.4-6 of the ER submitted by Dominion (Dominion 2004a). These releases considered the advanced boiling water reactor (ABWR) design to have an output level of 4300 MW(t) rather than the certified level of 3926 MW(t). This resulted in a slight increase in release rate for those isotopes where the ABWR design was the bounding condition. Other parameters used as input to the LADTAP II program including effluent discharge rate, dilution factor for discharge, transit time to receptor, and impoundment concentration are found in Tables 5.4-1 and 5.4-2 of the Dominion ER (Dominion 2004a).

Liquid pathway doses to the maximally exposed individuals calculated by Dominion (2004a) are presented in Table 5-8. The maximum annual dose to the total body was 0.013 mSv (1.3 mrem) to the adult. The maximum annual dose to the thyroid was 0.013 mSv (1.3 mrem) to the infant. The maximum annual dose to the liver was 0.017 mSv (1.7 mrem) to the child. The staff performed an independent evaluation of liquid pathway doses and found similar results.

Table 5-8. Liquid Pathway Doses for Maximally Exposed Individuals at Lake Anna

Pathway	Total Body Dose (mSv/yr)[a]	Thyroid Dose (mSv/yr)[a]	Liver Dose (mSv/yr)[a]
Fish	4.9×10^{-3}	0	5.9×10^{-3}
Invertebrate	6.6×10^{-4}	0	9.9×10^{-4}
Drinking	6.9×10^{-3}	1.3×10^{-2}	9.4×10^{-3}
Shoreline	3.0×10^{-4}	3.0×10^{-4}	3.0×10^{-4}
Swimming	3.0×10^{-6}	3.0×10^{-6}	3.0×10^{-6}
Boating	3.7×10^{-6}	3.7×10^{-6}	3.7×10^{-6}
Total	1.3×10^{-2}	1.3×10^{-2}	1.7×10^{-2}
Age group receiving maximum dose	Adult	Infant	Child

(a) Multiply mSv/yr times 100 to obtain mrem/yr
Source: Dominion 2004a, Table 5.4-8. Doses were estimated for one unit.

Gaseous Effluent Pathway

Gaseous pathway doses to the maximally exposed individual were calculated by Dominion using the GASPAR II computer program (Strenge et al. 1987) at the following locations: the nearest site boundary, nearest vegetable garden, nearest residence, and nearest meat cow. Doses from the milk pathway were not calculated as there were no milk cows or goats located within a 8-km (5-mi) radius of the ESP site (Dominion 2004a). The gaseous effluent releases used in the estimate of dose to the maximally exposed individual are found in Table 5.4-7 of the Dominion ER (Dominion 2004a). These releases, which were estimated for one unit, considered the ABWR design to have an output level of 4300 MW(t) rather than the certified level of 3926 MW(t). This resulted in a slight increase in release rate for those isotopes where the ABWR design, as certified, was the bounding condition. Other inputs to the GASPAR II program, including meat, and vegetable production rates, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors, are found in Tables 5.4-3 through 5.4-5 of the Dominion ER (Dominion 2004a).

Gaseous pathway doses to the maximally exposed individual calculated by Dominion (2004a) are presented in Table 5-9. The staff performed an independent evaluation of gaseous pathway doses and found similar results.

Table 5-9. Gaseous Pathway Doses for Maximally Exposed Individual

Location	Pathway	Total Body Dose (mSv/yr)[a]	Thyroid Dose (mSv/yr)[a]	Skin Dose (mSv/yr)[a]
Nearest Site Boundary (0.88 mi ESE)	Plume	1.4×10^{-2}	0	4.2×10^{-2}
Nearest Site Boundary (0.88 mi ESE)	Inhalation			
	Adult	3.0×10^{-3}	1.3×10^{-2}	0
	Teen	3.0×10^{-3}	1.6×10^{-2}	0
	Child	2.7×10^{-3}	1.9×10^{-2}	0
	Infant	1.6×10^{-3}	1.6×10^{-2}	0
Nearest Garden (0.94 mi NE)	Vegetable			
	Adult	4.1×10^{-3}	2.9×10^{-2}	0
	Teen	5.4×10^{-3}	3.9×10^{-2}	0
	Child	9.9×10^{-3}	7.4×10^{-2}	0
Nearest Residence (0.96 mi NNE)	Plume	9.0×10^{-3}	0	2.7×10^{-2}
Nearest Residence (0.96 mi NNE)	Inhalation			
	Adult	2.0×10^{-3}	8.3×10^{-3}	0
	Teen	2.0×10^{-3}	1.0×10^{-2}	0
	Child	1.8×10^{-3}	1.2×10^{-2}	0
	Infant	1.0×10^{-3}	1.0×10^{-2}	0
Nearest Meat Cow (1.37 mi SE)	Meat			
	Adult	5.7×10^{-4}	1.0×10^{-3}	0
	Teen	4.4×10^{-4}	7.6×10^{-4}	0
	Child	7.0×10^{-4}	1.2×10^{-3}	0

(a) Multiply mSv/yr times 100 to obtain mrem/yr.
Source: Dominion (2004a), Table 5.4-9. Doses were estimated for one unit. There were no milk cows or goats within 8 km (5 mi) (Dominion 2004a). No infant doses were calculated for the vegetable or meat pathway as infants do not consume these foods (Dominion 2004a).

5.9.3 Impacts to Members of the Public

Maximally Exposed Individual

Dominion (2004a) stated that whole body and organ dose estimates to the maximally exposed individual from liquid and gaseous effluents for one unit were within the design objectives of 10 CFR Part 50, Appendix I. Doses to whole body and maximum organ at Lake Anna from liquid effluents were well within the 0.03 mSv/yr (3 mrem/yr) and 0.01 mSv/yr (10 mrem/yr) Appendix I design objectives, respectively. Doses at the site boundary from gaseous effluents were well within the Appendix I design objectives of 0.1 mGy/yr (10 mrad/yr) gamma in air, 0.2 mGy/yr (20 mrad/yr) beta in air, 0.05 mSv/yr (5 mrem/yr) dose to the whole body, and 0.015 mSv/yr (15 mrem/yr) dose to the skin. In addition, dose to the thyroid was within the 0.15

mSv/yr (15 mrem/yr) Appendix I design objectives. A comparison of dose estimates for one unit to the Appendix I design objectives is presented in Table 5-10.

The cumulative effects of two new units would still be within the Appendix I design objectives. For comparison, gaseous and liquid effluents from the existing NAPS Units 1 and 2 contribute a small fraction of the Appendix I design objectives (i.e., less than 2 percent) (NRC 2002). Therefore, the cumulative effects of both the current operating units and the two proposed units would be within the Appendix I design objectives.

If Dominion applies for a CP or a COL, the staff would verify whether liquid and gaseous effluent releases for the actual reactor design(s) are bounded by the PPE bounding release values used by Dominion in its ESP application. Additional evaluations would be performed if bounding release values are exceeded.

Table 5-10. Comparison of Maximally Exposed Individual Dose Estimates from Liquid and Gaseous Effluents to 10 CFR Part 50, Appendix I, Design Objectives

Pathway/Type of Dose	Dominion (2003a)[a,b]	Appendix I Design Objectives
Liquid Effluents		
Whole body dose	0.013 mSv/yr adult	0.03 mSv/yr
Maximum organ dose	0.017 mSv/yr teen liver	0.1 mSv/yr
Gaseous Effluents (Noble gases only)		
Gamma air dose	0.021 mGy/yr	0.1 mGy/yr
Beta air dose	0.035 mGy/yr	0.2 mGy/yr
Whole body dose	0.017 mSv/yr	0.05 mSv/yr
Skin dose	0.042 mSv/yr	0.15 mSv/yr
Gaseous Effluents (Radioiodines and particulates)		
Organ dose	0.077 mSv/yr (thyroid)	0.15 mSv/yr

(a) Doses were estimated for one unit.
(b) Multiply mSv/yr (or mGy/yr) times 100 to obtain mrem/yr (or mrad/yr)

Dominion (2004a) stated that doses from liquid and gaseous effluents to the maximally exposed individual at the site boundary from the existing Units 1 and 2 and the two proposed Units 3 and 4 combined were well within the regulatory standards of 40 CFR Part 190. Doses from direct radiation were determined to be negligible (Dominion 2004a). The dose standards from 40 CFR Part 190 are 0.25 mSv/yr (25 mrem/yr) to the whole body, 0.75 mSv/yr (75 mrem/yr) to the thyroid, and 0.25 mSv/yr (25 mrem/yr) to any other organ. The combined estimated doses from the existing units and the proposed new units were 0.062 mSv/yr (6.2 mrem/yr) to the whole body, 0.18 mSv/yr (18 mrem/yr) to the thyroid, and 0.084 mSv/yr (8.4 mrem/yr) to the bone for the maximally exposed individual at the site boundary (Dominion 2004a). These data are summarized in Table 5-11. Adherence to the 40 CFR Part 190 dose standards, ensures compliance with 10 CFR 20.1301, which states that the total effective dose equivalent to individual members of the public from licensed operations shall not exceed 1 mSv (0.1 rem) in a year.

Table 5-11. Comparison of Maximally Exposed Individual Dose Estimates from Liquid and Gaseous Effluents to 40 CFR Part 190 Standards[a]

Dose	Dominion (2003a) Estimate[(b)(c)]	40 CFR 190 Standards
Whole body dose equivalent	0.062 mSv/yr	0.25 mSv/yr
Thyroid dose	0.18 mSv/yr	0.75 mSv/yr
Dose to another organ	0.084 mSv/yr (bone)	0.25 mSv/yr

(a) Doses from direct radiation were determined to be negligible (Dominion 2004a).
(b) Sum of dose from liquid and gaseous effluent releases for the two existing NAPS units and the proposed units (Dominion 2004c)
(c) Multiply mSv/yr times 100 to obtain mrem/yr.

Population Dose

Dominion (2004a) estimated a collective whole body dose within 80 km (50 mi) of each unit to be 0.32 person-Sv/yr (32 person-rem/yr). A collective dose of 0.14 person-Sv/yr (14 person-rem/yr) was calculated for the liquid effluent pathway using the LADTAP II computer code. A collective dose of 0.18 person-Sv/yr (18 person-rem/yr) was calculated for the liquid effluent pathway using the GASPAR II computer code. The staff performed an independent evaluation of population doses and found the applicant's estimates to be conservative. The estimated collective dose to the same population from natural background radiation was 9200 person-Sv/yr (920,000 person-rem/yr). The collective dose from natural background radiation was calculated by using the 80-km (50-mi) population data of 2.8 million and a dose rate of 3.25 mSv/person/yr (325 mrem/person/yr).

The staff conservatively estimated the risks to the population living within 80 km (50 mi) of the new Units 3 and 4 using the International Commission on Radiological Protection (ICRP) 60 nominal probability coefficients for fatal cancers (5×10^{-2}/Sv), non-fatal cancers (1×10^{-2}/Sv), and severe hereditary effects (1.3×10^{-2}/Sv) to the population (ICRP 1990). These probabilities were multiplied by the estimated collective whole body dose of 0.32 person-Sv/yr (32 person-rem/yr) to obtain an estimated number of fatal cancers, non-fatal cancer, and severe hereditary effects of less than 0.024 annually for a single new unit at the North Anna ESP site. This was compared to an estimated 460 fatal cancers, 92 non-fatal cancers, and 120 severe hereditary effects from natural background radiation exposure. The cumulative effects of operating two new units at the ESP site in addition to the currently operating Units 1 and 2 would be less than 1 cancer or hereditary effect annually. These cumulative effects are well below the estimated effects from natural background radiation. In addition, the U.S. Congress in 1990 requested the National Cancer Institute to study the cancer rates in the areas surrounding nuclear power plants to determine if there were detrimental effects on the population. This extensive report found no evidence of a link between operating nuclear power plants and any increase in cancer (NCI 1990). As a result, staff concluded there will be no observable health impact to the public from normal operation of the proposed new Units 3 and 4, and the health impacts would be SMALL.

5.9.4 Occupational Doses to Workers

NUREG-0713 (NRC 2002c) reported average annual collective dose per operating reactor of 1.72 person-Sv/yr (172 person-rem/yr) for the time period from 1992 to 2001. Limited information was available on occupational dose estimates from the advanced reactor designs. Dominion reported annual occupational dose estimates of 1.5 person-Sv (150 person-rem) for the AP1000, IRIS, and GT-MHR reactor designs (Dominion 2002). The estimated occupational doses for the advanced reactor designs were slightly lower than annual occupational doses for current light-water reactors. This relationship will need to be verified by the staff at the construction permit or COL stage when a specific design has been specified.

5.9.5 Impacts to Biota Other than Members of the Public

Dominion (2004a) estimated doses to surrogate species to include fish, invertebrates, algae, muskrat, raccoon, heron, and duck, which are referred to as surrogate species. Surrogate species are well defined and provide an acceptable method for judging doses to the biota (Dominion 2004a). Important biota species for the North Anna ESP site and the corresponding surrogate species are (1) bald eagle and loggerhead shrike (heron) and (2) dwarf wedgemussel, slippershell mussel, and fluted kidneyshell mussel (invertebrate).

Liquid Effluent Pathway

Dominion (2004a) used the LADTAP II computer code to calculate doses to biota from the liquid effluent pathway. The following exposure pathways were evaluated for the different surrogate biota:

- Fish and invertebrates – internal exposure from bioaccumulation of radionuclides and external exposure from swimming and shoreline activities

- Algae – internal exposure from bioaccumulation of radionuclides and external exposure from immersion in water

- Muskrat and duck – internal exposure from ingestion of aquatic plants and external exposure from swimming and shoreline activities

- Raccoon – internal exposure from ingestion of invertebrates and external exposure from shoreline activities

- Heron – internal exposure from ingestion of fish and external exposure from swimming and shoreline activities.

These pathways are illustrated in Figure 5-4.

Input parameters used in the dose calculation included food consumption rates, body masses, and effective body radii. These parameters were taken from NUREG/CR-4013 (Strenge et al. 1986) and Regulatory Guide 1.109 (NRC 1977a). These parameters are shown in Tables 5.4-14 and 5.4-15 of the Dominion ER (Dominion 2004a). The LADTAP II Program has an adjustment factor because the biota would be closer to any potential shoreline contamination than humans.

Gaseous Effluent Pathway

Dominion used the doses calculated for the maximally exposed individual from the gaseous effluent pathway (described earlier in this section) as a basis for the doses to the biota (Dominion 2004a). External doses from ground deposition were increased by a factor of two to account for the terrestrial organisms being closer to the ground (Dominion 2004a).

Impact of Estimated Biota Doses

Table 5-12 compares the estimated whole body dose to the biota from the liquid and gaseous effluent pathways calculated by Dominion (2004a) from one proposed new unit at the ESP site to the regulatory standard for humans in 40 CFR Part 190. The biota doses for all surrogate species except fish exceed the regulatory standard in 40 CFR Part 190 of 0.25 mSv/yr (25 mrem/yr) to the total body. This assumes mrem and mrad are approximately equivalent. The staff performed an independent evaluation of biota doses and found similar results.

The ICRP (1977, 1990) states that if man is adequately protected, then other living things are also likely to be sufficiently protected. The International Atomic Energy Agency (IAEA 1992) and the National Council on Radiation Protection and Measurements (NCRP 1991) reported that a chronic dose rate of no greater than 10 mGy/day (1 rad/day) to the maximally exposed individual in a population of aquatic organisms would ensure protection for the population. IAEA (1992) also concluded that chronic dose rates of 1 mGy/day (0.1 rad/day) or less do not appear to cause observable changes in terrestrial animal populations. Table 5-13 compares the estimated whole body dose to the biota from the proposed New Units 3 and 4 to the IAEA chronic dose rate values fro aquatic organisms and terrestrial animals. The cumulative effects of current operating units and proposed New Units 3 and 4 would result in dose rates significantly less than the NCRP and IAEA studies.

Table 5-12. Comparison of Biota Doses from Proposed New Units 3 and 4 to 40 CFR Part 190

Biota	Dose from Liquid Effluent/Unit (mGy/yr)[a]	Dose from Gaseous Effluent/Unit (mGy/yr)[a]	Total Dose/Unit (mGy/yr)[a]	Total Dose for Two Units (mGy/yr)[a]	40 CFR 190 Total Body Dose Limit (mSv/yr)
Fish	0.067	0	0.067	0.13	0.25
Invertebrates	0.45	0	0.45	0.90	0.25
Algae	0.39	0	0.39	0.78	0.25
Muskrat	0.22	0.27	0.49	0.98	0.25
Raccoon	0.049	0.27	0.32	0.64	0.25
Heron	0.50	0.27	0.77	1.54	0.25
Duck	0.22	0.27	0.49	0.98	0.25

(a) Multiply mGy/yr or mGy/day times 100 to obtain mrad/yr or mrad/day

Table 5-13. Comparison of Biota Doses from Proposed New Units 3 and 4 to IAEA Studies

Biota	Estimated Dose for Two Units (mGy/day)[a]	Chronic Dose Rate Values from IAEA Studies (mGy/day)[a]
Fish	3.7×10^{-4}	10
Invertebrates	2.4×10^{-3}	10
Algae	2.2×10^{-3}	10
Muskrat	2.6×10^{-3}	1
Raccoon	1.8×10^{-3}	1
Heron	4.2×10^{-3}	1
Duck	2.6×10^{-3}	1

(a) Multiply mGy/day times 100 to obtain mrad/day.

The staff reviewed the available information relative to the radiological impact on biota from the routine operation of the proposed New Units 3 and 4 and concluded the impacts would be SMALL, and mitigation is not warranted.

5.9.6 Radiological Monitoring

A radiological environmental monitoring program (REMP) has been in place for the NAPS site since 1976 (NRC 1976a). The REMP includes monitoring of the airborne exposure pathway, direct exposure pathway, water exposure pathway, aquatic exposure pathway from Lake Anna and the North Anna River, and the ingestion exposure pathway in a 40-km (25-mi) radius of the station. The pre-operational environmental radiation monitoring program sampled various media in the environment to determine a baseline to observe the magnitude and fluctuation of radioactivity in the environment once the units began operation (AEC 1973). The pre-operational program included collection and analysis of samples of air particulates, precipitation, milk, crops, soil, well water, surface water, fish, and silt as well as measurement of ambient gamma radiation. After operation of NAPS Units 1 and 2 began, the monitoring program continued to assess the radiological impacts to workers, the public, and the environment. Radiological releases are summarized in the two annual reports: the *Radiological Environmental Operating Program and Annual Radioactive Effluent Release Report*. The limits for all radiological releases are specified in the *North Anna Offsite Dose Calculation Manual* (ODCM) (Dominion 2003). No additional monitoring program has been proposed for the new units. The staff reviewed the documentation for the REMP, the ODCM, and recent monitoring reports and determined that the current operational monitoring program is adequate to establish the radiological impacts to the environment related to the construction and operation of two new units at the North Anna ESP site.

5.10 Environmental Impacts of Postulated Accidents

The staff considered the radiological consequences on the human environment of potential accidents at new nuclear units at the North Anna ESP site. Consequence estimates are based on the certified General Electric ABWR standard reactor design, which has been certified by the NRC, and the surrogate Westinghouse AP1000. The term "accident," as used in this section, refers to any off normal event, not addressed in Section 5.9, which results in the release of radioactive material into the environment. The focus of this review is on events that could lead to releases substantially in excess of permissible limits for normal operations. Normal release limits are specified in 10 CFR Part 20, Appendix B, Table 2.

Numerous features combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation of the plants, which comprise the first line of defense, are intended to prevent the release of radioactive material from the plant. The design objectives and the measures for keeping levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA) are specified in 10 CFR Part 50, Appendix I. There are additional measures that are designed to mitigate the consequences of failures in the first line of defense. These include the NRC's reactor site criteria in 10 CFR Part 100, which requires the site to have certain characteristics that reduce the risk to the public and the potential impacts of an accident; and emergency preparedness plans and protective action measures for the site and environs as set forth in 10 CFR 50.47; 10 CFR Part 50, Appendix E; and NUREG-0654/FEMA-REP-1. All of these safety features, measures, and plans make up the defense-in-depth philosophy to protect the health and safety of the public and the environment.

This section discusses (1) types of radioactive material, (2) paths to the environment, (3) the relationship between radiation dose and health effects, and (4) the environmental impacts of reactor accidents, both design-basis accidents (DBAs) and severe accidents. The environmental impacts of postulated accidents during the transportation of spent fuel are discussed in Chapter 6.

The potential for dispersion of radioactive material in the environment depends on the mechanical forces that physically transport the material and on the physical and chemical forms of the material. Radioactive material exists in a variety of physical and chemical forms. The majority of the material is in the form of nonvolatile solids. However, there is a significant amount of material that is in the form of volatile solids or gases. Gaseous radioactive material include the chemically inert noble gases krypton and xenon. Radioactive forms of iodine, which are created in substantial quantities in the fuel by fission, are volatile. Other radioactive material formed during the routine operation of a nuclear power plant have lower volatilities, and therefore, have less tendency to escape from the fuel than the noble gases and iodines.

Radiation exposure is determined by the proximity of individuals to radioactive material, the duration of exposure, and factors that shield the individuals from the radiation. Pathways that lead to radiation exposure include (1) external radiation from radioactive material in the air, on the ground, and in the water, (2) the inhalation of radioactive material, and (3) ingestion of food or water containing material initially deposited on the ground and in water.

The risks of health effects from radiation exposures below 0.1 Sv (10 rem), are either too small to be observed or are non-existent (HPS 2001). Incidences of cancer in the exposed general population may begin to develop after a lapse of 2 to 15 years (latent period) after exposure and then level off over a period of about 30 years (plateau period). In the case of radiation exposure of fetuses, cancer may begin to develop as early as birth (no latent period) to the age of 10.

Physiological effects are clinically detectable should individuals receive radiation exposure resulting in a dose greater than about 0.25 Sv (25 rem) over a short period of time (hours). Doses of about 2.5 to 5.0 Sv (250 to 500 rem) received over a relatively short period (hours to a few days) can be expected to cause some fatalities.

5.10.1 Design-Basis Accidents

The applicant has evaluated the potential consequences of postulated accidents to demonstrate that new units could be constructed and operated at the proposed North Anna ESP site without undue risk to the health and safety of the public. These evaluations use a set of surrogate DBAs that are representative for the range of reactor designs being considered for the ESP site and site-specific meteorological data. The set of accidents covers events that range from relatively high probability of occurrence with relatively low consequences to relatively low probability with high consequences.

The DBA review focuses on two light-water reactor designs: the ABWR and the surrogate AP1000. The bases for analyses of postulated accidents for these designs are well established because they have been considered as part of the certification process. Accidents for the other reactor designs listed in the application are not as well defined as those for the ABWR and the surrogate AP1000; acceptable assumptions and methodologies for the evaluation of postulated accidents have not been fully established. Since the source term for accident analyses are generally proportional to the power level, for the purposes of this site suitability evaluation, the potential consequences of accidents for the other reactor designs are expected to be bounded by those for the ABWR and surrogate AP1000 designs. For example, preliminary information on source terms for the IRIS and ACR-700 reactor designs indicates that the source term for the surrogate AP1000 loss-of-coolant accident (LOCA) is expected to bound the worst case accident release for these advanced reactor designs. Similarly, the ABWR source term is expected to bound the source term for the ESBWR design. The advanced gas reactor designs (GT-MHR and PBMR) postulate relatively small releases to the environment compared to water reactor technologies (Dominion 2004a).

Should an application that references an ESP for the North Anna ESP site be made to build and operate one of the other designs, the applicant would be required to show and the staff would verify that the radiological consequences of DBAs for the proposed reactor or reactors are bounded by the consequences of DBAs evaluated in this EIS.

Potential consequences of DBAs are evaluated following procedures outlined in regulatory guides and standard review plans. The potential consequences of accidental releases depend on the specific radionuclides released, the activity released for each radionuclide, and meteorological conditions. The source term for the ABWR reactor design is based on TID-14844 (AEC 1962) guidance, and guidance on methods for evaluating potential accidents for the ABWR are set forth in NUREG-0800 (NRC 1987), Regulatory Guide 1.3 (NRC 1974a), and Regulatory Guide 1.25 (NRC 1974b). The source term for the surrogate AP1000 reactor and methods for evaluating potential accidents are based on guidance in Regulatory Guide 1.183 (NRC 2000).

For environmental reviews, consequences are evaluated assuming realistic meteorological conditions. Meteorological conditions are represented in these consequence analyses by an atmospheric dispersion factor, which is also referred to as χ/Q. Acceptable methods of calculating χ/Q for DBAs from meteorological data are set forth in Regulatory Guide 1.145 (NRC 1983).

Dominion has provided the staff with meteorological data for 1996, 1997, and 1998 for the North Anna ESP site. These data have been reviewed by the staff and found to be representative of the meteorological conditions at the site. The meteorological conditions will need to be updated at the CP/COL stage to ensure that meteorological data reflect site conditions for the plant during operation. The meteorological instrumentation and its maintenance are consistent with staff guidance, and the data quality is consistent with standards set forth in that guidance. Therefore, the data are considered acceptable for use in evaluation of the consequences of DBAs. The staff also reviewed the applicant's procedures for calculating site-specific χ/Qs and found them to be consistent with staff guidance.

In Table 5-14, the first column lists the time periods and boundaries for which χ/Q values and dose estimates are needed. For the exclusion area boundary (EAB), the postulated DBA dose and its atmospheric dispersion factor are calculated for a short-term, i.e., 2 hours, and for the low population zone (LPZ), they are calculated for the course of the accident, i.e., 30 days (720 hours) comprised of four time periods. The second column lists the χ/Q values calculated by the applicant using the site meteorological information discussed in ER Section 2.7.4 (Dominion 2004a) and the EAB and LPZ distances from Section 2.7.5 of the ER. No credit was taken for building wake. The applicant also provided PPE χ/Q values; some of which neither the applicant nor the staff used in assessing site suitability.

Table 5-14. Atmospheric Dispersion Factors (χ/Q, s/m^3) for the North Anna ESP Site Design-Basis Accident Calculations

Time Period[a] and Boundary	Site
0 to 2 hr, Exclusion Area Boundary	3.34×10^{-5}
0 to 8 hr, Low Population Zone	2.17×10^{-6}
8 to 24 hr, Low Population Zone	1.5×10^{-6}
1 to 4 day, Low Population Zone	1.2×10^{-6}
4 to 30 day, Low Population Zone	9.0×10^{-7}

(a) Times are relative to the beginning of the release to the environment.

In its independent assessment, the staff evaluated the applicant's process for deriving the site χ/Q values from site-specific information and from information for existing reactor designs and has determined that the site χ/Q values are reasonable. The χ/Q values are based on typical meteorological conditions at the site and the locations of the EAB and LPZ given in the ESP application. These values indicate the atmospheric dilution capability in the vicinity of the site. Small χ/Q values are associated with greater dilution capability. Thus, if the design χ/Q value for a specific reactor design identified as part of the CP/COL is greater than or equal to the site χ/Q value, then atmospheric dispersion at the site is sufficient such that the doses predicted for postulated DBAs for the design are expected to be below regulatory limits.

The staff concludes that the atmospheric dispersion characteristics of the North Anna ESP site are acceptable with respect to the potential environmental consequences of postulated DBAs for reactor designs with design χ/Q values falling within the bounds set by the site χ/Q values. At the CP/COL stage, the staff will need to verify that the χ/Q values for reactor designs considered at the CP/COL stage are bounded by the χ/Q values specified by the site χ/Q values. Additional evaluation will be needed if reactor design χ/Q values are not bounded by those of the site χ/Q values.

Tables 5-15 and 5-16 list the set of surrogate DBAs considered by the applicant and present the applicant's estimate of the environmental consequences of each DBA in terms of total effective dose equivalent (TEDE). TEDE is the sum of the committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent from external exposure. Dose conversion factors from Federal Guidance Report 11 (Eckerman et al. 1988) were used to calculate the CEDE. Similarly, dose conversion factors from Federal Guidance Report 12 (Eckerman and Ryman 1993) were used to calculate the deep dose equivalent.

The Commission has determined that the ABWR design meets the TEDE dose criteria of 10 CFR 50.34. Equivalent TEDE values have been estimated for the ABWR from doses in the design certification document by multiplying the thyroid dose by a factor 0.03 (the organ weighting factor for the thyroid) and adding the product to the whole body dose. In addition, the ABWR doses have been scaled to a power level of 4386 MW(t), 102 percent of the power proposed for an ABWR unit at the North Anna ESP site (Dominion 2004a). However, the scaling was performed on doses and not on the source term.

In all cases, the calculated TEDEs are a small fraction of the regulatory dose limits. On these bases, the staff concludes that the North Anna ESP site is suitable for operation of new advanced light water reactors (ALWRs). The environmental impacts of DBAs have not been explicitly evaluated for gas-cooled reactors, however, the staff expects that releases to the environment under accident conditions will be small for such designs. At the CP/COL stage, the applicant and the staff will need to verify that the doses for postulated DBAs for the actual reactor design remain bounded by the environmental impacts from the surrogate reactor designs.

Table 5-15. Design-Basis Accident Doses for an ABWR Reactor

		TEDE in Sv[b]		
Accident	Standard Review Plan Section[a]	EAB	LPZ	Review Criterion
Main Steam Line Break	15.6.4			
Pre-Existing Iodine Spike		7.6×10^{-4}	4.9×10^{-5}	2.5×10^{-1}[c]
Accident-Initiated Iodine Spike		3.7×10^{-5}	2.4×10^{-6}	2.5×10^{-2}[d]
Loss-of-Coolant Accident	15.6.5	2.6×10^{-3}	1.7×10^{-2}	2.5×10^{-1}[c]
Failure of Small Lines Carrying Primary Coolant Outside Containment	15.6.2	6.4×10^{-5}	4.1×10^{-6}	2.5×10^{-2}[d]
Fuel Handling	15.7.4	9.2×10^{-4}	6.0×10^{-5}	6.3×10^{-2}[d]

(a) NUREG-0800 (NRC 1987).
(b) To convert an Sv value to a rem value, multiply Sv by 100.
(c) 10 CFR 50.34(a)(1) and 10 CFR 100.11 criterion.
(d) Standard Review Plan criterion.

Table 5-16. Design-Basis Accident Doses for the Surrogate AP1000 Reactor

		TEDE in Sv[b]		
Accident	Standard Review Plan Section[a]	EAB	LPZ	Review Criterion
Main Steam Line Break	15.1.5			
Pre-Existing Iodine Spike		3.9×10^{-4}	1.1×10^{-4}	2.5×10^{-1}[c]
Accident-Initiated Iodine Spike		4.5×10^{-4}	4.5×10^{-4}	2.5×10^{-2}[d]
Steam Generator Rupture	15.6.3			
Pre-Existing Iodine Spike		1.7×10^{-3}	5.7×10^{-5}	2.5×10^{-1}[c]
Accident-Initiated Iodine Spike		8.4×10^{-4}	4.5×10^{-5}	2.5×10^{-2}[d]
Loss-of-Coolant Accident	15.6.5	1.4×10^{-2}	2.0×10^{-3}	2.5×10^{-1}[c]
Feedwater System Pipe Break	15.2.8	4.5×10^{-4}	4.5×10^{-4}	2.5×10^{-2}[d]
Rod Ejection	15.4.8	1.7×10^{-3}	3.1×10^{-4}	6.3×10^{-2}[d]
Reactor Coolant Pump Rotor Seizure (Locked Rotor)	15.3.3	1.4×10^{-3}	9.6×10^{-5}	2.5×10^{-2}[d]
Reactor Coolant Pump Shaft Break	15.3.4	1.4×10^{-3}	9.6×10^{-5}	2.5×10^{-2}[d]
Failure of Small Lines Carrying Primary Coolant Outside Containment	15.6.2	7.2×10^{-4}	4.8×10^{-5}	2.5×10^{-2}[d]
Fuel Handling	15.7.4	1.3×10^{-3}	9.6×10^{-5}	6.3×10^{-2}[d]

(a) NUREG-0800 (NRC 1987).
(b) To convert an Sv value to a rem value, multiply Sv by 100.
(c) 10 CFR 50.34(a)(1) and 10 CFR 100.11 criterion.
(d) Standard Review Plan criterion.

Summary of Design Basis Accident Impacts

Although Dominion chose the PPE approach in the overall ESP application, it based its evaluation of the environmental impacts of design basis accidents on characteristics of the ABWR and the surrogate AP1000 reactor designs with the explicit assumption that these impacts would bound the impacts of other ALWRs designs (Dominion 2004a). The NRC staff reviewed the analysis in the ER, which is based on analyses performed for design certification of these reactor designs. The results of the Dominion analyses indicate that the environmental risks associated with design basis accidents, if an ALWR were to be located at the North Anna ESP site, would be well within regulatory limits. On this basis, the staff concludes that the consequences of design basis accidents at the North Anna ESP site are of SMALL significance for ALWRs and that the North Anna ESP site is suitable for operation of ALWRs. The environmental impacts of design basis accidents have not been explicitly evaluated for gas-cooled reactors and will need to be evaluated at the CP/COL stage. For this evaluation to bound the reactor design selected at the CP/COL stage, the applicant and the staff will need to verify that the environmental impacts of design basis accident at the North Anna ESP site remain bounded by the environmental impacts from the surrogate designs considered in this EIS.

5.10.2 Severe Accidents

Dominion bases its evaluation of the potential environmental consequences of severe accidents in the ER on the evaluation of potential consequences of severe accidents for current generation reactors presented in NUREG-1437 (NRC 1996). Three pathways were considered: (1) the atmospheric pathway in which radioactive material is released to the air, (2) the surface water pathway in which airborne radioactive material falls out on open bodies of water, and (3) the groundwater pathway in which groundwater is contaminated by a basemat melt-through with subsequent contamination of surface water by the groundwater.

In response to an NRC request for additional information dated March 12, 2004 (NRC 2004a), the applicant performed a site-specific analysis of the potential environmental consequences of postulated severe accidents at the North Anna ESP site. The PPE does not include source terms for severe accidents, therefore the applicant used source terms for the ABWR and the surrogate AP1000 reactors. The applicant used the MACCS2 computer code (Chanin et al. 1990; Jow et al. 1990) for the analysis. A summary of the results of the analysis was submitted to the NRC in a letter dated May 17, 2004 (Dominion 2004c), and detailed computer output was submitted by letter dated July 12, 2004 (Dominion 2004e).

The MACCS computer code was developed to evaluate the potential offsite consequences of severe accidents for the sites covered by NUREG-1150 (NRC 1990). MACCS2 (Chanin and Young 1997) is the current version of MACCS. The MACCS and MACCS2 codes evaluate the consequences of atmospheric releases of radioactive material following a severe accident. The pathways modeled include external exposure to the passing plume, external exposure to material deposited on the ground and skin, inhalation of material in the passing plume and resuspended from the ground, and ingestion of contaminated food and surface water. The primary enhancements in MACCS2 are that MACCS2 has (1) a more flexible emergency response model, (2) an expanded library of radionuclides, and (3) a semidynamic food-chain model (Chanin and Young 1997).

Three types of severe accident consequences were assessed: (1) human health, (2) economic costs, and (3) land area affected by contamination. Human-health effects are expressed in terms of the number of cancers that might be expected if a severe accident were to occur. These effects are directly related to the cumulative radiation dose received by the general population. MACCS2 estimates both early cancer fatalities and latent fatalities. Early fatalities are related to high doses or dose rates and can be expected to occur within a year of exposure (Jow et al. 1990). Latent fatalities are related to exposure of a large number of people to low doses and dose rates and could occur after a latent period of several (2 to 15) years. Population health risk estimates are based on the population distribution within an 80-km (50-mi) radius of the plant, whereas average individual health risks are based on the distribution of population close to the plant. Economic costs of a severe accident include the costs associated with short-term relocation of people, decontamination of property and equipment, interdiction of food supplies, land, and equipment use, and condemnation of property. The affected land area is a measure of the areal extent of the residual contamination following a severe accident.

Risk is the product of the frequency of an accident and the consequence of the accident. For example, the probability of a severe accident without loss of containment for an ABWR is estimated to be 1.34×10^{-7} per reactor year (Ryr^{-1}); and the cumulative population dose associated with a severe accident without loss of containment at the North Anna ESP site is calculated to be 7.86×10^{1} person-Sv (7.86×10^{3} person-rem). The population dose risk for this class of accidents is the product of 1.34×10^{-7} Ryr^{-1} and 7.86×10^{1} person-Sv, or 1.05×10^{-5} person-Sv Ryr^{-1} (1.05×10^{-3} person-rem Ryr^{-1}). The following sections discuss the estimated risks associated with each pathway.

Air Pathway

The MACCS2 code directly estimates consequences associated with releases to the air pathway. The results of the MACCS2 runs are presented in Tables 5-17 and 5-18. The core damage frequencies given in these tables are for internally initiated accident sequences while the plant is at power. Internally initiated accident sequences include those sequences initiated by human error, equipment failures, loss of offsite power, etc. Based on insights from the review of the ALWR probabilistic risk assessments, completed prior to the ESP application, the core damage frequencies for externally initiated events and during shutdown would be comparable to or lower than those for internally initiated events.

Tables 5-17 and 5-18 show that the probability weighted consequences (i.e., the risks) of severe accidents for the ABWR or the surrogate AP1000 reactor located on the North Anna ESP site are small for all risk categories considered. For perspective, Tables 5-19 and 5-20 compare the health risks from severe accidents for the ABWR or surrogate AP1000 reactors at the North Anna ESP site with the risks for current generation of operating reactors at various sites.

In Table 5-19, the health risks estimated for the ABWR and surrogate AP1000 reactors at the North Anna ESP site are compared with health risk estimates for the five reactors considered in NUREG-1150 (NRC 1990). Although risks associated with both internally and externally-initiated events were considered for the Peach Bottom and Surry reactors in NUREG-1150, only risks associated with internally initiated events are presented in Table 5-19. The health risks shown for the ABWR and surrogate AP1000 reactors at the North Anna ESP site are significantly lower than the risks associated with current generation of operating reactors presented in NUREG-1150.

Table 5-17. Mean Environmental Risks from ABWR Severe Accidents at the North Anna Power Station ESP Site

Release Category Description (Accident Class)		Core Damage Frequency (Ryr⁻¹)	Environmental Risk					
			Population Dose (person- Sv Ryr⁻¹)[a]	Fatalities (Ry⁻¹)		Cost[d] ($ Ryr⁻¹)	Land Requiring Decontamination[e] (ha Ryr⁻¹)	Population Dose from Water Ingestion (person-Sv Ryr⁻¹)[a]
				Early[b]	Latent[c]			
0	No loss of containment	1.34×10^{-7}	1.05×10^{-5}	0	4.66×10^{-7}	1.85×10^{-2}	7.34×10^{-7}	1.93×10^{-8}
1	Transients followed by failure of high-pressure coolant makeup water and failure to depressurize in timely fashion	2.08×10^{-8}	2.16×10^{-6}	0	9.86×10^{-8}	4.12×10^{-3}	1.26×10^{-7}	3.10×10^{-9}
2	Short-term station blackout with reactor core isolation cooling (RCIC) failure, onsite power recovery in 8 hr	1.00×10^{-10}	5.62×10^{-9}	0	2.40×10^{-10}	1.23×10^{-6}	9.57×10^{-13}	3.09×10^{-12}
3	Station blackout with RCIC available for about 8 hr	1.00×10^{-10}	4.47×10^{-7}	0	2.00×10^{-8}	1.18×10^{-2}	2.40×10^{-7}	1.37×10^{-9}
4	Station blackout (more than 8 hr) with RCIC failure	1.00×10^{-10}	3.39×10^{-7}	0	1.50×10^{-8}	7.72×10^{-3}	1.65×10^{-7}	9.89×10^{-10}
5	Transients followed by failure of high pressure coolant makeup water, successful depressurization of reactor, failure of low-pressure coolant makeup water	1.00×10^{-10}	1.43×10^{-7}	0	6.07×10^{-9}	4.19×10^{-3}	5.19×10^{-8}	3.28×10^{-10}

Table 5-17. (contd)

Release Category Description (Accident Class)		Core Damage Frequency (Ryr^{-1})	Population Dose (person-Sv Ryr^{-1})[a]	Fatalities (Ry^{-1})		Cost[d] (\$ Ryr^{-1})	Land Requiring Decontamination[e] (ha Ryr^{-1})	Population Dose from Water Ingestion (person-Sv Ryr^{-1})[a]
				Early[b]	Latent[c]			
6	Transient, loss-of-coolant accident (LOCA), and anticipated transient without scram (ATWS) events with successful coolant makeup water, but potential prior failure of containment	1.00×10^{-10}	2.81×10^{-6}	0	1.25×10^{-7}	6.04×10^{-1}	4.75×10^{-6}	4.81×10^{-8}
7	Small/medium LOCA followed by failure of high-pressure coolant makeup water and failure to depressurize	3.91×10^{-10}	1.26×10^{-5}	8.05×10^{-15}	5.55×10^{-7}	$2.70 \times 10^{+0}$	1.96×10^{-5}	2.42×10^{-7}
8	LOCA followed by failure of high-pressure coolant makeup water	4.05×10^{-10}	1.96×10^{-5}	2.17×10^{-11}	8.63×10^{-7}	5.06×10^{-0}	2.88×10^{-5}	5.63×10^{-7}
9	ATWS followed by boron injection failure and successful high-pressure coolant makeup water	1.70×10^{-10}	1.06×10^{-5}	2.41×10^{-12}	5.00×10^{-7}	$2.69 \times 10^{+0}$	1.39×10^{-5}	4.00×10^{-7}
Total		1.56×10^{-7}	5.93×10^{-5}	2.28×10^{-11}	2.65×10^{-6}	$1.11 \times 10^{+1}$	6.83×10^{-5}	1.28×10^{-6}

(a) To convert an Sv value to a rem value, multiply Sv by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that could occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990)
(e) Land risk is farm land requiring decontamination prior to resumption of agricultural usage. To convert hectares to acres, multiply by 2.47.

Table 5-18. Mean Environmental Risks from the Surrogate AP1000 Severe Accidents at the North Anna ESP Site

Release Category Description (Accident Class)		Core Damage Frequency (Ryr^{-1})	Environmental Risk					
			Population Dose (person- Sv Ryr^{-1})[(a)]	Fatalities (Ry^{-1})		Cost[(d)] ($ Ryr^{-1})	Land Requiring Decontamination[(e)] (ha Ryr^{-1})	Population Dose from Water Ingestion (person Sv Ryr^{-1})[(a)]
				Early[(b)]	Latent[(c)]			
CFI	Intermediate containment failure, after core relocation but before 24 h	1.89×10^{-10}	3.38×10^{-6}	2.23×10^{-13}	1.64×10^{-7}	5.42×10^{-1}	6.77×10^{-6}	3.80×10^{-8}
CFE	Early containment failure, after onset of core damage but before core relocation	7.47×10^{-9}	1.88×10^{-4}	5.15×10^{-11}	8.89×10^{-6}	$3.76 \times 10^{+1}$	3.12×10^{-4}	2.52×10^{-6}
IC	Intact containment	2.21×10^{-7}	1.05×10^{-5}	0	4.84×10^{-7}	9.86×10^{-3}	1.16×10^{-6}	3.40×10^{-8}
BP	Containment bypass, fission products released directly to environment	1.05×10^{-8}	5.96×10^{-4}	7.07×10^{-11}	2.90×10^{-5}	$1.42 \times 10^{+2}$	8.98×10^{-4}	1.66×10^{-5}
CI	Containment isolation failure occurs prior to onset of core damage	1.33×10^{-9}	2.97×10^{-5}	1.31×10^{-12}	1.65×10^{-6}	$5.49 \times 10^{+0}$	4.79×10^{-5}	3.87×10^{-7}
CFL	Late containment failure occurring after 24 h	3.45×10^{-13}	9.66×10^{-9}	3.69×10^{-15}	5.59×10^{-10}	1.96×10^{-3}	1.94×10^{-8}	8.73×10^{-12}
Total		2.40×10^{-7}	8.28×10^{-4}	1.24×10^{-10}	4.02×10^{-5}	$1.85 \times 10^{+2}$	1.27×10^{-3}	1.96×10^{-5}

(a) To convert an Sv value to a rem value, multiply Sv by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that could occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(e) Land risk is farm land requiring decontamination prior to resumption of agricultural usage. To convert hectares (ha) to acres, multiply by 2.47.

Table 5-19. Comparison of Environmental Risk for New Units at the North Anna ESP Site with Risks for Five Sites Evaluated in NUREG-1150

Reactor Site	Core Damage Frequency (Ryr^{-1})	50-mi (80-km) Population Dose Risk (person-Sv Ryr^{-1})[a]	Fatalities Ryr^{-1}		Average Individual Fatality Ryr^{-1}	
			Early	Latent	Early	Latent Cancer
Grand Gulf[b]	4.0×10^{-6}	5×10^{-1}	8×10^{-9}	9×10^{-4}	3×10^{-11}	3×10^{-10}
Peach Bottom[b]	4.5×10^{-6}	$7 \times 10^{+0}$	2×10^{-8}	5×10^{-3}	5×10^{-11}	4×10^{-10}
Sequoyah[b]	5.7×10^{-5}	$1 \times 10^{+1}$	3×10^{-5}	1×10^{-2}	1×10^{-8}	1×10^{-8}
Surry[b]	4.0×10^{-5}	$5 \times 10^{+0}$	2×10^{-6}	5×10^{-3}	2×10^{-8}	2×10^{-9}
Zion[b]	3.4×10^{-4}	$5 \times 10^{+1}$	1×10^{-4}	2×10^{-2}	9×10^{-9}	8×10^{-9}
ABWR at North Anna ESP Site[c]	1.6×10^{-7}	5.9×10^{-5}	2.3×10^{-11}	2.7×10^{-6}	4.6×10^{-14}	4.4×10^{-12}
AP1000 at North Anna ESP Site[c]	2.4×10^{-7}	8.3×10^{-4}	1.1×10^{-10}	4.0×10^{-5}	2.6×10^{-13}	4.9×10^{-11}

(a) To convert an Sv value to a rem value, multiply Sv by 100.
(b) Risks were calculated using the MACCS code and presented in NUREG-1150 (NRC 1990).
(c) Calculated with MACCS2 code using North Anna site-specific input.

The Commission has set safety goals for average individual early fatality and latent cancer fatality risks from internally initiated events (NRC 1986). These goals are that average individual early fatality risk be less than 5×10^{-7} Ryr^{-1} and that average individual latent cancer fatality risk be less than 2×10^{-6} Ryr^{-1}. The average individual early fatality risk is calculated using the population distribution within 1.6 km (1 mi) of the plant boundary. The average individual latent cancer fatality risk is calculated using the population distribution within 16 km (10 mi) of the plant. For the plants considered in NUREG-1150, these risks were well below the Commission's safety goals. Risks calculated for the ABWR and surrogate AP1000 at the North Anna ESP site are lower than the risks associated with the current generation reactors considered in NUREG-1150, and are well below the NRC safety goals.

The staff compared the core damage frequencies and population dose risk estimates for the ABWR and surrogate AP1000 reactors at the North Anna ESP site with comparable statistics summarizing the results of contemporary severe accident analyses performed for 28 current generation of operating reactors at 23 sites. The results of these analyses are included in the final site-specific Supplements 1 through 20 to the Generic Environmental Impact Statement for License Renewal (GEIS), NUREG-1437, and in the ERs included with license renewal applications for those plants for which supplements have not been published. All of the analyses were completed after publication of NUREG-1150, and the 23 analyses used MACCS2, which was released in 1997. Table 5-20 shows that the core damage frequencies estimated for the ABWR and AP1000 reactors are significantly lower than those of current generation reactors. Similarly, the population doses estimated for the advanced reactors at the North Anna ESP site are well below the mean and median values for current generation reactors undergoing license renewal.

The staff has considered the risk estimates given in Tables 5-17 and 5-18, the comparisons of atmospheric pathway risks in Tables 5-19 and 5-20, and the comparison of average individual early fatality and average individual latent cancer fatality risks with the Commission's safety goals in Table 5-19. Preliminary information on the IRIS and the ACR-700 reactor designs indicates that the surrogate AP1000 is expected to bound the risk for these advanced reactor designs. Similarly, the ESBWR risk is expected to be bounded by the ABWR. On this basis, the staff concludes that the North Anna ESP site is suitable for operation of ALWRs. If as stated in the ER, the releases from the gas-cooled reactor designs are bounded by the releases from the light water reactor designs, then the site would be suitable for these gas-cooled reactors. The PPE does not contain specific parameters related to severe accidents for gas cooled reactors, and the consequences of severe accidents have not been explicitly evaluated for gas-cooled reactors and will need to be evaluated at the CP/COL stage. For the evaluation in this EIS to bound the reactor design selected at the CP/COL stage, the applicant and the staff will need to verify that the environmental impacts of the atmospheric pathway releases for severe accidents at the North Anna ESP site remain bounded by the environmental impacts from the surrogate designs.

Table 5-20. Comparison of Environmental Risks from Severe Accidents Initiated by Internal Events for an ABWR and a Surrogate AP1000 at the North Anna ESP Site with Risks Initiated by Internal Events for 28 Current Operating Plants Undergoing License Renewal

Reactor Site	Core Damage Frequency (yr^{-1})	50-mi (80-km) Population Dose Risk (person-Sv Ryr^{-1})[(a)]
Current Reactor Maximum[(b)]	2.4×10^{-4}	6.9×10^{-1}
Current Reactor Mean[(b)]	3.6×10^{-5}	1.5×10^{-1}
Current Reactor Median[(b)]	2.8×10^{-5}	1.4×10^{-1}
Current Reactor Minimum[(b)]	1.9×10^{-6}	5.5×10^{-3}
ABWR at North Anna ESP Site[(c)]	1.6×10^{-7}	5.9×10^{-5}
AP1000 at North Anna ESP Site[(c)]	2.7×10^{-7}	8.3×10^{-4}

(a) To convert an Sv value to a rem value, multiply Sv by 100.
(b) Based on MACCS and MACCS2 calculations for current plants undergoing operating license renewal.
(c) Calculated with MACCS2 code using North Anna site-specific input.

Surface Water Pathways

Surface water pathways are an extension of the air pathway. These pathways cover the effects of radioactive material deposited on open bodies of water. The surface water pathways of interest include exposure to external radiation from submersion in water and activities near the water, ingestion of water, and ingestion of fish and other aquatic creatures. Of these pathways, the MACCS2 code only evaluates the ingestion of contaminated water. The risks associated with this surface water pathway calculated for the North Anna ESP site are included in the last columns of Table 5-17 and 5-18. For each accident class, the population dose risk from ingestion of water is a small fraction of the dose risk from the air pathway.

Lake Anna is used for recreational activities including swimming and fishing. Doses from these surface water pathways are not modeled in MACCS or MACCS2. NUREG-1437 (NRC 1996) provides an estimate of typical population exposure risk for the aquatic food pathway for plants located on small rivers. The North Anna ESP site is classified as being on a small river. For these plants, the risk associated with the aquatic food pathway is about 4×10^{-3} person-Sv Ryr^{-1} (4×10^{-1} person-rem Ryr^{-1}). The total risk for the existing NAPS Units 1 and 2 is about 2.5×10^{-1} person-Sv Ryr^{-1} (2.5×10^{1} person-rem Ryr^{-1}) (NRC 2002a). Thus, the generic aquatic pathway risk is less than 2 percent of the total risk. Analysis of water-related exposure pathways at the Fermi reactor (NRC 1981) suggests that population exposures from swimming are significantly lower than exposures from the aquatic ingestion pathway.

Dominion owns Lake Anna and, in the event of a large release of radioactive material, it could control access to the lake, which is the major surface water body in the vicinity of the North Anna ESP site. By exercising that control, Dominion could reduce exposures through the surface water pathways.

After considering the water ingestion dose estimates, the NUREG-1437 evaluations, and Dominion's control over access to Lake Anna, the staff concludes that the North Anna ESP site is suitable for operation of the ABWR and the surrogate AP1000; in a similar fashion to the air pathway, the environmental impacts of the surface water pathway for other ALWR is expected to be bounded by the ABWR and the surrogate AP1000. The environmental impacts of severe accidents have not been evaluated for gas-cooled reactors. The PPE does not contain specific parameters related to severe accidents for gas-cooled reactors, and the consequences of severe accidents have not been evaluated for gas-cooled reactors and will need to be evaluated at the CP/COL stage. For this evaluation to bound the reactor design selected at the CP/COL stage, the applicant and the staff will need to verify that the environmental impacts of the surface water pathway releases for severe accidents at the North Anna ESP site remain bounded by the environmental impacts from the surrogate designs.

Groundwater Pathway

Neither MACCS nor MACCS2 evaluates the environmental risks associated with severe accident releases of radioactive material to groundwater. However, this pathway has been addressed in NUREG-1437 in the context of renewal of licenses for the current generation reactors. NUREG-1437 assumes a 1×10^{-4} Ryr^{-1} probability of occurrence of a severe accident with a basemat melt-through leading to potential groundwater contamination, and the staff concluded that groundwater generally contributed a small fraction of the risk attributable to the atmospheric pathway. Although the staff assumed that the probability of occurrence of a release via the groundwater pathway is significantly larger than a release via the atmospheric pathway for either the ABWR or the surrogate AP1000, the groundwater pathway is more tortuous and affords a greater time for implementing protective actions and therefore results in a lower risk to the public. As a result, the staff concludes that the risks associated with releases to groundwater are sufficiently small that they would not have a significant effect on determination of suitability of the North Anna ESP site.

Summary of Severe Accident Impacts

Although Dominion chose the PPE approach in the overall ESP application, it based its evaluation of the environmental impacts of severe accidents on characteristics of the ABWR and the surrogate AP1000 reactor designs with the explicit assumption that these impacts would bound the impacts of other ALWR designs (Dominion 2004a). The NRC staff reviewed the analysis in the ER and conducted its own confirmatory analysis using the MACCS2 code. The results of both the Dominion and NRC analyses indicate that the environmental risks associated with severe accidents if an ALWR were to be located at the North Anna ESP site would be small compared to risks associated with operation of current generation reactors at the North Anna site and other sites. These risks are well below the NRC safety goals. On these bases, the staff concludes that the probability weighted consequences of severe accidents at the North Anna ESP site are of SMALL significance for ALWR and that the North Anna ESP site is suitable for operation of ALWR. The environmental impacts of severe accidents have not been evaluated for gas-cooled reactors and will need to be evaluated at the CP/COL stage. For this evaluation to bound the reactor design selected at the CP/COL stage, the applicant and the staff will need to verify that the environmental impacts of severe accidents at the North Anna ESP site remain bounded by the environmental impacts from the surrogate designs.

5.10.3 Summary of Postulated Accident Impacts

The staff evaluated the environmental impacts from design basis accidents and severe accidents using the ABWR and the surrogate AP1000 to characterize the environmental impacts from ALWR. As described previously, preliminary information on the IRIS and the ACR-700 reactor designs indicate that the surrogate AP1000 is expected to bound the source term, doses, and probability weighted consequences of design and severe accidents. Similarly, the ESBWR source term, doses, and probability weighted consequences of design and severe accidents is expected to be bounded by the ABWR. Based on the information provided by Dominion, and its own independent review, the staff concludes that the potential environmental impacts from postulated accident from the operation of two additional nuclear power plants would be SMALL, and mitigation is not warranted. As noted, the staff concludes that the North Anna ESP site is suitable for the operation of ALWRs. The staff did not explicitly evaluate the design basis or severe accident impacts for gas-cooled reactors which will need to be evaluated at the CP/COL stage. For this evaluation to bound the reactor design selected at the CP/COL stage, the applicant and the staff will need to verify that the environmental impacts of design basis and severe accidents at the North Anna ESP site remain bounded by the environmental impacts from the surrogate (ABWR and AP1000) designs.

5.11 Measures and Controls to Limit Adverse Impacts During Operation

The following general measures and controls on which the staff relied in its evaluation of environmental impacts during operation of the proposed new units at the North Anna ESP site include those for which Dominion would be required (Federal, State, and local) by applicable permits and authorizations (contained in Table 1.2-1 of the ER) as well as the feasible measures and controls contained in Table 5.10-1 of the ER:

- compliance with the applicable Federal, State, and local laws, ordinances, and regulations that prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emission control, noise control, storm water management, spill response and cleanup, hazardous material management)

- applicable requirements of permits and licenses required for operation (e.g., VPDES permit, operating license)

- compliance with VPDES permit requirements imposed on water discharges from the new units (ER Sections 5.1.1, 5.3.2, 5.5.1)

- compliance with VDEQ permit limits and regulations for installing and operating air emission sources (ER Section 5.8.1)

- compliance with Virginia Power procedures applicable to environmental control and management

Dominion specifically identified the following general plans or specific mitigation measures in its ER (Dominion 2004a) on which the staff relied in its evaluation:

- Current transmission line maintenance practices would continue if two new units were built at the ESP site (ER Section 5.6.1.1)

- Identify locations of rare or sensitive plant species within transmission line corridors so modified treatment practices can be used in these areas to avoid adverse impacts (ER Section 5.6.1.1)

- The intake structure for the new units at the ESP site would meet Section 316(b) of the Clean Water Act and the implementing regulations, as applicable (ER Section 5.3.1.2)

- A fish return system based on the latest technology available during detailed engineering would be considered for incorporation into the intake system (ER Section 5.3.1.2)

- Options to mitigate increases in lake temperature would be evaluated in the COL application, including submerged intake or curtain wall, helper towers, and spray cooling systems in the WHTF discharge canal (Section 5.3.2.1)

- Vegetative shielding would block a clear view of the new units from nearby residences, and a visual impact study would be performed and the results would be described in the COL application (ER Section 5.8.1.5)

- Noise levels would be controlled in accordance with applicable local county regulations (ER Section 5.8.1.2)

- Potential increases in traffic would be mitigated through effective traffic management (ER Section 5.1.1)

- Conduct any ground disturbing activities in coordination with VDHR and professional archaeological practices (ER Section 4.1.3)

Dominion evaluated the measures and controls shown in Table 5.10-1 of the ER (Dominion 2004a) and considered them feasible from both a technical and economic standpoint. In addition, Dominion expects these measures and controls to be adequate for avoiding or mitigating potential adverse impacts associated with operation of the new units. The staff considered these measures and controls in its evaluation of station operation impacts.

5.12 Summary of Operational Impacts

Impact level categories are denoted in Table 5-21 as SMALL, MODERATE, or LARGE as a measure of their expected adverse impacts, if any. With the socioeconomic issues in which the impacts are likely to be beneficially moderate or large, this is noted in Comments column. The Impact column designates beneficial impacts as SMALL.

Table 5-21. Characterization of Operational Impacts at the North Anna ESP Site

Category	Comments	Impact Level
Land use impacts		--
The site and vicinity	Operation of new units within existing site. Possible new housing and retail space added in vicinity due to potential growth.	SMALL
Transmission corridors	No new transmission corridors would be needed.	SMALL
Air quality impacts	Meteorological impacts are expected to be negligible. Pollutants emitted during operations considered insignificant and limits could be incorporated under existing Exclusionary Permit.	SMALL
Water-related impacts		--
Hydrological alterations	Increased circulation of water within Lake Anna resulting from the increased discharge from new Unit 3 will result in a change in the quantity and distribution of heat in the lake.	SMALL
Water use		
Normal years	During normal water years, the impact would be small.	SMALL
Drought years	During critical low-water years, the impacts could be temporarily moderate.	MODERATE
Water quality	Water effluents are regulated by the VPDES permit.	SMALL
Ecological impacts		--

Station Operation Impacts at the Proposed Site

Category	Comments	Impact Level
Terrestrial ecosystems	No detectable impacts noted; no important species in area.	SMALL
Aquatic ecosystems	The fish population is balanced. Proportion of resources subject to impingement and entrainment would be small. Additional heat could impact hatchery striped bass in parts of the lake in drought years. Mitigation in the form of additional stocking striped bass may be necessary. Refugia would be available.	SMALL
T&E Species		--
Terrestrial Species	No threatened or endangered species known to inhabit area.	SMALL
Aquatic Species	No threatened or endangered species known to inhabit area.	SMALL
Socioeconomic Impacts		--
Physical Impacts		--
Workers/Public	Workers would use protective equipment and receive training to mitigate any possible impact. North Anna location is relatively remote, so the public would not be impacted.	SMALL
Buildings	No impact to onsite or offsite buildings.	SMALL
Roads	Upgrades before or during construction would cover the lesser impact of operational work forces.	SMALL
Aesthetics	Visual impact would be minimal due to remote location. Lower water levels, and their effect on shoreline exposure during severe drought could temporarily impact area. These impacts are expected to be at the moderate level.	SMALL
Demography	Number of new employees small in proportion to population base.	SMALL
Community Characteristics		
Economy	Increased jobs would benefit the area economically, up to a moderate beneficial impact (Louisa and Orange Counties) is possible.	SMALL
Transportation	Improvements made for construction would be sufficient to cover any adverse impact from small number of additional operational workers.	SMALL

Category	Comments	Impact Level
Taxes	Depends on residence location; generally impacts are beneficial, especially for property taxes and employment. Beneficial impacts of additional taxes would be large for Louisa County.	SMALL
Recreation	Overall impacts to recreation minimal due to remote location. Traffic around and use of lake could increase. Lower water levels, and their effect on shoreline exposure and recreational usage during severe drought could temporarily impact area.	SMALL
Housing	Adequate housing is available in Henrico and Spotsylvania Counties and in Richmond to handle operational workers. Orange and Louisa Counties could experience a temporary shortage of upscale housing, possibly at the moderate impact level.	SMALL
Public Services	Adequate in all counties for any population increase due to operation workforce.	SMALL
Education	Current schools and planned additions would handle additional students.	SMALL
Historic and cultural resources	A cultural resource program is in place for minimizing impacts from routine land disturbances.	SMALL
Environmental justice	No unusual resource dependence in the area.	SMALL
Nonradiological health impacts	Health impacts monitored and controlled in accordance with Occupational Safety and Health regulations.	SMALL
Radiological health impacts	Doses to public and occupational workers are monitored and controlled in accordance with NRC limits.	SMALL
Impacts of postulated accidents		--
Design basis accidents	Doses for advanced light water reactors are expected to be a small fraction of the regulatory dose limits. Staff will verify that doses for postulated DBAs on chosen reactor designs are within regulatory limits.	SMALL
Severe accidents	Risks for ALWRs would be small. If gas-cooled reactor is selected at the CP/COL stage then the staff will evaluate the severe accident impacts for gas-cooled reactors.	SMALL

5.13 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

40 CFR 190. Code of Federal Regulations, Title 40, Protection of Environment, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

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6.0 Fuel Cycle, Transportation, and Decommissioning

This chapter addresses the environmental impacts from (1) the uranium fuel cycle and solid waste management, (2) transportation of radioactive material, and (3) decommissioning for the postulated Units 3 and 4 at the North Anna ESP site. Distinctions between the impacts of advanced light-water reactor (LWR) designs and the gas-cooled reactor designs are discussed.

In its evaluation of uranium fuel cycle impacts for the North Anna early site permit (ESP) site, Dominion Nuclear North Anna, LLC (Dominion) used the plant parameter envelope (PPE) approach for the advanced LWR designs but not for the two gas-cooled reactors. In its evaluation of the impacts from transportation of radioactive materials, Dominion did not use the PPE approach but rather evaluated each reactor design individually. Dominion would, therefore, have to perform a new evaluation if a different design is proposed at the construction permit (CP) or combined license (COL) stage.

6.1 Fuel Cycle Impacts and Solid Waste Management

This section discusses the environmental impacts from the uranium fuel cycle and solid waste management for both the advanced LWR designs and gas-cooled reactor designs. The impacts of the two types of design are presented separately because Title 10 of the Code of Federal Regulations (CFR), Section 51.51 provides specific criteria for evaluating the environmental impacts only for LWR designs.

6.1.1 Land Use Light-Water Reactors

10 CFR 51.51(a) states that "Every environmental report prepared for the construction permit 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 waste and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power plant. 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."

The PPE for the North Anna ESP site used the bounding input parameters from the following LWR designs:

- ACR-700 –This reactor, developed by Atomic Energy Canada Limited, is an evolutionary extension of CANDU 6 plant using very slightly enriched uranium fuel and light-water coolant.

- Advanced Boiling Water Reactor (ABWR) – This reactor, developed by General Electric Company, is a standardized plant that has been certified under the NRC requirements in 10 CFR Part 52. The ABWR is fueled with slightly enriched uranium and has light-water cooling.

- Surrogate AP1000 – Advanced Pressurized Water Reactor (PWR) – This is an earlier version of the AP1000 reactor final design approved by the NRC, and developed by Westinghouse Electric Company, using slightly enriched uranium and light-water cooling. This design is not the AP1000 that has receive final design approval from the NRC.

- Economic Simplified Boiling Water Reactor (ESBWR) – This reactor, developed by General Electric Company, is fueled with slightly enriched uranium and has light-water cooling.

- International Reactor Innovative and Secure (IRIS) next generation PWR – This reactor, under development by a consortium led by Westinghouse Electric Company, is a modular light-water reactor.

These light-water designs all use uranium dioxide fuel; therefore, Table S–3 can be used to assess environmental impacts. Table S–3 values are normalized for a reference 1000-MW(e) LWR at an 80 percent capacity factor. The PPE power rating for the North Anna ESP site is 8600 MW(t) assuming two ABWR units would be located on the ESP site with a PPE capacity factor of 96 percent (Dominion 2004a). This corresponds to 3200 MW(e). The 10 CFR 51.51(a) Table S-3 values are reproduced in Table 6-1, which follows.

Specific categories of natural resource use are included in Table S–3 (see Table 6-1). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high-level and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in Table S–3 for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposition of fuel for nuclear power reactors. Originally, two fuel cycle options were considered, which differed in the treatment of spent fuel removed from a reactor. "No recycle" treats all spent fuel as waste to be stored at a Federal waste repository; "uranium only recycle" involves reprocessing spent fuel to recover unused uranium and return it to the system. Neither cycle involves the recovery of plutonium.

Because current Federal policy does not support reprocessing spent fuel, only the no-recycle option is considered here. This option is presented schematically in Figure 6-1. Natural uranium is mined in either open-pit or underground mines or by an in situ leach solution mining process. In situ leach mining, the primary form of mining in the United States today, involves injecting a lixiviant solution into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The ore or in situ leach solution is transferred to mills where it is processed to produce uranium oxide or "yellowcake." A conversion facility prepares the uranium oxide from the mills for enrichment by converting it to uranium hexafluoride, which is then processed to separate the relatively nonfissile isotope U-238 from the more fissile isotope U-235. At a fuel-fabrication facility, the enriched uranium, which is approximately 5 percent U-235, is then converted to UO_2. The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies. The fuel assemblies are placed in the reactor to produce power. When the content of the U-235 reaches a point where the nuclear reactor has become inefficient with respect to neutron economy, the fuel assemblies are withdrawn from the reactor. After onsite storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies would be transferred to a waste repository for internment. Disposal of spent fuel elements in a repository constitutes the final step in the no-recycle option.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S–3 (see Table 6-1) and the staff's analysis of the radiological impact from radon and technetium. In NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC 1996), the staff provides a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG-1437 is specific to the impacts related to license renewal, the information is relevant to this review because the advanced LWR designs considered here use the same type of fuel; the staff's analyses in Section 6.2.3 of NUREG-1437 are summarized and incorporated by reference here.

The fuel cycle impacts in Table S-3 are based on a reference 1000-MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). In the following review and evaluation of the environmental impacts of the fuel cycle, the staff considered the capacity factor in the PPE of 96 percent with a total net electric output of 3200 MW(e) for the ESP site (Dominion 2004a) and this is approximately four times the impact values in Table S–3 (see Table 6-1). Throughout this chapter this will be referred to as the 1000-MW(e) LWR-scaled model reflecting 3200 MW(e) for the site.

Recent changes in the fuel cycle may have some bearing on environmental impacts, however, as discussed below, the staff is confident that the contemporary fuel cycle impacts below are those identified in Table S–3.

The values in Table S-3 were calculated from industry averages for the performance of each type of facility or operation within the fuel cycle. Recognizing that this approach meant that there would be a range of reasonable values for each estimate, the staff followed the policy of choosing the assumptions or factors to be applied so that the calculated values would not be underestimated. This approach was intended to ensure that the actual environmental impacts would be less than the quantities shown in Tables S-3 for all LWR nuclear power plants within the widest range of operating conditions. Many subtle fuel cycle parameters and interactions were recognized by the staff as being less than the precision of the estimates and were not considered or were considered but had no effect on the Table S-3 calculations. For example, to determine the quantity of fuel required for a year's operation of a nuclear power plant in Table S-3, the staff defined the model reactor as a 1000-MW(e) light-water-cooled reactor operating at 80 percent capacity with a 12-month fuel reloading cycle and an average fuel burnup of 33,000 Mwd/MTU. This is a "reactor reference year" or "reference reactor year" depending on the source (either Table S-3 or NUREG-1437), but it has the same meaning. The sum of the initial fuel loading plus all of the reloads for the lifetime of the reactor can be divided by the now more likely 60-year (40-year initial license term and 20-year renewal license term) lifetime to obtain an average annual fuel requirement. This was done for both boiling-water reactors (BWRs) and pressurized-water reactors (PWRs), and the higher annual requirement, 35 metric tonnes (MT) of uranium made into fuel for a BWR, was chosen in NUREG-1437 as the basis for the reference reactor year. A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. Since Table S-3 was promulgated, these improvements have reduced the annual fuel requirement.

Another change is the elimination of the U.S. restrictions on importation of foreign uranium. The economic conditions of the uranium market now and in the foreseeable future favor full utilization of foreign uranium at the expense of the domestic uranium industry. These market conditions have forced the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the U.S. from these activities. However, the Table S-3 estimates have not been reduced accordingly to ensure that these impacts, which have been experienced in the past and may be fully experienced again in the future, are considered. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop levels below those given in Table S-3.

Section 6.2 of NUREG-1437 discusses the sensitivity to recent changes in the fuel cycle on the environmental impacts in greater detail.

Table 6-1. Table of Uranium Fuel Cycle Environmental Data[a] – Taken From Table S–3 (Normalized to Model LWR Annual Fuel Requirement (WASH-1248 [AEC 1974]) or Reference Reactor Year (NUREG-0116 [NRC 1976])

Environmental Considerations	Total	Maximum Effect Per Annual Fuel Requirement or Reference Reactor-Year of Model 1000-MW(e) LWR
NATURAL RESOURCE USE		
Land (acres)		
Temporarily committed[b]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to 110-MW(e) coal-fired power plant
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95-MW(e) coal-fired power plant
Water (millions of gallons)		
Discharged to air	160	Equals 2 percent of model 1000-MW(e) LWR with cooling tower
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	Less than 4 percent of model 1000-MW(e) LWR with once-through cooling
Fossil fuel		
Electrical energy (thousands of MW-hour)	323	Less than 5 percent of model 1000-MW(e) LWR output
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45-MW(e) coal-fired power plant
Natural gas (millions of scf)	135	Less than 0.4 percent of model 1000-MW(e) energy output
Effluents–Chemical (MT)		
Gases (including entrainment)[c]		
SO_x	4400	
NO_x[d]	1190	Equivalent to emissions from 45-MW(e) coal-fired plant for a year

Table 6.1. (contd)

Environmental Considerations	Total	Maximum Effect Per Annual Fuel Requirement or Reference Reactor-Year of Model 1000-MW(e) LWR
Effluents–Chemical (MT) (contd)		
Hydrocarbons	14	
CO	29.6	
Particulates	1154	
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
HCl	0.014	
Liquids		
SO[d]	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. The constituents that require dilution and the flow of dilution water are NH_3, 600 cfs; NO_3, 20 cfs, Fluoride, 70 cfs.
NO[c]	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	0.4	
Tailings Solutions (thousands of MT)	240	From mills only – no significant effluents to environment
Solids	91,000	Principally from mills – no significant effluents to environment
Effluents–Radiological (Curies)		
Gases (including entrainment)		
Rn-222	--	Presently under reconsideration by the Commission
Ra-226	0.02	
Th-230	0.02	

Table 6.1. (contd)

Environmental Considerations	Total	Maximum Effect Per Annual Fuel Requirement or Reference Reactor-Year of Model 1000-MW(e) LWR
Effluents–Radiological (Curies) (contd)		
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	0.14	Principally from fuel-reprocessing plants
I-129	1.3	
I-131	0.83	
Tc-99	--	Presently under consideration by the Commission
Fission products and transuranics	0.203	
Liquids		
Uranium and daughters	2.1	Principally from milling – included in tailings liquor and returned to ground – no effluents; therefore, no effect on environment
Ra-226	0.0034	From UF_6 production
Th-230	0.0015	
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
Fission and activation products	5.9×10^{-6}	
Solids (buried onsite)		
Other than high level (shallow)	11,300	9100 Ci 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 from conversion and spent-fuel storage. No significant effluent to the environment.

Table 6.1. (contd)

Environmental Considerations	Total	Maximum Effect Per Annual Fuel Requirement or Reference Reactor-Year of Model 1000-MW(e) LWR
Effluents–Radiological (Curies) (contd)		
TRU and HLW (deep)	1.1 x 10^{7}	Buried at Federal repository
Effluents—thermal (billions of British thermal units)	4063	Less than 5 percent of model 1000-MW(e) LWR
Transportation (person-rem)		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management

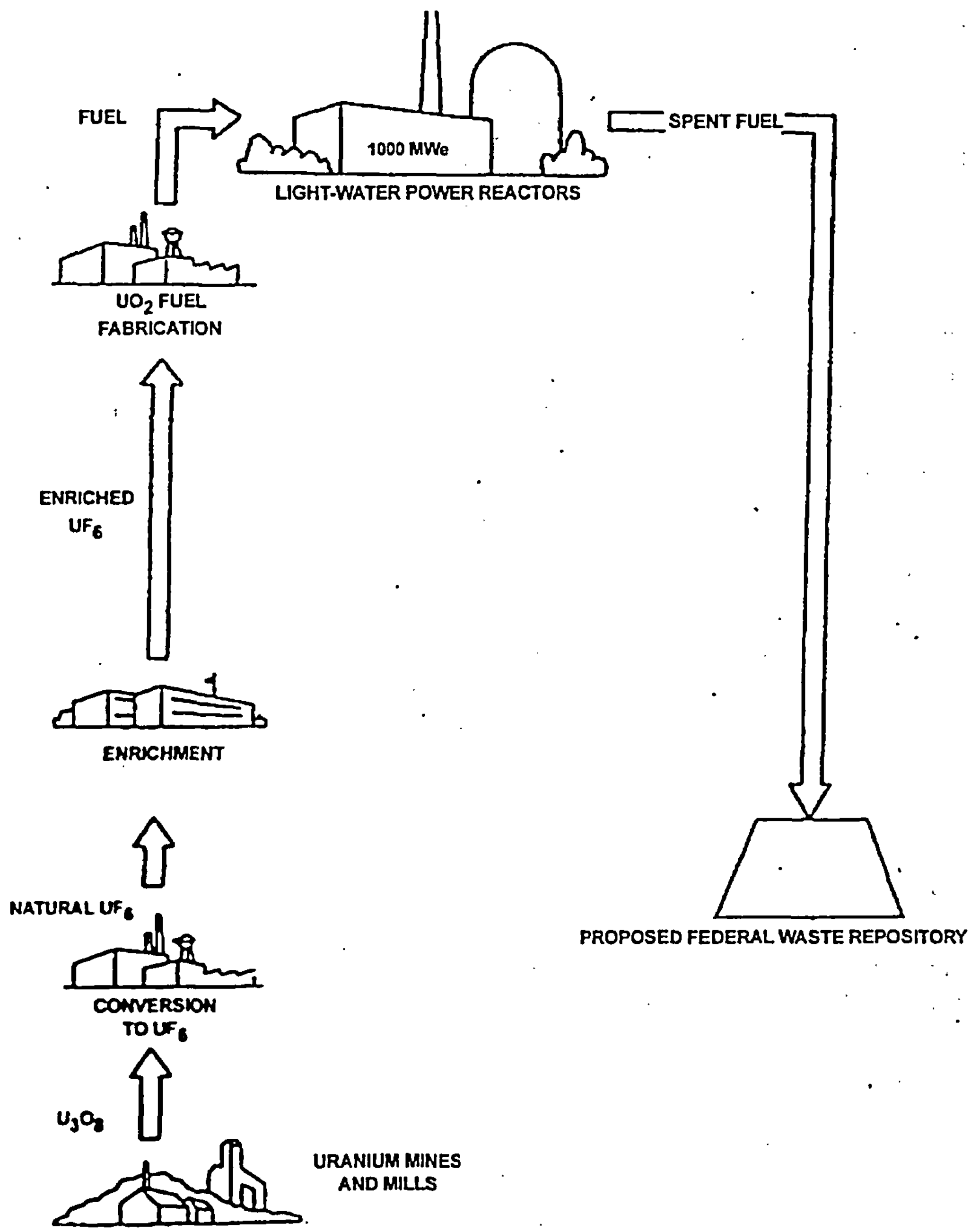
(a) In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the table. Table S–3 does not include health effects from the effluents described in the table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium-99 released from waste-management or reprocessing activities. These issues may be the subject of litigation in the individual licensing procedures.

Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248 [NRC 1977b]); and in the record of the final rulemaking pertaining to *Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management*, Docket RM-50-3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor, which are considered in Table S–4 of §51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

(b) The contributions to temporarily committed land from reprocessing are not prorated over 30 years because the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

(c) Estimated effluents based upon combustion of equivalent coal for power generation.

(d) 1.2 percent from natural gas use and process.



1 **Figure 6-1.** The Uranium Fuel Cycle: No-Recycle Option (derived from NRC 1999)

6.1.1.1 Land Use

The total annual land requirement for the fuel cycle supporting the 1000-MW(e) LWR-scaled model is about 184 ha (452 ac). Approximately 20 ha (52 ac) are permanently committed land, and 164 ha (400 ac) are temporarily committed. A "temporary" land commitment is a commitment for the life of the specific fuel cycle plant (e.g., 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 and/or decommissioning because decommissioning activities do not result in removal of sufficient radioactive material to meet the limits in 10 CFR Part 20, Subpart E for release of that area for unrestricted use. Of the 164 ha (400 ac) of temporarily committed land, 128 ha (316 ac) are undisturbed and 36 ha (88 ac) are disturbed. In comparison, a coal-fired power plant of 3200-MW(e) capacity using strip-mined coal requires the disturbance of about 324 ha (800 ac) per year for fuel alone. The staff concludes that the impacts on land use to support the 1000-MW(e) LWR-scaled model would be small.

6.1.1.2 Water Use

Principal water-use for the fuel cycle supporting a 1000-MW(e) LWR-scaled model is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Scaling from Table S-3, of the total annual water use of 1.72×10^8 m^3 (4.55×10^{10} gal), about 1.60×10^8 m^3 (4.44×10^{10} gal) are required for the removal of waste heat, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 2.42×10^6 m^3/yr (6.40×10^8 gal/yr) and water discharged to ground (e.g., mine drainage) of about 1.92×10^6 m^3/yr (5.08×10^8 gal/yr).

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4 percent of the 1000-MW(e) LWR-scaled model using once-through cooling. The consumptive water use of 2.42×10^6 m^3/yr (6.40×10^8 gal/yr) is about 2 percent of the 1000-MW(e) LWR-scaled model using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6 percent of the 1000-MW(e) LWR-scaled model using cooling towers. Under this condition, thermal effluents would be negligible. The staff concludes that the impacts on water use for these combinations of thermal loadings and water consumption would be small relative to the water use and thermal discharges of the proposed project.

6.1.1.3 Fossil Fuel Impacts

Electrical energy and process heat are required during various phases of the fuel cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5 percent of the annual electrical power production of the reference 1000-MW(e) LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.4 percent of the electrical output from the scaled model plant. The staff concludes that the fossil fuel impacts from the direct and indirect consumption of electrical energy for fuel cycle operations would be small relative to the net power production of the proposed project.

6.1.1.4 Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents with fuel cycle processes are given in Table S–3 (see Table 6-1) for the reference 1000-MW(e) LWR. The quantities of effluents would be approximately four times greater for the reference 1000-MW(e) LWR scaled model. The principal effluents are SO_x, NO_x, and particulates. Based on data in the Seventh Annual Report of the Council on Environmental Quality, these emissions constitute a small additional atmospheric loading in comparison with these emissions from the stationary fuel combustion and transportation sectors in the United States; that is, about 0.08 percent of the annual national releases for each of these effluents (CEQ 1976).

Liquid chemical effluents produced in fuel cycle processes are related to fuel enrichment and fabrication, and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table S–3 (see Table 6-1) specifies the amount of dilution water required for specific constituents. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel cycle operations will be subject to requirements and limitations set by an appropriate Federal, State, regional, local, or affected Native American tribal regulatory agency.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

The staff determined that the impacts of these chemical effluents would be small.

6.1.1.5 Radioactive Effluents

Radioactive effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle process are set forth in Table S–3 (see Table 6-1). Using these data, the staff has calculated for one year of operation of the

1000-MW(e) LWR-scaled model, the 100-year involuntary environmental dose commitment to the U.S. population from the LWR-supporting fuel cycle. These calculations estimate that the overall involuntary whole body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be approximately 16 person-Sv (1600 person-rem) per year of operation of the 1000-MW(e) LWR-scaled model; this reference reactor year is scaled to reflect the total electric power rating for the site for a year.

The additional involuntary whole body dose commitment to the U.S. population from radioactive liquid effluents due to all fuel cycle operations other than reactor operation would be approximately 8 person-Sv (800 person-rem) per year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is approximately 24 person-Sv (2400 person-rem) (whole body) per reference reactor-year. Using risk estimators of 500 cancer deaths per 10,000 person-Sv (1 million person-rem) (ICRP 1990), the estimated cancer risk would be 1.2 per reference reactor-year ($24 \times 500 \times 10^{-4}$) for the 1000-MW(e) LWR-scaled model.

Currently, the radiological impacts associated with radon-222 and technetium-99 release are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities.

In Section 6.2 of NUREG-1437, the staff estimated the radon-222 releases from mining and milling operation, and from mill tailings for each year of operations of the reference 1000-MW(e) LWR. The estimated releases of radon-222 for the reference reactor year for the 1000-MW(e) LWR-scaled model, or for the total electric power rating for the site for a year, is approximately 20,800 Curies. Of this total, about 78 percent would be from mining, 15 percent from milling operations, 7 percent from inactive tails prior to stabilization. For radon releases from stabilized tailings, the staff assumed that the scaled model would result in an emission of 4 Curies per site year ; i.e. four times the NUREG-1437 estimate for the reference reactor year. Based on the estimated releases of radon-222, the calculated 100-year environmental dose commitment from mining and milling for each site year (assuming the 1000-MW(e) LWR-scaled model) for mining, milling and tailings prior to stabilization would be 5.6 person-Sv (560 person-rem) to the whole body, 144 person-Sv (14,400 person-rem) to the bone, and 116 person-Sv (11,600 person-rem) to the lung. From stabilized tailings piles, the calculated 100-year dose commitment would be 0.1 person-Sv (10 person-rem) to the whole body, 2.8 person-Sv (275 person-rem) to the bone, and 2.3 person-Sv[225 person-rem]) to the lung. Additional insights regarding National policy/resource perspectives regarding institutional controls comparisons with routine radon-222 exposure and risk, and long-term releases from stabilized tailings piles are discussed in NUREG-1437.

Also in NUREG-1437, the staff considered the potential health effects associated with the releases of technetium-99. The estimated releases of technetium-99 for the reference reactor year for the 1000 MW(e) LWR-scaled model, or the total electric power rating for the site for a year is 1.1 $\times 10^9$ Bq (0.03 Ci) from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade and 7.4 $\times 10^8$ Bq (0.02 Ci) into the groundwater from a repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney, although there is a small risk from total-body exposure. Using organ-specific risk estimators, these individuals organ risks can be converted to a total-body 100-year dose commitment of 4 person-Sv (400 person-rem) for the 1000 MW(e) LWR-scaled model.

While the consideration of risks to large populations over long periods of time from exposures to very low concentrations of radionuclides involves many uncertainties, for discussion purposes, the linear no-threshold assumption continues to be used to calculate potential health effects where the NRC analyzes the impacts and potential impacts of activities under consideration. The issue of estimating risks from radon and daughters at levels comparable to those found in homes continues to be studied and have had conflicting results. Radon releases from tailings are undetectable from background levels at a few km from the tailings pile, or less than one km in some cases (NRC Docket 50-488 1986). Radon released from the tailing piles is a fraction of the background concentration at this range and is similar in magnitude to the natural variability in the background concentration. As reported in NUREG-1437, projecting risks from levels another order of magnitude or more lower involves even greater uncertainties. It is for these reasons that the NRC has taken a precautionary approach to assessing risks to populations from low concentrations of radionuclides and assumes a linear no-threshold relationship. Under the linear no-threshold assumption, small exposures to radiation will result in a small increase in the chance of developing cancer and as the exposure changes, the increase in cancer probability will change in a linear fashion.

These calculations use the concept of collective doses. Collective dose estimates the health effects across a very large population, assuming that a small amount of radiation dose spread out among a large population would yield similar effects to a larger amount of radiation dose to a much smaller population. This is a conservative assumption. The Health Physics Society, www.hps.org, states "below the dose of 10 rem [0.1 Sv], estimations of adverse health effect is [sic] speculative. Collective dose remains a useful index for quantifying dose in large populations and in comparing the magnitude of exposure from different radiations sources. However, for a population in which all individuals receive lifetime doses of less than 10 rem [0.1 Sv] above background collective dose is a highly speculative and uncertain measure of risk and should not be quantified for the purpose of estimating population health risks."

While a human carcinogen, radiation is a relatively weak inducer of cancer. The cancer risk factors, used in this analysis, are from the BEIR-V report, "Health Effects of Exposure to Low Levels of Ionizing Radiation" (National Research Council 1990). In this report, it is estimated that "if 100,000 persons of all ages received a whole body dose of 0.1 Gy (10 rad) [roughly equivalent to 10 rem] of gamma radiation in a single brief exposure, about 800 extra cancer deaths would be expected to occur during their remaining lifetimes in addition to the nearly 20,000 cancer deaths that would occur in the absence of radiation." Therefore, even with a large exposure (i.e., twice the annual dose limit for workers), the cancer mortality would change by less than a percentage point (i.e., from 20% to 20.8%). It is important to note that for a member of the public, it is nearly impossible to be exposed to 10 mSv (10 rem) in a lifetime from normal operations. The public dose limit is 1 mSv (100 mrem) per year, but most NRC power reactor licensees have air effluents resulting in doses of less than 0.01 mSv (1 mrem) per year (61 FR 65120).

The radiation dose to an individual is only a very small fraction of the radiation dose contribution to the population from the complete uranium fuel cycle. The contribution to the average dose received by an individual from the fuel cycle-related radiation and other sources is listed in the following table. The nuclear fuel cycle contribution to an individual's average radiation dose as shown in the Table 6-2 is extremely small (less than 0.00001 Sv [0.001 rem] per year).For the reasons stated above, the staff concludes that the environmental impacts of radioactive effluents from the fuel cycle are small.

Table 6-2. Comparison of Annual Average of Dose Received by an Individual from All Sources.

	Source	Dose (mrem/yr)[(a)]	Percent of Total
Natural			
	Radon	200	55
	Cosmic	27	8
	Terrestrial	28	8
	Internal (body)	39	11
	Total Natural	300	82
Artificial			
	Medical x-ray	39	11
	Nuclear medicine	14	4
	Consumer products	10	3
	Total Artificial	63	18

Table 6-2. (contd)

Source	Dose (mrem/yr)[a]	Percent of Total
Other		
Occupational	0.9	<0.30
Nuclear Fuel Cycle	<1	<0.03
Fallout	<1	<0.03
Miscellaneous	<1	<0.03

(a) to convert mrem to mSv, divide the number of mrem by 100.

6.1.1.6 Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S–3 (see Table 6-1). For low-level waste disposal at land burial facilities, the Commission notes in Table S–3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a repository, such as the candidate repository at Yucca Mountain, and that no release to the environment is expected to be associated with such disposal, although it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere before the disposal of the waste. NUREG-0116 (NRC 1976), which provides background and context for the high-level and transuranic Table S–3 values established by the Commission, indicates that these high-level and transuranic wastes will be buried and will not be released to the environment.

On February 15, 2002, subsequent to receipt of a recommendation by Secretary Abraham, U.S. Department of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste.

The Environmental Protection Agency (EPA) developed Yucca Mountain-specific repository standards which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion, issued July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated EPA's radiation protection standards for the candidate repository, which required compliance with certain dose limits over a 10,000 year period. The Court's decision also vacated the compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63.

Therefore, for the high-level waste and spent fuel disposal component of the fuel cycle, there is some uncertainty with respect to regulatory limits for offsite releases of radioactive nuclides for the current candidate repository site. However, prior to promulgation of the affected provisions of the Commission's regulations, we assumed that limits 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 Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem [1mSv] per year or less. (NRC 1996)

Despite the current uncertainty with respect to these rules, some judgment as to the regulatory NEPA implications of offsite radiological impacts of spent fuel and high-level waste disposal should be made. The staff concludes that these impacts are acceptable in that the impacts would not be sufficiently large to require the NEPA conclusion that the construction and operation of new units at the North Anna ESP site should be prohibited.

Section 6.2 of NUREG-1437 (NRC 1996), describes the generation, storage, and ultimate disposal of low-level waste, mixed waste, and spent fuel from power reactors. For the reasons stated above, the staff concludes that the environmental impacts of radioactive waste disposal are small.

6.1.1.7 Occupational Dose

In the review and evaluation of the environmental impacts of the fuel cycle, the staff considered the higher capacity factor in the PPE of 96 percent with a total net electrical output of 3200 MW(e) for the ESP site (Dominion 2004a). This is referred to as the 1000-MW(e) LWR-scaled model. The annual occupational dose attributable to all phases of the fuel cycle for the 1000-MW(e) LWR-scaled model is about 24 person-Sv (2400 person-rem). Occupational doses would be maintained to meet 10 CFR Part 20. On this basis, the staff concludes that environmental impacts from this occupational dose would be small.

6.1.1.8 Transportation

The transportation dose to workers and the public totals about 0.25 person-Sv (25 person-rem) annually for the reference 1000-MW(e) LWR per Table S–3 (see Table 6-1). This corresponds to dose of 1.0 person-Sv (100 person-rem) for the 1000-MW(e) LWR-scaled model. For comparative purposes, the estimated collective dose from natural background radiation to the population within 80 km (50 mi) of the ESP site is 9200 person-Sv/yr (920,000 person-rem/yr) (Dominion 2004a). On this basis, the staff concludes that environmental impacts of transportation would be small.

6.1.1.9 Conclusion

The staff evaluated the environmental impacts of the uranium fuel cycle as given in Table S–3 (see Table 6-1) considered the effects of radon-222 and technetium-99; and appropriately scaled for the 1000-MW(e) LWR-scaled model and determined that the impacts would be small, and mitigation is not warranted.

6.1.2 Gas-Cooled Reactors

Table S–3 from 10 CFR 51.51(a) can be used as a basis for bounding the environmental impacts from the uranium fuel cycle only for LWRs. Dominion performed an assessment of the environmental impacts of the fuel cycle for gas-cooled reactor designs by comparing key parameters for these reactor designs to those used to generate the impacts in Table S–3 (Dominion 2004a). Key parameters are energy usage, material involved, and number of shipments for each major fuel cycle activity (i.e., mining, milling, conversion, enrichment, fuel fabrication, and radioactive waste disposal). Dominion sought to demonstrate in the ER that the impacts for the gas-cooled reactor designs were comparable to the environmental impacts identified in the technical basis document, WASH-1248, "Environmental Summary of the Uranium Fuel Cycle," and its Supplement 1 (NUREG-0116) for Table S–3.

As discussed in Section 6.1, the fuel cycle impacts in Table S-3 were based on a reference 1000 MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). This is termed the "reference reactor year." For the purposes of evaluating fuel cycle impacts for the NAPS ESP site, it was assumed that the additional LWR's site-wide fuel impacts would be based on a total net electric output of 3200 MW(e) at 96 percent annual capacity factor. This was termed the 1000 MW(e) LWR-scaled model and resulted in a factor four times (i.e., 3200/800) the impacts in Table S-3.

One of the other-than-LWR's considered by Dominion, the GT-MHR, is a four module 2400-MW(t), nominal 1140-MW(e) unit assumed to operate at an annual capacity factor of 88 percent for a net electric output of 1032 MW(e). Therefore, the maximum number of GT-MHR units that could be sited at the NAPS ESP site and remain below the 3200 MW(e) total net electric output for the site is three (i.e., 3 x 1032) and it would result in a similar factor of four (i.e., 3096/800) for comparison with Table S-3 and LWRs.

The second other-than-LWR considered by Dominion, the PBMR, is an eight module, 3200 MW(t), nominal 1320 MW(e) unit assumed to operate at an annual capacity factor of 95 percent for a net electric output of 1253 MW(e). Therefore, the comparable number of PBMR units to remain below the 3200 MW(e) total net electric output for the site is two (i.e., 2 x 1253) and it would result in about a factor of three (i.e., 2506/800) for comparison with Table S-3 and LWRs.

Dominion (2004a) compared the impacts between the Table S-3 LWR to the gas-cooled reactor designs. The comparison used an annual fuel loading as a starting point and then proceeded in reverse direction through the fuel cycle (i.e., fuel fabrication, enrichment, conversion, milling, mining, radioactive waste). Table 6-3 provides an estimate of the impacts for each phase of the uranium fuel cycle assuming that the NAPS ESP site would host 3 GT-MHR units or 2 PBMR units with the multiplier factors described above.

Table 6-3. Fuel Cycle Environmental Impacts from Gas-Cooled Reactor Designs for the North Anna ESP Site[(a)]

Reactor Technology Facility/Activity	GT-MHR (4 Modules) (2400 MW[t] total) (≈1140 MW[e] total) 88 percent Capacity: Multiplier=4	PBMR (8 Modules) (3200 MW[t] total) (~1320 MW[e] total) 95 percent Capacity: Multiplier=3
Mining Operations		
Annual ore supply (Million MT)	1.35	1.01
Milling Operations		
Annual yellowcake (MT)	1200	900
UF_6 Production		
Annual UF_6 (MT)	1520	1140
Enrichment Operations		
Enriched UF_6 (MT)	32	37
Annual separative work unit (SWU) (MT)	800	600
Fuel Fabrication Plant Operations		
Enriched UO_2 (MT)	25	30
Annual fuel loading (MTU)	22	25
Solid Radioactive Waste		
Annual LLW from reactor operations (Ci)	4400 Ci[(b)] ; 400m^3	200 Ci[(b)]; 2400 drums
LLW from reactor decontamination and decommissioning Ci per reference reactor-year	Data not available	Data not available

(a) Values calculated by multiplying values from Table 5.7-1 of ER (Dominion 2004a) by multiplier.
(b) To convert from curies to becquerels, multiply by 3.7×10^{10} Bq/Ci.

Table 6-3. (contd)

References: 10 CFR 51.51(a), Table S–3 Table of Uranium Fuel Cycle Environmental Data

Notes:
1. The enrichment SWU calculation was performed using the United States Enrichment Corporation, Inc. (USEC) SWU calculator and assumes a 0.30 percent tails assay.
2. The information on the reference reactor (mining, milling, UF_6, enrichment, fuel fabrication values) taken from NUREG-0116, Table 3.2, no recycling.
3. The information on the reference reactor (solid radioactive waste) taken from 10 CFR 51.51, Table S–3.
4. The calculated information on the reference reactor uses the same methodology as for the reactor technologies.
5. The normalized information is based on 1000 MW(e) and the reactor vendor-supplied unit capacity factor.
6. For the new reactor technologies, the annual fuel loading was provided by the reactor vendor.
7. The USEC SWU calculator also calculated the kgs of U feed. This number was multiplied by 1.48 to get the necessary amount of UF_6.
8. The annual yellowcake number was generated using the relationship 2.61285 lb. of U_3O_8 to 1 kg U of UF_6; 1.185 kgs of U_3O_8 to 1.48 kg.
9. The annual ore supply was generated assuming an 0.1% ore body and a 90% recovery efficiency.
10. Co-60 with a 5.26 year half-life and Fe-55 with a 2.73 year half-life are the main nuclides listed for the PBMR D&D waste.

6.1.2.1 Fuel Fabrication

The quantity of UO_2 required for reactor fuel is a key parameter. The more UO_2 required, the greater the environmental impacts (i.e., more energy, greater emissions, and increased water usage). The 1000-MW(e) LWR scaled model described in Section 6.1.1 would require the equivalent of 160 MT of enriched UO_2 annually. This compares to 25 to 30 MT of enriched UO_2 annually for the gas-cooled reactor technologies.

GT-MHR fuel consists of microspheres of uranium oxycarbide (UCO) coated with multiple layers of pryrocarbon and silicon carbide referred to as TRISO coating. Two types of microspheres are used in the GT-MHR fuel, one enriched to 19.8 percent U-235 and one with natural uranium. The microspheres and graphite shims are bound together into a rod-shaped compact, which is stacked into graphite blocks referred to as fuel elements. A reactor core consists of 1020 fuel elements.

PBMR fuel consists of UO_2 kernels (enriched to 12.9 percent U-235) that are TRISO coated, similar to the GT-MHR fuel. The TRISO-coated particles are imbedded into a graphite matrix to form a fuel sphere that is 60 mm in diameter. Each fuel sphere contains approximately 15,000 TRISO-coated particles. Approximately 260,000 fuel spheres make up a core of a single reactor module.

The fuel described above for gas-cooled reactors are fabricated differently than fuel for LWRs. There are no currently operating large-scale fuel fabrication facilities producing gas-cooled reactor fuels in the United States, so a direct comparison of environmental impacts is not possible. Based on some environmental impacts from a small-scale fuel fabrication facility producing gas-cooled reactor fuel, Dominion concluded that the environmental impacts from producing gas-cooled reactor fuel would be "not inconsistent" with those of LWRs (Dominion 2004a). By comparison with the fuel fabrication impacts for LWR technologies, the staff concludes that the environmental impacts from producing gas-cooled reactor fuel likely would be small, but these impacts will need to be assessed at the CP or COL stage, when the staff will consider the environmental data that is available on a large-scale, fuel fabrication facility for gas-cooled reactors.

6.1.2.2 Enrichment

Dominion (2004a) identified two quantities of interest for enrichment. These were (1) the amount of energy required to enrich the fuel measured in separative work units (SWUs), and (2) the amount of UF_6 needed. A SWU is a measure of energy required to enrich the fuel. The major environmental impacts for the entire uranium fuel cycle are from the emissions of the fossil fuel plants used to supply energy for the gaseous diffusion plants that enrich the uranium. Enrichment technologies developed since the impacts in Table S-3 (see Table 6-1) were developed and evaluated include the gas centrifuge process that uses 90 percent less energy than the gaseous diffusion process.

To produce 160 MT of enriched UO_2 for the 1000-MW(e) LWR scaled model, the enrichment plant needs to produce about 210 MT of UF_6 which requires over 500 MT of SWUs (Dominion 2004a). For gas-cooled reactor technologies, the needed enriched UF_6 ranged from 32 to 37 MT of UF_6 The amount of energy to produce these quantities of enriched UF_6 for the gas-cooled reactor designs ranged from 600-800 MT of SWU. The upper range is approximately 20 to 60 percent higher than the energy required for the reference LWR. Dominion (2004a) concluded that the large reduction in energy associated with using an alternate enrichment technology (e.g., centrifuge) and its associated environmental impacts would more than offset the increase in SWUs. The staff concludes that, on balance, the environmental impacts of enriching gas-cooled fuels by comparison with the impacts of enriching LWR fuel would likely be small, but these impacts will need to be assessed at the CP or COL stage, when the staff will consider impacts from the enrichment technology in use at that time.

6.1.2.3 Uranium Hexafluoride Production – Conversion

There are two uranium conversion processes: a wet process and a dry process. In NUREG-1437 (NRC 1996a), the NRC stated that environmental releases are small from the conversion facilities compared to the overall fuel cycle impacts and that changing from 100 percent use of one process to 100 percent use of the other would make no significant difference in the overall impacts. Similar conversion technologies would be used today to produce UF_6 as were considered when determining the environmental impacts that were part of Table S–3 of 10 CFR 51.51(a).

The conversion facility would need to produce 1440 MT of UF_6 annually for the reference 1000-MW(e) LWR scaled-model compared to 1140 to 1520 MT of UF_6 for the gas-cooled reactors based on the USEC SWU calculator (Dominion 2004a). The other-than-LWR values are comparable to the amount of UF_6 required for the LWR; therefore, the associated environmental impacts are expected to be comparable. On this basis, the staff concludes that the environmental impacts from producing UF_6 for gas-cooled reactors would be small.

6.1.2.4 Uranium Milling

Annual yellowcake (U_3O_8) production is the metric of interest for uranium milling. Plants required to produce less yellowcake than the reference plant would require less energy, have fewer emissions, and use less water.

The uranium mill for the 1000-MW(e) LWR scaled-model would produce about 1200 MT of yellowcake. The uranium mill for the gas-cooled reactor technologies would need to produce 900 to 1200 MT of yellowcake, which is comparable to the amount of yellowcake needed for the scaled LWR (Dominion 2004a). On this basis, the staff concludes that the environmental impacts from uranium milling for the gas-cooled reactors would be small.

6.1.2.5 Uranium Mining

Annual ore supply is the metric of interest for uranium mining. The less ore mined, the smaller the environmental impacts (i.e., less energy used, fewer emissions, less water usage). For the 1000-MW(e) LWR, scaled-model, 1.09 Million MT of raw ore would be required to produce 1200 MT of yellowcake. For the gas-cooled reactor technologies, the scaled ore requirements ranged from 1.01 to 1.35 Million MT of ore, a range that is comparable to the amount of ore required for the reference 1000-MW(e) scaled-model LWR. For this reason, the staff concludes that the environmental impacts from uranium mining for the gas-cooled reactors would be small.

6.1.2.6 Solid Low-Level Radioactive Waste – Operations

Table S–3 (see Table 6-1) of 10 CFR 51.51(a) states that there are 3.4×10^8 MBq (9100 Ci) of low-level waste generated annually from operations of the reference LWR; the 1000 MW(e) LWR scaled-model would result in 1.3×10^9 MBq (36,400 Ci) of low-level waste annually. Gas-cooled reactor technologies are projected to generate 7.4×10^6 MBq to 1.6×10^8 MBq (200 to 4400 Ci) of low level waste scaled annually, far below the amounts generated by the reference LWR (Dominion 2004a). For this reason, the staff concludes that the environmental impacts from low-level radioactive waste operations for gas-cooled reactors would be small.

6.1.2.7 Solid Low-Level Radioactive Waste – Decontamination and Decommissioning

In Table S–3 (see Table 6-1) the Commission states 5.6 x 10^7 MBq (1500 Ci) per Reference-Reactor Year "...comes from reactor decontamination and decommissioning - buried at land burial facilities." Dominion (2004a) noted that gas-cooled reactor technologies would (1) operate much cleaner than the reference 1000-MW(e) LWR, as evidenced by lower estimates of low-level waste generated and (2) produce less heavy metal radioactive waste due to the higher thermal efficiency and higher fuel burnup. The gas-cooled reactor designs are also more compact than the reference LWR design, which would be expected to result in less decontamination and decommissioning waste (Dominion 2004a). Dominion concluded that low-level waste impact from decontamination and decommissioning are expected to be comparable to or less than that of the reference LWR (Dominion 2004a). On this basis, the staff concludes that the environmental impacts from solid low-level radioactive waste generated during decontamination and decommissioning for gas-cooled reactors would likely be small, but these impacts will need to be assessed again at the CP or COL stage.

6.1.2.8 Conclusions

The staff concludes that the environmental impacts from the uranium fuel cycle activities and solid waste management activities for the proposed gas-cooled reactors would be SMALL. However, because of the uncertainty in the final design of the gas cooled reactors and the change in technology that could be applied to uranium fuel cycle activities additional reviews would be needed at the CP or COL stage in the following areas: fuel fabrication, enrichment, and solid low-level waste operation during decontamination and decommissioning.

6.2 Transportation of Radioactive Materials

This section addresses both the radiological and nonradiological environmental impacts from normal operating and accident conditions resulting from (1) shipment of unirradiated fuel to the NAPS ESP site, (2) shipment of spent fuel to a monitored retrievable storage facility or a permanent repository, and (3) shipment of low-level radioactive waste and mixed waste to offsite disposal facilities. Distinctions between transportation impacts of advanced LWR (ALWR) designs and gas-cooled reactor designs are discussed.

The NRC evaluated the environmental effects of transportation of fuel and waste for light-water-cooled nuclear power reactors in WASH-1238 (AEC 1972) and NUREG-75/038 (NRC 1975) and found the impact to be small. These documents provided the basis for Table S–4 in 10 CFR 51.52 that summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3000 to 5000 MW[t] (1000 to 1500 MW[e]). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1100-MW(e) LWR.

Dose to transportation workers during normal transportation operations was estimated to result in a collective dose of 0.04 person-Sv (4 person-rem) per reference reactor- year. Dose to the public along the route and dose to onlookers both were estimated to result in a collective dose of 0.03 person-Sv (3 person-rem) per reference reactor-year. Doses to the public during accident conditions were determined to be small. Nonradiological impacts during accident conditions were estimated as one fatal injury in 100 reactor years and one nonfatal injury in 10 reference reactor-years. Subsequent reviews of transportation impacts in NUREG-0170 (NRC 1977a) and Sprung et al. (2000) concluded that impacts were bounded by Table S–4.

In accordance with 10 CFR 51.52(a), a full description and detailed analysis of transportation impacts is not required when licensing an LWR (i.e., impacts are assumed bounded by Table S–4) if an LWR meets the following criteria:

- The reactor has a core thermal power level not exceeding 3800 megawatts.

- Fuel is in the form of sintered UO_2 pellets having a U-235 enrichment not exceeding 4 percent by weight; and pellets are encapsulated in zirconium-clad fuel rods.

- Average level of irradiation of the fuel from the reactor does not exceed 33,000 MWd/MT, and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor.

- With the exception of irradiated fuel, all radioactive waste shipped from the reactor is packaged and in solid form.

- Unirradiated fuel is shipped to the reactor by truck; irradiated fuel is shipped from the reactor by truck, rail, or barge; and radioactive waste other than irradiated fuel is shipped from the reactor by truck or rail.

The environmental impacts of the transportation of fuel and radioactive wastes to and from nuclear power facilities were resolved generically in 10 CFR 51.52, provided that the specific conditions in the rule (see above) are met; if not, then a full description and detailed analysis is required for initial licensing. Once licensed, the NRC may consider requests to operate at conditions above those in the facility's licensing basis; for example, higher burnups, enrichments, or thermal power levels above 33,000 MWd/MTU, 4 percent, and 3800 MW(t), respectively. The rule has not been changed for the initial licensing of nuclear power facilities, and departures from the conditions itemized in the rule that were found to be acceptable for licensed facilities cannot serve as the basis for initial licensing.

Dominion has not identified a specific reactor design for the NAPS ESP but used bounding parameters from seven reactor designs. Five of the designs are LWRs, and include the ACR-700 (3964 MW[t]/unit); the ABWR (4300 MW[t]/unit); the AP1000 (3400 MW[t]/unit); the

ESBWR (4000 MW[t]/unit), and the IRIS (3000 MW[t]/unit). For the ACR-700 reactor design, two reactors make up a unit. For the IRIS design, three reactors (modules) make up a unit. For the remaining LWR designs, one reactor makes up a unit. None of the proposed LWR designs meets all the conditions in 10 CFR 51.52(a); therefore, a full description and detailed analysis are required for each LWR design. This conclusion is based on the following:

- The ACR-700, ABWR, and ESBWR designs exceed the 3800 MW(t) core thermal power level.

- The ABWR, AP1000, ESBWR, and IRIS designs require fuel that exceeds the U-235 enrichment of 4 percent.

- The ABWR, AP1000, ESBWR, and IRIS designs are expected to exceed the average irradiation level of 33,000 MWd/MTU.

The remaining two designs are gas-cooled reactors: the GT-MHR and the PBMR. Each GT-MHR unit is a four-module, 2400-MW(t), 1140-MW(e) gas-cooled reactor designed to operate at a unit capacity factor of 88 percent. Each PBMR is an eight-module, 3200-MW(t), 1320-MW(e) gas-cooled reactor designed to operate at a unit capacity factor of 95 percent. This compares to the reference reactor in WASH-1238 (AEC 1972), which is a single-unit, 1100-MW(e) LWR with a unit capacity factor of 80 percent. The gas-cooled reactor designs do not meet the conditions in 10 CFR 51.52 because these reactors are not LWR designs upon which Table S–4 impacts were based. Therefore, a full description and detailed analysis was required for each gas-cooled reactor design. This was provided by Dominion in its response to a request for additional information on July 12, 2004 (Dominion 2004b).

Dominion used a sensitivity analysis to show that transportation impacts from ALWR designs would be bounded by the criteria identified in Table S–4 (Dominion 2004a). NUREG-1437, Addendum 1, (NRC 1999) was referenced as the basis for exceeding 4 percent U-235 enrichment and 33,000 MWd/MTU. However, as discussed above, NUREG-1437, Addendum 1, applies to reactors that are listed in NUREG-1437, Appendix A and not to any other reactor designs.

Dominion also used a sensitivity analysis to show that transportation impacts from the advanced gas-cooled reactor designs would be bounded by the criteria identified in Table S–4 (Dominion 2004a); however, as discussed previously, this type of analysis does not adequately meet the requirements of 10 CFR 51.52. Dominion (2004a) identified the major contributors to transportation risk to be the number and type of shipment (shipment risk) and the kind of material being shipped (material risk). Their evaluation of shipment risk showed fewer shipments of unirradiated fuel, spent fuel, and low-level waste would be required for the advanced gas-cooled reactors compared to the reference LWR when averaged over 40 years of operation. Regarding material risk, Dominion (2004) concluded the following:

- The estimated total spent fuel radioactive inventory and fission product inventory was less for the gas-cooled reactors when compared to the reference LWR.
- Actinide inventories would be greater for the gas-cooled reactors (55 to 65 percent greater) due to the increased burnup rate for these types of reactors; however, actinides are not major contributors to dose during transportation accidents.
- Gas-cooled reactors would generate fewer kilowatts of decay heat per MTU and fewer kilowatts of decay heat per truck cask at the time of shipment.

6.2.1 Transportation of Unirradiated Fuel

The staff performed an independent review of the environmental impacts of transporting unirradiated (fresh) fuel to the proposed ESP site at NAPS. Environmental impacts of normal operating conditions and transportation accidents are discussed in this section. Appendix G provides the details of the analysis.

6.2.1.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities in which shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments would be from the low levels of radiation that penetrate the unirradiated fuel shipping casks.

Truck Shipments

Table 6-4 provides an estimate of the number of truck shipments of unirradiated fuel for each advanced reactor design compared to those of the reference 1100-MW(e) reactor specified in WASH-1238 (AEC 1972). Estimates are normalized for an equivalent 1100-MW(e) electric generating capacity. The basis for the shipment estimates can be found in Appendix G of this draft EIS. Only the ACR-700, PBMR, and GT-MHR reactor designs exceeded the number of truck shipments of unirradiated fuel estimated for the reference LWR in WASH-1238. The largest number of shipments, in excess of 700 shipments over 40 years, is for the PBMR. However, this equates to far less than the one truck shipment per day condition specified in Table S–4 of 10 CFR 51.52.

Table 6-4. Numbers of Truck Shipments of Unirradiated Fuel for Each Advanced Reactor Type

Reactor Type	Number of Shipments per Reactor Site			Site Electric Generation, MW(e)[c]	Capacity Factor[c]	Normalized, Shipments per 1,100 MW(e)[d,e]
	Initial Core[a]	Annual Reload	Total[b]			
Reference LWR (WASH-1238)	18	6	252	1100	0.8	252
ABWR/ESBWR[d,e]	30	6.1	267	1500	0.95	165
AP1000	14	3.8	161	1150	0.95	130
ACR-700	15	7.7	314	731	0.9	420
IRIS	34	4.3	201	1005[f]	0.96	184
GT-MHR	51	20	831	1140[g]	0.88	729
PBMR	44	20	824	1320[h]	0.95	579

NOTE: The reference LWR shipment values have all been normalized to 880 MW(e) net electrical generation.
(a) Shipments of the initial core have been rounded up to the next highest whole number.
(b) Total shipments of fresh fuel over a 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).
(c) Unit capacities and capacity factors were taken from INEEL (2003).
(d) Normalized to net electric output for WASH-1238 reference LWR (i.e., 1100 MW(e) plant at 80 percent or net electrical output of 880 MW(e)).
(e) Ranges of capacities are given in INEEL (2003) for these reactor fresh fuel shipments. The fresh fuel shipment data for these reactors were derived using the upper limit of the ranges.
(f) The IRIS site includes three units at 335 MW(e) per unit.
(g) The GT-MHR site includes four reactor units at 285 MW(e) per unit.
(h) The PBMR site includes eight reactor units at 165 MW(e) per unit.

Shipping Mode and Weight Limits

In 10 CFR 51.52 a condition is identified that states all unirradiated fuel is shipped to the reactor by truck. In information provided by Dominion, the applicant specifies that unirradiated fuel will be shipped to the reactor site by truck for all reactor designs that it references (INEEL 2003). 10 CFR 51.52 includes a requirement that the truck shipments not exceed 33,100 kg (73,000 lbs) as governed by Federal or State gross vehicle weight restrictions. All the advanced reactor designs would meet this weight restriction for unirradiated fuel (INEEL 2003).

Radiological Doses to Transport Workers and The Public

10 CFR 51.52, Table S–4, includes conditions related to radiological dose to transport workers and members of the public along transport routes. These doses are a function of many variables, including the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time in transit (including travel and stop times), and number of shipments to which the individuals are exposed. For this draft EIS, the radiological dose impacts of the transportation of unirradiated fuel were calculated for the worker and the public using the RADTRAN 5 computer code (Neuhauser et al. 2003). Details of the calculations are found in Appendix G.

Table 6-5 presents the radiological impacts to workers, onlookers (members of the public), and members of the public (along the route) for the advanced reactor designs. The cumulative annual dose estimates were normalized to 1100 MW(e). The staff performed an independent review and determined that all dose estimates are bounded by the Table S–4 conditions of 0.04 person-Sv/yr (4 person-rem/yr) to transportation workers, 0.03 person-Sv/yr (3 person-rem/yr) to onlookers, and 0.03 person-Sv/yr (3 person-rem/yr) to members of the public along the route.

Table 6-5. Radiological Impacts of Transporting Unirradiated Fuel to Advanced Reactor Sites

Plant Type	Normalized Average Annual Shipments	Cumulative Annual Dose; person-Sv/yr per 1,100 MW(e)[a]		
		Workers	Public - Onlookers	Public - Along Route
Reference LWR (WASH-1238)	6.1	1.1×10^{-4}	4.2×10^{-4}	1.0×10^{-5}
ABWR/ESBWR	4.2	7.1×10^{-5}	2.7×10^{-4}	6.6×10^{-6}
AP1000	3.3	5.6×10^{-5}	2.2×10^{-4}	5.2×10^{-6}
ACR-700	10.5	1.8×10^{-4}	7.0×10^{-4}	1.7×10^{-5}
IRIS	4.6	7.9×10^{-5}	3.1×10^{-4}	7.4×10^{-6}
GT-MHR	18.2	3.1×10^{-4}	1.2×10^{-3}	2.9×10^{-5}
PBMR	14.5	2.5×10^{-4}	9.6×10^{-4}	2.3×10^{-5}
10 CFR 51.52, Table S–4 Condition	<1 per day	4.0×10^{-2}	3.0×10^{-2}	3×10^{-2}

(a) Multiply person-Sv/yr times 100 to obtain doses in person-rem/yr.

6.2.1.2 Accidents

Accident risks are a combination of accident frequency and consequence. Accident frequencies for transportation of fuel to and from future reactors are expected to be lower that those used in the analysis in WASH-1238 (AEC 1972), which forms the basis for Table S–4 of 10 CFR 51.52, because of improvements in highway safety and security, and an expected decrease in traffic accident, injury, and fatality rates. Consequences of accidents that are severe enough to result in a release of unirradiated fuel particles to the environment are not significantly different for ALWRs from current generation LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238. Consequently, the impacts of accidents during transport of unirradiated fuel for ALWRs to the North Anna ESP site are expected to be smaller than the impacts listed in Table S–4 for current generation LWRs.

With respect to the advanced gas-cooled reactors, accident rates (accidents per unit distance) and associated accident frequencies (accidents per year) would be expected to follow the same trends as for LWRs (i.e., overall reduction relative to the accident rates used in the WASH-1238 analysis). The consequences of accidents involving gas-cooled reactor unirradiated fuel, however, are more uncertain. The staff assumed that the gas-cooled reactor unirradiated fuel shipments would have the same abilities as LWR unirradiated fuel to maintain functional integrity following a traffic accident. This assumption is considered to be conservative because gas-cooled reactor fuel operates at significantly higher temperatures, and thus maintains integrity under more severe thermal conditions than LWR fuel. Detailed information about the behavior of the gas-cooled reactor fuel under impact conditions was not available. However, packaging systems for unirradiated gas-cooled reactor fuel will be required to meet the same requirements as unirradiated LWR fuel packages. Properly designed and manufactured packaging systems are the most effective means of preventing damage and dispersal of the contained materials under accident conditions. Consequently, it is expected that packaging systems for unirradiated gas-cooled reactor fuels would provide equivalent release (i.e., consequence) prevention and mitigation to those designed for unirradiated LWR fuels. In addition, the fuel forms for the gas-cooled reactors are similar to LWRs (i.e., UO_2 for the PBMR and uranium oxycarbide for the GT-MHR versus UO_2 for LWRs), so the failure resistance provided by unirradiated gas-cooled reactor fuels should not be significantly lower than LWRs. Based on the assumption that unirradiated gas-cooled and LWR fuels and associated packaging systems would provide equivalent resistance to thermal and impact conditions, the staff concludes that the impacts of accidents involving unirradiated gas-cooled reactor fuel would not be significantly different than for LWR unirradiated fuel and will be within the impacts listed in Table S–4 for current generation LWRs. However, these impacts will need to be assessed at the CP or COL stage when specific information is available regarding other-than-LWR fuel performance, if the applicant references such designs.

6.2.2 Transportation of Spent Fuel

The staff performed an independent review of the environmental impacts of transporting spent fuel from the proposed North Anna ESP site to a spent fuel disposal repository. The Yucca Mountain, Nevada, location is a possible location for a geologic repository. The staff considers that an estimate of the impacts of the transportation of spent fuel to a possible repository in Nevada to be a reasonable bounding estimate of the transportation impacts to a monitored retrievable storage facility because of the distances involved and the representative exposure of members of the public in urban, suburban, and rural areas. Environmental impacts of normal operating conditions and transportation accidents are discussed in this section.

This analysis is based on shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in the evaluation of the environmental impacts of transportation of spent fuel in Addendum 1 to NUREG-1437 (NRC 1999). These assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks, which would reduce the overall number of spent fuel shipments (NRC 1999).

Environmental impacts of transportation of spent fuel were calculated using the RADTRAN 5 computer code (Neuhauser et al. 2003). Routing and population data used in the RADTRAN 5 for truck shipments were obtained from the TRAGIS routing code (Johnson and Michelbaugh 2000). The population data in the TRAGIS code are based on the 2000 census.

The staff's evaluation reviewed the impacts of spent fuel shipments originating from the primary ESP location (i.e., the NAPS site) and the alternative sites (Surry Power Station [Surry], Portsmouth Gaseous Diffusion Plant [Portsmouth], and Savannah River Site). Appendix G provides the details of the analysis.

6.2.2.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities in which shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments would be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation doses will occur to (1) persons residing along the transportation corridors between the ESP site and the proposed repository; (2) persons in vehicles passing a spent-fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers.

Shipping casks have not been designed for the advanced reactor designs. Information in INEEL (2003) indicated that ALWR fuel designs would not be significantly different from existing

LWR designs; therefore, current shipping cask designs were used for the analysis for ALWR designs. No information is available on spent fuel shipping cask designs for the gas-cooled reactor designs. For purposes of this analysis, their design was assumed to be the same as those for the existing LWRs. Spent fuel shipping cask designs for gas-cooled reactor designs will be evaluated at the CP or COL stage if the applicant references such designs.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate at 1 m from the vehicle, packaging dimensions, number in the truck crew, stop time, and population density at stops. For a listing of the values for these and other parameters, refer to Appendix G. Table 6-6 presents radiation dose estimates to the transport workers and the public for the primary and alternative ESP sites. Doses are presented on a per-shipment basis. The per-shipment dose estimates are independent of reactor technology because they were calculated based on an assumed external radiation dose rate emitted from the cask, which was fixed at the regulatory maximum limit for the advanced reactor designs (i.e., 10 mrem/h at 2 m).

Table 6-6. Routine (Incident-Free) Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from Potential Early Site Permit Sites to a Spent Fuel Disposal Facility

	Population Dose, person-Sv/shipment[a]		
ESP Site	**Crew**	**Onlookers**	**Along Route**
North Anna	1.0×10^{-3}	3.5×10^{-3}	9.2×10^{-5}
Portsmouth	9.1×10^{-4}	3.2×10^{-3}	7.3×10^{-5}
Savannah River Site	9.9×10^{-4}	3.5×10^{-3}	1.0×10^{-4}
Surry	1.1×10^{-3}	3.5×10^{-3}	9.7×10^{-5}

(a) Multiply person-Sv/yr times 100 to obtain doses in person-rem/yr.

Population dose estimates per reactor-year are presented in Table 6-7 for specific advanced reactor designs. Population doses were calculated by multiplying the number of spent fuel shipments per year for each advanced reactor design times the dose per shipment from Table 6-6. Population doses were normalized to the reference LWR design in WASH-1238 (880 net MW[e]). This corresponds to an 1100-MW(e) LWR operating at 80 percent capacity. Appendix G provides the basis upon which the number of spent fuel shipments were derived for each advanced reactor design.

Table 6-7. Routine (Incident-Free) Population Doses from Spent Fuel Transportation, Normalized to Reference Light-Water Reactors

Reactor Type	Reference LWR (WASH-1238)			ABWR/ESBWR			AP1000			ACR-700		
Shipments per Year	60			41			40			90		
Environmental Effects, person-Sv per reactor-year[(a)]												
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
NAPS	0.06	0.21	0.01	0.04	0.14	0	0.04	0.14	0	0.09	0.32	0.01
Portsmouth	0.06	0.19	0	0.04	0.13	0	0.04	0.12	0	0.08	0.28	0.01
Savannah River Site	0.06	0.21	0.01	0.04	0.14	0	0.04	0.14	0	0.09	0.32	0.01
Surry	0.06	0.21	0.01	0.04	0.14	0	0.04	0.14	0	0.1	0.32	0.01

Reactor Type	IRIS			GT MHR			PBMR		
Shipments per Year	35			34			12		
Environmental Effects, person-Sv per Reactor-Year									
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
NAPS	0.036	0.12	0.0032	0.034	0.12	0.0031	0.012	0.04	0.001
Portsmouth	0.031	0.11	0.0025	0.03	0.11	0.0024	0.01	0.036	0.00082
Savannah River Site	0.034	0.12	0.0035	0.033	0.12	0.0033	0.011	0.039	0.0011
Surry	0.037	0.12	0.0033	0.0033	0.12	0.0032	0.012	0.04	0.0011

(a) Multiply person-Sv/yr times 100 to obtain doses in person-rem/yr.

The bounding cumulative doses to the exposed population given in Table S–4 are

- 0.04 person-Sv/reactor-year (4 person-rem/reactor-year) to transport workers,
- 0.03 person-Sv/reactor-year (3 person-rem/reactor-year) to general public (onlookers)
- 0.03 person-Sv/reactor-year (3 person-rem/reactor-year) to general public (along route).

Population doses to the crew and the onlookers for all the reactor types including the reference reactor found in Table 6-7, exceed Table S–4 values. Two key reasons for the higher population doses relative to Table S–4 are the higher number of spent fuel shipments estimated for some of the reactor technologies and the longer shipping distances assumed for the analyses (i.e., to a possible repository in Nevada) than were used in WASH-1238. WASH-1238 used a "typical" distance for a spent fuel shipment of 1600 km (1000 mi), whereas the shipping distances used in this assessment ranged from about 3000 km (1800 mi) to 4700 km (2900 mi). The higher numbers of shipments are based on spent fuel shipping casks designed to transport shorter-cooled fuel (i.e., 150 days out of the reactor). It was assumed in this analysis that the shipping cask capacities are 0.5 MTU/shipment, roughly equivalent to one PWR or two BWR spent fuel assemblies per shipment.

Newer designs are based on longer-cooled spent fuel (i.e., 5 years out of reactor) and have larger capacities than those used in this assessment. DOE (2002) spent fuel shipping cask capacities were approximately 1.8 MTU/shipment, or up to four PWR or nine BWR fuel assemblies per shipment. Use of the newer shipping cask designs will reduce the number of spent fuel shipments and the associated environmental impacts. On balance, if the population doses are adjusted for the shipping distance and shipping cask capacity, the routine population doses from spent fuel shipments from all reactor types and all sites fall within Table S–4 requirements.

Other conservative assumptions in the staff's calculation include:

- <u>Use of the regulatory maximum dose rate (0.1 mSv/hr [10 mrem/hr] at 2 m) in the RADTRAN5 calculations</u>. The shipping casks assumed in the EIS prepared in support of the application for a geologic repository at the proposed Yucca Mountain site (DOE 2002b) were designed to transport spent fuel that has cooled for 5 years. In reality, most spent fuel will have cooled for much longer than 5 years before it is shipped to a possible geologic repository. Sprung et al. (2000) 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 to a possible geologic repository will have dose rates less than half of the regulatory limit. Consequently, the estimated population doses in Table 6-7 could be divided in half if more realistic dose rate projections are used.

- <u>Use of 30 minutes as the average time at a truck stop in the calculations</u>. Many stops made for actual spent fuel shipments are short duration stops (i.e., 10 minutes) for brief visual inspections of the cargo (checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area. Furthermore, empirical data provided in Griego et al. (1996) indicates that a 30-minute stop is toward the high end of the stop time distribution. Average stop times observed by Griego et al. (1996) are on the order of 18 minutes. Based on these observations, it was concluded that the stop model assumptions used in this study overestimate public doses at stops by at least a factor of two. Consequently, the doses to onlookers given in Table 6-7 could be reduced by a factor two to reflect more realistic truck shipping conditions.

Dominion performed its own RADTRAN 5 calculations looking at the impact of "incident-free" transport of spent fuel to a spent fuel disposal facility. The assumed transport of spent fuel originated from the Maine Yankee Nuclear Plant (a distance further than NAPS) and terminated at a disposal facility assumed to be at Yucca Mountain, Nevada. Dose estimates per shipment were similar to those calculated by the staff.

6.2.2.2 Accidents

As discussed previously, the staff used the RADTRAN 5 computer code to estimate impacts of transportation accidents involving spent fuel shipments. RADTRAN 5 considers a spectrum of potential transportation accidents, ranging from those with high frequencies and low consequences (e.g., "fender benders") to those with low frequencies and high consequences (i.e., accidents in which the shipping container is exposed to severe mechanical and thermal conditions). Details of the analysis are discussed in Appendix G.

Radionuclide inventories are important parameters in the calculation of accident risks. The radionuclide inventories used in this analysis were from *Early Site Permit Environmental Report Sections and Supporting Documentation* (INEEL 2003). This report included hundreds of radionuclides for each advanced reactor type. A screening analysis was conducted to select the dominant contributors to accident risks to simplify the RADTRAN 5 calculations. The screening identified the radionuclides that would contribute more than 99.999 percent of the dose from inhalation of radionuclides released following a transportation accident. The dominant radionuclides are similar regardless of the fuel type (i.e., ALWR fuel or gas-cooled reactor fuel). Spent fuel inventories used in the staff analysis are presented in Table 6-8. No radionuclide inventory data were presented in INEEL (2003) for the ACR-700 and IRIS advanced reactors; therefore, transportation accident risks were not quantified for these reactor types and would need to be assessed at the CP/COL stage if the applicant referenced either of these designs.

Massive shipping casks are used to transport spent fuel because of the radiation shielding and accident resistance required by 10 CFR Part 71. Spent fuel shipping casks must be certified Type B packaging systems, meaning they must withstand a series of severe hypothetical accident conditions with essentially no loss of containment or shielding capability. According to Sprung et al. (2000), the probability of encountering accident conditions that would lead to shipping cask failure is less than 0.01 percent (i.e., more than 99.99 percent of all accidents would result in no release of radioactive material from the shipping cask). The staff assumed that shipping casks for advanced reactor spent fuels will provide equivalent mechanical and thermal protection of the spent fuel cargo.

Table 6-8. Radionuclide Inventories Used in Transportation Accident Risk Calculations for Each Advanced Reactor Type

Radionuclide	ABWR and ESBWR Inventory, Bq/MTU	AP1000 Inventory, Bq/MTU	GT-MHR Inventory, Bq/MTU	PBMR Inventory, Bq/MTU
Am-241	4.96×10^{13}	2.69×10^{13}	8.18×10^{13}	7.55×10^{13}
Am-242m	1.24×10^{12}	4.85×10^{11}	5.03×10^{11}	8.51×10^{11}
Am-243	1.20×10^{12}	1.24×10^{12}	5.14×10^{11}	4.77×10^{12}
Ce-144	4.22×10^{14}	3.28×10^{14}	2.15×10^{15}	1.19×10^{15}
Cm-242	2.04×10^{12}	1.05×10^{12}	1.51×10^{12}	2.78×10^{12}
Cm-243	1.37×10^{12}	1.14×10^{12}	2.02×10^{11}	1.96×10^{12}
Cm-244	1.80×10^{14}	2.87×10^{14}	2.83×10^{13}	5.48×10^{14}
Cm-245	2.43×10^{10}	4.48×10^{10}	1.65×10^{8}	5.29×10^{10}
Co-60[(a)]	1.01×10^{14}	0	0	0
Cs-134	1.78×10^{15}	1.78×10^{15}	2.21×10^{15}	4.03×10^{15}
Cs-137	4.59×10^{15}	3.44×10^{15}	1.08×10^{16}	1.41×10^{16}
Eu-154	3.81×10^{14}	3.38×10^{14}	3.23×10^{14}	3.74×10^{14}
Eu-155	1.93×10^{14}	1.71×10^{14}	8.77×10^{13}	1.08×10^{14}
Pm-147	1.25×10^{15}	6.51×10^{14}	6.92×10^{15}	5.07×10^{15}
Pu-238	2.27×10^{14}	2.25×10^{14}	1.17×10^{14}	4.55×10^{14}
Pu-239	1.43×10^{13}	9.44×10^{12}	2.25×10^{13}	1.11×10^{13}
Pu-240	2.28×10^{13}	2.01×10^{13}	3.96×10^{13}	3.32×10^{13}
Pu-241	4.51×10^{15}	2.58×10^{15}	8.33×10^{15}	7.18×10^{15}
Pu-242	8.29×10^{10}	6.73×10^{10}	1.56×10^{11}	4.51×10^{11}
Ru-106	6.07×10^{14}	5.74×10^{14}	1.48×10^{15}	1.68×10^{15}
Sr-90	3.27×10^{15}	2.29×10^{15}	8.95×10^{15}	1.08×10^{16}
Y-90	3.27×10^{15}	2.29×10^{15}	8.95×10^{15}	1.08×10^{16}
Sb-125	1.99×10^{14}	1.42×10^{14}	2.21×10^{14}	2.51×10^{14}

(a) Co-60 is an activation product. Only the ABWR/ESBWR submittal in INEEL (2003) provided inventory data for activation products.

The RADTRAN 5 accident risk calculations were performed using unit radionuclide inventories (Bq/MTU) for the spent fuel shipments from the various reactor types. The resulting risk estimates were then multiplied by assumed annual spent fuel shipments (MTU/yr) to derive estimates of the annual accident risks associated with spent fuel shipments from each potential advanced reactor site. As was done for routine exposures, the staff assumed that the numbers of shipments of spent fuel per year are equivalent to the annual discharge quantities.

For this assessment, release fractions for current generation LWR fuels were used to approximate the impacts from the advanced reactor spent fuel shipments. This assumes that the fuel materials and containment systems (i.e., cladding, fuel coatings) behave similarly to current LWR fuel under applied mechanical and thermal conditions. Due to the lack of experimental data on gas-cooled reactor fuels, it is currently not known if this approach is bounding. However, gas-cooled reactors operate at much higher temperatures than LWRs; therefore, high temperature conditions anticipated in transportation accident fires should have less of an effect on radionuclide releases than they do for LWR fuels. Thus, smaller release fractions are anticipated for advanced gas-cooled reactor fuels than for LWR fuels subjected to thermal transients.

RADTRAN 5 calculated the population dose from the released radioactive material for five possible exposure pathways. These pathways are:

(1) external dose from exposure to the passing cloud of radioactive material

(2) external dose from the radionuclides deposited on the ground by the passing plume (the staff's analysis included the radiation exposure from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, thus preventing long-term exposures from this pathway)

(3) internal dose from inhalation of airborne radioactive contaminants

(4) internal dose from resuspension of radioactive materials that were deposited on the ground (the staff's analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures)

(5) internal dose from ingestion of contaminated food (the staff's analysis assumed interdiction of foodstuffs and evacuation after an accident so no internal dose due to ingestion of contaminated foods was calculated).

Table 6-9 presents the environmental consequences of transportation accidents when shipping spent fuel from the North Anna ESP site and alternative sites to a spent fuel repository assumed to be at Yucca Mountain, Nevada. The shipping distances and population distribution information for the routes were the same as those used for the normal "incident-free" conditions (for details, see Appendix G). The table presents estimates of population dose (person-Sv/reactor year), latent cancer fatalities per reactor-year, and total detrimental health effects per reactor year for several of the advanced reactor designs. These values are normalized to the WASH-1238 reference reactor (880-MW[e] net electrical generation, 1100-MW[e] reactor operating at 80 percent capacity). The health-effect conversion factors (i.e., 0.06 latent cancer fatalities per person-Sv and 0.085 total detrimental health effects per person-Sv for workers and the public) were taken from Federal Guidance Report 13 (EPA 2002). Total detriment could includes fatal and non-fatal cancers and severe hereditary effects.

Table 6-9. Annual Spent Fuel Transportation Accident Impacts for Advanced Reactors, Normalized to Reference 1000 – MW(e) LWR Net Electrical Generation

	Advanced Reactor Type			
	ABWR/ESBWR	**AP1000**	**GT-MHR**	**PBMR**
MTU/yr	**20.3**	**19.7**	**6**	**5.8**
Population Dose, person-Sv/yr[a]				
North Anna	4.7×10^{-6}	4.2×10^{-7}	1.9×10^{-7}	3.1×10^{-7}
Portsmouth	5.2×10^{-6}	4.0×10^{-7}	1.8×10^{-7}	3.0×10^{-7}
Savannah River Site	5.3×10^{-6}	4.7×10^{-7}	2.1×10^{-7}	3.5×10^{-7}
Surry	4.8×10^{-6}	4.3×10^{-7}	2.0×10^{-7}	3.2×10^{-7}
Latent Cancer Fatalities per Year				
North Anna	2.8×10^{-7}	2.5×10^{-8}	1.1×10^{-8}	1.9×10^{-8}
Portsmouth	3.1×10^{-7}	2.4×10^{-8}	1.1×10^{-8}	1.8×10^{-8}
Savannah River Site	3.2×10^{-7}	2.8×10^{-8}	1.3×10^{-8}	2.1×10^{-8}
Surry	2.9×10^{-7}	2.6×10^{-8}	1.2×10^{-8}	1.9×10^{-8}
Total Detrimental Health Effects per Year				
North Anna	4.0×10^{-7}	3.6×10^{-8}	1.6×10^{-8}	2.7×10^{-8}
Portsmouth	4.4×10^{-7}	3.4×10^{-8}	1.6×10^{-8}	2.6×10^{-8}
Savannah River Site	4.5×10^{-7}	4.0×10^{-8}	1.8×10^{-8}	3.0×10^{-8}
Surry	4.1×10^{-7}	3.7×10^{-8}	1.7×10^{-8}	2.7×10^{-8}

(a) Multiply person-Sv/yr times 100 to obtain person-rem/yr.

To put health effects in perspective, the staff estimated cancer fatalities to the approximately 725,000 persons that live within 800 m of the route between North Anna ESP site and the proposed Yucca Mountain repository. The 800 m is the distance on either side of the route used by RADTRAN 5 to compute the routine doses to the population along the route. The U.S. Centers for Disease Control and Prevention (NCHS 2004) reported the U.S. cancer mortality rate in 2001 to be 194.4 fatalities per 100,000 persons. Using this rate, the staff calculated about 1400 cancer fatalities per year in the exposed population between the North Anna ESP site and a proposed repository at Yucca Mountain, Nevada. This is many orders of magnitude greater than the accident risk values presented in Table 6-9. Therefore, no detectable increases in environmental effects from spent-fuel transportation accidents are expected as a result of shipping spent fuel from the North Anna ESP site to a spent fuel disposal repository.

6.2.2.3 Conclusion

Considering the uncertainties in the data and computational methods, the staff concludes that the overall transportation accident risks associated with advanced reactor spent fuel shipments are likely to be SMALL and are consistent with the risks associated with transportation of spent fuel from current generation reactors presented in Table S–4 of 10 CFR 51.52. The fuel performance characteristics, shipping casks, and accident risks for other-than-LWR designs would need to be assessed at the CP or COL stage if the applicant references such designs.

6.2.3 Transportation of Radioactive Waste

This section discusses the environmental effects of transporting waste from advanced reactor sites. The environmental conditions listed in 10 CFR 51.52 that apply to shipments of radioactive waste are as follows:

- Radioactive waste (except spent fuel) is packaged in solid form.
- Radioactive waste (except spent fuel) is shipped from the reactor by truck or rail.
- Weight limitation of 33,100 kg (73,000 lb) per truck and 100 tons per cask per railcar.
- Traffic density limitation of less than one truck shipment per day or three railcars per month.

In INEEL (2003), the applicant indicates that all the radioactive waste will be transported by truck, and it plans to solidify and package its waste regardless of which advanced reactor technology it chooses. In addition, waste from any of the advanced reactor technologies will be subject to NRC (10 CFR Part 71) and DOT (49 CFR Parts 173 and 178) regulations for the shipment of radioactive material.

Radioactive waste from any of the advanced reactor technologies are expected to be capable of being shipped in compliance with Federal or State weight restrictions.

Table 6-10 presents estimates of annual waste volumes and annual waste shipment numbers for the advanced reactor types normalized to the reference 1100-MW(e) LWR defined in WASH-1238 (AEC 1972). Annual waste volumes and waste shipments for the advanced reactor technologies were less than the 1100-MW(e) reference reactor that was the basis for Table S–4 for all designs except the PBMR. As shown in the table, only the PBMR would be expected to generate a larger volume of radioactive waste than the reference LWR in WASH-1238. However, the GT-MHR and PBMR information in INEEL (2003) assumed the applicant would ship their wastes using two different packaging systems: one that hauls 28.3 m^3/shipment (1000 ft^3 per shipment) and one that hauls 5.7 m^3/shipment (200 ft^3/shipment). Under those conditions, the number of shipments of radioactive waste per year, normalized to 1100 MW(e) electric generation capacity, would be about six shipments/year per 1100 MW(e) (880 net MW[e]) for the GT-MHR and seven shipments/year per 1100 MW[e] for the PBMR. These estimates are well below the reference LWR (46 shipments/yr per 1100 MW[e]).

All the estimates are well below the one truck shipment per day condition given in 10 CFR 51.52, Table S–4. Doubling the shipment estimates to account for empty return shipments is still well below the one-shipment-per-day-condition.

6.2.4 Conclusions

Considering the uncertainties in the data and computational methods, the staff concludes that the environmental impacts of transportation of fuel and radioactive wastes to and from advanced LWR designs would be SMALL, and would be consistent with the risks associated with transportation of fuel and radioactive wastes from current generation reactors presented in Table S–4 of 10 CFR 51.52. For gas-cooled designs, the impacts are likely to be SMALL, but at the CP or COL stage, the staff will need to validate the assumptions used in this transportation analysis with more design data. Assumptions that need validation include:

- verifying that unirradiated and spent fuel from gas-cooled reactors have the same abilities as LWR unirradiated and spent fuel to maintain integrity following a traffic accident

- verifying that the shipping cask design assumptions (e.g., cask capacities) are equal to or bounded by the assumptions in this analysis

- verifying that the fresh fuel initial core/refueling requirement, spent fuel generation rates, and radioactive waste generation rate assumptions are equal to or bounded by the assumptions in this analysis

- verifying that shipping cask capacities and accident source terms, including spent fuel inventories, severity fractions, and release fractions, are equal to or bounded by the assumptions in this analysis.

Should the ACR-700 or IRIS reactors be chosen for the ESP site, a transportation accident analysis will be performed, as spent fuel inventories were not available for the ESP analysis.

Table 6-10. Summary of Radioactive Waste Shipments for Advanced Reactors

Reactor Type	DOE (2003) Waste Generation Information	Annual Waste Volume, m^3/yr per Site	Electrical Output, MW(e) per Site	Normalized Rate, m^3/1100 MW(e) Plant (880 MW(e) Net)[a]	Shipments/ 1100 MW(e) (880 MW(e) Net) Electrical Output[b]
Reference LWR (WASH-1238)	100 m^3/yr per unit	108	1100	108	46
ABWR	100 m^3/yr per unit	100	1500	62	27
ESBWR	100 m^3/yr per unit	100	1500	62	27
AP1000	55 m^3/yr per unit	56	1150	45	20
ACR-700	47.5 m^3/yr per unit	47.5	731	64	28
IRIS	25 m^3/yr per unit	74 (3 units)	1,005 (3 units)	67	29
GT-MHR	98 m^3/yr (4 unit Plant)	98 (4 units)	1,320 (8 units)	86	37[c]
PBMR	100 drums/yr per unit	168 (8 units)	1,320 (8 units)	118	51[c]

Conversions: 1 m^3 = 35.31 ft^3. Drum volume = 210 liters (0.21 m^3).

(a) Capacity factors used to normalize the waste generation rates to an equivalent electrical generation output are given in Table 6-3 for each reactor type. All are normalized to 880 MW(e) net electrical output (1100-MW[e] plant with an 80 percent capacity factor).

(b) The number of shipments per 1100 MW(e) was calculated assuming the WASH-1238 average waste shipment capacity of 2.34 m^3 per shipment (108 m^3/yr divided by 46 shipments/yr).

(c) The applicant states in INEEL (2003) that 90 percent of the waste could be shipped on trucks carrying 28 m^3 (1000 ft^3) of waste and the remaining 10 percent in shipments carrying 5.7 m^3 (200 ft^3) of radioactive waste. This would result in six to seven shipments per year after normalization to the reference LWR electrical output.

6.3 Decommissioning Impacts

At the end of the operating life of a power reactor, the NRC regulations require that the facility undergo decommissioning. Decommissioning is the removal of a facility safely from service and the reduction of residual radioactivity to a level that permits termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.82 and 50.75.

Environmental impacts from the activities associated with the decommissioning of any LWR before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC 2002a). If Dominion applies for a license to operate additional units at North Anna, there is a requirement to provide a report containing a certification that financial assurance for radiological decommissioning will be provided. At the time an application is submitted, the requirements in 10 CFR 50.33, 10 CFR 50.75, and 10 CFR 52.77 (and any other applicable requirements) will have to be met.

At the ESP stage, Dominion is not required to submit information regarding the process of decommissioning such as the method chosen for decommissioning, the schedule, or any other aspect of planning for decommissioning. The regulatory requirements on decommissioning activities are expected to limit the impacts of decommissioning to a small impact. The impacts from decommissioning were evaluated for license renewal of Units 1 and 2 and no significant impacts beyond those described in NUREG-0586, Supplement 1 were identified. For Units 3 and 4, if LWR designs are chosen, or if other-than-LWRs that were considered in NUREG-0586, Supplement 1 are chosen, then the impacts from decommissioning are expected to be within the bounds described in NUREG-0586, Supplement 1. In such cases, the staff expects the impact from decommissioning to be SMALL. However, for whatever design that is selected, the impacts from decommissioning will have to be assessed.

6.4 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants."

10 CFR Part 71. Code of Federal Regulations, Title 10 *Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

49 CFR Part 173. Code of Federal Regulations, Title 49, *Transportation*, "Shippers - General Requirements for Shipments and Packaging."

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U.S. Atomic Energy Commission (AEC). 1974. *Environmental Survey of the Uranium Fuel Cycle.* WASH-1248, Washington, D.C.

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U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors.* NUREG-0586, Supplement 1, Volumes 1 and 2, Washington, D.C.

7.0 Cumulative Impacts

The staff considered potential cumulative impacts during the evaluation of information applicable to each of the potential impacts of constructing and operating reactors at the proposed North Anna Power Station (NAPS) early site permit (ESP) site for reactor designs that fall within the plant parameter envelope (PPE) (Dominion 2004). For purposes of this analysis, past actions were those related to the existing NAPS Units 1 and 2. Present actions are those related to the resources at the time of the ESP application until the start of construction. Future actions are those that are reasonably foreseeable through construction and operation of the proposed North Anna Units 3 and 4, including decommissioning. The geographical area over which past, present, and future actions could contribute to cumulative impacts depends on the type of action considered, and is described below for each impact area.

The impacts of the proposed action, as described in Chapters 4 and 5, are combined with other past, present, and reasonably foreseeable future actions in the vicinity of the NAPS site that would affect the same resources impacted by NAPS Units 1 and 2 regardless of what entity (Federal or non-Federal) or person undertakes such other actions. These combined impacts are defined as "cumulative" in 40 CFR 1508.7 and include individually minor but collectively significant actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important it if contributes to or accelerates the overall resource decline.

7.1 Land Use

For purposes of this analysis, the geographic area considered for cumulative impacts resulting from construction and operation of the North Anna Units 3 and 4 includes the three-county area of Louisa, Orange, and Spotsylvania Counties.

The staff reviewed the available information on the land-use impacts of constructing two additional nuclear units at the NAPS site. The counties surrounding the NAPS site have comprehensive land-use plans in place as required by Section 15.2-2223 of the Code of Virginia. The cumulative impacts for land use include possible additional growth and land conversions to accommodate new workers and services. Property tax revenue from Units 3 and 4 may also increase growth and infrastructure improvements in Louisa County. Based on the information provided by Dominion and its own independent review, the staff concludes that while lower tax rates or better services may encourage development, the comprehensive land-use plans would control development. As a result, cumulative land-use impacts would be SMALL, and mitigation is not warranted.

7.2 Air Quality

The NAPS site is located in an area that is in attainment for criteria pollutants. In addition, the State regulates emissions to the atmosphere. The air quality impacts of construction and operations are estimated to be small. No other significant impacts from other actions were identified. Based on its evaluation, the staff concludes that the cumulative impacts of air quality would be SMALL, and mitigation is not warranted.

7.3 Water Use and Quality

There are three primary effects of the operation of Unit 3 on the Lake Anna's water resources. The effects are, on lake level, downstream flow, and thermal effects on the lake. These effects impact three different categories including water use and quality, aquatic ecosystems and socioeconomic impacts. The cumulative effects are discussed in each category in this section. This section discusses lake level and downstream flow. Cumulative thermal effects are discussed in section 7.4.

The staff, while preparing this assessment, did not identify any other industrial, commercial, or public installations that would be located in the general vicinity of the North Anna ESP site prior to the end of Units 3 and 4 operations. The intake of water from, and the discharge of water to, Lake Anna from the new units would be regulated by Virginia Department of Environmental Quality (VDEQ) just as the existing NAPS Units 1 and 2 are presently regulated by the VDEQ. The intake and discharge limits for each installation are set considering the overall or cumulative impact of all of the other regulated activities in the area. Compliance with Clean Water Act and Virginia Pollutant Discharge Elimination System permits expects to minimize the cumulative effects on aquatic resources. Operation of North Anna Units 3 and 4 would require discharge permits from VDEQ, which would be expected to address changing requirements so that cumulative water-quality objectives are served. However, Unit 4 uses dry cooling towers and not Lake Anna for cooling water, and will have little operational impact on Lake Anna.

In Chapter 5, the staff evaluated the effects of the existing conditions and the effects of adding Units 3 and 4 on Lake Anna. The existing conditions include the effects of Units 1 and 2 as well as the effects of other existing water uses. The existing lake level and thermal conditions includes the impacts of not just Units 1 and 2, but all the effects as they exist today. A cumulative evaluation of the effects of Units 3 and 4 on Lake Anna, by nature starts with the existing lake conditions, and adds the effects of construction and operation to reach a cumulative impact on Lake Anna.

The staff determined that in normal years, the lake surface elevation would not drop below 75.6 m (248 ft) above mean sea level (MSL) and during a severe drought, the water surface elevation would drop an additional 0.6 m (2 ft), from below (246 ft) to below 74.4 m (244 ft), with the addition of Unit 3. A severe drought is expected to be an infrequent occurrence. The lake level will rapidly recover from a severe drought with normal precipitation.

Operation of Unit 3 would increase the duration of periods during drought conditions when the Lake Level Contingency Plan would be applied. The Lake Level Contingency Plan reduces flow from Lake Anna as the level in the lake decreases, to a minimum flow of 0.57 m^3/s (20 cfs). Hanover County, one of four downstream counties, has identified a need for additional water (Hanover County 2004). Any future conflicts over water use fall within the regulatory authority of the Commonwealth of Virginia

Therefore, the staff concludes that the potential cumulative impacts contributed by the construction, and operation, of the proposed North Anna Units 3 and 4 on water use and quality would be SMALL during normal years, and MODERATE during severe drought years, and mitigation is not warranted.

7.4 Terrestrial Ecosystem

The construction and operation of North Anna Units 3 and 4 were evaluated to determine if the potential exists for interactions with the past, present, and future actions that could result in adverse cumulative impacts to terrestrial resources such as wildlife populations and the size and distribution of habitat areas. For purposes of this analysis, the geographic area encompassing past, present, and foreseeable future actions that could contribute to adverse cumulative effects is the area around Lake Anna, within the NAPS site, and within the transmission line rights-of-way connecting the power plant to the power grid.

The rate of housing and recreational development around Lake Anna has been relatively high compared to other portions of central Virginia. The development of 81 ha (200 ac) at the North Anna ESP site would add to the cumulative habitat loss in the area. However, the habitats at the ESP site and in the vicinity of Lake Anna are common in central Virginia, are not considered to be unique, and the area is not critical for the survival of any threatened or endangered species. Therefore, the staff concludes that the contribution of the North Anna ESP site to the cumulative habitat loss in the region would be SMALL.

There are no important terrestrial species or important habitats in the vicinity of the site, transmission lines rights-of-way. The species have adapted to the noise levels from the existing Units 1 and 2. The noise produced by Units 3 and 4 will be of similar intensity to the noise produced by the existing Units 1 and 2. The proposed NAPS site is in an area with relatively few large noise-producing facilities; therefore, cumulative noise effects on wildlife are expected to be minimal.

There are no Federally listed terrestrial threatened or endangered animal species that are known to occur along the North Anna River downstream from Lake Anna. Therefore, if any changes to the flow regimes in this portion of the river were made, there would not be any cumulative effect on Federally listed threatened or endangered terrestrial species.

Once-through cooling systems, as proposed for Unit 3, require no elevated structures other than the reactor building that could pose a risk of avian collisions. Impacts to birds from collisions with heat dissipation structures from the Unit 4 dry cooling towers and the NAPS site itself are expected to be minimal. The NAPS site is in an area with relatively few tall facilities or features that would pose collision hazards to birds; therefore, cumulative effects on birds resulting from collisions are expected to be minimal.

There are no State or Federally regulated wetlands at the NAPS site or within the transmission line rights-of-way connecting the power plant to the power grid. No new lines are planned. Therefore, construction and operation of the proposed Units 3 and 4 and maintenance of the existing rights-of-way are not likely to contribute to a regional decline in wetland or floodplain resources. The maintenance procedures ensure minimal disturbance to wildlife. Because there would be no new transmission lines or alterations of the rights-of-way, no changes to this impact are expected to occur if additional power is transmitted through this system. Operation of the proposed new units would not affect the cumulative impacts of transmission line maintenance and operation in central Virginia. The staff concludes that the potential regional cumulative impacts on terrestrial ecology contributed by the construction and operation of the proposed North Anna Units 3 and 4 would be SMALL, and mitigation is not warranted.

7.5 Aquatic Ecosystem

The construction and operation of North Anna Units 3 and 4 were evaluated to determine if the potential exists for interactions with past (since Lake Anna's development), present, and future actions that cold result in adverse cumulative impacts to aquatic resources such as aquatic populations and the size and distribution of habitat areas. For the purposes of this analysis, the geographic area encompassing past, present, and foreseeable future actions that could contribute to adverse cumulative effects includes Lake Anna (the reservoir and the Waste Heat Treatment Facility) and the North Anna River.

The fish population in Lake Anna represents a balanced community. The Lake Anna fish community includes thriving populations of game fish and the forage species that support them. Over the years, the fishery of Lake Anna has matured and changed to meet the demands for public fishing through species additions (threadfin shad) and annual stockings of striped bass. Overall, the abundance and quality of the fishery has remained healthy and balanced despite increased fishing pressure and shoreline development.

The cumulative impact to the stripped bass is expected to be small during cooler months and in non-drought years and may be moderate during drought years. Because the Lake Anna striped bass population is a "put-grow-and-take" fishery of a non-indigenous species and because suitable habitat would continue to exist within Lake Anna, the staff concludes that the cumulative heat stress impact of Units 1, 2 and 3's once-through cooling systems on the striped bass would be SMALL during cooler months and non-drought years. During drought years, the impacts without mitigation may be MODERATE. In such circumstances, mitigation to reduce the impact could be accomplished by stocking more fish, stocking larger fish, or managing the fishery to provide more catch opportunities of larger fish.

Based on a worst-case estimate, the cumulative impact of impingement and entrainment would approximately double with the addition of Unit 3 with a once-through cooling system. Dominion proposes to use dry cooling towers for Unit 4, which would lead to a negligible contribution to impingement, entrainment, and thermal impacts (Dominion 2004). Because the fish most frequently impinged or entrained are prolific, exhibit a high reproductive potential, and compensatory responses of the fish population occur to offset losses, the relative fraction of the fish in Lake Anna that may be impinged or entrained during operation of three units is small. Therefore, the cumulative impacts from impingement of Lake Anna fish from operating Units 1, 2, and 3, unit would be SMALL, and mitigation is not warranted.

The staff evaluated the effects of the additional heat discharged to Lake Anna from the Waste Heat Treatment Facility and concluded it would increase water temperature throughout the lake but is not expected to exceed temperature thresholds that would destabilize the fish populations. During the summer, when warmer temperatures accumulate near the discharge, most of the lake is unaffected by operations and fish would be able find areas where they would not be exposed to heat discharged during plant operations. The staff concludes that because the relative proportion of the Lake Anna fish that may be exposed is small, the cumulative impacts from the additional heat resulting from operation of a new unit with once-through cooling would have a SMALL impact on the fishery community, and mitigation, with the possible exception of the striped bass, is not warranted.

7.6 Socioeconomic, Historic and Cultural Resources, Environmental Justice

Much of the analyses of the socioeconomic impacts presented in Sections 4.5 and 5.5 already incorporate cumulative impact analysis because the metrics used for analysis only make sense when placed in the total or cumulative context. For instance, the impact of the total number of additional housing units that may be needed can only be evaluated with respect to the total number that will be available in the impacted area. Therefore, the geographical area of the cumulative analysis varies depending on the particular impact considered, and may depend on specific boundaries, such as taxation jurisdictions or may be distance related, as in the case of environmental justice.

The potential cumulative increase in the number of vehicles during a combined outage, construction, and permanent workforce egress and ingress into the site could have adverse impacts on the local road system without some type of mitigating intervention.

The construction and operation of North Anna Units 3 and 4 would not be likely to add to any cumulative socioeconomic impacts beyond those already evaluated in Sections 4.5 and 5.5. In other words, the impacts of issues such as transportation or taxes are not likely to be detectable beyond the regions previously evaluated and will quickly decrease with increasing distance from the site. The staff concludes that construction impacts would generally be SMALL, but there are exceptions if more workers than expected settle in Louisa and Orange Counties, in which case MODERATE impacts may be reached for physical impacts on roads, housing, and some public services. During times of severe drought the impacts to aesthetics and recreation may also reach MODERATE. In terms of beneficial effects, the impact on regional economies and tax revenues would be beneficially SMALL to MODERATE.

With regard to historic and cultural resources, the construction and operation of North Anna Units 3 and 4 is not expected to add to any cumulative impacts to these resources beyond those identified in Sections 4.6 and 5.6. Dominion has developed procedures to ensure that either known or newly discovered potential historic and cultural sites will not be inadvertently impacted during onsite activities that involve land disturbances. Construction, operation, and maintenance of the plant would not affect land outside the bounds of current plant operations; therefore, additional cumulative impacts would be negligible. The staff concludes that the cumulative impacts of construction and operation on historic and cultural resources would be SMALL, and mitigation is not warranted.

The staff found no unusual resource dependencies or practices through which minority or low-income populations would be disproportionately affected. As a result, cumulative impacts of environmental justice would be SMALL.

Based on the above considerations, the staff concludes that construction and operation of North Anna Units 3 and 4 would not be likely to make a detectable contribution to the cumulative effects associated with the socioeconomic issues, including environmental justice and historic and cultural resources; therefore, the overall cumulative impacts are SMALL.

7.7 Nonradiological Health

The cumulative health impacts of construction and operation of the existing NAPS Units 1 and 2 and the proposed Units 3 and 4 on the ambient temperature of Lake Anna with regard to potential formation of thermophilic micro-organisms was evaluated in Section 5.8.1. The evaluation showed that the addition of two new units, one of which would use Lake Anna as a cooling source, would not increase the temperature in Lake Anna enough to create an environment conducive to the optimal growth of thermophilic organisms. Noise, dust emissions, and acute and chronic electromagnetic fields effects were also evaluated and found to have small impacts. The staff concludes that the cumulative impacts resulting from construction and operation of the North Anna Units 3 and 4 on nonradiological health would be SMALL, and mitigation is not warranted.

7.8 Radiological Impacts of Normal Operation

The radiological exposure limits and standards for the protection of the public and for occupational exposures have been developed assuming long-term exposures, and therefore incorporate cumulative impacts. As described in Section 5.9, the public and occupational doses predicted from the proposed operation of the proposed North Anna units are well below regulatory limits and standards. The cumulative health impact of operating the two new units, in addition to the existing operating NAPS Units 1 and 2, is estimated to be less than 1 cancer or hereditary effect cases annually. This is well below the estimated effects from natural background radiation. For purposes of this analysis, the geographical area is the area included within an 80-km (50-mi) radius of the North Anna ESP site. The U.S. Nuclear Regulatory Commission and the State would regulate any reasonably foreseeable future actions that could contribute to cumulative radiological impacts.

Therefore, the staff concludes that the cumulative radiological impacts of operation of the proposed North Anna units 3 and 4 and the existing operating NAPS Units 1 and 2 would be SMALL, and mitigation is not warranted.

7.9 Staff Conclusions and Recommendations

The staff considered the potential impacts resulting from construction and operation of North Anna Units 3 and 4 during the past, present, and future actions in the North Anna ESP site area. For each impact area, the staff concludes that the potential cumulative impacts resulting from construction and operation are SMALL, and mitigation is not warranted. Several areas have the potential for MODERATE impacts, most of which would occur under temporary circumstances or as the result of a larger than expected concentration of construction workers settling near the NAPS site. In addition, there may be temporary MODERATE impacts during severe drought conditions, on water use and aesthetics and recreation. Mitigation is not warranted due to the temporary nature of the impacts.

7.10 References

40 CFR Part 1508. Code of Federal Regulations. Title 40, *Protection of Environment*, Part 1508, Council on Environmental Quality.

Code of Virginia , Section 15.2-2223 Online at: http://www.virginia.gov/cmsportal/government_881/virginia_1048/.

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Dominion Nuclear North Anna, LLC (Dominion). 2004. *North Anna Early Site Permit Application - Part 3 - Environmental Report.* Revision 3, Richmond, Virginia.

Hanover County Department of Public Utilities. 2004. Letter to Chief, Rules and Directives Branch, NRC., regarding Dominion's ESP application, January 7, 2004.

8.0 Impacts of the Alternatives

The purpose of this portion of this draft environmental impact state (EIS) is to examine the environmental impacts of constructing and operating the proposed units at the alternative sites selected by Dominion in its early site permit (ESP) application (Dominion 2004). The results will be used in Chapter 9 to determine whether any alternative site is obviously superior to the proposed site. This is a two-part examination set forth in NUREG-1555, Section 9.3 (NRC 1999a), and stems from the U.S. Nuclear Regulatory Commission (NRC) decision related to licensing the Seabrook Nuclear Power Plant (Public Service Co. of New Hampshire [5 NRC 503], 1997). The first stage evaluates a full suite of environmental issues to determine if any of the alternative sites are environmentally preferable to the proposed site. If an alternative site appears environmentally preferable to the proposed site, the analysis proceeds to the second stage. If not, then the evaluation of alternative sites ends at the first stage. The second stage of the test considers economic, technological, and institutional factors among the environmentally preferred sites to determine if any is obviously superior to the proposed site. If there is no obviously superior site, then the proposed site prevails; if an obviously superior site is found, then it would lead to a recommendation that the ESP application be denied.

Section 8.1 discusses the no-action alternative. Section 8.2 examines the station design alternatives. Section 8.3 reviews the applicant's region of interest (ROI), and examines the suitability of the ROI and the applicant's alternative site selection process, describing the method the applicant used to select the candidate and alternative sites. Section 8.4 examines issues that are common to all the sites, and addresses them collectively. Sections 8.5 through 8.7 individually evaluate the selected alternative sites. Section 8.8 provides a summary of alternative site impacts, and Section 8.9 cites the references relevant to this chapter.

8.1 No-Action Alternative

For purposes of this ESP application, the no-action alternative refers to a scenario in which NRC would deny the ESP request. Upon such a denial, the construction and operation of a new nuclear power station at the proposed ESP location in accordance with the 10 CFR Part 52 process referencing an approved ESP would not occur.

The no-action alternative consists of two parts. First, the no-action alternative would include a scenario in which the NRC would not issue the ESP. There are no environmental impacts associated with not issuing the ESP except that the impacts associated with site preparation and preliminary work allowed pursuant to 10 CFR 52.17©) and 10 CFR 52.25(a) would be avoided. Second, given that the EIS addresses the environmental effects of construction and operation as directed by the Commission [10 CFR 52.18(a)(2)], the no-action alternative would result in no such construction and operation. Therefore, the impacts predicted in this draft EIS would not occur. Nonetheless, since Part 52 does not require an ER or EIS for an ESP to include consideration of energy alternatives or the benefits of construction and operation of a reactor or reactors at the ESP site, this draft EIS does not consider such matters. Accordingly, should the NRC ultimately determine to issue an ESP for the North Anna ESP site, these matters will be considered in the EIS for any CP or COL application that references such an ESP.

In this context, the no-action alternative would accomplish none of the benefits intended by the ESP process, which would include (1) early resolution of siting issues prior to large investments of financial capital and human resources in new plant design and construction, (2) early resolution of issues on the environmental impact of construction and operation of reactors that fall within the site parameters, (3) the ability to bank sites on which nuclear plants may be located, and (4) the facilitation of future decisions on whether to build new nuclear plants.

8.2 System Design Alternatives

Sections 8.2.1 and 8.2.2 contain information regarding alternative plant cooling systems for the proposed Unit 3 at the North Anna ESP site. Section 8.2.1 discusses wet cooling tower heat dissipation systems. Section 8.2.2 discusses dry cooling towers heat dissipation systems. A dry cooling tower has been proposed for Unit 4. Water and energy balance studies of Lake Anna suggest that the lake would not support either a once-through or wet cooling tower heat dissipation system for Unit 4. Reference Appendix G for more detail on the water budget analyses. Therefore, neither of these alternatives is considered for Unit 4.

8.2.1 Plant Cooling System: Wet Cooling Towers

The purpose of the plant cooling system is to dissipate energy to the environment. The various cooling system options differ in how the energy transfer takes place and, therefore, have different environmental impacts. In the once-through cooling system proposed for Unit 3, energy is transferred to the environment from Lake Anna by evaporation, long-wave radiation, and conduction. The environmental impacts result from the impingement and entrainment at the cooling system intake, evaporation of lake water, and effects of heated water on aquatic species.

The staff estimates that the proposed once-through cooling system for Unit 3 could extend waste heat treatment facility (WHTF) conditions into the main body of Lake Anna. Based on the additional heat load and associated flow, the staff estimates that WHTF conditions could extend into approximately 19 percent of the main body of the lake.

Cooling towers could be used to reduce the impacts of heated water on aquatic species. They would also reduce the cooling water flow through the intake structure, which could reduce impingement and entrainment impacts. However, these reductions come at an environmental cost. Substitution of cooling towers for once-through cooling would change the balance of the energy transfer mechanisms. With cooling towers, long-wave radiation and conduction are reduced by increasing evaporation and consequently increasing consumptive water use.

The impact of the increased evaporative loses would be particularly noticeable in drought years. The results of water balance calculations for Lake Anna for the years 2001 and 2002 suggest that the addition of Unit 3 with the proposed once-through cooling system could have resulted in an additional two-foot drawdown of the lake in September 2002. When the calculation is repeated with a wet cooling tower in place of the once-through cooling system, the results of the calculations suggest that the additional drawdown could have been about 4 feet.

Use of wet cooling towers in place of once-through cooling for the proposed Unit 3 changes the environmental impacts associated with operation of Unit 3. However, in either case there will be water-related impacts of cooling. Wet cooling towers have reduced entrainment and impingement impacts and a higher water consumption compared to once-through cooling systems. The staff concludes that a once-through cooling system for Unit 3 is preferable to a wet cooling tower based on the once-through cooling system's expected smaller impact on lake level and on downstream water users.

8.2.2 Plant Cooling System: Dry Cooling Towers

The use of a dry cooling tower for Unit 3 would largely eliminate the impacts on the lake and the aquatic ecosystem. The lake would not be heated by rejected heat from Unit 3, and there would not be additional consumptive water use.

A dry cooling tower heat dissipation system may reduce water-related impacts of operating Unit 3, but it also has some disadvantages. In particular, dry cooling systems are not as efficient as wet systems. They require movement of a large amount of air through the heat exchange to achieve the necessary cooling. The fans that force the air through the heat exchanger use a significant amount of power. This power reduces the net power output of the plant. In addition, the fans and the large volume of air required for cooling make dry cooling towers noisy. The dry cooling tower would also occupy more land than a once-through cooling system.

Based on the staff's analysis that Lake Anna would support Unit 3 using a once-through cooling system, and given the increased use of resources required by using a less efficient dry cooling system, the staff concludes that a once-through cooling system is acceptable.

8.3 Alternative Sites, Region of Interest, and Selection Process

NRC regulations require that the ER submitted in conjunction with an application for an ESP include an evaluation of alternative sites to determine whether there is any obviously superior alternative to the site proposed (10 CFR 52.17(a)(2)). This section includes subsections discussing Dominion's ROI for selecting alternative sites and its alternative site selection process. The three alternative sites examined in detail in this draft EIS are Dominion's Surry Power Station (Surry) site in Surry County, Virginia; the U.S. Department of Energy's (DOE's) Portsmouth Gaseous Diffusion Plant (Portsmouth) site in Pike County, Ohio; and DOE's Savannah River Site, which is in Aiken and Barnwell Counties, South Carolina.

Dominion stated that the two DOE sites were selected as candidate sites because:

- The sites represent valuable national assets with prior or existing nuclear energy potential.
- New nuclear power facilities would represent potentially promising new missions for these sites.
- The sites have the potential to support reactor demonstrations and/or commercial reactor development.
- There is extensive site information and an available infrastructure that could help to reduce site development costs.
- The partially or fully developed site environment and the available infrastructure reduces the incremental environmental impacts associated with the new plant construction and operation on land use, ecological resources, aesthetics, and local transportation networks.
- The sites are not in proximity to major population centers (Dominion 2004).

The Surry site was selected by Dominion as a ESP candidate site because:

- The existing environmental conditions and the environmental impacts are known from data collected during years of monitoring air, water, ecological, and other parameters.

- Construction of new transmission line rights-of-way may potentially be avoided if the existing transmission system (lines and rights-of-way) can accommodate the increased power generation.

- No additional land acquisitions would be necessary if a new transmission line can be avoided, and the resulting land-use impacts of the new plant would be small.

- The Surry site was recently subjected to an environmental review process during its license renewal review.

- The Surry site had extensive environmental studies performed during the original site selection process, which could be updated and used for new units.

- Site physical criteria, including primarily geologic/seismic suitability, have been characterized.

- Plant construction, operation, and maintenance costs would be reduced because of existing site infrastructure (e.g., roads, transmission line rights-of-way, water source, and intake/discharge system).

- The Surry site has nearby power markets.

- The Surry site has local community acceptance and support (Dominion 2004).

NRC's environmental review guidance for alternative nuclear plant sites recognizes that there will be special cases in which the proposed site was not selected on the basis of a systematic site selection process, rather it was selected on basis of environmentally acceptable operating experience at the site or because the site was previously found acceptable on the basis of a NEPA review. Examples include sites containing an existing nuclear facility previously found acceptable on the basis of a NEPA review and/or demonstrated to be environmentally acceptable on the basis of operating experience. In such cases the NRC will analyze the applicant's site-selection process only as it applies to the alternate sites. The site comparison may then be restricted to a site-by-site comparison of the alternate sites with the proposed site (NRC 1999a, b).

8.3.1 Dominion's Region of Interest

The ROI is the geographic area considered in searching for candidate ESP sites. More specifically, the ROI is:

> The geographical area initially considered in the site selection process. This area may represent the applicant's system, the power pool or area within which the applicant's planning studies are based, or the regional reliability council or the appropriate subregion or area of the reliability council (NRC 1999a, b).

In its ESP application, Dominion selected its ROI for examining potential sites as the Mid-Atlantic, Northeast, and Midwest regions of the United States. These regions were selected because of Dominion's interest in continuing to grow and operate in the region as a merchant plant operator (Dominion 2004). Within this ROI, Dominion used the candidate site criteria identified in NRC's *Environmental Standard Review Plan 9.3, Alternative Sites* (NRC 1999a) to identify candidate sites (Dominion 2004). The staff concludes that the ROI used by Dominion in its ESP application is appropriate for consideration and analysis of potential ESP sites because it meets the NRC approved guidance contained in the Environmental Standard Review Plan.

8.3.2 Dominion's Alternative Selection Process

Dominion evaluated its proposed North Anna ESP site and the three alternative sites using 45 site suitability/screening criteria (Dominion 2004). The criteria were grouped into four major categories: (1) economic, (2) engineering, (3) environmental, and (4) socioeconomic (see Table 8-1). The economic category was given a relative weight of 40 percent by Dominion, and the other three categories were weighted 20 percent each. A ranking or score for each of the 45 criteria was assigned by Dominion (from 0 to 5, with 5 being the most favorable). The relative importance of each criterion to the overall evaluation was established by assigning weights that reflected the collective judgment of Dominion's experts involved in the process. The sum of the weighted scores for all criteria represented a total site merit score. The preferred site was chosen based on the highest site merit score. Dominion found the North Anna site to be the preferred ESP site followed by the Savannah River, Portsmouth, and Surry ESP sites, respectively (Dominion and Bechtel 2002). (In this report, Dominion and Bechtel evaluated a fourth site, the Idaho National Engineering and Environmental Laboratory near Idaho Falls, Idaho, but Dominion did not consider it in this ESP action because it was outside the ROI.) Accordingly, Dominion submitted its ESP application for the North Anna site. However, Dominion concluded that all four sites are suitable locations for deployment of new nuclear power plants.

8.3.3 Greenfield and Brownfield Alternative Sites

Dominion also considered other existing nuclear power plant, greenfield, and brownfield sites within the ROI. In light of current nuclear facilities with space for additional units, the greenfield and brownfield sites were determined not to be environmentally preferable because of the large area that would need to be disturbed to build a new plant and to support necessary transmission line rights-of-way. The associated land use, ecological resource damage, and the aesthetic impacts were determined to be too large in comparison to alternative sites with existing nuclear units.

The staff reviewed Dominion's alternative site selection process as it applies to greenfield and brownfield sites and concludes that the approach used and the findings of impacts are reasonable.

Table 8-1. Dominion Site Screening Criteria

Economic	Engineering	Environmental	Socioeconomic
Electricity Projections	Site Size	Terrestrial Habitat	Present/Planned Land Use
Transmission System	Site Topography	Terrestrial Vegetation	Demography
Stakeholder Support	Environmentally Sensitive Areas	Aquatic Habitat/ Organisms	Socioeconomic Benefits
Site Development Costs	Emergency Planning	Groundwater	Agricultural/Industrial
	Labor Supply	Surface Water	Aesthetics
	Transportation Access	Population	Historic/Cultural
	Security		Transportation Network
	Hazardous Land Use		Environmental Justice
	Ease for Decommissioning		
	Water Rights and Air Quality Permits		
	Regulatory		
	Schedule		
	Geologic Hazards		
	Site-Specific Safe Shutdown Earthquake		
	Capable Faults		
	Liquefaction Potential		
	Bearing Material		
	Near-Surface Material		
	Groundwater		
	Flooding Potential		
	Ice Formation		
	Cooling Water Source		
	Temperature and Moisture		
	Winds		
	Rainfall		
	Snow		
	Atmospheric Dispersion		

8.4 Generic Issues Consistent Among Alternative Sites

In evaluating the alternative sites, NRC staff found that certain impact areas would not vary among sites, and as a result, would not affect the evaluation of whether an alternative site is environmentally preferable to the proposed site. These impact areas include air quality as it relates to emissions from the sites during construction and operation, nonradiological health impacts, and radiological health impacts to members of the public and during operation and to biota. In addition, the impacts to public service facilities (schools, water, and wastewater treatment, etc.) would not materially impact whether an alternative site is selected or not. As a result, air quality, health impacts, and radiation exposures are not evaluated as part of the site-specific alternatives analysis, but rather are discussed generically in the following sections.

8.4.1 Air Quality Impacts

During construction at any of the proposed alternative ESP sites, it is expected that some minor air quality impacts will occur in terms of fugitive dust emissions from general construction activities and the potential for elevated ambient air quality levels due to automotive emissions from the workforce traffic and emissions from construction equipment.

Air pollutants and fugitive dust will be emitted from operations of construction equipment and for earth-moving and material-handling activities. In addition, operation of other equipment for hauling debris, equipment, and supplies on unpaved roads will produce fugitive dust emissions. The pollutant emission of concern would be PM_{10} particulate matter (less than 10 microns in diameter), reactive organic gases, oxides of nitrogen, carbon monoxide, and sulfur dioxides from combustion engines of the construction equipment. Reasonable estimates of actual emissions cannot be determined at this time. However, all activities would be conducted in accordance with state air quality agency requirements for visible and fugitive dust emissions as well as emission standards for mobile sources. If the Surry ESP site were chosen as the alternative site, the same requirements set forth for the North Anna ESP site would apply because both are in the Commonwealth of Virginia. If the Savannah River Site were chosen, then requirements established by the South Carolina Department of Health and Environmental Control apply. The Ohio Environmental Protection Agency would be consulted if the Portsmouth site were chosen. In addition, if construction activities include burning of construction materials, a permit would need to be secured from the State and the applicant would need to contact local county officials to determine if local ordinances must be followed.

Dominion estimated that during construction activities approximately 5000 workers would be divided between two 10-hour shifts (Dominion 2004). Using an assumption of 1.8 workers per vehicle, this would represent 2800 additional vehicles per day traveling roads into and out of the site (Dominion 2004). For any of the proposed alternative sites, the estimate of required work is expected to be similar to that proposed for the North Anna ESP site. Some roadways leading into the site chosen may or may not experience congestion. This situation will impact the local ambient air quality levels due to emissions from vehicles both during normal operation and during congestion periods when vehicles are idling. However, because the current ambient air quality levels at the proposed alternative sites are well below current national standards, the resulting impact is estimated to be insignificant and would not create an air quality impact. Therefore, the staff concludes that air quality impacts from construction at any of the alternative sites would be similar to those at the proposed site, and would be temporary and SMALL.

The meteorological and air quality impacts from operating the proposed new reactors at any of the alternative sites would be limited to those resulting from operation of wet cooling towers and pollutant emissions from periodic operation of auxiliary boilers and generators.

Air quality impacts would be limited to additional nonradiological pollutants during the operation of auxiliary boilers, emergency generators, and emissions from onsite service vehicles. The amount of pollutants emitted to the atmosphere is anticipated to be less than 100 tons/yr for any alternative site (Dominion and Bechtel 2002) and is considered insignificant. However, the applicant will require approval under the existing New Source Federal, State, or local air quality laws and regulations. As of January 2004, there were no non-attainment areas in the region surrounding the proposed alternative sites for the mandated criteria pollutants (EPA 2004). Therefore, this is not expected to be a limiting factor in considering any of these sites, and the staff concludes that the air quality impacts from operation at any of the alternative sites would be SMALL and similar to those at the proposed site.

8.4.2 Nonradiological Health Impacts

Nonradiological health impacts from construction of the proposed nuclear power plants on the construction workers at all the alternative sites would be similar to those evaluated in Section 4.8. They would include noise, odor, vehicle exhaust, and dust emissions. The plant construction phase will be in compliance with all applicable State regulations regarding fugitive dust emissions and air pollution control. All the alternative sites are in rural areas and construction impacts would be minimal on the surrounding population. The staff concludes that health impacts to construction workers resulting from the construction of two new units at any of the alternative sites are expected to be SMALL.

Occupational health impacts to operational employees would be the same for all the alternative sites. Thermophilic micro-organisms would not be a concern at alternative sites for any facilities using either a wet or wet/dry cooling process because the temperatures in the water bodies receiving the cooling system discharges are below those known to be conducive to the growth and survival of thermophilic pathogens. Health impacts to workers from noise and electromagnetic fields would be similar among the sites. Noise and electromagnetic fields would be monitored and controlled in accordance with applicable Occupational Safety and Health Administration regulations. The staff concludes that the occupational health impacts to construction or operations employees of proposed units at any of the alternative sites are expected to be SMALL.

With respect to transmission systems, the potential exists for impacts to members of the public from operation of the transmission system in terms of electrical shock, electromagnetic field exposure, noise, and aesthetics. The impacts at the alternative sites are expected to be similar to those evaluated in Section 5.8. All transmission lines, either constructed or used as part of an existing nuclear site, must meet standards established by the most current version of the National Electrical Safety Code (NESC) (IEEE 2001). The standard is applicable to the systems and equipment operated by utilities. The areas of particular interest are the potential to create an electric shock that could disrupt the operation of pacemakers and health assistance devices, and the potential for chronic exposure to electromagnetic fields associated with the transport of electric current through large conductors, such as high-voltage transmission lines.

8.4.2.1 Acute Effects of Electromagnetic Fields

Currently, NESC requires the design of transmission lines be such that electrostatic effects from operation do not create a steady-state current that exceeds 5 mA root mean square to limit the potential for electric shock. For the alternative sites considered, it is expected that NESC requirements for preventing electric shock from induced current would be met and the impact to the public would be insignificant. However, this would need to be verified upon selection of an alternative site, reactor type, and condition and capacity of the transmission system.

8.4.2.2 Chronic Effects of Electromagnetic Fields

There has been considerable debate in scientific circles regarding the potential impact from exposure to 60-Hz electromagnetic fields resulting from energized transmission lines. The potential for chronic effects from these fields continues to be studied and consensus results are still outstanding. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the DOE. A recent report (NIEHS 1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF (extremely low frequency-electromagnetic field) exposure cannot be recognized as entirely safe because of weak scientific evidence that

> exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and is exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposure. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warranted concern.

This statement is not sufficient to cause the staff to consider the potential impact as significant to the public, but the staff will continue to follow developments on this issue.

8.4.3 Radiological Health Impacts

Exposure pathways for gaseous and liquid effluents from the proposed new Units 3 and 4 at North Anna ESP site would be similar for the alternative locations. Gaseous effluent pathways would include external exposure to the airborne plume, external exposure to contaminated soil, inhalation of airborne activity, and ingestion of contaminated agricultural products. Liquid effluent pathways would include ingestion of aquatic foods, ingestion of drinking water, external exposure to shoreline sediments, and external exposure to water through boating and swimming.

8.4.3.1 Radiation Doses and Health Impacts to Members of the Public

Section 5.9 provides an estimate of doses to the maximally exposed individual and the general population at the North Anna site for both the liquid effluent and gaseous effluent pathways during operation. The same bounding liquid and gaseous effluent releases would be used to evaluate doses to the maximally exposed individual and the population at each alternative site. However, there would be differences in the estimated doses at each of the sites. The differences would be due to the use of site-specific atmospheric and water dispersion data, different exposure pathways, and site-specific population data used in the dose calculations.

Section 5.9 shows that the estimated dose to the maximally exposed individual at the primary North Anna ESP site was well within the design objectives (10 CFR Part 50, Appendix I). Considering the differences in pathways analyzed, atmospheric and water dispersion factors, and population, doses estimated to the maximally exposed individual for the alternative sites would also be expected to be well within the Appendix I design objectives. Population dose within 80 km (50 mi) of those alternative sites that are closer to major population centers (e.g., Savannah River) could be higher than for the proposed North Anna ESP site; however, the dose is expected to be small compared to the population dose from natural background radiation.

Based on Dominion's ER (Dominion 2004) and its own independent evaluation, the staff concludes that the proposed system would likely result in annual doses to the public well within regulatory limits, and there would be no observable health impact to the public from construction or normal operation of the proposed North Anna ESP facility or from any of the alternative sites. Therefore, the staff concludes that radiation doses and resultant health impacts from construction or operation of the proposed new nuclear units at the alternative sites are expected to be SMALL.

8.4.3.2 Occupational Doses to Workers

Doses to construction workers during construction of Units 3 and 4 were estimated and compared against the requirements in 10 CFR 20. These doses were well below limits for members of the public. In addition, annual collective doses were estimated and appeared realistic and accurate. Occupational doses to workers during construction are expected to be approximately the same for the alternative sites as for the proposed North Anna ESP site. Therefore, the staff concludes that health impacts from radiological doses to construction workers would be SMALL.

Occupational doses to workers are expected to be approximately the same for the proposed ESP facility at the alternative locations as for the North Anna ESP site. The same (accumulated) annual occupational dose estimates of 1 person-Sv (100 person-rem) would be expected for all the proposed units regardless of the site location. The advanced reactor designs of the proposed nuclear units would be expected to result in less occupational exposure annually than current operating plants for the reasons discussed in section 5.9. The staff concludes that the occupational radiation doses from operation of the proposed facility at the alternative sites are expected to be SMALL.

8.4.3.3 Impacts to Biota

Table 5-16 provides the annual whole body dose estimates to surrogate biota species for the proposed new Units 3 and 4 at the North Anna ESP site. The 40 CFR Part 190 limits apply to members of the public in unrestricted areas, not specifically to biota. The North Anna ESP site dose estimates are conservative because they do not consider any dilution or decay of liquid effluents during transit. Actual doses to biota are likely to be much lower. The staff reviewed the available information relative to the radiological impact on biota, other than man, and performed an independent estimate of dose to the biota. The staff concludes that no measurable radiological impact on populations of biota is expected from the radiation and radioactive material released to the environment as a result of the construction or routine operation of the proposed two nuclear units, or of operation at any of the alternative sites. The staff concludes that the impacts to biota of radiation doses from the construction or operation of the proposed ESP facility at the alternative sites would be SMALL.

8.4.4 Postulated Accidents

A suite of design basis accidents (DBAs) has been considered for the new nuclear units at the North Anna ESP site. The evaluation involved calculation of doses for specified periods at the exclusion area and low population zone boundaries, and comparison of those doses with doses based on regulatory limits and guidelines. Similar analyses have not been conducted for the alternative sites. Had such evaluations been conducted, the differences in the results are expected to be due to meteorological conditions and the distances to the site boundaries. The release characteristics likely would have been similar at all sites, because the reactor designs are the same.

For the North Anna ESP site meteorology, the doses for each accident sequence considered were well below the corresponding regulatory limits and guidelines. The general climatological conditions at the North Anna ESP site are sufficiently similar to the conditions at the alternative sites that it is highly unlikely that differences in local meteorological conditions would be sufficient to cause doses from DBAs for new nuclear units at any of the alternative sites to exceed regulatory limits or guidelines. Similarly, because each of the alternative sites is located at a nuclear facility (although not a necessarily a nuclear reactor site), it is unlikely that differences in distances to the exclusion area and low population boundaries would be sufficient to cause doses from DBAs for new nuclear units at any of the alternative sites to exceed regulatory limits or guidelines. Therefore, the staff concludes that for the purposes of consideration of alternative sites, the impact of DBAs at each of the alternative sites is SMALL.

A detailed analysis of the potential consequences of severe accidents for the postulated plants has been conducted for the North Anna ESP site. Similar analyses have not been conducted for the alternative sites. Had such evaluations been conducted, the differences in the results would likely have been limited to site-specific factors such as meteorological conditions, population distribution, and land-use distribution. The release characteristics likely would have been similar at all sites, because the reactor designs are the same.

The probability-weighted consequences estimated for severe accidents for a new nuclear unit at the North Anna ESP site are well below the consequences estimated for severe accidents at current generation reactors (see Section 5.10). This result suggests that, as at the North Anna ESP site, the consequences of severe accidents at the any of the alternative sites would be less than the consequences of a severe accident for a current generation operating plant at the site. These risks are well below the NRC safety goals. In addition, the Commission has determined that the probability-weighted consequences of severe accidents is SMALL for all existing plants (10 CFR 51, Subpart B, Table B-1). On this basis, the staff concludes that, for the purposes of consideration of alternative sites, the impact of severe accidents at each of the alternative sites is SMALL.

8.5 Evaluation of Surry Power Station Site

The Surry site, operated by Dominion, was recently evaluated in a supplemental EIS prepared in connection with a license renewal application (NRC 2002). The analysis of environmental impacts for this section of the ESP EIS draws from the data and conclusions gathered in the licence renewal process as well as the analysis provided by Dominion and Bechtel (2002), and the staff independent review.

Certain assumptions were made by the staff in the review of the Surry ESP site as an alternative site to the proposed North Anna ESP site. These include the use of

- closed-cycle cooling
- mechanical draft towers
- the existing intake structures, with possible modifications to accommodate the proposed additional two units
- existing discharge canal
- land within the existing Surry site.

No additional transmission lines are assumed to be required for power transmission for two new nuclear units.

The station is on the Gravel Neck Peninsula on the south side of the James River in an unincorporated portion of Surry County, Virginia. The station is approximately 40 km (25 mi) upstream of the point where the James River enters Chesapeake Bay. The James River is about 4 km (2.5 mi) wide at the Surry site. The Surry site, shown in Figure 8.1, occupies approximately 340 ha (840 ac).

The Surry site is 10 km (7 mi) south of Colonial Williamsburg and 13 km (8 mi) east-northeast of the town of Surry. Jamestown Island, part of the Colonial National Historic Park, is to the northwest on the northern shore of the James River. The area within 16 km (10 mi) of the site includes Surry, Isle of Wight, York, and James City Counties, and parts of the cities of Newport News and Williamsburg. The counties surrounding the Surry site are predominantly rural, characterized by farmland, woods, and marshy wetlands. East and south of the site, at distances between 16 and 48 km (10 and 30 mi), are the urban areas of Hampton, Newport News, Norfolk, and Portsmouth, Virginia, and others, collectively known as Hampton Roads.

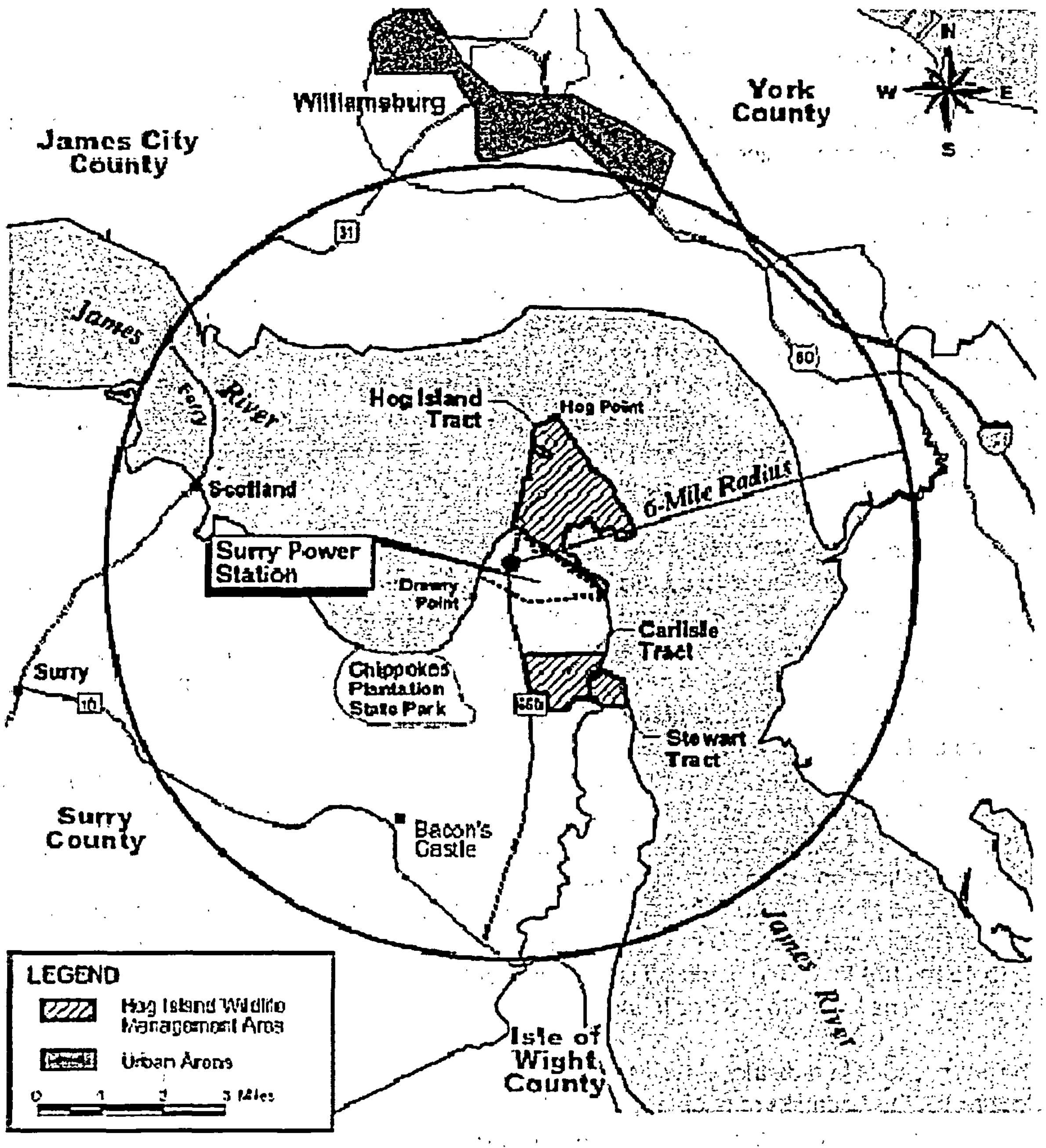
The site has two Westinghouse-designed light-water reactors, each with a design rating for a gross electrical power output of 855 megawatts-electric (MW[e]). The Surry site was originally planned for four units. Construction permits were issued for Units 3 and 4; however, the units were never built. Cooling for the existing Surry site reactors is provided by a once-through cooling system to remove waste heat from the reactor-steam electric system. Cooling water is withdrawn from and returned to the James River.

Distinctive features of the Surry site include the 40-m (135-ft)-diameter cylindrical containment buildings with hemispherical domes, and the cooling canal. When the plant was designed, there was a concern about the containment structures being visible from historic Jamestown Island; consequently, the containment buildings were designed so the elevation would be sufficiently low so as to blend with the surrounding forested lands. In addition to the two nuclear reactors and their turbine building, intake and discharge canals, and auxiliary buildings, the Surry site is the location of Dominion's Gravel Neck Combustion Turbine Station, a switchyard, and an independent spent fuel storage installation (ISFSI).

Gravel Neck Peninsula is at the upstream limit of saltwater incursion to the James River; upstream of Gravel Neck is tidal river and downstream is an estuary. Surry extends as a band across the peninsula. Steep bluffs drop to the river on either side and to the tip of the peninsula. Hog Island Wildlife Management Area, a Commonwealth of Virginia wildlife management area, is located on the tip of the Gravel Neck Peninsula, and contains primarily tidal marshes. Areas within 16 km (10 mi) of the site to the west, south, and east are predominantly rural, characterized by farmland, woods, and marshy wetlands. The tidal flats and marshes of Hog Island State Wildlife Management Area provide habitat for large numbers and numerous species of migratory shorebirds, wading birds, and waterfowl. It also provides habitat for numerous amphibians, reptiles, mammals, and upland game birds.

The terrestrial community at the Surry site consists of remnants of mixed pine-hardwood forests interspersed with early succession fields and developed areas. Wildlife species, found primarily in the forested portions of the site, are those typically found in upland forests of coastal Virginia. With the exception of the bald eagle (*Haliaeetus leucocephalus*) (Federally and State-listed as threatened), terrestrial species that are Federally and/or State-listed as endangered or threatened are not known to exist at the Surry site or along the rights-of-way of its associated transmission lines (NRC 2002). The barking tree frog (*Hyla gratiosa*) State-listed as threatened, is believed to be in the general vicinity but has not been observed at the Surry site.

The Surry site is located in one of the strongest economic areas in Virginia, and Dominion is the major employer in Surry County (NRC 2002). At present, because of the location of the Surry Power Station in Surry County, Dominion has a significant impact on the economic well-being of the county.



1 **Figure 8-1.** Surry Vicinity Map.

The following sections examine the major environmental issues reviewed by the staff. Section 8.5.1 evaluates land-use issues, including the site and transmission lines. Section 8.5.2 examines hydrology, water use, and water quality. Sections 8.5.3 and 8.5.4 evaluate the terrestrial and aquatic resources including endangered species, and Section 8.5.5 evaluates socioeconomics, historic and cultural, and environmental justice issues.

8.5.1 Land Use Including Site and Transmission Lines

Like the North Anna ESP site, the Surry site was originally designed for the construction of four reactor units. Surry Units 3 and 4 were to be constructed to the east of Unit 2 where the existing construction building and parking area are now situated. The original plans called for Units 3 and 4 to be offset from Units 1 and 2, with the turbine building roughly in line with the Units 1 and 2 containment buildings. The containment buildings for Units 3 and 4 were originally to be located farther north of the intake canal than the existing Units 1 and 2 containment buildings.

For purposes of its ESP application, Dominion determined that the originally planned location for Units 3 and 4 continues to be the best choice for potentially adding new nuclear generating units at the Surry site (Dominion and Bechtel 2002). The proposed location of new nuclear generating units at the Surry site is shown in Figure 8-2 (Dominion and Bechtel 2002). The proposed location is east of the radwaste facility and includes the construction, maintenance, and miscellaneous buildings and the uncleared area west of the ISFSI. Relocation of these existing buildings to another onsite location would be required. The existing cleared area measures approximately 300 m (900 ft) in the east-west direction. An additional 300 m (900 ft) could be cleared to the east, while still maintaining approximately 150 m (500 ft) to the ISFSI outer fence. The construction of an earthen berm around the ISFSI would likely be required to reduce construction and occupational radiation doses. Any expansion of the ISFSI would be to the east, away from the nuclear power units. In the north-south direction, the cleared area measures approximately 350 m (1100 ft), including the contractor parking area. An additional 40 to 45 m (100 to 150 ft) could be cleared without encroaching too close to the north site boundary. The areas to the north and east of the ISFSI could also be used if needed.

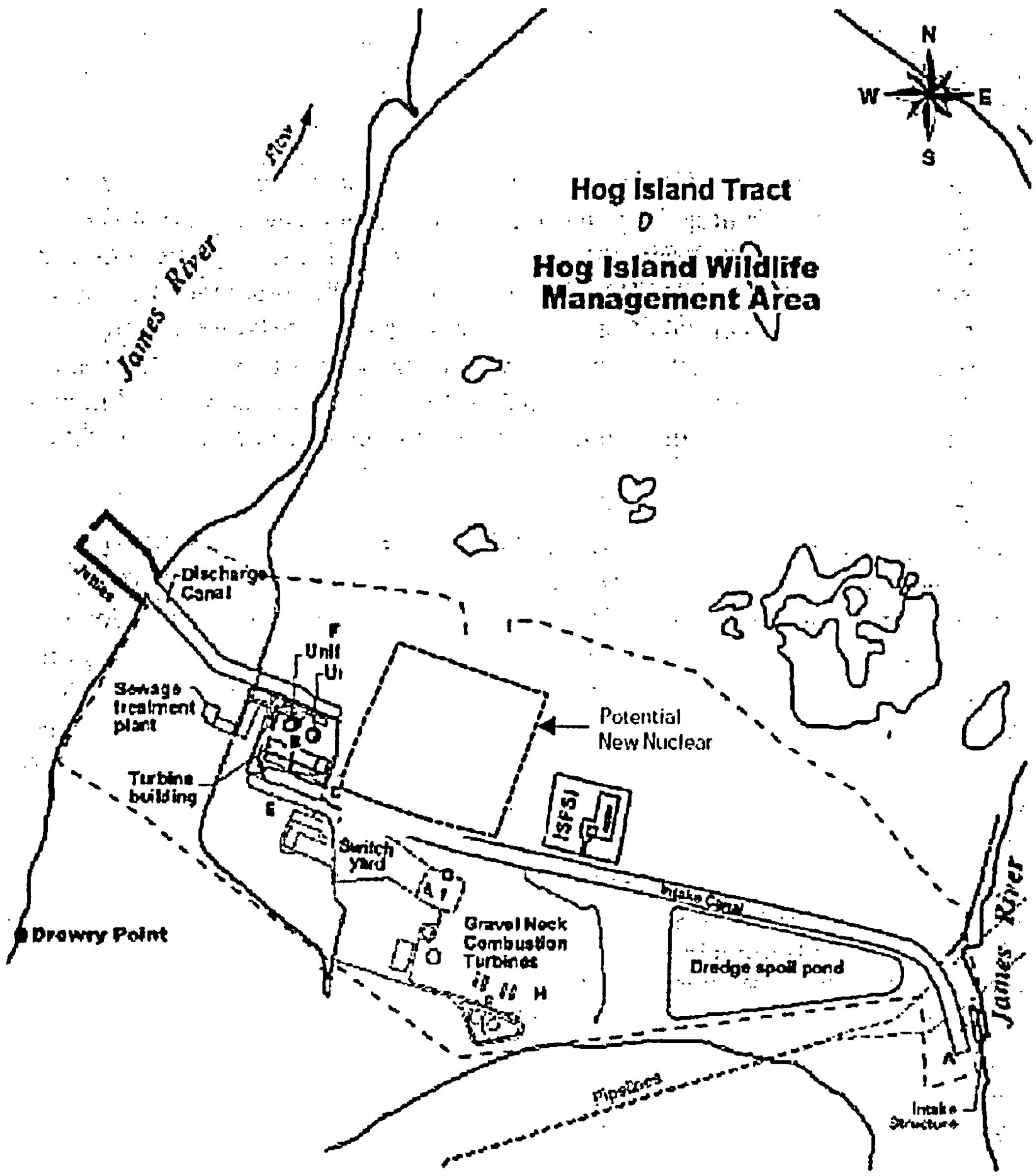
The Surry site is in a district classified as —2 General Industrial District by Surry County (Surry County 1975). Location of nuclear power plants and associated radioactive waste-handling facilities is permitted as a conditional use in this district upon approval by the County Board of Supervisors. Dominion has received such approval for Surry Units 1 and 2, but would need additional approval for new nuclear units.

The Surry site has an existing exclusion area that is consistent with NRC regulations. New nuclear units sited at the Surry site would likely have the same exclusion area as the existing nuclear units.

The residential locations of employees currently working at Surry are shown in Table 8-2 (NRC 2002a). Approximately 60 percent of the employees live in Isle of Wight, James City, or Surry Counties, or the City of Newport News. The remaining 40 percent of employees reside in 23 other counties and cities. The staff assumes that the residences of the workforce needed to construct new Units 3 and 4 at the Surry site would be similarly dispersed. Offsite land-use impacts associated with construction of new nuclear units are likely to be relatively limited, given the temporary nature of the construction (5 years). Construction of new rental housing and/or manufactured home and recreational vehicle parks could be expected to accommodate construction workers.

Section 307(c)(3)(A) of the Coastal Zone Management Act [16 USC 1456(c)(3)(A)] requires that applicants for Federal licenses to conduct an activity in a coastal zone area provide a certification that the proposed activity complies with the enforceable policies of the State's coastal zone program. Surry is within the Virginia coastal resources management area (VDEQ 2004b). If construction of new nuclear units at Surry were planned, Dominion would need to submit a certification to the Virginia Department of Environmental Quality (VDEQ) stating that construction of the new units is consistent with the Virginia Coastal Management Program. This submission would be reviewed by VDEQ.

New land-use impacts associated with operation of new nuclear generating units at the Surry site are expected to be limited. Some new housing in surrounding communities would likely be constructed to accommodate permanent workers at the new units. The incremental property tax revenue from the new units could affect future land use in Surry County as a result of infrastructure improvements made possible by the tax revenue. In the supplemental EIS related to renewal of the operating licenses for Surry Units 1 and 2, the staff determined that tax revenue impacts on land use during the 20-year license renewal term would be small (NRC 2002). The staff concludes that, although the new units would be licensed for 40 years, the impacts would be similar. Based on the information provided by Dominion and the staff's independent review, the staff concludes that the land-use impacts on the site and vicinity of construction and operation are expected to be SMALL.



1 **Figure 8-2.** Surry Power Station Site.
2

Table 8-2. Surry Power Station, Units 1 and 2, Permanent Employee Residence by County/Independent City

County/Independent City	Number of Personnel	Percentage of Total Personnel	Cumulative Percentage
Isle of Wight	212	24	24
James City	98	11	35
Newport News*	97	11	46
Surry	90	10	57
Hampton*	71	8	65
Suffolk*	52	6	71
Chesapeake*	42	5	75
Chesterfield	25	3	78
Portsmouth*	23	3	81
Virginia Beach*	21	2	83
York	20	2	85
Prince George	19	2	88
Sussex	18	2	90
Southampton	11	1	91
Others	79	9	100
Total	878	100	

* Independent City
Source: NRC 2001.

The transmission line rights-of-way from the Surry site consist of three 500-kV transmission lines from the breaker and a half 500-kV switchyard and six 230-kV transmission lines from the 230-kV switchyard. The lines are not at or near capacity (Dominion and Bechtel 2002). For the addition of two advanced boiling water reactor-size units, it appears that the 500-kV transmission line rights-of-way would be able to handle the new load; however, system studies (load flows) modeling the transmission lines and the new nuclear units would need to be performed to be certain whether any additional lines are required from the site. Based on the evaluation conducted by Dominion and Bechtel (2002), it is likely that no additional electrical transmission line rights-of-way would be required to transmit the power generated by additional units at the Surry site to the regional power grid. This impact would be similar to land-use impacts for construction and operation in the transmission line rights-of-way and offsite areas associated with the North Anna ESP site. Therefore, based on the information provided by Dominion and its own independent review, the staff concludes that the land-use impacts of transmission system construction and continued operation would likely be SMALL.

8.5.2 Water Use and Quality

The Surry site is located adjacent to the James River estuary. The consumptive use of water to support mechanical draft cooling towers for the two nuclear units would be undetectable relative to the supply available in the estuary. Discharges to the James River may contain water treatment chemicals that would be subject to regulation by the VDEQ to ensure protection of the environment. The additional small amount of heat from blowdown water would likely be undetectable if commingled with the once-through discharge of Surry Units 1 and 2. Therefore, based on the information provided by Dominion and its own independent review, the staff concludes that the impacts to water use and water supply at the Surry site from construction and operation of two new nuclear units would be SMALL.

8.5.3 Terrestrial Resources Including Endangered Species

A maximum of approximately 200 ha (500 ac) of land would be disturbed to develop two additional units with cooling towers at the Surry site (Dominion and Bechtel 2002). Much of this area has been previously disturbed during development of the existing nuclear units and associated facilities. Habitats in the area are a mixture of industrial areas, early successional grasslands, and remnant mixed pine-hardwood forests. There are no threatened, endangered, or other important species known to exist within the proposed development site, although bald eagles are known to nest near the Surry site. Other Federally and State-listed threatened or endangered species reported to occur in Surry County are listed in Table 8-3.

Table 8-3. Federally and State-Listed Threatened or Endangered Terrestrial Species Reported Within Surry County, Virginia

Scientific Name	Species	Federal Status	State Status
Birds			
Haliaeetus leucocephalus	bald eagle	T	T
Lanius ludovicianus migrans	migrant loggerhead shrike	SC	
Falco peregrinus	peregrine falcon		T
Mammals			
Plecotus rafinesquii macrotis	eastern big-eared bat		E
Amphibians			
Hyla gratiosa	barking tree frog		T

Scientific Name	Species	Federal Status	State Status
Ambystoma mabeei	Mabee's salamander		T
Insects			
Speyeria diana	Diana fritillary	SC	
Vascular Plants			
Aeschynomene virginica	sensitive joint-vetch	T	T

T= threatened, E= endangered, SC = species of concern.
Sources: VDGIF 2004; VDCR 2004.

Potential construction impacts, such as erosion, dust generation, and noise would be typical of large construction projects. These impacts could be mitigated using standard industrial procedures. Standard practices such as silt fences to control sedimentation and water sprays to limit dust generation should be protective of wetlands and other ecological resources in the site vicinity.

Construction noise could affect bald eagles nesting in the vicinity of the site. Prior to initiation of major construction activities, the presence and distribution of bald eagle nests in relation to the location of planned facilities would need to be determined. If eagle nests are in the area, mitigation measures would need to be developed. According to the Bald Eagle Protection Guidelines for Virginia (FWS and VDGIF 2000), no major construction activities should occur within 400 m (1300 ft) of an active eagle nest, and loud noises (such as blasting) should not occur during the nesting/breeding season. No active nests currently exist within 400 m (1300 ft) of the proposed construction site.

If new reactor units are constructed, very little usable habitat will remain within the proposed development area at the Surry ESP site. Operation of the proposed facility would typically result in some noise generation, salt drift, icing, fogging, and bird collisions. Noise is likely to be typical of operating reactor units and cooling towers, which have been found to be a SMALL impact (NRC 1996). However, it is possible that the such noise could deter bald eagles from nesting near the site. There are no sensitive habitat areas adjacent to the proposed site that would be adversely affected by noise from plant operations. The terrestrial vegetation in the immediate vicinity of the Surry site is not believed to be unusually sensitive to salt drift, fogging, or icing (Dominion and Bechtel 2002). However, because the cooling tower make-up water from the James River estuary is brackish (up to 17 parts per thousand of salt), the cooling tower drift may have higher salt content than at freshwater sites. Because it is likely that mechanical draft towers would be used rather than natural draft towers, bird collisions are not likely (NRC 1996). The staff evaluated the potential impacts of operation of the proposed new nuclear units, including operation of the plants, cooling systems, and transmission systems on terrestrial threatened and endangered species. Based on this evaluation, the staff concludes that the impacts of operating the proposed new units on terrestrial threatened and endangered species would be SMALL.

According to the analysis performed by Dominion and Bechtel (2002), no additional transmission lines would be required to transmit electrical power generated by new nuclear units at the Surry ESP site to the regional grid. The staff based its evaluation on the Surry ESP not requiring new transmission lines for the new nuclear units. Therefore, construction and operation of the existing transmission line rights-of-way would likely not be affected by two new nuclear units at the Surry site. NRC (2002a) determined that the impacts of continued operation of these transmission lines and maintenance of the rights-of-way would have a small impact on terrestrial ecosystems.

Based on the information provided by Dominion and its own independent review, the staff concludes that the overall impact to terrestrial ecological resources of both construction and operation of two new nuclear units and associated cooling systems and transmission line rights-of-way at the Surry site is expected to be SMALL.

8.5.4 Aquatic Resources Including Endangered Species

The aquatic environment near the Surry site is associated with the James River. The James River rises in the Allegheny Mountains near the Virginia/West Virginia border and flows in a southeasterly direction to Hampton Roads (that area of Virginia that includes Newport News, Norfolk, Portsmouth, Hampton, and surrounding cities and towns), where it enters Chesapeake Bay. The James River flows 692 km (430 mi) from its headwaters (the confluence of the Cowpasture and Jackson Rivers) to Chesapeake Bay, crossing portions of four physiographic regions: Blue Ridge, Valley and Ridge, Piedmont, and Coastal Plain. The river drains 25,900 km^2 (10,000 mi^2), just over 25 percent of the total land area of Virginia. Overall, about 71 percent of the basin is forested, 23 percent is agricultural, and 6 percent is urban. The lower James River flows through the Coastal Plain of Virginia, which is virtually flat in tidewater areas, generally ranging from 0 to 30 m (0 to 100 ft) above mean sea level (MSL).

Two major tributaries enter the river between Richmond and Hampton Roads. The Appomattox River enters the James River from the south, in the stretch of river between Richmond and Petersburg. The Chickahominy River enters from the north, just west of Williamsburg. Although the James River downstream of Richmond was severely polluted for many years, the passage of the Clean Water Act in 1972 and implementation of associated regulations, such as the National Pollutant Discharge Elimination System (NPDES), has reduced the flow of (toxic) point-source pollutants into the James River ecosystem. Pollution prevention measures and programs carried out by industrial entities in the area have further reduced chemical discharges to the James River. At present, nutrients from sewage treatment facilities, agricultural operations, and urban runoff and bacteria from combined sewer systems (those that combine storm water and sewage) are considered the chief threats to the water quality of the lower James River.

In the vicinity of Surry, the James River is approximately 4 km (2.5 mi) wide. Cobham Bay lies west (just upstream) of the Gravel Neck Peninsula and represents the approximate limit of saltwater incursion, effectively dividing the James River into a tidally influenced freshwater river upstream (to the fall line at Richmond) and an estuary downstream. The U.S. Army Corps of Engineers historically has dredged the main channel of the lower James River so ocean-going vessels can proceed upriver as far as Hopewell, approximately 80 river km (50 river mi) above the Surry site.

The lower James River supports a diverse assemblage of finfish species, ranging from exclusively marine species near Chesapeake Bay to exclusively freshwater species at the fall line in Richmond. Approximately 80 fish species are known from the brackish portion of the James River downstream of Surry, with another 40 or so species recorded from the tidally influenced (freshwater) portion of the river upstream of the Surry site. Distributions and abundances of particular species vary between seasons and years, depending on salinity differences and natural fluctuations in fish populations.

Dominion's predecessor organizations conducted extensive surveys of James River aquatic biota in the 1970s. While preparing its ESP ER, Dominion contacted Virginia Institute of Marine Sciences for more recent information (Virginia Institute of Marine Sciences 2001). The following paragraphs describe the historic Virginia Electric and Power Company (Virginia Power) data and the more recent data collected by the Virginia Institute of Marine Sciences.

Virginia Power collected 63 fish species in monthly haul seine surveys conducted from 1970 to 1978 that were intended to characterize fish populations of the shore zone in the vicinity of the Surry site. Five species made up more than 75 percent of fish collected. These were the Atlantic menhaden (*Brevoortia tyrannus*), blueback herring (*Alosa aestivalis*), inland silverside (*Menidia beryllina*), bay anchovy (*Anchoa mitchilli*), and spottail shiner (*Notropis hudsonius*). Over the same period, 42 fish species were collected in otter trawl samples that were intended to characterize fish populations in deeper waters (the "shelf zone") adjacent to the main river channel. Five species comprised more than 80 percent of fish collected in trawl samples. These species were the hogchoker (*Trinectes maculatus*), spot (*Leiostomus xanthurus*), channel catfish (*Ictalurus punctatus*), Atlantic croaker (*Micropogonias undulatus*), and bay anchovy.

Between 1996 and 2000 the Virginia Institute of Marine Sciences conducted approximately 350 deep water ichthyoplankton trawl surveys in the James River in the vicinity of Hog Island. In those collections, four species comprised more than 80 percent of the catch: hogchoker, white perch (*Morone americana*), Atlantic croaker, and bay anchovy. Spot was the fifth most abundant species. Salinity appears to be the most important factor influencing the relative abundances of fishes between the two sampling periods.

In addition to finfish, a number of invertebrate aquatic species were found in the vicinity of the Surry site. These include zooplankton (dominated by copepods), amphipods (notably the scud [*Gammarus* spp.]), and a variety of benthic organisms (e.g., polychaetes and shellfish). Shellfish formed the bulk of the benthic biomass from the transition zone in the vicinity of the Surry site to Chesapeake Bay. The brackish water clam (*Rangia cuneata*) a species capable of tolerating a wide range of salinities, dominated the benthic community in the vicinity of the Surry site. Larval American oysters (*Crassostrea virginica*) occurred in the area as meroplankton, but adults were uncommon. The more recent trawl survey collected oysters, blue crabs, spider crabs, eight species of shrimp, and five species of clams. The diversity of macroinvertebrate benthic fauna is usually low in a transition zone, increasing downstream to seawater and upstream (moderately) to freshwater. A combination of physical, chemical, and biological factors influence the distribution of benthic organisms, but, as with the finfish, salinity appears to exert the greatest influence.

No areas designated by the U.S. Fish and Wildlife Service (FWS) as "critical habitat" for endangered species exist in the James River. Virginia Power and its contractors conducted extensive surveys of fish and aquatic invertebrates in the lower James River in the vicinity of the Surry site in the 1970s. Based on these historical surveys and a review of the scientific literature, no Federally listed aquatic species is found in the lower James River. In Virginia's endangered species list, Jenkins and Burkhead (1994) identify only one threatened or endangered fish species in the entire James River drainage, the orangefin madtom (*Noturus gilberti*), which occurs in the headwaters of the river, several hundred miles upstream of the Surry site.

The Atlantic sturgeon (*Acipenser oxyrhynchus*), a candidate for Federal listing, was reported in the vicinity of the Surry site in the early 1970s and was subsequently collected in research and monitoring studies conducted by Virginia Power and Virginia Power-funded entities in the mid-to-late 1970s. A number of authorities on the fishes of Virginia and the mid-Atlantic coast also list this species as occurring in the lower reaches of the James River. The blackbanded sunfish (*Enneacanthus chaetodon*), listed as endangered by the Commonwealth of Virginia, is reported to occur in Prince George, Surry, and Sussex Counties west of the Surry site.

Although not recorded in Virginia for more than 100 years, the shortnose sturgeon (*Acipenser brevirostrum*) is on the State's list of rare animal species. This listing is based on the fact that the species occurs in major river systems north and south of the Chesapeake Bay, is presumed to have spawned in the four major estuarine drainages of the Chesapeake Bay (including the James River) in Virginia as late as the 19th century, and may reappear in the future if restoration efforts are successful. At present, the shortnose sturgeon is listed as Endangered by the National Marine Fisheries Service and by Virginia. It also appears on the Virginia Department of Cultural Resources list of "Extinct and Extirpated Animals of Virginia."

The staff evaluated the potential impacts of operating the proposed new nuclear units, including operating the plants, cooling systems, and transmission systems on aquatic threatened and endangered species. Based on this evaluation, the staff concludes that the impacts of operating the proposed new units on aquatic threatened and endangered species at the Surry site would be SMALL.

The potential for impingement and entrainment of aquatic resources is expected to be minimal because of closed-cycle cooling. The potential impacts of heated water is expected to be mitigated by the placement of the discharge structures. The overall impact on aquatic ecological resources of construction and operation of two reactor units and associated cooling towers and transmission facilities at the Surry site is expected to be SMALL.

8.5.5 Socioeconomics, Historic and Cultural Resources, Environmental Justice

In evaluating the socioeconomic impacts of construction at the Surry site, the staff made use of the license renewal supplemental EIS information (NRC 2002) and Dominion and Bechtel's (2002) analysis of potential sites. The staff also conducted a "reconnaissance" survey of the site using readily obtainable data from the Internet or published sources. No new data were collected. The socioeconomic sections follow the organizational structure of the socioeconomic discussions in Sections 2.8, 4.5, and 5.5. Both construction and station operation impacts are addressed.

8.5.5.1 Physical Impacts

Construction activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting, and dust emissions. The use of public roadways, railways, and barges would be necessary to transport construction materials and equipment. Dominion anticipates that the roadways could require some minor repairs or upgrading, such as patching and filling potholes, to allow safe transport of these materials and equipment. However, no extensive work is planned to the existing roads or railways, and no new routes would be required (Dominion and Bechtel 2002). It is expected that all construction activities would occur within the existing Surry site. Offsite areas that would support construction activities (e.g., borrow pits, quarries, disposal sites) are expected to be already permitted and operational. Impacts on those facilities from construction of the new units would be small incremental impacts associated with their normal operation.

Potential impacts from station operation include noise, odors, exhausts, thermal emissions, and visual intrusions. The new units would produce noise from the operation of pumps, dry tower fans, transformers, turbines, generators, and switchyard equipment, and noise from traffic. Dominion states in its ESP ER that any noise coming from the North Anna ESP site would be controlled in accordance with applicable local county regulations. By inference, this is also expected to apply to the Surry site. Virginia has no State regulations or guidelines regarding noise limits. Commuter traffic would be controlled by speed limits. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the ESP site (Dominion 2004).

The new units would have standby diesel generators and auxiliary power systems. Permits obtained for these generators would ensure that air emissions comply with regulations. In addition, the generators would be operated on a limited short-term basis. During normal plant operation, the new units would not use a significant quantity of chemicals that could generate odors exceeding odor threshold values. Good access roads and appropriate speed limits would minimize the dust generated by the commuting workforce (Dominion and Bechtel 2002).

Construction activities would be temporary and would occur mainly within the boundaries of the Surry Power station site. Offsite impacts would represent small incremental changes to offsite services supporting the construction activities. During station operations, noise levels would be managed to local ordinances. Air quality permits would be required for the diesel generators, and chemical use would be limited, which should limit odors. Based on the information provided by Dominion and its own independent review, the staff concludes that the physical impacts of construction and operation is expected to be SMALL.

8.5.5.2 Demography

The population base is considered to be the population of significant population centers within a 80-km (50-mi) radius of the Surry site. The combined population of the Richmond-Petersburg and Norfolk-Virginia Beach and Newport News, Virginia Metropolitan Statistical Area is 2,566,050 (USCB 2000a). The estimated population within an 80-km (50-mi) radius of the Surry site is 2,387,353 and is projected to grow by approximately 41 percent to 3,365,040 by 2030, (NRC 2002).

Most of the construction workforce is expected to come from within the region, and those who might relocate to the region would represent a small percentage of the larger population base. While the station operation workforce is expected to relocate into the region, their numbers are small (720 new operating employees and their families) when compared to the total base population and their locations of residence would probably be scattered throughout the region. Based on the information Dominion provided in its ER, in Dominion and Bechtel (2002), and its own independent review, the staff concludes that any increase in the population due to construction and operation within an 80-km (50-mi) radius of the site is expected to be SMALL.

8.5.5.3 Community Characteristics

Economy

The Surry site is located in one of the strongest economic areas in Virginia. The Richmond-Petersburg area is the primary economic driving force in the area within an 80-km (50-mi) radius of Surry. The Norfolk-Virginia Beach-Newport News area is characterized by the U.S. Navy's significant presence in the area (NRC 2002). Hampton Roads relies heavily on defense-related industry, particularly shipbuilding. In recent years, the regional economy has become more diversified with major businesses, financial and health care components, as well as a growing "high-tech" sector. Regionally, the service sector now offers the most employment opportunities. The construction and operation of two new nuclear units at the Surry site would be expected to benefit the economy of the region, especially Surry County.

Based on the information provided by Dominion and its own independent review, the staff reviewed the impacts of station construction and operation on the economy of the region and concludes that the impacts would be SMALL everywhere in the region except Surry County, where the impacts could be beneficially MODERATE. The magnitude of the economic impacts would be diffused in the larger economic bases of Henrico and Spotsylvania Counties and the City of Richmond. With Surry County's smaller economic base, the economic impacts would be more noticeable.

Availability of Workers

Dominion estimates it would take approximately 5000 construction workers more than 5 years to build two new nuclear units at the Surry site (Dominion 2004). Dominion is expected to be able to attract the necessary workforce for construction activities at the Surry site because of its proximity to the major population centers of Richmond-Petersburg and Norfolk-Virginia Beach and Newport News. While the availability of craft workers for outages at Surry is reported as very limited, this can be attributed to the short duration of the projects. However, the availability of craft workers for regular construction projects of longer duration is reported to be good (Dominion and Bechtel 2002). Construction workforce within 80 km (50 mi) of the site were estimated to number approximately 98,000 (Dominion and Bechtel 2002).

Approximately 990 employees work at Units 1 and 2 of the Surry site, (about 110 contract employees and 880 permanent employees). The addition of the proposed new units would require an increase in the operations workforce of 720 employees. In its ER, Dominion stated that it expected most of the operations labor force for the new units would relocate from outside the region. The ER does not address from where these employees would come (Dominion 2004). Some nuclear defense sites are reducing their workforces as they change missions (such as Portsmouth, Ohio, and the Savannah River Site), and workers from these sites could be potential pools of labor for the operating workforce at Surry.

Based on the information provided by Dominion and its own independent review, the staff concludes that the impact of the availability of construction and operating workers for the new units would be SMALL. Construction labor would be available from within the region, and there would be little problem recruiting the required labor skills to enable the construction of the nuclear units at the Surry site. The operations workforce would relocate to the region.

Transportation

The area around the Surry site is served by several major freeways and State and Federal highways (NRC 2002). The most direct vehicular access to the Surry site is from the more populous cities and counties on the north bank of the James River via State Route (SR) 31 and the James River Ferry service, operated by the Virginia Department of Transportation. The principal road access to the Surry site is via SR 650, which is a two-lane paved road. SR 650 carries a level-of-services (LOS) designation of "A," which reflects a free flow of traffic stream and users unaffected by the presence of others.

The construction of new nuclear units would require additions to the workforce. In addition, construction materials, wastes, and excavated materials would be transported both to and from the site. These activities would result in increases in operation of personal-use vehicles by commuting construction workers, in commercial truck traffic, and in traffic associated with daily operations. However, five of the seven reactor types under consideration for this project are generally smaller and modular in nature. Consequently, transportation of plant equipment could be less challenging and workforce requirements are expected to be less than those for the conventional nuclear plants (Dominion and Bechtel 2002).

The LOS designation on Highway 650 would likely be degraded from "A" to "C" (which reflects a stable flow that marks the beginning of the range of flow in which the operation of individual users is significantly affected by interactions with the traffic stream) during the peak construction period for a new nuclear plant at the Surry site (Dominion and Bechtel 2002). See Table 2-14 for the LOS definitions.

SR 650 intersects SR 10 approximately 8 km (5 mi) from the plant. SR 10 in the vicinity of the site, from Surry County Courthouse to the divergence of the business and bypass north of Smithfield, carries a LOS designation of "C." Portions of Highway 10 would receive significantly more traffic during plant construction (NRC 2002; Dominion and Bechtel 2002).

No direct rail access is available to the Surry site, so large equipment would have to be offloaded and transported by road and/or barge from the nearest rail access points in Richmond or Norfolk. Surry has an excellent barge slip adjacent to the cooling water intake. This slip was used for the transport of the replacement steam generators in the late 1970s and is regularly used to receive spent fuel storage casks and other large loads (Dominion and Bechtel 2002).

The Williamsburg-Jamestown Airport, Newport News/Williamsburg International Airport, Norfolk International Airport, and the Richmond International Airport all serve the area. The airports in Richmond and Norfolk provide regular freight and passenger jet services and are of sufficient size to accommodate the relatively small air shipments normally associated with a construction project (Dominion and Bechtel 2002).

The impact of station operation employees on the transportation system would be less than the impact incurred during construction. There would be increases in operation of personal-use vehicles by commuting operators of both the existing and new units and in traffic associated with daily operations. Portions of Highway 10 may be impacted by commuters to the plant site, particularly during shift changes. During new plant operation, the LOS designation on SR 650 may retain its "A" status or perhaps degrade to "B" designation, which reflects a condition of stable flow instead of the free flow indicated under an "A" designation. This change in designation indicates that the freedom to select speed is unaffected, but the freedom to maneuver is slightly diminished (Dominion and Bechtel 2002).

Based on a review of information provided by Dominion and its own independent review, the staff concludes than that the impacts of a construction workforce and related transportation of construction supplies and materials on transportation infrastructure at Surry would be SMALL to MODERATE (but temporary). Some of the local roads could have their LOS degraded during construction to the point where operations of individual drivers could be significantly affected by interactions with the rest of the traffic. This would be at LOS levels of C or lower. Also it possible that, given the heavy loads carried by vehicles transporting construction materials to the Surry site, some of the roads may need repair to carry the additional load. The impacts during operation are expected to be SMALL.

Taxes

Construction and operations workers would pay income, sales, and use taxes to Virginia and the local governments in the region where sales take place and property taxes to the counties in which they own a residence. Sales and use taxes would be paid from the sales of construction materials and supplies purchased for the project and on expenditures of both the construction and operations workforce for goods and services. Dominion estimates that about half of the day-to-day expenditures during construction would occur in the region (Dominion 2004). Corporate income taxes on profits would also be paid by those companies engaged in construction at the site.

There are two types of property taxes in Virginia. The first is the tangible personal property tax paid by contractors during construction of the additional units. This tax is based on the value of property owned by the contractors that acquire taxable status in Surry County during the construction period. The second is the real property tax levied for the incremental increase in value to the entire site from the operation of the additional units. It is expected that Surry County would be the only beneficiary of this tax. Dominion has a significant impact on the economic well-being of Surry County, with Dominion paying well over 70 percent of the property taxes between 1996 and 2000 (NRC 2002).

Based on the information provided by Dominion and its own independent review, the staff concludes that the overall impacts from construction and operation of taxes collected through the income, sales and use, and property taxes would be SMALL (with the exception of Surry County for property taxes). The taxes paid, while substantial, are nevertheless a small sum when compared to the total amount of taxes collected by Virginia and local governments in the region. The staff concludes the overall impacts of the property taxes collected in Surry County would be beneficially MODERATE (construction) and LARGE (operation) relative to the total amount of taxes the county collects through property taxes.

Aesthetics and Recreation

Although the Surry site is clearly an industrial site, its current structures are not visually obtrusive from any vantage point, even from across the James River. However, Units 1 and 2 at the Surry site are visible from the highest amusement rides at Busch Gardens (Dominion and Bechtel 2002). The reasons for the lack of visual intrusiveness are the general wooded habitat surrounding the site and the fact that Units 1 and 2 reactor/containment buildings are sunk into the ground to minimize visual obtrusion from offsite. Five of the seven new reactor technologies being considered for the Surry site could be designed to allow the reactor/containment building to be placed lower in the ground. The AP1000, which has a reactor/containment building approximately 71 m (234 ft) above grade and could potentially be more easily seen from Williamsburg across the James River from the Surry site. Dominion states that the AP1000 would be too expensive to redesign to allow the building to be placed lower in the ground. In its ER, Dominion did not address the feasibility of adapting the remaining reactor technology to minimize visual intrusiveness (Dominion and Bechtel 2002).

The Surry site is a minimum of 5 km (3 mi) from any point across the James River. Except for the west side of the site, which is open to the James River, the dense tree stands surrounding the site effectively screen it from all but a few locations. No parks or recreational areas are within 3 km (2 mi) of the Surry site. The closest recreational park is Chippokes State Park located 4 km (2.5 mi) to the southwest (NRC 2002). The only distinguishable view of the transmission lines by offsite observers is available from the James River (Dominion and Bechtel 2002).

The addition of new nuclear units at the site would likely require the use of mechanical draft cooling towers rather than the taller natural draft towers. Traditionally, visible plumes generated by the operation of cooling towers could cause a negative aesthetic effect. However, with the installation of modern drift eliminators, use of cooling towers would not create long, elevated visible plumes (Dominion and Bechtel 2002), so the aesthetic effect would likely be minimal.

Most construction activities would be screened from offsite viewing. The exception may be the reactor/containment building as it nears completion. For five of the seven reactor technologies under consideration, there is flexibility in lowering the reactor/containment buildings into the ground, which would minimize visual impacts. During operations visible plumes could be generated by the cooling towers. Based on the information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and operation on aesthetics in the vicinity of the Surry site would be SMALL to MODERATE.

Housing

A 10 percent vacancy rate out of a total 110,250 housing units currently exists in Isle of Wight, Surry, and James City Counties and Newport News Independent City. Surry County has the highest vacancy rate at 20 percent (NRC 2002). Given the closeness of the Surry site to four major metropolitan areas, housing for construction workers, most of whom will be coming from within the region, and the operations workforce is expected to be available.

Based on the information provided by Dominion and its own independent review, the staff concludes that the impacts of a construction and operations workforce on the demand and housing availability would be SMALL. The conclusion is based on approximately 10,000 vacant housing units in the region and the Surry site's proximity to the larger metropolitan areas in the region.

Public Services

Water Treatment Facilities

Isle of Wight County has municipal water supply systems in the towns of Windsor, Smithfield, and Franklin. Permitted groundwater wells supply these systems. Surry County has municipal water supply systems in the towns of Claremont, Dendron, and Surry. The municipal water supply for James City County is provided by the Newport News Waterworks and the James City Service Authority. Newport News Waterworks is one of the top 100 largest water utilities in the United States and one of the three largest in Virginia. James City Service Authority's water system consists of the central system with 29 well facilities and six independent water systems with five well facilities servicing them. Public water supply for Newport News is provided by the Newport News Waterworks. Water is supplied to nearly 400,000 residents of Poquoson, Hampton, and Newport News, and to portions of York and James City Counties. The primary source of raw water is the Chickahominy River. Water supply needs in the intermediate term are expected to be met, with all towns and cities in the region having excess capacity (NRC 2002).

Water supply needs near the Surry site are not a current concern with all towns and cities in the region having excess capacity. Most of the construction workforce would come from within the region, and therefore are already accounted for in the demands being placed on the systems and their excess capacities. The station operating workforce, while relocating to the region, would probably take up residence across the region, thus not particularly impacting any one community or jurisdiction. Based on based on the information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and operation on water supply treatment facilities would be SMALL.

Police, Fire, and Medical Facilities

In the larger metropolitan areas of Richmond and Henrico County and Norfolk, Hampton Roads, and Virginia Beach, police, fire, and medical facilities would not be materially impacted by an increase in the construction workforce. Many of the construction workers are anticipated to already live in the region and would commute to the Surry site. As a result, these workers are already served by existing services and facilities.

The operations workforce of about 720 workers and their families is anticipated to relocate to the site from outside the region. Most likely they would locate in residences across the region and would not concentrate in one location. As such, inordinate demands are not likely to be placed on these services and facilities.

Most construction workers already live within the region. The incoming operations workforce would likely have residences scattered across the region. As a result, there should be minimal new demands placed on these services and facilities by either construction or operations employees. Based on the information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and operations workforce on police, fire, and medical facilities would be SMALL.

Social Services

Social services in the state are provided in each county by the Virginia Department of Social Services. The department provides a variety of services to children and adults. The department has 131 local departments located throughout Virginia (VDSS 2004). During the construction phase at the Surry site, there may be an increased demand for social services.

Generally, construction and operation of the new nuclear units at the Surry ESP site would be viewed as beneficial economically to the disadvantaged population segments served by Virginia Department of Social Services. The workforce associated with the Surry ESP site would be relatively higher paid than other employment categories in the region. Construction and operation of the new units, through the multiplier effect, may enable members of the disadvantaged population to improve their social and economic position by moving up to higher paying jobs. At a minimum, the expenditures of the construction and operations workforce in the counties for food, services, etc. could, through the multiplier effect, increase the number of jobs that could be filled by the disadvantaged population.

Based on the information provided by Dominion and its own independent review, the staff concludes that the demand for social and related services as a result of construction and operation of the new facility would be SMALL. Construction and operation of two new units would be expected to have a beneficial economic impact to the economically disadvantaged population of the region, which should lessen the demand for social services. There could be an initial increase in demand for social services at the beginning of the construction period, but this is considered manageable and limited.

Education

The Surry County School system has just over 1200 students (Great Schools 2004). There currently is no overcrowding in the system (NRC 2002). In the other counties and cities of the region, it is anticipated that the construction and operations workforce would minimally impact school infrastructure. Many construction workers already live within the region. Those that do not live within the area are not expected to move their families into the area. This conclusion is based on Dominion's assertions in its ER for the North Anna ESP site (Dominion 2004), and by inference is applicable to the Surry site due to geographical proximity of the two sites. The operations workforce, while coming from outside and relocating into the region, would probably be scattered throughout the region, placing little demand on school infrastructure as a result.

It is anticipated that most of the construction workforce would come from within the area and not relocate their families. Those construction and operations workers potentially relocating to the region would most likely be scattered throughout the region and, as a result, would not be in sufficient concentrated pockets to place an undue burden on the existing infrastructure. Based on the information provided by Dominion and its own independent review, the staff concludes that the impacts of the construction and operations workforce on education facilities in Surry County and the area would be SMALL.

8.5.5.4 Historic and Cultural Resources

Historic and cultural resources at the Surry site have been addressed in the recent supplemental EIS relating to renewal of the existing operating licenses for Surry Units 1 and 2 (NRC 2002) and supporting information (The Louis Berger Group, Inc. 2001). Associated with that effort was consultation with eight Commonwealth of Virginia-recognized Native American Indian Tribes, including the Chickahominy Indian Tribe, Chickahominy Indians-Eastern Division, Mattaponi Indian Tribe, Monacan Indian Nation, Nansemond Indian Tribe, the Pamunkey Indian Tribe, the Rappahannock Tribe, and the Upper Mattaponi Indian Tribe.

While there are no presently recorded historic and cultural resources at the Surry site, evaluations of the potential for such occurrences included acreages with the following designations: No Potential (areas previously disturbed during initial construction of the plant), Low Potential (areas that may or may not have been disturbed during construction and areas with little potential for human occupation), and Moderate-to-High Potential (areas with little past surface disturbance and with a likelihood for prehistoric and historic sites based on regional comparative data). Should this alternate site be selected for an ESP, Dominion would consult with the Virginia Department of Historic Resources concerning the need for additional field inventory of acreage for historic and cultural resources prior to undertaking any ground-disturbing activities.

Based on information provided by Dominion and its own independent review, the staff concludes that the potential impacts on historic and cultural resources from construction would be SMALL, and operation of two new nuclear units at the a power station at the Surry site would be also be SMALL.

8.5.5.5 Environmental Justice

As part of the evaluation of the potential environmental justice impacts related to the Surry site, the staff used information from NRC's supplemental EIS for the license renewal of Surry Units 1 and 2 (NRC 2002). The pathways through which the environmental impacts associated with the construction of two additional new nuclear units at the Surry site could affect human populations were ascertained. The staff then evaluated whether minority and low-income populations could be disproportionately affected by these impacts. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing, through which the populations could be disproportionately affected. In addition, the staff did not identify any location-dependent disproportionate impacts affecting these minority and low-income populations.

Based on the information provided by Dominion and its own independent review, the staff concludes that the offsite impacts of construction and operation of the new units at the Surry site to minority and low-income populations would be SMALL. No disproportionately high and adverse impacts affecting minority and low-income populations were identified.

8.6 Evaluation of the Portsmouth ESP Site

Dominion identified a 138-ha (340-ac) parcel of land in the northeastern portion of the Portsmouth site in Ohio as a possible location for two commercial nuclear units (i.e., the proposed ESP site) (Dominion and Bechtel 2002). The parcel has been evaluated by DOE and slated for transfer from DOE to the Southern Ohio Diversification Initiative for possible reindustrialization (66 FR 64963).

For this evaluation, the following assumptions were made by the staff about the proposed ESP site at Portsmouth:

- The proposed units would use closed cycle cooling.
- Natural or mechanical draft cooling towers would be employed.
- Groundwater would be the source of cooling water (ostensibly from the Scioto River).

- The proposed plant would discharge blowdown water to the Scioto River.
- The land area for the ESP site would be approximately 140 ha (340 ac).
- Additional transmission lines would be needed.

The Portsmouth site is located in Pike County, Ohio, approximately 35 km (22 mi) north of the Ohio River and 5 km (3 mi) southeast of the town of Piketon. The Portsmouth site vicinity is shown in Figure 8-3.

Pike County's largest community, Waverly, is about 16 km (10 mi) north of the Portsmouth site and has a population of about 4400 residents. The nearest residential center to the site is Piketon, which is about 8 km (5 mi) north on U.S. 23; its 2000 population was approximately 1900. Additional population centers within 80 km (50 mi) of the plant are Portsmouth (population 20,909), 35 km (22 mi) south; Chillicothe (population 21,796), 43 km (27 mi) north; and Jackson (population 6184), 29 km (18 mi) east (Bechtel Jacobs 2003). Approximately 90 percent of Portsmouth site workers reside in Jackson, Pike, Ross, and Scioto Counties. The estimated 2003 population of the four counties is 215,700 (DOE 2003). The primary facility at the Portsmouth site is the Portsmouth Gaseous Diffusion Plant, a gaseous diffusion uranium enrichment plant previously operated first by DOE until 1993 and since then by the United States Enrichment Corporation (USEC). Uranium enrichment operations were discontinued in May 2001 and the plant was placed in cold standby, a nonoperational condition in which the plant retains the ability to resume operations within 18 to 24 months.

In December 2002, USEC announced that the Portsmouth site will be the location for a Lead Cascade Demonstration Facility for advanced centrifuge enrichment technology (SAIC 2004). NRC has recently authorized possession and use of source and special nuclear material at the proposed enrichment facility (69 FR 3956). In addition, USEC announced on January 12, 2004, that the Portsmouth site was selected as the location for a new $1.5 billion advanced centrifuge commercial plant (referred to as the American Centrifuge Uranium Enrichment Plant), expected to be operational by the end of the decade (DOE 2003). USEC submitted a license application for this proposed facility to the NRC on August 23, 2004.

The Portsmouth site encompasses approximately 1500 ha (3714 ac) including a 320-ha (800-ac) fenced core area that contains the former production facilities. The 1180-ha (2914-ac) area outside the core area includes restricted buffers, waste management areas, plant management and administrative facilities, gaseous diffusion plant support facilities, and vacant land. The site is 3 km (2 mi) east of the Scioto River in a small valley that runs parallel to and approximately 37 m (120 ft) above the Scioto River floodplain (Bechtel Jacobs 2003). Wayne National Forest borders the plant site on the east and southeast, and Brush Creek State Forest is located to the southwest, slightly more than 1.6 km (1 mi) from the site boundary. On the basis of an analysis of Landsat satellite imagery from 1992, dominant land cover categories in

Pike County include deciduous forest (64.6 percent), pasture/hay (21.6 percent), and row crops (10.3 percent) (DOE 2003).

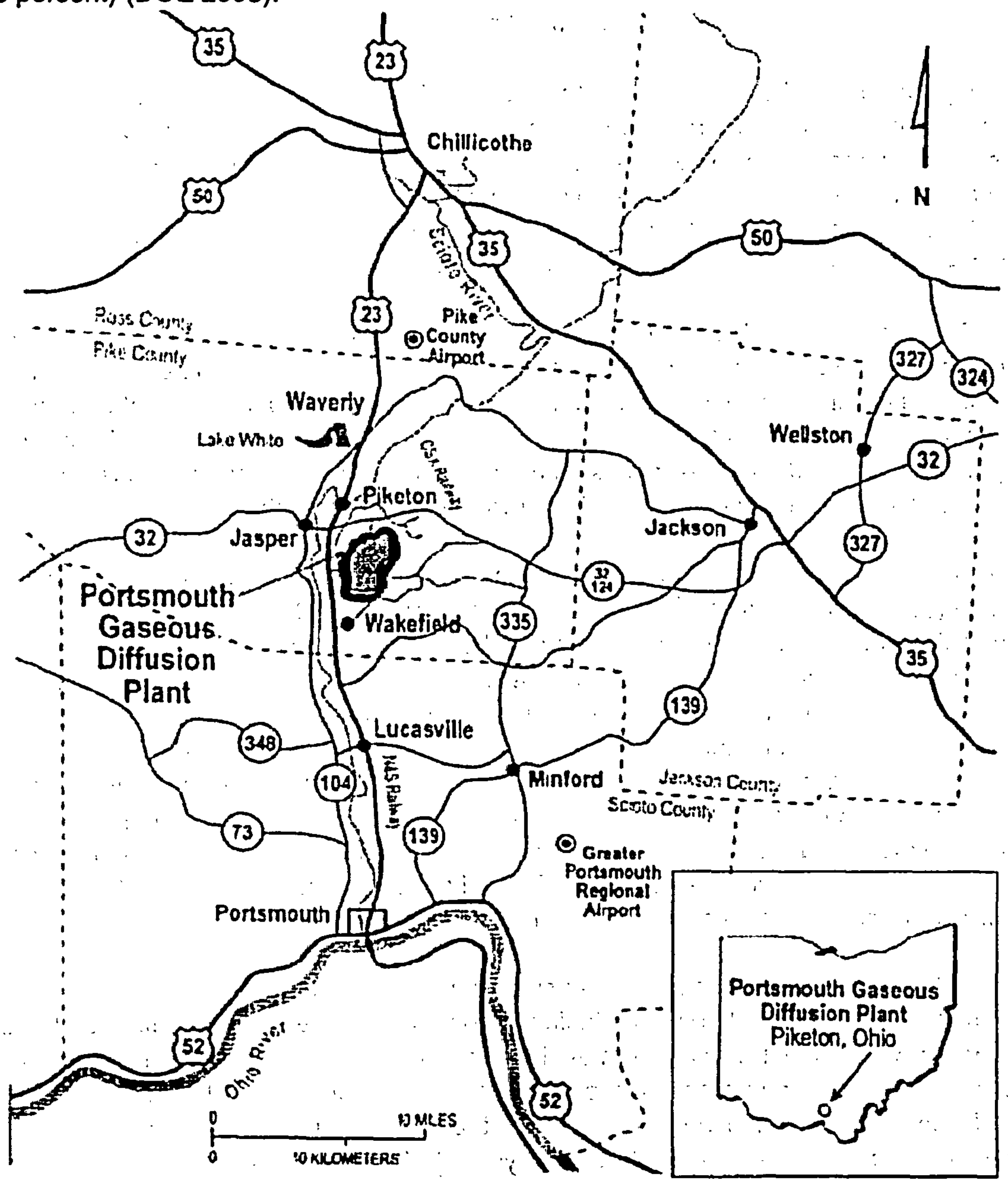


Figure 8-3. Portsmouth Gaseous Diffusion Plant Site Vicinity Map.

Water for the Portsmouth site comes from an onsite water treatment plant that in turn draws water from offsite supply wells adjacent to the Scioto River. The Ohio Valley Electric Corporation supplies the site with electrical power.

The topography of the Portsmouth site area consists of steep hills and narrow valleys, except where major rivers have formed broad floodplains. The site is underlain by bedrock composed of shale and sandstone. The most common type of vegetation on the Portsmouth site is managed grassland, which makes up approximately 30 percent of the site or about 445 ha (1100 ac). Approximately 28 percent of the site is forested, predominately stands of oak-hickory and mixed hardwood (DOE 2003).

The Portsmouth site is located in the humid continental climatic zone and has weather conditions that vary greatly throughout the year. The site is in a rural setting, and no residences or other sensitive locations (e.g., schools or hospitals) exist in the immediate vicinity of the site. The Portsmouth site has direct access to major highway and rail systems, a nearby regional airport, and barge terminals on the Ohio River. Use of the Ohio River barge terminals requires transportation by public road to or from the Portsmouth site.

The site is located within the Western Allegheny Plateau ecological province (Omernick 1987). The hilly, forested areas of the 138-ha (340-ac) proposed ESP site were harvested for timber before the Portsmouth facilities were established. The eastern portion of the site has steep forested slopes while the central and western area is composed mainly of old fields and managed grasslands that are not considered unique habitat or environmentally sensitive areas. Little Beaver Creek runs through the southwestern part of the 138-ha (340-ac) ESP area and is identified as having riparian forest along its banks (DOE 2003). Oak-hickory forest borders the riparian forest. Other than Little Beaver Creek, there are only about 1 ha (2 ac) of wetlands within the proposed ESP site. There is one Federally listed endangered species (the Indiana bat [*Myotis sodalis*]) and one non-listed Federal species of concern (the timber rattlesnake [*Crotalus horridus*]) that potentially could be found on the site.

The Portsmouth site itself has provided significant socioeconomic benefits for the surrounding communities over the last 50 years, including jobs with above-average salaries. DOE does not pay property taxes to the local communities around the Portsmouth site. However, it has provided $12.9 million in grants to the Southern Ohio Diversification Initiative. Other economic benefits include the collection of sales tax on the uranium enrichment services. Sales, property, and income taxes have been paid over the years to Ohio and local governments by employees working at the site (Dominion and Bechtel 2002).

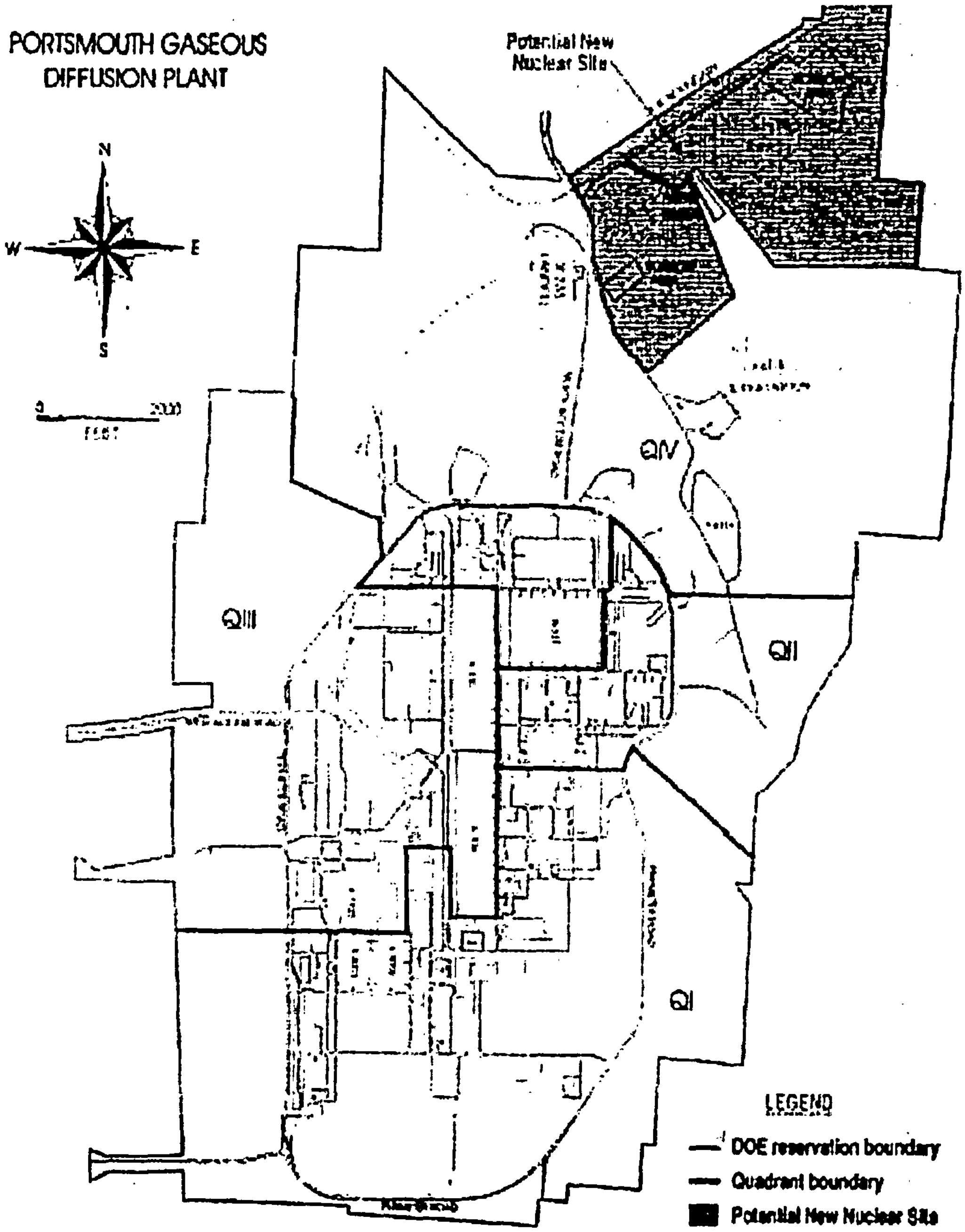
Major economic activities around Portsmouth consist mainly of farming, lumbering, and small businesses. Other industries include a cabinet manufacturer and an automotive parts manufacturer. The site itself has no prime agriculture lands. Sufficient public transportation (rail and road) is present to support activities at the site (Dominion and Bechtel 2002).

8.6.1 Land Use Including Site and Transmission Lines

The proposed ESP parcel at the Portsmouth site is irregular in shape. At its widest points, the parcel spans about 1737 m (5700 ft) in the north-south direction and about 1798 m (5900 ft) in the east-west direction. The parcel is in a mostly undisturbed part of the site. No hazardous substances have been stored, released, or disposed of on the parcel (Dominion and Bechtel 2002). The closest disturbed land is used by security personnel for training and as a firing range. The firing range is outside the 138-ha (340-ac) parcel, but is adjacent to its Portsmouth site boundary lines. The location of the 138-ha (340-ac) parcel is shown in Figure 8-4. Two commercial nuclear units sited at the Portsmouth site would need to have an exclusion area that meets NRC requirements (10 CFR 100.21(a)). The exclusion area is the area surrounding the reactor within which the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property from the area (10 CFR 100.3).

Six wetland areas comprise approximately 1 ha (2 ac) within the 138-ha (340-ac) parcel (66 FR 64963). Five of these areas are ditches within a borrow area. The remaining wetland is associated with a previously disturbed natural area. Dominion determined that construction activities could take place without affecting the wetland areas (Dominion and Bechtel 2002).

Land within 8 km (5 mi) of the Portsmouth site is used primarily for farms, forests, and urban or suburban residences (Dominion and Bechtel 2002). About 10,291 ha (25,430 ac) of farmland, including cropland, wooded lots, and pasture, lies within 8 km (5 mi) of the site. The cropland is mostly found on or adjacent to the Scioto River flood plain and is farmed extensively, particularly with grain crops. The hillsides and terraces are used as pasture for both beef and dairy cattle. There are no state or national parks, conservation areas, wild and scenic rivers, or other areas of recreational, ecological, scenic, or aesthetic importance within the immediate vicinity of the Portsmouth site. There are approximately 9874 ha (24,400 ac) of forestland within 8 km (5 mi) of the site. This land includes some commercial woodlands and a small portion of Brush Creek State Forest. A relatively small area of urban land, about 206 ha (510 ac), is also within 8 km (5 mi) of Portsmouth. This land is situated primarily in and around Piketon, approximately 5.6 km (3.5 mi) north of the center point of the Portsmouth site.



1 **Figure 8-4.** Potential New Nuclear Station Site at Portsmouth.

2

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The Portsmouth site is about 113 km (70 mi) south of Columbus, Ohio, and 121 km (75 mi) east of Cincinnati, Ohio, the two closest metropolitan areas. Huntington, West Virginia, is approximately 140 km (87 mi) away. The cities of Portsmouth, Jackson, and Chillicothe, Ohio, are approximately 40 km (25 mi) from the facility (south, east, and north, respectively). There are numerous small towns within 80 km (50 mi) of the site. Together, these communities could supply an adequate appropriate workforce for construction of new generating units and are within a 2-hour commuting distance via local transportation routes (Dominion and Bechtel 2002). The regional transportation network consists of two major highways, U.S. Route 23 and SR 32, and numerous SRs including 35, 52, 124, and 139. Offsite land-use impacts associated with construction of new nuclear generating units are likely to be relatively limited, given the temporary nature of the construction. Construction of new rental housing and/or new manufactured home and recreational vehicle parks could be expected to accommodate construction workers.

The majority of current Portsmouth workers live in Scioto and Pike Counties and in the City of Portsmouth, which is the county seat of Scioto County (DOE 2003). The staff assumed that workers at two commercial nuclear units located at the Portsmouth site would also primarily live in Scioto and Pike Counties. Some new housing in Scioto and Pike Counties plus surrounding communities would likely be constructed to accommodate permanent workers at the new units. The property tax revenue from the new units could affect future land use in the area surrounding the plant as a result of infrastructure improvements made possible by the tax revenue.

Based on the information provided by Dominion and its own independent review, the staff concludes that the land-use impacts on the site and vicinity of construction and operation would be SMALL.

An extensive existing electric power transmission system serves the Portsmouth site. During previous full power operations of the enrichment facility, the site imported approximately 1900 MW(e) of power with a reported system capacity of approximately 2260 MW(e) (Dominion and Bechtel 2002). One or more relatively short transmission lines (approximately 900 m [3000 ft]) could be used to connect to the existing transmission system serving the Portsmouth site. Transmission lines that would be constructed to connect new power reactors with the existing Portsmouth transmission system would primarily cross previously developed industrial lands within the boundaries of the Portsmouth site (Dominion and Bechtel 2002). Otherwise, relatively little land would be altered for the construction of the new lines, and the staff concluded that the overall impacts of constructing new lines and operating and maintaining them would be SMALL.

8.6.2 Water Use and Quality

Whether the consumptive water use for the Portsmouth site was provided indirectly from the Scioto River aquifer via groundwater wells as expected or directly from the river itself, the consumptive water use for a power reactor at the Portsmouth site would impact the Scioto River. Groundwater in the aquifer is directly connected to the Scioto River. The aquifer is a major source of water to domestic, industrial, and agricultural users in the region.

The staff reviewed streamflow records reported by the USGS for stream gauge 03231500 (Scioto River at Chillicothe, Ohio). This gauge reflects runoff from a drainage of 9969 km^2 (3849 mi^2) and has data for the period from 1921 to present. Using these data, the staff independently estimated the 7Q10 and 30Q2 values. The 7Q10 is the lowest 7 day discharge for low water condition that is estimated every 10 years. For this gauge the 7Q10 was estimated to be 5.72 m^3/s (202 cfs). The 30Q2 is the lowest 30 days of flow in an average year. For this gauge the 30Q2 is estimated to be 11.4 m^3/s (403 cfs). The 7Q10 provides an estimate of the short-term, low-flow conditions in a dry year. The 30Q2 provides an estimate of the intermediate-term low-flow conditions in an average year.

The maximum make-up water flow rate for a single unit is estimated in the PPE as 2.78 m^3/s (98.0 cfs); however, the portion of the flow not evaporated is ultimately returned to the river as blowdown flow. Based on the PPE, the maximum evaporation for a single unit using mechanical draft cooling towers is 1.23 m^3/s (43.5 cfs). For either one or two units this represents a significant fraction of both the 7Q10 and the 30Q2 values. Some mitigation, such as aquifer recharge, offstream storage, etc, may be required to limit the impacts to other water users in the region. Therefore, the staff estimates water use impacts at the Portsmouth site during construction would be SMALL, and during operation would be SMALL to MODERATE except during drought years when the impact is expected to be MODERATE. Discharge of thermal and chemical effluents would be regulated by the State of Ohio's NPDES permitting process to limit water quality impacts to the Scioto River, therefore water quality impacts during construction and operation would be expected to be SMALL.

8.6.3 Terrestrial Resources Including Endangered Species

Site preparation and construction of one or more nuclear reactor units at the Portsmouth ESP site would result in the loss of approximately 138 ha (340 acres) of wildlife habitat. In general, the types of habitat that would be lost are relatively common in south-central Ohio, and are not considered to be unique or sensitive. Less than 0.4 ha (1 ac) of wetlands would be disturbed for the development of this site (Dominion and Bechtel 2002). Site development would have the potential to result in erosion, dust generation, and noise impacts that are typical of large construction projects. These could be mitigated using standard methods of erosion control, dust suppression, and noise abatement.

Site development could result in the loss of habitat for several Federally or State-listed species (Table 8-4). The Indiana bat (*Myotis sodalis*) could inhabit the riparian forest along Little Beaver Creek, while the rough green snake (*Opheodrys aestivus*) and sharp-shinned hawk (*Accipiter striatus*) may inhabit the forested portions of the proposed development site. The timber rattlesnake (*Crotalus horridus*) has not been observed on the Portsmouth site, but is believed to occur in the vicinity. DOE has indicated that additional field surveys and evaluations would be required prior to development of this location (Dominion and Bechtel 2002).

Table 8-4. Federally and State-Listed Threatened or Endangered Terrestrial Species Potentially Near the Portsmouth ESP Site

Scientific Name	Species	Federal Status	State Status
Mammals			
Myotis sodalis	Indiana bat	E	E
Birds			
Accipiter stiatus	sharp-shinned hawk		E
Reptiles			
Crotalus horridus	timber rattlesnake		E
Opheodrys aistivus	rough green snake		S
Plants			
Rhexia virginica	Virginia meadow-beauty		P
Xyris difformis	Carolina yellow-eyed grass		E

E= endangered, S = Special concern, P= potentially threatened.
Sources" DOE 2003 (Draft EIS for construction and operation of a depleted uranium hexaflouride conversion facility at the Portsmouth, Ohio, Site. DOE/EIS-0360, Dec. 2003) occur in the vicinity. DOE has indicated that additional field surveys and evaluations would be required prior to development of this location (Dominion and Bechtel 2002).

Development of the site could adversely affect at least two Ohio State listed plant species, the Virginia meadow-beauty (*Rhexia virginica*) and the Carolina yellow-eyed grass (*Xyris difformis*). Evaluations for these species would be required prior to site development. Pending site specific surveys for Federally and State-listed species, site preparation and construction at the proposed location within the Portsmouth site would not result in noticeable or destabilizing impacts to the terrestrial ecology of the site. Therefore, pending more detailed evaluations of threatened and endangered species, the construction impacts would be SMALL. If the Federally or State-listed animal species are observed at the site, the impacts may be larger.

If new reactor units were constructed, it would be expected that very little usable habitat would remain within the proposed area at the Portsmouth ESP site. Operation of the facility would likely result in noise generation, and if wet cooling towers were employed, there could be impacts caused by salt drift, icing, fogging, and bird collisions. Noise is likely to be typical of operating reactor units and cooling towers, which has been found to have a minimal impact in most instances (NRC 1996). There are no sensitive habitat areas adjacent to the proposed site that would be adversely affected by noise from plant operations. The terrestrial vegetation in the vicinity of the Portsmouth ESP site is not believed to be unusually sensitive to salt drift, fogging, or icing (Dominion and Bechtel 2002). Bird collision impacts would not be expected to be different from most other power plants (NRC 1996). Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of operation of one or more reactor units at the Portsmouth ESP site on terrestrial systems would be SMALL.

Transmission lines that would be constructed to connect new power reactors with the existing Portsmouth transmission system would primarily cross either industrial lands or early-successional plant communities that are not considered to be unique in the region or otherwise sensitive. One exception is the potential for Indiana bats to inhabit the riparian zone along Little Beaver Creek. Additional evaluations and habitat preservation precautions may be required if the transmission lines cross this habitat. Otherwise, very little land would be altered for the construction of the new lines, and the overall impacts of constructing new lines would be minimal and would be similar to those of the construction of the reactor units.

Dominion has not indicated the specific maintenance procedures that would be followed for the new transmission lines, but would likely include regular mowing and herbicide applications as needed. The primary area of potential concern is whether the lines must cross Little Beaver Creek, where precautions to protect Indiana bats and their habitat may be required. Additionally, there are at least two rare plant species that could occur within transmission lines rights-of-way and could therefore be affected by transmission line maintenance. Additional evaluations for the Indiana bat and rare plant species would be needed. Otherwise, because the proposed transmission lines are short, entirely within the bounds of the Portsmouth site, and cross areas that have been previously disturbed, the impacts of operation and maintenance of the transmission line system on the terrestrial ecology are expected to be minimal. No special mitigation measures would be required, except protection of the riparian zone along Little Beaver Creek and conservation of rare plant species, if present.

Based on information provided by Dominion and its own independent review, the staff concludes that the overall impact of the construction and operation of two commercial nuclear units and associated cooling systems and transmission facilities at the Portsmouth site on terrestrial ecological resources would be SMALL, pending additional surveys for threatened and endangered species within the construction area or transmission line rights-of-way.

8.6.4 Aquatic Resources Including Endangered Species

The aquatic resources near the Portsmouth ESP site would not be expected to be impacted by the construction and operation of two commercial nuclear units. The water required for cooling at Portsmouth would be withdrawn from groundwater wells. The discharge of the cooling water would be expected to be discharged to the Scioto River. Discharge limits would be controlled by Federal and State regulations for protection of the river. Based on this information, the staff concludes that the overall impact on aquatic ecological resources (including threatened and endangered species) of construction and operation of two commercial nuclear units and associated cooling towers and transmission facilities at the Portsmouth site would be SMALL.

8.6.5 Socioeconomics, Historic and Cultural Resources, Environmental Justice

The potential impacts on socioeconomics, historic and cultural resources, and environmental justice from construction and operation of two commercial nuclear units at the Portsmouth Site were performed using a "reconnaissance" survey of the site. That is, readily obtainable data from the Internet or published sources were used in the evaluation, and no new data were collected. The subsections that follow reflect the organizational structure of the socioeconomic discussions found in Sections 2.8.4, 4.5, and 5.5. The impacts resulting from both construction and operation of the new two-unit facility are addressed.

8.6.5.1 Physical Impacts

Construction activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting, and dust emission. The use of public roadways, railways, and barges would be necessary to transport construction materials and equipment to the site. Ohio SR 32 and U.S. Route 23 appear to be well maintained and have been used for transporting heavy loads in the past (Dominion and Bechtel 2002). The staff expects that all construction activities would occur within the boundaries of the Portsmouth site. Offsite areas that would support construction activities (e.g., borrow pits, quarries, disposal sites) are expected to be already permitted and operational. Impacts on those facilities from constructing two commercial units would be small incremental impacts associated with their normal operation.

Potential impacts from station operation include noise, odors, exhausts, thermal emissions, and visual intrusions. The nuclear units would produce noise from the operation of pumps, transformers, turbines, generators, and switchyard equipment, and from traffic. Dominion states in its ESP ER that any noise coming from the North Anna ESP site would be controlled in accordance with applicable local county regulations. By inference, this is also expected to apply to the Portsmouth ESP site. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the ESP site.

The nuclear units would be expected to have emissions from auxiliary power systems and standby diesel generators. It is expected that the combined annual emissions of any pollutant would be less than 100 tons/year (Dominion and Bechtel 2002). Air permits acquired for these generators would ensure that air emissions comply with regulations. Paved access roads and appropriate speed limits would minimize the amount of dust emissions generated by the commuting workforce.

Based on the information provided by Dominion and its own independent review, the staff concludes that the physical impacts of construction and operation would be SMALL. Construction activities would be temporary and occur mainly within the boundaries of the Portsmouth ESP site. Offsite impacts would represent small incremental changes to offsite services supporting the construction activities. During station operations, noise levels would be managed to local ordinances. Air quality permits would be required for the diesel generators, auxiliary boilers, etc., which should limit air emissions and ensure that applicable standards are met.

8.6.5.2 Demography

The Portsmouth site is located in Pike County, Ohio, approximately 35 km (22 mi) north of the Ohio River and 5 km (3 mi) southeast of the town of Piketon. Pike County's largest community, Waverly, has a population of 4433 residents. The nearest residential center to the site is Piketon with a population of 1907. Additional population centers within 80 km (50 mi) of the plant are Portsmouth (population 20,909), 35 km (22 mi) south; Chillicothe (population 21,796), 43 km (27 mi) north; and Jackson (population 6184), 29 km (18 mi) east. Approximately 90 percent of Portsmouth site workers reside in Jackson, Pike, Ross, and Scioto Counties. The 2000 population for the four counties was 212,876 (USCB 2000b).

Most of the construction and operations workforce are expected to come from within the region, and those who might relocate to the region would represent a small percentage of the larger population base. Those who do relocate to the region would most likely take up residency across the region. Based on the information provided by Dominion and its own independent review, the staff concludes that any increase in the population within an 80-km (50-mi) radius of the Portsmouth site due to construction or operation would be SMALL.

8.6.5.3 Community Characteristics

Economy

Economic activities near the Portsmouth site consist primarily of farming, timber harvesting and processing, and small businesses. The only significant industry in the vicinity is an industrial park south of Waverly. Industries include a cabinet manufacturer and an automotive parts manufacturer (Dominion and Bechtel 2002).

The unemployment rate in Ohio was 6.1 percent as of July 2004. At that time, Jackson County had an unemployment rate of 9.2 percent, Pike County was at 8.3 percent unemployment, Ross County was at 7.8 percent unemployment, and Scioto County was at 8.5 percent unemployment (Ohio 2004). This data indicates that this area of Ohio has not fully recovered from the recession of 2001. The Portsmouth site itself has provided significant socioeconomic benefits for the surrounding communities over the last 50 years, providing jobs that paid above average wages and salaries. The overall economic impacts of constructing and operating two new nuclear units at the Portsmouth ESP site would be beneficial to the local economy.

Based on the information provided by Dominion and its own independent review, the staff concludes that the impacts of station construction and operation on the economy of the region would be SMALL everywhere in the region except Pike County, where the beneficial impact level on the region would be MODERATE. The magnitude of the economic impacts would be diffused in the larger economic bases of the region, whereas, within the smaller economic base of Pike County and the fact the new units would be located in the county, the economic impacts could be more noticeable and have a greater beneficial impact. Therefore, the adverse impact level would be SMALL.

Availability of Workers

Dominion estimates it would take approximately 5000 construction workers more than 5 years to build two nuclear units at the Portsmouth site. The Portsmouth site would draw its workers from the tri-state area of southern Ohio, northern Kentucky, and western West Virginia. The construction workforce in this region is estimated to be 491,265.[(a)]

(a) The estimate is based on a methodology explained in Dominion and Bechtel (2002) and updated using 2000 census data.

The craft availability in the Portsmouth area is currently reported at full employment for all crafts except electricians. The concentration of industrial facilities within this region (oil refineries, steel mills, etc.) provides yearly employment for the building trades. This could present significant competition for manpower if this site were selected for construction of a new commercial nuclear power facility. Moreover, this area has a reputation as a complicated labor environment, and the shutdown of the Portsmouth enrichment facility operations has contributed to this climate (Dominion and Bechtel 2002).

The Portsmouth site currently provides employment for more than 1800 people. The site employs a highly skilled workforce with decades of nuclear-related experience. During the last several years, Portsmouth has undergone a major downsizing. Dominion would require approximately 720 new employees to operate the proposed new nuclear units. The addition of commercial nuclear generation would be expected to add jobs of similar or higher quality to the existing workforce, many of which could be filled by current or former Portsmouth site employees (Dominion and Bechtel 2002).

Based on the information provided by Dominion and its own independent review, the staff concludes that the overall impacts of being able to obtain a ready supply of construction and operations workforce for the nuclear units at Portsmouth likely would be SMALL to MODERATE. There appears to be a large supply of construction workers but a limited availability of skilled craftsmen. Dominion may have to recruit from outside the region to fill its requirements for skilled craftsmen. Employees for station operation are expected to be available from within the region due to the downsizing of the Portsmouth site workforce.

Transportation

Two major highways serve the Portsmouth site: U.S. 23 and SR 32. At their nearest points, these highways run within 1.6 km (1 mi) of the site. Access to the site is by the main access road, a four-lane interchange with U.S. 23, and the north access road, which initially is a two-lane road that transitions to four lanes with SR 32. SR 32 and U.S. 23 both appear to be well maintained and have been used for the transport of heavy loads (Dominion and Bechtel 2002).

As previously mentioned, constructing the two commercial nuclear units would require a construction workforce of 5000. Operating two nuclear units would require an operations workforce of 720. During the Portsmouth site operational period, between the 1970s and 1985, the total workforce numbered about 5000 at its peak. Currently 1800 people work at the site. Based on this previous peak, nearby access roads should be capable of supporting both construction and operations commuter traffic at this level with some roadway upgrades and traffic signal improvements. In addition, there are adequate transportation routes in the area to handle transportation of bulk materials to and from the site (Dominion and Bechtel 2002).

Two major rail lines service the site: CSX and Norfolk and Southern. Both railways appear to be in excellent condition. Approximately 35 km (22 mi) south of the Portsmouth site, two main rail lines run east-west along the Ohio River. The river is used for barge transportation, so materials could be off-loaded from barges onto rail cars, making transportation to the site by either rail or road achievable (Dominion and Bechtel 2002).

Numerous airports are within 161 km (100 mi) of the site, including the airports at Columbus, Cincinnati and Dayton, Ohio and Charleston, West Virginia. All these airports conduct regular freight and passenger air services. In addition, there are numerous smaller airports in the immediate vicinity. Thus, air passenger service and shipment of small items via air are readily available (Dominion and Bechtel 2002).

The Portsmouth site is in a rural, low-population area. The regional transportation network is adequate for commuter and transient traffic in the area. The transportation system around the Portsmouth site was capable of handling 5000 workers during previous periods of peak operations. Based on information provided by Dominion and its own independent review, the staff concludes that the transportation impacts of a construction or operating workforce on the transportation infrastructure would be SMALL.

Taxes

The State of Ohio has a 5-percent sales tax. In addition to the State sales tax, each county in Ohio has a county sales tax. Jackson, Ross, and Scioto Counties have a county sales tax rate of 1.5 percent, and Pike County has a county sales tax rate of 1 percent (NRC 2004). Sales taxes would be paid from the sales of construction materials and supplies purchased for the project. The State of Ohio has a personal income tax rate with a top marginal rate of 5.2 percent for incomes in excess of $40,000 (NRC 2004).

The average property tax rates for Ohio cities are divided into three separate classifications: Class I Real (residential and agricultural); Class II Real (commercial, industrial, mineral, and public utility); and Class III Tangible Personal (general and public utility). For Waverly, in Pike County, the rate is $0.07412 per $1000 for all three classifications in 2001; for Portsmouth, in Scioto County, the rate is $0.06013 per $1000 for all three classifications in 2001; for Wellston, in Jackson County, the rate is $0.05500 per $1000 for all three classifications; and for Chillicothe, in Ross County, the Class I rate is $0.05407, the Class II rate is $0.05394, and the Class III rate is $0.05402 per $1000. Finally, because the nuclear units would be built by a private company (Dominion) and not DOE, a property tax might be levied on the value of the property that becomes part of the additional units as they are constructed and on the appraised value of the units once construction is completed and they are brought online. These taxes would most likely go to Pike County.

DOE does not pay property taxes to the local communities around the Portsmouth site. However, DOE has provided $12.9 million in grants to the Southern Ohio Diversification Initiative. Other economic benefits include the collection of sales tax on the uranium enrichment services. Adding commercial nuclear capacity at the Portsmouth site would be expected to increase the tax base for these localities for the life of the two nuclear units (Dominion and Bechtel 2002).[a]

Workers living outside Ohio and commuting to Portsmouth likely will have to pay income taxes to their state of residence (West Virginia and Kentucky). They may also have to pay sales taxes to the state and local governments in the region where sales take place and property taxes to the counties in which they might own a residence.

Based on the information provided by Dominion and its own independent review, the staff concludes the overall beneficial impacts of construction and operation of the new facility on taxes collected in the region through the income, sales and use, and property taxes (except for Pike County) would be SMALL. The taxes paid, while substantial, are nevertheless a small sum when compared to the total amount taxes collected by states and local governments in the region. For property taxes for Pike County, the staff considers the overall beneficial impacts of the property taxes collected would be LARGE[b] (operations) relative to the total amount of taxes the county collects through property taxes. Therefore, the adverse impact level of taxes would be SMALL.

Aesthetics and Recreation

There are no significant recreational or residential areas within 3 km (2 mi) of the proposed Portsmouth ESP site. Mechanical cooling towers or natural draft towers could function as part of the new nuclear units' cooling system, which could produce visible plumes offsite. Dominion has stated that, if necessary, drift eliminators could be installed on mechanical cooling towers to reduce long visible plumes. Nearby trees may serve as a visual buffer for the transmission

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(a) The proposed ESP site would not be on land owned by Dominion. Most likely, should the Portsmouth site be chosen for the new plant, the site for the new units would be leased to Dominion by DOE.

(b) The derivation of this impact is based on the fact that the fiscal year 2003 amount of property taxes collected in Pike County was $9,878,000 (Burton 2004). For comparison, NAPS Units 1 and 2 pay approximately $10 million in annual property tax to Louisa County (the actual amount that the proposed nuclear plant would pay to Pike County would depend on assessed value and millage rate per thousand of assessed value). On the assumption that there is a rough comparison between what Dominion pays to Louisa County and what they might pay to Pike County, it can be concluded that the potential percentage of the proposed facility's property taxes to the total of all property taxes paid in Pike County would be significant.

facilities. The preferred ESP site at the Portsmouth site is situated in an area with open terrain. Because the preferred site is close to the northeast corner of the existing site boundary, it is possible that the proposed new nuclear units would have an identifiable nuclear power plant view offsite (Dominion and Bechtel 2002) especially if natural draft towers were used for cooling.

Recreational facilities in the Portsmouth area include Brush Creek State Forest with an extremely light usage of about 20 people a year. Use of Lake White State Park is occasionally heavy and is concentrated on the 43 ha (107 ac) of land closest to the lake. The number of visitors in 1992 was 55,876 with a daily average of 153 (Dominion and Bechtel 2002).

The AP1000 reactor has a tall containment building, approximately 71 m (234 ft) above grade level. The design of this building includes a hatch that determines the height that it must be above ground. This building would be expensive to redesign to allow the building to be placed lower in the ground. Thus, the height of the AP1000 containment building sets the upper bound of what would be visible from offsite.

There are no significant residential areas or recreational facilities within 3 km (2 mi) of the site. Plumes from mechanical cooling towers could be visible offsite, although they could be mitigated through drift eliminators or air-cooled condensers could be another alternative. Trees may serve as a visual buffer for the transmission infrastructure. Based on information provided by Dominion, and its own independent review, the staff concludes that the impacts of construction and station operation on aesthetics would be SMALL. But the impacts could also be MODERATE, if the Portsmouth ESP parcel is on a mostly undisturbed part of the site and on open terrain, enabling the proposed reactors to be viewed from offsite.

Housing

In the four-county area of Jackson, Pike, Ross and Scioto, there were 89,026 housing units in 2000. Of these, 22,824 were rental units, 2150 of which were vacant, or a 8.6 percent vacancy rate (USCB 2000c). The Portsmouth site is about 113 km (70 mi) south of Columbus, Ohio, (population in 2000 of 711,470), and 121 km (75 mi) east of Cincinnati, Ohio, (population in 2000 of 331,285), which are the two closest metropolitan areas (USCB 2000b). Huntington, West Virginia (population 51,475), is approximately 140 km (87 mi) away. These three cities have a total housing stock of 519,075, of which 256,326 are renter-occupied and 24,868 units are available for rent or a vacancy rate of 8.8 percent (USCB 2000c). Because it is not unusual for construction workers to commute up to 2 hours (one way) per day, there appears to be enough vacant rental housing to house those who might relocate to the region.

In the four-county area of Jackson, Pike, Ross and Scioto there were 58,246 owner-occupied housing units in 2000. In the four-county area, 1085 units were for sale, or 1.8 percent of the total of owner-occupied and houses for sale. In the three-city area of Columbus, Cincinnati, and Huntington there were 218,258 owner-occupied housing units and 4778 units for sale, or 2.1 percent of total of owner-occupied and houses for sale (USCB 2000c). In both the local and larger metropolitan areas (i.e., Columbus, Cincinnati, and Huntington), the percentage of houses for sale in relation to owner-occupied housing is very low, indicating a fairly tight housing market.

The operations workforce is expected to come from current or former employees at the Portsmouth site. If, however, a substantial number of workers have to be recruited into the area, upward pressure on housing values could emerge. This assumption is based on the low number of homes for sale in the area and the fact that the workforce, which would be on the higher end of the salary scale when compared to other job classifications in the area, may tend to buy more upscale homes. In this case the operational impacts could be moderate.

It is not unusual for construction workers to commute up to 2 hours (one way) per day to the job site, and many of the construction workers are assumed to already live within the region. There appears to be sufficient vacant rental housing to house those who might relocate to the region. If, as expected, most of the operations workforce have residences already in the region, then the impacts on housing because of station operation would be small. Based on information provided by Dominion and its own independent review, and assuming the operations workforce comes from within the region, the staff concludes that the impacts to housing from construction of the two Units would be SMALL. For the operations workforce, the impacts could be SMALL and mitigation is not warranted.

Public Services

Water and Wastewater Treatment

The capacity of communities to absorb an increase in population depends on the availability of sufficient community resources, such as water and wastewater treatment. Within 145 km (90 mi) of the site are two large metropolitan areas (Columbus and Cincinnati). Huntington, West Virginia, is approximately 140 km (87 mi) away. The cities of Portsmouth, Jackson, and Chillicothe, Ohio, are within about 50 km (30 mi) from the facility (south, east and north, respectively). There are numerous small towns within 80 km (50 mi) of Portsmouth. All these towns and cities are within a 2-hour commuting distance via local transportation routes of the site (Dominion and Bechtel 2002) and could provide public services such as water and wastewater treatment to the construction and operations workforce who might relocate to the area.

A number of cities and towns in the region are located within a 2-hour commute of the Portsmouth site and could provide water and wastewater treatment services for the workforce. Many of the construction and operations workforce would come from within the region, and those that choose to relocate to the region would most likely take up residence throughout the region, thus placing minimal demands on the existing infrastructure. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of the construction and operations workforces on water and wastewater treatment in the region would be SMALL.

Police, Fire, and Medical Facilities

The hospital nearest to the Portsmouth site is the Pike Community Hospital, located approximately 12.1 km (7.5 mi) north of the facility on SR 104 south of Waverly. No other acute-care facilities are located in Pike County. There is an urgent-care facility, Adena Health Center, also on SR 104 near the hospital. In addition, two licensed nursing homes are located near Piketon, and one nursing home is located in Wakefield; all are located within 8 km (5 mi) of the site (NRC 2004). Other medical facilities exist in Jackson, Chillicothe, and Waverly.

Several State, county, and local police departments provide adequate law enforcement in the region (NRC 2004). Any additional demands on law enforcement services could potentially be met by the increased tax revenues available to support the services. There would most likely be a time delay between the demand for the services and the collection of the tax revenues, which could cause some short-term financial issues for the impacted jurisdictions.

Many of the potential construction and operations workforce probably already live within an (80-km [50-mi]) radius of the region. There are a number of towns within a 2-hour commuting distance of the site. Any new workers relocating to the area would most likely have places of residency located throughout the region, which would not place an undue burden on any one jurisdictional entity's infrastructure. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of the construction and operations workforce on police, fire and medical facilities in the Portsmouth area would be SMALL.

Social Services

In Ohio social services at the state level are overseen by the Ohio Department of Jobs and Family Services. It develops and oversees programs and services designed to help residents of Ohio become independent through education, employment, job skills, and training. A major responsibility of the department is to work with county departments of job and family services, child support enforcement agencies, and public children's services agencies to develop social service programs to strengthen families, protect children, and provide children with an opportunity for a better life. The department also administers the unemployment and medicaid programs for Ohio. During the early phases of construction, there may be increased demand for these social services.

Generally, construction and operation of the new units at Portsmouth would be viewed as beneficial economically to the disadvantaged population segments served by the Ohio Department of Jobs and Family Services. As with Surry, the workforce associated with the Portsmouth ESP nuclear units would most likely be better paid than workers in other employment categories in the region. It is expected that, through the multiplier effect, the number of jobs that could be filled by the disadvantaged population would increase.

Construction and operation would have a beneficial economic impact to the economically disadvantaged population in the region, which should lessen the demand for social services. There could be an initial increase in demand for social services at the beginning of the construction period, but this is considered manageable and limited. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and station operation of two commercial nuclear units on social and related services would be SMALL.

Education

Twenty-four public school districts provide public education for approximately 36,000 students in the region. There are two school systems in the immediate area to the Portsmouth site: the Pike County and Scioto County Schools. In 2002, the combined enrollment of these schools was approximately 2387 (NRC 2004). Within the same area, three facilities provide daycare or schooling for preschool-aged children and after-school care for school-aged children. Two of these facilities accommodate 390 children (NRC 2004).

Many of the potential construction and operating workforce probably already live within the region and any new workers relocating to the area would most likely take up residency throughout the region. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and station operation on educational facilities and services as a result of construction and operation of two additional nuclear units would be SMALL.

8.6.5.4 Historic and Cultural Resources

The area of southern Ohio where the Portsmouth site is located contains evidence from each of the major prehistoric periods for Eastern North America, including the Paleo-Indian, Archaic, Woodland, and Fort Ancient periods. In early historic times, the area was occupied by the Shawnee Tribe. The Euro-American historic period occupation in the vicinity began about 1800.

Archaeological and historic architectural surveys were completed in 1996 at the Portsmouth site, but the reports have not been finalized. Consultation is ongoing with the Ohio State Historic Preservation Officer concerning the results of these surveys (DOE 2003). Consultations with the Shawnee Indian Tribe have not identified any traditional cultural properties or other resources of Native American cultural value at the site.

The DOE survey found three archeological sites near the 138-ha (340-ac) parcel. The three sites are northeast of the parcel (Dominion and Bechtel 2002). The closest site to the Portsmouth parcel is the Holt Cemetery, which is located about 183 m (600 ft) from the eastern boundary of the parcel. No national landmarks are near the Portsmouth site, and no properties presently on the National Register of Historic Places are within the Portsmouth site. The nearest National Register locations are Buzzardroost Rock and Lynx Prairie in Adams County, about 48 km (30 mi) southeast of the Portsmouth site.

Based on information provided by Dominion and its own independent review, the staff concludes that the potential impacts on historic and cultural resources would be SMALL for construction at the Portsmouth alternative site. Potential impacts from operation of the proposed two commercial nuclear units at the Portsmouth ESP site would also be SMALL, because any such potential impacts would be identified and appropriate mitigation measures could be effected during the construction phase.

8.6.5.5 Environmental Justice

DOE recently performed an environmental assessment (DOE 2001) for the Portsmouth site as part of its winterization activities for placing the facility in cold standby. As part of that assessment, an evaluation as a result of potential environmental justice impacts was conducted. DOE evaluated the distribution of minority populations in a four-county area around the Portsmouth site. DOE defined a minority population as any area in which minority representation was greater than the national average of 24.2 percent. In all four counties, minority populations are smaller than the national average. Hence, using this definition, environmental justice was not a concern (DOE 2001), nor is it a concern using the NRC criteria defined in 69 FR 52040 (which is different than that used by DOE – see Section 2.8.4). DOE then carried the analysis a step further and examined the minority populations in the census tracts closest to the site. None of the tracts closest to the site had minority representation greater than the national average of 24.2 percent (DOE 2001).

Individuals with incomes below the poverty level were identified in the four-county region. For this study (Dominion and Bechtel 2002), a low-income population included any census tract (1990 data) in which the percentage of people with income below the poverty level was greater than the national average of 13.1 percent. Nearly all (41 of 48) of the census tracts in the four-county area qualified as low-income populations, but none of the low-income populations suffered disproportionate impacts as a result of proposed actions at the Portsmouth ESP site. The study concluded that no environmental justice impacts were expected because of the proposed action.

Based on the information provided by Dominion and its own independent review, the staff concludes that the offsite impacts of construction and operation of the proposed new nuclear units at the Portsmouth ESP site on minority and low-income populations would be SMALL. No disproportionately high and adverse impacts were identified.

8.7 Evaluation of the Savannah River Site

Dominion selected a 100-hectare (250-acre) parcel of land in the northern portion of DOE's Savannah River Site as a possible location for two commercial nuclear units (Dominion and Bechtel 2002). For this evaluation, certain assumptions were made by the staff about the proposed ESP site at Savannah River.

- The proposed units would use closed-cycle cooling.
- Natural or mechanical draft cooling towers would be employed.
- The Savannah River would be the source of cooling water.
- The existing intake structure is sufficient.
- Blowdown water would be discharged to the Savannah River or to Par Pond.
- The land area for the ESP site would be approximately 100 ha (250 ac).
- New transmission lines would be needed.

DOE's Savannah River Site occupies an area of approximately 800 km^2 (310 mi^2) adjacent to the Savannah River, in Aiken and Barnwell Counties, South Carolina. The site is approximately 40 km (25 mi) southeast of Augusta, Georgia, and 31 km (19.5 mi) south of Aiken, South Carolina. The site is bounded along its southwest border by the Savannah River for approximately 56 river km (35 river mi). The Savannah River Site vicinity is shown in Figure 8-5.

The average population density in the counties surrounding the site is approximately 85 people per square mile, with the largest concentration in the Augusta metropolitan area. Approximately 70 percent of the site employees live in South Carolina, primarily Aiken County, and 30 percent live in Georgia (Westinghouse 2001).

The U.S. Atomic Energy Commission, predecessor agency to DOE, established the Savannah River Site in the early 1950s. Historically, the mission of the site has been the production of special radioactive isotopes to support national programs. DOE produced these isotopes in five production reactors. After the material was produced at Savannah River Site, it was shipped to other DOE sites for further processing.

Approximately 73 percent of the surface area of the Savannah River Site is composed of open fields and upland forest. The forested areas consist primarily of upland pine and mixed hardwoods. The remaining area consists of wetlands, streams, and reservoirs (22 percent) and developed industrial and administrative areas (5 percent) (DOE 1999).

The Savannah River is the principal surface water system associated with the Savannah River Site. Five of its major tributaries (Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs) flow through and drain the site. The Savannah River serves as a domestic and industrial water source for the site and several downstream communities (the cities of Port Wentworth and Savannah in Georgia and Beaufort and Jasper Counties in South Carolina). In addition, the Vogtle Electric Generating Plant, located across the Savannah River from the Savannah River Site, uses water from the river for its cooling system (DOE 1999).

The southeastern United States has a humid subtropical climate characterized by relatively short, mild winters and long, warm, humid summers. Summer-like weather typically lasts from May through September. The humid conditions often result in scattered afternoon thunder-storms. Average seasonal rainfall is usually lowest during the fall (DOE 1999).

The Savannah River Site is within the Southeastern Plains ecological province (Omernick 1987) near the transition between northern oak-hickory-pine forest and southern mixed forest. Thus, species typical of both associations are found on the Savannah River Site (DOE 1995). Farming, fire, soil, and topography have strongly influenced Savannah River Site vegetation patterns.

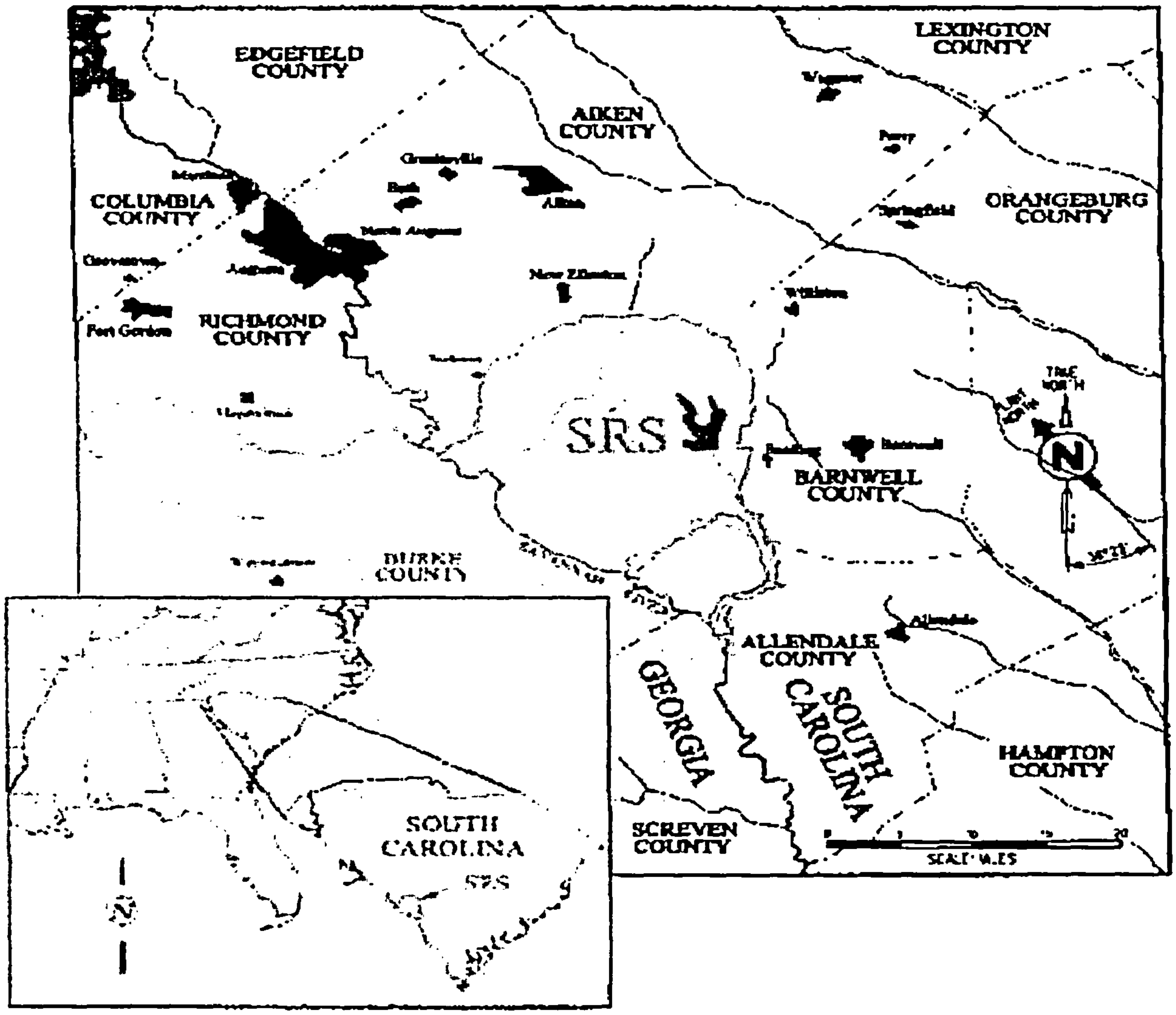

Figure 8-5. Savannah River Site Vicinity Map.

The Savannah River Site currently provides employment for more than 13,000 people, who are highly skilled and most of which are college educated. Salaries are above average for the area. During the last decade, the Savannah River Site has undergone a major downsizing due to the end of the Cold War. Because of downsizing, the Savannah River Site has contracted many nonclassified operations to private companies for support services (Dominion and Bechtel 2002).

The Savannah River Site itself has provided significant socioeconomic benefits for the surrounding communities over the last five decades. The facility injects about $1.5 billion annually into the economies of South Carolina and Georgia, the two states bordering the site. The facility provides thousands of jobs with above-average salaries, conducts environmental and nuclear technology research, and offers business development programs for local communities (Dominion and Bechtel 2002).

8.7.1 Land Use Including Site and Transmission Lines

The Savannah River Site has extensive undeveloped land that is potentially suitable for commercial nuclear power generation. DOE conducted a review of potential locations on the site for possible location of an accelerator for the production of tritium (DOE 1999). DOE identified six possible locations that satisfied its siting criteria. The preferred site from the DOE review is approximately 10.4 km (6.5 mi) from the Savannah River Site boundary, 5 km (3 mi) northeast of the Tritium Loading Facility, and north of Roads F and E (Dominion and Bechtel 2002). The site, which is divided by the boundary line between Aiken and Barnwell Counties, is bordered on the southwest by a 115-kV transmission line, a buried super-control and relay cable, and Monroe Owens Road. Three other secondary roads cross the site. The elevation of the site is 91 to 100 m (300 to 330 ft) MSL. Dominion has adopted the DOE-preferred site as an alternative site for new nuclear generation. This potential ESP site is shown in Figure 8-6.

Dominion did not identify any current or possible future land-use restrictions that would prohibit the construction of new nuclear power plants on the Savannah River Site (Dominion and Bechtel 2002). DOE would need to approve any such construction.

New nuclear generating units located at the Savannah River Site would need to have an exclusion area that meets NRC requirements (10 CFR 100.21(a)). The exclusion area is the area surrounding the reactor within which the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property from the area (10 CFR 100.3).

Approximately 90 percent of the workforce for the Savannah River Site lives in Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia. There are numerous small towns within 80 km (50 mi) of the site. These communities could supply an adequate construction and operating workforce and are within a 2-hour commuting distance via local transportation routes. Offsite land-use impacts associated with construction of two commercial nuclear units are likely to be relatively limited, given the temporary nature of the construction. Some new rental housing and/or new manufactured home and recreational vehicle parks would be expected to be constructed to accommodate construction workers.

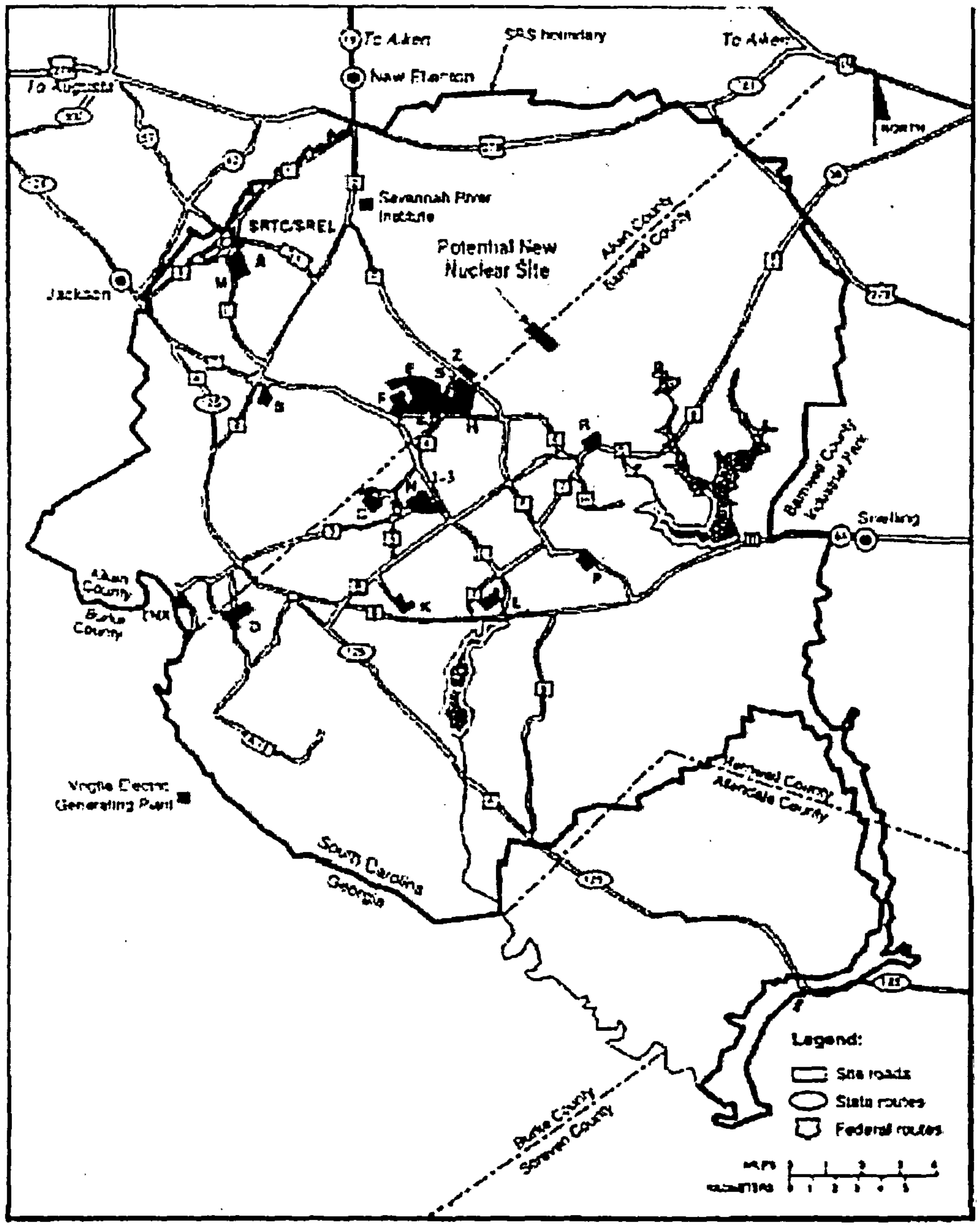

Figure 8-6. Potential New Nuclear Station Site at SRS

Section 307(c)(3)(A) of the Coastal Zone Management Act [16 USC 1456(c)(3)(A)] requires that applicants for Federal licenses to conduct an activity in a coastal zone are to provide to the licensing agency a certification that the proposed activity complies with the enforceable policies of the state's coastal zone program. However, the Savannah River Site is not within coastal zones of either South Carolina or Georgia for purposes of the Act (SCDHEC 2004).

The staff assumed that workers at two commercial nuclear units located at the Savannah River Site would also primarily live in the aforementioned counties. Some new housing in these counties would likely be constructed to accommodate permanent workers at the new units. The property tax revenue from the new units could affect future land use in these counties as a result of infrastructure improvements made possible by the tax revenue. Based on the information provided by Dominion and its own independent review, the staff concludes that the land use impacts of construction and operation are expected to be SMALL.

The transmission system on the Savannah River Site consists of multiple 115-kV transmission lines forming a ring network around the site. Three switching stations for the 115-kV transmission lines exist around the site to feed the different area loads. Construction of one or more new 500-kV transmission lines or several 230-kV transmission lines would be needed to transmit power from new nuclear units located on the site to the regional grid (Dominion and Bechtel 2002). Several options were evaluated by Dominion. The likely option would be to construct transmission line rights-of-way either to the west through the Savannah River Site, then cross the Savannah River to connect with the existing system near the Vogtle Nuclear Power Plant in Burke County, Georgia, or to a connection point approximately 97 km (60 mi) west of the Savannah River Site. Because the detailed routing of these transmission line rights-of-way are not known at this time, a detailed evaluation of the impacts to land use cannot be made. However, if a tie-in to the Vogtle Nuclear Power Plant is used, there would be minimal impacts to land use, because most of the rights-of-way would be located on the Savannah River Site. The staff concludes that the impact of construction of new transmission capability at the Savannah River Site would be greater than at the North Anna site, because no additional construction would occur at the North Anna site, and would likely be in the range of SMALL to MODERATE.

The actual routes of transmission lines that would connect new reactor units at the Savannah River Site with the regional grid have not been determined (Dominion and Bechtel 2002). Because the potential impacts of operation and maintenance of the transmission line rights-of-way on land use cannot be determined at this time, the staff concludes the impact of transmission line rights-of-way would range from SMALL to MODERATE during construction and operation. Rerouting would be expected if impacts were greater than moderate.

8.7.2 Water Use and Quality

Whether the consumptive water use for the Savannah River site was provided indirectly from the aquifer or directly from the river itself, the consumptive water use for a power reactor at the Savannah River Site would impact the Savannah River. Staff reviewed streamflow records reported by the U.S. Geological Survey for stream gauge 02197000 (Savannah River at Augusta, Georgia). This gauge reflects runoff from a drainage of 19450 km^2 (7508 mi^2) and has data for the period from 1884 to 2001. Using these data, the staff independently estimated the 7Q10 and 30Q2 values. The 7Q10 is the lowest 7-day discharge for low water condition that is estimated every 10 years. For this gauge the 7Q10 was estimated to be 60.8 m^3/s (2150 cfs). The 30Q2 is the lowest 30 days of flow in an average year. For this gauge the 30Q2 is estimated to be 130 m^3/s (4600 cfs). The 7Q10 provides an estimate of the short-term low-flow conditions in a dry year. The 30Q2 provides an estimate of the moderate-term, low-flow conditions in an average year.

The maximum make-up water flow rate for a single unit is estimated in the PPE as 2.78 m^3/s (98.0 cfs); however, the portion of the flow not evaporated is ultimately returned to the river as blowdown flow. Based on the PPE, the maximum evaporation for a single unit using mechanical draft cooling towers is 1.23 m^3/s (43.5 cfs). For either one or two units this represents a small fraction of both the 7Q10 and the 30Q2 values. Discharge of thermal and chemical effluents would be regulated by the State of South Carolina's NPDES permitting process to limit impacts to the Savannah River. Therefore, based on the information provided by Dominion, and its own independent review, the staff concludes the impact of construction and operation of two nuclear units on water use and quality at the Savannah River Site would be SMALL.

8.7.3 Terrestrial Resources Including Endangered Species

The Savannah River Site is within the Southeastern Plains ecological province (Omernick 1987) near the transition between northern oak-hickory-pine forest and southern mixed forest. Thus, species typical of both associations are found on the site (DOE 1995). Farming, fire, soil, and topography have strongly influenced vegetation patterns at the Savannah River Site.

A variety of plant communities occur in the upland areas. Typically, scrub oak communities are found on the drier, sandier areas. Longleaf pine (*Pinus palustris*), turkey oak (*Quercus laevis*), bluejack oak (*Q. incana*), and blackjack oak (*Q. marilandica*) dominate these communities, which typically have understories of wiregrass (*Aristida stricta*) and huckleberry (*Vaccinium spp.*). Oak-hickory communities are usually located on more fertile, dry uplands; characteristic species are white oak (*Q. alba*), post oak (*Q. stellata*), red oak (*Q. falcata*), mockernut hickory

(*Carya tomentosa*), pignut hickory ©. *glabra*), and loblolly pine (*Pinus taeda*), with an understory of sparkleberry (*Vaccinium arboreum*), holly (*Ilex spp.*), greenbriar (*Smilax spp.*), and poison ivy (*Toxicodendron radicans*) (DOE 1995).

Before the Federal government took over the site, the Savannah River Site was mainly farmland that had been highly eroded. Approximately 90 percent of the site has been planted with loblolly, slash pine (*Pinus elliottii*), and hardwood trees. The proposed ESP site consists of mostly wooded land, made up predominantly of loblolly and slash pine that have been planted since the late 1950s. The site is part of a designated forest timber unit under the Savannah River Site land-use system. The Savannah River Institute (formerly known as the Savannah River Forest Station) coordinates the removal and sale of marketable timber from the site (Dominion and Bechtel 2002).

The departure of residents in 1951 and the subsequent reforestation have provided the wildlife of Savannah River Site with excellent habitat. The site has extensive, widely distributed wetlands, most of which are associated with floodplains, creeks, or impoundments. In addition, approximately 200 Carolina bays occur on the site (DOE 1995). Carolina bays are unique wetland features of the southeastern United States. There are Federally and State-listed rare, threatened, and endangered species that have been seen within the Savannah River Site, including the bald eagle, wood stork (*Mycteria americana*), and red-cockaded woodpecker (*Picoides borealis*), which are known residents of the site. Federally and State threatened or endangered species potentially occurring in Aiken or Barnwell Counties are provided in Table 8-5. In addition to the species listed in Table 8-5, there are a large number of species,although not listed as threatened or endangered, that are still of concern or interest to the FWS (2004b) and/or the South Carolina Department of Natural Resources (SCDNR 2004).

Table 8-5. Federal and State Threatened or Endangered Terrestrial Species Potentially Occurring in Aiken and Barnwell Counties, South Carolina

Scientific Name	Species	Federal Status	State Status
Birds			
Haliaeetus leucocephalus	bald eagle	T	E
Mycteria americana	wood stork	E	E
Picoides borealis	red-cockaded woodpecker	E	E
Mammals			
Corynorhinus rafinesquii	Rafinesque's big-eared bat	SC	E
Amphibians			
Rana capito	gopher frog	SC	E

Scientific Name	Species	Federal Status	State Status
Reptiles			
Clemmys guttata	spotted turtle	--	T
Gopherus polyphemus	gopher tortoise	SC	E
Plants			
Trillium reliquum	relict trillium	E	E
Ptilimnium nodosum	harperella	E	E
Echinacea laevigata	smooth coneflower	E	E
Linderna melissifolia	pond berry	E	E
Oxypolis canbyi	Canby's dropwort	E	E
Schwalbea americana	American chaffseed	E	E

E= endangered, T= threatened, SC = species of concern.
Sources: FWS 2004a; SCDNR 2004.

If the commercial nuclear units were constructed, it is expected that very little usable habitat would remain within the proposed development area at the Savannah River ESP site. Operation of the new units would likely result in noise generation, and if wet cooling towers are employed, there could be impacts due to salt drift, icing, fogging, and bird collisions. Noise is likely to be typical of operating reactor units and cooling towers, which has been determined to be a SMALL impact in most instances (NRC 1996). There are no sensitive habitat areas adjacent to the proposed site that would be adversely affected by noise from plant operations. The nearest bald eagles and wood storks are approximately 5 km distant. Red-cockaded woodpeckers have not been observed at the proposed site, but could be deterred from using the area if there is increased noise and human activity.

The terrestrial vegetation in the vicinity of the proposed development area at the Savannah River Site are not believed to be unusually sensitive to salt drift, fogging, or icing (Dominion and Bechtel 2002). Bird collisions would not be expected to be different from most other power plants (NRC 1996), and if mechanical draft towers are selected, bird strikes are likely to be very rare. Overall, it is expected that the impacts of operation of one or more nuclear units at the Savannah River Site on terrestrial systems would be minimal.

The actual routes of transmission lines that would connect new nuclear units at the Savannah River Site with the regional grid have not been determined (Dominion and Bechtel 2002). Maintenance of the rights-of-way could impact wetlands, threatened or endangered species habitat areas, or other sensitive ecological resources. Therefore, the potential impacts of construction, operation and maintenance of the transmission line rights-of-way on terrestrial ecosystems cannot be determined without more detailed information concerning the location of the transmission line rights-of-way and the maintenance procedures that will be employed. However, large impacts would be avoided by rerouting, therefore the staff concludes the impact of construction on terrestrial resources (including threatened and endangered species) would be SMALL to MODERATE depending on the routing of the transmission line rights-of-way. Based on information provided by Dominion and its own independent review, the overall impact on terrestrial ecological resources of operating two commercial nuclear units and associated cooling systems at the Savannah River Site would be SMALL. Depending on the location of transmission line rights-of-way the operational impacts on threatened and endangered species could be SMALL to MODERATE.

8.7.4 Aquatic Resources Including Endangered Species

The aquatic environment at the Savannah River Site is associated with the Savannah River. The two main bodies of water onsite, Par Pond and L-Lake, were constructed to support site operations. Par Pond, which was constructed to provide cooling water for, and to receive heated cooling water from, P-Reactor and R-Reactor, has a surface area of about 1093 ha (2700 ac). The 405-ha (1000-ac) L-Lake was constructed to receive heated cooling water from L-Reactor. The Savannah River Site is bounded on its southwest border by the Savannah River for about 56 river km (35 river mi). Five major streams from the Savannah River Site feed into the river.

There are two endangered species in the Savannah River near the proposed ESP site. They are the shortnose sturgeon (*Acipenser brevirostrum*) and the fanshell (*Cyprogenia stegaria*). Both are protected under the current permits issued to the Savannah River Site. The staff evaluated the potential impacts of operating the proposed new nuclear units, including operating the plants, cooling systems, and transmission systems on aquatic threatened and endangered species. Based on this evaluation, the staff concludes that the impacts of operating the proposed new units on aquatic threatened and endangered species at the Savannah River Site would be SMALL.

All the water for cooling is expected to be withdrawn from the Savannah River. All water required for cooling is expected to be withdrawn pursuant to the current use permits for the site. The discharge of the cooling water blowdown is likely to be discharged to Par Pond or the Savannah River. Because the expected system is a closed-cycle system, the impacts to aquatic resources are expected to be minimal. The potential for impingement and entrainment of aquatic resources is expected to be mitigated by the current operation of the intake structure. The potential impacts of heated water are expected to be mitigated by the placement of the discharge structures. Based on the information provided by Dominion and its own independent review, the staff concludes that the overall impact on aquatic ecological resources of construction and operation of two nuclear units and associated cooling towers and transmission facilities at the Savannah River Site would be SMALL.

8.7.5 Socioeconomics, Historic and Cultural Resources, Environmental Justice

In evaluating the socioeconomic impacts of constructing and operating two commercial nuclear units at the Savannah River Site, the staff undertook a "reconnaissance" survey of the site. That is, readily obtainable data from the Internet or published sources were used in the evaluation, and no new data were collected. The subsections that follow, reflect the organizational structure of the socioeconomic discussions found in Sections 2.8.4, 4.5, and 5.5. The impacts resulting from both construction and operation of the new facility are addressed.

8.7.5.1 Physical Impacts

The physical impacts of construction activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting, and dust emissions. The use of public roadways, railways, and waterways would be necessary to transport construction materials and equipment to the site. There would, as a result, be increased use of these infrastructures, both in terms of increased volume and type of vehicular traffic.

Road access to the Savannah River Site is via State Highway 125. U.S. 278 cuts through a portion of the Savannah River Site. Easy access to the preferred site area at Savannah River could be accommodated by installing access roads from U.S. 278. Most roads leading to the site are two-lane roads, but appear to be kept in excellent condition (Dominion and Bechtel 2002).

CSX railroad serves the Savannah River Site. Some upgrades would likely be needed to accommodate the large and heavy loads associated with construction of a new nuclear power plant (Dominion and Bechtel 2002).

On the Savannah River, there is a barge slip situated on DOE property. This barge slip has been used in the past for heavy loads and large components such as steam generators. Shipment of heavy loads by barge to the Savannah River Site depends on the water level in the Savannah River. The preferred site is on the opposite side of the property from the barge slip and would require some additional heavy haul routes to be constructed (Dominion and Bechtel 2002).

It is expected that all construction activities would occur within the boundaries of the Savannah River Site. Offsite areas that would support construction activities (e.g., borrow pits, quarries, disposal sites) are expected to be already permitted and operational. Impacts on those facilities from constructing new nuclear units are expected to be small incremental impacts associated with their normal operation. The preferred site for the ESP facility is approximately 10.5 km (6.5 mi) from the Savannah River Site boundary (Dominion and Bechtel 2002).

Potential impacts from station operation include noise, odors, exhausts, thermal emissions, and visual intrusions. The new nuclear units would produce noise from the operation of pumps, transformers, turbines, generators, and switchyard equipment, and from traffic. Dominion states in its ESP ER (Dominion 2004) that any noise from construction and operation of the proposed new units at the North Anna site would be controlled in accordance with applicable local county regulations. By inference, this is also expected to apply to the construction and operation of comparable nuclear units at Savannah River Site. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the site.

The new units would be expected to have emissions from auxiliary power systems, standby diesel generators, and standby gas turbines generators (Dominion and Bechtel 2002). It is expected that the combined annual emissions of any pollutant would be less than 100 tons/year (Dominion and Bechtel 2002). Air quality permits acquired for these generators would ensure that air emissions comply with regulations. Paved access roads and appropriate speed limits would minimize the amount of dust generated by the commuting workforce.

Direct site-specific impacts from construction activities would be temporary and would occur mainly within the boundaries of the Savannah River Site. Offsite impacts would represent small incremental changes to offsite services supporting the construction activities. During station operations, noise levels would be managed to comply with local ordinances. Air quality permits would be required for the diesel generators, auxiliary boilers, and other equipment, which should limit air emissions and meet applicable standards. Based on the information provided by Dominion and its own independent review, the staff concludes that the physical impacts of construction and operation of the new power generating facility would be SMALL.

8.7.5.2 Demography

The center of the Savannah River Site is approximately 40 km (25 mi) southeast of the city limits of Augusta, Georgia. The population for Augusta-Richmond County, Georgia, is 195,182 (USCB 2000d). The site is 161 km (100 mi) from the Atlantic Coast, and about 175 km (110 mi) south-southeast of the North Carolina border. The largest nearby population centers are Aiken, South Carolina, with a population of 25,337 (USCB 2000d), and Augusta, Georgia.

The only towns within 24 km (15 mi) of the center of the Savannah River Site are New Ellenton, with a population of 2250; Jackson with a population of 1625; Barnwell with a population of 5035; Snelling, with a population of 246; and Williston with a population of 3307 (USCB 2000d). All these towns are in South Carolina.

Most of the construction and operations workforce are expected to come from within the region (see more detailed discussion in Section 8.7.5.3), and those who might relocate to the region would represent a small percentage of the larger population base. Those who do relocate to the region would most likely take up residency across the region. Based on the information provided by Dominion and its own independent review, the staff concludes that any increase in the population within an 80-km (50-mi) radius of the Savannah River Site because of construction and operation of two commercial nuclear units would be SMALL.

8.7.5.3 Community Characteristics

Economy

The unemployment rate in the Augusta-Aiken Metropolitan Statistical Area was 5.7 percent in June 2004 (Georgia 2004b). This compares to a 4.6 percent unemployment rate for Georgia (Georgia 2004b) and a 6.6 percent rate for South Carolina in June 2004 (South Carolina 2004a). Regional unemployment statistics for select South Carolina Counties in the vicinity of the Savannah River Site include Barnwell County at 12.3 percent unemployment in June 2004 and Aiken County at 7.1 percent (South Carolina 2004a).

The Savannah River Site itself has provided significant socioeconomic benefits for the surrounding communities over the last 50 years, and currently provides employment for more than 13,000 people who are highly skilled, and most of whom are college educated. Salaries are above average salaries of the area. The site injects about $1.5 billion annually into the economies of South Carolina and Georgia (Dominion and Bechtel 2002).

During the last decade, a major downsizing has occurred at the site because of the end of the Cold War. Construction and operation of two new nuclear units would increase employment at the site. These jobs would provide economic benefits to the local communities (Dominion and Bechtel 2002).

The magnitude of the economic impacts would be diffused in the larger economic bases of the region, whereas with the smaller economic base of Barnwell County and the higher unemployment rate (compared to Aiken County and the State of South Carolina), the economic impacts could be more noticeable and have a greater beneficial impact. Based on the information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and operation of two nuclear units on the economy of the region would be SMALL everywhere in the region except Barnwell County, where the beneficial impacts to the county could be MODERATE. Therefore the adverse impact level would be SMALL.

Availability of Workers

Dominion estimates it would take approximately 5000 construction workers over 5 years to build two commercial nuclear units (Dominion 2004a). As discussed in the previous section on the economy, the Savannah River Site currently provides employment for more than 13,000 people. However, during the last decade, some loss of jobs occurred because of the end of the Cold War (Dominion and Bechtel 2002).

Construction of a nuclear generating facility would draw workers from South Carolina and Georgia. The estimated number of construction workers in the two-state region is approximately 459,725 (BEA 2000). With the extensive local transportation network in the area, nearby cities could supply an adequate workforce and are well within a 2-hour commuting distance of the Savannah River Site. Therefore, a minimal influx of project-related population during plant construction and operation could be expected (Dominion and Bechtel 2002).

Dominion would need approximately 720 new employees to operate the proposed new facility. The Savannah River Site currently provides employment for more than 13,000 people but also has undergone downsizing. The addition of a new power generating facility would be expected to add jobs requiring skilled workers (i.e., with skills comparable to or higher than skills of the existing Savannah River Site workforce). Many of the jobs requiring skilled workers could be filled by current or former Savannah River Site employees (Dominion and Bechtel 2002).

There appears to be a large supply of construction labor and skilled craftsmen available. Dominion may have to add incentives to draw out-of-state craftsmen with specific skills to the area because of the lower prevailing wages when compared to other areas outside Georgia and South Carolina, but it believes it can successfully manage this issue. The unemployment rates in Aiken and Barnwell Counties are above the State of South Carolina average unemployment rate. Likewise, the unemployment rate in Augusta is above the average rate for the State of Georgia. Employees for station operation are expected to be available from within the region because of the downsizing at Savannah River Site. Based on the information provided by Dominion and its own independent review, the staff concludes that the overall impacts of being able to obtain a ready supply of construction and operations labor for the new power generating facility would be SMALL.

Transportation

Two interstate highways serve the vicinity of the Savannah River Site. Several other highways (U.S. highways 221, 301, 321, and 601) provide additional transport routes for the area. Approximately 84 percent of the Savannah River Site workforce of 13,000 resides in Aiken and Barnwell Counties in South Carolina and Columbia and Richmond Counties in Georgia (Dominion and Bechtel 2002).

The regional transportation networks in the Savannah River Site vicinity serve Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina and Columbia and Richmond Counties in Georgia. Eighty-eight percent of the Savannah River Site commuter traffic originates from these counties. On the site itself, there are more than (322 km) 200 mi of primary roads and more than 1600 km (1000 mi) of unpaved secondary roads.

In general, heavy traffic occurs in the early morning and late afternoon when workers commute to and from Savannah River. For the roads in the general region, the worst-case LOS is associated with routes near the Savannah River bridges, including I-20 and U.S. 1 and urban routes in North Augusta and Aiken, including South Carolina SRs 230, 25, 19, and 118. Significant congestion occurs during peak traffic period onsite on U.S. highways 1-A and 278 and on SRs 19 and 125 at Savannah River Site access points. Long delays are also experienced offsite along I-20 and U.S. highways 25 and 1 where they cross the Savannah River. The Savannah River Site has implemented changes to remedy the congestion at some access points (Dominion and Bechtel 2002).

Other transportation in the area also includes a rail line for CSX Transportation, Inc. The Savannah River Site has its own railroad system. Rail traffic is separated into two categories depending on which track system it would use: CSX operations and the Savannah River Site railway (Dominion and Bechtel 2002).

The major nearest airport to the Savannah River Site is in Atlanta, Georgia, and the closest regional airport is in Augusta, Georgia. The Augusta airport conducts regular freight and passenger airline services and is large enough to accommodate the relatively small air shipments normally associated with a large construction project. The Atlanta airport can accommodate large air shipments. Ground transportation from the Augusta airport is approximately 1 hour and from the Atlanta airport is approximately 3 hours (Dominion and Bechtel 2002).

During peak new plant construction, 5000 construction workers would be required.[a] The station operations workforce would be approximately 720. The extensive existing roadway network in the area and the sufficient rail lines near the preferred site are expected to be capable of handling an additional 38 percent of the workforce commuting to the site during construction and the transportation of bulk materials to and from the site. With implementation of traffic mitigation measures, the construction of two commercial nuclear units at the Savannah River Site is expected to result in impacts that are manageable for traffic patterns, workforce commuter traffic, and rail/truck delivery of materials (Dominion and Bechtel 2002).

The Savannah River Site is in a limited access DOE site adjacent to a rural, low-population area. The regional transportation network is adequate for commuter and transient traffic in the area. Based on the information provided by Dominion and its own independent review, the staff concludes that the transportation impacts of a construction workforce by adding a 38 percent increase to the existing workforce at Savannah River Site would be SMALL to MODERATE. Because the increase in employment with the operations workforce is less than 5.5 percent of the existing site workforce, the staff concludes the transportation impacts of the operations workforce would be SMALL.

Taxes

In lieu of property taxes, the Savannah River Site pays a fee to the localities bordering the site. For 2002, Barnwell County received a fee of approximately $2 million, Aiken County approximately $800,000, and Allendale County approximately $100,000 (Dominion and Bechtel 2002).

Construction and operation workers would pay personal income taxes to Georgia and South Carolina, sales taxes to the State and local governments in the region where sales take place, and property taxes to the counties in which they might own a residence. In addition, sales taxes would be paid from the sales of construction materials and supplies purchased for the project. Finally, because the nuclear units would be built by a private company (Dominion) and not DOE, a property tax might be levied on the value of the property that becomes part of the additional units as they are constructed. These taxes would most likely go to Aiken and Barnwell Counties.[b] Georgia and South Carolina both have corporate income taxes, with the tax rate being 6 and 5 percent, respectively (Federation of Tax Administration 2004).

(a) Dominion and Bechtel (2002) states that 3000 to 3500 craft and an additional 800 to 1000 non-manual personnel (or 4500 workers) would be required at the Savannah River Site. In its ESP ER (Dominon 2004), Dominion states that 5000 workers would be needed at the North Anna site.

(b) The proposed site of the new units would not be on land owned by Dominion. Most likely, should the Savannah River Site be chosen for the new power generating facility, the land for the new units would be leased from DOE by Dominion.

Based on the information provided by Dominion and its own independent review, the staff concludes that the overall beneficial impacts of taxes collected in the region through the income, sales and use taxes, and property taxes would be SMALL to LARGE. Therefore, the adverse impact level would be SMALL. The staff also concludes that the overall impacts of taxes collected through the income, sales and use taxes, and property taxes collected in the region would be SMALL for jurisdictions other than Barnwell County. The taxes paid, while large in absolute value, are nevertheless a small sum when compared to the total amount of taxes collected by State and local governments in the region. For property taxes in Barnwell County, the staff concludes that the overall beneficial impacts of the property taxes collected would be MODERATE (construction) and LARGE (operation) relative to the total amount of property taxes the county collects.[a] Therefore, the adverse impact level of the property taxes would be SMALL.

Aesthetics and Recreation

The preferred site for locating the two new nuclear units on the Savannah River Site is more than 10 km (6 mi) from the closest site boundary. There are no public amenity areas within 3 km (2 mi) of the site. Most of the site is dense forest; therefore, nearby trees would provide a visual buffer for the construction and operation of the proposed facilities to the public. Because the site is at least 10 km (6 mi) away from the existing site boundary, offsite observers would not have an identifiable nuclear power plant view (Dominion and Bechtel 2002).

Cooling towers, which could produce visible plumes offsite, are being proposed as part of the new nuclear units cooling system. Dominion has stated that, if necessary, drift eliminators could be installed on mechanical cooling towers to reduce visible plumes. Dry cooling towers could be an alternative method for plant cooling. Nearby trees would serve as a visual buffer for the transmission lines (Dominion and Bechtel 2002).

The AP1000 reactor has a tall containment building that is approximately 71 m (234 ft) above grade. The height above ground of a hatch, which is a key feature of the building housing the AP1000 reactor, determines the ultimate elevation of the building. Redesigning the building to

(a) The derivation of this impact is based on the fact the fiscal year 2003 amount of property taxes collected in Aiken and Barnwell Counties for fiscal year 2003 were $68,046,000 (Cornwell 2004 and $9,774,000 (Gibson 2004), respectively. For comparison, NAPS Units 1 and 2 pay approximately $10 million in annual property tax to Louisa County (the actual amount that the proposed nuclear plant would pay to Barnwell County would depend on assessed value and millage rate per thousand of assessed value). On the assumption that there is a rough comparison between what Dominion pays to Louisa County and what they might pay to Barnwell County, it can be concluded that the potential percentage of the proposed facility's property taxes to the total of all property taxes paid in Barnwell County would be significant.

allow placement lower in the ground would be expensive and is unlikely; therefore, the height of the AP1000 containment building sets the upper bound of what would be visible from offsite.

Prominent geographical features within 80 km (50 mi) of the Savannah River Site are Thurmond Lake (formerly called Clarks Hill Reservoir) and the Savannah River. The principal surface-water body associated with the Savannah River Site is the Savannah River, which flows along the site's southwest border (Dominion and Bechtel 2002). The closest state park is Redcliffe Plantation State Park, about 16 km (10 mi) northwest of the site location.

The proposed plant would be located about 10 km (6 mi) from the nearest site boundary and would be screened by trees. There are no significant residential areas or recreational facilities within 3 km (2 mi) of the site. Plumes from cooling towers could be visible offsite, although they could be mitigated by using drift eliminators. Based on information provided by Dominion and its own independent review, the staff concludes that the construction and station operation impacts on aesthetics and recreation would be SMALL.

Housing

In the four-county area of Richmond and Columbia Counties in Georgia and Barnwell and Aiken Counties in South Carolina, there were 187,811 housing units in 2000. Of these units, 52,405 were rental units, 6424 of which were vacant (10.9 percent vacancy rate) (USCB 2000e). There do appears to be vacant rental housing units available for construction workers who might want to relocate to the region.

In the same four-county area discussed above, there were 117,243 owner-occupied houses; 3089 of these houses were for sale (2.6 percent vacancy rate). The percentage of houses for sale in relation to owner-occupied housing is low, indicating the market for resale housing is tight.

The operations workforce is expected to come primarily from current or former employees at the Savannah River Site. If, however, a substantial number of workers were recruited into the area, there could be upward pressure on housing values. This assumption is based on the low number of homes for sale in the area and the fact that the workforce, which would be on the higher end of the salary scale when compared to other job classifications in the area, could tend to buy more expensive homes.

It is not unusual for construction workers to commute up to 2 hours (one way) per day to the job site. Many of the construction workers are assumed to already live within the region. Therefore, there appears to be enough vacant rental housing to house those who might relocate to the region. For the operations workforce, it is expected that most would already have residences in the region, and few would relocate to the area given the potential supply of workers in the region due to Savannah River Site downsizing. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts to housing from construction and operation of a commercial generating facility featuring two nuclear units at the Savannah River Site would be SMALL.

Public Services

Water and Wastewater Treatment

Four major public sewage treatment facilities with a combined design capacity of 302.2 million liters (79.8 million gallons) per day serve the six-county region composed of Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia. In 1989 (the latest year for which data was readily available), these systems were operating at approximately 56 percent capacity, with an average daily flow of 170 million L/day (44.9 MGD). Capacity utilization ranged from 45 percent in Aiken County to 80 percent in Barnwell County (DOE 2000).

There are approximately 120 public water systems in the six-county area. About 40 of these county and municipal systems are major facilities, while the remainder serve individual subdivisions, water districts, trailer parks, or miscellaneous facilities. In 1989 (again the latest year for which data is readily available), the 40 major facilities had a combined total flow of 576.3 million L/day (152.2 MGD). With an average daily flow rate of approximately 268.8 million L/day (71 MGD), these systems were operating at 47 percent capacity in 1989. Facility utilization rates ranged from 13 percent in Allendale County to 84 percent in the City of Aiken (DOE 2000).

The Savannah River Site is approximately 40 km (25 mi) southeast of Augusta, Georgia, and 31.4 km (19.5 mi) south of Aiken, South Carolina. There are numerous towns and cities within 80 km (50 mi) of the site, and all these towns and cities are within a 2-hour commuting distance via local transportation routes of the site (Dominion and Bechtel 2002). In addition, the utility infrastructures of the towns and cities could provide public services such as water and wastewater treatment to the construction and operations workforce who might relocate to the region.

There are a number of cities and towns in the region, all within a 2-hour commute of the Savannah River Site, that have existing water and wastewater treatment facilities. Many of the construction and operations workforce would come from within the region, and those that choose to relocate to the region would most likely take up residence throughout the region, thus placing minimal demands on the existing infrastructures. Based on information provided by

Dominion and its own independent review, the staff concludes that the impacts of the construction and operations workforces on water and wastewater treatment in the region would be SMALL.

Police, Fire and Medical Facilities

Seven general hospitals operate in the six-county region. Three of the seven general hospitals are in Richmond County (Augusta), Georgia, while Columbia County, Georgia, has no hospital. Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina each have one general hospital (DOE 2000).

Fifty-six fire departments provide fire protection in the region. Twenty-seven of these fire departments are classified as municipal fire departments, but many provide protection to rural areas outside municipal limits (DOE 2000).

County sheriff and municipal police departments provide most of the law enforcement in the region. In addition, State law enforcement agents and State troopers assigned to each county provide protection and assist county and municipal officers (DOE 2000).

Many of the potential construction and operations workforce probably already live within an 80-km (50-mi) radius of the region. There are a number of towns within a 2-hour commuting distance of the site. Any new workers relocating to the area would most likely have places of residency located throughout the region, which would not place an undue burden on the infrastructure of any one jurisdictional entity. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of the construction and operations workforce on public facilities in the Savannah River Site area would be SMALL.

Social Services

In Georgia, social services at the state level are overseen by the Department of Human Resources. It oversees about 80 wide-ranging programs that include controlling the spread of disease, enabling older people to live at home longer, preventing children from developing lifelong disabilities, training single parents to find and hold jobs, and helping people with mental or physical disabilities live and work in their communities (Georgia 2004a).

In South Carolina, social services are overseen by the Department of Social Service, which administers its programs through county offices. Services offered by the Department include child care assistance to needy families, adult protective services, child protective services, independent living, and emergency shelters food program, among other services (South Carolina 2004b). During the early phases of construction of new nuclear units at the Savannah

River Site, there may be increased demand for social services.

Generally, construction and operation of the new units at Savannah River Site would be viewed as beneficial economically to the disadvantaged population segments served by the Department of Human Resources and Department of Social Services. As with the other alternative sites, the workforce associated with construction and operation of a commercial nuclear facility at the Savannah River Site would most likely receive higher wages than other employment categories in the region. It is expected that through the multiplier effect, the number of jobs that could be filled by members of the disadvantaged population would increase.

Construction and operation of two commercial nuclear units would have a beneficial economic impact to the economically disadvantaged population in the region, which should lessen the demand for social services. There could be an initial increase in demand for social services at the beginning of the construction period, but this is considered manageable and limited. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and station operation of two commercial nuclear units on social and related services would be SMALL.

Education

Public education facilities in the six-county region (Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia) include approximately 95 elementary or intermediate schools and 25 high schools. In addition to the public schools, there are approximately 42 private and 16 post-secondary schools in the region (DOE 2000). There are also several local colleges, technical schools, and training facilities available, such as the University of South Carolina in Aiken, Augusta State, Paine College, Aiken Tech, and Augusta Tech.

Many of the potential construction and operating workforce probably already live within the region, and any new workers relocating to the area would most likely be take up residency throughout the region. Based on information provided by Dominion and its own independent review, the staff concludes that the impacts of construction and operation of two commercial nuclear units on educational facilities in the region would be SMALL.

8.7.5.4 Historic and Cultural Resources

Historic and cultural resources at the Savannah River Site are managed through a cooperative agreement between DOE and the South Carolina Institute of Archaeology of the University of South Carolina as the Savannah River Archaeological Research Program. Since 1974, more than 60 percent of the 777-km^2 (300-mi^2) site has been inventoried for prehistoric and historic sites and more than 1200 sites have been recorded, ranging in age from the Middle Archaic prehistoric period to the 20th century (DOE 2002). Archaeological research has provided considerable information about the distribution and content of archaeological and historic sites on the Savannah River Site.

Archaeologists have divided the Savannah River Site into three zones related to their potential for containing sites with multiple archaeological components or dense or diverse artifacts, and their potential for nomination to the National Register of Historic Places.

- Zone 1 is the zone of the highest archaeological site density, with a high probability of encountering large archaeological sites with dense and diverse artifacts, and a high potential for nomination to the National Register of Historic Places.

- Zone 2 includes areas of moderate archaeological site density. Activities in this zone have a moderate probability of encountering large sites with more than three prehistoric components or that would be eligible for nomination to the National Register of Historic Places.

- Zone 3 includes areas of low archaeological site density. Activities in this zone have a low probability of encountering archaeological sites and virtually no chance of encountering large sites with more than three prehistoric components; the need for site preservation is low. Some sites in the zone could be considered eligible for nomination to the National Register of Historic Places.

The proposed Savannah River ESP site lies in Zone 3. According to Savannah River Site staff (Dominion and Bechtel 2002), no known historic and cultural properties exsist in the site.

In conjunction with previous studies, DOE solicited the concerns of Native American tribes about religious rights in the Central Savannah River Valley. Three Native American groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy, expressed general concerns about the Savannah River Site and the Central Savannah River Area, but did not identify specific sites as possessing religious significance. The Yuchi Tribal Organization and the National Council of Muskogee Creek are interested in several plant species traditionally used in tribal ceremonies.

Based on information provided by Dominion and its own independent review, the staff concludes that the potential impacts on historic and cultural resources from construction and operation of two commercial nuclear units at the Savannah River ESP site would be SMALL.

8.7.5.5 Environmental Justice

DOE recently performed an environmental assessment for the construction and operation of a linear accelerator that would produce tritium (DOE 1999). As part of that assessment, an evaluation of potential environmental justice impacts was conducted (Dominion and Bechtel 2002).

DOE's environmental justice assessment evaluated whether minorities or low-income populations could receive disproportionately high and adverse human health and environmental impacts. Minority and low-income populations were identified by census tract. DOE's analysis concluded that releases from the site would not disproportionally affect minority communities (population equal to or greater than 35 percent of the total population) or low-income (equal to or greater than 25 percent of the total population) within an 80-km (50-mi) radius of the region, because the compared per capita doses did not vary significantly.[a] In addition, regarding downstream communities, DOE evaluated doses to people using the Savannah River for drinking water, sports, and food. Because the identified communities in the areas downstream from the SRS are well distributed, DOE concluded there were no disproportionate impacts among minority and low-income communities (Dominion and Bechtel 2002).

Based on the information provided by Dominion and its own independent review, the staff concludes that the offsite impacts of construction and operation of two commercial units at the Savannah River ESP site on minority and low-income populations would be SMALL. There are no disproportionately high and adverse impacts to these populations.

8.8 Summaries of Alternative Site Impacts

Summaries of the impacts of construction and operation on each of the three proposed alternative sites selected by Dominion are presented in Tables 8-6 and 8-7. Discussions of the stated impacts are presented in the individual site sections (sections 8.5 through 8.7). A comparison of the alternative site impacts with impacts at the proposed North Anna ESP site is presented in Chapter 9.

(a) NRC uses lower threshold limits than DOE for defining whether minority or low-income populations exist within an 80-km (50-mi) radius of the Savannah River Site – see Section 2.8.4 for a more detailed discussion of the NRC criteria.

Table 8-6. Characterization of Adverse Construction Impacts at the Alternative ESP Sites[(a)]

Category	Surry	Portsmouth	Savannah River
Land-use impacts	--	--	--
The site and vicinity	SMALL	SMALL	SMALL
Transmission corridors	SMALL	SMALL	SMALL TO MODERATE
Air quality impacts	SMALL	SMALL	SMALL
Water-related impacts	--	--	--
Water use	SMALL	SMALL	SMALL
Water quality	SMALL	SMALL	SMALL
Ecological impacts	--	--	--
Terrestrial ecosystems	SMALL	SMALL	SMALL TO MODERATE
Aquatic ecosystems	SMALL	SMALL	SMALL
T&E Species	SMALL	SMALL	SMALL TO MODERATE
Socioeconomic impacts	--	--	--
Physical Impacts	SMALL	SMALL	SMALL
Demography	SMALL	SMALL	SMALL
Community characteristics	SMALL TO MODERATE	SMALL TO MODERATE	SMALL TO MODERATE
Historic and cultural resources	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL
Nonradiological health impacts	SMALL	SMALL	SMALL
Radiological health impacts	SMALL	SMALL	SMALL

(a) Impacts of construction on the economy and increases in taxes collected are considered beneficial impacts. As a result the adverse impacts are considered SMALL and are reflected as such in Table 8-6. The beneficial economic impacts are discussed the applicable sections.

Table 8-7. Characterization of Adverse Operational Impacts at the Alternative ESP Sites[(a)]

Category	Surry	Portsmouth	Savannah River
Land-use impacts		--	--
The site and vicinity	SMALL	SMALL	SMALL
Transmission corridors	SMALL	SMALL	SMALL
Air quality impacts	SMALL	SMALL	SMALL
Water-related impacts	--	--	--
Water use and quality	SMALL	SMALL TO MODERATE	SMALL
Water use in drought year	SMALL	MODERATE	SMALL
Ecological impacts	--	--	--
Terrestrial ecosystems	SMALL	SMALL	SMALL
Aquatic ecosystems	SMALL	SMALL	SMALL
T&E Species	SMALL	SMALL	SMALL TO MODERATE
Socioeconomic impacts	--	--	--
Physical impacts	SMALL	SMALL	SMALL
Demographics	SMALL	SMALL	SMALL
Community characteristics	SMALL TO MODERATE	SMALL TO MODERATE	SMALL
Historic and cultural resources	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL
Nonradiological health impacts	SMALL	SMALL	SMALL
Radiological health impacts	SMALL	SMALL	SMALL
Impacts of postulated accidents	SMALL	SMALL	SMALL

(a) Impacts of operation on the economy and increases in taxes collected are considered beneficial impacts. As a result the adverse impacts are considered SMALL and are reflected as such in Table 8-7. The beneficial economic impacts are discussed the applicable sections.

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9.0 Comparison of the Impacts of the Proposed Action and Alternative Sites

The need to compare the proposed North Anna early site permit (ESP) site with other alternative sites arises from the requirement in Section 102(2)(c)(iii) of the National Environmental Policy Act of 1969 (NEPA) (42 U.S. Code 4332(2)(c)(iii)) that environmental impact statements include an analysis of alternatives to the proposed action. The test to be employed in assessing whether a proposed ESP site is to be rejected in favor of an alternative site is based on whether the alternative site is "obviously superior" to the site proposed by the applicant (Public Service Co. of New Hampshire 1977). An alternative site is "obviously superior" to the proposed site if it is "clearly and substantially" superior to the proposed site (Rochester Gas & Electric Corp. 1978).

The standard of obvious superiority "is designed to guarantee that a proposed site will not be rejected in favor of an alternate unless, on the basis of appropriate study, the Commission can be confident that such action is called for" (New England Coalition on Nuclear Pollution 1978). The "obviously superior" test is appropriate for two reasons. First, the analysis performed by The U.S. Nuclear Regulatory Commission (NRC) in evaluating alternative ESP sites is necessarily imprecise. Key factors considered in the alternative site analysis, such as population distribution and density, hydrology, air quality, aquatic and terrestrial ecological resources, aesthetics, land use, and socioeconomics, are difficult to quantify in common metrics. Given this difficulty, any evaluation of a particular site must necessarily have a wide range of uncertainty. Second, the applicant's proposed ESP site has been analyzed in detail, with the expectation that most adverse environmental impacts associated with the site have been identified. The alternative sites have not undergone a comparable level of detailed study. For these reasons, a proposed ESP site may be rejected in favor of an alternative site not when the alternative is "marginally better" than the proposed site, but only when it is "obviously superior" (Rochester Gas & Electric Corp. 1978). NEPA does not require that a nuclear plant be constructed on the single best site for environmental purposes. Rather, "all that NEPA requires is that alternative sites be considered and that the effects on the environment of building the plant at the alternative sites be carefully studied and factored into the ultimate decision" (New England Coalition on Nuclear Pollution 1978).

The NRC staff's review of alternative sites consists of a two-part sequential test for obvious superiority (NRC 2000). The first part of the test determines whether there are "environmentally preferred"[(a)] sites among the candidate ESP sites. The staff considers whether the applicant has (1) reasonably identified alternative sites, (2) evaluated the likely environmental impacts of construction and operation at these sites, and (3) used a logical means of comparing sites that has led to the applicant's selection of the proposed site. Based on its independent review, the staff then determines whether any of the alternative sites are environmentally preferable to the applicant's proposed ESP site.

If the staff determines that one or more alternative ESP sites is environmentally preferable, it will then compare the estimated costs (environmental, economic, and time) of constructing the proposed plant at the proposed site and at the environmentally preferable site or sites (NRC 2000). To find an obviously superior alternative site, the staff must determine that (1) one or more important aspects, either singly or in combination, of a reasonably available alternative site are obviously superior to the corresponding aspects of the applicant's proposed site; and (2) the alternative site does not have offsetting deficiencies in other important areas. A staff conclusion that an alternative site is obviously superior to the applicant's proposed site would normally lead to a recommendation that the application for the ESP be denied.

9.1 Comparison of the Proposed Site with the Alternatives

The staff reviewed the Environmental Report submitted by Dominion Nuclear North Anna, LLC (Dominion) (Dominion 2004) and supporting documentation, and conducted site visits at the proposed North Anna ESP site and the alternative sites. The staff found that the applicant had reasonably identified alternative sites, evaluated the environmental impacts of construction and operation, and used a logical means of comparing sites. The following section contains the staff's independent assessment of the alternative sites.

The staff's characterization of the expected environmental impacts of constructing and operating two new nuclear units at the proposed and alternative ESP sites within the bounds of the plant parameter envelope developed by Dominion are summarized in Tables 9-1 and 9-2. Explanations for the particular characterizations are in Chapters 4 and 5 for the site, in Section 8.5 for the Surry Power Station (Surry) site, in Section 8.6 for the Portsmouth Gaseous Diffusion Plant (Portsmouth) site, and in Section 8.7 for the Savannah River Site.

(a) An "environmentally preferred" alternative site is a site for which the environmental impacts are sufficiently less than the proposed site so that environmental preference for the alternative site can be established (NRC 2000).

Table 9-1. Comparison of the Construction Impacts at the Proposed and Alternative Early Site Permit Sites

Impact Area Category	North Anna ESP Site	Surry Site	Portsmouth Site	Savannah River Site
Land-use impacts	--	--	--	--
The site and vicinity	SMALL	SMALL	SMALL	SMALL
Transmission corridors	SMALL	SMALL	SMALL	SMALL TO MODERATE
Air quality impacts	SMALL	SMALL	SMALL	SMALL
Water-related impacts	--	--	--	--
Water use and quality	SMALL	SMALL	SMALL	SMALL
Ecological impacts	--	--	--	--
Terrestrial ecosystems	SMALL	SMALL	SMALL	SMALL TO MODERATE
Aquatic ecosystems	SMALL	SMALL	SMALL	SMALL
Threatened and endangered species	SMALL	SMALL	SMALL	SMALL TO MODERATE
Socioeconomic impacts	--	--	--	--
Physical impacts	SMALL	SMALL	SMALL	SMALL
Demography	SMALL	SMALL	SMALL	SMALL
Community characteristics	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Historic and cultural resources	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL
Non Radiological health impacts	SMALL	SMALL	SMALL	SMALL
Radiological health impacts	SMALL	SMALL	SMALL	SMALL

Table 9-2. Comparison of the Operational Impacts at the Proposed and Alternative Early Site Permit Sites

Impact Area Category	North Anna ESP Site	Surry Site	Portsmouth Site	Savannah River Site
Land-use impacts	--	--	--	--
The site and vicinity	SMALL	SMALL	SMALL	SMALL
Transmission corridors	SMALL	SMALL	SMALL	SMALL
Air quality impacts	SMALL	SMALL	SMALL	SMALL
Water-related impacts	--	--	--	--
Water use and quality	SMALL	SMALL	SMALL to MODERATE	SMALL
Water use in drought year	MODERATE	SMALL	MODERATE	SMALL
Ecological impacts	--	--	--	--
Terrestrial ecosystems	SMALL	SMALL	SMALL	SMALL
Aquatic ecosystems	SMALL	SMALL	SMALL	SMALL
Threatened and endangered species	SMALL	SMALL	SMALL	SMALL to MODERATE
Socioeconomic impacts	--	--	--	--
Physical impacts	SMALL	SMALL	SMALL	SMALL
Demographics	SMALL	SMALL	SMALL	SMALL
Community characteristics	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL
Historic and cultural resources	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL
Nonradiological health impacts	SMALL	SMALL	SMALL	SMALL
Radiological health impacts	SMALL	SMALL	SMALL	SMALL
Postulated accidents	SMALL	SMALL	SMALL	SMALL

Some environmental impacts considered for the North Anna ESP site or for the alternative sites are generic to all sites and therefore do not influence the comparison of impacts between the North Anna ESP site and the alternative sites. The generic environmental impacts common to all sites are, air quality, nonradiological and radiological health impacts, and environmental impacts from postulated accidents.

The environmental impact areas shown in Tables 9-1 and 9-2 have been evaluated using NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using the Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> 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 socioeconomic impact category reflects only the potential adverse impacts. Positive impacts (i.e., tax receipts to local government and public support of the proposed project) would occur but are not the determining factors in the analysis of an environmentally preferable or obviously superior site. For other impact categories in which a beneficial impact or no impact is predicted, the adverse impact level is shown as SMALL. Within some impact categories, impact levels varied. Professional judgment was employed to conclude, where possible, a single overall level of impact. In some cases, a range of probable impacts is given.

The staff determined the impact level from construction for most of the environmental issues at most of the sites is SMALL. In some cases, there are factors related to a site that could cause the impact level to increase from SMALL to MODERATE. More detailed information on these cases is presented in Chapter 4 for the North Anna ESP site, and Chapter 8 for the alternative sites. The staff based its analysis of the environmental impacts on the applicant complying with the Federal, State and local permit requirements and on the mitigation measures identified in the ER. The staff in its analysis of the alternative sites assumed similar permit requirements and mitigative measures would apply.

The staff determined the impact level from operation for most of the environmental issues at most of the sites is SMALL. In some cases, there are factors related to a site that could cause the impact level to increase from SMALL to MODERATE. More detailed information on these cases is presented in Chapter 5 for the North Anna ESP site, and Chapter 8 for the alternative sites.

9.2 Environmentally Preferable Sites

9.2.1 Construction

The impacts of construction at the North Anna ESP site are SMALL for all major impact categories. However, as noted in Section 4.5, there are some impact sub-categories under community characteristics (housing, public services, and education) for which the impacts could be MODERATE if a larger number of construction workers than the staff assumed relocate to Louisa or Orange Counties.

The impacts of construction at the Surry alternative ESP site are SMALL for all impact categories except community characteristics. As noted in Section 8.5, the impacts in this area are SMALL to MODERATE for transportation.

The impacts of construction at the Portsmouth alternative ESP site are SMALL for all impact categories except community characteristics. As noted in Section 8.6, the impacts in this area are SMALL to MODERATE for availability of workers and aesthetics.

The impacts of construction at the Savannah River Site alternative are SMALL for all impact categories except terrestrial resources (including endangered species) and community characteristics. As noted in Section 8.7, the impacts on terrestrial resources are SMALL to MODERATE. The staff arrived at this broad range of potential impacts because the routing for the new transmission line rights-of-way that would be needed is not known and so the associated impacts of construction cannot be assessed. In addition, under community characteristics the impacts are SMALL to MODERATE for transportation.

While there are minor differences in the construction impacts at the four sites, the staff concludes that none of these differences is sufficient to determine that any of the alternative sites is environmentally preferable to the proposed North Anna ESP site.

9.2.2 Operations

The impacts of operations at the North Anna ESP site are SMALL for all major impact categories except water use and community characteristics categories. As discussed in Section 5.3, the impacts of Unit 3 operations on water use are SMALL most years. However, during a significant drought, the impacts could be MODERATE. In addition, as discussed in Section 5.5, the impacts for aesthetics and housing are SMALL to MODERATE and impacts to recreation may be MODERATE during drought years.

The impacts of operations at the Surry alternative ESP site are SMALL for all impact categories except community characteristics. As noted in Section 8.5, the impacts in this area are SMALL to MODERATE for aesthetics.

The impacts of operations at the Portsmouth alternative ESP site are SMALL for all impact categories except water use and community characteristics. As noted in Section 8.6, the impacts of plant operations on water use are SMALL to MODERATE most years. However, during a significant drought, the impacts would be MODERATE. In addition, impacts under community characteristics are SMALL to MODERATE for aesthetics.

The impacts of operations at the Savannah River Site alternative ESP site are SMALL for all impact categories except threatened and endangered species. As noted in Section 8.7, the impacts in this area are SMALL to MODERATE. The staff arrived at this broad range of potential impacts because the routing for the new transmission line rights-of-way that would be needed for plant operation is not known and so the associated impacts of operation and maintenance must be assigned a broad range of potential impacts.

In summary, although the water-use impacts at the North Anna ESP site are projected to be MODERATE during years when there is a severe drought, this is expected to be an infrequent occurrence. The operational impact of the units at North Anna is also expected to have a MODERATE impact in the recreational sub-category of socioeconomics during a severe drought. This may affect the size of the striped bass available for recreational fishing. This impact can be mitigated by stocking more fish, stocking larger fish, or managing the fishery to provide more catch opportunities of larger fish. The Portsmouth site has a similar water-use issue and the Savannah River Site has significant unknown impacts associated with the transmission line rights-of-way (could be anywhere from SMALL to MODERATE). The Surry site has one socioeconomic issue with impacts in the SMALL to MODERATE range. While there are some differences in the environmental impacts of operation at the four sites, the staff concludes that none of these differences is sufficient to determine that any of the alternative sites is environmentally preferable to the proposed North Anna ESP site.

9.3 Obviously Superior Sites

None of the alternative sites were determined to be environmentally preferable to the North Anna ESP site. Therefore, the staff concluded that none of the alternative sites is obviously superior to the North Anna ESP site.

9.4 Comparison with the No-Action Alternative

The no-action alternative refers to a scenario in which the NRC would deny the ESP request. If the ESP application for the proposed North Anna ESP site location were denied, the impacts of construction and operation of a new nuclear power facility would not occur.

In the event of NRC's denial of the ESP application, Dominion could follow several paths to satisfy its electric power needs. The potential paths include (1) seeking an ESP for a different location, (2) purchase of power from other electricity providers, (3) conservation and demand-side management programs, (4) construction of new generation facilities other than nuclear at the North Anna site, (5) construction of new generation facilities at other locations, (6) delayed retirement of existing generating facilities, and (7) reactivation of previously retired generating facilities. These paths could be pursued individually or in combination. Each of the paths would have associated environmental impacts. Nonetheless, since Part 52 does not require an ER or EIS for an ESP to include consideration of energy alternatives or the benefits of construction and operation of a reactor or reactors at the ESP site, this draft EIS does not consider such matters. Accordingly, should the NRC ultimately determine to issue an ESP for the North Anna ESP site, these matters will be considered in the EIS for any CP or COL application that references such an ESP.

No significant environmental impacts would be avoided by the no-action alternative because no such impacts are caused by a site-suitability determination. The only activities that are permissible under an ESP are limited to site preparation activities allowed by 10 CFR 50.10(e)(1). Site preparation 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.

9.5 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

Dominion Nuclear North Anna, LLC (Dominion). 2004. *North Anna Early Site Permit Application - Part 3 - Environmental Report.* Revision 3, Glenn Allen, Virginia.

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321 et seq.

New England Coalition on Nuclear Pollution. 1978. *New England Coalition on Nuclear Pollution v. NRC,* 582 F.2d 87 (1st Circuit 1978).

Public Service Co. of New Hampshire. 1977. *Public Service Co. of New Hampshire* (Seabrook Station, Units 1 & 2), CLI-77-8, 5 NRC 503, 526 (1977), *affirmed, New England Coalition on Nuclear Pollution v. NRC,* 582 F.2d 87 (1st Circuit 1978).

Rochester Gas & Electric Corp. 1978. *Rochester Gas & Electric Corp.* (Sterling Power Project Nuclear Unit No. 1), ALAB-502, 8 NRC 383, 397 (1978), *affirmed,* CLI-80-23, 11 NRC 731 (1980).

U.S. Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants.* NUREG-1555, Vol. 1, Washington, D.C.

10.0 Conclusions and Recommendations

On September 25, 2003, the U.S. Nuclear Regulatory Commission (NRC) received an application from Dominion Nuclear North Anna, LLC (Dominion) for an early site permit (ESP) for a location adjacent to the North Anna Power Station (NAPS), Units 1 and 2. Dominion submitted revisions to the environmental report (ER) on October 2, 2003, July 15, 2004, and September 7, 2004. Any reference in this draft environmental impact statement (EIS) to the ER refers to Revision 3, unless otherwise stated. The North Anna ESP site is located in Louisa County, Virginia, approximately 10 km (6 mi) northeast of the town of Mineral. An ESP is a Commission approval of a location for siting one or more nuclear power facilities and is a separate action from the filing of an application for a construction permit (CP) or a combined construction permit and operating license (combined license or COL) for such a facility. An ESP application may refer to a reactor's or reactors' characteristics or a plant parameter envelope, which is a set of postulated design parameters that bound the characteristics of a reactor or reactors that might be built at a selected site; alternatively an ESP may refer to a detailed reactor design. The ESP is not a license to build a nuclear power plant; rather, the application for an ESP initiates a process undertaken to assess whether a proposed site is suitable should the applicant decide to pursue a CP or COL.

Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321) directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. Subpart A of Title 10 of the Code of Federal Regulations (CFR) Part 52 contains the NRC regulations related to ESPs. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. As set forth in 10 CFR 52.18, the Commission has determined that an EIS will be prepared during the review of an application for an ESP. The purpose of Dominion's requested action, issuance of the ESP, is for the NRC to determine whether the North Anna ESP site is suitable for new nuclear units by resolving certain safety and environmental issues before Dominion incurs the substantial additional time and expense of designing and seeking approval to construct such facilities at the site. Part 52 of Title 10 describes the ESP as a "partial construction permit." An applicant for a CP or COL for a nuclear power plant or plants to be located at the site for which an ESP was issued can reference the ESP, thus reducing the review of siting issues at that stage of the licensing process. However, a CP or COL to construct and operate a nuclear power plant is a major federal action that requires its own environmental review in accordance with 10 CFR Part 51.

Three primary issues – site safety, environmental impacts, and emergency planning – must be addressed in the ESP application. Likewise, in its review of the application, the NRC assesses the applicant's proposal in relation to these issues and determines if the application meets the requirements of the Atomic Energy Act and NRC regulations. This draft environmental impact statement addresses the environmental impacts of the proposed action.

Dominion requested in its application authorization to perform certain site preparation activities after the ESP is issued. The application, therefore, included a site redress plan that specifies how the applicant would stabilize and restore the site to its preconstruction condition (or conditions consistent with an alternative use) in the event a nuclear power plant is not constructed on the approved site. Pursuant to 10 CFR 52.17(a)(2), the applicant did not address the benefits of the proposed action (e.g., the need for power). In accordance with 10 CFR 52.18, the EIS is focused on the environmental effects of construction and operation of a reactor, or reactors, which have characteristics that fall within the postulated site parameters.

Upon acceptance of the Dominion ESP application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing in the *Federal Register* a Notice of Intent (68 FR 65961) to prepare an EIS and conduct scoping. The staff visited the North Anna ESP site during December 2003 and held a public scoping meeting on December 8, 2003, in Mineral, Virginia. Subsequent to the site visit and the scoping meeting and in accordance with NEPA and 10 CFR Part 51, the staff has determined and evaluated the potential environmental impacts of constructing and operating two nuclear power plants at the North Anna ESP site. Included in this draft EIS are (1) the results of the NRC staff's preliminary analyses, which consider and weigh the environmental effects of the proposed action (issuance of the ESP) and of constructing and operating two nuclear units at the ESP site; (2) mitigation measures for reducing or avoiding adverse effects; (3) the environmental impacts of alternatives, and (4) the staff's preliminary recommendation regarding the proposed action.

During the course of preparing this draft EIS, the staff reviewed the Environmental Report submitted by Dominion, consulted with Federal, State, Tribal and local agencies, and followed the guidance set forth in review standard RS-002, *Processing Applications for Early Site Permits,* to conduct an independent review of the issues. The review standard draws from the previously published NUREG-0800, *Standard Review Plans for the Review of Safety Analysis for Nuclear Power Plants,* and NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants.* In addition, the staff considered the public comments related to the environmental review received during the scoping process. These comments are provided in Appendix D of this draft EIS.

In following the precedent of the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437) and supplemental license renewal EISs, environmental issues are evaluated using a three-level standard of significance – SMALL, MODERATE, or LARGE – developed by NRC using guidelines from the Council on Environmental Quality. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

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.

Mitigation measures were considered for each environmental issue and are presented in the appropriate sections.

NEPA requires that an EIS include information on:

- any adverse environmental effects that cannot be avoided should the proposal be implemented
- any irreversible and irretrievable commitments of resources that would be involved if the proposed action is implemented
- the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Activities permitted under an ESP include preparation of the site for construction of the facility, installation of temporary construction support facilities, excavation for facility structures, construction of service facilities, and construction of certain structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents. These activities are identified in the site redress plan. However, the following discussion of the NEPA requirements addresses the impacts of construction and operation of two new units at the North Anna ESP site. The construction impacts bounds any impacts of the site preparation and preliminary construction activities allowed under 10 CFR 52.25(a).

10.1 Unavoidable Adverse Environmental Impacts

Section 102(C)(ii) of NEPA requires that an EIS include information on any adverse environmental effects that cannot be avoided should the proposal be implemented. Unavoidable adverse environmental impacts are those potential impacts of construction and operation of the proposed new units that cannot be avoided and for which no practical means of mitigation are available.

There will be no unavoidable adverse environmental impacts associated with the granting of the ESP with the exception of impacts associated with the limited site preparation and preliminary construction activities allowed under the site redress plan. The impacts associated with the site preparation and preliminary construction activities are bounded by the construction activities. However, there are unavoidable adverse environmental impacts associated with the construction and operation of two new units at the North Anna ESP site.

If granted, the only activities authorized by the ESP would be the following site preparation and preliminary construction activities sought by Dominion, which are described in Part 4 of the application (Dominion 2004b) and enumerated in 10 CFR 50.10(e)(1):

- preparation of the site for construction of the facility (including such activities as clearing, grading, and construction of temporary access roads and borrow areas)

- installation of temporary construction support facilities (including such items as warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings)

- excavation for facility structures

- construction of service facilities (including such facilities as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, and sanitary sewage treatment facilities)

- the construction of structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents, that could cause undue risk to the health and safety of the public.

If the ESP is granted to Dominion and if Dominion performs any or all of the activities above, but does not, in the future, seek a CP under 10 CFR Part 50 or a COL under 10 CFR Part 52, Dominion would need to redress the site according to the site redress plan included in Part 4, Chapter 1 of its ESP application (Dominion 2004b). The staff reviewed the list of allowed site preparation and preliminary construction activities in the event that the ESP is granted and reviewed the full site redress plan submitted by Dominion. In accordance with 10 CFR 52.17, the application demonstrated that there is reasonable assurance that redress carried out under the plan will achieve an environmentally stable and aesthetically site suitable for whatever non-nuclear use may conform with local zoning laws. As a result of its own independent review, the staff, in accordance with 10 CFR 52.25(a), preliminarily concludes that the potential site preparation and preliminary construction activities described in the applicant's site redress plan would not result in any significant adverse impacts that could not be redressed.

Unavoidable Adverse Impacts During Construction

Chapter 4 discusses the impacts from construction in detail. The unavoidable adverse impacts related to construction are listed in Table 10-1 and summarized below. The primary unavoidable adverse environmental impacts during construction would be related to land use. All construction activities for Units 3 and 4, including ground-disturbing activities, would occur within the existing NAPS site boundary. According to Dominion, the area that would be affected on a long-term basis as a result of permanent facilities is approximately 52 ha (128 ac). An additional 27.5 ha (67.9 ac) would be disturbed on a short-term basis as a result of temporary activities and facilities and laydown areas (Dominion 2004a).

Table 10-1. Unavoidable Adverse Environmental Impacts from Construction

Impact Category	Adverse Impacts Based on Applicant's Proposal	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land Use	Yes	Comply with requirements of applicable Federal, State and Local Permits	52 ha (128 ac) disturbed on long term basis, additional 27.5 ha (67.9 ac) would be disturbed on a short-term basis
Hydrological and Water Use	Yes	Use best construction management practices	Fill, and grading operations at the North Anna ESP site will alter two ephemeral streams
Ecological a. Terrestrial b. Aquatic	a. Yes b. Yes	a. Use of construction best management practices adherence to applicable permit conditions and avoid sensitive areas. Where possible, reestablish habitat after construction. b. Performing wetland surveys to determine Clean Water Act Section 404 eligibility	a. Removal of trees and vegetation and habitat. b. Disturbance of intermittent streams, destruction of wetlands
Socioeconomic	Yes	Implement traffic management plan	Increased traffic congestion
Radiological	Yes	Use of as low as reasonably achievable (ALARA) principles	Dose to construction workers

Impact Category	Adverse Impacts Based on Applicant's Proposal	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Atmospheric and Meteorological	Yes	Implement dust control plan	Equipment emissions and fugitive dust from operation of earth-moving equipment are sources of air pollution
Environmental Justice	No	Not applicable	Not applicable

The construction impacts on the terrestrial ecology of the site would be short-term. Construction of Units 3 and 4 would result in the removal of approximately 32 ha (80 ac) of forested habitat within the site. The ESP site does not contain any old growth timber, unique or sensitive plants or communities. Therefore, construction activities would not noticeably reduce the local or regional diversity of plants or plant communities. There are no important animal species or habitats on the ESP site. No areas designated by the U.S. Fish and Wildlife Service (FWS) as critical habitat for endangered or threatened species exist at or near the site, nor are threatened or endangered plants or animals known to exist at the site. Therefore, construction likely would have no impact on any threatened or endangered species, or other important species or habitats. Socioeconomic impacts of construction include an increase in traffic. Atmospheric and meteorological impacts include fugitive dust from construction activities and can be mitigated by the dust control plan. Radiological doses to construction workers from the adjacent units are expected to be well below regulatory limits. Regarding environmental justice, there are no unusual resource dependencies by low income or minority groups.

Unavoidable Adverse Impacts During Operation

Chapter 5 provides a detailed discussion of the impacts from operation. The unavoidable adverse impacts related to operation are listed in Table 10-2 and summarized below. Hydrological and water use impacts during operation are primarily the result of the operation of the once through cooling system for proposed Unit 3. The unavoidable adverse impacts are the increased temperature in Lake Anna and the decrease in lake level. The ecological impacts are primarily affected by the operation of the once through cooling system for proposed Unit 3. The increase in lake temperature will limit the growth and size of the striped bass during severe drought conditions. The impact to the striped bass can be mitigated by stocking more fish, stocking larger fish, or managing the fishery to provide more catch opportunities of larger fish. Socioeconomic impacts are primarily increased demand for services, with the increased tax revenue to support the increase in services. Visual impact of lower water levels, and their effect on shoreline exposure during severe drought could temporarily impact the area. Meteorological impacts are expected to be negligible. Pollutants emitted during operations are considered insignificant. The unavoidable adverse impacts from operation for land use are small and further mitigation is not warranted.

Table 10-2. Unavoidable Adverse Environmental Impacts from Operation

Impact Category	Adverse Impacts Based on Applicant's Proposal	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land Use	Yes	Local land management plans	Possible new housing and retail space added in vicinity due to potential growth
Hydrological and Water Use	Yes	Comply with State permit limits	Decrease in lake level and reduction in available water released from dam
Ecological a. Terrestrial b. Aquatic	a. No b. Yes	a. None b . Mitigation in the form of additional stocking striped bass may be necessary.	a. None. b. Proportion of resources subject to impingement and entrainment would be small. Additional heat could impact hatchery striped bass in parts of the lake in drought years
Socioeconomic	Yes	Evaluate options to reduce consumptive water use at the CP/COL stage	Lower lake during drought conditions
Radiological	Yes	Use of as low as reasonably achievable (ALARA) requirements	Dose to workers, the public and biota
Atmospheric and Meteorological	No	None	None. Meteorological impacts are expected to be negligible
Environmental Justice	No	Not applicable	Not applicable

10.2 Irreversible and Irretrievable Commitments of Resources

Section 102(C)(v) of NEPA requires that an EIS include information on any irreversible and irretrievable commitments of resources that would occur if the proposed action is implemented. The only irreversible and irretrievable commitments of resources that would be expended if the proposed action is implemented would be resources used by Dominion for site preparation activities. If not used during the duration of the ESP, any such resource commitments for site preparation activities would be used at the CP/COL stage or could potentially be used for other activities even if Dominion does not eventually seek a CP or a COL for the ESP location.

Irretrievable commitments of resources during construction of the proposed new units generally would be similar to that of any major, construction project. The actual commitment of construction resources (concrete, steel, and other building materials) would depend on the reactor design selected at the CP/COL stage. Hazardous materials such as asbestos would not be used, if possible. If materials such as asbestos were used, it would be in accordance with safety regulations and practices. The actual estimate of construction materials would be performed at the CP/COL stage when the reactor design is selected.

The staff expects that the use of construction materials in the quantities associated with those expected for the two new units, while irretrievable, would be a small impact, with respect to the availability of such resources.

The main resource that would be irretrievably committed during operation of two new nuclear unit would be uranium. The availability of uranium ore and existing stockpiles of highly enriched uranium in the United States and Russia that could be processed into fuel is sufficient, so that the irreversible and irretrievable commitment would be a small impact.

10.3 Relationship Between Short-Term Uses and Long-Term Productivity of the Human Environment

Section 102(C)(iv) of NEPA requires that an EIS include information on the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. The only short-term use of the environment that could occur if the proposed action is implemented would be site preparation activities conducted by Dominion that would be authorized in an ESP. Any such activities are unlikely to adversely affect the long-term productivity of the environment. The evaluation of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity for the construction and operation of the two new units can only be performed by discussing the benefits of operating the units. The benefit is the production of electricity. In accordance with 10 CFR 52.18, an EIS for an ESP does not need to include an assessment of the benefits of the proposed action. Therefore, an assessment of the evaluation of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity for the construction and operation of the two units will be performed at the CP/COL stage.

10.4 Cumulative Impacts

The staff considered the potential cumulative impacts resulting from construction and operation the proposed Units 3 and 4 during the past, present, and future actions in the North Anna ESP site area in chapter 7 of this EIS. For each impact area, the staff's determination is that the potential cumulative impacts resulting from construction and operation are SMALL, and mitigation is not warranted. The geographical area over which past, present, and future actions could contribute to cumulative impacts is dependent on the type of type of action considered, and is described below for each impact area. Several issues have the potential for MODERATE impacts, most of which would occur under temporary circumstances or as the result of a larger than expected concentration of construction workers settling near the North Anna ESP site.

10.5 Staff Conclusions and Recommendations

The staff's preliminary recommendation is that the ESP should be issued. This preliminary recommendation is based on (1) the Environmental Report submitted by Dominion, as revised; (2) consultation with Federal, State, Tribal and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments received during the public scoping process and; (5) the assessments summarized in this draft EIS, including the potential mitigation measures identified in the ER and in the EIS. In addition, in making its preliminary recommendation, the staff has concluded that there are no environmentally preferable or obviously superior sites. Finally, the staff has preliminarily concluded that the site preparation and preliminary construction activities allowed by 10 CFR 50.10(e)(1) will not result in any significant adverse environmental impact that cannot be redressed.

A comparative summary showing the environmental impacts of locating two new units at the North Anna ESP site, or at any of the alternative sites is shown in Table 10-3. Impacts of the no-action alternative, or denial of the ESP application, is also shown. Table 10-3 shows that the significance of the environmental impacts of the proposed action is SMALL for all impact categories with the exception of water use and quality and certain socioeconomic categories. The alternative sites, may have environmental effects in at least some categories that reach MODERATE significance. The staff concludes that none of the alternative sites assessed are obviously superior to the North Anna ESP site.

Table 10-3. Summary of Environmental Significance of Station Location at the North Anna Power Station Early Site Permit Site, at Alternative Sites, and for the No-Action Alternative

	Proposed Action	No-Action Alternative	Alternative Site Options		
Impact Category	**ESP Permit at North Anna**	**Denial of ESP**	**Surry**	**Portsmouth**	**Savannah River**
Land Use	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Ecology	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Water Use and Quality	SMALL to MODERATE	SMALL	SMALL	SMALL to MODERATE	SMALL
Air Quality	SMALL	SMALL	SMALL	SMALL	SMALL
Waste	SMALL	SMALL	SMALL	SMALL	SMALL
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Historic and Archaeological Resources	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental Justice	SMALL	SMALL	SMALL	SMALL	SMALL

10.6 References

10 CFR Part 50. Code of Federal Regulations, Title 10 *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10 *Energy*, Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

Atomic Energy Act of 1954. 42 USC 2011, et seq.

Dominion Nuclear North Anna, LLC (Dominion). 2004a. *North Anna Early Site Permit Application – Part 3 – Environmental Report*. Revision 3, Glen Allen, Virginia.

Dominion Nuclear North Anna, LLC (Dominion). 2004b. *North Anna Early Site Permit Application – Part 4 – Programs and Plans.* Revision 3, Glen Allen, Virginia.

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

U.S. Nuclear Regulatory Commission (NRC). 1987. *Standard Review Plans for the Review of Safety Analysis Reports for Nuclear Power Plants.* NUREG-0800, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental Review for Nuclear Power Plants, Main Report, Supplement : Operating License Renewal.* NUREG-1555, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2004. *Processing Applications for Early Site Permits.* RS-002, Washington, D.C.

Appendix A

Contributors to the Environmental Impact Statement

The overall responsibility for the preparation of this environmental impact statement was assigned to the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC). The statement was prepared by members of the Offices of Nuclear Reactor Regulation with assistance from other NRC organizations and Pacific Northwest National Laboratory.

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(a) Pacific Northwest National Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute.

Appendix B

Organizations Contacted

Appendix B

Organizations Contacted

During the course of the staff's independent review of potential environmental impacts from siting two new nuclear units at the North Anna site, the following Federal, State, regional, Tribal and local agencies were contacted:

Lake Anna State Park, Spotsylvania, Virginia

Louisa County Historical Society, Louisa, Virginia

Virginia Department of Conservation and Recreation, Richmond, Virginia

Virginia Department of Historic Resources, Richmond, Virginia

Chickahominy Indian Tribe, Providence Forge, Virginia

Chickahominy Indians – Eastern Division, Providence Forge, Virginia

Mattaponi Indian Tribe, West Point, Virginia

Monacan Indian Nation, Madison Heights, Virginia

Nansemond Indian Tribe, Suffolk, Virginia

Pamunkey Indian Tribe, King William, Virginia

Rappahannock Tribe, Indian Neck, Virginia

Upper Mattaponi Indian Tribe, Mechanicsville, Virginia

Virginia Council on Indians, Richmond, Virginia

South Carolina Field Office, U.S. Fish and Wildlife Service, Charleston, South Carolina

Ohio Field Office, U.S. Fish and Wildlife Service, Reynoldsburg, Ohio

Virginia Department of Environmental Quality, Richmond, Virginia

Department of Conservation and Recreation, Richmond, Virginia

Virginia Department of Game and Inland Fisheries, Richmond, Virginia

Wildlife Diversity Division, Virginia Department of Game and Inland Fisheries, Richmond, Virginia

Department of Mines, Minerals, and Energy, Richmond, Virginia

Marine Resources Commission, Newport News, Virginia

Virginia Department of Transportation, Richmond, Virginia

Department of Agriculture and Consumer Services, Richmond, Virginia

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Finance Director, Louisa County, Louisa, Virginia

Treasurer, Orange County, Orange, Virginia

Reservoir Coordinator, Nuclear Site Services, Dominion Generation, North Anna Site

Commissioner of Revenue, Louisa County, Louisa, Virginia

Assessor, Louisa County, Louisa, Virginia

Director of Planning and Community Development, Louisa County, Louisa, Virginia

Director Planning and Zoning, Louisa County, Louisa, Virginia

Director Department of Planning, Spotsylvania County, Spotsylvania, Virginia

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Director of Economic Development, Spotsylvania County, Spotsylvania, Virginia

President of Fredericksburg Regional Alliance; Fredericksburg, Virginia

Realtor, Century 21, Fredericksburg, Virginia

Owner/Broker Century 21, Fredericksburg, Virginia

Rappahannock Area Development Commission, Fredericksburg, Virginia

Louisa County Farm Service Agency, Louisa, Virginia

Administrative Assistant for School Admissions, Spotsylvania Public Schools, Spotsylvania, Virginia

School Superintendent, Louisa County Public Schools, Louisa, Virginia

School Superintendent, Orange County Public Schools, Orange, Virginia

County Administrator, Louisa County, Louisa, Virginia

Director Office of Economic Development, Orange County, Orange, Virginia

Director Planning and Zoning, Orange County, Orange, Virginia

Director of Economic Development, Louisa County, Louisa, Virginia

Louisa Town Manager, Louisa, Virginia

Real Estate Agent, Century 21, Mineral, Virginia

Director of Social Services, Orange County, Virginia

Director of Social Services, Louisa County, Virginia

County Administrator, Orange County, Virginia

Town Manager, Orange, Virginia

Director of Public Works, Orange, Virginia

Managing Broker, Century 21, Orange, Virginia

Branch Manager, Virginia Community Bank, Louisa, Virginia

Town Manager, Mineral, Virginia

Interim County Manager, Spotsylvania County, Spotsylvania, Virginia

Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to Dominion Nuclear North Anna, LLC's Application for Early Site Permit at North Anna Nuclear Plant Site

Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to Dominion Nuclear North Anna, LLC's Application for Early Site Permit at North Anna Nuclear Plant Site

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and Dominion Nuclear North Anna, LLC (Dominion) and other correspondence related to the NRC staff's environmental review, under 10 CFR Part 51, for Dominion's application for an early site permit at the North Anna Nuclear Plant site. All documents, with the exception of those containing proprietary information, have been placed in the Commission's Public Document Room, at One White Flint North, 11555 Rockville Pike (first floor), Rockville, MD, and are available electronically from the Public Electronic Reading Room found on the Internet at the following web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Document Access and Management Systems (ADAMS), which provides text and image files of NRC's public documents in the Publicly Available Records (PARS) component of ADAMS. The ADAMS accession numbers for each document are included below.

September 25, 2003	Letter from Mr. David A. Christian, Dominion, to NRC submitting the application for an early site permit at North Anna (Accession No. ML032731511).
September 29, 2003	Letter from Mr. Tony Banks, Dominion, to Ms. Joanne Tetrault, Louisa County Library, forwarding application for an early site permit at North Anna (Accession No. ML032880335).
September 29, 2003	Letter from Ms. Pamela Faggert, Dominion, to Ms. Ellie Irons, Virginia Department of Environmental Quality (VDEQ), forwarding the early site permit application and requesting a Coastal Zone Management Act consistency determination (Accession No. ML040780219).
October 2, 2003	Letter from Mr. David A. Christian, Dominion, to NRC submitting Revision 1 of the application for an early site permit at North Anna (Accession No. ML032731511).

October 9, 2003	Letter from NRC to Mr. David A. Christian, Dominion, regarding the receipt and availability of the application for an early site permit at North Anna (Accession No. ML032600005).
October 9, 2003	NRC press release announcing the availability of the early site permit application for North Anna (Accession No. ML032820297).
October 16, 2003	Federal Register Notice of receipt of the application for an early site permit at North Anna (68 FR 59642).
October 23, 2003	Letter from NRC to Mr. David A. Christian, Dominion, regarding acceptance of the application for an early site permit at North Anna (Accession No. ML032740025).
October 29, 2003	Federal Register Notice of acceptance for docketing of the application and notice of opportunity for a hearing regarding the application for an early site permit at North Anna (68 FR 61705).
November 6, 2003	Letter from Ms. Pamela Faggert, Dominion, to Ms. Ellie Irons, VDEQ, forwarding a Coastal Zone Management Act consistency determination for the early site permit application and requesting concurrence (Accession No. ML033280533).
November 24, 2003	Federal Register Notice of Intent to prepare an environmental impact statement and conduct scoping process for an early site permit at North Anna (68 FR 65961).
November 24, 2003	NRC meeting notice announcing public meeting in Mineral, Virginia on December 8, 2003, to discuss the environmental scoping process for the application for an early site permit at North Anna (Accession No. ML033280550).
November 28, 2003	Letters from NRC to public officials announcing receipt and review of the application for an early site permit at North Anna (Accession No. ML033020111).
December 3, 2003	Letter from NRC to Ms. Deanna Beacham, Virginia Council on Indians, regarding the early site permit review for the North Anna Power Station site (Accession No. ML033390103).

December 3, 2003	Letter from NRC to Chief Leo Henry, Tuscarora Nation, regarding the early site permit review for the North Anna Power Station site (Accession No. ML033390155).
December 3, 2003	Letter from NRC to Chief Arnold Hewitt, Tuscarora Nation, regarding the early site permit review for the North Anna Power Station site (Accession No. ML033390191).
December 3, 2003	Letter from NRC to Neil Patterson, Jr., Tuscarora Environmental Nation, regarding the early site permit review for the North Anna Power Station site (Accession No. ML033390172).
December 8, 2003	Placement of public meeting materials into public document room (Accession No. ML033450406).
December 12, 2003	E-mail from Ms. Carrie E. Girstantas to NRC, providing scoping comments regarding the early site permit review for the North Anna Power Station site (Accession No. ML040140310).
December 12, 2003	Letter from NRC to Mr. David Ritter, Mr. Brendan Hoffman, and Mr. Jon Kessler regarding requests made during the environmental scoping meeting to extend the time to file a petition for leave to intervene in proceeding on early site permit for the North Anna Power Station site (Accession No. ML033580505).
December 21, 2003	Letter from NRC to Mr. John Wolflin, Chesapeake Bay Field Office of the U.S. Fish and Wildlife Service, requesting a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the North Anna Power Station and Surry Power Station sites (Accession No. ML033570088).
December 21, 2003	Letter from NRC to Ms. Mary Colligan, Northeast Regional Office of NOAA Fisheries, requesting a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the North Anna Power Station and Surry Power Station sites (Accession No. ML033560365).
December 21, 2003	Letter from NRC to Dr. Mary Knapp, Reynoldsburg Ecological Services Office of the U.S. Fish and Wildlife Service, requesting a list of species and information on protected, proposed, and candidate species and

critical habitat that may be in the vicinity of the U.S. Department of Energy's Portsmouth Site (Accession No. ML033560384).

December 21, 2003	Letter from NRC to Mr. Roger L. Banks, Charleston Ecological Services Office of the U.S. Fish and Wildlife Service, requesting a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the U.S. Department of Energy's Savannah River Site (Accession No. ML033560437).
December 21, 2003	Email from Aviv Goldsmith to NRC, providing scoping comments regarding the early site permit review for the North Anna Power Station site (Accession No. ML040060329).
January 5, 2004	Letter from NRC to Ms. Georgia Cranmore, Southeast Regional Office of NOAA Fisheries, requesting a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the U.S. Department of Energy's Savannah River Site (Accession No. ML040080759).
January 5, 2004	Letter from NRC to Mr. Don Klima, Advisory Council on Historic Preservation, inviting comments on the effects of an early site permit for the North Anna Power Station site on historic properties in accordance with the National Historic Preservation Act (Accession No. ML040080790).
January 6, 2004	Letter from Ms. Mary Colligan, Northeast Regional Office of NOAA Fisheries, to NRC, providing a response to a letter requesting a list of species in the vicinity of the North Anna Power Station and Surry Power Station sites (Accession No. ML040230669).
January 7, 2004	Letter from the Hanover County, Virginia, Department of Public Utilities to NRC, providing scoping comments regarding the early site permit review for the North Anna Power Station site (Accession No. ML040130744).
January 8, 2004	Letter from an unknown individual to NRC, providing scoping comments regarding the early site permit review for the North Anna Power Station site (Accession No. ML040230552).

January 9, 2004	Email from Diane Curran to NRC, providing scoping comments on behalf of Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, and Public Citizen regarding the early site permit review for the North Anna Power Station site (Accession No. ML040230548).
January 12, 2004	Letter from Ms. Pamela Faggert, Dominion, to Ms. Ellie Irons, VDEQ, withdrawing Federal Consistency Certification under the Coastal Zone Management Act for North Anna's Early Site Permit Application (Accession No. ML040230690).
January 13, 2003	NRC summary of public scoping meetings to support review of the early site permit application for the North Anna Power Station site (Accession No. ML040140627).
January 15, 2004	Letter from Mr. Timothy N. Hall, U.S. Fish and Wildlife Service, Charleston, South Carolina, to NRC, providing a response to a letter requesting a list of species in the vicinity of the Savannah River alternate site (Accession No. ML040270227).
February 3, 2004	Letter from Dr. Mary Knapp, U.S. Fish and Wildlife Service, Reynoldsburg, Ohio, to NRC, providing a response to a letter requesting a list of species in the vicinity of the Portsmouth alternate site (Accession No. ML040480521).
February 10, 2004	Letter from Ms. Ellie Irons, VDEQ, to Ms. Pamela Faggert, Dominion, acknowledging January 12, 2004 withdrawal of Federal Consistency Certification under the Coastal Zone Management Act and forwarding copies of comments developed by reviewing agencies regarding the early site permit application for the North Anna Power Station site (Accession No. ML40490249).
February 26, 2004	Letter from NRC to Mr. David A. Christian, Dominion, revising schedule for review of early site permit for North Anna Power Station site (Accession No. ML040570185).
March 12, 2004	Letter from NRC to Mr. David A. Christian, Dominion, transmitting request for additional information regarding environmental portion of early site permit application for North Anna Power Station site (Accession No. ML040720580).

March 19, 2004	Letter from Mr. Eugene Grecheck, Dominion, to NRC providing Lake Anna modeling calculations for North Anna Early Site Permit application (Accession No. ML040910433).
March 27, 2004	Summary of Environmental Site Audit to Support Review of the North Anna Early Site Permit Application (Accession No. ML040860222).
March 31, 2004	Letter from Mr. Eugene Grecheck, Dominion, to NRC stating revised approach for Unit 4 normal plant cooling (Accession No. ML040980485).
April 5, 2004	Letter from NRC to Mr. Brent Gutierrez, Savannah River Operations Office, expressing thanks for support provided during site visit at Savannah River Site, an alternative to the North Anna Power Station site (Accession No. ML040970408).
April 5, 2004	Letter from NRC to Mr. Russ Vranicar, Portsmouth Project, expressing thanks for support provided during site visit at Portsmouth site, an alternative to the North Anna Power Station site (Accession No. ML040970276).
April 14, 2004	Letter from NRC to Mr. David A. Christian, Dominion, regarding new Environmental Project Manager for the review of the Early Site Permit application at the North Anna site (Accession No. ML041050879).
April 19, 2004	Summary of Telephone Call between NRC and Dominion concerning clarification of the request for additional information pertaining to the North Anna Early Site Permit Application (Accession No. ML041130241).
May 6, 2004	NRC Trip Report of Visits to the Savannah River Site and Portsmouth Site, Alternatives to the North Anna Early Site Permit Site (Accession No. ML041270548).
May 12, 2004	Letter from NRC to Mr. Steven D. Routh, Bechtel Power Corporation, regarding request for withholding information from public disclosure for the North Anna Early Site Permit (Accession No. ML041390448).
May 17, 2004	Dominion's Response to NRC's March 12, 2004 Request for Additional Information Regarding Environmental Portion of Early Site Permit Application (Accession No. ML041450037).

June 22, 2004	Letter from NRC to Mr. David Christian, Dominion, regarding revised early site permit environmental review schedule (Accession No. ML04170014).
June 23, 2004	Summary of Telephone Call between NRC and Dominion concerning clarification of Dominion's May 17, 2004, response to NRC's requests for additional information pertaining to the North Anna Early Site Permit Application (Accession No. ML041830193).
June 24, 2004	Issuance of Environmental Scoping Summary Report (Accession No. ML041770579).
June 28, 2004	Letter from Dominion to NRC, responding to comments in VDEQ's February 10, 2004, letter related to the Coastal Zone Management Act certification (Accession No. ML041890324).
July 12, 2004	Letter from Dominion to NRC, Additional Responses to NRC's March 2, 2004 Request for Additional Information Regarding Environmental Portion of Early Site Permit Application (Accession No. ML041970396).
July 15, 2004	Letter from Dominion to NRC, forwarding Revision 2 to the North Anna early site permit application (Accession No. ML042010009).
August 17, 2004	Summary of telephone calls between the U.S. Nuclear Regulatory Commission and Dominion pertaining to the environmental review of the North Anna early site permit application (Accession No. ML042310737).
August 27, 2004	E-mail from NRC (Andrew Kugler) to Bill Borduin in response to concerns expressed regarding the early site permit for the North Anna Power Station (Accession No. ML042440891).
September 16, 2004	E-mail from Mr. Joesph Hegner, Dominion, to NRC in response to August 2004 Telecon question No. 4 pertaining to NRC's Environmental Review (Accession No. ML042640344).

September 22, 2004	Email from Mr. Tony Banks, Dominion, to NRC transmitting Lake Anna State Park attendance data (Accession No. ML042670291).
September 30, 2004	North Anna Early Site Permit Application, Revision 3, Part 3-Environmental Report Chapters 1 - 3:2:260 (Accession No. ML042590096).
September 30, 2004	North Anna Early Site Permit Application, Revision 3, Part 3-Environmental Report Chapters 3:3:1 - 4:1:9 (Accession No. ML042590097).
October 29, 2004	Letter from the US Fish and Wildlife service containing a list of threatened or endangered species for the North Anna ESP site and the alternate Surry ESP site (Accession No. ML 043090290).
October 29, 2004	Letter from NRC to Mr. David Christian, Dominion, requesting additional information regarding the uranium fuel cycle (Accession No. ML043030707).

Appendix D

Scoping Meeting Comments and Responses

Note: Due to the size of the documents, in the Final EIS the comments contained in Appendix D and E will be bound in a separate volume.

Appendix D

Scoping Meeting Comments and Responses

On November 24, 2003, the U.S. Nuclear Regulatory Commission (NRC) published a Notice of Intent in the *Federal Register* (68 FR 65961) to notify the public of the staff's intent to prepare an environmental impact statement (EIS) to support the ESP application for the North Anna early site permit (ESP) site. The EIS will be prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), Council on Environmental Quality guidelines, and Title 10 of the Code of Federal Regulations (CFR) Parts 51 and 52. As outlined by NEPA, NRC initiated the scoping process with the issuance of the *Federal Register* Notice. NRC invited the applicant; Federal, Tribal, State, and local government agencies; local organizations; and individuals to participate in the scoping process by providing oral comments at the scheduled public meeting and/or submitting written suggestions and comments no later than January 9, 2004.

The scoping process included a public scoping meeting, which was held at the Louisa County Middle School in Louisa, Virginia, on December 8, 2004. Approximately 80 members of the public attended the meeting. This session began with NRC staff members providing a brief overview of the ESP process and the NEPA process. Following the NRC's prepared statements, the meeting was open for public comments. Twenty-nine attendees provided either oral comments or written statements that were recorded and transcribed by a certified court reporter. The transcript of the meeting can be found as an attachment to the Scoping Meeting Summary, which was issued on January 13, 2004. The meeting summary is available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS) under accession number ML040140614. ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room) (Note that the URL is case-sensitive). Additional comments received later are also available.

The scoping process provides an opportunity for public participation to identify issues to be addressed in the EIS and highlight public concerns and issues. The Notice of Intent identified the following objectives of the scoping process:

- Define the proposed action which is to be the subject of the EIS.

- Determine the scope of the EIS and identify significant issues to be analyzed in depth.

- Identify and eliminate from detailed study those issues that are peripheral or that are not significant.

- Identify any environmental assessments and other EISs that are being prepared or will be prepared that are related to, but not part of the scope of the EIS being considered.

- Identify other environmental review and consultation requirements related to the proposed action.

- Indicate the relationship between the timing of the preparation of the environmental analyses and the Commission's tentative planning and decisionmaking schedule.

- Identify any cooperating agencies and, as appropriate, allocate assignments for preparation and schedules for completing the EIS to the NRC and any cooperating agencies.

- Describe how the EIS will be prepared, and include any contractor assistance to be used.

At the conclusion of the scoping period, the NRC staff and its contractor reviewed the transcripts and all written material received, and identified individual comments. Two letters and three email messages containing comments were received during the scoping period. All comments and suggestions received orally during the scoping meeting or in writing were considered. Each set of comments from a given commenter was given a unique alpha identifier (commenter ID letter), allowing each set of comments from a commenter to be traced back to the transcript, letter, or email in which the comments were submitted.

Table D-1 identifies the individuals providing comments and the commenter ID letter associated with each person's set(s) of comments. The commenter ID letter is preceded by NASC (short for North Anna scoping). For oral comments, the individuals are listed in the order in which they spoke at the public meeting. Accession numbers indicate the location of the written comments in ADAMS.

Comments were consolidated and categorized according to the topic within the proposed EIS or according to the general topic if outside the scope of the EIS. Comments with similar specific objectives were combined to capture the common essential issues that had been raised in the source comments. Once comments were grouped according to subject area, the staff and contractor determined the appropriate action for the comment. The staff made a determination on each comment that it was one of the following:

- A comment that was actually a question and introduces no new information.

- A comment that was either related to support or opposition of early site permitting in general (or specifically, the North Anna ESP) or that makes a general statement about the early site permit process. In addition, it provides no new information and does not pertain to 10 CFR Part 52.

- A comment about an environmental issue that

  - provided new information that will require evaluation during the review, or
  - provided no new information

- A comment that is outside the scope of the ESP, which includes, but is not limited to

  - comment regarding the need for, or cost of, power
  - comment regarding alternative energy sources
  - comment on the safety of the existing units.

The comments that are considered in the evaluation of environmental impacts in this EIS are summarized in the following pages. To review all the comments received during scoping, refer to the meeting summary (ML040140614). For reference, the unique identifier for each comment (commenter ID letter listed in Table D-1 plus the comment number) is provided. The responses provided here have been updated to provide the location in the EIS where the subject is addressed.

Preparation of the EIS will take into account all the relevant issues raised during the scoping process. The EIS will be made available for public comment. The comment period for the EIS will offer the next opportunity for the applicant; interested Federal, Tribal, State, and local government agencies; local organizations; and members of the public to provide input to the NRC's environmental review process. The comments received on the EIS will be considered in the preparation of the final EIS. The final EIS, along with the staff's Safety Evaluation Report (SER), will provide much of the basis for the NRC's decision on the North Anna ESP.

Table D-1. Individuals Providing Comments During Scoping Comment Period

Commenter ID	Commenter	Affiliation (if stated)	Comment Source (ADAMS Accession #)
NASC-A	Paul Gunter	Nuclear Information and Resource Service	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-B	Ernie Reed	Citizen and teacher from Charlottesville, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-C	Alexis Zeigler	Citizen of Charlottesville, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-D	Donald Day	Citizen of Charlottesville, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-E	Dave Ritter	Public Citizen Critical Mass Energy and Environment Program	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-F	Dewey Keeton	Citizen of Louisa County, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-G	Lou Zeller	Blue Ridge Environmental Defense League	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-H	Brian Buckley	Citizen of Louisa, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-I	Gene Grecheck	Vice President, Nuclear Support Services	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-J	Bill Borduin	Lake Anna Civic Association	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-K	Jerry Rosenthal	Concerned Citizens of Louisa County, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-L	Terry Jones	Member First Baptist Church and Louisa County, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-M	Dan Holmes	Piedmont Environmental Council	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-N	Abhaya Thiele	Resident of Buckingham County, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)

Table D-1. (contd)

Commenter ID	Commenter	Affiliation (if stated)	Comment Source (ADAMS Accession #)
NASC-O	Bill Murphey	Resident of Louisa County, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-P	Marione Cobb		12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-Q	Brianne Boylan		12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-R	Olivia Ryan	Resident of Louisa County, Virginia, and Lake Anna	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-S	James Griffis	Retired Presbyterian Pastor living at Lake Anna	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-T	Sam Forrest	Citizen of Greensprings, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-U	Steve Montgomery	Citizen of Louisa, Virginia. Employee North Anna Power Station	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-V	Page Kemp	Citizen of Louisa County, Virginia. Employee North Anna Power Station	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-W	Bill Streit	Resident of Louisa County, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-X	Alex McGee	Resident of Albermarle County, Virginia. Previously of Louisa County	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-Y	Amzic Sullivan	Resident of Green County, Virginia	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-Z	Jon Kessler	Resident of Charlottesville, Virginia. Past Resident of Louisa.	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-AA	Ian Burke		12/8/03 Scoping Meeting Transcript (ML040140634)

Table D-1. (contd)

Commenter ID	Commenter	Affiliation (if stated)	Comment Source (ADAMS Accession #)

NASC-BB	Bob Bishop	Nuclear Energy Institute	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-CC	Brendan Hoffman	Public Citizen, Washington D.C.	12/8/03 Scoping Meeting Transcript (ML040140634)
NASC-DD	Carrie Girstantas	Citizen of Louisa County, Virginia	12/12/03 - email (ML040140310)
NASC-EE	Aviv Goldsmith	Citizen of Spotsylvania, Virginia	12/21/03 - email (ML040060329)
NASC-FF	Frank W. Harksen, Jr	Director Department of Public Utilities, Hanover County, Virginia	1/7/04 - letter (ML040130744)
NASC-GG	Diane Curran	Harmon, Curran, Spielberg and Eisenberg, LLP	1/9/04 - email/letter (ML040230548)
NASC-HH	Unsigned		1/8/04 - letter (ML040230552)

(a) The transcripts can be found under accession number ML040140634.

D.1 Comments and Responses

This summarizes the in-scope comments and suggestions received as part of the scoping process, and discusses their disposition. Parenthetical numbers after each comment refer to the commenter's ID letter and the comment number. Comments can be tracked to the commenter and the source document through the ID letter and comment number listed in Table D-1. Comments are grouped by the following categories:

D.1.1 Comments concerning air quality

D.1.2 Comments concerning aquatic ecology

D.1.3 Comments concerning groundwater use and quality

D.1.4 Comments concerning surface water use and quality

D.1.5 Comments concerning socioeconomics

D.1.6 Comments concerning human health

D.1.7 Comments concerning uranium fuel cycle and waste management

D.1.8 Comments concerning postulated accidents

D.1.9 Comments concerning site redress

D.1.10 Comments concerning alternatives

D.1.11 Comments concerning the safety review for the ESP, including safeguards and security and emergency preparedness

D.1.1 Air Quality

Comment: You should know that nuclear energy does not emit greenhouse gases. That is of grave concern to many who study and worry about environmental future. (NASC-BB 4)

Response: *This information will be considered in the staff's evaluation of air quality impacts in the EIS. The results of the analysis will be presented in Chapter 4 [now Chapter 5] of the EIS.*

D.1.2 Aquatic Ecology

Comment: The EIS for the North Anna nuclear power station is therefore required to address all of the following environmental impacts, including but not limited to: 3. All impacts on Lake Anna arising from the increased impingement and entrainment of fish, fish spawn, other aquatic life and nutrients arising from the increased reactor cooling water intake for any proposed additional nuclear power units. (NASC-GG 2)

Comment: One of the areas that the Lake Anna Civic Association should be looking at is the impact of not only fish but spawn of fish and how that impacts the future populations of fish in the Lake Anna area. (NASC-A 6)

Comment: [The Lake Anna Civic Association has identified seven issues of concern, one of which is] natural environments such as fish and plant life. (NASC-J 5)

Comment: What impact would this [additional water use] have on wildlife and fish species in and surrounding the lake, and on the North Anna River downstream? (NASC-M 3)

Response: *The NRC staff will evaluate aquatic and terrestrial impacts during its evaluation of the ESP application, and the results of the analysis will be presented in Chapter 4 [and Chapter 5] in the EIS.*

Comment: There were two studies that just came out in early summer of this year. One was prepared by the New York State Department of Environmental Protection looking at the Hudson River and it was a detailed study that looked at both the thermal pollution and the entrainment and impingement of fish on and through the Indian Point units 2 and 3 nuclear power station as well as a couple of much smaller fossil fuel facilities. ...Another study we'd like to provide you with is from the State of California, the Central Coastal Water Region, that's the equivalent to the DEP for the coastal water regions of California where they looked at the impingement and entrainment of fish in Diablo Cove, which is the receiving water for Diablo Canyon's 1 and 2 nuclear power stations. (NASC-A 11)

Response: *The NRC staff will consider the results of these two studies in preparing its evaluation of the aquatic impacts of the ESP. The results of the analysis will be presented in Chapter 4 [now Chapter 5] of the EIS.*

Comment: We currently have problems with contaminants in the fish in Lake Anna that we're unsure where the contaminants are coming from. The way I understand it, the checks and balances of the NRC or the plant itself in the checking of these fish have long since ceased. And Lake Anna Civic Association now are monitoring the lake. Is this going to be something that's going to happen again?...I've read the plant was regulating and checking on the fish population. And they stopped at some point in time and its just [a] concern of mine because what's bad for the fish is bad for me. ...Since the lake was created for the nuclear plant, it seems to me that they should be checking on this fish population and monitoring the water at all times. ...For all contaminants. (NASC-F 1)

Response: *The human health impacts related to radioactive effluent releases from any new nuclear plants will be evaluated in the EIS. NRC regulations require strict monitoring of radioactive effluent releases. In addition, new plants are commonly required to perform special monitoring of aquatic and terrestrial species for some period of time after a new plant commences operation. With respect to effluents that are not radioactive, the Virginia Department of Environmental Quality (VDEQ) would regulate the release of such effluents to Lake Anna. The VDEQ would specify whatever monitoring requirements it deems necessary. These requirements would normally be included in the NPDES/VPDES permit.*

D.1.3 Groundwater Use and Quality

Comment: I actually heard tonight that even ground water would be considered [as a possible cooling water source]. Since this additional source would be necessary for the operation of the facility, why is it suggested in the permit that this issue be addressed during the COL application and not in the EIS? Consider the difficulties in bringing the additional water to the [plant] and the fact that this is an essential piece for operation, we urge NRC to consider addressing this issue now during the EIS process rather than later with the construction permitting processes. (NASC-M 6)

Response: *The NRC will evaluate cooling system impacts in the EIS. This portion of the review would include the impacts associated with the source of cooling tower makeup-water for Unit 4. The results of this analysis will be presented in Chapter 4 [now Chapter 5] of the EIS.*

D.1.4 Surface Water Quality and Use

Comment: The County [Hanover] wishes to ensure that any environmental impact review evaluates the changes to Lake Anna releases and related impacts on County facilities, its citizens and other instream and offstream beneficial uses of the North Anna and Pamunkey Rivers that will result from the construction and operation of an additional reactor. Such a review should also determine the appropriate and necessary minimum Lake Anna release to protect these uses. (NASC-FF 1)

Comment: Downstream users have designed their water intake and wastewater discharge systems around this 40 cfs low flow condition, and cannot get by with less water. And, increasingly more stringent regulations affect the ability to operate at the 40 cfs [cubic feet per second]. (NASC-FF 2)

Comment: Although this is a different permit and permitting process, many of the prior [historical] comments [related to water availability] are applicable from an environmental perspective and should be included in the scope of an environmental impact statement. (NASC-FF 3)

Comment: The EIS for the North Anna nuclear power station is.... required to address the following environmental impacts, including but not limited to: 1. All impacts on the water levels in Lake Anna arising from increased intake of reactor cooling water for the operation of any proposed new nuclear power units 2. All impacts on the aquatic environment of Lake Anna arising from the increase in thermal discharge of reactor cooling water as result of the operation of additional nuclear power units. [and].... 4. All impacts arising from the increase in the routine discharge of chemicals, heavy metals, cleaning solvents, biocides and radioactive isotopes into Lake Anna arising from the operation of additional nuclear power units. (NASC-GG 3)

Comment: The Lake Anna Civic Association has identified seven issues of concern, one of which is Water issues. They consist of thermal changes, volume, flow and lake level. (NASC-J 1)

Comment: It's our understanding that the additional reactors would increase the water use of the facility dramatically. It's been estimated that the evaporative loss could be as high as 41 million gallons per day. ...Will this affect the flow rates downstream from the lake and the dam, and downstream users of the river? (NASC-M 1)

Comment: The temperature changes are addressed in great detail in the application itself. And the temperature concerns are real, but I believe there are reasonable solutions to them. (NASC-O 4)

Comment: I wanted to address was the lake level concerns for units 3 and 4. ...So one observation is that [some]one should examine the agreement between Dominion Power and the State of Virginia on the matter of water released over the dam. (NASC-O 5)

Comment: What I understand is that Virginia Power or Dominion Power has submitted a sort of an envelope that describes the potential impact of this new project....we just experienced, of course, a serious drought in Central Virginia followed by a year of abundant rainfall. But I wanted to know how you approached issues of drought; whether or not when you do that, you just sort of look at the historical record and then make extrapolations of what you can expect in terms of meeting the demands for water that this new project might have. ...So in other words history, the recent history as well as more distant history plays a major role in projecting forward? (NASC-D 1)

Comment: One other environmental issue I wanted to mention was as far as drought and water issues, ...I would encourage when the water issues are examined, that more severe droughts are considered, certainly than the one a couple of years ago, recently. Even worse than any on record, I would suggest being considered. (NASC-Z 4)

Comment: Flows into the lake may not be sufficient to meet the demands of the expansion. Within the early site permit it is noted that the makeup water may have to be taken from another source if all units were to continue operation during low flow periods. What is the estimated amount of additional water needed to meet the demand of the facility during these low flow periods? And what are the possible sources under consideration? (NASC-M 4)

Comment: Another point, on page 3-5-8 of the early site permit application under the heading "Water Use Impacts" there appears the sentence "The impacts of adding new unit four would depend on specific heat dissipation systems selected and would be evaluated in the COL application." Again, we urge NRC to request the data necessary from the applicant to determine the impacts. If we are determining the feasibility of new reactors, it seems reasonable to know these impacts with the completion of an EIS. (NASC-M 7)

Comment: During this drought it [the lake level] went down five feet. And if there's a third unit in operation, it would go down to about 7 feet below. ...What can one do about that? One recommendation has been to make up this evaporative loss from other water sources. ...The second recommendation is that Dominion start looking now into other sources of water. That is, most of the time no additional water makeup would be needed. But there would be times where it would be very good for public relations to be able to make up the evaporative loss, mainly during times of drought. (NASC-O 6)

Comment: And so toward the fourth unit, we would like to recommend very strongly that Dominion look into getting additional water from another source, it could be from another river, it could be from the cities, they're processing more, that sort of thing. But to have an external source of water to make up for the loss for the fourth unit. (NASC-O 7)

***Response:** Surface water impacts of the types described in the comments will be evaluated by the NRC staff in Chapter 4 [now Chapter 5] of the EIS.*

D.1.5 Socioeconomics

Comment: The EIS for the North Anna nuclear power station is ..... required to address all potential socio-economic impacts from the elevated national security requirements and counter-measures to protect a larger target of terrorism with the expansion of the nuclear power station site including the indefinite and possibly permanent closure of Lake Anna to public access for sporting, recreation and other means of community economic livelihood. (NASC-GG 4)

Comment: We've also committed tonight to provide you with an ongoing and increasing list of lake closures and restrictions to public right of way to lakes around nuclear power stations because of security reasons. (NASC-A 12)

***Response:** The NRC staff will evaluate socioeconomic impacts of the proposed action in Chapter 4 [now Chapter 5] of the EIS, including any reasonably foreseeable impacts resulting from security measures.*

Comment: And as we look at this from those of us who live here and who plan on living here, and want our children to live here, we have to look at our property values. Putting a new nuclear plant out there has no chance of doing anything but reducing property values around the lake. (NASC-K 3)

Comment: It's our understanding that the additional reactors would increase the water use of the facility dramatically. It's been estimated that the evaporative loss could be as high as 41 million gallons per day. ...What impact would this have on the residents of the lake and their continued recreational use? (NASC-M 2)

Comment: So the one question that had to be asked was what's the public reaction to the change in the lake level as a function of height below 250? And the answer is people start to get concerned when it goes down three feet. (NASC-O 2)

Comment: Now for the fourth unit, we're talking about evaporative loss of around 23,900 gallons per minute, or about 54 cubic feet per second. It's all opinion, but there is no way that this can be taken from the input to Lake Anna without having the lake level drop, you know, beyond what is considered by useful use for the people around the lake. (NASC-O 3)

Comment: I'm also glad for the school building and the thousands of taxes that Virginia Power pays to Louisa County so we citizens didn't have to build it alone. I'm glad for the influence it has made in the past 25 years in Louisa County. I'd like to see it continue. (NASC-S 2)

Comment: In the business I ran here, many customers were Dominion Power employees, so I am definitely aware of the economic value of the plant being here. (NASC-X 1)

Response: *The NRC staff will evaluate the socioeconomic impacts of the proposed action in Chapter 4 [and Chapter 5] of the EIS, including impacts related to taxes, property values, and recreational use of the lake.*

D.1.6 Human Health

Comment: The EIS for the North Anna nuclear power station is.... required to address all impacts on the public health and environment arising out of the increase in routine and accidental radioactive emissions to the air and to the water as the result of the operation of additional nuclear power units. The analysis should consider work by Dr. John Gofman, showing that low-level radiation, at levels considered to be safe for medical use, is a significant contributor to deaths from heart disease and cancer. See Radiation from Medical Procedures in the Pathogenesis of Cancer and Ischemic Heart Disease (Committee for Nuclear Responsibility: 1999). (NASC-GG 5)

Comment: Build this nuclear reactor? I don't think so. Killing tens of thousands of people and not to mention years of genetic mutation in all walks of life. (NASC-AA 5)

Comment: Strontium-90 remains radioactive for 600 years and concentrates in the food chain. Like other isotopes it's odorless, tasteless and invisible. It acts like calcium in the body's organisms where it enters the bones and animals and lactating breasts of mammals. It's a carcinogen causing leukemia, bone and breast cancer. Cesium-137, another byproduct, also remains radioactive for 600 years. It also concentrates in the food chain, but it stores in the muscles where it induces malignant muscle cancers called sarcomas. Plutonium is so carcinogenic that one pound of the stuff evenly distributed can cause cancer in every person on earth. Plutonium has a radioactive life of half a million years. It enters the body through the lung, migrates to the bone and liver, crosses the placenta into the embryo, mothers with child. Causes bone cancer, leukemia, liver cancer, testicular cancer, birth deformities and genetic mutations in humans and other animals that are passed from generation to generation. (NASC-B 14)

Comment: I heard something about permitted releases. The plants are actually allowed, as long as its diluted to the proper amount, to put radioactive releases into air, water and the surrounding environment. And this occurs at the same time that the Nuclear Regulatory Commission formally agrees with the linear-no-threshold – response model which says that any increase in radioactive dose, no matter how small, results in an incremental increase in risk. And at the same time, the Nuclear Regulatory Commission tells us that its primary mission is to protect the public health and safety in matters regarding radiation exposure. (NASC-E 11)

Comment: This is from the Nuclear Regulatory Commission, NUREG/CR-2907, radioactive materials released from nuclear power plants. This was an annual report from 1988. I've selected 1988, about 15 years ago, because of the cancer latency period. After 20 years you have – and I believe you are beginning – maybe beginning to reap the whirlwind. In this report, this NUREG report, there was a risk in here for the North Anna plant 40 miles northwest of Richmond, unit 1 and unit 2. There are airborne effluents and radionuclides released which number 26 including some of the cesium and other elements that were mentioned by previous speakers. Liquid effluents, nuclear – or radionuclides released number 32 in this report. And just scanning the highlights here. The volume of total liquid tritium released in that year was 1,940 liters. (NASC-G 2)

Comment: I'm standing here because of concerns as far as public health. ...In my line of work in my job, I see a lot of our fellow community citizens coming and they have been diagnosed with cancer. The cancer rate for Louisa County has increased in the last 20 years. And my concern is what's happening? What's happening? I'm not saying that this is because of Dominion Power, but there are issues that we need to consider before we go any further. (NASC-L 1)

Comment: For 30 years I lived downstream from the Connecticut Nuclear Power plant that Old Dominion runs. And 27 years after I was in college I was diagnosed with breast cancer. I had both my breasts cut off to save my life so that I could raise my two young daughters.

(NASC-Y 3)

Comment: We do know, as has been said very eloquently by the scientists who have spoken already, that radiation is exceedingly dangerous and toxic. (NASC-Y 4)

Comment: The Nuclear Regulatory Commission essentially is not even going to take a serious look at...placing the onus on the waste generator, the polluter or the creator of the energy to prove that energy is safe for us. ...The onus should not be on the affected individual to prove the health detriment. (NASC-E 12)

Comment: According to our estimation, nuclear power is a public health catastrophe hidden in plain sight. (NASC-G 8)

Comment: It's not about -- so much about the water and the temperature of the water and what's happening, but what happens to the people who play in that water? What happens to the grandfathers who take their children fishing? And they eat fish from that lake. These are things that we need to address. (NASC-L 2)

Comment: I think that we need to look at the issue of public health more so than the issue of is it just a safety factor for the environment. (NASC-L 3)

Comment: And I ask that those of you on the nuclear regulation committee whose salaries my tax dollars pay, that higher consideration be given to the risk, to the life and health and my daughter, the water, the air and the animals than to the financial risk of 21st century of robber barons who are so disconnected from reality that they cannot see the risk not just to me, but to their own families. (NASC-Y 1)

Comment: We know that the only safe decision, the only decision that carries no risk is the decision not to use nuclear decision. We know that. We don't need more research. (NASC-Y 2)

Response: *The NRC will evaluate human health impacts of the proposed action in the EIS. The results of this analysis will be presented in Chapter 4 [now Chapter 5] of the EIS.*

Comment: I previously lived in Utah with my parents where they have seen the tragedy of "downwinders." This is the term used for the cities subjected to radioactive waste in testing in the 1940s. And these people were assured by the government that they were safe. And these people are now suffering from deformities and their children are suffering from deformities. (NASC-X 2)

Response: *Nuclear testing in the 1940s is outside the scope of this review and will not be addressed in the EIS.*

D.1.7 Uranium Fuel Cycle and Waste Management

Comment: The EIS for the North Anna nuclear power station is.... required to address ..all impacts arising from the additional accumulation of high-level nuclear waste generated and indefinitely stored on-site at the North Anna nuclear power station as the result of the operation of additional nuclear power reactors. This discussion is required, given that the Waste Confidence Rule applies only to waste generated by "existing facility licenses." 55 Fed. Reg. 38,474 (September 18, 1990). (NASC-GG 6)

Comment: This agency [the NRC] has confidence, enough confidence [in the Waste Confidence Act] that they're not going to allow the issue of more nuclear waste being stored on the shores of Lake Anna to be raised in the early site permit process and the environmental review. (NASC-A 9)

Comment: And all of these [uranium fuel] processes from mining, processing the uranium to taking it to Yucca Mountain, if indeed that is going to be the alleged solution, all of these things are going to take massive quantities of fossil fuels and will in their own way contribute to greenhouse gases, global warming, whatever, carbon dioxide emissions we want to talk about there. ...do we want global warming or do we want nuclear waste and the water to be drained from our local lake? ...I think that's a false choice to present to the public, and it's also questionable just on the scientific basis if you really look at the entire fuel cycle. (NASC-E 8)

Comment: And I also think there's a larger problem with the waste issue. If someone has made some decision at some point that waste is not being considered as part of the environmental impact, it seems like a major problem. There's been waste in the plant for the whole existence, and there's no reason to think – I mean, there's always going to be waste there, even if it's transported out of the county. Even if it is transported, it'll still be generated there, so the waste issue has to be addressed. (NASC-Z 3)

Comment: Will the scope, environmental scoping of this project include the continued storage of that waste on site? ...So, I guess my question is will the continued storage of high level radioactive waste be included in the environmental impact statement for this new facility? (NASC-D 2)

Comment: There's a reluctance for other states to allow transport of nuclear materials through their jurisdiction. Given this, will the EIS address the plan for disposal of the additional nuclear waste generated by the new units? (NASC-M 8)

Comment: My parents' home State, Utah, is a popular destination for the nuclear waste that no one knows what to do with. Impoverished Navajos are resorting to selling their land for nuclear waste storage. (NASC-X 3)

Comment: I'd really add in this situation it's like getting a permit without a plan for a septic system. And that's something that's not reasonable to build a home, and it's certainly not reasonable to build a nuclear power station. (NASC-A 10)

Comment: Man has never created a more long lived or dangerous substance than the radio-active substances that are byproducts of the nuclear reaction process. ...Both fuel waste and decommissioned equipment all pose long term health threats of many lifetimes to humans and other species and animals. (NASC-B 8)

Comments: There's no solution to the nuclear waste problem. People have asked this question tonight about how much nuclear waste is extracted out of the reactors. ...Virginia Power has gone 450 days between refuelings. But at every refueling, approximately 1500 metric tons of highly radioactive waste is removed from the reactor. There's no solution to this radioactive waste problem that at present is being stored on the site waiting for a solution that, frankly, will never appear because of the confluence of technical and political problems. (NASC-D 5)

Comments: [The Lake Anna Civic Association has identified seven issues of concern, one of which is] spent fuel, dry cask storage. (NASC-J 6)

Comments: Does anybody really have confidence that they're going to move the nuclear waste? They [NRC] are starting this discussion saying that's where they are. They have the confidence that this waste is going to be moved, and it hasn't. (NASC-K 1)

Comment: I am concerned about the toxicity of the waste that's generated. ...I would like this waste not to be stored here, and I would like this waste not to be stored anywhere. I think this is a danger for ourselves, for our children and our great, great, great, great, great, great, great grandchildren. (NASC-P 1)

Comment: And I just think that public health and the environmental events cannot be separated, ...And that the site is obviously not environmentally safe if we cannot take care of the plant's waste. It's not -- nuclear energy is obviously not suitable because we have no way of reintegrating this waste back into our environment in any foreseeable future. Clean up your own mess before you make a new one. (NASC-Q 1)

Comment: My opposition to nuclear weapons is not only the nightmare at the opposing their use, but their very existence because of the pollution and the poisoning of the planet. And whether it's wastes from nuclear weapons or waste from a commercial reactor, it's poison. It seems to me it doesn't make any sense when we don't have, as was said so well by so many others here, we don't have any solution to this problem why create more of the problem? (NASC-W 2)

Comment: You know, if we don't know what we're doing with all the waste that's piling up already, you know, why create more. It's like the toilet that doesn't work, you know. (NASC-W 4)

Comment: The NRC claims that it can produce this electricity with minimal effects on the environment, but all it can do is postpone the effects by further regulations and burying its waste underground for future generations to deal with. These things that we're burying underground are leaking into our underground aquifers and poisoning the environment. All it's going to do is leave it for, like I said, other people to deal...with later instead of us. It's already been pointed out [that] most of the effects of isotopes are produced in nuclear waste. On of them is plutonium, which one pound of it is enough to give everybody in the world cancer. And in the year 2000 it was estimated that nuclear power generated 1,139 tons of plutonium. (NASC-AA 3)

Comment: We do know that the half life of spent nuclear material is far longer than our ability to contain it. (NASC-Y 6)

Comment: You commented on a waste confidence decision that was made by the NRC. And guaranteed that in the first quarter of this century a repository will be made available. ...And it seems like Yucca Mountain is a proposed site, ...My question is how much waste is Lake Anna putting out, how much more waste would Lake Anna with two additional reactors? (NASC-H 1)

Comment: How much additional waste will be generated? We still don't really have an idea. And I'd really like to get a hold of that figure. (NASC-M 9)

Response: *The NRC staff will evaluate the environmental impacts of the uranium fuel cycle including the impacts of fuel manufacturing, transportation, and onsite storage and eventual disposal of spent fuel. The staff's evaluation will account for the Commission's "Waste Confidence" decision embodied in 10 CFR 51.23 to the extent that decision applies to such impacts. The results of this analysis will be presented in Chapter 4 [now Chapter 5] of the EIS.*

D.1.8 Postulated Accidents

Comment: The EIS for the North Anna nuclear power station is ....required to address all of the .. impacts on public health and safety and the environment arising from a severe accident, including the impacts of the accident itself, and the impacts of any emergency response measures such as relocation of the population. (NASC-GG 7)

Comment: In building the nuclear power plants we must remember that the costs go way beyond that of economic decisions that govern the decisions that things such as the power company entities make. But it causes high environmental devastation one way or another – if there is a nuclear meltdown. (NASC-AA 4)

Comment: Hopefully we're all aware of past nuclear accidents. In the winter of 1957 a tank holding radioactive waste exploded and 10,000 people were evacuated in a rural Russian countryside. And the names of 30 towns and villages disappeared from Soviet maps. And I shouldn't have to remind you of history lessons from Liverpool, England, Browns Ferry, Alabama, Three Mile Island, Pennsylvania or Chernobyl. (NASC-B 16)

Comment: We do know that Murphy's Law says that what can go wrong, will go wrong. Think Chernobyl, Three Mile Island and so forth. (NASC-Y 5)

Response: *The environmental impacts of postulated accidents will be evaluated, and the results of this analysis will be presented in Chapter 5 of the EIS.*

Comment: The EIS for the North Anna nuclear power station is.... required to address all of the ....impacts arising from the simultaneous operation of the existing and aging North Anna Unit 1 and Unit 2 power reactors in close proximity to any new proposed advanced reactor design, including the possibility of multiple, simultaneous accidents, whether related (e.g. by fire or natural disaster) or unrelated. (NASC-GG 8)

Comment: What liability did they have in the event of some significant environmental catastrophe connected with this? (NASC-B 4)

Response: *The issue of severe accidents will be addressed in Chapter 5 of the EIS. In addition cumulative impacts will be addressed in Chapter 4 [now Chapter 5] of the EIS.*

D.1.9 Site Redress

Comment: And I'd like to, first of all, just point out that we are at the beginning of a process on a very crucial process. ... this process does provide for the expansion of a site which in fact is probably both the agency and the industry emphasize that this does not authorize construction, but in fact it is a partial construction permit. (NASC-A 5)

Response: *As the staff stated during the scoping meeting, the North Anna ESP application includes a site redress plan. The environmental impacts of the site redress plan will be evaluated in the EIS. If the redress plan is approved and incorporated into an approved ESP, then Dominion would have NRC authorization to perform the activities listed in the site redress* *plan. These include activities such as clearing the land, excavating for buildings, etc. The redress plan explains how Dominion would repair any environmental damage associated with these pre-construction activities if it later decided not to apply for a construction permit or a combined license. The applicant's site redress plan includes a commitment to provide the NRC with a guarantee of $10 million as financial assurance for Dominion's obligation to comply with the redress plan.*

D.1.10 Alternatives

Comment: As an engineer, I know that the state of art with regards to Nuclear Power has changed, as well as many other forms of electricity generation being possible. I would like the options developed [in the EIS] and a clear choice offered to the citizens of Louisa County. (NASC-DD 2)

Comment: The environmental impacts of such alternatives that need to be explored and objectively evaluated include: 1. Whether effects on the environment would be reduced if Dominion alternatively implemented more applications of energy efficiency technologies and energy conservation rather than the development of additional nuclear power capacity at the North Anna site. For instance, for the entire southeastern United States, the Renewable Energy Policy Project has demonstrated that innovative and well-managed efficiency programs would reduce annual increases in electric growth by 61%, reducing new demand by 236 MWh over a twenty-year period. See Powering the South: a Clean and Affordable Energy Plan for the Southern United States (Renewable Energy Project: January 2002). www.repp.org. 2. Whether effects on the environment would be reduced if Dominion alternatively implemented use of passive solar, photovoltaic, wind turbines and hybrid renewable energy systems rather than the development of additional nuclear power capacity at the North Anna site. 3. Whether effects on the environment would be reduced if Dominion alternatively implemented greater use of natural gas energy rather than the development of additional nuclear power capacity at the North Anna site. 4. Whether effects on the environment would be reduced if Dominion alternatively implemented broader applications of the above-mentioned resources as distributed power systems rather than increased reliance on an increasingly vulnerable electrical grid system connecting any additional new power capacity at the North Anna site. (NASC-GG 9)

Comment: So there is a very cheap answer to the energy problem, which is to use much, much less of it. There were about -- I don't know -- 20 percent of us in the world who live like we Americans do, yet we use 80 percent of its resources. So I'm sure we could use much, much less. (NASC-AA 1)

Comment: Conservation is undoubtedly the most effective method of ensuring energy security. Conservation efforts defuse energy producers of energy by reducing the need for generating capacity while stimulating the technologies, the research, the manufacturing and the job creation of more efficient technology's progress. Less for you means more for us. It's a fact that with existing technologies we could continue our current standard of living with less than half the energy generating capacity now in this country. (NASC-B 12)

Comment: The environmental benefits of nuclear are not well known, and are certainly not emphasized. ...nuclear energy in Virginia caused there to be roughly 7 million -- it's a big number -- metric tons less of carbon ...not to be emitted into the environment in 2002 because of the operation of their nuclear facilities. (NASC-BB 3)

Comment: All over the world people are generating power either by creating megawatts, meaning you use less or wind, which is the fastest growing of the alternative energies. If you take the train from the Washington, D.C. to Chicago and you'll see the big wind mills popping up in Pennsylvania. That's real. That's something that people are doing. It works. That's a large scale power that could meet future demand. (NASC-C 4)

Comment: Conservation is the best and cheapest way to go with preserving that power. (NASC-CC 3)

Comment: We don't need nuclear power, we need conservation. We need to respect current generations and future ones. Using the earth's resources for our material needs cannot do any of this. (NASC-AA 6)

Comment: To be frank, nuclear power actually is just a ridiculously stupid and expensive method for doing what is nothing more than boiling water. There are alternatives to boiling water, ones that don't involve nuclear waste that lasts for hundreds of thousands of years. ...Dominion Power owes Virginians a better place. And I might note that in the words and comments of a Dominion Power official here tonight, he never mentioned the one technology, the one opportunity to provide our future needs, and that is conservation. (NASC-D 8)

Comment: This was generated by Institute for Energy and Environmental Research in April of 1996."...reliance on nuclear power has grown and the already large quantities of weapons-useable plutonium in the world are rising rapidly." He quotes Johanson here. ...The path of sustainable society requires more efficient use and a shift to a variety of renewable energy resources." (NASC-G 3)

Comment: And people call this NIMBY, not in my backyard syndrome, and yet I think it a very natural instinct that people do not want someone else's waste in their state or in their locality. ...should we not be focused more on using a type of energy that doesn't have such a poisonous effect on people, on life? (NASC-H 2)

Comment: Just about anything that burns fuel, whether it's burning oil or coal, natural gas; anything that's burning anything is putting various contaminants into the atmosphere, including various types of oxides and carbon dioxide. And carbon dioxide is, of course, what's related to various theories to explain global warming. So again, one of the reasons that we think that nuclear energy is an option to consider whether we'll do it in the future is that of all the various alternative energy forms that we're aware of, it is the only one that can produce energy on a scale large enough to make a difference in terms of what we actually put in the air by energy production. So it is the only large scale non-emitting generation technology that's available. (NASC-I 6)

Comment: Now if you look over the last 10 or 15 years, the only generation that has been added in the United States has been natural gas. So if you think about what we're doing here, is we are banking our entire future on the supply of natural gas. And what that does, it certainly makes us very vulnerable to any disruption in fuel supply. We're already talking about now importing natural gas from overseas, which would put us into the same situation that we've had with oil for the last 20 or 30 years. And natural gas up to now has been a domestic supply, but we're outstripping that supply and we're now saying in order to meet the natural gas demand, we're going to have to start importing natural gas from many of the same areas of the world that currently are problems in terms of imported oil. (NASC-I 9)

Comment: I for one as a taxpayer would like to see my money go to the support of energy that's renewable and safe. (NASC-N 3)

Comment: But I would like the subsidies to go to safer forms of energy that would not be a threat to me and my children and my children's children. (NASC-P 3)

Comment: So I would really like to be a part of a meeting in the future that talks seriously about dismantling the power stations at Lake Anna and that seriously considers alternative ways of energy and conservation. (NASC-W 3)

Comment: And we do know that monied interests are more interested in technology which can enrich them further than in finding safe sources of energy which are less lucrative and would protect someone like me or my daughter or your sister. (NASC-Y 3)

Comment: As a consumer of Dominion Power, I would like my consumer dollars to go to wind and hydro power, not nuclear power. I believe these are safer for employees and all citizens. And as a taxpayer, I would like to ask of the NRC to use your government influence to reallocate government subsidies away from nuclear power and towards hydro and wind power. (NASC-X 4)

Response: *The NRC staff will prepare an EIS in accordance with the requirements of*

10 CFR 52.18 and 10 CFR Part 51. The EIS need not address the benefits of reactor construction and operation, including the need for power, as discussed in 10 CFR 52.18 and the NRC's "Environmental Standard Review Plan," NUREG-1555, Appendix A. As discussed in a June 2, 2003, letter from NRC to Dominion, and in proposed changes to Part 52 published in the Federal Register on July 3, 2003 (68 Fed. Reg. 40025), consideration of alternative energy sources need not be included in the applicant's environmental report. In the case of the North Anna ESP application, Dominion chose not to include consideration of alternative energy sources, and therefore, these will not be included in the EIS. If Dominion applies for a construction permit or a combined license in the future, the issue of alternative energy sources will then be evaluated, as required to satisfy NEPA.

In addition with respect to the comments on conservation, 10 CFR Part 51, Appendix A, states that "consideration will be given to the potential impacts of conservation in determining demand for power and the consequent need for additional generating capacity". Section 52.18, however, provides that the EIS need not include an assessment of the benefits (for example, the need power) of the proposed action. Because need for power and alternative energy sources need not be considered in the EIS, conservation need not be considered in that context. Accordingly, conservation need not be considered in the EIS.

Comment: My question is why the North Anna site was chosen in the first place?...[and why did they choose] North Anna specifically as opposed to all the other potential sites around the country that could have been chosen, why North Anna was picked. (NASC-CC 1)

Response: *The applicant is required by the regulations (10 CFR 52.17) to evaluate alternative sites to determine whether there is any obviously superior alternative to the site proposed. In preparing its application for the ESP, Dominion considered multiple sites. The details of their evaluation are presented in Chapter 9 of the Environmental Report and in "Study of Potential Sites for the Deployment of New Nuclear Plants in the United States," prepared by Dominion and Bechtel Power Corporation through an agreement with the U.S. Department of Energy. This report is available through the NRC's document management system (ADAMS; Accession Number ML040630512). Based on the results of this study, Dominion concluded that North Anna was the best option for construction of new nuclear plants. The alternate sites will be evaluated, and the results of this analysis will be presented in the EIS.*

Comment: Well, according to my understanding of the law that under the National Environmental Policy Act the no action alternative must also be considered. The no action alternative if power needs are rising, forces us to consider other forms of power generation. Not only fossil fuel but the other forms which are renewable. (NASC-G 5)

Response: *The NRC staff will consider the no-action alternative in its EIS. For this review, the* *no-action alternative means denying the ESP application. As discussed above, alternative energy sources will not be evaluated at this time.*

D.1.11 Comments Concerning the Safety Review for the ESP, Including Safeguards and Security and Emergency Preparedness

Safety Review

Comment: [The EIS for the North Anna nuclear power station is therefore required to address all of the following environmental impacts, including but not limited to: 11.] All impacts arising from seismic hazards posed to the North Anna site expansion highlighted as a consequence of the December 09, 2003 regional earthquake, given that the U.S. Geological Survey considers that Virginia is vulnerable to earthquakes. (NASC-GG 10)

Response: *The seismic hazards posed to such a reactor or reactors is not within the scope of the environmental review. As part of the NRC's site safety review, the staff will consider whether, taking into consideration the site criteria in 10 CFR Part 100, such a reactor or reactors can be constructed and operated without undue risk to the health and safety of the public.*

Safeguards and Security

Comment: The EIS for the North Anna nuclear power station is required to address all impacts arising from increased security risks and tasks associated with the proposed site expansion of the North Anna nuclear power station given the federal government's acknowledgment that threats to nuclear power stations by acts of terrorism can be delivered in part or in combination from the air, the water and by land. (NASC-GG 11)

Comment: Tonight as we're talking about expanding the site of North Anna, we're talking about expanding the possible pre-deployed weapons of mass destruction if used against us. (NASC-A 7)

Comment: 9/11 changed everything, and at the same time it changed nothing. The officials at Dominion Power have not yet realized that on their power station exists one of the most attractive – [targets] for a terrorist organization. ...I can imagine that a direct hit on the spent fuel nuclear storage would have a catastrophic environmental impact. (NASC-D 6)

Comment: [The Lake Anna Civic Association has identified seven issues of concern, one of which is] security issues, issues that deal with terrorists that would lead to radiation release. (NASC-J 3)

Comment: Security is another big issue that we need to deal with. (NASC-K 2)

Comment: I hate to say this, but with the amount of terrorism in the world, we do not need more invitations to terrorists, and that's what nuclear power plants are. They cannot be safe enough, despite the claims by the nuclear industry. (NASC-N 4)

Response: *Comments related to aspects of the security plan, including a safeguards contingency plan, a physical security plan, and a guard training and qualifications plan are safety issues that are not within the scope of the staff's environmental review. In addition, the Commission, has determined that terrorism is not predictable and is not an inevitable consequence of a proposed licensing action, and that an EIS is not an appropriate format to address the challenges of terrorism. Additional information about the NRC staff's actions regarding physical security since September 11, 2001, can be found on the NRC's public web site (www.nrc.gov).*

Emergency Preparedness

Comment: My concern is for notification and evacuation of the public in the North Anna area, as this area is rapidly developing. My chief concern is for the safety, protection and welfare of the public. (NASC-HH 1)

Comment: My concern is in regard to the rapid development in the immediate area, the installation of new early warning sirens, emergency backup notification and route alerting. Dominion closely works with the Virginia Department of Emergency Management who provides plans regarding these areas. An audit of this area, by your organization, would better identify these areas concerning early warning notification. (NASC-HH 3)

Comment: Backup Route Alerting is essential for the protection of the general public in the North Anna area since it is rapidly developing in areas where no early warning sirens are currently located and residents must rely on route alerting. ...please verify that these newly developed areas requiring backup route alerting or the installation of an early warning siren are identified by Dominion. Additionally, if no measures are currently in place, they should be implemented to ensure future identification of any new additional areas of development and how they will be addressed for the protection and safety of the general public before any additional site permit is obtained. (NASC-HH 4)

Comment: I don't live in a house, I live in an apartment. But my apartment doesn't release radiation on a regular basis. It doesn't require an evacuation plan, only if there is a fire, of course. But for other people, there's no iodine pills if you live nearby my apartment. (NASC-E 6)

Comment: [The Lake Anna Civic Association has identified seven issues of concern, one of which is] an evaluation [evacuation] plan relative to roads. (NASC-J 4)

Response: *The comments relate to the adequacy of emergency plans, which is a safety issue that is outside the scope of the staff's environmental review. As part of its site safety review, the NRC staff will determine, after consultation with the U.S. Department of Homeland Security (DHS) and the Federal Energy Management Administration (FEMA), whether there are any significant impediments to the development of emergency plans and whether the major features of emergency plans submitted by Dominion are acceptable. The currently operating units have emergency plans in place that have been reviewed by NRC, DHS, and FEMA.*

Appendix E

Draft Environmental Impact Statement Comments and Responses

Note: Due to the size of the documents, in the Final EIS the comments contained in Appendix D and E will be bound in a separate volume.

Appendix E

Draft Environmental Impact Statement Comments and Responses

This appendix is intentionally left blank. The final Environmental Impact Statement (EIS) will contain the comments and responses on the draft EIS in this appendix.

Appendix F

Key Correspondence

Appendix F

Dominion Nuclear North Anna LLC's Key Early Site Permit Consultation Correspondence

Correspondence received during the evaluation process of the early site permit application for Dominion Nuclear North Anna LLC for the proposed North Anna site is identified in Table F-1. Copies of the correspondence are included at the end of this appendix.

Source	Recipient	Date of Letter
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	Virginia Department of Historic Resources (Ethel Eaton)	November 21, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	Virginia Council on Indians (Deanna Beacham)	December 3, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	Tuscarora Environmental Program (Neil Patterson)	December 3, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	Chief Arnold Hewitt	December 3, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	Chief Leo Henry	December 3, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	NOAA Fisheries (Mary Colligan)	December 21, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	U.S. Fish and Wildlife Service (John Wolflin)	December 21, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	U.S. Fish and Wildlife Service (Roger Banks)	December 21, 2003

Source	Recipient	Date of Letter
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	U.S. Fish and Wildlife Service (Mary Knapp)	December 21, 2003
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	Advisory Council on Historic Preservation (Don Klima)	January 5, 2004
United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	NOAA Fisheries (Georgia Cranmore)	January 5, 2004
NOAA Fisheries (Mary Colligan)	United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	January 6, 2004
Dominion Virginia Power Company (Pamela Faggert)	Virginia Department of Environmental Quality (Ellie Irons)	January 12, 2004
U.S. Fish and Wildlife Service (Timothy Hall)	United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	January 15, 2004
U.S. Fish and Wildlife Service (Mary Knapp)	United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	February 3, 2004
Virginia Department of Environmental Quality (Ellie Irons)	Dominion Virginia Power Company (Pamela Faggert)	February 10, 2004
NOAA (David Bernhart)	United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	May 19, 2004
Dominion Nuclear North Anna, LLC (Eugene Grecheck)	United States Nuclear Regulatory Commission (Pao-Tsin Kuo)	June 28, 2004
U.S. Fish & Wildlife Service (Karen Mayne)	United Stated Nuclear Regulatory Commission (Pao-Tsin Kuo)	October 25, 2004

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 21, 2003

Dr. Ethel Eaton, Manager
Office of Review and Compliance
Virginia Department of Historic Resources
2801 Kensington Avenue
Richmond, Virginia 23221

SUBJECT: EARLY SITE PERMIT REVIEW FOR THE NORTH ANNA POWER STATION SITE

Dear Dr. Eaton:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. The NRC staff is currently seeking information from consulting parties, and other individuals and organizations likely to have knowledge of, or concerns with, historic properties in the area, and to identify issues relating to the proposed undertaking's potential effects on historic properties.

If built, the new unit(s) would be located at the existing North Anna Power Station site near Mineral in Louisa County, Virginia, on the southern shore of Lake Anna. The application for an ESP was submitted by Dominion Nuclear North Anna, LLC (Dominion), on September 25, 2003, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 52. (10 CFR Part 52). See Enclosure 1, the application on CD-ROM. As part of its review of the application, the NRC staff will prepare an environmental impact statement (EIS) under the provisions of 10 CFR Part 51, the NRC rules that implement the National Environmental Policy Act (NEPA). In accordance with 36 CFR 800.8, the EIS will include analyses of potential impacts to historic and cultural resources. A draft EIS is scheduled for publication in October 2004, and will be provided to you for review and comment.

If approved, the ESP will document the NRC staff's determination regarding the suitability of the proposed site for the construction and operation of one or more new nuclear plants. The ESP would not authorize the applicant to begin construction of the unit(s). However, in its review the NRC staff will evaluate the environmental impacts of construction and operation and will also consider alternatives, including alternative sites.

Dominion has also included a site redress plan in its application in accordance with 10 CFR 52.17(c) and 52.25. If a site redress plan is included in an ESP approved by the NRC, the applicant may carry out certain site preparation and limited construction activities. See Part 4 of the application for the site redress plan. Dominion would still be required to obtain the appropriate local, State, and other Federal permits required for these activities prior to starting work.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for this ESP review is the area at the power plant site and its immediate environs which may be impacted by land-disturbing activities

Dr. E. Eaton - 2 -

associated with the construction and operation of the new unit(s). However, in some instances these land-disturbing activities may potentially have an effect on known or proposed historic sites located beyond the immediate environs of the proposed site.

In its application, Dominion has stated that, prior to any activities that would disturb existing ground conditions, it would assess the need, in coordination with the Virginia Department of Historic Resources, to undertake subsurface investigations for the identification of potentially significant historic or cultural resources in the area(s) to be disturbed. In addition, Dominion has stated that it would implement the necessary administrative steps to make proper notifications in the event of an unanticipated discovery (including human remains). Enclosed for your information is a cultural resources survey of the North Anna site, prepared for the owner of the site in 2001 (Enclosures 2 and 3). The NRC staff has previously discussed this report with you during its review of the license renewal application for the existing North Anna Power Station, Units 1 and 2.

We invite you and your staff to participate in the review of the North Anna ESP application. We will also be contacting any Native American Tribes that may have a potential interest in the proposed undertaking, affording them the opportunity to participate in this process and identify issues of concern to them. These tribes are identified by records research with the Bureau of Indian Affairs, State and local governments, tribal organizations, and through other historical documentation.

On December 8, 2003, the NRC will conduct a public environmental scoping meeting at the Louisa County Middle School, 1009 Davis Highway, Mineral, Virginia. You and your staff are invited to attend. Your office will receive a copy of the draft EIS along with a request for comments. This draft EIS will include identification of historic sites, assessment of impacts, and our preliminary determination. The anticipated publication date for the draft EIS is October 2004.

If you have any questions or require additional information, please contact the Environmental Project Manager for the North Anna ESP project, Mr. Andrew Kugler at 301-415-2828 or ajk1@nrc.gov.

Sincerely,

Stephen T. Hoffman

for

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

Enclosure: As stated
1) North Anna ESP Application
2) Assession No. ML020160087
3) Assession No. ML020160094

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 3, 2003

Ms. Deanna Beacham
Virginia Council on Indians
P.O. Box 1475
Richmond, VA 23218

SUBJECT: EARLY SITE PERMIT REVIEW FOR THE NORTH ANNA POWER STATION SITE

Dear Ms. Beacham:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. If built, the new unit(s) would be located at the existing North Anna Power Station site near Mineral in Louisa County, Virginia, on the southern shore of Lake Anna. The application for an ESP was submitted by Dominion Nuclear North Anna, LLC (Dominion), on September 25, 2003, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 52 (10 CFR Part 52). The application is available through the web-based version of the NRC's Agencywide Documents Access and Management System (ADAMS) which can be found at http://www.nrc.gov/reading-rm/adams.html. The application is under accession number ML032731517.

As part of its review of the application, the NRC staff will prepare an environmental impact statement (EIS) under the provisions of 10 CFR Part 51, the NRC rules that implement the National Environmental Policy Act (NEPA). In addition, as outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act," the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act in meeting the requirements of NEPA. A draft EIS is scheduled for publication in October of 2004, and will be provided to you for review and comment.

If approved, the ESP will document the NRC staff's determination regarding the suitability of the proposed site for the construction and operation of one or more new nuclear plants. The ESP would not authorize the applicant to begin construction of the unit(s). However, in its review, the NRC staff will evaluate the environmental impacts of construction and operation and will also consider alternatives, including alternative sites.

Dominion has also included a site redress plan in its application in accordance with 10 CFR 52.17(c) and 52.25. If a site redress plan is included in an ESP approved by the NRC, the applicant may carry out certain site preparation and limited construction activities. See Part 4 of the application for the associated site redress plan. Dominion would still be required to obtain the appropriate local, State, and other Federal permits required for these activities prior to starting work.

D. Beacham -2-

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for this ESP review is the area at the power plant site and its immediate environs which may be impacted by land-disturbing activities associated with the construction and operation of the new unit(s). The APE may extend beyond the immediate environs in those instances where these land-disturbing activities may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

In its application, Dominion has stated that, prior to any activities that would disturb existing ground conditions, it would assess the need, in coordination with the Virginia Department of Historic Resources, to undertake subsurface investigations for the identification of potentially significant historic or cultural resources in the area(s) to be disturbed. In addition, Dominion has stated that it would implement the necessary administrative steps to make proper notifications in the event of an unanticipated discovery (including human remains).

Pursuant to 36 CFR 800.2(c)(i), the NRC wishes to ensure that Indian tribes that might have an interest in any potential historic properties in the APE are afforded the opportunity to identify their concerns, provide advice on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, and, if necessary, participate in the resolution of any adverse effects to such properties.

On December 8, 2003, the NRC will conduct a public environmental scoping meeting at the Louisa County Middle School, 1009 Davis Highway, Mineral, Virginia. Representatives of the Council or any of the Virginia tribes are invited to attend. Your office will receive a copy of the draft EIS along with a request for comments. The anticipated publication date for the draft EIS is October 2004. If you have any questions or require additional information, please contact the Environmental Project Manager for the North Anna ESP project, Mr. Andrew Kugler, at 301-415-2828 or ajk1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 3, 2003

Mr. Neil Patterson, Jr., Director
Tuscarora Environmental Program
Tuscarora Nation
2045 Upper Mtn. Road
Sanborn, NY 14132

SUBJECT: EARLY SITE PERMIT REVIEW FOR THE NORTH ANNA POWER STATION SITE

Dear Mr. Patterson:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. If built, the new unit(s) would be located at the existing North Anna Power Station site near Mineral in Louisa County, Virginia, on the southern shore of Lake Anna. The application for an ESP was submitted by Dominion Nuclear North Anna, LLC (Dominion), on September 25, 2003, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 52 (10 CFR Part 52). The application is available through the web-based version of the NRC's Agencywide Documents Access and Management System (ADAMS) which can be found at http://www.nrc.gov/reading-rm/adams.html. The application is under accession number ML032731517.

As part of its review of the application, the NRC staff will prepare an environmental impact statement (EIS) under the provisions of 10 CFR Part 51, the NRC rules that implement the National Environmental Policy Act (NEPA) of 1969. In addition, as outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 in meeting the requirements of NEPA. A draft EIS is scheduled for publication in October of 2004, and will be provided to you for review and comment.

Representatives of the Bureau of Indian Affairs (Department of the Interior) had previously expressed their interest in ensuring that the NRC provide you with the opportunity to share your views on licensing actions in Louisa County, Virginia. Therefore, the NRC staff is contacting you regarding this ESP review. The North Anna Power Station site, which is the subject of this review, is a considerable distance from the Neuse and Roanoke Rivers. It is located on Lake Anna, 10 miles Northeast of Mineral, VA.

If approved, the ESP will document the NRC staff's determination regarding the suitability of the proposed site for the construction and operation of one or more new nuclear plants. The ESP would not authorize the applicant to begin construction of the unit(s). However, in its review, the NRC staff will evaluate the environmental impacts of construction and operation and will also consider alternatives, including alternative sites.

N. Patterson -2-

Dominion has also included a site redress plan in its application in accordance with 10 CFR 52.17(c) and 52.25. If a site redress plan is included in an ESP approved by the NRC, the applicant may carry out certain site preparation and limited construction activities. See Part 4 of the application for the associated site redress plan. Dominion would still be required to obtain the appropriate local, State, and other Federal permits required for these activities prior to starting work.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for this ESP review is the area at the power plant site and its immediate environs which may be impacted by land-disturbing activities associated with the construction and operation of the new unit(s). The APE may extend beyond the immediate environs in those instances where these land-disturbing activities may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

In its application, Dominion has stated that, prior to any activities that would disturb existing ground conditions, it would assess the need, in coordination with the Virginia Department of Historic Resources, to undertake subsurface investigations for the identification of potentially significant historic or cultural resources in the area(s) to be disturbed. In addition, Dominion has stated that it would implement the necessary administrative steps to make proper notifications in the event of an unanticipated discovery (including human remains).

Pursuant to 36 CFR 800.2(c)(i), the NRC wishes to ensure that Indian tribes that might have an interest in any potential historic properties in the APE are afforded the opportunity to identify their concerns, provide advice on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, and, if necessary, participate in the resolution of any adverse effects to such properties.

On December 8, 2003, the NRC will conduct a public environmental scoping meeting at the Louisa County Middle School, 1009 Davis Highway, Mineral, Virginia. Representatives of the tribes are invited to attend. Your office will receive a copy of the draft EIS along with a request for comments. The anticipated publication date for the draft EIS is October 2004. If you have any questions or require additional information, please contact the Environmental Project Manager for the North Anna ESP project, Mr. Andrew Kugler, at 301-415-2828 or alx1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 3, 2003

The Honorable Arnold Hewitt, Chief
5616 Walmore Road
Lewiston, NY 14092

SUBJECT: EARLY SITE PERMIT REVIEW FOR THE NORTH ANNA POWER STATION SITE

Dear Chief Hewitt:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. If built, the new unit(s) would be located at the existing North Anna Power Station site near Mineral in Louisa County, Virginia, on the southern shore of Lake Anna. The application for an ESP was submitted by Dominion Nuclear North Anna, LLC (Dominion), on September 25, 2003, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 52 (10 CFR Part 52). The application is available through the web-based version of the NRC's Agencywide Documents Access and Management System (ADAMS) which can be found at http://www.nrc.gov/reading-rm/adams.html. The application is under accession number ML032731517.

As part of its review of the application, the NRC staff will prepare an environmental impact statement (EIS) under the provisions of 10 CFR Part 51, the NRC rules that implement the National Environmental Policy Act (NEPA) of 1969. In addition, as outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 in meeting the requirements of NEPA. A draft EIS is scheduled for publication in October of 2004, and will be provided to you for review and comment.

Representatives of the Bureau of Indian Affairs (Department of the Interior) had previously expressed their interest in ensuring that the NRC provide you with the opportunity to share your views on licensing actions in Louisa County, Virginia. Therefore, the NRC staff is contacting you regarding this ESP review. The North Anna Power Station site, which is the subject of this review, is a considerable distance from the Neuse and Roanoke Rivers. It is located on Lake Anna, 10 miles Northeast of Mineral, VA.

If approved, the ESP will document the NRC staff's determination regarding the suitability of the proposed site for the construction and operation of one or more new nuclear plants. The ESP would not authorize the applicant to begin construction of the unit(s). However, in its review, the NRC staff will evaluate the environmental impacts of construction and operation and will also consider alternatives, including alternative sites.

A. Hewitt -2-

Dominion has also included a site redress plan in its application in accordance with 10 CFR 52.17(c) and 52.25. If a site redress plan is included in an ESP approved by the NRC, the applicant may carry out certain site preparation and limited construction activities. See Part 4 of the application for the associated site redress plan. Dominion would still be required to obtain the appropriate local, State, and other Federal permits required for these activities prior to starting work.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for this ESP review is the area at the power plant site and its immediate environs which may be impacted by land-disturbing activities associated with the construction and operation of the new unit(s). The APE may extend beyond the immediate environs in those instances where these land-disturbing activities may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

In its application, Dominion has stated that, prior to any activities that would disturb existing ground conditions, it would assess the need, in coordination with the Virginia Department of Historic Resources, to undertake subsurface investigations for the identification of potentially significant historic or cultural resources in the area(s) to be disturbed. In addition, Dominion has stated that it would implement the necessary administrative steps to make proper notifications in the event of an unanticipated discovery (including human remains).

Pursuant to 36 CFR 800.2(c)(l), the NRC wishes to ensure that Indian tribes that might have an interest in any potential historic properties in the APE are afforded the opportunity to identify their concerns, provide advice on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, and, if necessary, participate in the resolution of any adverse effects to such properties.

On December 8, 2003, the NRC will conduct a public environmental scoping meeting at the Louisa County Middle School, 1009 Davis Highway, Mineral, Virginia. Representatives of the tribes are invited to attend. Your office will receive a copy of the draft EIS along with a request for comments. The anticipated publication date for the draft EIS is October 2004. If you have any questions or require additional information, please contact the Environmental Project Manager for the North Anna ESP project, Mr. Andrew Kugler, at 301-415-2828 or ajk1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 3, 2003

The Honorable Leo Henry, Chief
2006 Mt. Hope Road
Lewiston, NY 14092

SUBJECT: EARLY SITE PERMIT REVIEW FOR THE NORTH ANNA POWER STATION SITE

Dear Chief Henry:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. If built, the new unit(s) would be located at the existing North Anna Power Station site near Mineral in Louisa County, Virginia, on the southern shore of Lake Anna. The application for an ESP was submitted by Dominion Nuclear North Anna, LLC (Dominion), on September 25, 2003, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 52 (10 CFR Part 52). The application is available through the web-based version of the NRC's Agencywide Documents Access and Management System (ADAMS) which can be found at http://www.nrc.gov/reading-rm/adams.html. The application is under accession number ML032731517.

As part of its review of the application, the NRC staff will prepare an environmental impact statement (EIS) under the provisions of 10 CFR Part 51, the NRC rules that implement the National Environmental Policy Act (NEPA) of 1969. In addition, as outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 in meeting the requirements of NEPA. A draft EIS is scheduled for publication in October of 2004, and will be provided to you for review and comment.

Representatives of the Bureau of Indian Affairs (Department of the Interior) had previously expressed their interest in ensuring that the NRC provide you with the opportunity to share your views on licensing actions in Louisa County, Virginia. Therefore, the NRC staff is contacting you regarding this ESP review. The North Anna Power Station site, which is the subject of this review, is a considerable distance from the Neuse and Roanoke Rivers. It is located on Lake Anna, 10 miles Northeast of Mineral, VA.

If approved, the ESP will document the NRC staff's determination regarding the suitability of the proposed site for the construction and operation of one or more new nuclear plants. The ESP would not authorize the applicant to begin construction of the unit(s). However, in its review, the NRC staff will evaluate the environmental impacts of construction and operation and will also consider alternatives, including alternative sites.

1

L. Henry -2-

Dominion has also included a site redress plan in its application in accordance with 10 CFR 52.17(c) and 52.25. If a site redress plan is included in an ESP approved by the NRC, the applicant may carry out certain site preparation and limited construction activities. See Part 4 of the application for the associated site redress plan. Dominion would still be required to obtain the appropriate local, State, and other Federal permits required for these activities prior to starting work.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for this ESP review is the area at the power plant site and its immediate environs which may be impacted by land-disturbing activities associated with the construction and operation of the new unit(s). The APE may extend beyond the immediate environs in those instances where these land-disturbing activities may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

In its application, Dominion has stated that, prior to any activities that would disturb existing ground conditions, it would assess the need, in coordination with the Virginia Department of Historic Resources, to undertake subsurface investigations for the identification of potentially significant historic or cultural resources in the area(s) to be disturbed. In addition, Dominion has stated that it would implement the necessary administrative steps to make proper notifications in the event of an unanticipated discovery (including human remains).

Pursuant to 36 CFR 800.2(c)(i), the NRC wishes to ensure that Indian tribes that might have an interest in any potential historic properties in the APE are afforded the opportunity to identify their concerns, provide advice on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, and, if necessary, participate in the resolution of any adverse effects to such properties.

On December 8, 2003, the NRC will conduct a public environmental scoping meeting at the Louisa County Middle School, 1009 Davis Highway, Mineral, Virginia. Representatives of the tribes are invited to attend. Your office will receive a copy of the draft EIS along with a request for comments. The anticipated publication date for the draft EIS is October 2004. If you have any questions or require additional information, please contact the Environmental Project Manager for the North Anna ESP project, Mr. Andrew Kugler, at 301-415-2828 or ajk1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 21, 2003

Ms. Mary Colligan
Assistant Regional Administrator
Protected Resources
Northeast Regional Office
NOAA Fisheries
One Blackburn Drive
Gloucester, MA 01930-2298

SUBJECT: APPLICATION FOR AN EARLY SITE PERMIT FOR THE NORTH ANNA POWER STATION SITE

Dear Ms. Colligan:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application submitted by Dominion Nuclear North Anna LLC (Dominion), for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. As part of the review of this application the NRC is preparing an environmental impact statement (EIS). The impact analysis in the EIS includes the potential impacts of the construction and operation of a new nuclear power plant at the preferred or alternate sites, including the potential impacts to fish and wildlife and threatened and endangered species.

Dominion's preferred alternative for the location of the proposed new power plant is within the site boundaries of the existing North Anna Power Station, located on the south shore of Lake Anna Reservoir in Louisa County, Virginia. Lake Anna is an impoundment of the North Anna River, a tributary to the Pamunky river north of Richmond. One of the alternate sites considered within the ESP application is the existing Surry Power Station located on the south bank of the James River in Surry County, Virginia. Each of these sites were evaluated in 2001 and 2002 regarding the renewal of operating licenses for existing nuclear power plants at these locations.

To support the environmental impact statement preparation process and to ensure compliance with Section 7 of the Endangered Species Act of 1973, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the North Anna and Surry Sites. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act of 1934. The NRC has also contacted the Fish and Wildlife Service and requested a list of species and information on protected, proposed, and candidate species and critical habitat that may be in
1 the vicinity of the North Anna and Surry Sites.

M. Colligan 2

If you have any questions concerning the ESP application, or other aspects of this project, please contact Mr. Andrew Kugler, Environmental Project Manager, at (301) 415-2828 or by e-mail at AJK1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 21, 2003

Mr. John Wolflin, Supervisor
Chesapeake Bay Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401

SUBJECT: APPLICATION FOR AN EARLY SITE PERMIT FOR THE NORTH ANNA POWER STATION SITE

Dear Mr. Wolflin:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application submitted by Dominion Nuclear North Anna LLC (Dominion) for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. As part of the review of this application the NRC is preparing an environmental impact statement (EIS). The impact analysis in the EIS includes the potential impacts of the construction and operation of a new nuclear power plant at the preferred or alternate sites, including the potential impacts to fish and wildlife and threatened and endangered species.

Dominion's preferred alternative for the location of the proposed new power plant is within the site boundaries of the existing North Anna Power Station, located on the south shore of Lake Anna Reservoir in Louisa County, Virginia. Lake Anna is an impoundment of the North Anna River, a tributary to the Pamunkey River north of Richmond. One of the alternate sites considered within the ESP application is the existing Surry Power Station located on the south bank of the James River in Surry County, Virginia. The electricity generated by a new plant at either site would most likely be transmitted to the regional grid via existing transmission lines. Each of these sites were evaluated in 2001 and 2002 regarding the renewal of operating licenses for existing nuclear power plants at these locations.

To support the EIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act of 1973, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the North Anna and Surry Sites. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act of 1934.

The NRC intends to inspect the proposed and alternate sites, consult the National Wetland Database, and work with the Virginia Department of Environmental Quality to assess potential impacts to wetlands at this site. NRC staff also will interact with the appropriate State agencies concerning potential environmental impacts of constructing and operating a new nuclear power plant at either the North Anna or Surry sites.

1

J. Wolflin 2

If you have any questions concerning the ESP application or other aspects of this project, please contact Mr. Andrew Kugler, Environmental Project Manager, at (301) 415-2828 or by e-mail at AJK1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 21, 2003

Mr. Roger L. Banks
Field Supervisor
Charleston Ecological Services Office
U.S. Fish and Wildlife Service
176 Croghan Spur Road, Suite 200
Charleston, SC 29407

SUBJECT: APPLICATION FOR AN EARLY SITE PERMIT FOR THE NORTH ANNA POWER STATION SITE

Dear Mr. Banks:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application submitted by Dominion Nuclear North Anna LLC (Dominion), for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. As part of the review of this application the NRC is preparing an environmental impact statement (EIS). The impact analysis in the EIS includes the potential impacts of the construction and operation of a new nuclear power plant at the preferred or alternate sites, including the potential impacts to fish and wildlife and threatened and endangered species.

Dominion's preferred alternative for the location of the proposed new power plant is within the site boundaries of the existing North Anna Power Station, located on the south shore of Lake Anna Reservoir in Louisa County, Virginia. One of the alternate sites considered within the ESP application is the U.S. Department of Energy's Savannah River Site (SRS), located in Aiken and Barnwell Counties, South Carolina. A new plant located at this site would likely utilize a closed cycle cooling system, drawing make-up water from either the Savannah River or from Parr Pond on the SRS. The electricity generated by a new plant most likely would be transmitted to the regional electrical grid via new transmission lines that would cross the SRS and the Savannah River and connect to the switchyard at the Vogtle Nuclear Station in Burke County, Georgia.

To support the EIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act of 1973, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the SRS. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act of 1934.

The NRC intends to inspect the proposed alternate site, consult the National Wetland Database, and work with SRS staff to assess potential impacts to wetlands at this site. NRC staff will also interact with the South Carolina Department of Natural Resources concerning potential environmental impacts of constructing and operating a new nuclear power plant at the SRS.

1 R. Banks 2

If you have any questions concerning the ESP application, or other aspects of this project, please contact Mr. Andrew Kugler, Environmental Project Manager, at (301) 415-2828 or by e-mail at AJK1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 21, 2003

Dr. Mary Knapp
Field Supervisor
Reynoldsburg Ecological Services Office
U.S. Fish and Wildlife Service
6950-H Americana Parkway
Reynoldsburg, OH 43068-4127

SUBJECT: APPLICATION FOR AN EARLY SITE PERMIT FOR THE NORTH ANNA POWER STATION SITE

Dear Dr. Knapp:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application submitted by Dominion Nuclear North Anna LLC (Dominion), for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. As part of the review of this application the NRC staff is preparing an environmental impact statement (EIS). The impact analysis in the EIS includes the potential impacts of the construction and operation of a new nuclear power plant at the preferred or alternate sites, including the potential impacts to fish and wildlife and threatened and endangered species.

Dominion's preferred alternative for the location of the proposed new nuclear power plant is within the site boundaries of the existing North Anna Power Station, located on the south shore of Lake Anna Reservoir in Louisa County, Virginia. One of the alternate sites considered within the ESP application is the U.S. Department of Energy's Portsmouth Site, located in Pike County, Ohio. The electricity generated by a new power plant at this location most likely would be transmitted to the regional electrical grid via new transmission lines that would be routed completely within the boundaries of the Portsmouth site.

To support the EIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act of 1973, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the Portsmouth Site. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act of 1934.

The NRC intends to inspect the proposed site, consult the National Wetland Database, and work with Portsmouth Site staff to assess potential impacts to wetlands at this site. NRC staff also will interact with the Ohio Department of Natural Resources concerning potential environmental impacts of constructing and operating a new nuclear power plant at the Portsmouth Site.

M. Knapp 2

If you have any questions concerning the ESP application, or other aspects of this project, please contact Mr. Andrew Kugler, Environmental Project Manager, at (301) 415-2828 or by e-mail at AJK1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 5, 2004

Mr. Don Klima, Director
Office of Federal Agency Programs
Advisory Council on Historic Preservation
Old Post Office Building
1100 Pennsylvania Avenue, NW, Suite 809
Washington, DC 20004

SUBJECT: EARLY SITE PERMIT REVIEW FOR THE NORTH ANNA SITE

Dear Mr. Klima:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application for an early site permit (ESP) submitted by Dominion Nuclear North Anna, LLC (Dominion) on September 25, 2003. An ESP allows an applicant to set aside a site for potential future construction of one or more new nuclear power plants, and provides the opportunity to resolve site safety and environmental issues before construction begins. An ESP does not allow actual construction of a nuclear plant, which must be requested through another application. The ESP site proposed by Dominion is on property within the site boundary of the existing North Anna Power Station site near the town of Mineral in Louisa County, Virginia. The application was submitted by Dominion pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 52 (10 CFR Part 52).

Dominion has also included a site redress plan in its application in accordance with 10 CFR 52.17(c) and 52.25. If a site redress plan is included in an ESP approved by the NRC, the applicant may carry out certain site preparation and limited construction activities. Dominion would still be required to obtain the appropriate local, State, and other Federal permits required for these activities prior to starting work.

As part of its review of the application, the NRC staff will prepare an environmental impact statement (EIS) pursuant to 10 CFR Part 51, the NRC regulations that implement the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8, the EIS will include analyses of potential impacts to historic and cultural resources. A draft EIS is scheduled for publication in October 2004, and will be provided to you for review and comment.

If you have any questions or require additional information, please contact the Environmental Project Manager for the North Anna ESP project, Mr. Andrew Kugler at 301-415-2828 or AJK1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 52-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 5, 2004

Ms. Georgia Cranmore
Acting Assistant Regional Administrator
for Protected Resources
Southeast Regional Office
NOAA Fisheries
9721 Executive Center Dr, N.
St. Petersburg, FL 33702

SUBJECT: APPLICATION FOR AN EARLY SITE PERMIT FOR THE NORTH ANNA POWER STATION SITE

Dear Ms. Cranmore:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application submitted by Dominion Nuclear North Anna LLC (Dominion), for an early site permit (ESP) for the potential future construction of one or more new nuclear power plants. As part of the review of this application the NRC is preparing an environmental impact statement (EIS). The impact analysis in the EIS includes the potential impacts of the construction and operation of a new nuclear power plant at the preferred or alternate sites, including the potential impacts to fish and wildlife and threatened and endangered species.

The location of the proposed new power plant is within the site boundaries of the existing North Anna Power Station, located on the south shore of Lake Anna Reservoir in Louisa County, Virginia. One of the alternate sites considered within the ESP application is the U.S. Department of Energy's Savannah River Site (SRS), located in Aiken and Barnwell Counties, South Carolina. A new plant located at this site would likely utilize a closed cycle cooling system, drawing make-up water from either the Savannah River or from Parr Pond on the SRS. The electricity generated by a new plant most likely would be transmitted to the regional electrical grid via new transmission lines that would cross the SRS and the Savannah River and connect to the switchyard at the Vogtle Nuclear Station in Burke County, Georgia.

To support the environmental impact statement preparation process, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the SRS. The NRC has also contacted the Fish and Wildlife Service and requested a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the SRS.

G. Cranmore 2

If you have any questions concerning the ESP application, or other aspects of this project, please contact Mr. Andrew Kugler, Environmental Project Manager, at (301) 415-2828 or by e-mail at AJK1@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 52-008

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

JAN -6 2004

Pao-Tsin Kuo
Program Director, License Renewal and Environmental Impacts
Division of Regulatory Improvement Projects
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Docket No. 52-008

Dear Mr. Kuo,

This responds to your letter dated December 21, 2003, requesting information on the presence of any federally listed threatened or endangered species and/or designated critical habitat for listed species under the jurisdiction of the National Marine Fisheries Service (NOAA Fisheries) in the vicinity of two sites for potential new nuclear power plants. The US Nuclear Regulatory Commission (NRC) is currently reviewing an application submitted by Dominion Nuclear North Anna LLC for an early site permit for the potential future construction of one or more new nuclear power plants. The preferred alternative for the location of the proposed new power plants is within the site boundaries of the existing North Anna Power Station, located on the south shore of Lake Anna Reservoir in Louisa County, Virginia. One of the alternate sites is within the site boundaries of the existing Surry Power Station located on the south bank of the James River in Surry County, Virginia.

No federally listed or proposed threatened or endangered species under the jurisdiction of NOAA Fisheries are known to exist in the vicinity of the existing North Anna Power Station. However, several threatened and endangered species are known to exist in the Chesapeake Bay, of which the James River is a tributary. While several species of sea turtles are known to be seasonally present in the Chesapeake Bay, none are likely to occur in the vicinity of the Surry Power Station.

The federally endangered shortnose sturgeon (*Acipenser brevirostrum*) is known to be present in the Chesapeake Bay. The NOAA Fisheries recovery plan (1998) indicates that shortnose sturgeon found in the Chesapeake Bay and its tributaries are considered part of the Chesapeake Bay population. The US Fish and Wildlife Service Reward Program for Atlantic Sturgeon began in 1996. Shortnose sturgeon have been incidentally captured via this program. As of spring 2003, fifty-two shortnose sturgeon were captured via the reward program in the Chesapeake Bay and its tributaries – four from the lower Susquehanna River, two in the Bohemia River, six in the Potomac River, two south of the Bay Bridge near Kent Island, one near Howell Point, one just

1 JAN-21-2004 15:24 P.03

north of Hoopers Island, one in the Elk River and two in Fishing Bay. The remaining shortnose sturgeon were captured in the upper Bay north of Hart-Miller Island. These fish were captured alive in either commercial gillnets, poundnets, fykenets, eel pots, hoop nets, or catfish traps. No critical habitat has been designated for shortnose sturgeon. On October 22, 2003, one shortnose sturgeon was observed in a pre-dredge trawl operation in Thimble Shoals Channel. This capture provides the only concrete evidence of recent shortnose sturgeon presence in the vicinity of the James River. However, the occurrence of shortnose sturgeon in other areas of the Bay suggests that this species is likely present in Virginia waters of the Chesapeake Bay and may be present in the James River. Habitat analysis in the James River has revealed that this river contains suitable spawning habitat for shortnose sturgeon. As such, shortnose sturgeon may be present in the vicinity of the Surry Power Station.

Section 7(a)(2) of the Endangered Species Act (ESA) states that each Federal agency shall, in consultation with the Secretary, insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Because shortnose sturgeon may be present in the vicinity of the Surry Power Station and may be affected by the construction and operation of a new nuclear power project, an action at the Surry site would have to undergo Section 7 consultation. The federal action agency, in this case the NRC, would be responsible for initiating Section 7 consultation. If the Surry Power Station alternative is chosen, please submit a description of the project along with an assessment of the projects impacts on shortnose sturgeon to the attention of the Endangered Species Coordinator, NOAA Fisheries, Northeast Regional Office, One Blackburn Drive, Gloucester, MA 01930. After reviewing this information, NOAA Fisheries will then be able to conduct a consultation under Section 7 of the ESA. If you have any questions or concerns about these comments or about the consultation process in general, please contact Julie Crocker of my staff at (978) 281-9328 ext. 6530.

Sincerely,

Mary A. Colligan

Mary A. Colligan
Assistant Regional Administrator
for Protected Resources

File Code: Sec 7 NRC Virginia

TOTAL P.03

1

Pamela F. Faggert
Vice President and Chief Environmental Officer
5000 Dominion Boulevard, Glen Allen, VA 23060
Phone: 804-273-3467

Dominion

January 12, 2004

Ms. Ellie Irons
Program Manager
Office of Environmental Impact Review
Virginia Department of Environmental Quality
629 East Maine Street, 6th Floor
Richmond, VA 23219

Re: Federal Consistency Certification Under Coastal Zone Management Act
Virginia Coastal Resources Management Program
North Anna Early Site Permit Application

Dear Ms. Irons:

Thank you for discussing the Federal Consistency Certification for North Anna's Early Site Permit with us and the NRC staff on January 7, 2004. The certification, which we submitted to your office on November 6, 2003, was for the Commonwealth's review and concurrence.

Based on this discussion, we understand that the Commonwealth would prefer to await NRC's issuance of the draft environmental impact statement (DEIS) before deciding whether to concur with our consistency certification under the Coastal Zone Management Act. Accordingly, Dominion Nuclear North Anna has agreed to withdraw its certification and to resubmit it upon issuance of the DEIS. As we have agreed, and as permitted by 15 C.F.R. § 930.60(a)(3), the time-clock for the State's review of the consistency determination will not commence until this re-submittal. Pursuant to this agreement, Dominion Nuclear North Anna hereby withdraws its certification.

The withdrawal of the certification does not affect the NRC's request for comments on the scope of the DEIS. In addition, we would at any time welcome comments that you may have either on the environmental report included as part of the Early Site Permit Application before the NRC, or any informal comments that you may have based on your initial review of the Coastal Zone Management Act certification before it was withdrawn.

If you have any comments, or if we can be of any other assistance, please contact Jud White at (804) 273-2948 or Tony Banks at (804) 273-2170.

Sincerely,

Pamela F. Faggert

Pamela F. Faggert

cc: Michael Murphy – VDEQ
→ Andy Kugler – NRC

1

United States Department of the Interior

FISH AND WILDLIFE SERVICE
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407

January 15, 2004

Mr. Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: North Anna Power Station Alternate
Barnwell County, South Carolina
FWS Log No: 4-6-04-T-110

Dear Mr. Kuo:

We have reviewed the information received December 21, 2003, concerning the above-referenced project. The following comments are provided in accordance with the Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661-667e), and section 7 of the Endangered Species Act, as amended (16 U.S.C. 1531-1543).

We believe there is potential habitat for federally protected species and/or the presence of designated or proposed critical habitat within the action area of the alternate project location at the Savannah River Site. You did not provide detailed information on the location of the potential alternate site and we can provide you with only general comments at this time.

Therefore, we are providing a list of the federally endangered (E) and threatened (T) and candidate (C) species which potentially occur in Aiken County and Barnwell County, South Carolina to aid you in determining the impacts your project may have on protected species. The list also includes species of concern identified by the Service. Species of concern (SC) are not legally protected under the Endangered Species Act, and are not subject to any of its provisions, including Section 7, unless they are formally proposed or listed in the future as endangered/threatened. We are including these species in our response for the purpose of giving you advance notification. These species may be listed in the future, at which time they will be protected under the Endangered Species Act.

Therefore, it would be prudent for you to consider these species early in project planning to avoid any adverse effects.

In-house surveys should be conducted by comparing the habitat requirements for the attached listed species with available habitat types at the project site. Field surveys for the species should be performed if habitat requirements overlap with that available at the project site. Surveys for protected plant species must be conducted by a qualified biologist during the flowering or fruiting period(s) of the species. Surveys for the red-cockaded woodpecker should be conducted in accordance with the "Guidelines for preparation of biological assessments and evaluations for the red-cockaded woodpecker" by Gary Henry. A copy of these guidelines is available from this office. Please notify this office with the results of any surveys for the below list of species and an analysis of the "effects of the action," as defined by 50 CFR 402.02 on any listed species including consideration of direct, indirect, and cumulative effects.

We also recommend you contact the S.C. Department of Natural Resources (SCDNR), Data Manager, Wildlife Diversity Section, Columbia, SC 29202, concerning known populations of federal and/or state endangered or threatened species, and other sensitive species in the project area. Additional habitat information may also be available from SCDNR. The National Marine Fisheries Service, 9721 Executive Center Drive North, St. Petersburg, FL 33702-2449 should be contacted for consultation on species under their jurisdiction.

Aiken County

Bald eagle	*Haliaeetus leucocephalus*	T
Wood stork	*Mycteria americana*	E
Red-cockaded woodpecker	*Picoides borealis*	E
Shortnose sturgeon	*Acipenser brevirostrum**	E
Relict trillium	*Trillium reliquum*	E
Piedmont bishop-weed	*Ptilimnium nodosum*	E
Smooth coneflower	*Echinacea laevigata*	E
Southern Dusky Salamander	*Desmognathus auriculatus*	SC
Gopher frog	*Rana capito*	SC
Small-flowered buckeye	*Aesculus parviflora*	SC
Sandhills milk-vetch	*Astragalus michauxii*	SC
Elliott's croton	*Croton elliottii*	SC
Dwarf burhead	*Echinodorus parvulus*	SC
Shoals spider-lily	*Hymenocallis coronaria*	SC
White-wicky	*Kalmia cuneata*	SC
Bog spicebush	*Lindera subcoriacea*	SC
Boykin's lobelia	*Lobelia boykinii*	SC
Carolina bogmint	*Macbridea caroliniana*	SC
Awned-meadowbeauty	*Rhexia aristosa*	SC
Pickering's morning-glory	*Stylisma pickeringii var. Pickeringii*	SC

2

Reclined meadow-rue	*Thalictrum subrotundum*	SC
Bachman's sparrow	*Aimophila aestivalis*	SC
Henslow's sparrow	*Ammodramus henslowii*	SC
American kestrel	*Falco sparverius*	SC
Loggerhead shrike	*Lanius ludovicianus*	SC
Painted bunting	*Passerina ciris ciris*	SC
Redhorse, Robust	Moxostoma robustum	SC
Arogos skipper	*Atrytone arogos arogos*	SC
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	SC
Gopher tortoise	*Gopherus polyphemus*	SC
Southern hognose snake	Heterodon simus	SC
Pine or Gopher snake	*Pituophis melanoleucus melanoleucus*	SC

Barnwell County

Bald eagle	*Haliaeetus leucocephalus*	T
Wood stork	*Mycteria americana*	E
Red-cockaded woodpecker	*Picoides borealis*	E
Shortnose sturgeon	*Acipenser brevirostrum**	E
Smooth coneflower	*Echinacea laevigata*	E
Pondberry	*Lindera melissifolia*	E
Canby's dropwort	*Oxypolis canbyi*	E
Piedmont bishop-weed	*Ptilimnium nodosum*	E
American chaffseed	*Schwalbea americana*	E
Southern Dusky Salamander	*Desmognathus auriculatus*	SC
Gopher frog	*Rana capito*	SC
Sandhills milk-vetch	*Astragalus michauxii*	SC
Elliott's croton	*Croton elliottii*	SC
Dwarf burhead	*Echinodorus parvulus*	SC
Creeping St. John's wort	*Hypericum adpressum*	SC
Bog spicebush	*Lindera subcoriacea*	SC
Boykin's lobelia	*Lobelia boykinii*	SC
Carolina bogmint	*Macbridea caroliniana*	SC
Awned meadowbeauty	*Rhexia aristosa*	SC
Bachman's sparrow	*Aimophila aestivalis*	SC
Henslow's sparrow	*Ammodramus henslowii*	SC
American kestrel	*Falco sparverius*	SC
Loggerhead shrike	*Lanius ludovicianus*	SC
Painted bunting	*Passerina ciris ciris*	SC
Yellow lampmussel	*Lampsilis cariosa*	SC
Southern hognose snake	*Heterodon simus*	SC

We are particularly concerned about potential project impacts to mussel species of concern and anadromous fish in the Savannah River. The Savannah River continues to support remnant but nationally important populations of anadromous fishes including

3

1 American shad, blueback herring, striped bass, Atlantic sturgeon, and the federally listed endangered shortnose sturgeon. Populations of these species have been seriously diminished as a result of dam construction, over-fishing, habitat degradation, and pollution. The Service is seeking, through Federal Energy Regulatory Commission relicensing and Corps project modifications, to restore access to needed spawning habitat for these fishes from New Savannah Bluff Lock and Dam to Thurmond Dam.

In addition, the Savannah River basin supports one of the most diverse unionid mussel faunas of all Atlantic Slope river systems in North America. Freshwater mussels are currently experiencing a nationwide decline, and considering channel alterations, impoundment, and flow regulation, the Savannah River is almost certainly no exception to these national trends. The extensive forested wetlands of the Savannah River floodplain below Augusta are important habitat for many significant fish and wildlife species, including neotropical migratory birds as well as many other plants and animals of management concern.

Your interest in the protection of endangered species is appreciated. If you have further questions or require additional information, please contact Ed EuDaly of this office at (843) 727-4707 ext. 13. In future correspondence concerning this project, please reference FWS Log No. 4-6-04-T-110.

Sincerely yours,

Timothy N. Hall
Field Supervisor

TNH/EME

1 FEB-12-2004 17:05 P.02

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
6950 Americana Parkway, Suite H
Reynoldsburg, Ohio 43068-4127

February 3, 2004

Pao-Tsin Kuo,
U.S. Nuclear Regulatory Commission
License Renewal and Environmental Impacts
Washington, D.C. 20555-0001

re: Docket Nos.: 52-008

Dear Mr. Kuo:

This responds to your letter of December 21, 2003 requesting Federally listed threatened and endangered species information for the U.S. Department of Energy's Portsmouth Site in Pike County, Ohio. We understand that the Portsmouth Site is being considered as an alternate location for the construction of a nuclear power plant. Such a power plant would also entail construction of new transmission lines completely within the Portsmouth site.

In general, we recommend that proposed industrial developments minimize water quality impacts. We are especially concerned with impacts to fishery resources from water contamination, depletion, or warming associated with cooling systems and other water supply and discharge operations. Impingement and entrainment of fish should also be considered in your environmental impact statement. Impacts to fish and wildlife habitat, such as forests, streams, and wetlands should be avoided where possible. Construction and operation techniques should be used that minimize erosion and run-off of other pollutants, particularly on slopes. All disturbed areas should be mulched and vegetated with native plant species.

ENDANGERED SPECIES COMMENTS: This project lies within the range of the Indiana bat (Myotis sodalis), a federally listed endangered species, and the timber rattlesnake (Crotalus horridus), a species for which a federal pro-listing conservation plan exists.

Summer habitat requirements for the Indiana bat are not well defined but the following are thought to be of importance.

1. Dead or live trees and snags with peeling or exfoliating bark, split tree trunk and/or branches, or cavities, which may be used as maternity roost areas.
2. Live trees (such as shagbark hickory) which have exfoliating bark.
3. Stream corridors, riparian areas, and upland woodlots which provide forage sites.

Should the proposed site contain trees exhibiting any of the characteristics listed above, we recommend that they and surrounding trees be saved wherever possible. If they must be cut, they should not be cut between April 15 and September 15.

If potential bat roost trees are present, and if the above time restriction is unacceptable, mist net or other surveys should be conducted to determine if bats are present. The survey should be designed and conducted in coordination with the endangered species coordinator for this office. The survey should be conducted in June or July, the period when peak bat populations could be expected.

1 FEB-12-2004 17:05 P.03

We recommend that if potential bat roost trees with the above characteristics are encountered in the project area, they and surrounding trees should be saved wherever possible. If they must be cut, they should not be cut between April 15 and September 15.

The project also lies within the range of the timber rattlesnake *(Crotalus horridus horridus)*, a species with a pre-listing Conservation Plan. Your proactive efforts to conserve this species now may help avoid the need to list the species under the Endangered Species Act in the future. In Ohio, the timber rattlesnake is restricted to the un-glaciated Allegheny Plateau. Winters are spent in dens usually associated with high, dry ridges. In the fall, timber rattlesnakes return to the same den.

It may be helpful to inquire about timber rattlesnake sightings with local resource agency personnel or reliable local residents. Local herpetologists may have knowledge of historical populations as well as precise knowledge of the habits, especially the specific local types of habitats that may contain timber rattlesnakes.

In areas where timber rattlesnakes or their dens are known or likely to exist, clearing, construction, and maintenance activities (mowing, cutting, burning, etc.) should be avoided at least 100 feet, or more, from ridges and areas of exposed rock, and should be conducted from November 1 to March 1 when timber rattlesnakes are hibernating.

The timber rattlesnake is a large shy rattlesnake that is declining throughout its national range. No Federal listing status has been assigned to this species. Instead, the U.S. Fish and Wildlife Service has initiated a pre-listing Conservation Action Plan to support state and local conservation efforts. Your proactive efforts to conserve this species now may help avoid the need to list the species under the Endangered Species Act in the future. The timber rattlesnake is protected throughout much of its range and is listed as endangered by the State of Ohio. Due to their rarity and reclusive nature, we encourage early project coordination to avoid potential impacts to timber rattlesnakes and their habitat.

In Ohio, the timber rattlesnake is restricted to the un-glaciated Allegheny Plateau and utilizes the specific habitat types, depending upon season. Winters are spent in dens usually associated with high, dry ridges. These dens may face any direction, but southeast to southwest are most common. Such dens usually consist of narrow crevices in the bedrock. Rocks may or may not be present on the surface. From these dens, timber rattlesnakes radiate throughout the surrounding hills and move distances as great as 4.5 miles. In the fall, timber rattlesnakes return to the same den. Intensive efforts to transplant timber rattlesnakes have not been successful. Thus protection of the winter dens is critical to the survival of this species. Some project management ideas include the following:

1) At a minimum, project evaluations should contain delineations of timber rattlesnake habitat within project boundaries. Descriptions should indicate the quality and quantity of timber rattlesnake habitat (den sites, basking sites, and foraging area, etc.) that may be affected by the project.

2) In cases where timber rattlesnakes are known to occur or where potential habitat is rated moderate to high, timber rattlesnake surveys may be necessary. If surveys are to be conducted, it may be helpful to inquire about timber rattlesnake sightings with local resource agency personnel or reliable local residents. In addition, local herpetologists may have knowledge of historical populations as well as precise knowledge of the habits, and especially the specific, local types of habitats that may contain timber rattlesnakes. Surveys should be performed during the periods of spring emergence from dens (usually a narrow window in April or May) and throughout the

1 FEB-12-2004 17:06 P.04

active season until October. The species is often easiest to locate during the summer months when pregnant females seek open areas in early morning, especially after cool evenings.

3) In portions of projects where timber rattlesnakes will be affected, clearing and construction activities should occur at distances greater than 100 feet from known dens. Most importantly, tops of ridges and areas of exposed rock should be avoided.

4) In areas where timber rattlesnake dens are known or likely to exist, maintenance activities (mowing, cutting, burning, etc.) should be conducted from November 1 to March 1, when timber rattlesnakes are hibernating.

Two divisions of the Ohio Department of Natural Resources, the Division of Wildlife (614-265-6300) and the Division of Natural Areas and Preserves (614-265-6472), maintain lists of plants and animals of concern to the State of Ohio. If you have not already done so, you may wish to contact these agencies to obtain site-specific information on species of state concern.

This technical assistance letter is submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C.661 et seq.), the Endangered Species Act of 1973, as amended, and is consistent with the intent of the National Environmental Policy Act of 1969, and the U.S. Fish and Wildlife Service's Mitigation Policy.

We expect that there will be further coordination with our office if the Portsmouth site is chosen as the location for construction of a new nuclear power plant.

If you have questions or we may be of further assistance in this matter please contact Mr. Bill Kurey of this office at: 614-469-6923 ext. 14.

Sincerely,

Mary Knapp

Mary Knapp, Ph.D.
Supervisor

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DEPARTMENT OF ENVIRONMENTAL QUALITY

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February 10, 2004

Ms. Pamela F. Faggert
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RE: Federal Consistency Certification under the Coastal Zone Management Act and the Virginia Coastal Resources Management Program: North Anna Early Site Permit Application
DEQ-03-223F

Dear Ms. Faggert:

Thank you for your January 12, 2004 letter (received January 20) withdrawing the above federal consistency certification pursuant to our January 7 discussion with the Nuclear Regulatory Commission staff. As you requested, I am enclosing copies of the comments developed by our reviewing agencies thus far.

As you know, the Department of Environmental Quality (DEQ), through this Office, is responsible for coordinating Virginia's review of federal environmental documents and responding to appropriate federal officials on behalf of the Commonwealth. DEQ is also the lead agency for coordination of federal consistency reviews under the Virginia Coastal Resource Management Program and the federal Coastal Zone Management Act. The following agencies and planning district commission joined in this review (starred (*) agencies administer one or more of the Enforceable Policies of the Coastal Resources Management Program):

- Department of Environmental Quality:
  - Water Division*
  - Air Division*
  - Waste Division
  - Northern Virginia Regional Office*
  - Office of Environmental Impact Review* (this Office)
- Department of Game and Inland Fisheries*

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Department of Agriculture and Consumer Services
Department of Conservation and Recreation*
Department of Health*
Department of Mines, Minerals, and Energy
Thomas Jefferson Planning District Commission.

In addition, the following agencies and localities were invited to comment (same reference (*) as above):

Marine Resources Commission*
Department of Historic Resources
Chesapeake Bay Local Assistance Department*
Louisa County
Spotsylvania County.*

The following summary of the comments submitted by reviewers is provided to inform Dominion Virginia Power Company ("Dominion"), as applicant, and the Nuclear Regulatory Commission ("NRC"), as federal licensing agency, of issues that may merit attention as the consistency certification is reconsidered and as the Draft Environmental Impact Statement is prepared.

<u>Project Description and Background</u>

Dominion filed an Early Site Permit Application ("Application") with the NRC to add two units to the North Anna Power Station. The NRC is to determine whether the site is suitable for constructing new reactors using an Early Site Permit (ESP). Permits are issued for 10 to 20 years and can be renewed for 20 years. Environmental issues are addressed as part of the ESP, independent of any review of any specific reactor design. The ESP process uses a Plant Parameters Approach, which postulates an envelope of possible reactor designs; Dominion is considering seven different designs. In this Application, Dominion has postulated a maximum of two reactors of up to 4300 megawatts each of rated thermal capacity. The two reactors that Dominion formerly proposed but then cancelled each had a rated electrical capacity of 907 megawatts. Dominion postulates that the first new unit (referred to as Unit 3 herein) would use once-through cooling; the second would use a cooling tower. Issues resolved with finality under the ESP process, including environmental issues, are not re-examined in any subsequent licensing action by the NRC. The ESP process does not approve a particular reactor design, nor allow the construction of the reactor. However, it does authorize construction of all the items identified in the site redress plan, including:

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- site clearing
- foundations
- intake structures
- outfall structures.

Dominion has requested that NRC issue the permit for 20 years (the maximum) and allow land clearing, stream filling, and intake structure construction to proceed under the site redress plan.

Deficiencies in the Document

The Application includes proposed Unit 4, but does not identify a source of water for that unit. The NRC regulations, at 10 CFR section 51.29, require that "information provided to the Commission by an applicant for a license, ... shall be complete and accurate in all material respects." For ESP applications, the NRC requires information on "types of cooling system intake and outflows for each facility" (10 CFR section 52.17(v)) (emphasis added). Because no water source for Unit 4 is identified in the Application, DEQ's Water Division cannot form an opinion on prospects for approval of such a project, or whether it would be consistent with state laws and regulations. The logical water source for Unit 4 would be Lake Anna. Groundwater resources are not capable of producing the large quantities of water that would be needed; nor does there appear to be any surface water source nearby, other than the Lake. Unit 4 should be withdrawn from the Application unless its water source(s) and related cumulative impacts are identified. If Dominion leaves Unit 4 in the Application, but does not identify a water source, then NRC should consider denying the application for any site redress work associated with Unit 4.

If Lake Anna were the source of water identified for Unit 4, the additional heat load and evaporative losses would result in deeper and longer drawdown periods on the Lake and longer periods of low flows in the North Anna River. Given the small watershed, with average runoff of only 370 cubic feet per second (cfs), it is probable that the additional cumulative impact of a fourth unit would have an unacceptable impact on the Lake and the River downstream of it.

Federal Consistency Certification Issues

Federally licensed or permitted activities affecting coastal uses or resources must be conducted in a manner consistent with Virginia's approved Coastal Resources Management Program ("VCP"). In order to be consistent with the VCP, the project must be consistent with the Enforceable Policies of the VCP (15 CFR Part 930, section 930.50) (first enclosure). In addition, we recommend that applicants and federal licensing agencies take the Advisory Policies of the VCP into account (second enclosure).

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The VCP applies in Virginia localities bordering the seacoast and our tidal tributaries, including Spotsylvania County, which is bounded by the North Anna River and Lake Anna. As DEQ's Office of Wetlands and Water Protection indicates, operation of one or both of the proposed generating units would diminish in-stream flows on the North Anna River, directly affecting the River and the anadromous fish habitat therein.

1. Fisheries Management Concerns. As the Department of Game and Inland Fisheries (DGIF) indicates (enclosed comments), the proposed addition of two generating units to the two that are already operating at the North Anna Power Station would have a number of adverse effects upon the lake and the river downstream of it.

(a) Water Withdrawal Increases in the Lake. Increases in water withdrawals would present complications for fish populations through increased fish impingement and entrainment in water intakes. Impingement, or the collisions of fish against water intake screens, would increase by 230% over current levels with the addition of the proposed intakes, according to DGIF. Estimated impingement mortality of striped bass would nearly double; it should be mentioned that striped bass is a leading Lake Anna sportfish annually stocked by DGIF.

Similarly, the number of fish entrained by virtue of increased water withdrawals from the Lake is expected to increase. Using estimates from the applicant's six-species category, DGIF states that the number of fish lost to entrainment could exceed 468 million fish annually, 63% of which would be gizzard shad, another important North Anna River species. (Confirmed, Ellis/Odenkirk, 2/9/04. The lower estimate by DEQ's Office of Wetlands and Water Protection is a sub-set of the above estimate; it is based on losses attributable to the addition of Unit 3 only (Ellis/Hassell, 2/9/04).

Existing intake criteria at the North Anna Power Station substantially exceed DGIF recommendations, as the chart shows:

	water velocity (feet per second)	screen mesh (millimeters)
DGIF recommendation	0.25 FPS	1.0 mm
existing criteria	0.70 FPS	9.5 mm

DGIF indicates that even its recommendations, which reflect current state-of-the-art technology, are not expected to provide full resource protection. The existing screen would be expected to exclude only compressed fish (such as sunfish) larger than 50 mm and elongated fish (such as striped bass and largemouth bass) larger than 86 mm. Accordingly, DGIF recommends that Dominion investigate further the addition of a submerged intake structure (a curtain wall as detailed on page 3-5-38 of the Application

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that would reduce fish impingement and entrainment and align the intake criteria with current DGIF recommendations.

(b) Water Withdrawal Increases and the River Downstream. The addition of one or two new units to the North Anna Power Station would have significant impacts on downstream resources by reducing river flows and the frequency of higher flows. For example, the water budget presented in the Application shows that significant changes in flows have already taken place as a result of the construction of the dam; drought flow frequency (flows less than 20 cfs) occurs 5.3% of the time now, versus 4.2% of the time before the dam was built (1929-1971). Drought flow frequency would rise to 11.8% of the time with one additional unit; the flow analysis did not address what would happen with a fourth unit. The impact of a fourth unit should be addressed in this process, or else the fourth unit should be taken out of the permit application.

DGIF recommends an In-stream Flow Incremental Methodology (IFIM) Study as a means of determining flow recommendations downstream of the Lake. The study should include evaluation of a habitat time series (i.e., pre-project, current, and proposed conditions) for native and naturalized species, and may result in recommendations for different flow operating rules than currently exist for the downstream resource. The Tennant Method yields a summer flow in the range of 74 to 111 cfs for resource protection, and current minimum flows would be rated as poor to degraded in that regard. As DEQ's Office of Wetlands and Water Protection states, the addition of another generating unit, which is expected to increase the consumptive loss from the watershed by an additional 39 cfs, would create nearly perennial conditions of severe degradation every fall. See "Additional Analysis Needs," item 4, below.

(c) Water Temperature Increases. Water temperature increases resulting from the additional units are likely to affect fish habitat in Lake Anna and in the North Anna River. This issue has several aspects.

(i) Present Conditions. Dominion has documented the current situation and available literature (Application, pages 3-5-55 through 3-5-58). The current temperature and oxygen stratification patterns at the Lake limit the potential of the Lake fishery, but have not resulted in catastrophic fish kills to date. Adult striped bass grow slowly, exhibit reduced fitness, and have low maximum sizes as a result of the present marginal habitat conditions, but an important recreational fishery has nonetheless developed in this habitat. The Lake does not often stratify, but when it does the stratification is weak. Total temperature differences (top to bottom) in many cases were less than 1 degree Celsius (1.8 degrees Fahrenheit) based on DGIF samples taken in late summer and early fall at lower reservoir sites. Stratification patterns dictate striped bass habitat and are subject to much variability at Lake Anna. Accordingly, a horizontal and vertical increase in the thermal plume would exacerbate a currently tenuous situation.

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(ii) Impacts of Water Temperature Increases; Mitigation. It is likely that a small increase in reservoir water temperature would have a dramatic effect, further reducing already limited habitat and perhaps jeopardizing the entire striped bass fishery. The maximum daily surface temperature is expected to rise by 7.2 degrees Fahrenheit (4 degrees Celsius) near the dam as a consequence of the proposed new generating units. Re-configuring the flow within the waste heat treatment facility (WHTF) to allow for more efficient cooling (i.e., forcing water to use the entire facility, consisting of three cooling lagoons, by sealing the lower tributary arm between Elk Creek and Millpond Creek and cutting a canal through the headwater areas; Ellis/Kauffman, 2/6/04) would expand the residence time within the WHTF and probably reduce thermal impacts to Lake Anna and the North Anna River.

(d) Alternatives. Given the scope and magnitude of aquatic resource impacts anticipated in the event of building out the two units, it seems prudent, according to the Department of Game and Inland Fisheries, to investigate alternatives to the heavily consumptive proposal of another once-through system and a new wet cooling tower. See "Additional Analysis Needs," item 2, below. One alternative, addressing the conflict between consumptive use and impingement and entrainment, would be to consider a single new reactor using a cooling tower with Lake Anna as its source water (see item 3(b)(ii), below). The Draft EIS should include a thorough analysis of this and other alternatives to the proposed project.

2. *Wetland Management and Water Resources.* DEQ's Water Division indicates that additional studies on the impacts to in-stream beneficial uses, water quality, and aquatic life would be needed to adequately assess the impacts of the proposed new generating units. Preservation of in-stream flows for protection of fish and wildlife habitat and resources and also recreation values is a beneficial use of state waters. Habitat and recreational uses are present in both the Lake and downstream, in the North Anna and Pamunkey Rivers. Conditions in a Virginia Water Protection Permit may include, but are not limited to, the volume of water to be withdrawn as part of the permitted activity.

(a) Consumptive Use and In-stream Flow. An additional unit of the size contemplated in the Application would be the largest single consumptive withdrawal ever considered in the history of the Virginia Water Protection Permit Program. The average annual flow of Lake Anna and the North Anna River is 370 cfs. The typical recommendation to the Water Division from the Department of Game and Inland Fisheries, in processing a Water Protection Permit, is not to allow cumulative consumptive use to exceed 10% of the river's flow. The current evaporation rate and the existing two generating units very often exceed this benchmark. Accordingly, permitting of additional withdrawals, even with prescriptive conditions, cannot be guaranteed.

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For these reasons, DEQ's Office of Wetlands and Water Protection has recommended that Dominion withdraw its federal consistency certification, at least until such time as a Draft Environmental Impact Statement is available. Under the present circumstance, DEQ's Office of Wetlands and Water Protection could not agree with the certification that the project would be in compliance with the Enforceable Policies of the Virginia Coastal Resources Management Program, because that Office does not have the information necessary to allow such concurrence.

(b) Impingement and Entrainment. As mentioned above (item 1(a)), a once-through cooling process for Unit 3 will result in a significant addition to the number of aquatic organisms impinged (240,000) or entrained (148,000,000) every year (see item 1(a), above, for the Department of Game and Inland Fisheries (DGIF) estimate of the total losses with all units; this number is a sub-set of the DGIF estimate). While once-through cooling represents a cost saving over cooling towers, it results in higher impingement and entrainment losses. On the other hand, it has less consumptive loss per megawatt of electricity produced, because some of the heat in once-through cooling is dissipated by processes other than pure evaporation.

(i) Permitting Questions. DEQ's Office of Wetlands and Water Protection and its Northern Virginia Regional Office would normally address impingement and entrainment through the Virginia Water Protection Permit. However, because the intake is for cooling water and will not be built for some time, the impingement and entrainment issue will fall under the new regulations pursuant to Section 316(b) of the Clean Water Act and be addressed in the facility's Virginia Pollutant Discharge Elimination System (VPDES) permit. The new unit may be treated as an existing intake or a new intake under the section 316(b) regulations (see item 4 and also "Regulatory and Coordination Needs Summary," item 1, below).

(ii) Limiting Impingement/Entrainment versus Limiting Consumption. The proposed once-through cooling proposed for Unit 3 will raise impingement and entrainment losses as compared with a cooling tower, but it would reduce consumptive use. A cooling tower would also keep thermal conditions in the Lake tolerable for aquatic life. DEQ's Office of Wetlands and Water Protection recommends that the Draft EIS include an alternative not considered in the Application to address this matter: such an alternative would consist of a single new reactor using a cooling tower with Lake Anna as its source.

(c) Water Quantity Issues. For the purpose of this discussion, DEQ's Office of Wetlands and Water Protection assumes that only one additional unit is proposed, because proposed Unit 4 has no identifiable water source.

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The proposed addition of Unit 3 would increase the frequency and duration of drawdowns in the Lake. The Application indicates, in Table 2.4.6, that the amount of time that Lake Anna would drop two feet or more would increase from 5.6% of the time to 11.6% of the time. As DEQ's Office of Wetlands and Water Protection indicates, this would mean that flow in the North Anna River below the dam is 20 cfs for 11.6% of the time. Under pre-dam conditions (1929-1971), the streamflow in the River below the dam was 20 cfs only 4.2% of the time, as the Department of Game and Inland Fisheries also points out (see item 1(b), above). This flow rate equals 5.4% of the River's mean annual flow (MAF) at the dam. Under the Tennant rating system, a stream flow of between 0 and 10% of MAF is rated as "severe degradation." Unlike natural drought, which is temporary, the addition of another generating unit which increases the consumptive loss from the watershed would create nearly perennial conditions of severe degradation every fall. For this reason, DEQ's Office of Wetlands and Water Protection is requesting additional studies; see "Additional Analysis Needs," items 1 and 2, below.

The addition of a fourth unit would cause a net loss of 35 additional cfs, according to DEQ's Northern Virginia Regional Office. This would bring the operating level of the lake down to 242 feet MSL, which is 6 feet lower than the target level at which the lake contingency plan currently goes into effect.

(d) Regulatory Authority under the Virginia Water Protection Permit Program. The Application and the request for concurrence with the consistency certification both fail to describe correctly the applicability of State laws and regulations pertaining to water withdrawals. Table 1.2.1 indicates that the Virginia Water Protection Permit regulation, 9 VAC 25-210, is only necessary for "discharge of dredge, fill, or pollutants into surface waters." In fact, since 2000, a wider range of activities in surface waters has been covered by this program, including water withdrawals in particular. Secondly, the attachment listing programs for coastal zone management consistency fails to make the connection, saying only that permits under *Virginia Code* section 62.1-44.15:5 are required to excavate in a wetland. These regulatory authorities should be clarified in the new submission of the federal consistency certification as well as in the license application and Draft EIS.

(e) Timing of NRC Action in relation to Virginia Water Protection Permit. DEQ's Office of Wetlands and Water Protection recommends that because of the lack of abundant water resources in the Lake Anna watershed and the possibility that a Virginia Water Protection Permit may not be issued, the Nuclear Regulatory Commission should consider one of the following:

- Do not issue the Early Site Permit until Dominion receives a Virginia Water Protection Permit; or

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- Require that Dominion obtain a Virginia Water Protection Permit prior to conducting any work specified in the site redress plan associated with the Early Site Permit.

3. Non-point Source Water Pollution Control. Utility companies that undertake land-disturbing activities of 10,000 square feet or more for construction, installation, and maintenance of power lines (including essential supporting activities inside and outside the utility easement, such as sub-stations, staging areas, access roads, and borrow/spoil areas) must file general erosion and sediment control specifications annually with the Department of Conservation and Recreation's Division of Soil and Water Conservation for review and approval in accordance with the Virginia Erosion and Sediment Control Law (*Virginia Code* section 10.1-563.D.). All regulated activities must comply with the Erosion and Sediment Control specifications, irrespective of whether work is undertaken on company property or on an easement owned by another party (including VDOT right-of-way).

Construction of company buildings, facilities, and other structures are not regulated by section 10.1-563.D., and must therefore comply with the requirements of the appropriate local program. Dominion should contact Louisa County (David Fisher, Soil and Water Conservation Director, telephone (540) 967-0401) to ensure compliance with applicable local requirements.

Erosion and Sediment Control specifications should include, at a minimum, a description of all measures and policies that will be implemented on the project site to ensure compliance with the state program. Standard practices (general narrative and plan sheets with appropriate details and symbols) must be provided that meet the requirements of the 19 Minimum Standards in the Virginia Erosion and Sediment Control Regulations (see 4 VAC 50-30-40) that apply. Practices in the most current edition of the *Virginia Erosion and Sediment Control Handbook* must serve as minimum design criteria. Variance requests (especially those for MS-16, Trench Length) must be submitted for approval on a project-specific basis to ensure that site characteristics (soils, topography, adjacent areas) are fully considered.

Specifications covering all planned regulated activities for a given calendar year must be approved by the Department of Conservation and Recreation's Division of Soil and Water Conservation prior to initiation of the project. Questions may be addressed to the Division's central office (Lee Hill, telephone (804) 786-3998).

4. Point Source Water Pollution Control. As indicated above (item 2(b)(i)), the impingement and entrainment issue will fall under the new regulations pursuant to Section 316(b) of the Clean Water Act and be addressed in the facility's Virginia Pollutant Discharge Elimination System (VPDES) permit. Whether the new unit would

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be treated as an existing intake or a new intake under the section 316(b) regulations is not yet clear. (See "Regulatory and Coordination Needs Summary," item 1, below.)

5. Air Pollution Control.

(a) Permitting Requirements. According to DEQ's Northern Virginia Regional Office, the project does not appear to require any air pollution control permits at this time. In light of the fact that the Application mentions concrete batch plants, however, we recommend that Dominion verify this "no permits required" conclusion with DEQ's Northern Virginia Regional Office (John Bowden, telephone (703) 583-3880) following completion of the design phase of the project.

(b) Fugitive Dust Rules. The Application did not indicate a commitment to abide by fugitive emissions rules. During construction, fugitive dust must be kept to a minimum by using control methods outlined in 9 VAC 5-50-60 et seq. of the Regulations for the Control and Abatement of Air Pollution. These precautions include, but are not limited to, the following:

- Use, where possible, of water or chemicals for dust control;
- Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials;
- Covering of open equipment for conveying materials; and
- Prompt removal of spilled or tracked dirt or other materials from paved streets and removal of dried sediments resulting from soil erosion.

(c) Open Burning Rules. If project activities include the burning of construction or demolition material, this activity must meet the requirements of the Regulations for open burning (9 VAC 5-40-5600 et seq.), and it may require a permit. The Regulations provide for, but do not require, the local adoption of a model ordinance concerning open burning. The applicant should contact Louisa County officials to determine what local requirements, if any, exist. The model ordinance includes, but is not limited to, the following provisions:

- All reasonable effort shall be made to minimize the amount of material burned, with the number and size of the debris piles;
- The material to be burned shall consist of brush, stumps and similar debris waste and clean burning demolition material;
- The burning shall be at least 500 feet from any occupied building unless the occupants have given prior permission, other than a building located on the property on which the burning is conducted;
- The burning shall be conducted at the greatest distance practicable from highways and air fields;

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- The burning shall be attended at all times and conducted to ensure the best possible combustion with a minimum of smoke being produced;
- The burning shall not be allowed to smolder beyond the minimum period of time necessary for the destruction of the materials; and
- The burning shall be conducted only when the prevailing winds are away from any city, town or built-up area.

Advisory Policies and Other Environmental Issues

1. Natural Heritage Resources. The Department of Conservation and Recreation has searched its Biotics Data System for occurrences of natural heritage resources in the project area. "Natural heritage resources" are defined as the habitat of rare, threatened, or endangered plants and animals, unique or exemplary natural communities, significant geologic formations, and similar features of scientific interest. The Department of Conservation and Recreation (DCR) reports that natural heritage resources have not been documented in the project area.

The Department of Agriculture and Consumer Services (VDACS) has responsibility for state-listed endangered or threatened plant and insect species. VDACS indicates that the data bases maintained by the Department of Game and Inland Fisheries and the U.S. Fish and Wildlife Service, with whom Dominion consulted concerning endangered species, have incomplete records of state-protected plant and insect species. Recent changes in regulations implementing the Virginia Endangered Plant and Insect Species Act will necessitate further review of the project by VDACS or by DCR's Natural Heritage Division.

Under a memorandum of agreement between the Department of Conservation and Recreation and the Department of Agriculture and Consumer Services, DCR represents VDACS in commenting on potential impacts on state-listed threatened and endangered plant and insect species. According to DCR's records, the proposed project would not affect any documented state-listed plants or insects.

2. Recreation Impacts. The increased water withdrawal needed for new generating units would be likely to reduce lake levels during the summer and fall due to increased power plant demand and evaporation. Most of the 43,000 anglers visiting this important recreational lake every year use the ramps at the State Park or those belonging to commercial operators to gain access to the Lake. Pleasure traffic greatly exceeds angler traffic, by as much as 10 to 15 times according to DGIF wardens. Increased drawdowns proposed to serve the new units would adversely affect lake access, and local economic conditions in the process. For example, during the 2002 drought, the reservoir pool dropped from 250 feet above mean sea level to 245.1 feet, and most boat ramps could not support launches. If the third generating unit had been added in that situation,

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the drawdown would have been an additional 2.5 feet, or 242.6 feet MSL. The Draft EIS should provide a full analysis of the impacts of the proposed units upon Lake recreation, along with an analysis of potential mitigation of such impacts. The analysis should include the time of year (presumably in the fall) that drawdowns occur (see "Additional Analysis Needs," item 3, below).

The project may affect the views from across the Lake as well as from Route 76, the interstate bicycle route. Designs for development of the proposed site should include efforts to minimize these visual impacts, according to the Department of Conservation and Recreation.

3. VPDES Stormwater General Permit Applicability. According to DEQ's Northern Virginia Regional Office, the disturbance of approximately 200 acres of land on the south side of Lake Anna for the proposed project will necessitate permit coverage under the Virginia Pollutant Discharge Elimination System (VPDES) permit for stormwater discharges associated with construction activity. Questions on fulfillment of this requirement may be addressed to DEQ's Northern Virginia Regional Office (John Bowden, telephone (703) 583-3880).

4. Solid and Hazardous Waste Management. The Application addressed solid and hazardous waste issues, but did not include a search of waste-related databases, according to DEQ's Waste Division. The Waste Division did a cursory review of its data files and did not find any contamination sites that might affect or be affected by the proposed project.

Any soil that is suspected of contamination, or wastes that are generated, must be tested and disposed of in accordance with applicable federal, state, and local laws and regulations. These include, but are not limited to, the Virginia Waste Management Act (*Virginia Code* sections 10.1-1400 et seq.), the Virginia Hazardous Waste Management Regulations (9 VAC 20-60), and the Virginia Solid Waste Management Regulations (9 VAC 20-80). (For additional citations, see the enclosed DEQ memo, Modena to Irons, dated January 29, 2004).

The Application addressed pollution prevention. DEQ encourages Dominion to implement pollution prevention principles in all projects, including the reduction of waste materials at the source, re-use of materials, and recycling of waste materials.

5. Alternatives Discussion. As mentioned above, the Draft EIS should demonstrate consideration and analysis of a single new unit with a cooling tower and Lake Anna as a water source (see "Federal Consistency...," items 1(e) and 2(b)(ii), above). Moreover, it should consider alternatives to the entire proposal as a means of

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ensuring that significant environmental impacts do not occur to the fishery resources in and downstream of Lake Anna (see "Federal Consistency...," item 1(e), above).

6. Local and Regional Concerns. The Thomas Jefferson Planning District Commission considered this review at its regular meeting on January 8, 2004. The Commission had no comment on the project.

Additional Analysis Needs

1. Downstream Flows. DEQ's Office of Wetlands and Water Protection recommends that a range of variability study be performed, comparing the pre- and post-project Index of Hydrologic Alterations for the North Anna River immediately below the dam. The methodology for conducting such a study may be found at:

http://www.conserveonline.org/2000/12/a/en/iha_meth.pdf

DEQ's Office of Wetlands and Water Protection is interested in whether and to what extent the pre- and post-project conditions are different for the 90-day minima, creating long-term low-flow stress conditions. The range of variability analysis may not show a significant change in pre- and post-project conditions. The minimum flow release (20 cfs) is above the extreme minimum flows experienced by the river in its natural pre-dam state in the 1930 drought and similar to low flows in the 1933 drought. However, the full range of the record needs to be examined.

In addition, DEQ's Office of Wetlands and Water Protection is interested in whether the Lake and reactors have significantly changed the Julian date of annual maxima which could affect spring spawning. It is possible that the watershed and wintertime stream flows are large enough that the Lake returns to a full condition each spring, and the Julian date of annual maxima is not changed by the power plants, but the simulation modeling and range of variability analysis should be done to confirm this.

Performance of these statistical studies does not require field work, so they could be initiated immediately, and the results reported in the Draft Environmental Impact Statement ("Draft EIS").

2. In-stream Studies: Usable Habitat as a Function of Flow. DEQ's Office of Wetlands and Water Protection may also recommend further in-stream studies as a supplement to the Draft EIS or as pre-requisite to any permit issuance, depending on confirmation of the concerns expressed above regarding near-perennial low-flow conditions (see "Federal Consistency...," item 2(c), above). This work should characterize weighted usable habitat as a function of flow for the indigenous fishery species in the North Anna River.

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DEQ's Office of Wetlands and Water Protection requests the daily output of the simulation models used by Dominion, if it is available in Excel worksheet format, to predict the frequency and duration of the lake drawdown, inflows, evaporation losses, and outflows that were used to develop Tables 5.2.3 and 5.2.4 in the Application.

A statistical analysis of the indicators of hydrologic alteration should be performed, and the results presented in the Draft EIS, according to DEQ's Office of Wetlands and Water Protection.

3. Impact on Recreational Uses of Lake Anna. The Application does not thoroughly address the water-based recreational uses of Lake Anna. While Table 5.2.4. demonstrates the frequency with which the Lake will fall below certain levels (see "Federal Consistency...," item 2(c) and "Advisory Policies...," item 2, above), we do not know the time of year this occurs and what impact it has on lake recreation. This information should be developed for the Draft EIS for the proposed project.

4. Submerged Intake Structure. The Department of Game and Inland Fisheries (DGIF) recommends that Dominion investigate further the addition of a submerged intake structure (a curtain wall as detailed on page 3-5-38 of the Application that would reduce fish impingement and entrainment and align the intake criteria with current DGIF recommendations (see "Federal Consistency...,"item 1(a), above). Results of this analysis should be provided in the Draft EIS for this project.

5. Federal Consistency Certification. Dominion's re-submission of the federal consistency certification may be accomplished separately or, as we would recommend, in conjunction with either the Draft or the Final EIS for this project but would, in any case, be subject to the requirements applicable to consistency certifications for federally licensed projects. These appear in the Federal Consistency Regulations at Title 15, Code of Federal Regulations, Part 930, sub-part D ("Consistency for Activities Requiring a Federal License or Permit," sections 930.50 through 930.66). The new consistency certification should reflect not only further development of the project proposal, but also appropriate additional analysis as detailed in this letter. Questions on consistency may be addressed to this Office (Charles Ellis, telephone 698-4488).

6. Draft Environmental Impact Statement. Although not required to satisfy the Federal Consistency Regulations, for administrative purposes we recommend that the federal consistency certification be submitted at the same time as the Draft EIS. This would allow for concurrent reviews of the two documents, and the information and analysis in the Draft EIS can support the analysis of the consistency certification. If you have questions about the interplay of the Draft EIS and the consistency certification requirement, please feel free to contact me at telephone 698-4325.

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Regulatory and Coordination Needs Summary

1. Water Resources Permitting. As indicated previously, the proposed addition of either one or both of the proposed new generating units at the North Anna Power Station will require Virginia Water Protection Permits and, to the extent the land disturbance exceeds one acre, VPDES Stormwater General Permit coverage for construction activities. For water withdrawals requiring Virginia Water Protection Permits, Dominion must apply to DEQ's Office of Wetlands and Water Protection (Joe Hassell, telephone 698-4072). Results of the studies requested or recommended in regard to water resources (see "Additional Analysis Needs," items 1 and 2, above) should be submitted to that Office at 629 East Main Street, 9th floor, Richmond, Virginia 23219, Attn: Joseph P. Hassell. Copies of these study results should be submitted to the Department of Game and Inland Fisheries, attn: Gary Martel (Director, Fisheries Division), 4010 West Broad Street, Richmond, Virginia 23230.

For land disturbance involving one acre or more, Dominion should apply to DEQ's Northern Virginia Regional Office (John Bowden, Deputy Regional Director, telephone (703) 583-3880) for coverage under the VPDES Stormwater General Permit for construction activities. Similarly, the issue of impingement and entrainment effects is to be addressed under new regulations implementing section 316(b) of the Clean Water Act; advice on this matter may be obtained from the same Office or from DEQ's Office of Wetlands and Water Protection (Joe Hassell, telephone (804) 698-4072).

2. Air Permitting. Questions relating to air quality rules and air permitting, for activities ranging from open burning to operation of concrete batch plants or other fuel-burning equipment, should be addressed to DEQ's Northern Virginia Regional Office (Mr. Terry Darton, Air Permits Manager, telephone (703) 583-3845).

3. Erosion and Sediment Control; Stormwater Management. Questions relating to the fulfillment of the Erosion and Sediment Control Plan and Stormwater Management Plan requirements should be addressed to the Department of Conservation and Recreation's Soil and Water Conservation Division (Lee Hill, telephone 786-3998). Questions on fulfillment of local erosion control requirements should be addressed to Louisa County (David Fisher, Soil and Water Conservation Director, telephone (540) 967-0401).

Ms. Pamela F. Faggert
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We hope this information is helpful to you.

Sincerely,

Ellie L. Irons
Program Manager
Office of Environmental Impact Review

Enclosures

cc: Michael P. Murphy, DEQ
Joseph P. Hassell, DEQ-Water
John B. Bowden, DEQ-NVRO
Jeffrey Talbott, DEQ-NVRO
Kotur S. Narasimhan, DEQ-Air
Thomas D. Modena, DEQ-Waste
Gary Martel, DGIF
Keith R. Tignor, VDACS
Derral Jones, DCR
Catherine M. Harold, CBLAD
Gerald P. Wilkes, DMME
Alan D. Weber, VDH
Rochelle Garwood, Thomas Jefferson PDC
David Fisher, Louisa County
C. Lee Hill, DCR-DSWC
Andrew J. Kugler, USNRC
Jud White, Dominion
Tony Banks, Dominion

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JAN 29 2004

DEQ-Office of Environmental Impact Review

COMMONWEALTH of VIRGINIA

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

Department of Game and Inland Fisheries

William L. Woodfin, Jr.
Director

January 27, 2004

Ms. Ellie Irons
Program Manager
Office of Environmental Impact Review
Virginia Department of Environmental Quality
629 East Main Street, 6th Floor
Richmond, VA 23219

Dear Ms. Irons:

I am responding to your November 6, 2003 request for comment on the North Anna Early Site Permit (ESP) Application. Staff members have reviewed pertinent portions of the ESP submitted to the Nuclear Regulatory Commission (NRC) for development of an Environmental Impact Statement to satisfy National Environmental Policy Act (NEPA) requirements.

Fish community impacts to Lake Anna and the North Anna River and public access to Lake Anna are the primary concerns of the Department of Game and Inland Fisheries (DGIF) relating to this proposal. The operation of the two additional nuclear power units (numbers three and four) is expected to result in: (1) water withdrawal increases from the reservoir, (2) water temperature increases in the reservoir, and (3) decreased flows in the North Anna River. These issues and other concerns are discussed below.

Water withdrawal increases to accommodate a third and fourth nuclear unit present biological complications for fish populations through increased fish impingement and entrainment. Annual estimated fish impingement of six "representative important species" with build-out (defined herein as the addition of a third "once-through" and a fourth "cooling tower" unit) is 426,887 fish including 4,441 striped bass, a leading Lake Anna sportfish stocked annually by DGIF. With the proposed intakes, the number of fish impinged would increase by 230% over current levels. Estimated impingement mortality of striped bass would nearly double as the result of build-out; however, the size and age distributions of impinged fish were not provided. The number of fish entrained is expected to increase in a similar fashion with an estimated 468,886,689 fish (from the applicant's six-species category) lost annually – including about 63% gizzard shad. Existing intake criteria at North Anna Power Station (velocity of 0.7 feet per second [FPS] and screen mesh of 9.5 mm) substantially exceed our current recommendations of 0.25 FPS and 1 mm mesh. Even our current recommendations are not expected to provide full resource protection but utilize current state-of-the-art technology. The existing screen would be expected to only exclude compressed fish such as sunfish larger than 50 mm and elongated fish

4010 WEST BROAD STREET, P.O. BOX 11104, RICHMOND, VA 23230-1104
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1 Ms. Ellie Irons
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January 27, 2004

such as stripers and largemouth bass larger than 86 mm. Thus, it seems appropriate for the applicant to further investigate the addition of a submerged intake structure (curtain wall as detailed on page 3-5-38) to reduce fish impingement and entrainment and align intake criteria with current DGIF recommendations.

Water withdrawal increases are also likely to result in lower lake levels during summer and fall months due to increased power plant demand and evaporation. Lake Anna is an important recreational fishery, and most of the estimated 43,000 anglers annually access the reservoir by boat from one of the many commercial ramps or via the State Park. Pleasure boat traffic greatly exceeds angler traffic, and proposed increased drawdowns could have a deleterious impact on lake access (thereby impacting local economic conditions). For example, during the drought of 2002, the reservoir pool dropped from 250' MSL to 245.1' MSL, and most ramps could not support launches. With the addition of the third unit, the drawdown would have been an additional 2.5'. Estimates from our Wardens are that recreational boating is 10-15 times that of fishing boating. The Early Site Permit review needs to fully analyze impacts and discuss potential mitigation for impacts on recreational boating.

Addition of one to two new units will have significant impacts on downstream resources by reducing flow and the frequency of higher flows. The current minimum release is 40 cubic feet per second (CFS) with 20 CFS during drought periods. Drought releases are triggered when the lake declines to elevation 248' MSL. Current minimum releases are about 10% of mean annual flow and drought releases are about 5% of mean annual flow. It is apparent from the water budget that significant changes in the flow regime have occurred with significant increases in the time flows are under 100 CFS. Preliminary analysis of drought flow frequency indicates that prior to dam construction, flows less than 20 CFS occurred only 4.2% of the time, occur now at 5.3%, and would be expected to increase with one more unit to 11.8%. A fourth unit would increase that occurrence even more, but Unit 4 fails to be addressed in the flow analysis. It is highly unlikely that an outside source of water will be used for unit 4, and its water consumption should be addressed as if water were being withdrawn from the lake (or Unit 4 should not be part of the permitting process). We recommend use of the Index of Hydrologic Analysis to compare pre-lake, current and predicted flow conditions based upon the addition of units three and four. This will quantify the changes in the hydrologic regime.

Changes in the hydrologic regime would be expected to impact the downstream aquatic resource. A common desktop method for flow recommendations is the Tennant method. Resource agency flow recommendations using that method generally are in the range of 20-30% of mean annual flow for the summer and higher levels (60-100% MAF) for the spring spawning period. Recommendations using this method would yield summer flows in the range of 74 to 111 cfs for resource protection. Current minimum releases would be rated in the poor to

1 Ms. Ellie Irons
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degraded range of resource protection. Since this is an over allocated resource, we recommend quantifiable procedures than the Tennant desktop method. An Instream Flow Incremental Methodology study should be conducted for the impacted downstream reaches. Such a study should include evaluation of a habitat time series (pre-project, current and proposed) for native and naturalized species and may result in a recommendations for different flow operating rules than currently exists for the downstream resource.

Water temperature increases predicted to occur as a result of build-out will likely impact fish habitat in Lake Anna and in the North Anna River. Probably the greatest issue is the potential decrease in striped bass habitat within the reservoir. The applicant documented the current situation and available literature concerning the phenomena of striped bass "habitat squeeze" in southeastern reservoirs (the impacts of summer thermal stratification patterns on the habitat needs of adult striped bass) on pages 3-5-55 to 3-5-58. Current conditions (temperature and oxygen stratification patterns) at Lake Anna limit the potential of this fishery but have not resulted in catastrophic fish kills to date. Adult striped bass grow slowly, exhibit reduced fitness (condition) and have low maximum sizes as a result of the marginal habitat conditions now present, but an important recreational fishery within this habitat capacity has developed. However, it is likely that even a small increase in reservoir water temperature would have a dramatic effect – further reducing already limited habitat and perhaps jeopardizing the entire striped bass fishery. The maximum daily surface temperature is expected to increase by 7.2°F near the dam. Currently, the lake frequently does not stratify, and when it does; many times it is a weak stratification. Total temperature differences (top to bottom) in many cases were less than 1°C based on DGIF samples taken during late summer and early fall at lower reservoir sites. Stratification patterns dictate striped bass habitat and are subject to a great deal of variability at Lake Anna – a horizontal and vertical increase in the thermal plume would exacerbate a currently tenuous situation.

Reconfiguring the flow within the WHTF to allow for more efficient cooling (e.g., forcing water to use the entire WHTF by sealing the lower tributary arm between Elk Creek and Millpond Creek and cutting a canal through the headwater areas) would expand the residence time within the WHTF and probably reduce thermal impacts to Lake Anna and the North Anna River. Conflicting information was provided concerning efficiency and water residence time in the WHTF: a figure of 14 days was listed on page 3-2-71, while a figure of seven days was listed on page 3-5-42.

Additional comments concern several inconsistencies in the applicant's report. The proposed fourth unit was addressed repeatedly throughout the document as a "closed-cycle cooling water system" using towers (either wet or dry); however, on page 3-5-45 a reference is made to this unit under "Scenario 3" as a once-through cooling system (e.g., a fourth once-

Ms. Ellie Irons
January 27, 2004
Page 4

through unit). This reference is particularly disconcerting since no evaluations of the dramatic increase in water consumption and heat output under this scenario were discussed. In short, it appeared the possibility of a fourth once-through unit was never mentioned either before or after this point, and no review of its environmental impact was made. Frequent references were also made throughout the document to "make-up water" replacing water lost from the cooling processes originating "from an outside source", but these sources were not readily apparent. It seems likely that "outside sources" would likely either be surface or subsurface draws from within the Lake Anna watershed exacerbating the proposed aquatic impacts. A great deal of importance was placed on the Lake Anna water budget, and a key component of this equation was reservoir inflow. This variable was estimated due to an absence of stream gauges and real data, and 370 CFS was presented in Table 5.2-1. This figure was referenced from a model in Section 5.2.2, but no calculations were given with 370 CFS as a derivative. Thus, the figure's origin remains unclear.

Due to the scope and magnitude of aquatic resource impacts anticipated with build-out, it seems prudent to investigate alternatives to the heavily consumptive proposal of another once-through system and a new wet cooling tower.

I hope that this information is helpful as you contemplate license renewal at North Anna Power Station. Please do not hesitate to contact either John Odenkirk (540-899-4169) or John Kauffman (434-296-4731) of my staff if we can be of further assistance.

Sincerely,

Gary Martel
Director, Fisheries Division

cc: J. W. Kauffman
J. S. Odenkirk
D. K. Whitehurst
W. L. Woodfin, Jr.

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JAN 15 2004

DEQ-Office of Environmental Impact Review

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

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Mailing address: P.O. Box 10009, Richmond, Virginia 23240
Fax (804) 698-4500 TDD (804) 698-4021
www.deq.state.va.us

Robert G. Burnley
Director
(804) 698-4000
1-800-592-5482

Subject: North Anna Early Site Permit Coastal Zone Consistency Determination

To: Ellie Irons

From: Joseph P. Hassell *Joseph P. Hassell*

Copies: Mike Murphy, Larry Lawson, Terry Wagner, Ellen Gilinsky, DEQ; John Davy, DCR; Charlie Sledd, DGIF

Date: January 15, 2004

I. Summary

The Office of Wetlands and Water Protection and the Division of Water Resources have reviewed the Early Site Permit (ESP) Application. We believe that it is premature to concur that the issuance of this ESP would be consistent with Virginia's Coastal Zone Management Program nor does the application currently form an adequate basis for the preparation of an Environmental Impact Statement by the Nuclear Regulatory Commission (NRC). Additional studies on the impacts to instream beneficial uses from consumptive loss of water by one or both reactors would be required to adequately assess the environmental impacts of the project, particularly the impacts to the recreational use of the lake and the impacts to water quality and aquatic life downstream of Lake Anna within the North Anna River.

II. Background

Dominion Power filed an ESP application with the NRC to add two units to the North Anna Power Station. The NRC determines whether or not the site is suitable for constructing new reactors using an ESP. Permits are issued for 10 to 20 years and can be renewed for 20 years. Environmental issues are addressed as part of the ESP, independent of any review of any specific reactor design. The ESP process uses a Plant Parameters Approach, which postulates an envelope of possible reactor designs. Dominion is considering seven different designs. In this application Dominion has postulated a maximum of two reactors of up to 4300 megawatts each of rated thermal capacity. That is an extremely large outside envelope. The two reactors that Dominion formerly proposed but then cancelled each had a rated electrical capacity of 907

- 1 -

1 **North Anna Early Site Permit Coastal Zone Consistency Determination (continued)**

megawatts. Dominion postulates that the first new unit would use once through cooling. The second new unit would use a cooling tower. Issues resolved with finality under the ESP (including environmental issues) are not reexamined in any subsequent licensing action by the NRC. The ESP does not approve a particular reactor design nor allows the construction of the reactor. The ESP authorizes construction of all of the items identified in the site redress plan, in this case site clearing, foundations, intake structures and outfall structures. Dominion has requested that NRC issue the permit for 20 years (the maximum) and allow land clearing, stream filling and intake structure construction to proceed under the site redress plan.

III. Unit 4

Unit 4 is included in the ESP application, yet Dominion does not identify a source of water for Unit 4. NRC regulation, 10 CFR 51.29 requires that "information provided to the Commission by an applicant for a license,..., shall be complete and accurate in all material respects". For Early Site Permit Applications NRC regulation 10 CFR 52.17 (v), requires information on "types of cooling system intake and outflows for each facility" (emphasis added) Because no water source is identified in the ESP application, it is not possible to form an opinion on the prospects for approval of such a project or whether it would be consistent with State laws and regulations. The logical water source for Unit 4 would be Lake Anna. Groundwater resources are not capable of producing the large quantities of water needed, nor does there appear to be any surface water source nearby other than Lake Anna. The inclusion of Unit 4 should be withdrawn from the application unless its water source(s) and related cumulative impacts are identified. If Dominion leaves Unit 4 in the application, but does not identify a water source, then the NRC should consider denying the application for any site redress work associated with Unit 4

If the source of water for Unit 4 were Lake Anna, the additional heat load and evaporative losses would result in deeper and lengthier drawdown periods on the Lake and longer periods of low instream flows in the North Anna River. Although no analysis of the additional impacts have been provided, given the small watershed with average runoff of only 370 cfs, there is a good probability that the additional cumulative impact of a fourth unit would have an unacceptable impact on Lake Anna and the North Anna River.

IV. Coastal Zone Management Act Consistency

An applicant for a federal Permit or license shall provide in the application a certification that the proposed activity complies with the enforceable policies of the State approved program. The decision by Dominion to seek CZM consistency was appropriate. Although the power plant is located outside of the Coastal Zone proper, operation of the power plant will have a direct effect on the Coastal Zone because it will diminish instream flow on the North Anna River which is suitable anadromous fish habitat.

The Virginia Water Protection Permit is an enforceable part of the Virginia's Coastal Zone Management Program. The State Water Control Board issues Virginia Water Protection Permits

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North Anna Early Site Permit Coastal Zone Consistency Determination (continued)

for projects impacting state waters if it has determined that the proposed activity will protect instream beneficial uses. The preservation of instream flows for purposes of the protection of fish and wildlife resources and habitat and recreation values is a beneficial use of Virginia's waters. These uses are present in both Lake Anna and downstream in the North Anna and Pamunkey Rivers. Conditions contained in a Virginia Water Protection Permit may include, but are not limited to, the volume of water which may be withdrawn as a part of the permitted activity. (§62.1 44:15.5 C, Code of Virginia).

The issuance of a permit for an additional unit of the size envisioned would constitute the approval of the single largest consumptive withdrawal ever considered in the history of the Virginia Water Protection Permit Program. This consumptive withdrawal would be from a water body with an average annual flow of 370 cubic feet per second. The typical recommendation that we receive from the Department of Game and Inland Fisheries is not to allow cumulative consumptive use to exceed 10% of the river's flow. The lake's current evaporation rate and the existing two units already surpass that mark much of the time. Therefore granting of additional withdrawals, even with prescriptive conditions, can not be guaranteed.

For the above reason, the Office of Wetlands and Water Protection recommends that Dominion withdraw their request for Coastal Zone Management Program consistency at least until such time as a draft environmental impact statement is available. If Dominion does not withdraw the request, then we cannot agree with Dominion's certification that the proposed activity is in compliance with the enforceable policies of Virginia Coastal Zone Management Program, due to a lack of information to make that determination. Dominion could definitively resolve the issue by applying for a permit for the proposed withdrawal. VWP Permits for water withdrawals have long durations and are granted for up to a 15-year term.

V. Water Quantity Issues:

For the purpose of this discussion we will assume only one unit is proposed, because as we have noted earlier, the second unit, unit 4, has no identifiable water source.

The addition of Unit 3 will affect water resources by increasing the frequency and duration of drawdown on Lake Anna and increasing the frequency and duration of low flow downstream. According to Table 2.4.6 in the ESP, the amount of time that Lake Anna would drop two feet or more will increase from 5.6 % of the time to 11.6 % of the time. Assuming the modeling is correct and assuming the current minimum low flow release stays the same, this will increase the amount of time that flow in the North Anna below the dam is equal to 20 cfs to 11.6% of the time. Under pre-dam conditions dam (1929-1971), streamflow in the North Anna River below the dam was 20 cfs or less only 4.2 % of the time. That statistic is based on streamflow records from USGS North Anna near Doswell gage adjusted to reflect the smaller drainage area at the dam site.

North Anna Early Site Permit Coastal Zone Consistency Determination (continued)

The State Corporation Commission set the original minimum release for the North Anna dam in 1969. The State Water Control Board proposed 80 cfs. The Attorney General in 1971 opined that because of the language of the Water Power Act §62.1 – 82, the State Corporation Commission was the appropriate authority to set such a release, and that the SWCB itself could not set a higher rate. In response to the drought of 1989-2002 and complaints about low water levels by lake front property owners, legislation was created that required the development of lake level contingency plans in VPDES permits that contained minimum releases for impoundments whose primary purpose was cooling water. This legislation applies only to Dominion and Lake Anna. Thus, the 40 cfs figure that the State Water Control Board did not think was sufficient in 1971 to protect downstream water quality has been cut in half by the lake level contingency plan whenever the lake level falls to 248.0 feet above mean sea level.

A minimum release of 20-cfs equals 5.4 % of the North Anna River's mean annual flow at the dam. Donald Tennant, a U.S. Fish and Wildlife Service fishery biologist, devised a well known rating system based on percentages of mean annual flow. In the Tennant rating system, a streamflow of 0% to 10 % of the mean annual flow is rated as "severe degradation". Unlike natural drought which is temporary, our concern is that with the addition of another unit, which is expected to increase the consumptive loss from the watershed by another 39 cfs, nearly perennial conditions of severe degradation will likely be created each fall. Accordingly we are requesting that Dominion perform additional statistical studies to determine whether these concerns have merit.

A range of variability study should be performed comparing the pre and post project Index of Hydrologic Alterations for the North Anna River immediately below the dam. The following URL address contains a methodology for conducting such a study:

http://www.conserveonline.org/2000/12/a/en/iha_meth.pdf

We are particularly interested in whether or not and to what extent the pre- and post- project conditions are different for the 90-day minima, thereby creating long-term low flow stress conditions. It is quite possible that the range of variability analysis will not show a significant change in pre- and post- project conditions. The minimum flow release (20 cfs) is above the extreme minimum flows experienced by the river in its natural pre-dam state in the 1930 drought and similar to low flows in the 1933 drought. However the full range of the record needs to be examined.

We are interested in whether or not the lake and reactors have significantly changed the Julian date of annual maxima which could impact spring spawning. It is possible that the watershed and winter- time stream flows are large enough that the lake returns to a full condition each and every spring and the Julian date of annual maxima is not changed by the power plants, but the simulation modeling and range of variability analysis should be done to confirm this.

1 **North Anna Early Site Permit Coastal Zone Consistency Determination (continued)**

We note that the performance of these statistical studies does not require field work, so they could be initiated immediately and hopefully the results reported in the draft environmental impact statement.

Pending the results of a range of variability study we might recommend further instream work as a supplement to the draft environmental impact statement or prior to the issuance of any permits. If our concerns regarding near perennial chronic low flow conditions are confirmed, we would recommend the performance of instream work to characterize weighted usable habitat as a function of flow for the indigenous fishery species of the North Anna River. We are not requesting these studies at this time but may request them in the future.

If it is available in Excel worksheet format we would appreciate being provided with the daily output of the simulation models used by Dominion to predict the frequency and duration of the lake drawdown, inflows, evaporation losses and outflows that were used to develop Table 5.2.3 and 5.2.4.

Another instream beneficial use that has not been thoroughly addressed by the ESP is how the additional consumptive use will affect the water-based recreational uses of Lake Anna. The most useful information appears in Table 5.2.4, which demonstrates the frequency with which the lake will fall below certain levels. What is not known is what time of year this occurs, presumably predominantly in the fall, and what impact this has on lake-based recreation.

VI. Impingement and Entrainment

A once through cooling process for Unit 3 will result in a significant number of aquatic organisms impinged (240,000) or entrained (148,000,000) annually. Normally, the Virginia Water Protection Permit is used to address this issue. However, in this case, because the intake is for cooling water and will not be built for some time, the impingement and entrainment issue will fall under the new Section 316(b) regulations and be addressed in the facility's VPDES permit. The Office of Water Permits and the Northern Regional Office will be the appropriate contacts. DEQ has had preliminary discussions with NRC and EPA on whether the new units would be treated as an existing intake or a new intake under the new 316(b) regulations. DEQ has not made a decision in this regard

Dominion proposes to first build Unit 3 as a once through cooling facility. Once through cooling represents a greater cost savings over cooling towers but will result in higher impingement and entrainment losses. On the positive side, once through cooling has lower consumptive loss per megawatt of electrical energy produced than the cooling towers because some of the heat in once through cooling is dissipated by processes other than pure evaporation.

Regardless of our ultimate decision on Section 316 (b), the use of a cooling tower may eventually be required, not just to reduce impingement and entrainment, but to keep the thermal conditions in the lake tolerable to aquatic life. DEQ's preference for once through cooling (to

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1 **North Anna Early Site Permit Coastal Zone Consistency Determination (continued)**

reduce consumptive use) will be balanced against the need to keep thermal conditions acceptable and to limit impingement and entrainment. Therefore, an alternative not considered in the ESP application, namely the construction of a single new reactor using a cooling tower with Lake Anna as it source water, may ultimately prove to be the least environmentally damaging practicable alternative. Such an alternative should be thoroughly explored in the draft EIS.

VII. Comments on Regulatory Authority under the Virginia Water Protection Permit Program

Both the ESP application (Table 1.2.1 Federal State and Local Authorizations) and the request for CZM concurrence attachment which lists the applicable programs fail to correctly characterize the applicability of State laws and regulations related to water withdrawals. Table 1.2.1 claims that the Virginia Water Protection Permit Regulation, 9 VAC 25-210 is only necessary for the "discharge of dredge, fill or pollutants into surface waters"; actually since 2000 a wider range of activities in surface waters have been covered by this program, and in particular the program regulates water withdrawals. Likewise the attachment listing programs for coastal zone management consistency fails to make this connection, saying only that permits under §62.1-44.15.5 are required to excavate in a wetland. The regulatory authority under the Virginia Water Protection Permit Program should be clarified in the application.

VIII. Timing Issues and License Term

Dominion Resources has requested that the NRC issue a permit for a maximum of 20 years. Under the regulation, NRC has the authority to issue a permit for a term of not less than 10 years nor more than 20 years. Due to the lack of abundant water resources in the basin and the possibility that a VWP permit would not be issued, we would recommend that the NRC consider the following possibilities in issuing an ESP:

- Do not issue the ESP until Dominion receives a VWP Permit, or,
- Require that Dominion obtain a VWP Permit prior to conducting any work specified in the site redress plan.

IX. Conclusions and Recommendations

The site is probably not suitable for the construction of two new nuclear reactors of the size proposed due to a lack of sufficient water resources. Two new reactors would remove an additional 78-cfs from a watershed that had an average flow of only 370 cfs even before the lake and the first two reactors were built.

The site may be suitable for the construction of one additional unit, however there is no guarantee that the appropriate permits could be obtained. We would recommend that Dominion Power seek a Virginia Water Protection Permit as early in the process as practicable to resolve water resource issues prior to investing large sums of money in site preparation.

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North Anna Early Site Permit Coastal Zone Consistency Determination (continued)

A request for concurrence with Coastal Zone Management Consistency should only be granted to the extent that the determination is given with the caveat that a Virginia Water Protection Permit would have to be obtained for the consistency determination to be valid. Probably the same qualifying statement can be applied to any necessary amendments to the VPDES permit to accommodate the additional thermal load on Lake Anna.

Additional instream flow studies would be needed before the DEQ would grant a permit to remove an additional 39-cfs from the Lake Anna Watershed. A statistical analysis that analyzes the indicators of hydrologic alteration should be performed and the results made available as a part of the preparation of the Draft Environmental Impact Statement.

If you cannot meet the deadline, please notify ELLIE IRONS at 804/698-4325 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

REVIEW INSTRUCTIONS:

A. Please review the document carefully. If the proposal has been reviewed earlier (i.e. if the document is a federal Final EIS or a state supplement), please consider whether your earlier comments have been adequately addressed.

B. Prepare your agency's comments in a form which would be acceptable for responding directly to a project proponent agency.

C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

MS. ELLIE IRONS
DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

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DEQ-Office of Environmental Impact Review

Ellie Irons
Ellie Irons, Program Manager
Environmental Impact Review

COMMENTS

Statements in the project document concerning endangered species were reviewed. The document references consultation with USFWS and DGIF on federal and state listed endangered and threatened species. Databases maintained by these agencies have incomplete records of state protected plant and insect species. Recent changes in regulation of the Virginia Endangered Plant and Insect Species Act would necessitate further review of this project by the Natural Heritage Division of DCR or VDACS.

(signed) Keith R. Tignor (Keith R. Tignor) (date) January 28, 2004

(title) Endangered Species Coordinator

(agency) VDACS, Office of Plant and Pest Service

PROJECT # 03-223F 8/98

1 February, 2004

MEMORANDUM

TO: Ellie Irons, OCS

FROM: Jeff Talbott, NVRO

COPY: Tom Faha, NVRO

SUBJECT: Early Site Permit Review – Virginia Power – North Anna Facility
VPDES No. VA0052451

Here are the main concerns that are not address in the Joe Hassell's memo. They are:
1) Water level in the cold side of the lake.
2) Water level in the hot side of the lake.
3) Temperatures in the hot and cold side of the lake.
4) Effects on down stream users.

The following are facts listed in the ESP report

Unit 3 will be once-through cooling water system and have the following effects:
- Increase the water temp would effect the both the hot and cold sides of Lake Anna
- The additional uptake of 29 cfs
- During drought conditions, this could result in the operating level of the lake at 245'. Stated in the report that with Unit 3 operational during the drought years of 1981 and 2002 the draw down would have been 1.5 to 2.5 feet greater. The 245' is 3' lower than the target 248' in which the lake contingency plan currently goes into effect. This will have a significant effect on the lake and it's uses.

Unit 4 will be a closed cycle cooling tower system and will have the following effects:
- A further increase in the water temp in both the hot and cold sides.
- The additional uptake of 44 cfs with 9 cfs being discharged back into the lake with a net lost of 35 cfs.
- During drought conditions, this would result in the operating level of the lake at 242'. The 242' is 6' lower than the target 248' in which the lake contingency plan currently goes into effect. This will have a huge effect on the lake and it's uses.

The following is a statement in the report: "the water supply for the lake can support the water supply needs for Unit 3 and 4 on a long-term average basis. On a short-term basis during drought conditions there may be periods when an additional source of water maybe required." There were also statements that this may effect the downstream users.

1 **Irons,Ellie**

From: Bowden,John
Sent: Friday, January 30, 2004 10:11 AM
To: Irons,Ellie
Subject: Consistency Certification #03-223F

NVRO comments regarding North Anna Early Site Permit (ESP) sponored by the Nuclear Regulatory Commission are as follows:

1. Wetlands and Water Permitting-NVRO concurs with comments by Joe Hassel, Central Office, and have coordinated this review with him.

2. Water Program Compliance-The project as described will involve land disturbance activities on approximately 200 acres of land located in Louisa County, Virginia, within the existing site of the North Anna Power Station on the south side of Lake Anna. VPDES permit coverage for stormwater discharges associated with construction activity will be required. Observance of state and local erosion and sediment control requirements should minimize short term impacts to surface water quality.

3. Air Program Compliance-The summary of the applicable regulatory framework for the proposed project discusses the attainment status of two areas: Louisa County and the Richmond Metro Statistical Area. NVRO will defer to Central Office on the accuarcy of the non-attainment discussion. While the report acknowledges in the introduction that theré are air regulatory issues related to construction (e.g., concrete batch plants), I see no discussion of the issue in detail, nor a commitment to abide by the relevant regulations pertaining to fugitive emissions.

4. Air Program Permitting-In the information package, it was stated that the facility would comply with all air permitting laws and regulation as they were derived from the Code of Federal Regulation and the Virginia Administrative Code. It went on to state the all appropriate applications would be provided once the design phase had been completed. Based on the information provided on the CD the Early Permitting Project does not require any air pollution control permits at this time.

John D. Bowden
Deputy Regional Director
Department of Environmental Quality
Northern Virginia Regional Office
(703) 583-3880
jdbowden@deq.state.va.us

1

RECEIVED

JAN 2 9 2004

Office of Environmental Impact Review

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 10009, Richmond, Virginia 23240
Fax (804) 698-4500 TDD (804) 698-4021
www.deq.state.va.us

Robert G. Burnley
Director

(804) 698-4000
1-800-592-5482

MEMORANDUM

TO: Ellie Irons

FROM: Thomas Modena TDM

DATE: January 29, 2004

COPIES: Kevin Greene

SUBJECT: Coastal Zone Management Consistency Certification
North Anna Power Station Early Site Permit

The Waste Division has reviewed the North Anna Power Station Early Site Permit Coastal Zone Management Consistency Certification, Louisa County. We have the following comments concerning waste issues associated with this project.

The report addressed solid and hazardous waste issues, but did not include a search of waste-related databases. The Central Office of the Waste Division did a cursory review of its data files, and did not find any sites that might impact or be impacted by this project.

Any soil that is suspected of contamination or wastes that are generated must be tested and disposed of in accordance with applicable Federal, State, and local laws and regulations. Some of the applicable state laws and regulations are: Virginia Waste Management Act, Code of Virginia Section 10.1-1400 *et seq.*; Virginia Hazardous Waste Management Regulations (VHWMR) (9VAC 20-60); Virginia Solid Waste Management Regulations (VSWMR) (9VAC 20-80); Virginia Regulations for the Transportation of Hazardous Materials (9VAC 20-110). Some of the applicable Federal laws and regulations are: the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Section 6901 *et seq.*, and the applicable regulations contained in Title 40 of the Code of Federal Regulations; and the U.S. Department of Transportation Rules for Transportation of Hazardous Materials, 49 CFR Parts 107, 171.1-172.558.

Finally, pollution prevention was addressed in the report. VDEQ encourages all construction projects and facilities to implement pollution prevention principles, including the reduction, reuse, and recycling of all solid wastes generated.

If you have any questions or need further information, please let me know.

1

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

Joseph H. Maroon
Director

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street
Richmond, Virginia 23219-2010
TDD (804) 786-2121

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JAN 07 2004
DEQ-Office of Environmental Impact Review

MEMORANDUM

Date: 2 January 2004

To: Ellie Irons, Virginia Department of Environmental Quality

Derral Jones

From: Derral Jones, Planning Bureau Manager

Subject: DEQ#03-223F: North Anna Early Site Permit (ESP), Nuclear Regulatory Commission

The Department of Conservation and Recreation (DCR) functions to preserve and protect the environment of the Commonwealth of Virginia and advocate the wise use of its scenic, cultural, recreation and natural heritage resources. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, state unique or exemplary natural communities, significant geologic formations and similar features of scientific interest.

DCR has searched its Biotics Data System for occurrences of natural heritage resources from the area outlined on the submitted map. According to the information currently in our files, natural heritage resources have not been documented in the project area. This absence of data may indicate that the project area has not been surveyed rather than confirm that the area lacks natural heritage resources.

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the Virginia Department of Conservation and Recreation (DCR), DCR represents VDACS in comments regarding potential impacts on state-listed threatened and endangered plant and insect species. The current activity will not affect any documented state-listed plants or insects.

New and updated information is continually added to Biotics. Please contact DCR for an update on this natural heritage information if a significant amount of time passes before it is utilized.

On page 5, under "Environmental Impacts", it indicates that the project will be undertaken in accordance with best management practices in the Virginia Erosion and Sediment Control

Conserving Virginia's Natural and Recreational Resources

Handbook. The applicant also needs to be aware that utility companies that undertake land-disturbing activities of 10,000 square feet or more for construction, installation, and maintenance of lines (including essential supporting activities within and outside the easement, such as substations, staging areas, access roads, borrow/spoil areas) must file general erosion and sediment control (ESC) specifications annually with DCR's Division of Soil & Water Conservation (DCR-DSWC) for review and approval in accordance with Section 10.1-563D of the Virginia Erosion and Sediment Control Law (VESCL). All regulated activities must comply with the ESC specifications, whether work is undertaken on company property or an easement (including VDOT right-of way) owned by another party. Construction of company buildings, facilities, and other structures are not regulated at Section 10.1-563D, and therefore, must comply with the requirements of the appropriate local ESC Program. ESC specifications should include, at a minimum, a description of all ESC measures and policies that will be implemented on site to ensure compliance with the state program. Standard practices (general narrative and plan sheets with appropriate details, symbols, etc.) must be provided that meet the requirements of the 19 Minimum Standards (MS) in Section 4VAC50-30-40 of the Virginia Erosion and Sediment Control Regulations (VESCR) that apply to company activities. Practices in the most current edition of the *Virginia Erosion & Sediment Control Handbook* must serve as minimum design criteria. Variances requests (especially those for MS-16, trench length) must be submitted for approval on a project-specific basis to ensure that site-specific characteristics (soils, topography, adjacent areas) are fully considered.

Company-specific specifications that cover all planned regulated activities for a given calendar year must be approved by DCR-DSWC prior to project initiation. Inquiries and questions regarding ESC specifications should be directed to Mr. C. Lee Hill in DCR's Central Office, at (804) 786-3998. *[Reference: VESCL§10.1-563.D; VESCR §4VAC50-30-30, §4VAC50-30-40]*

If the site is determined to be suitable, the potential exists for visual impacts to the view from across the lake as well as from Route 76, the interstate bicycle route. Designs for the development of the proposed site should make efforts to minimize these visual impacts.

Thank you for the opportunity to comment on this project.

1

DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF AIR PROGRAM COORDINATION

ENVIRONMENTAL REVIEW COMMENTS APPLICABLE TO AIR QUALITY

TO: Ellie Irons **DEQ - OEIA PROJECT NUMBER: 03 – 223F**

RECEIVED
DEC 19 2003
DEQ-Office of Environmental Impact Review

PROJECT TYPE: ☐ STATE EA / EIR / FONSI X FEDERAL EA / EIS ☐ SCC

X CONSISTENCY DETERMINATION/CERTIFICATION

PROJECT TITLE: NORTH ANN EARLY SITE PERMIT (ESP)

PROJECT SPONSOR: NUCLEAR REGULATORY COMMISSION

PROJECT LOCATION: ☐ OZONE NON ATTAINMENT AREA
☐ OZONE MAINTENANCE AREA
☐ STATE VOLATILE ORGANIC COMPOUNDS & NITROGEN OXIDES EMISSION CONTROL AREA

REGULATORY REQUIREMENTSMAY BE APPLICABLE TO: ☐ CONSTRUCTION
☐ OPERATION

STATE AIR POLLUTION CONTROL BOARD REGULATIONS THAT MAY APPLY:

1. ☐ 9 VAC 5-40-5200 C & 9 VAC 5-40-5220 E – STAGE I
2. ☐ 9 VAC 5-40-5200 C & 9 VAC 5-40-5220 F – STAGE II Vapor Recovery
3. ☐ 9 VAC 5-40-5490 et seq. – Asphalt Paving operations
4. X **9 VAC 5-40-5600 et seq. – Open Burning**
5. X **9 VAC 5-50-60 et seq. Fugitive Dust Emissions**
6. ☐ 9 VAC 5-50-130 et seq. - Odorous Emissions; Applicable to____________
7. ☐ 9 VAC 5-50-160 et seq. – Standards of Perfomance for Toxic Pollutants
8. ☐ 9 VAC 5-50-400 Subpart_____, Standards of Performance for New Stationary Sources, designates standards of perfomance for the____________
9. ☐ 9 VAC 5-80-10 et seq. of the regulations – Permits for Stationary Sources
10. ☐ 9 VAC 5-80-1700 et seq. Of the regulations – Major or Modified Sources located in PSD areas. This rule may be applicable to the ____________
11. ☐ 9 VAC 5-80-2000 et seq. of the regulations – New and modified sources located in non-attainment areas
12. ☐ 9 VAC 5-80-800 et seq. Of the regulations – Operating Permits and exemptions. This rule may be applicable to ____________

COMMENTS SPECIFIC TO THE PROJECT:

Subject to obtaining necessary construction permits as applicable.

K. S. Narasimhan

(Kotur S. Narasimhan)
Office of Air Data Analysis

DATE: December 19, 2003

If you cannot meet the deadline, please notify ELLIE IRONS at 804/698-4325 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

REVIEW INSTRUCTIONS:

A. Please review the document carefully. If the proposal has been reviewed earlier (i.e. if the document is a federal Final EIS or a state supplement), please consider whether your earlier comments have been adequately addressed.

B. Prepare your agency's comments in a form which would be acceptable for responding directly to a project proponent agency.

C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

MS. ELLIE IRONS
DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

RECEIVED
JAN 30 2004
DEQ-Office of Environmental Impact Review

Ellie Irons
Ellie Irons, Program Manager
Environmental Impact Review

COMMENTS

No comments

(signed) Alan O Weber (date) 1-27-04

(title)

(agency) VDH

PROJECT # 03-223F 8/98

1 **If you cannot meet the deadline, please notify ELLIE IRONS at 804/698-4325 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.**

REVIEW INSTRUCTIONS:

A. Please review the document carefully. If the proposal has been reviewed earlier (i.e. if the document is a federal Final EIS or a state supplement), please consider whether your earlier comments have been adequately addressed.

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Please return your comments to:

MS. ELLIE IRONS
DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

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Ellie Irons
Ellie Irons, Program Manager
Environmental Impact Review

COMMENTS

NO COMMENTS CONCERNING THE VA COASTAL RESOURCES MANAGEMENT PROGRAM

(signed) [illegible] (date) 20 January 2004

(title) GEOLOGIST

(agency) DMME

PROJECT # 03-223F 8/98

1 Thomas Jefferson
Planning District Commission
Regional planning linking transportation, land use, economy & environment

RECEIVED
JAN 2 7 2004
DEQ-Office of Environmental Impact Review

January 22, 2004

Ms. Ellie Irons
Virginia Department of Environmental Quality
Office of Environmental Impact Review
629 East Main St., Sixth Floor
Richmond, VA 23219

Dear Ms. Irons:

The Thomas Jefferson Planning District Commission reviewed project #03-223F, North Anna Early Site Permit, at its regular meeting on January 8, 2004. However, the Commission had no comment on this project. Thank you for the opportunity to review the project.

Sincerely,

Rochelle Garwood
Senior Planner – Environment

300 East Main Street, P.O. Box 1505, Charlottesville, VA 22902-1505
Telephone (434) 979-7310 Fax (434) 979-1597 Virginia Relay Users: 711 (TDD)
email: info@tjpdc.org / web site: www.tjpdc.org

1 JUN-22-2004 17:55 P.02

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, FL 33702
(727) 570-5312, FAX 570-5517
http://caldera.sero.nmfs.gov

MAY 19 2004

F/SER3:JAM

Pao-Tsin Kuo
Division of Regulatory Improvements Programs
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Kuo:

We have received your letter dated January 5, 2004, requesting a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of the potential future construction of one or more new nuclear power plants. One of the proposed sites is the U.S. Department of Energy's Savannah River Site, located in Aiken and Barnwell Counties, South Carolina.

Enclosed is a list of federally-protected species under the jurisdiction of NOAA Fisheries for the state of South Carolina. Biological information on federally protected sea turtles, sturgeon, and other listed species and candidate species can be found at the following website addresses: NOAA Fisheries Southeast Regional Office (http://caldera.sero.nmfs.gov/protect/protect.htm); NOAA Fisheries Office of Protected Resources (http://www.nmfs.noaa.gov/prot_res/prot_res.html); U.S. Fish and Wildlife Service (http://nofloride.fws.gov/SeaTurtles/seaturtle-info.htm), http://endangered.fws.gov/wildlife.html#Species; the Ocean Conservancy (http://www.cmc-ocean.org/main.php3); the Caribbean Conservation Corporation (http://www.cccturtle.org/); Florida Fish and Wildlife Conservation Commission (http://floridaconservation.org/psm/turtles/turtle.htm); http://www.turtles.org; http://www/seaturtle.org; http://alabama.fws.gov/gs/; http://obis.env.duke.edu/data/sp_profiles.php; www.mote.org/~colins/Sawfish/SawfishHomePage.html; www.floridasawfish.com; http://www.flmnh.ufl.edu/fish/Sharks/sawfish/srt/srt.htm www.flmnh.ufl.edu/fish/sharks/InNews/sawprop.htm.

We look forward to continued cooperation with the Nuclear Regulatory Commission in conserving our endangered and threatened resources. If you have any questions, please contact Ms. Jennifer Moore, natural resource specialist, at (727) 570-5312, or by e-mail at jennifer.moore@noaa.gov.

Sincerely,

David Bernhart
Assistant Regional Administrator
for Protected Resources

Enclosure

File: 1514-22 .M. NRC

1 JUN-22-2004 17:55 P.03

Endangered and Threatened Species and Critical Habitats under the Jurisdiction of the National Marine Fisheries Service South Carolina

Listed Species	Scientific Name	Status	Date Listed
Marine Mammals			
blue whale	*Balaenoptera musculus*	Endangered	12/02/70
finback whale	*Balaenoptera physalus*	Endangered	12/02/70
humpback whale	*Megaptera novaeangliae*	Endangered	12/02/70
right whale	*Eubalaena glacialis*	Endangered	12/02/70
sei whale	*Balaenoptera borealis*	Endangered	12/02/70
sperm whale	*Physeter macrocephalus*	Endangered	12/02/70
Turtles			
green sea turtle	*Chelonia mydas*	Threatened[1]	07/28/78
hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	06/02/70
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	12/02/70
leatherback sea turtle	*Dermochelys coriacea*	Endangered	06/02/70
loggerhead sea turtle	*Caretta caretta*	Threatened	07/28/78
Fish			
shortnose sturgeon	*Acipenser brevirostrum*	Endangered	03/11/67

Species Proposed for Listing

None

Designated Critical Habitat

None

Proposed Critical Habitat

None

1 JUN-22-2004 17:55 P.04

Candidate Species[2]	Scientific Name
Fish	
Atlantic sturgeon	*Acipenser oxyrhynchus oxyrhynchus*
dusky shark	*Carcharhinus obscurus*
night shark	*Carcharinus signatus*
sand tiger shark	*Odontaspis taurus*
speckled hind	*Epinephelus drummondhayi*
Warsaw grouper	*Epinephelus nigritus*

1. Green turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.
2. Candidate species are not protected under the Endangered Species Act, but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

1

Dominion Nuclear North Anna, LLC
5000 Dominion Boulevard, Glen Allen, VA 23060

Dominion®

June 28, 2004

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No. 04-364
ESP/LTB
Docket No. 52-008

DOMINION NUCLEAR NORTH ANNA, LLC
NORTH ANNA EARLY SITE PERMIT APPLICATION
RESPONSE TO VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY
COMMENT LETTER

On November 6, 2003, Dominion Nuclear North Anna, LLC (Dominion) submitted a Federal Consistency Certification under the Coastal Zone Management Act (CZMA) and Virginia Coastal Resources Management Program to the Virginia Department of Environmental Quality (VDEQ). The action was taken in support of Dominion's September 25, 2003 submittal to the NRC of the North Anna Early Site Permit application. At the request of the VDEQ, Dominion withdrew its request for CZMA certification on January 12, 2004, in order to coordinate the State's period for review and concurrence of this certification with the NRC publishing its Draft Environmental Impact Statement.

However, during the preceding interval before Dominion withdrew its request, a number of state agencies had expended considerable resources reviewing Dominion's November 6, 2003 submittal. Although incomplete, these reviews had generated a number of comments. Those comments were forwarded to Dominion by VDEQ on February 10, 2004.

Dominion has reviewed these advance comments from various state agencies and has addressed each of the comments with further information or clarifications. The comments and how each was dispositioned are provided in the enclosure.

It is our intent to update the North Anna ESP application to incorporate our responses to these advance comments and support issuance of the NRC staff's draft safety and environmental evaluations scheduled for later this year. These additions and clarifications are identified following the response to each comment.

Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

If you have any questions or require additional information, please contact us.

Very truly yours,

Eugene S. Grecheck
Vice President-Nuclear Support Services

Enclosure: Response to Virginia DEQ Comments

Commitments made in this letter:

1. Revise North Anna ESP application to incorporate responses to advance VDEQ comments.

cc: U.S. Nuclear Regulatory Commission, Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW
Suite 23T85
Atlanta, Georgia 30303

Mr. Jack Cushing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. M. T. Widmann
NRC Senior Resident Inspector
North Anna Power Station

Ms. Ellie L. Irons, Program Manager
Office of Environmental Impact Review
Virginia Department of Environmental Quality

Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Eugene S. Grecheck, who is Vice President, Nuclear Support Services, of Dominion Nuclear North Anna, LLC. He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of Dominion Nuclear North Anna, LLC, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 28th day of June, 2004

My Commission expires: 3/31/08

Maggie McClure
Notary Public

(SEAL)

1 Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

Enclosure 1

Response to February 10, 2004 Virginia Department of Environmental Quality Comment Letter On the North Anna ESP Application Coastal Zone Certification

1

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Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

VDEQ Comment on Deficiencies in the Document

Deficiencies in the Document

The Application includes proposed Unit 4, but does not identify a source of water for that unit. The NRC regulations, at 10 CFR section 51.29, require that "information provided to the Commission by an applicant for a license, ... shall be complete and accurate in all material respects." For ESP applications, the NRC requires information on "types of cooling system intake and outflows for each facility" (10 CFR section 52.17(v)) (emphasis added). Because no water source for Unit 4 is identified in the Application, DEQ's Water Division cannot form an opinion on prospects for approval of such a project, or whether it would be consistent with state laws and regulations. The logical water source for Unit 4 would be Lake Anna. Groundwater resources are not capable of producing the large quantities of water that would be needed; nor does there appear to be any surface water source nearby, other than the Lake. Unit 4 should be withdrawn from the Application unless its water source(s) and related cumulative impacts are identified. If Dominion leaves Unit 4 in the Application, but does not identify a water source, then NRC should consider denying the application for any site redress work associated with Unit 4.

If Lake Anna were the source of water identified for Unit 4, the additional heat load and evaporative losses would result in deeper and longer drawdown periods on the Lake and longer periods of low flows in the North Anna River. Given the small watershed, with average runoff of only 370 cubic feet per second (cfs), it is probable that the additional cumulative impact of a fourth unit would have an unacceptable impact on the Lake and the River downstream of it.

Response

The Environmental Report (ER) indicates that cooling tower makeup water necessary to replace the water lost to evaporation from the Unit 4 cooling towers would be obtained from Lake Anna and supplemented, as necessary, from an outside source to maintain acceptable lake levels. The ER does not identify this outside source. To eliminate uncertainty concerning the adequacy of the Unit 4 makeup water sources, Dominion decided to revise the ESP application to change the base case for heat dissipation for Unit 4 from wet cooling towers to dry towers. This revision from wet to dry cooling towers for Unit 4 eliminates the need for obtaining makeup water from Lake Anna or from another external source.

Dominion notified the NRC of plans to use dry towers for Unit 4 in a letter dated March 31, 2004 (Reference 1). As stated in the same letter, the Unit 3 cooling water approach is unchanged. Options for Unit 3 cooling are evaluated in ER Section 9.4.1.1, which concludes that once-through cooling is the environmentally and economically preferable heat dissipation system.

2

Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

References

1. March 31, 2004 Letter from Eugene S. Grecheck, Vice President-Nuclear Support Services, Dominion, to U. S. Nuclear Regulatory Commission, Document Control Desk, "Dominion Nuclear North Anna, LLC, North Anna Early Site Permit Application, Revised Approach for Unit 4 Normal Plant Cooling," NRC Accession Number ML040980485.

Application Revision

SSAR Section 2.4 and ER Sections 1, 2, 3, 5, 9, and 10 will be revised to reflect the change in the Unit 4 cooling approach from wet towers to dry towers.

3

1 Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

VDEQ Comment F1(a)

1. Fisheries Management Concerns. As the Department of Game and Inland Fisheries (DGIF) indicates (enclosed comments), the proposed addition of two generating units to the two that are already operating at the North Anna Power Station would have a number of adverse effects upon the lake and the river downstream of it.

(a) Water Withdrawal Increases in the Lake. Increases in water withdrawals would present complications for fish populations through increased fish impingement and entrainment in water intakes. Impingement, or the collisions of fish against water intake screens, would increase by 230% over current levels with the addition of the proposed intakes, according to DGIF. Estimated impingement mortality of striped bass would nearly double; it should be mentioned that striped bass is a leading Lake Anna sportfish annually stocked by DGIF.

Similarly, the number of fish entrained by virtue of increased water withdrawals from the Lake is expected to increase. Using estimates from the applicant's six-species category, DGIF states that the number of fish lost to entrainment could exceed 468 million fish annually, 63% of which would be gizzard shad, another important North Anna River species. (Confirmed, Ellis/Odenkirk, 2/9/04. The lower estimate by DEQ's Office of Wetlands and Water Protection is a sub-set of the above estimate; it is based on losses attributable to the addition of Unit 3 only (Ellis/Hassell, 2/9/04).

Existing intake criteria at the North Anna Power Station substantially exceed DGIF recommendations, as the chart shows:

	water velocity (feet per second)	screen mesh (millimeters)
DGIF recommendation	0.25 FPS	1.0 mm
existing criteria	0.70 FPS	9.5 mm

DGIF indicates that even its recommendations, which reflect current state-of-the-art technology, are not expected to provide full resource protection. The existing screen would be expected to exclude only compressed fish (such as sunfish) larger than 50 mm and elongated fish (such as striped bass and largemouth bass) larger than 86 mm. Accordingly, DGIF recommends that Dominion investigate further the addition of a submerged intake structure (a curtain wall as detailed on page 3-5-38 of the Application that would reduce fish impingement and entrainment and align the intake criteria with current DGIF recommendations.

4

Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

Response

As stated in Environmental Report (ER) Section 5.3.1.2, increases in water withdrawal associated with the implementation of Unit 3 and Unit 4 would result in increased impingement and entrainment. However, Dominion disagrees with the VDEQ statement that these withdrawals "would present complications for fish populations." Dominion presented a thorough analysis of the impacts of impingement and entrainment in the ER, using available data from the Section 316(b) Demonstration (May 1985), *Impingement and Entrainment Studies for North Anna Power Station, 1978-1983* and its original data (Reference 4 of ER Section 5.3). These data were deemed representative of the current fish community in Lake Anna and provided a basis for extrapolating impingement and entrainment estimates with assumptions as presented in ER Sections 5.3.1.2.1 through 5.3.1.2.5.

Assumptions for impingement were:

- Fish distribution and composition have remained generally the same as in the 1978-1983 study
- A new once-through CWIS would operate at <u>100 percent pumping capacity</u>
- The intake screen mesh size and approach flow velocity of the new units would be the same as that of the existing units.

Assumptions for entrainment were:

- Fish distribution and composition have remained generally the same as in the 1978-1983 study
- A new once-through CWIS would operate at <u>100 percent pumping capacity</u>
- The intake screen mesh size and approach velocity of the new units would remain the same as that of the existing units

Using these assumptions, an analysis of the implications of increasing withdrawal rates for new units on impingement and entrainment was done and the results presented in the ER. ER Section 5.3.1.2.2 states that adding an additional once-through unit with conservative assumptions (i.e., <u>worst case</u>) would double the number of fish impinged. The VDEQ statement that impingement would increase by 230% over current levels with the addition of the proposed intakes is misworded. A more accurate way to present this percentage increase is that while 422,027 fish (estimated impinged annually from current operations and Unit 3) is 230% of 187,440 fish (estimated impinged annually by current operations), increasing impinged organisms from 187,440 to 422,027 is a 131% increase in impingement rates. One needs to keep in mind that the estimated impingement rates for the new unit represent a conservative "worst case" and actual

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impingement could be significantly less because the units would not operate at 100 percent pumping capacity year round. In addition, this increase in impingement is estimated to be 63 percent gizzard shad, a prolific forage fish.

The statement that impingement mortality of striped bass, a leading sportfish that is annually stocked by VDGIF, would nearly double needs to be put into perspective. Total estimated impingement from a new once-through unit for striped bass is estimated (with the assumptions presented above) to be 2,354 annually or approximately 1% of the estimated 239,587 fish impinged annually. Based on VDGIF reports, an average of 134,000 striped bass were stocked annually in Lake Anna over the 1992-2002 time period. Striped bass are not native to Lake Anna or the North Anna River and are present only due to stocking by VDGIF.

Dominion presented an analysis and discussion of entrainment in the ER based on the assumptions identified above. VDEQ references the VDGIF letter of January 27, 2004 that estimated 468 million fish would be entrained annually. Dominion believes that this number is an overestimate. Our analysis estimates that 300 million fish would be entrained with a total of four units operating under the conservative assumptions presented earlier. ER Table 5.3-5 (current operations), Table 5.3-6 (Unit 3), and Table 5.3-8 (Unit 4) represent "worst case" entrainment estimates, and, as noted for impingement, actual numbers entrained would likely be significantly less.

VDEQ states that existing NAPS intake parameters substantially exceed VDGIF recommendations for water velocity, 0.25 fps, and screen mesh size, 1 mm, which are more stringent than EPA's proposed requirements for Section 316(b). The precise status of the EPA and state requirements are uncertain at this time and they may undergo further revision before Dominion makes a decision to apply for a COL and an NPDES permit for new units. Dominion understands that the state may impose requirements that are more stringent than EPA and that these requirements might reduce the intake impacts that Dominion has identified in the ER. However, Dominion believes that its conservative ("worst case") analysis in the ER bounds any possible impacts. More stringent requirements could only further reduce impacts. Dominion has committed in ER Section 3.4.2.1 to comply with Section 316(b) of the Clean Water Act and its applicable implementing regulations.

Regarding the recommendation that Dominion investigate further the addition of a submerged intake structure, the design of the intake structure would be reviewed by VDEQ in support of a 316(b) determination, if Dominion decides to proceed with development of new units. As stated in ER Section 5.3.1.2.5, a curtain wall might mitigate increased water temperatures, significantly reduce impingement, and reduce entrainment and as such, is a reasonable mitigation option that would be explored further.

In summary, because of the size of the fish populations in Lake Anna (based on annual sampling conducted by VDGIF and discussed in ER Section 2.4.2), the fecundity of the

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most frequently impinged representative important fishes (analyzed in the 316(b) study), the assumptions presented for impingement and entrainment estimates in the ER, and the ability of aquatic populations to accommodate environmental perturbations, Dominion concluded that doubling impingement estimates for the representative important species analyzed in the ER would not affect the fish community in Lake Anna sufficiently to require mitigation (reference ER Sections 5.3.1.2.2 and 5.3.1.2.4).

Application Revision

None.

VDEQ Comment F1(b)

1. Fisheries Management Concerns (continued)

(b) Water Withdrawal Increases and the River Downstream. The addition of one or two new units to the North Anna Power Station would have significant impacts on downstream resources by reducing river flows and the frequency of higher flows. For example, the water budget presented in the Application shows that significant changes in flows have already taken place as a result of the construction of the dam; drought flow frequency (flows less than 20 cfs) occurs 5.3% of the time now, versus 4.2% of the time before the dam was built (1929-1971). Drought flow frequency would rise to 11.8% of the time with one additional unit; the flow analysis did not address what would happen with a fourth unit. The impact of a fourth unit should be addressed in this process, or else the fourth unit should be taken out of the permit application.

DGIF recommends an In-stream Flow Incremental Methodology (IFIM) Study as a means of determining flow recommendations downstream of the Lake. The study should include evaluation of a habitat time series (i.e., pre-project, current, and proposed conditions) for native and naturalized species, and may result in recommendations for different flow operating rules than currently exist for the downstream resource. The Tennant Method yields a summer flow in the range of 74 to 111 cfs for resource protection, and current minimum flows would be rated as poor to degraded in that regard. As DEQ's Office of Wetlands and Water Protection states, the addition of another generating unit, which is expected to increase the consumptive loss from the watershed by an additional 39 cfs, would create nearly perennial conditions of severe degradation every fall. See "Additional Analysis Needs," item 4, below.

<u>Response</u>

The ER indicates that cooling tower make-up water necessary to replace the water lost to evaporation from the Unit 4 cooling towers would be obtained from Lake Anna and supplemented, as necessary, from an outside source to maintain acceptable lake levels. The ER does not identify this outside source. To eliminate uncertainty concerning the adequacy of the Unit 4 make-up water sources, Dominion decided to revise the ESP application to change the base case for heat dissipation for Unit 4 from wet cooling towers to dry towers. Dry tower systems typically have no evaporative water losses, require no make-up water to replace evaporative losses, and have no blowdown discharge compared to mechanical draft (or natural draft) cooling towers. In the event that the secondary cooling water loop of the dry tower system selected incorporates a pump sump with a free water surface, a small amount of evaporation will occur. The evaporation from this surface has been estimated to be on the order of 1 gpm (0.002 cfs).

This revision from wet to dry cooling towers for Unit 4 eliminates the need for obtaining makeup water from Lake Anna or from another external source. Consumptive surface water use for Unit 4 would decrease from about 36 cfs to less than 2 cfs under normal operating conditions. With this revision, there is no need to include Unit 4 in the water budget analysis.

Dominion notified the NRC of plans to use dry towers for Unit 4 in a letter dated March 31, 2004 (Reference 1). The same letter indicates that the North Anna ESP application will be revised to reflect this change.

Dominion notes that the Tennant Method was developed for application to western United States coldwater streams. Historically, summer flows in the North Anna River prior to impoundment generally were much lower than 74 cfs, and sometimes less than 20 cfs. Downstream river flows have never been below 20 cfs since impoundment. Dominion understands the recommendation for an instream flow study to protect aquatic life. However, long-term monitoring of the North Anna River has documented improvements in the abundance and diversity of aquatic biota since impoundment. Further, a diverse and stable fish assemblage has persisted since impoundment under existing instream flow regulations, including the most recent passed by the Virginia General Assembly in 2001. At this time, Dominion does not see an additional in-stream flow monitoring study as necessary.

Note also that the VDEQ's comment identifies that the addition of another generating unit would be expected to increase the consumptive loss from the watershed by an additional 39 cfs. Dominion would like to clarify that the additional evaporative loss associated with Unit 3 is estimated to be 29 cfs (not 39 cfs) during normal plant operation as is described in ER Section 5.2.1.1. On a long-term operating basis, the additional evaporative loss is slightly less (28 cfs) as discussed in ER Section 5.2.1.4.

See also the responses to VDEQ Comments F2(a) and F2(c).

References

1. March 31, 2004 Letter from Eugene S. Grecheck, Vice President-Nuclear Support Services, Dominion, to U. S. Nuclear Regulatory Commission, Document Control Desk, "Dominion Nuclear North Anna, LLC, North Anna Early Site Permit Application, Revised Approach for Unit 4 Normal Plant Cooling," NRC Accession Number ML040980485.

Application Revision

SSAR Section 2.4 and ER Sections 1, 2, 3, 5, 9, and 10 will be revised to reflect the change in the Unit 4 cooling approach from wet towers to dry towers.

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VDEQ Comment F1(c)(i)

1. Fisheries Management Concerns (continued)

(c) Water Temperature Increases. Water temperature increases resulting from the additional units are likely to affect fish habitat in Lake Anna and in the North Anna River. This issue has several aspects.

(i) Present Conditions. Dominion has documented the current situation and available literature (Application, pages 3-5-55 through 3-5-58). The current temperature and oxygen stratification patterns at the Lake limit the potential of the Lake fishery, but have not resulted in catastrophic fish kills to date. Adult striped bass grow slowly, exhibit reduced fitness, and have low maximum sizes as a result of the present marginal habitat conditions, but an important recreational fishery has nonetheless developed in this habitat. The Lake does not often stratify, but when it does the stratification is weak. Total temperature differences (top to bottom) in many cases were less than 1 degree Celsius (1.8 degrees Fahrenheit) based on DGIF samples taken in late summer and early fall at lower reservoir sites. Stratification patterns dictate striped bass habitat and are subject to much variability at Lake Anna. Accordingly, a horizontal and vertical increase in the thermal plume would exacerbate a currently tenuous situation.

<u>Response</u>

Dominion does not agree that a "tenuous situation" exists in Lake Anna or that a small additional stressor could have a catastrophic effect. We believe the following statements are true and verifiable:

- Lake Anna striped bass provide an important recreational fishery
- Lake Anna striped bass occupy habitat that is "marginal"
- Lake Anna striped bass grow slowly as adults, exhibit reduced fitness, and do not reach sizes seen in other southeastern reservoirs
- Lake Anna striped bass, like striped bass in many southeastern reservoirs, face a late-summer habitat squeeze
- No major striped bass die-offs have been observed in Lake Anna, even during the height of the 1998-2002 drought

We have seen no hard evidence that a "tenuous situation" currently exists or that the population is likely to collapse as the result of a modest additional thermal input.

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With regard to striped bass habitat, Dominion acknowledges in the ER that increases in water temperatures could have a "moderate" impact on non-native striped bass, which have more demanding habitat requirements than native game fish (black bass, crappies, lepomids) and forage fish (shad and minnows). Striped bass do not spawn in the Lake Anna watershed and must be stocked to maintain their numbers. Striped bass in reservoirs across the southeast are subject to thermal stress and habitat restriction in drought years, even in reservoirs that do not receive thermal inputs from power plants. Late-summer movements of striped bass to cooler refuge areas have been observed in reservoirs from Alabama to North Carolina, with sporadic die-offs of larger, older fish in some reservoirs in particularly hot and dry summers.

Dominion believes, based on more than 20 years of water quality and fisheries monitoring, that Lake Anna currently supports a healthy, balanced indigenous fish community and will continue to support a healthy, balanced indigenous fish community with the additional heat input that would be expected with a third once-through unit. Warmwater fish species native to the southeastern U.S., such as largemouth bass, black crappie, bluegill, channel catfish, and white catfish, are able to tolerate water temperatures predicted in Lake Anna under 3-unit operation without experiencing any ill effects. There are documented instances of these species flourishing in cooling ponds and cooling reservoirs that receive thermal effluent in excess of 100°F (see Table 1). A short list of cooling ponds and reservoirs with summer (surface) water temperatures in the 95-105°F range would include Par Pond (SC) at the Savannah River Site; Monticello Reservoir (SC), the cooling reservoir for SCE&G's V.C. Summer Nuclear Station; Lake Robinson (SC), the cooling pond for Progress Energy's H.B. Robinson Nuclear Plant; Lake Norman (NC), the cooling reservoir for Duke Energy's McGuire Nuclear Station and Marshall Steam Station; and Keowee Reservoir, the cooling reservoir for Duke Energy's Oconee Nuclear Station. ER Section 5.3.2.2.c.1 contains a discussion of the Mt. Storm Lake (WV) fish community, which by all accounts is thriving in spite of late-summer water temperatures in the discharge area that can exceed 99°F. This 1,200-acre impoundment serves as the cooling water source for Dominion Energy's Mt. Storm Power Station.

In these cooling reservoirs, fish simply move in summer to portions of the reservoir that are less affected by the thermal discharge. These include deeper, cooler portions of the water body, arms of the pond/reservoir that receive cool flows from tributary streams, and thermal refuges created by subaqueous springs and seeps. It should be noted that in winter, elevated temperatures in the discharge areas of these cooling reservoirs often attract large numbers of baitfish, gamefish, and fishermen. Olmsted and Clugston (1986) (Reference 7) discuss the opportunities (e.g., extended growing season, enhanced primary and secondary productivity, improved winter-time fishing) and challenges (e.g., sub-optimal habitat for top-of-the-food chain predators, such as striped bass; stimulation of nuisance aquatic weeds) that these southeastern cooling reservoirs present to fisheries managers.

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Table 1. Power Plant Cooling Ponds

Reservoir	Surface Area	Owner/ Manager	Power Plant	Cooling System	Discharge Temperatures/ Reservoir Temperatures	Important Gamefish	Source(s)
Par Pond	2,500 acres	DOE	Received heated effluent from nuclear production reactors until 1988.	Series of pre-cooler ponds.	Ranged from 59-111°F in 1985 in area of "Hot Dam" (where heated effluent entered reservoir), when one reactor (P Reactor) was running	Largemouth bass, black crappie, bluegill, redbreast sunfish, chain pickerel	Reference 1
Monticello Reservoir	6,000 acres	SCE&G	VC Summer Nuclear Station, single unit nominally rated at 1,000 MWe	Once-through; discharge canal configuration and jetty designed to direct thermal plume north/uplake and prevent recirculation to intake.	NPDES permit discharge limit (end of pipe) is 113°F. Temperatures outside of discharge canal as high as 103.7°F	Largemouth bass, black crappie, bluegill, white bass, white catfish, channel catfish, blue catfish	Reference 2
Lake Robinson	2,250 acres	Progress Energy	H.B. Robinson Nuclear Plant, single unit nominally rated at 700 MWe	Once-through to Lake Robinson; 4.0-mile-long discharge canal intended to dissipate heat prior to entering Lake Robinson.	NPDES discharge limit (June-Sept. daily max) is 111.2°F; highest temp. recorded in impoundment is 105.8°F	Largemouth bass, black crappie, bluegill, warmouth, yellow bullhead	Reference 3

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Table 1. Power Plant Cooling Ponds

Reservoir	Surface Area	Owner/ Manager	Power Plant	Cooling System	Discharge Temperatures/ Reservoir Temperatures	Important Gamefish	Source(s)
Lake Norman	32,150 acres	Duke Power	McGuire Nuclear Station (two units, each 1,129 MWe) and Marshall Steam Station	Once-through to Lake Norman; 0.6 mi. long discharge canal.	NPDES discharge limit is 95°F for Oct.-June and 99°F for July-Sept; monthly average discharge temp. in August is 98.2°F.	Striped bass, largemouth bass, black crappie, white bass, several Lepomid spp., and blue catfish.	Reference 4
Keowee Reservoir	18,500 acres	Duke Power	Oconee Nuclear Station, three units rated at 887 MWe each	Once-through to Keowee Reservoir; skimmer wall on intake side promotes withdrawal of deeper, cooler water for condenser cooling.	NPDES discharge limit is 100°F; from 1973-1993, maximum daily average temperature in discharge canal was 98.4°F	Spotted bass, largemouth bass, black crappie, bluegill, redear sunfish, white catfish	References 5 and 6

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References

1. E. I. duPont de Nemours & Company (duPont). 1985. Compliance of the Savannah River Plant P-Reactor Cooling System with Environmental Regulations: demonstrations in accordance with Sections 316(a) and (b) of the Federal Pollution Water Control Act of 1972. Prepared for the U. S. Dept. of Energy by duPont's Savannah River Laboratory.

2. South Carolina Electric & Gas Company. 2002. Applicant's Environmental Report --- Operating License Renewal Stage, V. C. Summer Nuclear Station.

3. Progress Energy. 2002. Applicant's Environmental Report --- Operating License Renewal Stage, H. B. Robinson Steam Electric Plant, Unit 2.

4. Duke Energy. 2001. Applicant's Environmental Report --- Operating License Renewal Stage, McGuire Nuclear Station.

5. Duke Energy. 1998. Applicant's Environmental Report --- Operating License Renewal Stage, Oconee Nuclear Station.

6. NRC. 1999. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 2. Regarding Oconee Nuclear Station. Office of Nuclear Reactor Regulation, Washington, DC.

7. Olmsted, L. L. and J. P. Clugston. 1986. Fishery Management in Cooling Impoundments. Pg. 227-237 in G. E. Hall and M. J. Van Den Avyle, editors, *Reservoir Fisheries Management: Strategies for the 80s*. Reservoir Committee, Southern Division American Fisheries Society, Bethesda, MD.

Application Revision

None.

VDEQ Comment F1(c)(ii)

1. Fisheries Management Concerns (continued)

(c) Water Temperature Increases (continued)

(ii) Impacts of Water Temperature Increases; Mitigation. It is likely that a small increase in reservoir water temperature would have a dramatic effect, further reducing already limited habitat and perhaps jeopardizing the entire striped bass fishery. The maximum daily surface temperature is expected to rise by 7.2 degrees Fahrenheit (4 degrees Celsius) near the dam as a consequence of the proposed new generating units. Re-configuring the flow within the waste heat treatment facility (WHTF) to allow for more efficient cooling (i.e., forcing water to use the entire facility, consisting of three cooling lagoons, by sealing the lower tributary arm between Elk Creek and Millpond Creek and cutting a canal through the headwater areas; Ellis/Kauffman, 2/6/04) would expand the residence time within the WHTF and probably reduce thermal impacts to Lake Anna and the North Anna River.

Response

ER Section 5.3.2.1.2 describes the predicted thermal impacts for the following three scenarios:

1. Operation of the once-through cooling systems of the existing units;

2. Future combined operation of the once-through cooling systems of the existing units, a once-through cooling system for Unit 3, and a closed-cycle cooling system for Unit 4; and

3. Future combined operation of the once-through cooling systems of the existing units, a once-through cooling system for Unit 3, and a once-through cooling system for Unit 4.

ER Table 5.3-17 summarizes for various Lake Anna locations the predicted maximum daily surface temperature increases associated with the addition of one new once-through cooling system (Scenario 2) and two new once-through cooling systems (Scenario 3). The predicted maximum surface temperature increase at the dam for the Scenario 2, the base case cooling scenario, is 3.6 degrees Fahrenheit (2 degrees Celsius) and not 7.2 degrees Fahrenheit (4 degrees Celsius) as indicated in the VDEQ comment. Given that Unit 4 would have no thermal impact on the lake with either a closed-cycle cooling system using wet cooling towers, as was initially planned, or dry cooling towers, as is currently specified, the VDEQ's use of a 7.2 degrees Fahrenheit temperature increase incorrectly overstates the thermal impacts to the lake. Furthermore, it is predicted that the maximum daily surface temperature at the dam for

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Scenario 1 of 93.3 degrees Fahrenheit is exceeded only about 1.6% of the time for Scenario 2. These results indicate that the addition of Unit 3's once-through cooling system would result in a surface temperature at the dam higher than the current daily maximum for about 6 days out of the year on average, which is a relatively small duration.

Dominion agrees that re-configuring the WHTF as described in the VDEQ's comment would increase the residence time and promote more efficient cooling. However, as described in ER Section 9.4.1.1.3.a.1, the construction work to connect the headwaters of the Elk Creek and Millpond Creek arms of the WHTF would be expensive and disruptive to nearby residential areas, as large diameter tunnels or major canals would be required. Based on cooling pond simulations, the expected improvements in intake temperatures would be in the 0.5-1.0 degree Fahrenheit range. ER Section 9.4.1.1.3.a.1 concludes that, because this level of mitigation could be achieved more economically in other ways, the combination of high costs and construction impacts results in this option being eliminated from further consideration.

Application Revision

None.

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VDEQ Comment F1(d)

1. Fisheries Management Concerns (continued)

(d) Alternatives. Given the scope and magnitude of aquatic resource impacts anticipated in the event of building out the two units, it seems prudent, according to the Department of Game and Inland Fisheries, to investigate alternatives to the heavily consumptive proposal of another once-through system and a new wet cooling tower. See "Additional Analysis Needs," item 2, below. One alternative, addressing the conflict between consumptive use and impingement and entrainment, would be to consider a single new reactor using a cooling tower with Lake Anna as its source water (see item 3(b)(ii), below). The Draft EIS should include a thorough analysis of this and other alternatives to the proposed project.

Response

The ER already evaluates alternative heat dissipation systems for Units 3 and 4. These alternatives are described and evaluated in ER Section 9.4.1 and include natural draft and mechanical draft cooling towers. With Dominion's decision to use dry cooling towers for Unit 4 [see the response to VDEQ Comment F1(b)], the VDEQ's recommendation to consider a single new reactor using a cooling tower with the lake as its source of water is effectively addressed in the current ER. Further, ER Table 9.4-1 indicates that the overall evaporative losses would be greater for wet cooling tower systems compared to once-through cooling systems. The evaporative losses associated with the addition of Unit 3 are estimated to be 29 cfs during normal plant operation, as described in ER Section 5.2.1.1. If a wet cooling tower were used for Unit 3, the evaporative losses would be about 35 cfs during normal plant operation, based on information included in the same section. Therefore, use of a wet cooling tower system for Unit 3 in lieu of a once-through system would have greater impact on lake levels and downstream releases.

With respect to impingement and entrainment, any intake structure, including one for a once-through cooling system, would be required to meet Section 316(b) of the CWA and the implementing regulations, as applicable.

Application Revision

None.

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VDEQ Comment F2(a)

> 2. *Wetland Management and Water Resources.* DEQ's Water Division indicates that additional studies on the impacts to in-stream beneficial uses, water quality, and aquatic life would be needed to adequately assess the impacts of the proposed new generating units. Preservation of in-stream flows for protection of fish and wildlife habitat and resources and also recreation values is a beneficial use of state waters. Habitat and recreational uses are present in both the Lake and downstream, in the North Anna and Pamunkey Rivers. Conditions in a Virginia Water Protection Permit may include, but are not limited to, the volume of water to be withdrawn as part of the permitted activity.
>
> *(a) Consumptive Use and In-stream Flow.* An additional unit of the size contemplated in the Application would be the largest single consumptive withdrawal ever considered in the history of the Virginia Water Protection Permit Program. The average annual flow of Lake Anna and the North Anna River is 370 cfs. The typical recommendation to the Water Division from the Department of Game and Inland Fisheries, in processing a Water Protection Permit, is not to allow cumulative consumptive use to exceed 10% of the river's flow. The current evaporation rate and the existing two generating units very often exceed this benchmark. Accordingly, permitting of additional withdrawals, even with prescriptive conditions, cannot be guaranteed.
>
> For these reasons, DEQ's Office of Wetlands and Water Protection has recommended that Dominion withdraw its federal consistency certification, at least until such time as a Draft Environmental Impact Statement is available. Under the present circumstance, DEQ's Office of Wetlands and Water Protection could not agree with the certification that the project would be in compliance with the Enforceable Policies of the Virginia Coastal Resources Management Program, because that Office does not have the information necessary to allow such concurrence.

<u>Response</u>

The comment that an additional unit of the size contemplated in the ESP application would be the largest single consumptive withdrawal ever considered in the history of the Virginia Water Protection Permit Program needs clarification for proper perspective. While the cooling water withdrawal contemplated for Unit 3 might be the largest withdrawal considered by the permit program, it should be noted the entire flow withdrawn from the North Anna Reservoir (up to 2540 cfs) would be returned to the reservoir via the Waste Heat Treatment Facility. The actual consumptive use of water would be the lake evaporation associated with the additional heat rejection from a new Unit 3. The additional evaporation has been estimated to be 28 cfs on a long-term operating basis as described in ER Section 5.2.1.4.

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Nevertheless, Dominion understands the concern about consumptive use and in-stream flow. To eliminate uncertainty concerning the adequacy of the Unit 4 makeup water sources, Dominion decided to revise the ESP application to change the base case for heat dissipation for a new Unit 4 from wet cooling towers to dry towers. This revision from wet to dry cooling towers for Unit 4 eliminates the need for obtaining makeup water from Lake Anna or from another external source.

Consistent with the VDEQ request, Dominion notified the NRC of plans to use dry towers for Unit 4 in a letter dated March 31, 2004 (Reference 1). The same letter indicates that the North Anna ESP application will be revised to reflect this change.

Dominion has withdrawn its consistency certification and will resubmit it during the time period in which the Draft Environmental Impact Statement (EIS) is published and available for review and comment. This will allow the VDEQ time to review the Draft EIS while considering the consistency certification.

In addition to water withdrawal changes due to Unit 4 dry cooling, the response to VDEQ Comment AA1 indicates a mean annual flow of 265 cfs under current conditions and a mean annual flow of 240 cfs with the addition of a new Unit 3 (see Table 2, Non-Parametric IHA Scorecard, North Anna River). The resulting decrease in the mean annual flow would be 25 cfs, which would represent less than a 10% reduction in mean annual downstream flow. This result would fall within the VDGIF's recommendations for acceptable consumptive use.

References

1. March 31, 2004 Letter from Eugene S. Grecheck, Vice President-Nuclear Support Services, Dominion, to U. S. Nuclear Regulatory Commission, Document Control Desk, "Dominion Nuclear North Anna, LLC, North Anna Early Site Permit Application, Revised Approach for Unit 4 Normal Plant Cooling," NRC Accession Number ML040980485.

Application Revision

SSAR Section 2.4 and ER Sections 1, 2, 3, 5, 9, and 10 will be revised to reflect the change in the Unit 4 cooling approach from wet towers to dry towers.

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VDEQ Comment F2(b)

2. *Wetland Management and Water Resources (cont'd)*

(b) Impingement and Entrainment. As mentioned above (item 1(a)), a once-through cooling process for Unit 3 will result in a significant addition to the number of aquatic organisms impinged (240,000) or entrained (148,000,000) every year (see item 1(a), above, for the Department of Game and Inland Fisheries (DGIF) estimate of the total losses with all units; this number is a subset of the DGIF estimate). While once-through cooling represents a cost saving over cooling towers, it results in higher impingement and entrainment losses. On the other hand, it has less consumptive loss per megawatt of electricity produced, because some of the heat in once-through cooling is dissipated by processes other than pure evaporation.

<u>**Response**</u>

See the response to VDEQ Comment F1(a).

<u>**Application Revision**</u>

See the response to VDEQ Comment F1(a).

VDEQ Comment F2(b)(i)

> 2. *Wetland Management and Water Resources (continued)*
>
> *(b) Impingement and Entrainment (continued)*
>
> *(i) Permitting Questions.* DEQ's Office of Wetlands and Water Protection and its Northern Virginia Regional Office would normally address impingement and entrainment through the Virginia Water Protection Permit. However, because the intake is for cooling water and will not be built for some time, the impingement and entrainment issue will fall under the new regulations pursuant to Section 316(b) of the Clean Water Act and be addressed in the facility's Virginia Pollutant Discharge Elimination System (VPDES) permit. The new unit may be treated as an existing intake or a new intake under the section 316(b) regulations (see item 4 and also "Regulatory and Coordination Needs Summary," item 1, below).

Response

Dominion understands that impingement and entrainment issues will fall under the new EPA regulations pursuant to Section 316(b) of the Clean Water Act and will be addressed in the VPDES permit. Regulations now exist for new facilities (Phase 1) with cooling water intake structures at 40 CFR 125.80 et seq. as well as for existing facilities (Phase 2) at 40 CFR 125.90 et seq. The comment indicated some uncertainty whether the ESP project would be considered a new or existing facility under these regulations. It is Dominion's position that the regulations are clear that this project would fall under the Phase 2 existing facility rule due to the definitions provided in the regulations. The Phase 2 rule states in the definition of existing facility the following: "and any modification of, or any addition of a unit at such a facility that does not meet the definition of a new facility at section 125.83." The Phase 1 rule states in the definition of new facility the following:

> New facilities include only "greenfield" and "stand-alone" facilities. A greenfield facility is a facility that is constructed at a site at which no other source is located or that totally replaces the process or production equipment at an existing facility (see 40 CFR 122.29(b)(1)(i) and (ii)). A stand-alone facility is a new, separate facility that is constructed on property where an existing facility is located and whose processes are substantially independent of the existing facility at the same site (see 40 CFR 122.29(b)(1)(iii)). New facility does not include new units that are added to a facility for purposes of the same general industrial operation (for example, a new peaking unit at an electrical generating station).

Our interpretation is consistent with the January 11, 2002 EPA headquarters memorandum from Sheila Frace, Director of Engineering and Analysis Division, to Alexis Strauss, Director of Water Management Division. The North Anna site was originally designed to accommodate four units, but only two were eventually licensed for operation. Much of the infrastructure for the original design remains to support additional units, especially the intake and discharge tunnels. The ESP project is basically within the original footprint for purposes of the same general industrial operation. It is clearly not a greenfield or stand-alone project.

Application Revision

None.

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VDEQ Comment F2(b)(ii)

2. Wetland Management and Water Resources (continued)

(b) Impingement and Entrainment (continued)

(ii) Limiting Impingement/Entrainment versus Limiting Consumption. The proposed once-through cooling proposed for Unit 3 will raise impingement and entrainment losses as compared with a cooling tower, but it would reduce consumptive use. A cooling tower would also keep thermal conditions in the Lake tolerable for aquatic life. DEQ's Office of Wetlands and Water Protection recommends that the Draft EIS include an alternative not considered in the Application to address this matter: such an alternative would consist of a single new reactor using a cooling tower with Lake Anna as its source.

Response

See response to VDEQ Comment F1(d).

Application Revision

None.

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VDEQ Comment F2(c)

2. *Wetland Management and Water Resources (continued)*

(c) Water Quantity Issues. For the purpose of this discussion, DEQ's Office of Wetlands and Water Protection assumes that only one additional unit is proposed, because proposed Unit 4 has no identifiable water source.

The proposed addition of Unit 3 would increase the frequency and duration of drawdowns in the Lake. The Application indicates, in Table 2.4.6, that the amount of time that Lake Anna would drop two feet or more would increase from 5.6% of the time to 11.6% of the time. As DEQ's Office of Wetlands and Water Protection indicates, this would mean that flow in the North Anna River below the dam is 20 cfs for 11.6% of the time. Under pre-dam conditions (1929-1971), the streamflow in the River below the dam was 20 cfs only 4.2% of the time, as the Department of Game and Inland Fisheries also points out (see Item 1(b), above). This flow rate equals 5.4% of the River's mean annual flow (MAF) at the dam. Under the Tennant rating system, a stream flow of between 0 and 10% of MAF is rated as "severe degradation." Unlike natural drought, which is temporary, the addition of another generating unit which increases the consumptive loss from the watershed would create nearly perennial conditions of severe degradation every fall. For this reason, DEQ's Office of Wetlands and Water Protection is requesting additional studies; see "Additional Analysis Needs," items 1 and 2, below.

The addition of a fourth unit would cause a net loss of 35 additional cfs, according to DEQ's Northern Virginia Regional Office. This would bring the operating level of the lake down to 242 feet MSL, which is 6 feet lower than the target level at which the lake contingency plan currently goes into effect.

Response

VDEQ's comment suggests that the increase in consumptive loss from the watershed due to the addition of Unit 3 would create nearly perennial conditions of severe degradation every fall, unlike natural droughts that are temporary. Results produced from the water balance model and presented in ER Figure 5.2-2 demonstrate that this is not the case. Table 1 summarizes the number of weeks in each calendar year during which the dam outflow was predicted to be 20 cfs for the simulated period of 1978-2003. Results are presented for the existing units by themselves and also with a Unit 3 added. Major droughts that have occurred during this period, as documented by the Virginia District of the U. S. Geological Survey, are identified in the remarks column of this table. The data included in this table indicate that drought flows (20 cfs) would not occur on a perennial basis with the addition of Unit 3. In fact, the minimum 20 cfs flow is predicted to occur in 10 years out of every 25-year (1978-2003) period simulated. Outflows are in excess of 20 cfs in the other 15 years. For comparative purposes, an outflow of 20 cfs

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is predicted to occur in 3 years out of the 25-year (1978-2003) period simulated for the existing units by themselves. Based on this information, perennial conditions of "severe degradation" would not occur every fall. See the response to VDEQ Comment AA1 for additional information.

Table 1. Weeks Per Year Dam Outflow Predicted to be 20 cfs for 1978-2003

Year	Number of Weeks per Year Outflow Is 20 cfs		Remarks
	Existing Units	Existing Units + Unit 3	
1978	0	0	
1979	0	0	
1980	0	14	Drought[1]
1981	0	33	Drought[1]
1982	0	2	Drought[1]
1983	0	0	
1984	0	0	
1985	0	0	
1986	0	4	
1987	0	0	
1988	0	0	
1989	0	0	
1990	0	0	
1991	0	0	
1992	0	0	
1993	0	6	
1994	0	0	
1995	0	0	
1996	0	0	
1997	0	0	
1998	7	12	Drought[1]
1999	0	7	Drought[1]
2000	0	0	
2001	11	14	Drought[2]
2002	49	52	Drought[3]
2003	0	6	

[1] U. S. Geological Survey, Virginia District, Seasonal Streamflow Conditions and Historic Droughts in Virginia. Available at http://va.water.usgs.gov/GLOBAL/histcond.htm. Accessed May 26, 2004.
[2] U. S. Geological Survey, Virginia District, Drought Monitoring Task Force, Drought Status Report, December 7, 2001. Available at http://va.water.usgs.gov/drought/dsr_12-07-01.htm. Accessed May 26, 2004.
[3] U. S. Geological Survey, Virginia District, Drought Monitoring Task Force, Drought Status Report, June 7, 2002. Available at http://va.water.usgs.gov/drought/DMTF-Report-june2002.doc. Accessed May 26, 2004.

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With respect to the comment regarding the additional consumptive water use of 35 cfs by Unit 4, Dominion has decided to use dry towers as a means of heat dissipation for this unit (Reference 1). Consumptive water use for Unit 4 is now estimated to be less than 2 cfs under normal operating conditions. With this change, water-related impacts associated with Unit 4 would be small. See the response to VDEQ Comment F1(b) for additional information.

References

1. March 31, 2004 Letter from Eugene S. Grecheck, Vice President-Nuclear Support Services, Dominion, to U. S. Nuclear Regulatory Commission, Document Control Desk, "Dominion Nuclear North Anna, LLC, North Anna Early Site Permit Application, Revised Approach for Unit 4 Normal Plant Cooling," NRC Accession Number ML040980485.

Application Revision

None.

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VDEQ Comment F2(d)

2. *Wetland Management and Water Resources (continued)*

(d) Regulatory Authority under the Virginia Water Protection Permit Program. The Application and the request for concurrence with the consistency certification both fail to describe correctly the applicability of State laws and regulations pertaining to water withdrawals. Table 1.2.1 indicates that the Virginia Water Protection Permit regulation, 9 VAC 25-210, is only necessary for "discharge of dredge, fill, or pollutants into surface waters." In fact, since 2000, a wider range of activities in surface waters has been covered by this program, including water withdrawals in particular. Secondly, the attachment listing programs for coastal zone management consistency fails to make the connection, saying only that permits under *Virginia Code* section 62.1-44.15:5 are required to excavate in a wetland. These regulatory authorities should be clarified in the new submission of the federal consistency certification as well as in the license application and Draft EIS.

<u>Response</u>

It is understood that a Virginia Water Protection Permit would be required for construction of the intake to address water withdrawal issues as well as any wetland impacts. This clarification will be made in future submittals.

<u>Application Revision</u>

None.

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VDEQ Comment F2(e)

2. *Wetland Management and Water Resources (continued)*

(e) Timing of NRC Action in relation to Virginia Water Protection Permit. DEQ's Office of Wetlands and Water Protection recommends that because of the lack of abundant water resources in the Lake Anna watershed and the possibility that a Virginia Water Protection Permit may not be issued, the Nuclear Regulatory Commission should consider one of the following:

- Do not issue the Early Site Permit until Dominion receives a Virginia Water Protection Permit; or
- Require that Dominion obtain a Virginia Water Protection Permit prior to conducting any work specified in the site redress plan associated with the Early Site Permit.

<u>Response</u>

Dominion does not support the option of deferring the ESP until a Virginia Water Protection Permit is obtained. Such a deferral is not necessary for the ESP process to be completed. As indicated in the withdrawn consistency certification, if a decision is made to proceed with new units, Dominion would obtain any required permits, including a Virginia Water Protection Permit. Further, Dominion commits that it would not conduct any pre-construction work related to the intake and cooling water systems prior to obtaining a Virginia Water Protection Permit and approvals required under sections 316(a) and (b) of the Clean Water Act.

<u>Application Revision</u>

None.

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VDEQ Comment F3

3. Non-point Source Water Pollution Control. Utility companies that undertake land-disturbing activities of 10,000 square feet or more for construction, installation, and maintenance of power lines (including essential supporting activities inside and outside the utility easement, such as sub-stations, staging areas, access roads, and borrow/spoil areas) must file general erosion and sediment control specifications annually with the Department of Conservation and Recreation's Division of Soil and Water Conservation for review and approval in accordance with the Virginia Erosion and Sediment Control Law (*Virginia Code* section 10.1-563.D.). All regulated activities must comply with the Erosion and Sediment Control specifications, irrespective of whether work is undertaken on company property or on an easement owned by another party (including VDOT right-of-way).

Construction of company buildings, facilities, and other structures are not regulated by section 10.1-563.D., and must therefore comply with the requirements of the appropriate local program. Dominion should contact Louisa County (David Fisher, Soil and Water Conservation Director, telephone (540) 967-0401) to ensure compliance with applicable local requirements.

Erosion and Sediment Control specifications should include, at a minimum, a description of all measures and policies that will be implemented on the project site to ensure compliance with the state program. Standard practices (general narrative and plan sheets with appropriate details and symbols) must be provided that meet the requirements of the 19 Minimum Standards in the Virginia Erosion and Sediment Control Regulations (see 4 VAC 50-30-40) that apply. Practices in the most current edition of the *Virginia Erosion and Sediment Control Handbook* must serve as minimum design criteria. Variance requests (especially those for MS-16, Trench Length) must be submitted for approval on a project-specific basis to ensure that site characteristics (soils, topography, adjacent areas) are fully considered.

Specifications covering all planned regulated activities for a given calendar year must be approved by the Department of Conservation and Recreation's Division of Soil and Water Conservation prior to initiation of the project. Questions may be addressed to the Division's central office (Lee Hill, telephone (804) 786-3998).

Response

If Dominion decides to proceed with construction, Dominion will comply with the applicable requirements from the Virginia Erosion and Sediment Control Regulations that govern land-disturbing activities associated with the construction, installation and

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maintenance of power lines. However, it has not yet been determined whether additional power line construction will be needed.

If needed, required permits would be obtained prior to commencing such activities. Likewise, specifications that address the measures and policies to be implemented for any planned, regulated activities would be prepared in accordance with the then current version of the Virginia Erosion and Sediment Control Handbook. These specifications would be submitted in a timely manner in order that agency approval would be obtained prior to initiating those activities, and similarly on a calendar-year basis thereafter.

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None.

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VDEQ Comment F4

> *4. Point Source Water Pollution Control.* As indicated above (item 2(b)(i)), the impingement and entrainment issue will fall under the new regulations pursuant to Section 316(b) of the Clean Water Act and be addressed in the facility's Virginia Pollutant Discharge Elimination System (VPDES) permit. Whether the new unit would be treated as an existing intake or a new intake under the section 316(b) regulations is not yet clear. (See "Regulatory and Coordination Needs Summary," item 1, below.)

Response

See the response VDEQ comment F2(b)(i).

Application Revision

None.

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VDEQ Comment F5(a)

> *5. Air Pollution Control*
>
> *(a) Permitting Requirements.* According to DEQ's Northern Virginia Regional Office, the project does not appear to require any air pollution control permits at this time. In light of the fact that the Application mentions concrete batch plants, however, we recommend that Dominion verify this "no permits required" conclusion with DEQ's Northern Virginia Regional Office (John Bowden, telephone (703) 583-3880) following completion of the design phase of the project.

Response

VDEQ regulates airborne emissions at the North Anna site. The number of new unit-related, non-radiological air emission sources at the site is not known at this time. Potential emission sources during plant operation may include auxiliary boilers, stand-by diesel generators, and cooling towers, as well as concrete batch plants during construction. If a decision were made to build new units, Dominion would confirm its project-specific air permitting requirements with the appropriate VDEQ Regional Office following completion of the design phase of the project, including confirmation of any requirements that apply specifically to concrete batch plants.

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None.

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VDEQ Comment F5(b)

5. Air Pollution Control (continued)

(b) Fugitive Dust Rules. The Application did not indicate a commitment to abide by fugitive emissions rules. During construction, fugitive dust must be kept to a minimum by using control methods outlined in 9 VAC 5-50-60 et seq. of the Regulations for the Control and Abatement of Air Pollution. These precautions include, but are not limited to, the following:

- Use, where possible, of water or chemicals for dust control;
- Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials;
- Covering of open equipment for conveying materials; and
- Prompt removal of spilled or tracked dirt or other materials from paved streets and removal of dried sediments resulting from soil erosion.

Response

ER Section 4.4.1.2.2 identifies the fugitive dust rules as an applicable standard. Fugitive dust generated during earth-moving and material-handling activities may include emissions from haul roads, wind erosion of exposed surfaces and storage piles, and other activities in which the material is removed, stored, transported or redistributed.

Dominion is committed to complying with the applicable Commonwealth of Virginia fugitive emissions rules that govern the construction and operation phases of the new units. If Dominion decides to proceed with construction, specific mitigation measures to reasonably keep the generation of fugitive dust to a minimum would be identified in a dust control plan or similar document, prepared prior to initiating project construction activities.

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None.

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VDEQ Comment F5(c)

5. Air Pollution Control (continued)

(c) Open Burning Rules. If project activities include the burning of construction or demolition material, this activity must meet the requirements of the Regulations for open burning (9 VAC 5-40-5600 et seq.), and it may require a permit. The Regulations provide for, but do not require, the local adoption of a model ordinance concerning open burning. The applicant should contact Louisa County officials to determine what local requirements, if any, exist. The model ordinance includes, but is not limited to, the following provisions:

- All reasonable effort shall be made to minimize the amount of material burned, with the number and size of the debris piles;
- The material to be burned shall consist of brush, stumps and similar debris waste and clean burning demolition material;
- The burning shall be at least 500 feet from any occupied building unless the occupants have given prior permission, other than a building located on the property on which the burning is conducted;
- The burning shall be conducted at the greatest distance practicable from highways and air fields;
- The burning shall be attended at all times and conducted to ensure the best possible combustion with a minimum of smoke being produced;
- The burning shall not be allowed to smolder beyond the minimum period of time necessary for the destruction of the materials; and
- The burning shall be conducted only when the prevailing winds are away from any city, town or built-up area.

Response

If Dominion decides to proceed with construction and if open burning activities were considered necessary during construction of the new units, Dominion would contact Louisa County officials (or other cognizant agencies – for example, the Department of Forestry) to determine what local requirements, if any, exist.

Dominion is committed to meeting the requirements of the air quality regulations for open burning set forth by VDEQ and, if applicable, Louisa County, as well as any relevant regulations established by the Virginia Department of Forestry.

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None.

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VDEQ Comment AP1

Advisory Policies and Other Environmental Issues

1. Natural Heritage Resources. The Department of Conservation and Recreation has searched its Biotics Data System for occurrences of natural heritage resources in the project area. "Natural heritage resources" are defined as the habitat of rare, threatened, or endangered plants and animals, unique or exemplary natural communities, significant geologic formations, and similar features of scientific interest. The Department of Conservation and Recreation (DCR) reports that natural heritage resources have not been documented in the project area.

The Department of Agriculture and Consumer Services (VDACS) has responsibility for state-listed endangered or threatened plant and insect species. VDACS indicates that the data bases maintained by the Department of Game and Inland Fisheries and the U.S. Fish and Wildlife Service, with whom Dominion consulted concerning endangered species, have incomplete records of state-protected plant and insect species. Recent changes in regulations implementing the Virginia Endangered Plant and Insect Species Act will necessitate further review of the project by VDACS or by DCR's Natural Heritage Division.

Under a memorandum of agreement between the Department of Conservation and Recreation and the Department of Agriculture and Consumer Services, DCR represents VDACS in commenting on potential impacts on state-listed threatened and endangered plant and insect species. According to DCR's records, the proposed project would not affect any documented state-listed plants or insects.

Response

Dominion understands that the Virginia Department of Agriculture and Consumer Services (VDACS) and the Virginia Department of Conservation and Recreation (VDCR) have the responsibility for maintaining state-listed species databases. Following consultation with state agencies, Dominion agrees with the VDCR's findings that impacts from work relevant to the ESP site project would not affect any documented state-listed plants or insects. In addition, previous findings from NRC's License Renewal GEIS Supplement 7 conclude that impacts on species around the North Anna site and associated transmission lines would be small.

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None.

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VDEQ Comment AP2

2. *Recreation Impacts.* The increased water withdrawal needed for new generating units would be likely to reduce lake levels during the summer and fall due to increased power plant demand and evaporation. Most of the 43,000 anglers visiting this important recreational lake every year use the ramps at the State Park or those belonging to commercial operators to gain access to the Lake. Pleasure traffic greatly exceeds angler traffic, by as much as 10 to 15 times according to DGIF wardens. Increased drawdowns proposed to serve the new units would adversely affect lake access, and local economic conditions in the process. For example, during the 2002 drought, the reservoir pool dropped from 250 feet above mean sea level to 245.1 feet, and most boat ramps could not support launches. If the third generating unit had been added in that situation, the drawdown would have been an additional 2.5 feet, or 242.6 feet MSL. The Draft EIS should provide a full analysis of the impacts of the proposed units upon Lake recreation, along with an analysis of potential mitigation of such impacts. The analysis should include the time of year (presumably in the fall) that drawdowns occur (see "Additional Analysis Needs," item 3, below).

The project may affect the views from across the Lake as well as from Route 76, the interstate bicycle route. Designs for development of the proposed site should include efforts to minimize these visual impacts, according to the Department of Conservation and Recreation.

Response

VDEQ's comment suggests that the increase in lake drawdown caused by the addition of Unit 3 would adversely affect lake access and local economic conditions in the process. VDEQ, citing results presented in ER Section 5.2.2.2, correctly notes that the drawdown would have been an additional 2.5 feet during the 2002 drought. (In terms of precipitation, water year 2002 was the driest year on record out of the 108-year period of record for the Virginia Division 2 climate region.) It is noted that an extended drought period (longer than 1 year) would be necessary to have the drawdown effect anticipated. Results produced from the water balance model and presented in ER Figure 5.2-3 show that the additional lake drawdown caused by adding Unit 3 is significantly less in non-drought years. This figure also shows that the minimum lake levels occur in the latter half of the calendar year, which is generally outside of peak recreational periods. Table 1 below summarizes the minimum lake elevation for the latter half of each year in the 1978-2002 period simulated along with the date on which the minimum lake elevation would have occurred. Data are provided for both pre-project (existing units by themselves) and post-project (existing units plus Unit 3) conditions. The last column in Table 1 represents the difference between post- and pre-project minimum lake elevations for each year.

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Table 1. Minimum Lake Elevation for the Latter Half of Years 1978-2002

Year[1]	Existing Units		Existing Units + Unit 3		Difference in Minimum Lake Elevation (ft)
	Minimum Lake Elevation (ft MSL)	Date of Minimum Lake Elevation	Minimum Lake Elevation (ft MSL)	Date of Minimum Lake Elevation	
1978	248.44	11/5/78	248.22	11/5/78	-0.22
1979	250.08	7/29/79	249.96	7/29/79	-0.12
1980	248.47	10/26/80	247.74	10/26/80	-0.73
1981	248.03	10/11/81	246.37	10/11/81	-1.66
1982	249.49	10/10/82	249.02	11/14/82	-0.47
1983	248.62	10/2/83	248.01	10/9/83	-0.61
1984	249.89	9/16/84	249.68	9/23/84	-0.21
1985	249.68	8/4/85	249.35	8/4/85	-0.33
1986	248.75	10/12/86	247.96	10/12/86	-0.79
1987	249.01	8/23/87	248.51	8/23/87	-0.50
1988	248.95	10/23/88	248.36	10/23/88	-0.59
1989	249.98	8/27/89	249.89	8/27/89	-0.09
1990	249.71	9/30/90	249.27	9/30/90	-0.44
1991	248.87	11/10/91	248.19	11/10/91	-0.68
1992	249.67	10/18/92	249.26	10/18/92	-0.41
1993	248.37	11/14/93	247.64	11/14/93	-0.73
1994	249.96	10/2/94	249.84	7/3/94	-0.12
1995	249.34	9/17/95	249.02	9/17/95	-0.32
1996	250.06	9/22/96	250.03	9/22/96	-0.03
1997	249.35	10/5/97	248.66	10/5/97	-0.69
1998	247.83	11/22/98	247.08	12/20/98	-0.75
1999	248.37	8/15/99	247.73	8/22/99	-0.64
2000	249.51	11/12/00	248.78	11/26/00	-0.73
2001	247.33	12/30/01	246.36	12/30/01	-0.97
2002	245.07	10/13/02	242.61	10/13/02	-2.46

[1] Minimum lake elevations identified from July-December period of each year to ensure independence of events.

The Table 1 results indicate that annual minimum lake elevations under post-project conditions are 0.03 to 2.46 feet lower than for pre-project conditions, with this difference averaging 0.61 feet. The greatest difference occurs during drought years, such as those that occurred in 1981 (1.66 feet) and 2002 (2.46 feet). During non-drought years [see the response to VDEQ Comment F2(c) for identification of drought years], the differences in minimum lake elevations are significantly less. The Table 1 results further indicate that the minimum lake elevation occurs most frequently in October for the

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existing units by themselves (10 out of 25 years) and for the existing units plus Unit 3 (8 out of 25 years).

Note that with Dominion's decision to use dry cooling towers for Unit 4 [see the response to VDEQ Comment F1(b)], the impact to lake levels due to the addition of this unit would be small.

With respect to the recreational impact due to the additional drawdown from operation of Unit 3, the analysis of the effects in non-drought years shows that the overall impacts on the lake levels are relatively small, with the minimum lake levels typically being greater than, or slightly less than, the 248 foot level, mainly in the fall months. Throughout the summer months, the lake levels would be higher than these minimum levels. Although the recreational use of the lake would still be high in the early fall, the greatest use would be during the summer months. Therefore, the impacts on the recreational use of the lake due to decreases in lake level during these non-drought years would be small during the summer months when recreational use is at its peak. Furthermore, the information in Table 1 demonstrates that even with a new Unit 3 in operation, the lake level would have dropped to 245 ft msl (where the VDEQ indicates that most boat ramps could not support launches), only one year in the last 24 and that was during the record 2002 drought.

The potential for visual impacts is addressed in the ER Sections 5.8.1 and 5.8.2. It was concluded that the magnitude of any visual impacts would be specific to the design and layout of the power plant to be constructed, especially the selection of cooling systems. If a decision were made to proceed with new units, a detailed impact analysis using the selected reactor would be performed as part of detailed engineering and described in the COL application. Part of this impact analysis would be to develop mitigation measures to reduce the visual impacts, if needed.

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See the response to VDEQ Comment AA1.

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VDEQ Comment AP3

3. VPDES Stormwater General Permit Applicability. According to DEQ's Northern Virginia Regional Office, the disturbance of approximately 200 acres of land on the south side of Lake Anna for the proposed project will necessitate permit coverage under the Virginia Pollutant Discharge Elimination System (VPDES) permit for stormwater discharges associated with construction activity. Questions on fulfillment of this requirement may be addressed to DEQ's Northern Virginia Regional Office (John Bowden, telephone (703) 583-3880).

Response

If a decision is made to proceed with new units, necessary permits for stormwater discharges would be obtained prior to any construction-related activity associated with the project.

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None.

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VDEQ Comment AP4

4. *Solid and Hazardous Waste Management.* The Application addressed solid and hazardous waste issues, but did not include a search of waste-related databases, according to DEQ's Waste Division. The Waste Division did a cursory review of its data files and did not find any contamination sites that might affect or be affected by the proposed project.

Any soil that is suspected of contamination, or wastes that are generated, must be tested and disposed of in accordance with applicable federal, state, and local laws and regulations. These include, but are not limited to, the Virginia Waste Management Act (*Virginia Code* sections 10.1-1400 et seq.), the Virginia Hazardous Waste Management Regulations (9 VAC 20-60), and the Virginia Solid Waste Management Regulations (9 VAC 20-80). (For additional citations, see the enclosed DEQ memo, Modena to Irons, dated January 29, 2004).

The Application addressed pollution prevention. DEQ encourages Dominion to implement pollution prevention principles in all projects, including the reduction of waste materials at the source, re-use of materials, and recycling of waste materials.

Response

Dominion recognizes that any soil suspected of contamination or any waste generated will be disposed of in accordance with applicable federal, state, and local laws and regulations. If a decision is made to proceed with new units, pollution prevention principles would be implemented where appropriate and practicable.

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None.

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VDEQ Comment AP5

> *5. Alternatives Discussion.* As mentioned above, the Draft EIS should demonstrate consideration and analysis of a single new unit with a cooling tower and Lake Anna as a water source (see "Federal Consistency...," items 1(e) and 2(b)(ii), above). Moreover, it should consider alternatives to the entire proposal as a means of ensuring that significant environmental impacts do not occur to the fishery resources in and downstream of Lake Anna (see "Federal Consistency...," item 1(e), above).

Response

See the response to VDEQ Comment F1(d).

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None.

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VDEQ Comment AP6

6. Local and Regional Concerns. The Thomas Jefferson Planning District Commission considered this review at its regular meeting on January 8, 2004. The Commission had no comment on the project.

Response

No response is required to this comment.

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None.

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VDEQ Comment AA1

Additional Analysis Needs

1. Downstream Flows. DEQ's Office of Wetlands and Water Protection recommends that a range of variability study be performed, comparing the pre- and post-project Index of Hydrologic Alterations for the North Anna River immediately below the dam. The methodology for conducting such a study may be found at:

http://www.conserveonline.org/2000/12/a/en/iha_meth.pdf

DEQ's Office of Wetlands and Water Protection is interested in whether and to what extent the pre- and post-project conditions are different for the 90-day minima, creating long-term low-flow stress conditions. The range of variability analysis may not show a significant change in pre- and post-project conditions. The minimum flow release (20 cfs) is above the extreme minimum flows experienced by the river in its natural pre-dam state in the 1930 drought and similar to low flows in the 1933 drought. However, the full range of the record needs to be examined.

In addition, DEQ's Office of Wetlands and Water Protection is interested in whether the Lake and reactors have significantly changed the Julian date of annual maxima which could affect spring spawning. It is possible that the watershed and wintertime stream flows are large enough that the Lake returns to a full condition each spring, and the Julian date of annual maxima is not changed by the power plants, but the simulation modeling and range of variability analysis should be done to confirm this.

Performance of these statistical studies does not require field work, so they could be initiated immediately, and the results reported in the Draft Environmental Impact Statement ("Draft EIS").

Response

As recommended by the VDEQ, Indicators of Hydrologic Alteration (IHA) have been calculated for the outflow from the North Anna Dam under both pre- and post-impact conditions, and the Range of Variability Approach (RVA) has been applied to assess hydrologic alteration. These analyses have been performed using the IHA software package (Reference 1), which calculates statistical descriptions of the streamflow record and changes in these statistics for 33 hydrologic parameters. These parameters are organized into 5 groups that are intended to characterize the following:

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- Magnitude of monthly water conditions
- Magnitude and duration of annual extreme water conditions
- Timing of annual extreme water conditions
- Frequency and duration of high and low pulses
- Rate and frequency of water condition changes

Richter et al. (References 2-4) describe the methodology that is used by the IHA software package to perform the IHA and RVA analyses. The application of this methodology to the North Anna River and associated results are described below.

IHA were calculated for the Lake Anna weekly outflows as predicted by the water balance model described in ER Section 5.2.2.1. The period of record for this simulation includes water years 1979-2002 (24 years). Daily outflows, required as input to the IHA software package, were obtained through linear interpolation of the weekly time series. The pre-impact condition is defined to be Lake Anna in its current, impounded condition with the existing Units 1 and 2 using the lake for condenser cooling. The post-impact condition assumes the addition of Unit 3 with a once-through system for condenser cooling. Note that the post-impact condition does not consider Unit 4. With Dominion's decision to use dry cooling towers for Unit 4 [see the response to VDEQ Comment F1(b)], the impact to lake outflows due Unit 4 would be small.

Results of the statistical analyses are summarized in Tables 1, 2, and 3. Table 1 includes the 10%, 25%, 50%, 75% and 90% quantiles for each of the 33 hydrologic parameters for pre- and post-impact conditions. Table 2 summarizes the results of the IHA analysis, provides the medians and coefficients of dispersion for each hydrologic parameter in a "scorecard" format, and quantifies changes in the IHA between the pre-impact and post-impact water regimes. Table 3 provides the results of the RVA analysis. In each of these tables, the IHA statistics have been calculated non-parametrically as recommended in the IHA User's Manual (Reference 1). Note that post-impact period is assumed to extend from 2003-2026 for the purpose of comparing pre- and post-impact streamflow statistics. Also note that several IHA are associated with durations of less than 7 days (e.g., 1-day minimum flow). Because the daily outflows were obtained through linear interpolation of the weekly values, any of the IHA associated with durations of less than 7 days may not be representative.

With respect to the VDEQ's comments above regarding the 90-day minimum flow, the results in Tables 1 and 2 indicate that there is no change in the median 90-day minimum flow as a consequence of adding Unit 3. The results do indicate greater variability in the 90-day minimum flow with the addition of Unit 3. The VDEQ also expressed interest in any significant changes to the Julian date of annual maximum, which could affect spring spawning. Results included in Tables 1 and 2 demonstrate that the Julian date of the annual maximum does not change significantly with the addition of Unit 3. This would indicate that the spring spawning regime in the North Anna River below the North Anna Dam would not be impacted by the operation of a new Unit 3 on Lake Anna.

<u>References</u>

1. Indicators of Hydrologic Alteration, User's Manual, The Nature Conservancy with Smythe Scientific Software, July 2001.

2. Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. A method for assessing hydrologic alteration within ecosystems. *Conservation Biology* 10:1163-1174, 1996.

3. Richter, B.D, J.V. Baumgartner, R. Wigington, and D.P. Braun. How much water does a river need? *Freshwater Biology* 37:231-249, 1997

4. Richter, B.D., J.V. Baumgartner, D.P. Braun, and J. Powell, A Spatial Assessment of Hydrologic Alteration Within a River Network. *Regul. Rivers: Res. Mgmt.* 14:329-340, 1998.

<u>**Application Revision**</u>

ER Section 5.2.2.2 will be revised to read as follows:

5.2.2.2 Analysis and Evaluations of Impacts on Water Use

The results described in Section 5.2.2.1 indicate there would be water-use impacts associated with the operation of Unit 3. These impacts include reductions in the volume of water available for release from the North Anna Dam, which would decrease the volume of water available for downstream users. Impacts also include increases in lake drawdown during the summer months, which could impact other lake users. These impacts are analyzed and evaluated below.

Results included in Figure 5.2-2 and Table 5.2-3 quantify the impact of the releases from the North Anna Dam that would occur with the addition of Unit 3. Given that the minimum releases would comply with the existing VPDES permit Lake Level Contingency Plan (Reference 2), there would be no impact on downstream water users in terms of the minimum flow rate in the North Anna River. The duration of the minimum flow release rates would increase with the addition of Unit 3, however. For the existing units, the duration for which the minimum release is less than or equal to 40 cfs would be 43.9 percent of the time; and the duration for which the minimum release is 20 cfs would be 5.3 percent of the time. Comparable durations with the addition of Unit 3 are 52.4

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percent of the time for flows less than or equal to 40 cfs, and 11.8 percent of the time for a flow of 20 cfs. Potential impacts would be greatest in the reach of the North Anna River extending from below the North Anna Dam to its confluence with the South Anna River.

To better quantify impacts to instream flows in the North Anna River, Indicators of Hydrologic Alteration (IHA) have been calculated for the outflow from the North Anna Dam under both pre- and post-impact conditions, and the Range of Variability Approach (RVA) has been applied to assess hydrologic alteration. These analyses have been performed using the methodology proposed by Richter et al. (References 4-6), which calculates statistical descriptions of the streamflow record and changes in these statistics for 33 hydrologic parameters. These parameters are organized into 5 groups that are intended to characterize the following:

- Magnitude of monthly water conditions
- Magnitude and duration of annual extreme water conditions
- Timing of annual extreme water conditions
- Frequency and duration of high and low pulses
- Rate and frequency of water condition changes

The IHA software package (Reference 7) has been used to perform the IHA and RVA analyses. The application of this methodology to the North Anna River and associated results are described below.

IHA were calculated for the Lake Anna weekly outflows as predicted by the water balance model described in ER Section 5.2.2.1. The period of record for this simulation includes water years 1979-2002 (24 years). Daily outflows, required as input to the IHA software package, were obtained through linear interpolation of the weekly time series. The pre-impact condition is defined to be Lake Anna in its current, impounded condition with the existing Units 1 and 2 utilizing the lake for condenser cooling. The post-impact condition assumes the addition of Unit 3 with a once-through system for condenser cooling, and the addition of Unit 4 with a closed-cycle, dry tower system for condenser cooling. Note that the heat dissipation system selected for Unit 4 will have no to negligible impacts to lake levels or outflows.

Results of the statistical analyses are summarized in Tables 5.2-5, 5.2-6, and 5.2-7. Table 5.2-5 includes the 10%, 25%, 50%, 75% and 90% quantiles for each of the 33 hydrologic parameters for pre- and post-impact conditions. Table 5.2-6 summarizes the results of the IHA analysis, provides the medians and coefficients of dispersion for each hydrologic parameter in a "scorecard" format, and quantifies changes in the IHA between the pre-impact and post-impact water regimes. Table 5.2-7 provides the results of the RVA analysis. In each of these tables, the IHA statistics have been calculated non-parametrically as

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recommended in the IHA User's Manual (Reference 7). Note that post-impact period is assumed to extend from 2003-2026 for the purpose of comparing pre- and post-impact streamflow statistics. Also note that several IHA are associated with durations of less than 7 days (e.g., 1-day minimum flow). Because the daily outflows were obtained through linear interpolation of the weekly values, any of the IHA associated with durations of less than 7 days may not be representative.

The results in Tables 5.2-5, 5.2-6, and 5.2-7 indicate that there are no changes in the median 7-day, 30-day and 90-day minimum flows as a consequence of adding Unit 3. The results do indicate greater variability in the minimum flows with the addition of Unit 3. Results included in Tables 5.2-5, 5.2-6, and 5.2-7 also demonstrate that the Julian date of the annual maximum does not change significantly with the addition of Unit 3. This would indicate that the spring spawning regime in the North Anna River below the North Anna Dam would not be impacted by the operation of a new Unit 3 on Lake Anna.

Results presented in Figure 5.2-3 and Table 5.2-4 quantify the impact on lake levels that would occur with the addition of Unit 3. Figure 5.2-3 indicates that the maximum annual drawdown in most years would not differ greatly from the current operation of the existing units. This figure also shows that the minimum lake levels occur in the latter half of the calendar year. To further quantify the impact on lake levels associated with the addition of Unit 3, the minimum lake elevation for the latter half of each year in the 1978-2002 period simulated along with the date on which the minimum lake elevation would have occurred have been summarized in Table 5.2-8. Data are provided for both pre-impact (existing units by themselves) and post-impact (existing units plus Unit 3) conditions. The last column in Table 5.2-8 represents the difference between post- and pre-impact minimum lake elevations for each year.

The Table 5.2-8 results indicate that annual minimum lake elevations under post-impact conditions are 0.03 to 2.46 feet lower than for pre-impact conditions, with this difference averaging 0.61 feet. The greatest difference occurs during drought years, such as those that occurred in 1981 (1.66 feet) and 2002 (2.46 feet). During non-drought years, the differences in minimum lake elevations are significantly less. The Table 5.2-8 results further indicate that the minimum lake elevation occurs most frequently in October for the existing units by themselves (10 out of 25 years) and for the existing units plus Unit 3 (8 out of 25 years). With respect to the recreational impact due to the additional drawdown from operation of Unit 3, the analysis of the effects in non-drought years shows that the overall impacts on the lake levels are relatively small, with the minimum lake levels typically being greater than, or slightly less than, the 248 foot level, mainly in the fall months. Throughout the summer months, the lake levels would be higher than these minimum levels. Although the recreational use of the lake would still be high in the early fall, the greatest use would be during the summer

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months. Therefore, the impacts on the recreational use of the lake due to decreases in lake level during these non-drought years would be small.

Lake drawdown to Elevation 244 ft msl and below would impact the existing units. The Technical Requirements Manual for the existing units currently requires plant shutdown when the lake level drops below Elevation 244 ft msl. Results included in Table 5.2-4 indicate that lake levels would fall to or below Elevation 244 ft msl 1.1 percent of the time when Unit 3 is added. Dominion would work with Virginia Power to change the minimum operating level of the existing units to 242 ft msl.

No other water-use impacts on surface water or groundwater users due to the normal operation of a new unit or units at the ESP site are anticipated other than those described above.

The following new tables will be added to ER Section 5.2.2.2:

- Table 5.2-5 (Table 1 in this response)
- Table 5.2-6 (Table 2 in this response)
- Table 5.2-7 (Table 3 in this response)
- Table 5.2-8 (Table 1 in response to DEQ Comment AP2)

The following new references will be added to Section 5.2 References:

4. Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. A method for assessing hydrologic alteration within ecosystems. *Conservation Biology* 10:1163-1174, 1996.

5. Richter, B.D, J.V. Baumgartner, R. Wigington, and D.P. Braun. How much water does a river need? *Freshwater Biology* 37:231-249, 1997

6. Richter, B.D., J.V. Baumgartner, D.P. Braun, and J. Powell, A Spatial Assessment of Hydrologic Alteration Within a River Network. *Regul. Rivers: Res. Mgmt.* 14:329-340, 1998.

7. Indicators of Hydrologic Alteration, User's Manual, The Nature Conservancy with Smythe Scientific Software, July 2001.

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Table 1. IHA Percentile Data North Anna River

	Pre-Impact Period: 1979-2002 (24 years)						Post-Impact Period: 2003-2026 (24 years)					
	10%	25%	50%	75%	90%	(75-25)/50	10%	25%	50%	75%	90%	(75-25)/50
Parameter Group #1												
October	40.00	40.00	40.00	120.20	365.40	2.00	20.00	28.39	40.00	44.51	318.69	.40
November	31.33	40 00	126.36	369.14	520.52	2.60	20.00	40.00	57.84	334.97	425.66	5.10
December	32.58	46.97	225.08	396.67	635.22	1.55	20.00	40.00	167.17	376.99	606.46	2.02
January	40.00	122.51	388.23	578.91	802.92	1.18	26.77	40.00	369.04	557.28	764.30	1.40
February	42.59	220 21	375.13	707.84	1423.49	1.30	40.00	100.21	351.33	686.30	1403.55	1.67
March	108.30	277.94	523.58	740.93	1247.35	.88	95.11	245.01	475.92	716.40	1222.78	.99
April	54.76	165.76	396.48	471.49	1115.81	.77	47.67	143.24	367.48	442.91	1088.27	.82
May	40.00	91.01	161.05	371.43	665.01	1.74	40.00	67.73	140.89	340.48	634.49	1.94
June	40.00	42.69	100.89	150.76	385.22	1.07	33.33	40.00	78.57	129.09	354.54	1.13
July	40.00	40.00	46.52	85.88	315.73	.99	29.03	40.00	40.00	50.25	277.74	.26
August	40.00	40.00	40.20	107.07	312.76	1.67	20.14	40.00	40.00	66.10	281.30	.65
September	40.00	40.00	40.00	40.90	370.44	.02	28.00	39.79	40.00	40.00	332.57	.01
Parameter Group #2												
1-day minimum	30.00	40.00	40.00	40.00	40.00	.00	20.00	20.00	40.00	40.00	40.00	.50
3-day minimum	30.00	40.00	40.00	40.00	40.00	.00	20.00	20.00	40.00	40.00	40.00	.50
7-day minimum	30.00	40 00	40.00	40.00	40.00	.00	20.00	20.00	40.00	40.00	40.00	.50
30-day minimum	26.00	40.00	40.00	40.00	40.00	.00	20.00	20.00	40.00	40.00	40.00	.50
90-day minimum	26.56	40.00	40.00	49.29	94.14	.23	20.00	20.44	40.00	40.00	73.40	.49
1-day maximum	268.11	1070.27	1618.86	2831.02	3871.94	1.09	242.98	908.40	1587.92	2798.42	3851.00	1.19
3-day maximum	261.40	1027.20	1595.72	2521.88	3603.93	.94	226.33	888.22	1564.91	2489.27	3582.93	1.02
7-day maximum	250.39	965.61	1560.21	2044.34	3227.55	.69	200.62	856.29	1529.32	2013.57	3206.42	.78
30-day maximum	200.97	601.78	871.71	1314.51	1630.08	.82	147.52	564.94	844.63	1287.24	1608.98	.86
90-day maximum	119.47	411.83	597.18	796.76	1162.81	.64	80.12	355.63	567.63	769.90	1139.01	.73
Number of zero days	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Base flow	.08	.10	.15	.25	.65	.98	.07	.10	.15	.24	.60	.94
Parameter Group #3												
Date of minimum	168.00	275.00	275.00	275.00	288.00	.00	273.00	275.00	275.00	275.00	281.50	.00
Date of maximum	338.50	37.50	85.00	169.75	275.00	.36	338.50	32.50	83.00	143.00	263.50	.30

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Table 1. IHA Percentile Data North Anna River

	Pre-impact Period: 1979-2002 (24 years)						Post-impact Period: 2003-2026 (24 years)					
	10%	25%	50%	75%	90%	(75-25)/50	10%	25%	50%	75%	90%	(75-25)/50
Parameter Group #4												
Low pulse count	.00	.00	.00	.00	.50	.00	.00	.00	.00	1.00	2.00	.00
Low pulse duration	.00	.00	.00	.00	27.50	.00	.00	.00	.00	5.75	65.00	.00
High pulse count	.50	3.00	4.00	6.75	7.50	.94	.50	3.00	4.00	6.00	7.00	.75
High pulse duration	4.67	14.25	17.64	27.74	40.38	.76	1.67	12.81	15.67	21.28	32.71	.54
Parameter Group #5												
Rise rate	13.29	25.42	35.30	52.71	64.81	.77	10.11	25.58	35.20	49.43	73.89	.68
Fall rate	-63.38	-48.80	-34.84	-21.28	-8.74	-.79	-66.06	-50.28	-38.26	-24.16	-8.37	-.68
Number of reversals	2.50	13.50	19.00	21.75	24.50	.43	2.00	11.00	15.00	19.75	22.00	.58

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Table 2. Non-Parametric IHA Scorecard, North Anna River

	Pre-impact period: 1979-2002 (24 years)	Post-impact period: 2003-2026 (24 years)
Watershed area	343.00	
Mean annual flow	264.85	240.43
Mean flow/area	.77	.70
Annual C. V.	.90	1.05
Flow predictability	.45	.43
Constancy/predictability	.71	.70
% of floods in 60d period	.31	.31
Flood-free season	2.00	5.00

	MEDIANS		COEFF. of DISP.		DEVIATION FACTOR		SIGNIFICANCE COUNT	
	Pre	Post	Pre	Post	Medians	C.V.	Medians	C.V.
Parameter Group #1								
October	40.0	40.0	2.00	.40	.00	.80	.04	.83
November	126.4	57.8	2.60	5.10	.54	.96	.81	.33
December	225.1	167.2	1.55	2.02	.26	.30	.64	.43
January	388.2	369.0	1.18	1.40	.05	.19	.68	.53
February	375.1	351.3	1.30	1.67	.06	.28	.73	.49
March	523.6	475.9	.88	.99	.09	.12	.81	.88
April	396.5	367.5	.77	.82	.07	.06	.71	.91
May	161.0	140.9	1.74	1.94	.13	.11	.77	.71
June	100.9	78.6	1.07	1.13	.22	.06	.52	.93
July	46.5	40.0	.99	.26	.14	.74	.14	.71
August	40.2	40.0	1.67	.65	.01	.61	.15	.74
September	40.0	40.0	.02	.01	.00	.76	.00	.64
Parameter Group #2								
1-day minimum	40.0	40.0	.00	.50	.00	999999.00	.00	.00
3-day minimum	40.0	40.0	.00	.50	.00	999999.00	.00	.00
7-day minimum	40.0	40.0	.00	.50	.00	999999.00	.00	.00
30-day minimum	40.0	40.0	.00	.50	.00	999999.00	.00	.00
90-day minimum	40.0	40.0	.23	.49	.00	1.10	.01	.22
1-day maximum	1618.9	1587.9	1.09	1.19	.02	.09	.94	.79
3-day maximum	1595.7	1564.9	.94	1.02	.02	.09	.93	.81
7-day maximum	1560.2	1529.3	.69	.76	.02	.09	.85	.82

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Table 2. Non-Parametric IHA Scorecard, North Anna River

	MEDIANS		COEFF. of DISP.		DEVIATION FACTOR		SIGNIFICANCE COUNT	
	Pre	Post	Pre	Post	Medians	C.V.	Medians	C.V.
30-day maximum	871.7	844.6	.82	.86	.03	.05	.81	.90
90-day maximum	597.2	567.6	.64	.73	.05	.13	.63	.78
Number of zero days	.0	.0	.00	.00	999999.00	999999.00	.00	.00
Base flow	.2	.2	.98	.94	.01	.04	1.00	.93
Parameter Group #3								
Date of minimum	275.0	275.0	.00	.00	.00	999999.00	.00	.00
Date of maximum	85.0	83.0	.36	.30	.01	.16	.73	.75
Parameter Group #4								
Low pulse count	.0	.0	.00	.00	999999.00	999999.00	.00	.00
Low pulse duration	.0	.0	.00	.00	999999.00	999999.00	.00	.00
High pulse count	4.0	4.0	.94	.75	.00	.20	.51	.58
High pulse duration	17.6	15.7	.76	.54	.11	.29	.38	.76
The low pulse threshold is 40.00								
The high pulse level is 349.79								
Parameter Group #5								
Rise rate	35.3	35.2	.77	.68	.00	.12	1.00	.81
Fall rate	-34.8	-38.3	-.79	-.68	.10	.14	.71	.66
Number of reversals	19.0	15.0	.43	.58	.21	.34	.33	.51

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Table 3. IHA Non-Parametric RVA Scorecard, North Anna River

	Pre-impact period: 1979-2002				Post-impact period: 2003-2026				RVA Categories		Hydrologic Alteration (Middle Category)
	Medians	Coeff. of Variance	Range Limits Low	Range Limits High	Medians	Coeff. of Variance	Range Limits Low	Range Limits High	Low	High	
Parameter Group #1											
October	40.0	2.00	31.0	660.4	40.0	.40	20.0	632.5	40.00	47.15	-.13
November	126.4	2.60	20.0	1033.8	57.8	5.10	20.0	1007.6	40.00	336.96	-.07
December	225.1	1.55	20.0	957.0	167.2	2.02	20.0	935.6	75.99	349.75	-.13
January	388.2	1.18	20.0	1810.5	369.0	1.40	20.0	1788.5	180.14	545.41	.13
February	375.1	1.30	20.0	2662.4	351.3	1.67	20.0	2639.9	260.35	567.10	.00
March	523.6	.88	20.0	1514.2	475.9	.99	20.0	1489.0	363.63	657.29	.00
April	396.5	.77	20.0	1308.9	367.5	.82	20.0	1278.9	192.40	434.02	-.13
May	161.0	1.74	20.0	852.7	140.9	1.94	20.0	819.3	124.71	298.15	-.25
June	100.9	1.07	20.0	879.2	78.6	1.13	20.0	846.3	50.82	139.25	.13
July	46.5	.99	20.0	556.7	40.0	.26	20.0	510.1	40.00	64.83	.07
August	40.2	1.67	20.0	397.2	40.0	.65	20.0	385.7	40.00	68.42	.00
September	40.0	.02	20.3	833.1	40.0	.01	20.0	799.2	40.00	40.00	-.24
Parameter Group #2											
1-day minimum	40.0	.00	20.0	40.0	40.0	.50	20.0	40.0	40.00	40.00	-.32
3-day minimum	40.0	.00	20.0	40.0	40.0	.50	20.0	40.0	40.00	40.00	-.32
7-day minimum	40.0	.00	20.0	40.0	40.0	.50	20.0	40.0	40.00	40.00	-.41
30-day minimum	40.0	.00	20.0	181.2	40.0	.50	20.0	103.5	40.00	40.00	-.40
90-day minimum	40.0	.23	20.0	289.9	40.0	.49	20.0	238.0	40.00	41.87	-.17
1-day maximum	1618.9	1.09	40.0	4712.9	1587.9	1.19	20.0	4688.7	1271.88	2327.47	.00
3-day maximum	1595.7	.94	40.0	4655.8	1564.9	1.02	20.0	4631.4	1230.87	2198.12	.00
7-day maximum	1560.2	.69	40.0	4549.0	1529.3	.76	20.0	4524.4	1132.03	1914.16	.13
30-day maximum	871.7	.82	39.7	3426.3	844.6	.86	20.0	3403.3	655.70	1179.77	.00
90-day maximum	597.2	.64	40.0	1939.3	567.6	.73	20.0	1914.0	447.35	676.70	.00
Number of zero days	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Base flow	.15	.98	.07	1.00	.15	.94	.04	1.00	.12	.20	-.13

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Table 3. IHA Non-Parametric RVA Scorecard, North Anna River											
	Pre-impact period: 1979-2002				Post-impact period: 2003-2026				RVA Categories		Hydrologic Alteration (Middle Category)
	Medians	Coeff. of Variance	Range Limits Low	Range Limits High	Medians	Coeff. of Variance	Range Limits Low	Range Limits High	Low	High	
Parameter Group #3											
Date of minimum	275.0	.00	153.0	313.0	275.0	.00	153.0	285.0	275.00	275.00	-.06
Date of maximum	85.0	.36	13.0	343.0	83.0	.30	13.0	343.0	80.50	217.50	.38
Parameter Group #4											
Low Pulse Count	.0	.00	.0	1.0	.0	.00	.0	2.0	.00	.00	-.32
Low Pulse Duration	.0	.00	.0	351.0	.0	.00	.0	107.0	.00	.00	-.23
High Pulse Count	4.0	.94	.0	10.0	4.0	.75	.0	8.0	3.00	5.75	.09
High Pulse Duration	17.6	.76	.0	48.0	15.7	.54	.0	39.0	15.00	20.04	-.30
The low pulse threshold is 40.00											
The high pulse level is 349.79											
Parameter Group #5											
Rise rate	35.3	.77	.0	94.9	35.2	.68	.0	96.3	29.86	42.13	-.25
Fall rate	-34.8	-.79	-72.8	.0	-38.3	-.68	-77.8	.0	-47.35	-22.93	.63
Number of reversals	19.0	.43	.0	27.0	15.0	.58	.0	24.0	15.00	20.75	-.20

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Table 3, IHA Non-Parametric RVA Scorecard, North Anna River

Assessment of Hydrologic Alteration

	Middle RVA Category			High RVA Category			Low RVA Category		
	Expected	Observed	Alter.	Expected	Observed	Alter.	Expected	Observed	Alter.
Parameter Group #1									
October	15.00	13.00	-.13	8.00	5.00	-.38	1.00	6.00	5.00
November	14.00	13.00	-.07	8.00	6.00	-.25	2.00	5.00	1.50
December	8.00	7.00	-.13	8.00	7.00	-.13	8.00	10.00	.25
January	8.00	9.00	.13	8.00	6.00	-.25	8.00	9.00	.13
February	8.00	8.00	.00	8.00	7.00	-.13	8.00	9.00	.13
March	8.00	8.00	.00	8.00	6.00	-.25	8.00	10.00	.25
April	8.00	7.00	-.13	8.00	7.00	-.13	8.00	10.00	.25
May	8.00	6.00	-.25	8.00	7.00	-.13	8.00	11.00	.38
June	8.00	9.00	.13	8.00	5.00	-.38	8.00	10.00	.25
July	15.00	16.00	.07	8.00	5.00	-.38	1.00	3.00	2.00
August	15.00	15.00	.00	8.00	6.00	-.25	1.00	3.00	2.00
September	17.00	13.00	-.24	6.00	5.00	-.17	1.00	6.00	5.00
Parameter Group #2									
1-day minimum	22.00	15.00	-.32	.00	.00	.00	2.00	9.00	3.50
3-day minimum	22.00	15.00	-.32	.00	.00	.00	2.00	9.00	3.50
7-day minimum	22.00	13.00	-.41	.00	.00	.00	2.00	11.00	4.50
30-day minimum	20.00	12.00	-.40	1.00	1.00	.00	3.00	11.00	2.67
90-day minimum	12.00	10.00	-.17	8.00	5.00	-.38	4.00	9.00	1.25
1-day maximum	8.00	8.00	.00	8.00	8.00	.00	8.00	8.00	.00
3-day maximum	8.00	8.00	.00	8.00	7.00	-.13	8.00	9.00	.13
7-day maximum	8.00	9.00	.13	8.00	7.00	-.13	8.00	8.00	.00
30-day maximum	8.00	8.00	.00	8.00	7.00	-.13	8.00	9.00	.13
90-day maximum	8.00	8.00	.00	8.00	7.00	-.13	8.00	9.00	.13
Number of zero days	24.00	24.00	.00	.00	.00	.00	.00	.00	.00
Base flow	8.00	7.00	-.13	8.00	7.00	-.13	8.00	10.00	.25

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Serial No. 04-364
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Table 3. IHA Non-Parametric RVA Scorecard, North Anna River									
Assessment of Hydrologic Alteration									
	Middle RVA Category			High RVA Category			Low RVA Category		
	Expected	Observed	Alter.	Expected	Observed	Alter.	Expected	Observed	Alter.
Parameter Group #3									
Date of minimum	17.00	16.00	-.06	4.00	4.00	.00	3.00	4.00	.33
Date of maximum	8.00	11.00	.38	8.00	6.00	-.25	8.00	7.00	-.13
Parameter Group #4									
Low Pulse Count	22.00	15.00	-.32	2.00	9.00	3.50	.00	.00	.00
Low Pulse Duration	22.00	17.00	-.23	2.00	7.00	2.50	.00	.00	.00
High Pulse Count	11.00	12.00	.09	8.00	7.00	-.13	5.00	5.00	.00
High Pulse Duration	10.00	7.00	-.30	8.00	8.00	.00	6.00	9.00	.50
Parameter Group #5									
Rise rate	8.00	6.00	-.25	8.00	9.00	.13	8.00	9.00	.13
Fall rate	8.00	13.00	.63	8.00	4.00	-.50	8.00	7.00	-.13
Number of reversals	10.00	8 00	-.20	8 00	5.00	-.38	6.00	11.00	.83

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Response to VDEQ Comments

VDEQ Comment AA2

2. In-stream Studies: Usable Habitat as a Function of Flow. DEQ's Office of Wetlands and Water Protection may also recommend further in-stream studies as a supplement to the Draft EIS or as pre-requisite to any permit issuance, depending on confirmation of the concerns expressed above regarding near-perennial low-flow conditions (see "Federal Consistency...," item 2(c), above). This work should characterize weighted usable habitat as a function of flow for the indigenous fishery species in the North Anna River.

DEQ's Office of Wetlands and Water Protection requests the daily output of the simulation models used by Dominion, if it is available in Excel worksheet format, to predict the frequency and duration of the lake drawdown, inflows, evaporation losses, and outflows that were used to develop Tables 5.2.3 and 5.2.4 in the Application.

A statistical analysis of the indicators of hydrologic alteration should be performed, and the results presented in the Draft EIS, according to DEQ's Office of Wetlands and Water Protection.

Response

Bechtel Calculation No. 24830-G-018 (submitted to the NRC in Reference 1) includes the water balance model that was used to assess impacts on lake levels and outflows, which are reported in ER Section 5.2.2. The water balance model was developed using Excel spreadsheets. These spreadsheets are included with the calculation in electronic format. As noted in ER Section 5.2.2.1.3, the water balance modeling was conducted on a weekly basis. The inflows, evaporation losses, outflows, and lake levels used in the model represent weekly (7-day) averages. Daily output is not available.

With respect to the VDEQ's recommendation to conduct a statistical analysis of the indicators of hydrologic alteration, this analysis has been completed and is described in the response to VDEQ Comment AA1.

References

1. March 19, 2004 Letter from Eugene S. Grecheck, Vice President, Nuclear Support Services, Dominion, to U. S. Nuclear Regulatory Commission, Document Control Desk, "North Anna Early Site Permit Application, Lake Anna Modeling Calculations", NRC Accession Number ML040910433.

Application Revision

None.

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Response to VDEQ Comments

VDEQ Comment AA3

> *3. Impact on Recreational Uses of Lake Anna.* The Application does not thoroughly address the water-based recreational uses of Lake Anna. While Table 5.2.4 demonstrates the frequency with which the Lake will fall below certain levels (see "Federal Consistency...," item 2(c) and "Advisory Policies...," item 2, above), we do not know the time of year this occurs and what impact it has on lake recreation. This information should be developed for the Draft EIS for the proposed project.

Response

See the response to VDEQ Comment AP2.

Application Revision

None.

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Serial No. 04-364
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Response to VDEQ Comments

VDEQ Comment AA4

> *4. Submerged Intake Structure.* The Department of Game and Inland Fisheries (DGIF) recommends that Dominion investigate further the addition of a submerged intake structure (a curtain wall as detailed on page 3-5-38 of the Application that would reduce fish impingement and entrainment and align the intake criteria with current DGIF recommendations (see "Federal Consistency....,"item 1(a), above). Results of this analysis should be provided in the Draft EIS for this project.

<u>Response</u>

If a decision is made to proceed with new units, Dominion would evaluate the use of a submerged intake as a temperature mitigation option as described in ER Section 9.4.1.1.3. ER Section 5.3.1.2.5 indicates that a submerged intake, consisting of a solid skimmer wall or a flexible floating curtain in the North Anna Reservoir, could reduce impingement and entrainment rates.

The design of the intake structure would be reviewed by VDEQ in support of a 316(b) determination, which Dominion would seek if it decides to proceed with new units.

<u>Application Revision</u>

None.

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Response to VDEQ Comments

VDEQ Comment AA5

5. Federal Consistency Certification. Dominion's re-submission of the federal consistency certification may be accomplished separately or, as we would recommend, in conjunction with either the Draft or the Final EIS for this project but would, in any case, be subject to the requirements applicable to consistency certifications for federally licensed projects. These appear in the Federal Consistency Regulations at Title 15, Code of Federal Regulations, Part 930, sub-part D ("Consistency for Activities Requiring a Federal License or Permit," sections 930.50 through 930.66). The new consistency certification should reflect not only further development of the project proposal, but also appropriate additional analysis as detailed in this letter. Questions on consistency may be addressed to this Office (Charles Ellis, telephone 698-4488).

Response

Dominion recognizes the need for consultation with the VDEQ and compliance with its Coastal Resources Management Program, in accordance with 15CFR930. Dominion will resubmit the Federal Consistency Certification for the North Anna ESP site during the time period in which the Draft Environmental Impact Statement (EIS) is published and available for review and comment. This consistency submittal will reflect appropriate analyses conducted and conclusions reached to address the relevant coastal zone issues.

Application Revision

None.

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Docket No. 52-008
Response to VDEQ Comments

VDEQ Comment AA6

> *6. Draft Environmental Impact Statement.* Although not required to satisfy the Federal Consistency Regulations, for administrative purposes we recommend that the federal consistency certification be submitted at the same time as the Draft EIS. This would allow for concurrent reviews of the two documents, and the information and analysis in the Draft EIS can support the analysis of the consistency certification. If you have questions about the interplay of the Draft EIS and the consistency certification requirement, please feel free to contact me at telephone 698-4325.

Response

See the response to VDEQ Comment AA5.

Application Revision

None.

Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

VDEQ Comment RC1

Regulatory and Coordination Needs Summary

1. Water Resources Permitting. As indicated previously, the proposed addition of either one or both of the proposed new generating units at the North Anna Power Station will require Virginia Water Protection Permits and, to the extent the land disturbance exceeds one acre, VPDES Stormwater General Permit coverage for construction activities. For water withdrawals requiring Virginia Water Protection Permits, Dominion must apply to DEQ's Office of Wetlands and Water Protection (Joe Hassell, telephone 698-4072). Results of the studies requested or recommended in regard to water resources (see "Additional Analysis Needs," items 1 and 2, above) should be submitted to that Office at 629 East Main Street, 9th floor, Richmond, Virginia 23219, Attn: Joseph P. Hassell. Copies of these study results should be submitted to the Department of Game and Inland Fisheries, attn: Gary Martel (Director, Fisheries Division), 4010 West Broad Street, Richmond, Virginia 23230.

For land disturbance involving one acre or more, Dominion should apply to DEQ's Northern Virginia Regional Office (John Bowden, Deputy Regional Director, telephone (703) 583-3880) for coverage under the VPDES Stormwater General Permit for construction activities. Similarly, the issue of impingement and entrainment effects is to be addressed under new regulations implementing section 316(b) of the Clean Water Act; advice on this matter may be obtained from the same Office or from DEQ's Office of Wetlands and Water Protection (Joe Hassell, telephone (804) 698-4072).

Response

No response is needed for this comment.

Application Revision

None.

Serial No. 04-364
Docket No. 52-008
Response to VDEQ Comments

VDEQ Comment RC2

> *2. Air Permitting.* Questions relating to air quality rules and air permitting, for activities ranging from open burning to operation of concrete batch plants or other fuel-burning equipment, should be addressed to DEQ's Northern Virginia Regional Office (Mr. Terry Darton, Air Permits Manager, telephone (703) 583-3845).

Response

No response is needed for this comment.

Application Revision

None.

Serial No. 04-364
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Response to VDEQ Comments

VDEQ Comment RC3

3. Erosion and Sediment Control; Stormwater Management. Questions relating to the fulfillment of the Erosion and Sediment Control Plan and Stormwater Management Plan requirements should be addressed to the Department of Conservation and Recreation's Soil and Water Conservation Division (Lee Hill, telephone 786-3998). Questions on fulfillment of local erosion control requirements should be addressed to Louisa County (David Fisher, Soil and Water Conservation Director, telephone (540) 967-0401).

Response

No response is needed for this comment.

Application Revision

None.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
6669 Short Lane
Gloucester, VA 23061

Date: October 25, 2004

Project name: NRC's North Anna and Surry Power Stations

Project number: 9064 City/County, VA Surry, Louisa, Hanover, Caroline, Orange, + Spotsylvania

The U.S. Fish and Wildlife Service (Service) has reviewed your request for information on federally listed or proposed endangered or threatened species and designated critical habitat for the above referenced project. The following comments are provided under provisions of the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*).

_____ We believe that the proposed action will not adversely affect federally listed species or federally designated critical habitat because no federally listed species are known to occur in the project area. Should project plans change or if additional information on listed and proposed species becomes available, this determination may be reconsidered.

_____ We recommend that you contact **both** of the following State agencies for site specific information on listed species in Virginia. Each agency maintains a different database and has differing expertise and/or regulatory responsibility:

Virginia Dept. of Game & Inland Fisheries
Environmental Services Section
P.O. Box 11104
Richmond, VA 23230
(804) 367-1000

Virginia Dept. of Conservation and Recreation
Division of Natural Heritage
217 Governor Street, 2nd Floor
Richmond, VA 23219
(804) 786-7951

If either agency indicates a federally listed species **is present**, please resubmit your project description with letters from both agencies attached.

✓ **If appropriate habitat may be present**, we recommend surveys within appropriate habitat by a qualified surveyor. Enclosed are county lists with fact sheets that contain information the species' habitat requirements and lists of qualified surveyors. If this project involves a Federal agency (Federal permit, funding, or land), we encourage the Federal agency to contact this office if appropriate habitat is present and if they determine their proposed action is likely to affect federally listed species or critical habitat.

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_____ Enclosed is information about communication towers and measures to minimize and avoid impacts to migratory birds, including a list of types of work that do not require further coordination with the Service.

_____ Determinations of the presence of waters of the United States, including wetlands, and the need for permits are made by the U.S. Army Corps of Engineers. They may be contacted at: Regulatory Branch, U.S. Army Corps of Engineers, Norfolk District, 803 Front Street, Norfolk, Virginia 23510, telephone (757) 441-7652.

Our website http://virginiafieldoffice.fws.gov contains many resources that may assist with project reviews. Point of contact is Eric Davis at (804) 693-6694, ext. 104.

Sincerely,

for Karen L. Mayne
Supervisor
Virginia Field Office

cc: CBFO (David Sutherland)

1

KEY

LE - federally listed endangered.

LT - federally listed threatened.

PE - federally proposed endangered.

PT - federally proposed threatened.

EX - believed to be extirpated in Virginia.

LE(S/A) - federally listed endangered due to similarity of appearance to a federally listed species.

LT(S/A) - federally listed threatened due to similarity of appearance to a federally listed species.

C - candidate species; the U.S. Fish and Wildlife Service has enough information to list the species as threatened or endangered, but this action is precluded by other listing activities.

SOC - species of concern; those species that have been identified as potentially imperiled or vulnerable throughout their range or a portion of their range. These species are not protected under the Endangered Species Act.

G - global rank; the species rarity throughout its total range.

G1 - extremely rare and critically imperiled with 5 or fewer occurrences or very few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction.

G2 - very rare and imperiled with 6 to 20 occurrences or few remaining individuals; or because of some factor(s) making it vulnerable to extinction.

G3 - either very rare and local throughout its range or found locally (abundantly at some of its locations) in a restricted range; or vulnerable to extinction because of other factors. Usually fewer than 100 occurrences are documented.

G_T_ - signifies the rank of a subspecies or variety. For example, a G3T1 would apply to a subspecies of a species that is very rare and local throughout its range or found locally in a restricted range (G3) but the subspecies warrants a rank of T1, critically imperiled.

G_Q - The taxon has a questionable taxonomic assignment.

SURRY COUNTY, VIRGINIA
Federally Listed, Proposed, and Candidate Species

SCIENTIFIC NAME	COMMON NAME	STATUS
BIRDS		
Haliaeetus leucocephalus[1]	Bald eagle	LT
PLANTS		
Aeschynomene virginica	Sensitive joint-vetch	LT

Species of Concern (No official Federal status)

INVERTEBRATES		
Speyeria diana	Diana fritillary	G3
Stygobromus araeus	Tidewater interstitial amphipod	G2
VASCULAR PLANTS		
Carex decomposita	Epiphytic sdege	G3
Chamaecrista fasciculata var. macrosperma	Marsh senna	G5T2
Desmodium ochroleucum	Creamflower tick-trefoil	G2G3
Rudbeckia heliopsidis[2]	Sun-facing coneflower	G2
Trillium pusillum var. virginianum	Virginia least trillium	G3T2

[1]Nesting occurs in this county; concentrated shoreline use has been documented on the James River.
[2]Surveys needed within 5-miles of Prince George County species location.

March 22, 1999
Prepared by U.S. Fish and Wildlife Service, Virginia Field Office

LOUISA COUNTY, VIRGINIA
Federally Listed, Proposed, and Candidate Species

SCIENTIFIC NAME	COMMON NAME	STATUS
INVERTEBRATES		
Alasmidonta heterodon	Dwarf wedgemussel	LE

Species of Concern (No official Federal status)

INVERTEBRATES		
Elliptio lanceolata	Yellow lance	G3
Lasmigona subviridis	Green floater	G3

February 8, 2001
Prepared by U.S. Fish and Wildlife Service, Virginia Field Office

1

HANOVER COUNTY, VIRGINIA
Federally Listed, Proposed, and Candidate Species

SCIENTIFIC NAME	COMMON NAME	STATUS
BIRDS		
Haliaeetus leucocephalus	Bald eagle	LT
INVERTEBRATES		
Alasmidonta heterodon	Dwarf wedgemussel	LE
VASCULAR PLANTS		
Aeschynomene virginica[1]	Sensitive joint-vetch	LT
Helonias bullata[2]	Swamp pink	LT
Isotria medeoloides[2]	Small whorled pogonia	LT

Species of Concern (No official Federal status)

INVERTEBRATES		
Elliptio lanceolata	Yellow lance	G3
Lasmigona subviridis	Green floater	G3
Sigara depressa	Virginia Piedmont water boatmen	G1G3
VASCULAR PLANTS		
Chamaecrista fasciculata var. macrosperma[1]	Marsh senna	G5T2

[1]This species has been documented in an adjacent county and may occur in this county.
[2]This species has been documented in an adjacent county & may occur in this county east of I-95.

November 12, 2002
Prepared by U.S. Fish and Wildlife Service, Virginia Field Office

CAROLINE COUNTY, VIRGINIA
Federally Listed, Proposed, and Candidate Species

SCIENTIFIC NAME	COMMON NAME	STATUS
BIRDS		
Haliaeetus leucocephalus[1]	Bald eagle	LT
VASCULAR PLANTS		
Aeschynomene virginica[2]	Sensitive joint-vetch	LT
Helonias bullata	Swamp pink	LT
Isotria medeoloides	Small whorled pogonia	LT

Species of Concern (No official Federal status)

BIRDS		
Aimophila aestivalis	Bachman's sparrow	G3
INVERTEBRATES		
Sigara depressa	Virginia piedmont water boatman	G1G3
Stygobromus indentatus	Tidewater amphipod	G2G3
VASCULAR PLANTS		
Chamaecrista fasciculata var. macrosperma[2]	Marsh senna	G5T2
Desmodium ochroleucum	Creamflower tick-trefoil	G2G3
Eriocaulan parkeri	Parker's pipewort	G3
Juncus caesariensis	New Jersey rush	G2
Sabatia kennedyana	Plymouth gentian	G3

[1]Nesting occurs in this county; concentrated shoreline use has been documented on the Rappahannock River.
[2]This species has been documented in an adjacent county and may occur in this county.

May 29, 2001
Prepared by U.S. Fish and Wildlife Service, Virginia Field Office

ORANGE COUNTY, VIRGINIA
Federally Listed, Proposed, and Candidate Species

SCIENTIFIC NAME	COMMON NAME	STATUS
INVERTEBRATES		
Alasmidonta heterodon[1]	Dwarf wedgemussel	LE

Species of Concern (No official Federal status)

INVERTEBRATES		
Elliptio lanceolata	Yellow lance	G3
Lasmigona subviridis	Green Floater	G3
Speyeria idalia	Regal fritillary	G3

[1]This species has been documented in an adjacent county and may occur in this county.

September 19, 2002
Prepared by U.S. Fish and Wildlife Service, Virginia Field Office

SPOTSYLVANIA COUNTY, VIRGINIA
Federally Listed, Proposed, and Candidate Species

SCIENTIFIC NAME	COMMON NAME	STATUS
INVERTEBRATES		
Alasmidonta heterodon	Dwarf wedge mussel	LE
VASCULAR PLANTS		
Helonias bullata[1]	Swamp pink	LT
Isotria medeoloides	Small whorled pogonia	LT

Species of Concern (No official Federal status)

INVERTEBRATES		
Elliptio lanceolata	Yellow lance	G3
Lasmigona subviridis	Green floater	G3
Sigara depressa	Virginia Piedmont water boatmen	G1G3
Speyeria idalia	Regal fritillary	G3
NON-VASCULAR PLANTS		
Sphagnum carolinianum	Carolina peatmoss	G3

[1]This species has been documented in an adjacent county & may occur in this county east of I-95.

November 12, 2002
Prepared by U.S. Fish and Wildlife Service, Virginia Field Office

1

U.S. Fish & Wildlife Service

Bald Eagle

Haliaeetus leucocephalus

Description - The bald eagle occurs throughout the United States. It is a large bird-of-prey with dark brown plumage, a white head and tail, and a yellow bill, feet, and eyes. Juvenile eagles generally have a dark brown body, sometimes with white patches on the tail, belly, and underwings. The head and tail become completely white when full adult plumage is reached at four to five years of age.

Life History - The majority of Virginia's eagle population is found on the coastal plain. The bald eagle breeding season begins in mid-November when large nests are built (or the previous year's nest is repaired) usually in loblolly pine trees that are in close proximity to water. Eagles lay one to three eggs between mid-January and late March. In March, most eggs hatch and by June or July most young have fledged. However, the young will continue to use the nest for several weeks. In Virginia, during the summer and winter months, juvenile and nonbreeding adult eagles congregate along large rivers in areas with abundant food and little human disturbance. During the day, these eagles feed and perch along the river shoreline. In late afternoon, they move inland to roost either singly or communally. Roosts are typically located away from human disturbance and near water and a food source. Bald eagles feed primarily on fish, but will also eat carrion, waterfowl, small mammals, snakes, and turtles.

U.S. Fish and Wildlife Service
Virginia Field Office
6669 Short Lane
Gloucester, Virginia 23061
(804) 693-6694
http://www.fws.gov
August 1999

Conservation - The bald eagle was federally listed as an endangered species in the Chesapeake Bay Region on March 11, 1967. On July 12, 1995, the bald eagle was reclassified to threatened throughout the 48 lower states because the population had increased due to the banning persistent pesticides, habitat protection, and other recovery activities. On July 6, 1999, the bald eagle was proposed for removal from the list of endangered and threatened wildlife in the lower 48 states. This action was proposed because the available data indicated that this species has recovered. The recovery is due in part to habitat protection and management actions initiated under the Endangered Species Act. It is also due to reduction in levels of persistent pesticides occurring in the environment. If and when the eagle is no longer protected by the Endangered Species Act, it will still be protected by the Bald and Golden Eagle Protection Act, Migratory Bird Treaty Act, and state laws. Until the eagle is officially delisted, it will continue to receive protection pursuant to the Endangered Species Act. Bald eagles in the Chesapeake Bay are increasing. However, habitat destruction through urban and residential development and human disturbance in nesting, roosting, and foraging habitats continue to be a threat.

What You Can Do To Help - If you know of a bald eagle nest on or near property proposed for clearing, development, or logging please contact one of the following agencies for assistance:

Virginia Department of Game and Inland Fisheries
P.O. Box 11104
Richmond, Virginia 23230
(804) 367-1000

U. S. Fish and Wildlife Service
6669 Short Lane
Gloucester, Virginia 23061
(804) 693-6694

References

U.S. Fish and Wildlife Service. 1990. Chesapeake Bay Region bald eagle recovery plan: first revision. Newton Corner, Massachusetts.

U.S. Fish and Wildlife Service. 1999. Proposed rule to remove the bald eagle in the lower 48 states from the list of endangered and threatened wildlife. Federal Register 64(128): 36453-36464.

Watts, B.D., K.W. Cline, and M.A. Byrd. 1994. The bald eagle in Virginia: An information booklet for land planners. The Center for Conservation Biology, College of William and Mary, Williamsburg, Virginia.

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U.S. Fish & Wildlife Service

Sensitive Joint-Vetch

Aeschynomene virginica

© M. Rollins

Description - The sensitive joint-vetch is an annual legume native to the eastern United States. Populations currently exist in Maryland, New Jersey, North Carolina, and Virginia. The historical range for the species extended to Delaware and Pennsylvania. In Virginia, populations are found along the Potomac, Mattaponi, Pamunkey, Rappahannock, Chickahominy, and James Rivers and their tributaries. This plant usually attains a height of three to six feet in a single growing season, but may grow as tall as eight feet. The flowers are yellow, streaked with red and the fruit is a pod, turning dark brown when ripe.

Life History - The joint-vetch occurs in fresh to slightly brackish tidal river systems, within the intertidal zone where populations are flooded twice daily. It typically occurs at the outer fringe of marshes or shores; its presence in marsh interiors may be a result of nutrient deficiencies, ice scouring, or muskrat herbivory. The sensitive joint-vetch is found in localities where plant diversity is high and annual species are prevalent. Bare to sparsely vegetated substrates appear to be a habitat feature of critical importance for establishment and growth of this species. Plants flower from July through September and into October in some years. Fruits are produced from July through late October, concurrent with flowering.

U.S. Fish and Wildlife Service
Virginia Field Office
6669 Short Lane
Gloucester, Virginia 23061
(804) 693-6694
http://www.fws.gov
August 1999

Conservation - The sensitive joint-vetch was federally listed as a threatened species on June 19, 1992. Threats to the species include sedimentation, competition from non-native plant species, dams, dredging, filling, recreational activities, shoreline stabilization, shoreline structures, road and bridge construction, commercial and residential development, water withdrawal projects, water quality degradation, agricultural practices, introduced pest species, mining, timber harvest, over-visitation, declines in muskrat populations, rise in sea level (this may also be a result of natural cycles), and collection. Natural threats are often identified with disturbances, such as wave and ice action associated with severe storm events, competition, herbivory, channel migration, sea level rise and natural sedimentation processes. Adequate habitat conservation for this species will only be achieved through on-site protection of marshes supporting plant populations when coupled with protection of the natural ecological processes responsible for creating and maintaining habitat for the sensitive joint-vetch.

What You Can Do To Help - Avoid the use of herbicides in or near waterways. If you are planning construction or stabilization activities along the shoreline in one of the counties indicated on the attached map, please contact the U.S. Fish and Wildlife Service.

References

Davison, S.E. and L.P. Bruderle. 1984. Element stewardship abstract for *Aeschynomene virginica* - sensitive joint vetch. The Nature Conservancy. Arlington, Virginia.

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Rouse, G.D. 1994. Sensitive joint-vetch life history and habitat study, 1993 Field Season, Mattaponi and Rappahannock River systems, Virginia. Schnabel Environmental Services. Richmond, Virginia.

U.S. Fish and Wildlife Service. 1995. Sensitive joint-vetch (*Aeschynomene virginica*) recovery plan. Hadley, Massachusetts.

1

U.S. Fish & Wildlife Service

Dwarf Wedge Mussel

Alasmidonta heterodon

B. Windsor

Description - The dwarf wedge mussel has a spotty distribution in Atlantic coast drainage rivers and their tributaries from Canada to North Carolina. It is a small mussel whose shell rarely exceeds 1.5 inches in length. The shell outline is ovate or trapezoidal. The female shell is shorter, trapezoidal, and inflated in the back whereas the male shell is elongate, compressed, and ovate. The outer shell layer is brown to yellowish-brown, with greenish rays in young or pale-colored specimens. This mussel is unique in that it has two lateral teeth on its right valve and only one tooth on its left valve (opposite of all other North American mussel species).

Life History - The dwarf wedge mussel lives in shallow to deep rivers and creeks of various sizes where the current is slow to moderate. This mussel lives on muddy sand, sandy, and gravel stream bottoms that are nearly silt free. Like other freshwater mussels,
this species is a filter feeder. It feeds on plankton collected from water that is passed over its gills. Reproduction occurs sexually. Females carry eggs in their gills. During spawning, the male releases sperm into the water column and the sperm is taken into the female through the gills. The resulting larvae (known as glochidia) are released from the female into the water column and must attach to a fish host to survive. While attached to the fish host, development of the glochidia continues. Once metamorphosis is complete, the juvenile mussel drops off the fish host and continues to develop on the stream bottom. Fish hosts for this species include the mottled sculpin (*Cottus bairdi*), slimy sculpin (*Cottus cognatus*), tessellated darter (*Etheostoma olmstedi*), and johnny darter (*Etheostoma nigrum*).

Conservation - The dwarf wedge mussel was federally listed as an endangered species on March 14, 1990. The decline of this species is due to human degradation of habitat and water quality which have resulted in the continuing decline and subsequent loss of this species from previously occupied habitat. Threats to the species include agricultural, domestic, organic, and industrial pollution; impoundments that destroy habitat and cause silt deposits, low oxygen levels, and fluctuations in water levels and temperatures of the flooded area; and erosion and siltation from land clearing and construction of bridges or roads.

What You Can Do To Help - If you reside on property that borders a stream or other waterway, avoid using chemicals or fertilizers. To help control erosion and reduce runoff, maintain a buffer of natural vegetation along streambanks. Install fencing to prevent livestock from entering streams to reduce trampling of mussels, siltation, and input of waste products. Protecting water quality is the most effective way to conserve mussels.

To find out more about the dwarf wedge mussel contact:

Virginia Department of Game and Inland Fisheries
P.O. Box 11104
Richmond, Virginia 23230
(804) 367-1000

References

Michaelson, D.L. and R.J. Neves. 1995. Life history and habitat of the endangered dwarf wedgemussel *Alasmidonta heterodon* (Bivalvia:Unionidae). Journal of the North American Benthological Society 14(2):324-340.

U.S. Fish and Wildlife Service. 1993. Dwarf wedge mussel (*Alasmidonta heterodon*) recovery plan. Hadley, Massachusetts.

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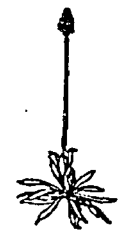
August 1999

U.S. Fish & Wildlife Service

Swamp Pink
Helonias bullata



Description - The swamp pink is a perennial evergreen herb found in scattered populations from New Jersey south to Georgia. Historically, this plant was found from Staten Island, New York to the southern Appalachians. In Virginia, this lily has been documented in four counties. Its bright green, lance-shaped leaves form a basal rosette. A hollow flower stalk rises one to two feet from the center of the rosette and produces a pink or lavender flower head that consists of 30 to 50 small fragrant flowers. Few of the plants in a population produce flowers.

Life History - Swamp pink occurs in a variety of wetland habitats that include bogs, spring seeps, stream edges, wet meadows, and headwater wetlands. Sites are saturated year-round, but are rarely flooded and soils are generally neutral to acidic. Wetland habitat is easily altered through both direct and secondary disturbance. It is difficult for seedlings to get established and they are particularly vulnerable to human foot traffic. Flowering occurs from March to May. The basal leaves turn reddish-brown in the winter and lie flat on the ground or are slightly raised. These winter leaves are often hidden by fallen leaf litter. Reproduction is primarily asexual and seed dispersal is limited.

Conservation - The swamp pink was federally listed as a threatened species on September 9, 1988 due to population decline and threats to its wetland habitats. Historically, wetland drainage and/or filling associated with urban and agricultural development have been the primary threat to this species. However, with the enactment of the federal Clean Water Act and state wetland legislation, direct habitat loss has been slowed. Secondary effects from activities such as timber clearing, land development, siltation from run-off associated with adjacent development, and agriculture have become the major threat. These activities affect the hydrologic regime and increase the release of sediments and pollution. Plant collection and soil compaction from trampling are also threats to this species.

What You Can Do To Help - If you find a plant that appears to be the swamp pink, take note of the location and photograph the plant, if possible. Please do not remove the plant!

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Swamp Pink

Helonias bullata

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1 Contact one of the following agencies for assistance:

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Office of Plant Protection
P.O. Box 1163
Richmond, Virginia 23209
(804) 786-3515

Virginia Department of
Conservation and Recreation
Division of Natural Heritage
217 Governor Street, 3rd Floor
Richmond, Virginia 23219
(804) 786-7951

U.S. Fish and Wildlife Service
Virginia Field Office
6669 Short Lane
Gloucester, Virginia 23061
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References

Stevens, E.C. 1991. Swamp pink. Pages 88-89 in K. Terwilliger, ed. Virginia's Endangered Species, Proceedings of a Symposium. McDonald and Woodward Publishing Company, Blacksburg, Virginia.

U.S. Fish and Wildlife Service. 1991. Swamp pink *(Helonias bullata)* recovery plan. Newton Corner, Massachusetts.

1 U.S. Fish & Wildlife Service

Small Whorled Pogonia

Isotria medeoloides

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Description - The small whorled pogonia is a herbaceous perennial orchid. It has a widely scattered distribution in the eastern United States along the Atlantic coast from Maine to Georgia with outlying occurrences in the midwest and Canada. This species has pale green, elliptical leaves, usually five or six, that grow in a single whorl at the top of a hairless, grayish-green stem. The one or two flowers per plant are yellowish-green, unscented, and form in the center of the whorl.

Life History - In Virginia, the small whorled pogonia is found in ordinary looking third-growth upland forests with an open understory and a closed canopy where the topography is typically moderately sloping or almost level. The plants are usually associated with decaying vegetative matter such as fallen trunks and limbs, leaf litter, bark, and tree roots. The pogonia is found in soils that are acidic sandy loams with low nutrient content. The flowers appear in late April to mid-May. The small whorled pogonia reproduces primarily through self-pollination and occasionally vegetatively. It is often confused with the Indian cucumber-root (*Medeola virginiana*) and the large whorled pogonia (*Isotria verticillata*). The Indian cucumber-root has deep green leaves with a stem that is thin, hairy, and wiry. The large whorled pogonia has a reddish-purple stem and dark green leaves; its flower is reddish-purple.

Conservation - The small whorled pogonia was federally listed as an endangered species on September 10, 1982. It was reclassified as threatened on November 7, 1994. This was possible because at the time of reclassification 61% of the viable populations had been protected. The small whorled pogonia and its habitat continue to be threatened, directly and indirectly, by residential and commercial development. The upland habitat where it is found is seldom protected by federal or state laws unless it occurs on federally-owned property. Without voluntary landowner protection many pogonia populations have been and will be destroyed. Other threats to this species are collection by plant enthusiasts and browsing by white-tailed deer and invertebrates.

What You Can Do To Help - If you find a plant that appears to be the small whorled pogonia, take note of the location and photograph the plant, if possible. Please do not remove the plant!

Contact one of the following agencies for assistance:

Virginia Department of Agriculture
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Virginia Field Office
6669 Short Lane
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References

U.S. Fish and Wildlife Service. 1992. Small whorled pogonia (*Isotria medeoloides*) recovery plan, first revision. Newton Corner, Massachusetts.

Ware, D.M.E. 1991. Small whorled pogonia. Pages 95-97 in K. Terwilliger, ed. Virginia's Endangered Species, Proceedings of a Symposium. McDonald and Woodward Publishing Company, Blacksburg, Virginia.

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SENSITIVE JOINT-VETCH
(Aeschynomene virginica)
SURVEY CONTACTS IN VIRGINIA

This list contains individuals who we have already determined are qualified to conduct surveys for the species listed above. This list does not include all individuals qualified or authorized to survey for this species. If you select someone not on this pre-approved surveyor list, please provide the proposed surveyor's qualifications to this office 30 days prior to the start of the survey. Please send copies of all survey results to this office. If the survey determines that any rare species are present, please contact this office to allow us the opportunity to work with you to ensure that a project avoids or minimizes adverse effects to rare species and their habitats. Inclusion of names on this list does not constitute endorsement by the U.S. Fish and Wildlife Service or any other U.S. Government agency. Listed alphabetically. September 8, 2004

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ATLANTIC SLOPE FRESHWATER MUSSELS
SURVEY CONTACTS IN VIRGINIA

This list contains individuals who we have already determined are qualified to conduct surveys for the species listed above. This list does not include all individuals qualified or authorized to survey for this species. If you select someone not on this pre-approved surveyor list, please provide the proposed surveyor's qualifications to this office 30 days prior to the start of the survey. Please send copies of all survey results to this office. If the survey determines that any rare species are present, please contact this office to allow us the opportunity to work with you to ensure that a project avoids or minimizes adverse effects to rare species and their habitats. Inclusion of names on this list does not constitute endorsement by the U.S. Fish and Wildlife Service or any other U.S. Government agency. Listed alphabetically. September 9, 2004

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SWAMP PINK
(Helonias bullata)
SURVEY CONTACTS

This list contains individuals who we have already determined are qualified to conduct surveys for the species listed above. This list does not include all individuals qualified or authorized to survey for this species. If you select someone not on this pre-approved surveyor list, please provide the proposed surveyor's qualifications to this office 30 days prior to the start of the survey. Please send copies of all survey results to this office. If the survey determines that any rare species are present, please contact this office to allow us the opportunity to work with you t ensure that a project avoids or minimizes adverse effects to rare species and their habitats. Inclusion of names on this list does not constitute endorsement by the U.S. Fish and Wildlife Service or any other U.S. Government agency. Listed alphabetically. September 8, 2004

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1 **SMALL WHORLED POGONIA**
(Isotria medeoloides)
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Appendix G

Data and Information to Support Specific Analyses Environmental Impacts of Transportation

Appendix G

Data and Information to Support Specific Analyses Environmental Impacts of Transportation

This appendix discusses the potential environmental effects of transportation of reactor fuel and radioactive waste to and from potential ESP sites. Section G.1 briefly discusses the effects of transportation of fresh fuel to ESP sites, and Section G.2 discusses the effects of transportation of spent fuel from ESP sites to a spent fuel disposal facility. In addition, Section G.2 discusses the effects of both incident-free transportation and transportation accidents. Section G.3 discusses the environmental effects of radioactive waste shipments.

G.1 Fresh Fuel Shipping

This section addresses the number and characteristics of shipments of fresh fuel to ESP sites relative to the conditions in 10 CFR 51.52. Comparisons are also made against Table S-4 and WASH-1238 (NRC 1972) which provided the data that supports Table S-4. Section G.1.1 presents the basic fresh fuel shipping requirements for each advanced reactor design. These data were extracted from INEEL (2003). Section G.1.2 presents the comparisons to 10 CFR 51.52 conditions.

G.1.1 Advanced Reactor Fresh Fuel Shipping Data

In WASH-1238, a reference boiling water reactor (BWR) and pressurized water reactor (PWR) were used to formulate the basic numbers of fresh fuel shipments required for initial core loading and refueling. The reference BWR and PWR plants were 1100 MW(e) plants. The reference BWR assumed an initial core loading of 150 MTU and the reference PWR assumed 100 MTU. Both reactor types resulted in 18 truck shipments of fresh fuel per plant. Annual reload quantities were assumed to be 30 MTU/yr for both reactor types, which resulted in an additional 6 truck shipments per year per plant. In total, about 252 truck shipments of fresh fuel are required over a 40-year plant life, including the initial core and 39 years of reloads, for both reactor types.

The initial fuel loading and annual reload quantities for the Advanced Boiling Water Reactor (ABWR), a 1500 MW(e) plant, and the Economic Simplified Boiling Water Reactor (ESBWR) are approximately the same; 156.96 MTU per plant initial core loading and 32.76 MTU/yr per plant reload quantities (INEEL 2003). This equates to about 872 fresh fuel elements in the initial core and 213 elements per year for refueling. Truck shipment capacities were stated in INEEL (2003) to be 28 to 30 fresh fuel elements per truck shipment. Assuming 30 fuel elements per truck shipment results in about 30 shipments of fresh fuel to load the initial core and 6.1 truck shipments per year for refueling. If 28 fuel elements per truck shipment are used, the initial core load requires about 32 shipments of fresh fuel and annual refueling requires about 6.5 truck shipments per year.

The AP1000 is a 1150 MW(e) advanced PWR power plant. The initial core load was estimated to be 84.5 MTU per plant and annual reload requirements were estimated at 24.4 MTU/yr per plant. The data in INEEL (2003) also indicated that the average uranium mass in a fresh AP1000 fuel assembly was 0.583 MTU and that 12 fuel elements per truck shipment would be transported. This resulted in about 14 truck shipments to supply the initial core and about 3.8 truck shipments/year to support refueling.

The ACR-700 is an advanced design CANDU reactor assumed to generate 731 MW(e). It was stated in INEEL (2003) that the initial core load for the ACR-700 included 61.3 MTU per plant and the annual refueling requirements are 33.1 MTU/yr per plant. Each fuel element contains 18 kgU (INEEL 2003). This corresponds to 3406 fuel elements in the initial core loading and 1839 fuel elements per year for refueling. A range of truck shipment capacities was given in INEEL (2003) to be 180 to 240 fuel elements per truck shipment. This equates to 15 to 19 truck shipments to supply the initial core load and from 7.7 to 10.2 annual refueling shipments.

The International Reactor Innovative and Secure (IRIS) design is a 335 MW(e) advanced PWR. It requires an initial core load of 48.67 MTU or 89 fuel elements per unit (546.9 kgU per fuel element) (INEEL 2003). For refueling, the IRIS reactor was assumed to require an additional 6.26 MTU/yr of fresh fuel per unit or about 40 fresh fuel elements every 3.5 years. INEEL (2003) indicates a "typical" site may contain three units. Assuming each truck shipment carries eight fuel elements, the initial core load requires 34 truck shipments per three-unit site and annual refueling requires an additional 4.3 truck shipments per year per three-unit site.

The Gas Turbine-Modular Helium Reactor (GT-MHR) is a gas-cooled reactor that uses a substantially different fuel design than current and advanced LWRs. The reactor's thermal power level is rated at 600 MWt per unit and electric generation capacity is rated at 285 MW(e) per unit. A standard GT-MHR plant is assumed to be composed of four reactor units. INEEL (2003) states that the initial core load for a single unit is about 1020 fuel elements. Annual average reload requirements are 510 fuel elements per unit. INEEL (2003) also indicates that each truck shipment can carry 80 fuel elements so it will require about 51 truck shipments to transport the initial core load for all 4 units and about 20 truck shipments per year for the annual reload requirements for all four units.

The Pebble Bed Modular Reactor (PBMR) is a gas-cooled reactor that is rated at 400 MW(t) (165 MW[e]) per unit. A typical PBMR plant is assumed to consist of eight units. The PBMR uses a substantially different fuel design than a typical LWR. INEEL (2003) states that each unit requires 260,000 fuel spheres per unit for its initial core load; 120,000 fuel spheres per unit are required for annual average reloads. A total of 48,000 fuel spheres is assumed to be transported in a typical truck shipment. As a result, it will take about 44 shipments of fuel spheres to transport the initial core load for all eight units and about 20 shipments per year to transport the annual reload quantity for all eight units.

G.1.2 Analysis of the Environmental Impacts of Fresh Fuel Shipments

As required by 10 CFR 51.52, applicants are required to submit a statement that the reactor and the transportation of fuel and waste to and from the reactor meet all the conditions specified in 10 CFR 51.52(a) or fulfil the requirements set forth in 10 CFR 51.52(b). The conditions specified in 10 CFR 51.52(a) that apply to fresh fuel include the following:

(1) Reactor core has thermal loading less than 3800 MW.

(2) Reactor fuel is in the form of sintered UO_2 pellets not exceeding 4 percent U-235 by weight and the pellets are encapsulated in zircalloy rods.

(3) Unirradiated fuel is shipped to the reactor by truck.

(4) The environmental impacts of transportation of fuel as set forth in Summary Table S-4 in 10 CFR 51.52(c).

Fresh fuel shipment information for the advanced reactors is discussed below for each of these criteria.

G.1.2.1 Reactor Core Thermal Loading

The thermal output ratings of the seven advanced reactor types as given in INEEL (2003) are as follows:

(1) ABWR – 4300 MW(t) (single unit)
(2) ESBWR – 4000 MW(t) (single unit)
(2) AP1000 – 3400 MW(t) (single unit)
(4) ACR-700 – 1982 MW(t)/unit x 2 units/site = 3964 MW(t)/site
(5) IRIS – 1000 MW(t)/unit x 3 units/site = 3000 MW(t)/site
(6) GT-MHR – 600 MW(t)/unit x 4 units/site = 2400 MW(t)/site
(7) PBMR – 400 MW(t)/unit x 8 units/site = 3200 MW(t)/site

As shown above, single-unit ABWR and ESBWR plants would exceed the 3800 MW(t) guideline in 10 CFR 51.52(a)(1). In addition, a twin-unit ACR-700 plant would exceed the core thermal power guideline.

G.1.2.2 Reactor Fuel Form

All of the advanced LWRs (i.e., the ABWR, ESBWR, AP1000, IRIS, and ACR-700) use sintered UO_2 fuel pellets encapsulated in zircaloy rods. The average enrichment for the ACR-700 fuel is about 2 percent, which is well within the 10 CFR 51.52(a)(2) condition. The average enrichments for the other advanced LWR fuels exceed the 4 percent U-235 by weight condition in 10 CFR 51.52(a)(2).

The gas-cooled reactors (i.e., the GT-MHR and PBMR) have a substantially different fuel form than described in 10 CFR 51.52(a)(2). The fuel forms for these reactors are coated uranium oxycarbide fuel kernels (GT-MHR) or coated UO_2 fuel kernels (PBMR). The fuel kernels are coated with layers of pyrolitic carbon and silicone carbide. Thus, these fuel forms are not the same as the conditions specified in 10 CFR 51.52(a)(2). Furthermore, the equilibrium enrichments for these fuels are 12.9 percent (PBMR) and 19.8 percent (GT-MHR). Therefore, the advanced gas-cooled reactor fuel forms do not meet the conditions specified in 10 CFR 51.52(a)(2).

G.1.2.3 Shipping Mode

All four reactor types were stated in INEEL (2003) to use trucks to ship fresh fuel to the various ESP sites.

G.1.2.4 WASH-1238 and Table S-4

The Table S-4 condition that is applicable to shipment of fresh fuel is that the number of shipments of fuel and waste to and from a commercial nuclear power plant must be less than 1 per day. Table G.1 summarizes the number of truck shipments of fresh fuel required for each reactor type. The table also normalizes the numbers of shipments to the net electrical generation output for the reference reactor in WASH-1238, or 880 MW(e) (1100 MW[e] plant operating at 80 percent annual capacity factor).

As shown, the ACR-700, PBMR, and GT-MHR advanced reactor types exceed the number of truck shipments estimated for the reference LWR in WASH-1238. The largest number of shipments, in excess of 700 shipments over 40 years, is for the GT-MHR. However, this equates to far less than one truck shipment per day. Consequently, the numbers of shipments for all the advanced reactor types are within the relevant condition specified in Table S-4.

Table S-4 includes a condition that the truck shipments not exceed 33,000 kg (73,000 lb) as governed by Federal or State gross vehicle weight restrictions. All of the advanced reactors were indicated in INEEL (2003) to be capable of meeting this restriction for fresh fuel shipments.

Table G-1. Number of Truck Shipments of Fresh Fuel for Each Advanced Reactor Type

Reactor Type	Number of Shipments per Reactor Site: Initial Core[a]	Number of Shipments per Reactor Site: Annual Reload	Number of Shipments per Reactor Site: Total[b]	Site Electric Generation, MW(e)[c]	Capacity Factor[c]	Normalized, Shipments per 1100 MW(e)[e]
Reference LWR (WASH-1238)	18	6.0	252	1,100	0.8	252
ABWR/ESBWR[d]	30	6.1	267	1,500	0.95	165
AP1000	14	3.8	161	1,150	0.95	130
ACR-700	15	7.7	314	731	0.9	420
IRIS	34	4.3	201	1,005(f)	0.96	184
GT-MHR	51	20.0	831	1,140(g)	0.88	729
PBMR	44	20.0	824	1,320(h)	0.95	579

NOTE: The reference LWR shipment values have all been normalized to 880 MW(e) net electrical generation.
(a) Shipments of the initial core have been rounded up to the next highest whole number.
(b) Total shipments of fresh fuel over 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).
(c) Unit capacities and capacity factors were taken from INEEL (2003).
(d) Ranges of capacities are given in INEEL (2003) for these reactor fresh fuel shipments. The fresh fuel shipment data for these reactors were derived using the upper limit of the ranges.
(e) Normalized to net electric output for WASH-1238 reference plant (i.e., 1100 MW[e]) plant at 80 percent or net electrical output of 880 MW[e]).
(f) The IRIS site includes three units at 335 MW(e) per unit.
(g) The GT-MHR site includes four reactor units at 285 MW(e) per unit.
(h) The PBMR site includes eight reactor units at 165 MW(e) per unit.

Finally, Table S-4 includes conditions related to radiological doses to transport workers and members of the public along transport routes. These doses are a function of the radiation dose rate emitted from the fresh fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time in transit (including travel time and stop time), and number of shipments to which the individuals are exposed. The radiological dose impacts of the transportation of fresh fuel were calculated using the RADTRAN 5 computer code (Neuhauser et al. 2003). The RADTRAN 5 calculations were performed to develop estimates of the worker and public doses associated with annual fresh fuel shipments to the ESP sites.

One of the key assumptions in WASH-1238 for the reference LWR fresh fuel shipments is that the radiation dose rate at 1 m (3 ft) from the transport vehicle is about 0.001 mSv/hr (0.1 mrem/hr). This assumption was also used in the analysis of advanced reactor fresh fuel shipments. This assumption is reasonable for all of the advanced reactor fuel types because the fuel materials will all be low dose rate uranium radionuclides and will be packaged similarly (i.e., inside a metal container that provides little radiation shielding). The numbers of shipments per year were obtained by dividing the normalized shipments in Table G.1 by 40 years of operation. Other key input parameters used in the radiation dose analysis for fresh fuel are shown in Table G.2.

The RADTRAN 5 results for this "generic" fresh fuel shipment are as follows:

- Transport workers: 1.71×10^{-5} person-Sv/shipment (1.71×10^{-3} person-rem/shipment)

- General public (Onlookers – persons at stops and sharing the highway): 6.65×10^{-5} person-Sv/shipment (6.65×10^{-3} person-rem/shipment)

- General public (Along Route – persons living near a highway): 1.61×10^{-6} person-Sv/shipment (1.61×10^{-4} person-rem/shipment).

These values were combined with the average annual shipments of fresh fuel for each advanced reactor type (see Table G.1) normalized to the WASH-1238 reference LWR electric output (880 MW[e]) to calculate annual doses to the public and workers that can be compared to Table S-4 conditions. The results are shown in Table G.3. As shown, the calculated radiation doses for shipping fresh fuel to ESP sites are within the Table S-4 conditions.

G.1.3 Transportation Accidents

Accidents involving fresh fuel shipments are also addressed in Table S-4. Accident risks are a combination of accident frequency and consequence. Accident frequencies are likely to be lower than they were when WASH-1238 was published because traffic accident, injury, and fatality rates have fallen over the past 30 years. Consequences of accidents that are severe enough to result in a release of fresh fuel particles are not significantly different for advanced LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238. Consequently, the impacts of accidents during transport of fresh fuel to advanced LWR sites would be smaller than the WASH-1238 results that formed the basis for Table S-4.

Table G-2. RADTRAN 5 Input Parameters for Fresh Fuel Shipments

Parameter	RADTRAN 5 Input Value	Source
Shipping distance, km	3200	NRC (1972)[a]
Travel Fraction – Rural	0.90	NRC (1977)
Travel Fraction – Suburban	0.05	
Travel Fraction – Urban	0.05	
Population Density – Rural, persons/km^2	10	DOE (2002a)
Population Density – Suburban, persons/km^2	349	
Population Density – Urban, persons/km^2	2260	
Vehicle speed – Rural, km/hr	88.49	Based on average speed in rural areas given in DOE (2002a)
Vehicle speed – Suburban, km/hr	88.49	
Vehicle speed – Urban, km/hr	88.49	
Traffic count – Rural, vehicles/hr	530	DOE (2002a)
Traffic count – Suburban, vehicles/hr	760	
Traffic count – Urban, vehicles/hr	2400	
Dose rate at 1 m from vehicle, mrem/hr	0.1	NRC (1972)
Packaging length, m	7.3	Approximate length of 2 LWR fuel element packages placed on end
Number of truck crew	2	NRC (1972), NRC (1977), and DOE (2002a)
Stop time, hr/trip	4.5	Based on 0.0014 hr stop time per km (Hostick et al. 1992)
Population density at stops, persons/km^2	64,300	Based on 20 people in annular ring extending from 1 to 10 m from vehicle

(a) NRC (1972) have a range of shipping distances between 40 km (25 mi) and 4800 km (3000 mi) for fresh fuel shipments. A 3200-km (2000-mi) "average" shipping distance was assumed.

Table G-3. Radiological Impacts of Transporting Fresh Fuel to ESP Sites

Plant Type	Normalized Average Annual Shipments	Cumulative Annual dose, person-rem/yr per 1100 MW(e)		
		Workers	Public – Onlookers	Public – Along Route
Reference LWR (WASH-1238)	6.3	1.1E-02	4.2E-02	1.0E-03
ABWR/ESBWR	4.1	7.1E-03	2.7E-02	6.6E-04
AP1000	3.3	5.6E-03	2.2E-02	5.2E-04
ACR-700	10.5	1.8E-02	7.0E-02	1.7E-03
IRIS	4.6	7.9E-03	3.1E-02	7.4E-04
GT-MHR	18.2	3.1E-02	1.2E-01	2.9E-03
PBMR	14.5	2.5E-02	9.6E-02	2.3E-03
10 CFR 51.52 Table S-4 Condition	<1 per day	4	3	3

With respect to the advanced gas-cooled reactors, accident rates (accidents per unit distance) and associated accident frequencies (accidents per year) would follow the same trends as LWRs (i.e., overall reduction relative to the accident rates used in WASH-1238 [AEC 1972]). The consequences of accidents involving gas-cooled reactor fresh fuel, however, are more uncertain. A literature search was conducted to identify publicly available documents that describe the effects of accidents (i.e., exposure of fresh gas-cooled reactor fuel to structural and thermal transients). No definitive references were found. Consequently, it was assumed here that the gas-cooled reactor fresh fuel shipments would have the same abilities as LWR fresh fuel to maintain its functional integrity following a traffic accident. This assumption is judged to be conservative because gas-cooled reactor fuel operates at significantly higher temperatures, and thus maintains integrity under more severe thermal conditions than LWR fuel. Detailed information about the behavior of the gas-cooled reactor fuel under impact conditions was not found. However, packaging systems for fresh gas-cooled reactor fuel will be required to meet the same requirements as fresh LWR fuel packages. Properly designed and manufactured packaging systems are the most effective means of preventing damage and dispersal of the contained materials under accident conditions. Consequently, packaging systems for fresh gas-cooled reactor fuels would provide equivalent release (i.e., consequence) prevention and mitigation to those designed for fresh LWR fuels. In addition, the fuel forms for the gas-cooled reactors are similar to LWRs (i.e., uranium oxide for the PBMR and uranium oxycarbide for the GT-MHR versus uranium oxide for LWRs), so the failure resistance provided by fresh gas-cooled reactor fuels should not be significantly lower than LWRs. Based on the assumption, which will need to be verified at the CP/COL stage, that fresh gas-cooled and LWR fuels and associated packaging systems provide equivalent resistance to thermal and impact conditions, it was concluded that the impacts of accidents involving gas-cooled reactor fresh fuel would not be significantly different than for LWR fresh fuel.

G.2 Spent Fuel Shipping

This section discusses the impact of transporting spent advanced reactor fuel from candidate sites to a potential spent fuel disposal facility located at Yucca Mountain, Nevada. The section is divided into two parts. The first part considers incident-free transportation, and the second part considers transportation accidents.

The analysis is based on shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (i.e., massive, heavily-shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded onto a modified trailer. These assumptions are consistent with assumptions made in the evaluation of the environmental impacts of transportation of spent fuel presented in Addendum I to NUREG-1437 (NRC 1999a). As discussed in Addendum I, these assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks, which would reduce the number of spent-fuel shipments.

Environmental impacts of the transportation of spent fuel were calculated using the RADTRAN 5 computer code (Neuhauser et al. 2003). Routing and population data for input to RADTRAN for shipment by truck were obtained from the TRAGIS routing code (Johnson and Michelhaugh 2000). The population data in the TRAGIS code is based on the 2000 census.

G.2.1 Incident-Free Transportation of Spent Fuel

"Incident-free" transportation refers to transportation activities in which the shipments of radioactive material reach their destination without releasing any radioactive cargo to the environment. The vast majority of radioactive shipments are expected to reach their destination without experiencing an accident or incident or releasing any cargo. The "incident-free" impacts from these normal, routine shipments arise from the low levels of radiation that penetrate the heavily-shielded spent fuel shipping cask. Although Federal regulations in 10 CFR Part 71 and 49 CFR Part 173 impose constraints on radioactive material shipments, some radiation penetrates the shipping container and exposes nearby persons to low levels of radiation.

Incident-free, legal-weight truck transportation of spent fuel has been evaluated by considering shipments from six representative reactor sites to a repository at Yucca Mountain, Nevada, for disposal. This assumption is conservative because it tends to maximize the shipping distance from the east coast and the midwest where most of the reactors are assumed to be located. Therefore, shipment to one or more other potential sites would reduce the impacts.

Environmental impacts from these shipments will occur to persons residing along the transportation corridors between potential ESP sites and the repository; to persons in vehicles passing the spent-fuel shipment; to persons at vehicle stops for refueling, rest, and vehicle inspections; and to transportation crew members. The impacts to these exposed population groups were quantified using the RADTRAN 5 computer code (Neuhauser et al. 2003).

This analysis addressed the impacts of spent nuclear fuel transport to a high level waste repository from a generic perspective because the Congress has directed the U.S. Department of Energy to study only Yucca Mountain for the potential proposed repository. The analysis assumed that all spent nuclear fuel would be shipped to that potential repository.

The characteristics of specific shipping routes (e.g., population densities, shipping distances) influence the normal radiological exposures. To address the differences that arise from the specific reactor site from which the spent-fuel shipment originates, each advanced reactor design was assumed to be located at all the primary and alternative early site permit sites.

These sites are:

Primary Site	Alternative Site
North Anna	Savannah River Site (SRS)
Clinton	Portsmouth Gaseous Diffusion Plant (PGDP)
Grand Gulf	Fitzpatrick
	Pilgrim
	Zion
	Quad Cities
	Braidwood
	Surry Power Station

Input to RADTRAN 5 includes the total shipping distance between the origin and destination sites and the population distributions along the routes. This information was obtained by running the TRAGIS computer code (Johnson and Michelhaugh 2000) for the origin-destination combinations of interest for legal weight trucks. The resulting route characteristics information is shown in Table G.4. Note that for truck shipments, all the spent fuel is assumed to be shipped to the potential Yucca Mountain site over designated highway-route controlled quantity (HRCQ) routes. The routes used here are the same as those used in the Yucca Mountain Environmental Impact Statement (DOE 2002b).

Shipping casks have not been designed for advanced reactor spent fuel. Although some of the advanced reactor fuel designs are similar to current LWR fuel, no attempt has been made to optimize the cargo capacities of shipping casks for advanced LWR fuels. For the non-LWR fuel types (that is, the GT-MHR, and PBMR), there is little information on even a conceptual basis that would provide a defensible technical basis for shipping cask capacities. The shipping cask capacity data in the report *Early Site Permit Environmental Report Sections and Supporting Documentation* (INEEL 2003) are summarized as follows:

- ABWR – ABWR fuel is not significantly different than existing LWR fuel designs so the number of ABWR assemblies than can be transported in a legal weight truck shipment (i.e., 25 ton shipping cask) should not be different than current cargo capacities.

- ESBWR – The ESBWR fuel is similar to the ABWR fuel.

- AP1000 – AP1000 fuel assemblies are similar to current generation PWR fuel. No information was provided in INEEL (2003) on shipping cask capacities for AP1000 spent nuclear fuel.

- ACR-700 – The ACR-700 fuel is somewhat different than the current and advanced LWR fuel designs. The applicant estimated that an ACR-700 rail cask would hold about 10 MTU of spent fuel, similar to the current cask designs. This value is nearly identical to the cargo capacities of current rail cask designs so it was assumed that the truck cask capacity for ACR-700 and current generation LWRs would also be about the same (i.e., 1.8 MTU/shipment).

- IRIS – The IRIS fuel is similar to current generation PWR fuel. No information was provided in INEEL (2003) on shipping cask capacities for IRIS spent nuclear fuel.

- GT-MHR – The GT-MHR fuel is a spherical coated particle fuel with a uranium oxycarbide fuel kernel loaded into graphite fuel elements. This fuel concept is significantly different than current and advanced LWR fuels (sintered UO2 pellets loaded into zircaloy tubes). According to INEEL (2003), six spent fuel elements containing 0.023 MTU of spent fuel are assumed to be transported in a legal weight truck cask.

- PBMR – The PBMR fuel is also a spherical coated particle fuel with uranium oxide fuel kernels. In INEEL (2003), it is estimated that 0.495 MTU of spent PBMR fuel can be transported in a single legal weight truck shipment.

Table G-4. Transportation Route Information for Shipments from ESP Sites to the Potential Yucca Mountain Spent Fuel Disposal Facility

Advance Reactor Site	One-way Shipping Distance, km				Population Density, persons/km2			Stop time per trip, hr
	Total	Rural	Suburban	Urban	Rural	Suburban	Urban	
Primary Site								
North Anna	4409.5	3498	812.4	99.1	11.3	319	2310.6	5
Clinton	3076.3	2626.3	398.3	51.7	9.4	306.1	2372.2	3.5
Grand Gulf	3718.3	3030.4	581.3	106.6	9.2	339.4	2429.4	4
Alternative Site								
Savannah River Site	4263	3260	881	122	11	331.5	2311.2	5
Portsmouth	3902.2	3166.9	647.2	88.1	10.7	316.4	2339.7	4.5
Fitzpatrick	4212.2	3228.6	875.4	108.2	11.4	312.4	2348.7	5
Pilgrim	4682.3	3469.3	1091.7	121.3	11.8	312.3	2377.2	5.5
Zion	3138.9	2629.6	441.3	68	9.5	323.8	2360.3	3.5
Quad Cities	2853.1	2451	352.6	49.5	9.1	310.2	2391.3	3
Braidwood	3034.5	2604.4	378.7	51.4	9.4	308.9	2377.2	3.5
Surry	4555.4	3590.7	863.9	100.8	11.4	317.6	2301.6	5

The aforementioned shipping cask capacities are approximations based on current shipping cask designs. Actual shipping cask capacities in the future may be significantly different. Applicants must account for this in their applications at the CP/COL stage.

Incident-free radiation doses are a function of many variables. The most important of these variables are presented in Table G.5. Most of these variables were extracted from the literature are considered to be "standard" values used in many RADTRAN applications, including environmental impact statements, and regulatory analyses.

For purposes of this analysis, the transportation crew for truck spent fuel shipments consisted of two drivers. Escorts were considered, but they were not included because their distance from the shipping cask would reduce the dose rates to levels well below the dose rates experienced by the drivers. Stop times were assumed to accrue at the rate of 30 minutes per 4 hours driving time. TRAGIS outputs were used to determine the number of stops for each origin-destination.

Doses to the public at truck stops have been significant contributors to the doses calculated in previous RADTRAN analyses. For this analysis, stop doses are the sum of the doses to individuals located in two annular rings centered at the stopped vehicle, as illustrated in Figure G.1. The inner ring represents persons who may be at the truck stop at the same time as a spent fuel shipment and extends 1 to 10 m from the edge of the vehicle. The outer ring represents persons who reside near a truck stop and extends from 10 to 800 m from the vehicle. This scheme is the same as that used in NRC (2000). Population densities and shielding factors were also taken from NRC (2000), which were based on the observations of Griego et al. (1996).

The results of these routine (incident-free) exposure calculations are shown in Table G.6 for spent-fuel shipments from all 11 primary and alternative sites to the potential Yucca Mountain repository. Population dose estimates are given for workers (i.e., truck crew members), onlookers (doses to persons at truck stops and persons on highways exposed to the spent fuel shipments), and along the route (persons living near the highway).

This discussion addresses whether or not the environmental effects of incident-free advanced reactor spent-fuel shipments are within the guidelines established in Table S-4 of 10 CFR 51.52. The bounding cumulative doses to the exposed population given in Table S-4 are:

- Transport workers: 0.04 person-Sv/reactor-year (4 person-rem/reactor-year)
- General public (onlookers): 0.03 person-Sv/reactor-year (3 person-rem/reactor-year)
- General public (along route): 0.03 person-Sv/reactor-year (3 person-rem/reactor-year).

Calculation of the cumulative doses entailed converting the per-shipment risks given in Table G.6 to estimates of environmental effects per reactor-year of operation. The per-shipment results, which are independent of reactor technology (in other words, the doses are dependent on the assumed external radiation dose rate emitted from the cask, which is fixed at the regulatory maximum limit for all of the advanced reactor technologies), are given in terms of the population dose per shipment of spent fuel. To develop estimates of the annual environmental impacts, the following assumptions were made:

- The basis for the annual number of shipments of spent fuel from the reference LWR in WASH-1238 will be used. In WASH-1238, it was assumed that 60 shipments per year will be made, each shipment carrying 0.5 MTU of spent fuel. This equates to shipping 30 MTU of spent fuel per year. This is equivalent to the annual refueling requirements for the reference LWR. It was assumed that spent fuel will be shipped from other reactor types at a rate equal to their annual refueling requirements.

- Shipping cask capacities used to calculate annual spent fuel shipments for the advanced LWRs were assumed to be the same as the reference LWR (i.e., approximately 0.5 MTU per truck shipment).

- The annual numbers of spent fuel shipments from the advanced gas-cooled reactors were taken directly from INEEL (2003). These estimates were 38 shipments/yr from the GT-MHR site and 16 shipments/yr from the PBMR site.

Table G.7 provides the estimated annual population doses from routine (incident-free) transportation of spent fuel from ESP sites to the potential Yucca Mountain disposal facility. The collective population doses (person-rem) were converted to population risk using health-effects conversion factors. The dose to risk factors, which were taken from Federal Guidance Report 13 (Eckerman et al. 2002), assume 6.0E-04 latent cancer fatalities (LCFs) per person-rem and 8.5E-04 total detrimental health effects per person-rem for workers and the general public. Total detriment includes fatal and non-fatal cancers and severe hereditary effects. The annual LCF and total detriment estimates are presented in Tables G.8 and G.9, respectively, for each reactor site/reactor type combination. The results in Tables G.7 to G.9 have been normalized to the WASH-1238 net electrical generation (i.e., 880 MW[e]).

As shown in Table G.7, some of the estimated population doses are higher than the Table S-4 conditions. Two key reasons for the higher population doses relative to Table S-4 are the higher number of spent fuel shipments estimated for some of the reactor technologies and the longer shipping distances used in this assessment than were used in WASH-1238. WASH-1238 used a "typical" distance for a spent fuel shipment of 1600 km (1000 mi) whereas the shipping distances used in this assessment ranged from about 3000 km (1800 mi) to 4700 km (2900 mi). The higher numbers of shipments are based on spent fuel shipping casks designed to transport short-cooled fuel (150 days out of the reactor). It was assumed in this analysis that the shipping cask capacities are 0.5 MTU/shipment, roughly equivalent to one PWR or two BWR spent fuel assemblies per shipment. Newer designs are based on longer-cooled spent fuel (5 years out of reactor) and have larger capacities than those used in this assessment. DOE (2002b) spent fuel shipping cask capacities were approximately 1.8 MTU/shipment, or up to four PWR or nine BWR fuel assemblies per shipment. Use of the newer shipping cask designs will reduce the number of spent fuel shipments and the associated environmental impacts. If the population doses are adjusted for the shipping distance (factor of 2 to 3) and shipping cask capacity (factor of 4), the routine population doses from spent fuel shipments from all reactor types and all sites fall within the Table S-4 conditions.

Table G-5. RADTRAN 5 Incident-free Exposure Parameters

Parameter	RADTRAN 5 Input Value	Source
Vehicle speed – Rural, km/hr	88.49	Based on average speed in rural areas given in DOE (2002a). Because most travel is on interstate highways, the same vehicle speed is assumed in rural, suburban, and urban areas. No speed reductions were assumed for travel at rush hour.
Vehicle speed – Suburban, km/hr	88.49	
Vehicle speed – Urban, km/hr	88.49	
Traffic count – Rural, vehicles/hr	530	DOE 2002a
Traffic count – Suburban, vehicles/hr	760	
Traffic count – Urban, vehicles/hr	2400	
Dose rate at 1 m from vehicle, mrem/hr	14	DOE 2002b – approximate dose rate at 1 m that is equivalent to maximum dose rate allowed by Federal regulations (i.e., 10 mrem/hr at 2 m from the side of a transport vehicle).
Packaging dimensions, m	Length 5.2 Diameter 1.0	DOE 2002b
Number of truck crew	2	NRC 1972, NRC 1977, and DOE 2002a
Stop time, hr/trip	Route-specific	See Table G.4.
Population Density at Stops, persons/km^2	30,000	Sprung et al. (2000)
Min/Max Radii of Annular Area Around Vehicle at Stops, m	1 to 10	Sprung et al. (2000)
Shielding Factor Applied to Annular Area Surrounding Vehicle at Stops	1 (no shielding)	Sprung et al. (2000)
Population Density Surrounding truck stops, persons/km^2	340	Sprung et al. (2000)
Min/Max Radius of Annular Area Surrounding Truck Stop, m	10 to 800	Sprung et al. (2000)
Shielding Factor Applied to Annular Area Surrounding Truck Stop	0.2	Sprung et al. (2000)

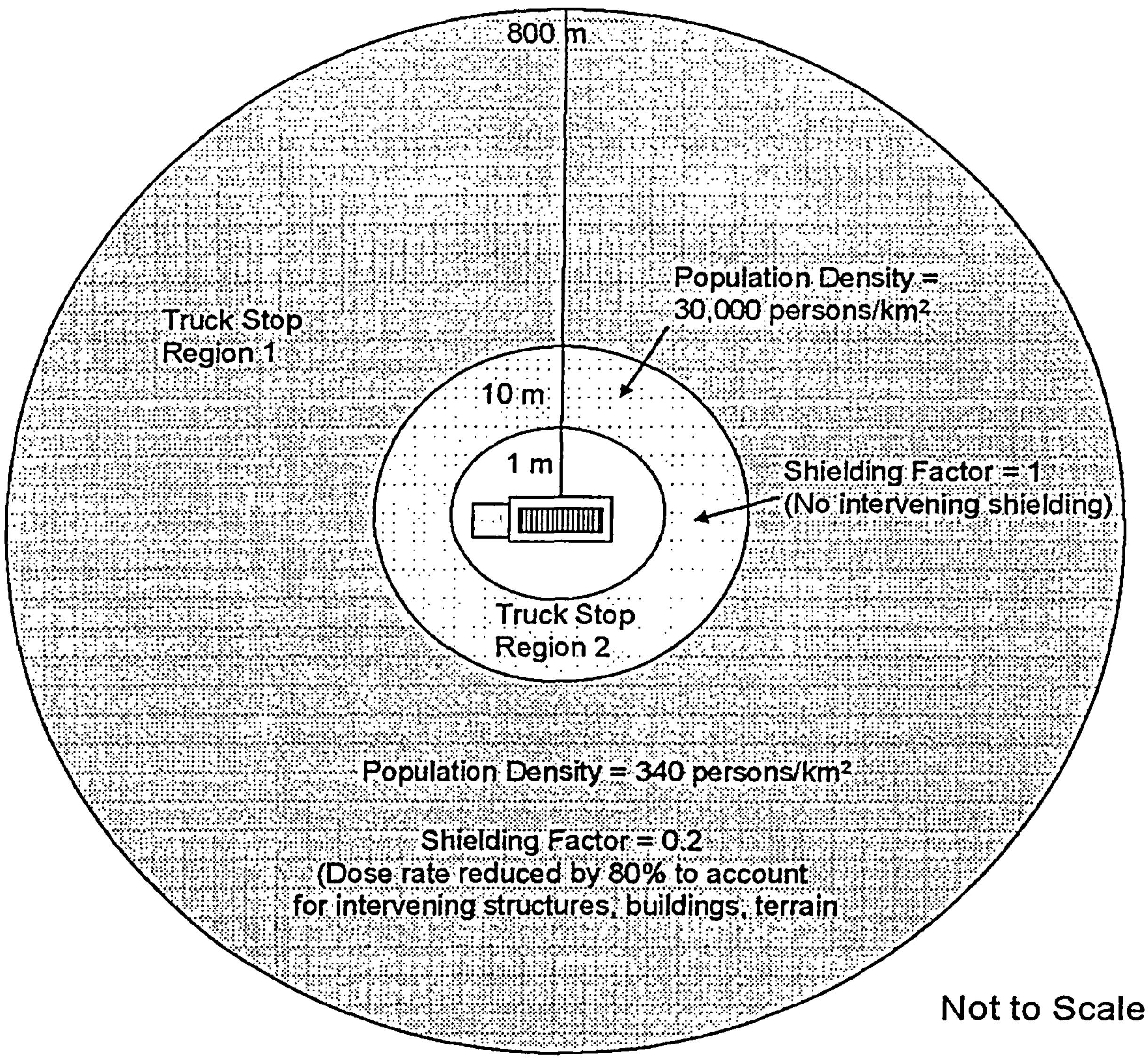

Figure G-1. Illustration of Truck Stop Model (NRC 2000)

Table G-6. Routine (Incident-Free) Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from Potential Advanced Reactor Sites to the Potential Yucca Mountain Disposal Facility

	Population Dose (person-rem/shipment)[a]		
Reactor Site	**Crew**	**Public (Onlookers)**	**Public (Along Route)**
Braidwood	7.1E-02	2.4E-01	4.4E-03
Clinton	7.2E-02	2.5E-01	4.5E-03
Fitzpatrick	9.8E-02	3.5E-01	9.5E-03
Grand Gulf	8.7E-02	2.8E-01	7.0E-03
North Anna	1.0E-01	3.5E-01	9.2E-03
Pilgrim	1.1E-01	3.9E-01	1.2E-02
Portsmouth	9.1E-02	3.2E-01	7.3E-03
Quad Cities	6.7E-02	2.1E-01	4.1E-03
Savannah River	9.9E-02	3.5E-01	1.0E-02
Surry	1.1E-01	3.5E-01	9.7E-03
Zion	7.3E-02	2.5E-01	5.2E-03

(a) to convert person-rem to person-Sv, divide the number by 100.

Table G.7. Routine (Incident free) Population Doses From Spent Fuel Transportation, Normalized to Reference LWR Net Electrical Generation

Reactor Type	Reference LWR (WASH-1238)			ABWR/ESBWR			AP1000			ACR-700		
No Shipments per yr	60			41			40			90		
	Environmental Effects, person-rem per reactor year(a)											
Reactor Site	Crew	On-lookers	Along Route	Crew	On-lookers	Along Route	Crew	On-lookers	Along Route	Crew	On-lookers	Along Route
Braidwood	4.2E+00	1.5E+01	2.6E-01	2.9E+00	1.0E+01	1.8E-01	2.8E+00	9.7E+00	1.7E-01	6.3E+00	2.2E+01	3.9E-01
Clinton	4.3E+00	1.5E+01	2.7E-01	2.9E+00	1.0E+01	1.8E-01	2.8E+00	9.7E+00	1.8E-01	6.4E+00	2.2E+01	4.1E-01
Fitzpatrick	5.9E+00	2.1E+01	5.7E-01	4.0E+00	1.4E+01	3.9E-01	3.9E+00	1.4E+01	3.8E-01	8.8E+00	3.1E+01	8.5E-01
Grand Gulf	5.2E+00	1.7E+01	4.2E-01	3.5E+00	1.2E+01	2.8E-01	3.4E+00	1.1E+01	2.7E-01	7.8E+00	2.5E+01	6.2E-01
North Anna	6.2E+00	2.1E+01	5.5E-01	4.2E+00	1.4E+01	3.7E-01	4.1E+00	1.4E+01	3.6E-01	9.2E+00	3.2E+01	8.2E-01
Pilgrim	6.5E+00	2.3E+01	7.0E-01	4.4E+00	1.6E+01	4.8E-01	4.3E+00	1.5E+01	4.6E-01	9.8E+00	3.5E+01	1.0E+00
Portsmouth	5.5E+00	1.9E+01	4.4E-01	3.7E+00	1.3E+01	3.0E-01	3.6E+00	1.2E+01	2.9E-01	8.1E+00	2.8E+01	6.6E-01
Quad Cities	4.0E+00	1.3E+01	2.4E-01	2.7E+00	8.6E+00	1.7E-01	2.6E+00	8.4E+00	1.6E-01	6.0E+00	1.9E+01	3.6E-01
Savannah River	6.0E+00	2.1E+01	6.0E-01	4.0E+00	1.4E-01	4.1E-01	3.9E+00	1.4E+01	4.0E-01	8.9E+00	3.2E+01	9.0E-01
Surry	6.4E+00	2.1E+01	5.8E-01	4.3E+00	1.4E+01	3.9E-01	4.2E+00	1.4E+01	3.8E-01	9.5E+00	3.2E+01	8.7E-01
Zion	4.4E+00	1.5E+01	3.1E-01	3.0E+00	1.0E+01	2.1E-01	2.9E+00	9.7E+00	2.0E-01	6.5E+00	2.2E+01	4.6E-01

(a) to convert person-rem to person-Sv, divide the number by 100.

Table G-7. (cont)

Reactor Type	IRIS			GT MHR			PBMR		
No Shipments per yr	35			34			12		
	Environmental Effects, person-rem per reactor year[a]								
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
Braidwood	2.5E+00	8.5E+00	1.5E-01	2.4E+00	8.2E+00	1.5E-01	7.9E-01	2.7E+00	4.9E-02
Clinton	2.5E+00	8.5E+00	1.6E-01	2.4E+00	8.2E+00	1.5E-01	8.0E-01	2.8E+00	5.1E-02
Fitzpatrick	3.4E+00	1.2E+01	3.3E-01	3.3E+00	1.2E+01	3.2E-01	1.1E+00	3.9E+00	1.1E-01
Grand Gulf	3.0E+00	9.8E+00	2.4E-01	2.9E+00	9.4E+00	2.3E-01	9.7E-01	3.2E+00	7.8E-02
North Anna	3.6E+00	1.2E+01	3.2E-01	3.4E+00	1.2E+01	3.1E-01	1.2E+00	4.0E+00	1.0E-01
Pilgrim	3.8E+00	1.3E+01	4.0E-01	3.6E+00	1.3E+01	3.9E-01	1.2E+00	4.3E+00	1.3E-01
Portsmouth	3.1E+00	1.1E+01	2.5E-01	3.0E+00	1.1E+01	2.4E-01	1.0E+00	3.6E+00	8.2E-02
Quad Cities	2.3E+00	7.4E+00	1.4E-01	2.2E+00	7.1E+00	1.4E-01	7.5E-01	2.4E+00	4.6E-02
Savannah River	3.4E+00	1.2E+01	3.5E-01	3.3E+00	1.2E+01	3.3E-01	1.1E+00	3.9E+00	1.1E-01
Surry	3.7E+00	1.2E+01	3.3E-01	3.5E+00	1.2E+01	3.2E-01	1.2E+00	4.0E+00	1.1E-01
Zion	2.5E+00	8.5E+00	1.8E-01	2.4E+00	8.2E+00	1.7E-01	8.2E-01	2.8E+00	5.8E-02

(a) to convert person-rem to person-Sv, divide the number by 100.

Table G.8. Latent Cancer Fatality Impacts From Routine Spent Fuel Transportation, Normalized to Reference LWR Net Electrical Generation

Reactor Type	Environmental Effects, Latent Cancer Fatalities Per Reactor Year											
	Reference LWR (WASH-1238)			ABWR/ESBWR			AP1000			ACR-700		
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
Braidwood	2.5E-03	8.8E-03	1.6E-04	1.7E-03	6.0E-03	1.1E-04	1.7E-03	5.8E-03	1.0E-04	3.8E-03	1.3E-02	2.3E-04
Clinton	2.6E-03	8.8E-03	1.6E-04	1.8E-03	6.0E-03	1.1E-04	1.7E-03	5.8E-03	1.1E-04	3.9E-03	1.3E-02	2.4E-04
Fitzpatrick	3.5E-03	1.3E-02	3.4E-04	2.4E-03	8.6E-03	2.3E-04	2.3E-03	8.3E-03	2.3E-04	5.3E-03	1.9E-02	5.1E-04
Grand Gulf	3.1E-03	1.0E-02	2.5E-04	2.1E-03	6.9E-03	1.7E-04	2.1E-03	6.7E-03	1.6E-04	4.7E-03	1.5E-02	3.7E-04
North Anna	3.7E-03	1.3E-02	3.3E-04	2.5E-03	8.6E-03	2.2E-04	2.4E-03	8.3E-03	2.2E-04	5.5E-03	1.9E-02	4.9E-04
Pilgrim	3.9E-03	1.4E-02	4.2E-04	2.7E-03	9.4E-03	2.9E-04	2.6E-03	9.1E-03	2.8E-04	5.9E-03	2.1E-02	6.3E-04
Portsmouth	3.3E-03	1.1E-02	2.6E-04	2.2E-03	7.7E-03	1.8E-04	2.2E-03	7.5E-03	1.7E-04	4.9E-03	1.7E-02	3.9E-04
Quad Cities	2.4E-03	7.6E-03	1.5E-04	1.6E-03	5.2E-03	1.0E-04	1.6E-03	5.0E-03	9.6E-05	3.6E-03	1.1E-02	2.2E-04
Savannah River	3.6E-03	1.3E-02	3.6E-04	2.4E-03	8.6E-03	2.5E-04	2.4E-03	8.3E-03	2.4E-04	5.3E-03	1.9E-02	5.4E-04
Surry	3.8E-03	1.3E-02	3.5E-04	2.6E-03	8.6E-03	2.4E-04	2.5E-03	8.4E-03	2.3E-04	5.7E-03	1.9E-02	5.2E-04
Zion	2.6E-03	8.9E-03	1.9E-04	1.8E-03	6.0E-03	1.3E-04	1.7E-03	5.8E-03	1.2E-04	3.9E-03	1.3E-02	2.8E-04

Appendix G

Table G.8. (cont)

	Environmental Effects, Latent Cancer Fatalities Per Reactor Year								
Reactor Type	IRIS			GT MHR			PBMR		
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
Braidwood	1.5E-03	5.1E-03	9.1E-05	1.4E-03	4.9E-03	8.7E-05	4.8E-04	1.6E-03	2.9E-05
Clinton	1.5E-03	5.1E-03	9.4E-05	1.4E-03	4.9E-03	9.0E-05	4.8E-04	1.7E-03	3.0E-05
Fitzpatrick	2.0E-03	7.3E-03	2.0E-04	2.0E-03	7.0E-03	1.9E-04	6.6E-04	2.4E-03	6.4E-05
Grand Gulf	1.8E-03	5.9E-03	1.4E-04	1.7E-03	5.7E-03	1.4E-04	5.8E-04	1.9E-03	4.7E-05
North Anna	2.1E-03	7.3E-03	1.9E-04	2.1E-03	7.0E-03	1.8E-04	6.9E-04	2.4E-03	6.2E-05
Pilgrim	2.3E-03	8.0E-03	2.4E-04	2.2E-03	7.7E-03	2.3E-04	7.3E-04	2.6E-03	7.9E-05
Portsmouth	1.9E-03	6.6E-03	1.5E-04	1.8E-03	6.3E-03	1.5E-04	6.1E-04	2.1E-03	4.9E-05
Quad Cities	1.4E-03	4.4E-03	8.5E-05	1.3E-03	4.2E-03	8.1E-05	4.5E-04	1.4E-03	2.7E-05
Savannah River	2.1E-03	7.3E-03	2.1E-04	2.0E-03	7.0E-03	2.0E-04	6.7E-04	2.4E-03	6.8E-05
Surry	2.2E-03	7.3E-03	2.0E-04	2.1E-03	7.1E-03	1.9E-04	7.1E-04	2.4E-03	6.5E-05
Zion	1.5E-03	5.1E-03	1.1E-04	1.5E-03	4.9E-03	1.0E-04	4.9E-04	1.7E-03	3.5E-05

Table G.9. Total Detrimental Health Effects From Routine Spent Fuel Transportation, Normalized to Reference LWR Net Electrical Generation

Reactor Type	Reference LWR (WASH-1238)			ABWR/ESBWR			AP1000			ACR-700		
	Environmental Effects, Total Detrimental Health Effects per reactor year											
Reactor Site	Crew	On-lookers	Along Route	Crew	On-lookers	Along Route	Crew	On-lookers	Along Route	Crew	On-lookers	Along Route
Braidwood	3.6E-03	1.2E-02	2.2E-04	2.4E-03	8.5E-03	1.5E-04	2.4E-03	8.2E-03	1.5E-04	5.4E-03	1.9E-02	3.3E-04
Clinton	3.7E-03	1.3E-02	2.3E-04	2.5E-03	8.5E-03	1.6E-04	2.4E-03	8.2E-03	1.5E-04	5.5E-03	1.9E-02	3.4E-04
Fitzpatrick	5.0E-03	1.8E-02	4.8E-04	3.4E-03	1.2E-02	3.3E-04	3.3E-03	1.2E-02	3.2E-04	7.5E-03	2.7E-02	7.2E-04
Grand Gulf	4.4E-03	1.4E-02	3.5E-04	3.0E-03	9.8E-03	2.4E-04	2.9E-03	9.5E-03	2.3E-04	6.6E-03	2.2E-02	5.3E-04
North Anna	5.2E-03	1.8E-02	4.7E-04	3.6E-03	1.2E-02	3.2E-04	3.4E-03	1.2E-02	3.1E-04	7.8E-03	2.7E-02	7.0E-04
Pilgrim	5.6E-03	2.0E-02	6.0E-04	3.8E-03	1.3E-02	4.0E-04	3.7E-03	1.3E-02	3.9E-04	8.3E-03	2.9E-02	8.9E-04
Portsmouth	4.6E-03	1.6E-02	3.7E-04	3.1E-03	1.1E-02	2.5E-04	3.0E-03	1.1E-02	2.5E-04	6.9E-03	2.4E-02	5.6E-04
Quad Cities	3.4E-03	1.1E-02	2.1E-04	2.3E-03	7.4E-03	1.4E-04	2.2E-03	7.1E-03	1.4E-04	5.1E-03	1.6E-02	3.1E-04
Savannah River	5.1E-03	1.8E-02	5.1E-04	3.4E-03	1.2E-02	3.5E-04	3.3E-03	1.2E-02	3.4E-04	7.6E-03	2.7E-02	7.7E-04
Surry	5.4E-03	1.8E-02	4.9E-04	3.7E-03	1.2E-02	3.3E-04	3.6E-03	1.2E-02	3.2E-04	8.1E-03	2.7E-02	7.4E-04
Zion	3.7E-03	1.3E-02	2.6E-04	2.5E-03	8.5E-03	1.8E-04	2.5E-03	8.3E-03	1.7E-04	5.6E-03	1.9E-02	4.0E-04

Table G.9. (cont)

	Environmental Effects, Total Detrimental Health Effects per reactor year								
Reactor Type	IRIS			GT MHR			PBMR		
Reactor Site	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route	Crew	Onlookers	Along Route
Braidwood	2.1E-03	7.2E-03	1.3E-04	2.0E-03	6.9E-03	1.2E-04	6.7E-04	2.3E-03	4.2E-05
Clinton	2.1E-03	7.2E-03	1.3E-04	2.0E-03	6.9E-03	1.3E-04	6.8E-04	2.3E-03	4.3E-05
Fitzpatrick	2.9E-03	1.0E-02	2.8E-04	2.8E-03	9.9E-03	2.7E-04	9.4E-04	3.3E-03	9.1E-05
Grand Gulf	2.6E-03	8.3E-03	2.0E-04	2.5E-03	8.0E-03	2.0E-04	8.3E-04	2.7E-03	6.6E-05
North Anna	3.0E-03	1.0E-02	2.7E-04	2.9E-03	1.0E-02	2.6E-04	9.8E-04	3.4E-03	8.7E-05
Pilgrim	3.2E-03	1.1E-02	3.4E-04	3.1E-03	1.1E-02	3.3E-04	1.0E-03	3.7E-03	1.1E-04
Portsmouth	2.7E-03	9.3E-03	2.2E-04	2.6E-03	9.0E-03	2.1E-04	8.7E-04	3.0E-03	7.0E-05
Quad Cities	2.0E-03	6.3E-03	1.2E-04	1.9E-03	6.0E-03	1.2E-04	6.3E-04	2.0E-03	3.9E-05
Savannah River	2.9E-03	1.0E-02	3.0E-04	2.8E-03	1.0E-02	2.8E-04	9.5E-04	3.4E-03	9.6E-05
Surry	3.1E-03	1.0E-02	2.8E-04	3.0E-03	1.0E-02	2.7E-04	1.0E-03	3.4E-03	9.2E-05
Zion	2.2E-03	7.3E-03	1.5E-04	2.1E-03	7.0E-03	1.5E-04	7.0E-04	2.3E-03	5.0E-05

The results in Tables G.7 to G.9 are highly sensitive to the assumed dose rate emitted from the shipping cask. For conservatism, the regulatory maximum dose rate (10 mrem/hr at 2 m) was assumed in the RADTRAN 5 calculations (i.e., the dose rate can be no greater than that value). The shipping casks assumed in the Yucca Mountain EIS (DOE 2002b) were designed to transport spent fuel that has cooled for 5 years. In reality, most spent fuel will have cooled for much longer than 5 years before it is shipped to a geologic repository. Sprung et al. (2000) 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 to a geologic repository will have dose rates less than half of the regulatory limit. Consequently, the estimated population doses in Table G.7 could be divided in half if realistic dose rate projections are used.

Doses at truck stops have been found in many studies to be important contributors to public dose estimates. RADTRAN 5 parameters that are used to calculate doses at stops include the amount of stop time per trip, number of exposed people, and the dose rate (see Table G.5). The RADTRAN 5 stop model used here assumes that a 30-minute stop is made approximately every 4 hours for food, rest, refueling, and inspections. This assumption is conservative relative to the stop assumptions used in the Yucca Mountain EIS (DOE 2002), in which a 30-minute stop is assumed to occur every 845 km (approximately every 8 to 10 hours) and short duration (10 minutes) stops are made every 161 km (approximately every 2 hours). This equates to an approximate doubling of the number of truck stops for food and refueling relative to DOE (2002b).

Most of the stops made for actual spent fuel shipments are short duration stops (i.e., 10 minutes) for brief visual inspections of the cargo (e.g., checking the cask tie-downs). These stops typically occur in areas devoid of people, such as an overpass or freeway ramp in an unpopulated area. Therefore, doses to residents surrounding these types of stops are negligible. In DOE (2002b), close-proximity exposures (i.e., from 1 to 15.8 m from the cask) were not assumed to occur at the short-duration inspection stops. In this analysis, for the purpose of developing bounding estimates of environmental effects, close-proximity (1 to 10 m from cask) exposures at all truck stops were included in the RADTRAN 5 calculations. Since the numbers of stops in this analysis are effectively doubled relative to DOE (2002b), truck stop doses are also doubled. The doses to residents would also be lower; however, since doses to residents are two to three orders of magnitude (that is, a factor of 100 to 1000) less than the calculated close-proximity doses, this reduction does not affect the total stop dose.

The number of exposed persons at stops is higher in this analysis by about a factor of 1.5 relative to DOE (2002b) assumptions (6.9 persons in DOE 2002b versus 10 persons assumed in this analysis). Thus, the bounding doses calculated in this analysis are also a factor of 1.5 (10 divided by 6.9) greater than those given in DOE (2002b). Furthermore, empirical data provided in Griego et al. (1996) indicates that a 30-minute stop is toward the high end of the stop time distribution. Average stop times for food and refueling observed by Griego et al.

(1996) are on the order of 18 minutes. This amounts to another factor of 1.5 increase in stop doses calculated here relative to DOE (2002b).

Based on these observations, the staff concluded that the stop model used in this study overestimates public doses at stops by at approximately a factor of four (factor of 2 for close-proximity exposure time at stops, factor of 1.5 for average stop time at food and refueling stops, and factor of 1.5 for the number of people in close-proximity to the shipping cask). Coupled with the factor of 2 reduction in shipping cask dose rates that result from fuel aging, the doses to onlookers at stops could be reduced to about one-eighth of the doses shown in Tables G.7 to G.9 [$1/(2 \times 1.5 \times 1.5 \times 2) \approx 0.12$] to reflect more realistic truck shipping conditions.

Based on the above, use of more realistic dose rates, shipping cask capacities, and truck stop model assumptions in the RADTRAN 5 calculations could substantially reduce the environmental effects presented in Tables G.7 to G.9.

Table G.10 provides a comparison between the radiological incident-free doses calculated in NUREG-0170 (NRC 1977) and those calculated here. The table also summarizes the key incident-free input parameters that were used in NUREG-0170 and this study. Comparisons are also made between the doses for spent fuel shipments in NUREG-0170 and doses calculated for a shipment from Quad Cities to a potential geologic repository at Yucca Mountain because the shipping distances are comparable (2530 km in NUREG-0170 versus 2,853 km for Quad Cities to Yucca Mountain). As shown in the table, many parameters have changed over the years and the technical bases for them have improved. For example, the work of Griego et al. (1996) has improved the basis for assumptions about stop times and persons exposed at truck stops, and the TRAGIS computer code has improved the basis for shipping distances and population distributions along highway routes.

The incident-free impacts at truck stops shown in the table have been adjusted as discussed above to reflect more realistic conditions than assumed in the bounding analysis. Adjustments were not made to the on-link, off-link, and crew doses shown in Table G.7. As shown, the adjusted doses in Table G.10 for spent fuel shipments from Quad Cities to potential geologic repository at the potential Yucca Mountain site are about a factor of 2 lower than the per-shipment doses from NUREG-0170 when the doses to and doses associated with in-transit storage from NUREG-0170 are excluded. Storage doses were excluded from this analysis because spent fuel shipments proceed directly from the reactor site to the potential Yucca Mountain site with no intermediate storage involved. Handler doses were excluded from this analysis because doses to workers that load the spent fuel cask at reactors and unload them at the potential repository the are treated as facility doses, not transportation doses, in recent National Environmental Policy Act of 1969 (NEPA) documents.

Table G.10. Comparison of Incident Free Doses from NUREG-0170 Spent Fuel Shipments and Spent Fuel Shipment from Quad-Cities to a Potential Geologic Repository at Yucca Mountain in this Analysis

Incident-Free Exposure Parameter	NUREG-0170 (NRC 1977)	This Study (Quad Cities to Yucca Mountain)[a]
One-Way Shipping Distance, km	2530	2853
Travel Fraction		
Urban	0.05	0.02
Suburban	0.05	0.12
Rural	0.9	0.86
Population Density along Highway, persons per km^2		
Urban	3861	2391.3
Suburban	719	310.2
Rural	6	9.1
Speed, km/hr		
Urban	24	88
Suburban	40	88
Rural	88	88
Traffic Count, vehicles/hr		
Urban	2800	2400
Suburban	780	760
Rural	470	530
Shipment Dose Rate, mrem/hr at 2m	10	10
Crew Dose Rate, mrem/hr	2	Calculated (7.4 m from package)
Stop time, hr per trip		
Urban	2	3 hours per trip (30 minutes per 4 hours driving time)
Suburban	5	
Rural	1	

Table G-10. (cont)

Incident-Free Exposure Parameter	NUREG-0170 (NRC 1977)	This Study (Quad Cities to Yucca Mountain)[(a)]
Population Density at Stops (per km^2)		
Urban	3861	Distribution: 1 to 10 m - 30,000; 10 to 800 m - 340 (see Figure G.1)
Suburban	719	
Rural	6	
Person-rem/Shipment		
Crew	1.2E-01	4.8E-02
Off-link	1.5E-02	3.1E-03
On-link	7.4E-03	1.7E-02
Stops	1.9E-02	1.7E-02(b)
Total	1.6E-01	8.5E-02
Handlers + Storage	2.1E-01	Not Calculated
Grand Total	3.7E-01	8.5E-02

(a) Tables G-5 and G-6 provide the bases for these input parameters.
(b) Stop doses have been adjusted as described in the text to reflect more realistic assumptions than were used in the bounding analysis (Table G.7).

G.2.2 Transportation Accident Impacts

RADTRAN 5 assesses accident risk by combining the probabilities and consequences of accidents to produce a risk value. RADTRAN 5 considers a spectrum of potential transportation accidents, ranging from those with high frequencies and low consequences (e.g., "fender benders") to those with low frequencies and high consequences (i.e., accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

Radionuclide inventories are important parameters in the calculation of accident risks. The radionuclide inventories used in this analysis were taken directly from the Early Site Permit Environmental Report Sections and Supporting Data (DOE 2003). The report included hundreds of radionuclides for each advanced reactor type. A screening analysis was conducted to select the dominant contributors to accident risks to simplify the RADTRAN 5 calculations. The screening identifies the radionuclides that will contribute more than 99.999 percent of the dose from inhalation. A "sum-of-fractions" approach was used for this screening. First, the inventory of each radionuclide was multiplied by its respective inhalation dose conversion factor taken from FGR-13 (Eckerman et al. 2002). These values were then summed. Then, each inventory-conversion factor product was divided by the sum of the products to obtain the fraction of the total inhalation dose for each radionuclide. The resulting fractions were then sorted from largest to smallest, their cumulative contributions were calculated, and those that contributed to 99.999 percent of the inhalation dose potential were selected. Several gases, including H-3, Kr-85, and I-129, were added to the list because they are more easily released than the solid and semi-volatile species contained in the fuel. The inventories of radionuclides used in this study are shown in Table G.11. Note that the dominant radionuclides are approximately the same regardless of fuel type. Also note that adequate radionuclide inventory data was not given in INEEL (2003) for the ACR-700 and IRIS advanced reactors. It was also not provided in WASH-1238 for the reference LWR. Consequently, accident risks were not quantified for these plant types.

Massive shipping casks are used to transport spent fuel because of the heavy radiation shielding and accident resistance required by 10 CFR Part 71. Spent fuel shipping casks must be certified Type B packaging systems, meaning they must withstand a series of severe hypothetical accident conditions with essentially no loss of containment or shielding capability. The tests include a 9 m (30 ft) free drop onto an unyielding surface, drop onto a puncture probe, exposure to an engulfing 800°C fire for 30 minutes, and underwater immersion. According to Sprung et al. (2000), the probability of encountering accident conditions more severe than these tests that could lead to shipping cask failure are less than 0.01 percent of all accidents (that is, more than 99.99 percent of all accidents would not result in a release of radioactive material from the shipping cask). It was assumed that shipping casks for advanced reactor spent fuels will provide equivalent mechanical and thermal protection of the spent fuel cargo.

The RADTRAN 5 accident risk calculations were performed using unit radionuclide inventories (Ci/MTU) for the spent fuel shipments from the various reactor types. The resulting risk estimates were then multiplied by assumed annual spent fuel shipments (MTU/yr) to derive estimates of the annual accident risks associated with spent fuel shipments from each potential advanced reactor site. As was done for routine exposures, it was assumed that the numbers of shipments of spent fuel per year are equivalent to the annual discharge quantities. These are 32.76 MTU/yr for the ABWR and ESBWR, 24.4 MTU/yr for the AP1000, 6.8 MTU/yr for the four-module GT-MHR, and 8.3 MTU/yr for the eight-module PBMR. These data were taken from INEEL (2003) and have not been normalized to the reference LWR net electrical generation.

Route-specific accident rates (accidents per km) were derived for the RADTRAN 5 accident risk analysis. The approach used to develop accident rates for spent fuel shipments is as follows. The TRAGIS data provides estimates of the distance traveled in each state along a route and the type of highway (interstate, state highway, or other). Saricks and Tompkins (1999) provide accident rates for each state that are a function of highway type. The approach taken to

Table G-11. Radionuclide Inventories Used in the Transportation Accident Risk Calculations for Each Advanced Reactor Type

ABWR and ESBWR		AP1000		GT-MHR		PBMR	
Radio-nuclide	Inventory, Ci/MTU	Radio-nuclide	Inventory, Ci/MTU	Radio-nuclide	Inventory, Ci/MTU	Radio-nuclide	Inventory, Ci/MTU
Am-241	1.34E+03	Am-241	7.27E+02	Am-241	2.21E+03	Am-241	2.04E+03
Am-242m	3.34E+01	Am-242m	1.31E+01	Am-242m	1.36E+01	Am-242m	2.30E+01
Am-243	3.24E+01	Am-243	3.34E+01	Am-243	1.39E+01	Am-243	1.29E+02
Ce-144	1.14E+04	Ce-144	8.87E+03	Ce-144	5.82E+04	Ce-144	3.22E+04
Cm-242	5.51E+01	Cm-242	2.83E+01	Cm-242	4.08E+01	Cm-242	7.52E+01
Cm-243	3.69E+01	Cm-243	3.07E+01	Cm-243	5.45E+00	Cm-243	5.29E+01
Cm-244	4.86E+03	Cm-244	7.75E+03	Cm-244	7.64E+02	Cm-244	1.48E+04
Cm-245	6.56E-01	Cm-245	1.21E+00	Cm-245	4.46E-03	Cm-245	1.43E+00
Co-60(a)	2.73E+03	Co-60	0.00E+00	Co-60	0.00E+00	Co-60	0.00E+00
Cs-134	4.81E+04	Cs-134	4.80E+04	Cs-134	5.98E+04	Cs-134	1.09E+05
Cs-137	1.24E+05	Cs-137	9.31E+04	Cs-137	2.93E+05	Cs-137	3.82E+05
Eu-154	1.03E+04	Eu-154	9.13E+03	Eu-154	8.72E+03	Eu-154	1.01E+04
Eu-155	5.22E+03	Eu-155	4.62E+03	Eu-155	2.37E+03	Eu-155	2.93E+03
Pm-147	3.37E+04	Pm-147	1.76E+04	Pm-147	1.87E+05	Pm-147	1.37E+05
Pu-238	6.14E+03	Pu-238	6.07E+03	Pu-238	3.17E+03	Pu-238	1.23E+04
Pu-239	3.87E+02	Pu-239	2.55E+02	Pu-239	6.07E+02	Pu-239	2.99E+02
Pu-240	6.15E+02	Pu-240	5.43E+02	Pu-240	1.07E+03	Pu-240	8.98E+02
Pu-241	1.22E+05	Pu-241	6.96E+04	Pu-241	2.25E+05	Pu-241	1.94E+05
Pu-242	2.24E+00	Pu-242	1.82E+00	Pu-242	4.21E+00	Pu-242	1.22E+01
Ru-106	1.64E+04	Ru-106	1.55E+04	Ru-106	4.01E+04	Ru-106	4.53E+04
Sb-125	5.37E+03	Sb-125	3.83E+03	Sb-125	5.96E+03	Sb-125	6.79E+03
Sr-90	8.85E+04	Sr-90	6.19E+04	Sr-90	2.42E+05	Sr-90	2.92E+05
Y-90	8.85E+04	Y-90	6.19E+04	Y-90	2.42E+05	Y-90	2.92E+05

(a) Co-60 is an activation product. Only the ABWR/ESBWR submittal in INEEL (2003) provided inventory data for activation products.

estimate route-specific accident rates was to multiply the state-level accident or fatality rates by the distances traveled in each state on the corresponding highway type and then sum over all the states on each route. For example, for interstate highways, the interstate distances and interstate accident rates were used. For non-interstate highway travel, either the "Primary" or "Other" rates given by Saricks and Tompkins (1999) were used. This allowed computation of route-specific accident rates.

Transportation accident risk analysis in RADTRAN 5 is performed using an accident severity and package release model. The user can define up to 30 severity categories, with each category increasing in magnitude. Severity categories are related to fire, puncture, crush, and immersion environments created in vehicular accidents. For this analysis, the 19 severity categories defined in NUREG/CR-6672 (Sprung et al. 2000) were adopted.

Each severity category has an assigned conditional probability (or the probability, given an accident occurs that it will be of the specified severity). The accident scenarios are further defined by allowing the user to input release fractions and aerosol and respirable fractions for each severity category. These fractions are a function of the physical-chemical properties of the materials being transported as well as the mechanical and thermal accident conditions that define the severity categories. The severity and release fractions used here are presented in Table G-12.

The severity categories and release fractions in Sprung et al. (2000) were designed specifically to address accidents involving current generation LWR fuel and the current generation of spent fuel shipping casks. While some of the advanced reactor fuel designs are similar to the current generation (e.g., the ABWR, ESBWR, AP1000, ACR-700, and IRIS), others are significantly different, including the GT-MHR, and PBMR. Extrapolating the current generation of fuel and shipping casks to advanced reactor fuels and shipping casks is relatively straightforward since the fuel form, cladding, physical and mechanical properties, are similar. Furthermore, substantial experimental data exists to develop technically defensible release fractions for various radionuclide groups (e.g., gases, semi-volatiles such as cesium and ruthenium, and particulates). However, detailed experimental studies of releases from GT-MHR, and PBMR fuels have not been conducted, so there are significant uncertainties about potential release quantities from these fuels. For this assessment, release fractions for current generation LWR fuels were used to approximate the impacts from the advanced reactor spent fuel shipments. This essentially assumes that the fuel materials and containment systems (i.e., cladding, fuel coatings) behave similarly to current LWR fuel under applied mechanical and thermal conditions. Due to the lack of data on gas-cooled reactor fuels, it is currently not known if this approach is bounding. This approach will have to be evaluated at the CP/COL stage. However, gas-cooled reactors are designed to operate at much higher temperatures than LWRs and thus high temperature conditions anticipated in transportation accident fires should have less of an

Table G-12. Severity and Release Fractions Used to Model Spent Fuel Transportation Accidents (Sprung et al. 2000)

Severity Category	Severity Fraction(a)	Release Fractions(b)				
		Gas	Cesium	Ruthenium	Particulates	Crud
1	1.53E-08	0.8	2.4E-08	6.0E-07	6.0E-07	2.0E-03
2	5.88E-05	0.14	4.1E-09	1.0E-07	1.0E-07	1.4E-03
3	1.81E-06	0.18	5.4E-09	1.3E-07	1.3E-07	1.8E-03
4	7.49E-08	0.84	3.6E-05	3.8E-06	3.8E-06	3.2E-03
5	4.65E-07	0.43	1.3E-08	3.2E-07	3.2E-07	1.8E-03
6	3.31E-09	0.49	1.5E-08	3.7E-07	3.7E-07	2.1E-03
7	0	0.85	2.7E-05	2.1E-06	2.1E-06	3.1E-03
8	1.13E-08	0.82	2.4E-08	6.1E-07	6.1E-07	2.0E-02
9	8.03E-11	0.89	2.7E-08	6.7E-07	6.7E-07	2.2E-03
10	0	0.91	5.9E-06	6.8E-07	6.8E-07	2.5E-03
11	1.44E-10	0.82	2.4E-08	6.1E-07	6.1E-07	2.0E-03
12	1.02E-12	0.89	2.7E-08	6.7E-07	6.7E-07	2.2E-03
13	0	0.91	5.9E-06	6.8E-07	6.8E-07	2.5E-03
14	7.49E-11	0.84	9.6E-05	8.4E-05	1.8E-05	6.4E-03
15	0	0.85	5.5E-05	5.0E-05	9.0E-06	5.9E-03
16	0	0.91	5.9E-06	6.4E-06	6.8E-07	3.3E-03
17	0	0.91	5.9E-06	6.4E-06	6.8E-07	3.3E-03
18	5.86E-06	0.84	1.7E-05	6.7E-08	6.7E-08	2.5E-03
19	0.99993	0	0	0	0	0

(a) Severity fractions are the conditional probabilities, given the occurrence of an accident, that the mechanical and thermal conditions experienced by a spent fuel shipping cask are within the conditions defined by the Severity Category. See Sprung et al. (2000) for detailed information about the derivation of these data.

(b) RADTRAN5 also models the fraction of the released material that is of small enough particle size to be dispersible in prevailing wind conditions and the fraction that is respirable. For this analysis, these parameters were set to 1.0 (i.e., 100 percent dispersible and 100 percent respirable).

effect on radionuclide releases than they do for LWR fuels. Thus, smaller release fractions are anticipated for advanced gas-cooled reactor fuels than for LWR fuels subjected to thermal transients.

For accidents that result in a release of radioactive material, RADTRAN 5 assumes the material is dispersed into the environment according to standard Gaussian diffusion models. The code allows the user to choose two different methods for modeling the atmospheric transport of radionuclides after a potential accident. The user can either input Pasquill atmospheric-stability category data or averaged time-integrated concentrations. In this analysis, the default standard cloud option (using time-integrated concentrations) was used.

RADTRAN 5 calculates the population dose from the released radioactive material for five possible exposure pathways. These pathways are:

- External dose from exposure to the passing cloud of radioactive material.

- External dose from radionuclides deposited on the ground by the passing plume. The analysis included the radiation exposures from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, thus preventing long-term exposures from this pathway.

- Internal dose from inhalation of airborne radioactive contaminants.

- Internal dose from radioactive materials that were deposited on the ground and the resuspended. The analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures.

- Internal dose from ingestion of contaminated food. The analysis assumed interdiction of foodstuffs and evacuation after an accident so no internal dose due to ingestion of contaminated foods was calculated.

A sixth pathway, external doses arising from increased radiation fields surrounding a shipping cask with damaged shielding, was considered, but not included in the analysis. It is possible that shielding materials incorporated into the cask structures could become damaged as a result of an accident. For example, casks with lead shielding could undergo a slumping phenomenon in which impact or fire causes gaps to form in the lead. Radiation would penetrate through the gaps in the shielding at higher intensities, leading to higher radiation dose rates. These are commonly referred to as Loss of Shielding (LOS) events. They were not included in this assessment because their contribution to spent fuel transportation risks is much smaller than the dispersal accident risks.

Standard radionuclide uptake and dosimetry models are incorporated into RADTRAN 5. The computer code combines the accident consequences and frequencies of each severity category, sums up the severity categories, and then integrates across all the shipments. Accident-risk impacts that are provided in the form of a collective population dose (person-rem over the entire shipping campaign) are then converted to population risk using health-effects conversion factors. The dose to risk factors, which were taken from Federal Guidance Report 13 (Eckerman et al. 2002), assume 6.0E-04 LCFs per person-rem and 8.5E-04 total detrimental health effects per person-rem for workers and the general public. Total detriment includes fatal and non-fatal cancers and severe hereditary effects.

The shipping distances and population distribution information for the routes used for the evaluation of the impacts of incident-free transportation (see Table G.4) were also used to calculate transportation impacts. Representative shipping casks described above were assumed.

Table G.13 presents unit (per MTU) accident risks associated with transportation of spent fuel from each potential advanced reactor site to the potential Yucca Mountain HLW repository. Projected annual accident risks, normalized to the WASH-1238 reference LWR net electrical generation (i.e., 880 MW[e]) are presented in Table G.14. As expected, accident risks are highest for the longest shipments. Also, consistent with past spent fuel transportation risk assessments, the human health impacts associated with routine (incident-free) transportation are several orders of magnitude greater than accident risks.

Considering the uncertainties in the data and computational methods, the overall transportation accident risks associated with ABWR, ESBWR, AP1000, GT-MHR, and PBMR spent fuel shipments are judged to be small. Although likely to also be small, accident risks associated with IRIS and ACR-700 spent fuel shipments could not be analyzed due to lack of radionuclide source term data. Additional analyses are necessary to quantify the impacts of IRIS and ACR-700 spent fuel shipments.

For perspective, there are approximately 725,000 persons that live within 800 m of the route between the North Anna ESP site and the potential Yucca Mountain (800 m is the distance on either side of the route used by RADTRAN 5 to compute the routine repository site doses to the population along the route). According to the U.S. Centers for Disease Control and Prevention, the cancer mortality rate in the United States in 2001 was 194.4 fatalities per 100,000 persons (NCHS 2004). Using this rate, one would expect there to be about 1400 cancer fatalities per year from among the 725,000 people along the route between the North Anna ESP site and the potential Yucca Mountain repository site. This is many orders of magnitude greater than the annual accident risk values presented in Table G.14. Therefore, no increase in environmental effects of spent-fuel transportation accidents are expected as a result of shipping spent fuel from ESP sites to the potential Yucca Mountain spent fuel disposal facility.

G.3 Shipment of Radioactive Waste

This section discusses the environmental effects of transporting radioactive waste from ESP sites. The environmental conditions listed in 10 CFR 51.52 that apply to shipments of radioactive waste are:

- Radioactive waste (except spent fuel) is packaged and in a solid form.
- Radioactive waste (except spent fuel) is shipped from the reactor by truck or rail.

INEEL (2003) indicates that all of the advanced reactor technologies will transport their radioactive waste by truck. Furthermore, INEEL (2003) indicates that all of the advanced reactor technologies plan to solidify and package their radioactive waste. In addition, all of the advanced reactor technologies will be subject to NRC (10 CFR Part 71) and Department of Transportation (DOT, 49 CFR Parts 173 and 178) regulations for the shipment of radioactive material.

Table S-4 also specifies the following limits that apply to shipment of radioactive waste:

- Weight – less than 73,000 lbs. per truck or 100 tons per cask per railcar
- Traffic density – less than one truck shipment per day or 3 railcars per month.

The advanced reactor technologies would be capable of shipping their radioactive wastes in compliance with Federal or State weight restrictions. With respect to the traffic density, all of the advanced reactor vendors provided radioactive waste generation estimates. Table G.15 provides these estimates, in addition to the radioactive waste generation estimates for the reference LWR in WASH-1238.

As shown in the table, only the PBMR generates a larger volume of radioactive waste than the reference LWR in WASH-1238. However, the GT-MHR and PBMR information in INEEL (2003) assumed the wastes generated from those designs would be shipped using two different packaging systems: one that hauls 28.3 m^3/shipment (1000 ft^3 per shipment) and one that hauls 5.7 m^3/shipment (200 ft^3 per shipment). Under those conditions, the number of shipments of radioactive waste per year, normalized to 1100 MW(e) electric generation capacity, would be about six shipments/year per 1100 MW(e) (880 net MW[e]) for the GT-MHR and seven shipments/year per 1100 MW(e) for the PBMR. These estimates are well below the reference LWR (42 shipments/yr per 1100 MW[e]). In any event, all the estimates are well below the 1 truck shipment per day condition given in 10 CFR 51.52 Table S-4. Doubling the shipment estimates to account for empty return shipments is still well below the 1 shipment per day condition.

Table G-13. Unit Spent Fuel Transportation Accident Risks for Advanced Reactors

	Advanced Reactor Type			
Site	**ABWR/ESBWR**	**AP1000**	**GT-MHR**	**PBMR**
Population Dose, person-rem/MTU				
Braidwood	1.1E-05	1.0E-06	1.5E-06	2.5E-06
Clinton	5.1E-05	1.0E-06	1.5E-06	2.6E-06
Fitzpatrick	1.9E-05	1.7E-06	2.5E-06	4.3E-06
Grand Gulf	2.1E-05	1.9E-06	2.8E-06	4.7E-06
North Anna	2.3E-05	2.1E-06	3.2E-06	5.4E-06
Pilgrim	4.0E-05	3.7E-06	5.8E-06	9.3E-06
Portsmouth	2.6E-05	2.1E-06	3.1E-06	5.2E-06
Quad Cities	1.0E-05	9.4E-07	1.4E-06	1.4E-06
Savannah River	2.6E-05	2.4E-06	3.6E-06	6.1E-06
Surry	2.4E-05	2.2E-06	3.3E-06	5.6E-06
Zion	1.5E-05	1.4E-06	2.1E-06	3.5E-06
Latent Cancer Fatalities per MTU				
Braidwood	6.7E-09	6.0E-10	8.9E-10	1.5E-09
Clinton	3.1E-08	6.1E-10	9.1E-10	1.5E-09
Fitzpatrick	1.1E-08	1.0E-09	1.5E-09	2.6E-09
Grand Gulf	1.2E-08	1.1E-09	1.7E-09	2.8E-09
North Anna	1.4E-08	1.3E-09	1.9E-09	3.2E-09
Pilgrim	2.4E-08	2.2E-09	3.5E-09	5.6E-09
Portsmouth	1.5E-08	1.2E-09	1.8E-09	3.1E-09
Quad Cities	6.2E-09	5.6E-10	8.4E-10	8.4E-10
Savannah River	1.6E-08	1.4E-09	2.2E-09	3.7E-09
Surry	1.4E-08	1.3E-09	2.0E-09	3.3E-09
Zion	9.0E-09	8.2E-10	1.2E-09	2.1E-09

Table G-13. (cont)

Site	Advanced Reactor Type			
	ABWR/ESBWR	AP1000	GT-MHR	PBMR
Total Detrimental Health Effects per MTU				
Braidwood	9.4E-09	8.5E-10	1.3E-09	2.2E-09
Clinton	4.3E-08	8.6E-10	1.3E-09	2.2E-09
Fitzpatrick	1.6E-08	1.4E-09	2.2E-09	3.7E-09
Grand Gulf	1.7E-08	1.6E-09	2.4E-09	4.0E-09
North Anna	2.0E-08	1.8E-09	2.7E-09	4.6E-09
Pilgrim	3.4E-08	3.1E-09	5.0E-09	7.9E-09
Portsmouth	2.2E-08	1.7E-09	2.6E-09	4.4E-09
Quad Cities	8.8E-09	8.0E-10	1.2E-09	1.2E-09
Savannah River	2.2E-08	2.0E-09	3.1E-09	5.2E-09
Surry	2.0E-08	1.9E-09	2.8E-09	4.7E-09
Zion	1.3E-08	1.2E-09	1.7E-09	3.0E-09

Table G.14. Annual Spent Fuel Transportation Accident Impacts for Advanced Reactors, Normalized to Reference LWR Net Electrical Generation

	Advanced Reactor Type			
	ABWR/ESBWR	AP1000	GT-MHR	PBMR
MTU/yr	20.3	19.7	6.0	5.8
Population Dose, person-rem/yr				
Braidwood	2.2E-04	2.0E-05	8.9E-06	1.5E-05
Clinton	1.0E-03	2.0E-05	9.0E-06	1.5E-05
Fitzpatrick	3.8E-04	3.3E-05	1.5E-05	2.5E-05
Grand Gulf	4.2E-04	3.7E-05	1.7E-05	2.7E-05
North Anna	4.7E-04	4.2E-05	1.9E-05	3.1E-05

Table G-14. (contd)

	Advanced Reactor Type			
	ABWR/ESBWR	AP1000	GT-MHR	PBMR
Pilgrim	8.1E-04	7.2E-05	3.5E-05	5.4E-05
Portsmouth	5.2E-04	4.0E-05	1.8E-05	3.0E-05
Quad Cities	2.1E-04	1.8E-05	8.4E-06	8.2E-06
Savannah River	5.3E-04	4.7E-05	2.1E-05	3.5E-05
Surry	4.8E-04	4.3E-05	2.0E-05	3.2E-05
Zion	3.0E-04	2.7E-05	1.2E-05	2.0E-05
Latent Cancer Fatalities per Year				
Braidwood	1.3E-07	1.2E-08	5.3E-09	8.8E-09
Clinton	6.2E-07	1.2E-08	5.4E-09	8.9E-09
Fitzpatrick	2.3E-07	2.0E-08	9.1E-09	1.5E-08
Grand Gulf	2.5E-07	2.2E-08	1.0E-08	1.6E-08
North Anna	2.8E-07	2.5E-08	1.1E-08	1.9E-08
Pilgrim	4.9E-07	4.3E-08	2.1E-08	3.3E-08
Portsmouth	3.1E-07	2.4E-08	1.1E-08	1.8E-08
Quad Cities	1.3E-07	1.1E-08	5.0E-09	4.9E-09
Savannah River	3.2E-07	2.8E-08	1.3E-08	2.1E-08
Surry	2.9E-07	2.6E-08	1.2E-08	1.9E-08
Zion	1.8E-07	1.6E-08	7.3E-09	1.2E-08
Total Detrimental Health Effects per Year				
Braidwood	1.9E-07	1.7E-08	7.6E-09	1.3E-08
Clinton	8.8E-07	1.7E-08	7.7E-09	1.3E-08
Fitzpatrick	3.2E-07	2.8E-08	1.3E-08	2.1E-08
Grand Gulf	3.5E-07	3.1E-08	1.4E-08	2.3E-08
North Anna	4.0E-07	3.6E-08	1.6E-08	2.7E-08
Pilgrim	6.9E-07	6.1E-08	3.0E-08	4.6E-08
Portsmouth	4.4E-07	3.4E-08	1.6E-08	2.6E-08

Table G-14. (contd)

	Advanced Reactor Type			
	ABWR/ESBWR	AP1000	GT-MHR	PBMR
Quad Cities	1.8E-07	1.6E-08	7.1E-09	6.9E-09
Savannah River	4.5E-07	4.0E-08	1.8E-08	3.0E-08
Surry	4.1E-07	3.7E-08	1.7E-08	2.7E-08
Zion	2.6E-07	2.3E-08	1.0E-08	1.7E-08

Table G-15. Summary of Radioactive Waste Shipments for Advanced Reactors

Reactor Type	INEEL (2003) Waste Generation Information	Annual Waste Volume, m^3/yr per site	Electrical Output, MW(e)/site	Normalized Rate, m^3/1100 MW(e) plant (880 MW[e] net)(a)	Shipments/1100 MW(e) (880 MW[e] net) Electrical Output(b)
Reference LWR (WASH-1238)	3800 ft^3/yr per unit	108	1100	108	46
ABWR	100 m^3/yr per unit	100	1500	62	27
ESBWR	100 m^3/yr per unit	100	1500	62	27
AP1000	1964 ft^3/yr per unit	56	1150	45	20
ACR-700	47.5 m^3/yr per unit	47.5	731	64	28
IRIS	870 ft^3/yr per unit	74(3 units)	1005 (3 units)	67	29
GT-MHR	98 m^3/yr (4 unit plant)	98 (4 units)	1140 (4 units)	86	37[(c)]
PBMR	100 drums/yr per unit	168 (8 units)	1320 (8 units)	118	51[(c)]

Table G-15. (contd)

Conversions: 1 m^3 = 35.31 ft^3. Drum volume = 210 liters (0.21 m^3).

(a) Capacity factors used to normalize the waste generations rates to an equivalent electrical generation output are given in Table G.1 for each reactor type. All are normalized to 880 MW(e) net electrical output (1100 MW[e] plant with an 80 percent capacity factor).

(b) The number of shipments per 1100 MW(e) was calculated assuming the WASH-1238 average waste shipment capacity of 2.34 m^3 per shipment (108 m^3/yr divided by 46 shipments/yr).

(c) INEEL (2003) states that 90 percent of the waste could be shipped on trucks carrying 28 m^3 (1000 ft3) of waste and the remaining 10 percent in shipments carrying 5.7 m^3 (200 ft^3) of radioactive waste. This would result in 6 to 7 shipments per year after normalization to the reference LWR electrical output.

G.4 References

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Appendix H

Authorizations and Consultations

Appendix H

Authorizations and Consultations

This appendix contains a list of the environmental-related authorization, permits, and certifications potentially required by Federal, State, regional, local, and affected Native American tribal agencies for activities related to the construction and operation of potential new nuclear units at the North Anna ESP site, as listed in Revision 3 of the Environmental Report (Table 1.2-1).

Table 1.2-1 Federal, State, and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. (a)	Expiration Date (a)	Activity Covered
FAA	49 USC 1501	Construction Notice			Notice of erection of structures (>200 feet) potentially impacting air navigation.
Lake Anna Special Area Plan Committee		Conditional Land Use Approval	N/A	N/A	Local land use approval – Lake Overlay District.
NRC	Atomic Energy Act (AEA), 10 CFR 51, 10 CFR 52.17	EIS	N/A	N/A	Environmental effects of construction and operation of a reactor
NRC	10 CFR 52, Subpart C	Combined License			Combined construction permit and operating license for a nuclear power facility
NRC	10 CFR 52, Subpart A	Early Site Permit			Approval of the site for one or more nuclear power facilities, and approval of limited construction as per 10 CFR 50.10(e)(1)
NRC	10 CFR 30	By-product License			Approval to possess special nuclear materials
NRC	10 CFR 70	Special Nuclear Materials License			Approval to possess fuel
SCC					Approval of the purchase or lease of the site
SCC	VA Code 56-580D				Approval for construction of new generating facility
USACE	Clean Water Act (CWA)	Section 404 Permit (individual, regional, general)			Disturbance or crossing wetland areas or navigable waters
USACE	Rivers and Harbors Act	Section 10 Permit			Impacts to navigable waters of the U.S.
USFWS	Endangered Species Act	Consultation regarding potential to adversely impact protected species. Letter of Concurrence	N/A	N/A	Concurrence with no adverse impact or consultation on appropriate mitigation measures

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Table 1.2-1 Federal, State, and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. (a)	Expira-tion Date (a)	Activity Covered
USFWS	Migratory Bird Treaty Act	Federal or State Permit			Adverse impact on protected species (e.g., eagles, ospreys) and/or their nests
VDEQ	9 VAC 5-20-160	Registration.			Annual re-certification of air emission sources.
VDEQ	Federal Clean Air Act Amendments (CAAA) Title V9 VAC 5-80-50	Title V Operating Permit.			Operation of air emission sources
VDEQ	9 VAC 5-80-120	Minor Source - General Permit.			Construction and operation of minor air emission sources.
VDEQ	FWCA 9 VAC 25-10	Virginia Pollutant Discharge Elimination System Permit (VPDES).			Regulated limits of pollutants in liquid discharge to surface water
VDEQ	FWCA 9 VAC 25-150	General Permit Registration Statement for storm water discharges from industrial activity (VAR5).			General permit to discharge storm water from site during operations
VDEQ	FWCA 9 VAC 25-180	General Permit NOT for storm water discharges from industrial activity (VAR5)			Termination of coverage under the general permit for storm water discharge associated with operational site activities
VDEQ	Federal Clean Water Act 9 VAC 25-180	General Permit Notice of Termination (NOT) for storm water discharges from construction activities (VAR4).			Termination of coverage under the general permit for storm water discharge from construction site activities
VDEQ	9 VAC 25-210	Virginia Water Protection Permit (Individual or General)			Permit to dredge, fill, discharge pollutants into or adjacent to surface water. Joint application with USACE Section 404 permit.

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Table 1.2-1 Federal, State, and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. (a)	Expiration Date (a)	Activity Covered
VDEQ	Federal Clean Water Act	Section 401 Certification			Compliance with water quality standards.
VDEQ	Federal Clean Water Act (FWCA) 9 VAC 25-220	Surface Water Withdrawal Permit			Permit to draw water from Lake Anna (unless otherwise regulated by State Water Control Board)
VDEQ	Coastal Zone Management Act, Section 307.	Consistency determination.	N/A	N/A	Compliance with Virginia Coastal Program.
VDEQ	Virginia Coastal Resources Management Program	Consistency determination	N/A	N/A	Compliance with Virginia Coastal Program.
VDEQ	Federal Clean Water Act 9 VAC 25-180	General Permit Registration Statement for storm water discharges from construction activities (VAR10).			General permit to discharge storm water from site during construction
VDHR	National Historic Preservation Act, 36 CFR 800	Cultural Resources Survey/Review	N/A	N/A	Confirm site does not contain protected historic/cultural resources
VMRC	9 VAC 25-210	VMRC Permit			Permit to fill submerged land. Joint application with USACE Section 404 permit.

N/A - Not applicable (A license or permit is not required at the ESP stage)

a. The information does not currently exist. Licenses and permits would be applied for and received at the appropriate time, which may not be until the COL phase.

Appendix I

Plant Parameter Envelope Values

Appendix I

Plant Parameter Envelope Values

This appendix contains the Dominion Plant Parameter Envelope as submitted in Revision 3 of the Environmental Report (Table 3.1-1).

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
1. Structures			c	
1.1 Building Characteristics				
1.1.1 Height	234 ft-0 in. [Same for 2nd unit/group]	1		The height from finished grade to the top of the tallest power block structure, excluding cooling towers.
1.1.2 Foundation Embedment	140 ft [Same for 2nd unit/group]	2		The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure.
1.2 Precipitation (for Roof Design)				
1.2.1 Maximum Rainfall Rate	19.4 in/hr (6.2 in/5 min) [Same for 2nd unit/group]	2, 3, 4, 5		The probable maximum precipitation (PMP) value that can be accommodated by a plant design. Expressed as maximum precipitation for 1 hour in 1 square mile with a ratio for five minutes to the 1 hour PMP of 0.32 as found in National Weather Service Publication HMR No. 52.
1.2.2 Snow and Ice Load	50 lb/sq ft [Same for 2nd unit/group]	2, 3, 4		The maximum load on structure roofs due to the accumulation of snow and ice that can be accommodated by a plant design.
1.3 Safe Shutdown Earthquake (SSE)				
1.3.1 Design Response Spectra	RG 1.60 [Same for 2nd unit/group]	6		The assumed design response spectra used to establish a plant's seismic design.
1.3.2 Peak Ground Acceleration	0.30g [Same for 2nd unit/group]	6		The maximum earthquake ground acceleration for which a plant is designed; this is defined as the acceleration which corresponds to the zero period in the response spectra taken in the free field at plant grade elevation.
1.3.3 Time History	Envelope SSE Response Spectra [Same for 2nd unit/group]	6		The plot of earthquake ground motion as a function of time used to establish a plant's seismic design.
1.3.4 Capable Tectonic Structures or Sources	No fault displacement potential within the investigative area [Same for 2nd unit/group]	1		The assumption made in a plant design about the presence of capable faults or earthquake sources in the vicinity of the plant site (e.g., no fault displacement potential within the investigative area).

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
1.4 Site Water Level (Allowable)				
1.4.1 Maximum Flood (or Tsunami)	1 ft below plant grade [Same for 2nd unit/group]	2, 3, 4		Design assumption regarding the difference in elevation between finished plant grade and the water level due to the probable maximum flood and probable maximum precipitation (defined in ANSI/ANS 2.8-1992) used in the plant design.
1.4.2 Maximum Ground Water	1 meter below grade (i e., 3.3 feet below grade) [Same for 2nd unit/group]	7		Design assumption regarding the difference in elevation between finished plant grade and the maximum site ground water level used in the plant design.
1.5 Soil Properties Design Bases				
1.5.1 Liquefaction	None at Site-Specific SSE [Same for 2nd unit/group]	6		Design assumption regarding the presence of potentially liquefying soils at a site (e.g., none at Site-Specific SSE).
1.5.2 Minimum Bearing Capacity (Static)	15 ksf [Same for 2nd unit/group]	2, 3		Design assumption regarding the capacity of the competent load-bearing layer required to support the loads exerted by plant structures used in the plant design.
1.5.3 Minimum Shear Wave Velocity	≥3,500 fps [Same for 2nd unit/group.]	1		The assumed limiting propagation velocity of shear waves through the foundation materials used in the plant design.
1.6 Tornado (Design Bases)				
1.6.1 Maximum Pressure Drop	2.0 psi [Same for 2nd unit/group]	6		The design assumption for the decrease in ambient pressure from normal atmospheric pressure due to the passage of the tornado.
1.6.2 Maximum Rotational Speed	240 mph [Same for 2nd unit/group]	6		The design assumption for the component of tornado wind speed due to the rotation within the tornado.
1.6.3 Maximum Translational Speed	60 mph [Same for 2nd unit/group]	6		The design assumption for the component of tornado wind speed due to the movement of the tornado over the ground.
1.6.4 Maximum Wind Speed	300 MPH [Same for 2nd unit/group]	6		The design assumption for the sum of maximum rotational and maximum translational wind speed components.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
1.6.5 Missile Spectra	Spectrum II from NUREG-0800 SRP Section 3.5.1.4 [Same for 2nd unit/group]	4, 8		The design assumptions regarding missiles that could be ejected either horizontally or vertically from a tornado. The spectra identify mass, dimensions and velocity of credible missiles.
1.6.6 Radius of Maximum Rotational Speed	150 ft [Same for 2nd unit/group]	6		The design assumption for distance from the center of the tornado at which the maximum rotational wind speed occurs.
1.6.7 Rate of Pressure Drop	1.2 psi/sec [Same for 2nd unit/group]	6		The assumed design rate at which the pressure drops due to the passage of the tornado.
1.7 Wind				
1.7.1 Basic Wind Speed	110 mph [Same for 2nd unit/group]	2, 3, 4		The design wind, or "fastest mile of wind" with a 100-year return period (NUREG-0800, Sections 2.3.1 and 3.3.1) for which the facility is designed.
1.7.2 Importance Factors	1.0 (non-safety related)/ 1.11 (safety related) [Same for 2nd unit/group]	2, 3		Multiplication factors (as defined in ANSI A58.1-1982) applied to basic wind speed to develop the plant design.
2. Normal Plant Heat Sink				
2.1 Ambient Air Requirements				
2.1.1 Normal Shutdown Max Ambient Temp (1% Exceed)	100°F db / 77°F wb coincident [Same for 2nd unit/group]	6		Assumption used for the maximum ambient temperature that will be exceeded no more than 1% of the time, to design plant systems capable of effecting normal shutdown under the assumed temperature condition.
2.1.2 Normal Shutdown Max Wet Bulb Temp (1% Exceed)	80°F wb non-coincident [Same for 2nd unit/group]	6		Assumption used for the maximum wet bulb temperature that will be exceeded no more than 1% of the time – used in design of plant systems that must be capable of effecting normal shutdown under the assumed temperature condition.
2.1.3 Normal Shutdown Min Ambient Temp (1% Exceed)	-10°F [Same for 2nd unit/group]	6		Assumption used for the minimum ambient temperature that will be exceeded no more than 1% of the time to design of plant systems that must be capable of effecting normal shutdown under the assumed temperature condition.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
2.1.4 Rx Thermal Power Max Ambient Temp (0% Exceed)	115°F db/80 F wb coincident [Same for 2nd unit/group]	6		Assumption used for the maximum ambient temperature that will never be exceeded – used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition
2.1.5 Rx Thermal Power Max Wet Bulb Temp (0% Exceed)	81 F wb non-coincident [Same for 2nd unit/group]	6		Assumption used for the maximum wet bulb temperature that will never be exceeded – used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition
2.1.6 Rx Thermal Power Min Ambient Temp (0% Exceed)	-40 F [Same for 2nd unit/group]	6		Assumption used for the minimum ambient temperature that will never be exceeded – used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition.
2.2 Condenser				
2.2.1 Max Inlet Temp Condenser/ Heat Exchanger	91°F [Same for 2nd unit/group.]	1, 7		Design assumption for the maximum acceptable circulating water temperature at the inlet to the condenser or cooling water system heat exchangers.
2.2.2 Condenser/Heat Exchanger Duty	9.7 E9 btu/hr [Additional 9.7 E9 btu/hr for 2nd unit/group]	3, 5		Design value for the waste heat rejected to the circulating water system across the condensers.
2.3 Mechanical Draft Cooling Towers			d	
2.3.1 Acreage	50 acres [100 acres]	3, 5	e	The land required for cooling towers or ponds, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.
2.3.2 Approach Temperature	10°F [Same for 2nd unit/group]	1, 4, 7		The difference between the cold water temperature and the ambient wet bulb temperature.
2.3.3 Blowdown Constituents and Concentrations	See Table 3.1-3 [Twice that shown in table]		f	The maximum expected concentrations for anticipated constituents in the cooling water systems blowdown to the receiving water body.

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Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
2.3.4 Blowdown Flow Rate	6400 gpm expected (24,500 gpm max) [12,800 gpm expected (49,000 gpm max)]	1, 5	g	The normal (and maximum) flow rate of the blowdown stream from the cooling water systems to the receiving water body for closed system designs.
2.3.5 Blowdown Temperature	100°F [Same for 2nd unit/group]	1, 2, 3, 4, 5	g	The maximum expected blowdown temperature at the point of discharge to the receiving water body.
2.3.6 Cycles of Concentration	4 [Same for 2nd unit/group]	6	f	The ratio of total dissolved solids in the cooling water blowdown streams to the total dissolved solids in the make-up water streams.
2.3.7 Evaporation Rate	17,550 gpm expected (19,500 gpm max) [35,100 gpm expected (39,000 gpm max)]	3	h	The expected (and maximum) rate at which water is lost by evaporation from the cooling water systems.
2.3.8 Height	60 ft [Same for 2nd unit/group]	1, 3, 4, 5, 7	c	The vertical height above finished grade of either natural draft or mechanical draft cooling towers associated with the cooling water systems.
2.3.9 Make-up Flow Rate	23,950 gpm expected (44,000 gpm max) [47,900 gpm expected (88,000 gpm max)]	9	g	The expected (and maximum) rate of removal of water from a natural source to replace water losses from closed cooling water system.
2.3.10 Noise	55 dBA at 1000 ft [Same for 2nd unit/group]	6	i	The maximum expected sound level produced by operation of cooling towers, measured at 1000 feet from the noise source.
2.3.11 Cooling Tower Temperature Range	23°F [Same for 2nd unit/group]	7		The temperature difference between the cooling water entering and leaving the towers or ponds.
2.3.12 Cooling Water Flow Rate	800,000 gpm [1,600,000 gpm]	5		The total cooling water flow rate through the condenser/heat exchangers.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
2.3.13 Heat Rejection Rate (Blowdown)	6,400 gpm expected (19,500 gpm max) @100°F [12,800 gpm expected (39,000 gpm max)]	3, 5		The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Fahrenheit.
2.3.14 Maximum Consumption of Raw Water	30,000 gpm [60,000 gpm]	1		The expected maximum short-term consumptive use of water by the cooling water systems (evaporation and drift losses).
2.3.15 Monthly Average Consumption of Raw Water	23,000 gpm [46,000 gpm]	10		The expected normal operating consumption of water by the cooling water systems (evaporation and drift losses).
2.3.16 Stored Water Volume	11,800,000 gal [23,600,000 gal]	5		The quantity of water stored in cooling water system impoundments, basins, tanks and/or ponds.
2.4 Natural Draft Cooling Towers			d	
2.4.1 Acreage	34.5 acres [69 acres]	7	e	The land required for cooling towers or ponds, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.
2.4.2 Approach Temperature	10°F [Same for 2nd unit/group.]	1, 4, 7		The difference between the cold water temperature and the ambient wet bulb temperature.
2.4.3 Blowdown Constituents and Concentrations	See Table 3.1-3 [Twice that shown in table]		f	The maximum expected concentrations for anticipated constituents in the cooling water systems blowdown to the receiving water body.
2.4.4 Blowdown Flow Rate	6,400 gpm expected (24,500 gpm max) [12,800 gpm expected (49,000 gpm max)]	1, 5	g	The normal (and maximum) flow rate of the blowdown stream from the cooling water systems to the receiving water body for closed system designs.
2.4.5 Blowdown Temperature	100°F [Same for 2nd unit/group]	1, 3, 4, 5	g	The maximum expected blowdown temperature at the point of discharge to the receiving water body.

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Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
2.4.6 Cycles of Concentration	4 [Same for 2nd unit/group]	1, 3, 4, 5, 7	f	The ratio of total dissolved solids in the cooling water blowdown streams to the total dissolved solids in the make-up water streams
2.4.7 Evaporation Rate	17,550 gpm expected (19,500 gpm max) [35,100 gpm expected (39,000 gpm max)]	3	h	The expected (and maximum) rate at which water is lost by evaporation from the cooling water systems
2.4.8 Height	550 ft [Same for 2nd unit/group]	3, 5, 7	j	The vertical height above finished grade of either natural draft or mechanical draft cooling towers associated with the cooling water systems.
2.4.9 Make-up Flow Rate	23,950 gpm expected (44,000 gpm max) [47,900 gpm expected (88,000 gpm max)]	9	g	The expected (and maximum) rate of removal of water from a natural source to replace water losses from closed cooling water systems.
2.4.10 Noise	55 dBA at 1000 ft [Same for 2nd unit/group]	1, 3, 4, 5, 7	i	The maximum expected sound level produced by operation of cooling towers, measured at 1000 feet from the noise source.
2.4.11 Cooling Tower Temperature Range	23°F [Same for 2nd unit/group]	7		The temperature difference between the cooling water entering and leaving the towers or ponds.
2.4.12 Cooling Water Flow Rate	800,000 gpm [1,600,000 gpm]	5		The total cooling water flow rate through the condenser/heat exchangers.
2.4.13 Heat Rejection Rate (Blowdown)	6,400 gpm expected (19,500 gpm max) @ 100°F [12,800 gpm expected (39,000 gpm max) @ 100°F	3, 5		The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Fahrenheit.
2.4.14 Maximum Consumption of Raw Water	33,720 gpm [67,440 gpm]	4		The expected maximum short-term consumptive use of water by the cooling water systems (evaporation and drift losses).

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
2.4.15 Monthly Average Consumption of Raw Water	23,000 gpm [46,000 gpm]	10		The expected normal operating consumption of water by the cooling water systems (evaporation and drift losses).
2.4.16 Stored Water Volume	11,800,000 gal [23,600,000 gal]	5		The quantity of water stored in cooling water system impoundments, basins, tanks and/or ponds.
2.5 Once-Through Cooling			d	
2.5.1 Cooling Water Discharge Temperature	127°F [Same for 2nd unit/group.]	2	g	Expected temperature of the cooling water at the exit of the condenser/heat exchangers.
2.5.2 Cooling Water Flow Rate	1,140,000 gpm [2,280,000 gpm]	5	g	Total cooling water flow rate through the condenser (also the rate of withdrawal from and return to the water source).
2.5.3 Cooling Water Temperature Rise	18°F [Same for 2nd unit/group.]	1, 3, 5	g	Temperature rise across the condenser (temperature of water out minus temperature of water in).
2.5.4 Evaporation Rate	10,550 gpm expected (11,700 gpm max) [21,100 gpm expected (23,400 gpm max)]	3	h	The expected (and maximum) rate at which water is lost by evaporation from the receiving water body as a result of heating in the condenser.
2.5.5 Heat Rejection Rate	9.7 E9 Btu/hr [19.4 E9 Btu/hr]	3, 5		The expected heat rejection rate to a receiving water body.
3. Ultimate Heat Sink			k	
3.1 Ambient Air Requirements				
3.1.1 Maximum Ambient Temp (0% Exceedance)	115°F db/80°F wb coincident [Same for 2nd unit/group]	2, 3, 5, 7		Assumption used for the maximum ambient temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
3.1.2 Maximum Wet Bulb Temp (0% Exceedance)	81°F wb (non-coincident) [Same for 2nd unit/group]	2, 3, 5, 7		Assumption used for the maximum wet bulb temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.1.3 Minimum Ambient Temp (0% Exceedance)	-40°F [Same for 2nd unit/group]	2, 3, 5, 7		Assumption used for the minimum ambient temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.2 CCW Heat Exchanger				
3.2.1 Maximum Inlet Temp to CCW Heat Exchanger	95°F [Same for 2nd unit/group]	3, 5, 7		The maximum temperature of safety-related service water at the inlet of the UHS component cooling water heat exchanger.
3.2.2 CCW Heat Exchanger Duty	420 E6 Btu/hr (shutdown) [Additional 420 E6 Btu/hr (shutdown) for 2nd unit]	3		The heat transferred to the safety-related service water system for rejection to the environment in UHS heat removal devices.
3 3 Mech Draft Cooling Towers				
3.3.1 Acreage	0.5 acre [1.0 acre]	3, 5	k	The land required for UHS cooling towers or ponds, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.
3.3.2 Approach Temperature	15°F [Same for 2nd unit/group]	3, 5		The difference between the cold water temperature and the ambient wet bulb temperature.
3.3.3 Blowdown Constituents and Concentrations	See Table 3.1-3 [Twice that shown in table]		k	The maximum expected concentrations for anticipated constituents in the UHS blowdown to the receiving water body.
3.3.4 Blowdown Flow Rate	144 gpm expected (850 gpm max) [288 gpm expected (1700 gpm max)]	3, 7	k	The normal (and maximum) flow rate of the blowdown stream from the UHS system to receiving water body for closed system designs.
3.3.5 Blowdown Temperature	95°F [Same for 2nd unit/group]	3, 5	k	The maximum expected UHS blowdown temperature at the point of discharge to the receiving water body.
3.3.6 Cycles of Concentration	4 (2 Minimum) [Same for 2nd unit/group]	3, 5, 7	k	The ratio of total dissolved solids in the UHS system blowdown streams to the total dissolved solids in the make-up water streams.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
3.3.7 Evaporation Rate	411 gpm normal 850 gpm shutdown [822 gpm normal 1700 gpm shutdown]	3, 7	k	The expected (and maximum) rate at which water is lost by evaporation from the UHS system.
3.3.8 Height	60 ft [Same for 2nd unit/group]	3, 5, 7	k	The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system.
3.3.9 Make-up Flow Rate	555 gpm 1700 gpm max [1,110 gpm, 3,400 gpm max]	3, 7, 9	k	The expected (and maximum) rate of removal of water from a natural source to replace water losses from the UHS system
3.3.10 Noise	55 dBA at 1000 ft [Same for 2nd unit/group]	2, 3, 5, 7	k	The maximum expected sound level produced by operation of mechanical draft UHS cooling towers, measured at 1000 feet from the noise source.
3.3.11 Cooling Tower Temperature Range	16°F [Same for 2nd unit/group]	5		The temperature difference between the cooling water entering and leaving the UHS system.
3.3.12 Cooling Water Flow Rate	26,125 gpm (normal) 52,250 gpm (shutdown/ accident) [52,250 gpm (normal), 104,500 (shutdown/ accident)]	3		The total cooling water flow rate through the UHS system.
3.3.13 Heat Rejection Rate (Blowdown)	100 gpm expected (850 gpm max) @ 95°F [200 gpm expected (1,700 gpm max) @ 95°F]	3		The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Fahrenheit.
3.3.14 Maximum Consumption of Raw Water	900 gpm [1800 gpm]	7		The expected maximum short-term consumptive use of water by the UHS system (evaporation and drift losses).

1

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
3.3.15 Monthly Average Consumption of Raw Water	533 gpm [1066 gpm]	10		The expected normal operating consumption of water by the UHS system (evaporation and drift losses).
3.3.16 Stored Water Volume	30,600,000 gal [61,200,000 gal]	3		The quantity of water stored in UHS impoundments, basins, tanks and/or ponds.
4. Containment Heat Removal System (Post-Accident)				
4.1 Ambient Air Requirements				
4.1.1 Maximum Ambient Air Temperature (0% Exceedance)	115°F db/80°F wb coincident [Same for 2nd unit/group]	1, 7		Assumed maximum ambient temperature used in designing the containment heat removal system.
4.1.2 Minimum Ambient Temperature (0% Exceedance)	-40°F [Same for 2nd unit/group]	1, 7		Assumed minimum ambient temperature used in designing the containment heat removal system.
5. Potable Water/Sanitary Waste System				
5.1 Discharge to Site Water Bodies				
5.1.1 Flow Rate	60 gpm expected (105 gpm max) [120 gpm expected (210 gpm max)]	7	I	The expected (and maximum) effluent flow rate from the potable and sanitary waste water systems to the receiving water body.
5.2 Raw Water Requirements				
5.2.1 Maximum Use	120 gpm [240 gpm]	5	I	The maximum short-term rate of withdrawal from the water source for the potable and sanitary waste water systems.
5.2.2 Monthly Average Use	90 gpm [180 gpm]	5	I	The average rate of withdrawal from the water source for the potable and sanitary waste water systems.

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Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
6. Demineralized Water System				
6.1 Discharge to Site Water Bodies				
6.1.1 Flow Rate	110 gpm expected (150 gpm max) [220 gpm expected (300 gpm max)]	5, 7	I	The expected (and maximum) effluent flow rate from the demineralized system to the receiving water body.
6.2 Raw Water Requirements				
6.2.1 Maximum Use	720 gpm [1440 gpm]	5	I	The maximum short-term rate of withdrawal from the water source for the demineralized water system.
6.2.2 Monthly Average Use	550 gpm [1100 gpm]	5	I	The average rate of withdrawal from the water source for the demineralized water system.
7. Fire Protection System				
7.1 Raw Water Requirements				
7.1.1 Maximum Use	2,500 gpm [5,000 gpm]	11	I	The maximum short-term rate of withdrawal from the water source for the fire protection water system.
7.1.2 Monthly Average Use	675,000 gal/mo [1,350,000 gal/mo]	7	I	The average rate of withdrawal from the water source for the fire protection water system.
7.1.3 Stored Water Volume	2,325,000 gallons [4,650,000 gallons]	7		The quantity of water stored in fire protection system impoundments, basins or tanks.
8. Miscellaneous Drain				
8.1 Discharge to Site Water Bodies				
8.1.1 Flow Rate	100 gpm expected (150 gpm max) [200 gpm expected (300 gpm max)]	3, 7	I	The expected (and maximum) effluent flow rate from miscellaneous drains to the receiving water body.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
9. Unit Vent/Airborne Effluent Release Point				
9.1 Atmospheric Dispersion (CHI/Q) (Accident)			m	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases.
9.1.1 0–2 hr @EAB	0.61 E-3 sec/m^3 [Same for 2nd unit/group]	1		
9.1.2 0–8 hr @LPZ	1.30 E-4 sec/m^3 [Same for 2nd unit/group]	5		
9.1.3 8–24 hr @LPZ	1.0 E-4 sec/m^3 [Same for 2nd unit/group]	1, 5		
9.1.4 1–4 day @LPZ	3.36 E-5 sec/m^3 [Same for 2nd unit/group]	3		
9.1.5 4–30 day @LPZ	7.42 E-6 sec/m^3 [Same for 2nd unit/group]	3		
9.2 Atmospheric Dispersion (χ/Q) (Annual Average)	1.17 E-6 sec/m^3 [Same for 2nd unit/group]	3	m	The atmospheric dispersion coefficients used in the safety analysis for the dose consequences of normal airborne releases.
9.3 Dose Consequences			n	
9.3.1 Normal	10 CFR 20, 10 CFR 50 App I [Same for 2nd unit/group]	6		The estimated design radiological dose consequences due to gaseous releases from normal operation of the plant.
9.3.2 Post-Accident	10 CFR 100 [Same for 2nd unit/group]	1, 3, 4, 5, 7		The estimated design radiological dose consequences due to gaseous releases from postulated accidents.
9.3.3 Severe Accidents	25 rem wb in 24 hr 0.5 mi <1 E-6/rx-yr [Same for 2nd unit/group]	1, 3, 7		

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
9.4 Release Point			o	
9.4.1 Configuration (Horiz vs. Vert)	Horizontal	2		The orientation of the release point discharge flow.
9.4.2 Elevation (Normal)	95.5 ft [Same for 2nd unit/group]	2		The elevation above finished grade of the release point for routine operational releases.
9 4.3 Elevation (Post Accident)	Ground level [Same for 2nd unit/group]	1, 2, 3, 5, 7		The elevation above finished grade of the release point for accident sequence releases.
9.4.4 Minimum Distance to Site Boundary	0.5 mi exclusion area [Same for 2nd unit/group]	1, 3, 7		The minimum lateral distance from the release point to the site boundary.
9.4.5 Temperature	No value bounds, overall range is 35-120°F [Same for 2nd unit/group]			The temperature of the airborne effluent stream at the release point.
9.4.6 Volumetric Flow Rate	118,000 scfm for 2 units (normal operation) [for 2 units]	5		The volumetric flow rate of the airborne effluent stream at the release point.
9.5 Source Term			p	
9.5.1 Gaseous (Normal)	13,070 Ci/yr [26,140 Ci/yr] See Table 3.1-8 for isotopic breakdown	12		The annual activity, by isotope, contained in routine plant airborne effluent streams.
9.5.2 Gaseous (Post-Accident)	See Chap 15 Tables RG 1.70 [Same for 2nd unit/group]	1, 3	q	The activity, by isotope, contained in post-accident airborne effluents.
9.5.3 Tritium	3530 ci/yr [7060 ci/yr]	5		The annual activity of tritium contained in routine plant airborne effluent streams.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
10. Liquid Radwaste System				
10.1 Dose Consequences			r	
10.1.1 Normal	10 CFR 50, Appendix I, 10 CFR 20	1, 3, 4, 5		The estimated design radiological dose consequences due to liquid effluent releases from normal operation of the plant.
10.1.2 Post-Accident	10 CFR 20, 10 CFR 100 [Same for 2nd unit/group]	1, 3, 4, 5		The estimated design radiological dose consequences due to liquid effluent releases from postulated accidents.
10.2 Release Point			s	
10.2.1 Flow Rate	100 gpm + 10,000 gpm dilution [200 gpm + 20,000 gpm dilution]	3		The discharge (including minimum dilution flow, if any) of liquid potentially radioactive effluent streams from plant systems to the receiving water body.
10.3 Source Term			t	
10.3.1 Liquid	0.313 ci/yr [0.626 ci/yr] See Table 3.1-7 for isotopic breakdown	13		The annual activity, by isotope, contained in routine plant liquid effluent streams.
10.3.2 Tritium	3100 ci/yr [6200 ci/yr]	5		The annual activity of tritium contained in routine plant liquid effluent streams.
11. Solid Radwaste System			u	
11.1 Acreage				
11.1.1 Low Level Radwaste Storage	2 years in radwaste building @ expected generation rate [Same for 2nd unit/group]	1		The land usage required to provide onsite storage of low level radioactive wastes.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
11.2 Solid Radwaste				
11.2.1 Activity	2700 ci/yr [5400 ci/yr]	3		The annual activity contained in solid radioactive wastes generated during routine plant operations.
11.2.2 Volume	9041 cu ft/yr [18,646 cu ft/yr]	4		The expected volume of solid radioactive wastes generated during routine plant operations.
12. Auxiliary Boiler System				
12.1 Exhaust Elevation	110 ft above plant grade [Same for 2nd unit/group]	5	v	The height above finished plant grade at which the flue gas effluents are released to the environment.
12.2 Flue Gas Effluents	See Table 3.1-4 [Twice that shown in table]		v	The expected combustion products and anticipated quantities released to the environment due to operation of the auxiliary boilers, diesel engines and gas turbines.
12.3 Fuel Type	No. 2 [Same for 2nd unit/group]	1, 3, 5, 7	v	The type of fuel oil required for proper operation of the auxiliary boilers, diesel engines and gas turbines.
12.4 Heat Input Rate (btu/hr)	156,000,000 Btu/hr [312,000,000 Btu/hr]	1		The average heat input rate due to the periodic operation of the auxiliary boilers.
13. Heating, Ventilation and Air Conditioning System				
13.1 Ambient Air Requirements				
13.1.1 Non-safety HVAC max ambient temp (1% Exceed)	100°F db/77°F wb coincident [Same for 2nd unit/group]	6		Assumption used for the maximum ambient temperature that will be exceeded no more than 1% of the time, to design the non-safety HVAC systems.
13.1.2 Non-safety HVAC min ambient temp (1% Exceed)	–10°F [Same for 2nd unit/group]	6		Assumption used for the minimum ambient temperature that will be exceeded no more than 1% of the time, to design the non-safety HVAC systems.

Table 3.1-1 Plant Parameters Envelope

PPE Section		Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
13.1.3	Safety HVAC max ambient temp (0% Exceed)	115°F db/80°F wb coincident [Same for 2nd unit/group]	1, 3, 5, 7		Assumption used for the maximum ambient temperature that will never be exceeded, to design the safety-related HVAC systems.
13.1.4	Safety HVAC min ambient temp (0% Exceed)	–40°F [Same for 2nd unit/group]	1, 3, 5, 7		Assumption used for the minimum ambient temperature that will never be exceeded, to design the safety-related HVAC systems.
13.1.5	Vent System max ambient temp (5% Exceed)	95°F dry bulb/ 77°F wb coincident), 79°F wb (non-coincident) [Same for 2nd unit/group]	3, 5		Assumption used for the maximum ambient temperature that will be exceeded no more than 5% of the time to design the non-HVAC ventilation systems.
13.1.6	Vent System min ambient temp (5% Exceed)	– 5°F [Same for 2nd unit/group]	3		Assumption used for the minimum ambient temperature that will be exceeded no more than 5% of the time to design the non-HVAC ventilation systems.
14. Onsite/Offsite Electrical Power System					
14.1 Acreage					
14.1.1	Switchyard	15 acres [30 acres]	7	e	The land usage required for the high voltage switchyard used to connect the plant to the transmission grid.
15. Standby Power System					
15.1 Diesels					
15.1.1	Diesel Capacity	4 x 6500 kw [8 x 6500 kw]	5		The capacity of diesel engines used for generation of standby electrical power.
15.1.2	Diesel Exhaust Elevation	30 ft [Same for 2nd unit/group]	4	v	The elevation above finished grade of the release point for standby diesel exhaust releases.
15.1.3	Diesel Flue Gas Effluents	See Table 3 1-5 [Twice that shown in table]		v	The expected combustion products and anticipated quantities released to the environment due to operation of the emergency standby diesel generators.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
15.1.4 Diesel Noise	55 dBA at 1000 ft [Same for 2nd unit/group]	1, 3, 4, 5, 7	i	The maximum expected sound level produced by operation of diesel engines turbines, measured at 1000 feet from the noise source.
15.1.5 Diesel Fuel Type	No. 2 per ASTM D975-1974 [Same for 2nd unit/group]	1, 3, 4, 5, 7		The type of fuel oil required for proper operation of the diesel engines.
15.2 Gas Turbines				
15.2.1 Gas Turbine Capacity (kw)	20 MWe at limiting site conditions [40 MWe at limiting site conditions]	3		The capacity of gas turbines used for generation of standby electrical power.
15.2.2 Gas Turbine Exhaust Elevation	60 ft [Same for 2nd unit/group]	3	v	The elevation above finished grade of the release point for standby gas turbine exhaust releases.
15.2.3 Gas Turbine Flue Gas Effluents	See Table 3.1-6 [Twice that shown in table]		v	The expected combustion products and anticipated quantities released to the environment due to operation of the emergency standby gas-turbine generators.
15.2.4 Gas Turbine Noise	55 dBA at 1000 ft [Same for 2nd unit/group]	2, 3	i	The maximum expected sound level produced by operation of gas turbines, measured at 1000 feet from the noise source.
15.2.5 Gas Turbine Fuel Type	Distillate [Same for 2nd unit/group]	2, 3	v	The type of fuel oil required for proper operation of the gas turbines.
16. Plant Characteristics				
16.1 Access Routes				
16.1.1 Heavy Haul Routes	7 acres [Same for 2nd unit/group]	3, 7	e	The land usage required for permanent heavy haul routes to support normal operations and refueling.
16.1.2 Spent Fuel Cask Weight	150 tons [Same for 2nd unit/group]	3	w	The weight of the heaviest expected shipment during normal plant operations and refueling.

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Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
16.2 Acreage	87 acres [174 acres]	2	x	The land area required to provide space for plant facilities.
16.2.1 Office Facilities	1.8 acres [2.18 acre (95,200 sq ft)]	2		
16.2.2 Parking Lots	3.86 acres [7.72 acres]	3		
16.2.3 Permanent Support Facilities	12 acres [8.4 acres]	2		
16.2.4 Power Block	11.64 acres [23.3 acres]	7		
16.2.5 Protected Area	40 acres [80 acres]	7		
16.3 Megawatts Thermal	4300 MWt [8600 MWt]	3		The thermal power generated by one unit (may be the total of several modules).
16.4 Plant Design Life	60 years [Same for 2nd unit/group]	1, 2, 3, 5, 7	y	The operational life for which the plant is designed.
16.5 Plant Population				
16.5.1 Operation	580 people [1160 people]	5	y	The number of people required to operate and maintain the plant.
16.5.2 Refueling / Major Maintenance	1000 people [Same for 2nd unit/group]	1	y	The additional number of temporary staff required to conduct refueling and major maintenance activities.
16.6 Station Capacity Factor	96% [Same for 2nd unit/group]	2		The percentage of time that a plant is capable of providing power to the grid.

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition
17. Construction				
17.1 Access Routes				
17.1.1 Construction Module Dimensions	90' (H) x 82' (W) x 93' (L) or 130' (Dia) x 51' (H) [Same for 2nd unit/group]	1, 7	w	The maximum expected length, width, and height of the largest construction modules or components and delivery vehicles to be transported to the site during construction.
17.1.2 Heaviest Construction Shipment	2,200,00 lb. [Same for 2nd unit/group]	2	w	The maximum expected weight of the heaviest construction shipment to the site.
17.2 Acreage				The land area required to provide space for construction support facilities.
17.2.1 Laydown Area	29 acres [58 acres]	3	e	
17.2.2 Temporary Construction Facilities	52 acres [104 acres]	3	e	
17.3 Construction				
17.3.1 Noise	76–101 db @ 50 ft [Same for 2nd unit/group]	1, 3, 4, 5, 7	l	The maximum expected sound level due to construction activities, measured at 50 feet from the noise source.
17.4 Plant Population				
17.4.1 Construction	3150 people max [5,355 for unit simultaneous construction]	3, 14	y	Peak employment during plant construction.
17.5 Site Preparation Duration	18 months [Same for 2nd unit/group]	1, 3, 7	y	Length of time required to prepare the site for construction.

1

Table 3.1-1 Plant Parameters Envelope

PPE Section	Bounding Value [a] [Value for 2 Units in brackets] [b]	Bound Notes See Table 3.1-2	Comments	Definition

Comments:

a. PPE values should be based on plant designs being considered. The Bounding PPE values provide an envelope (most restrictive values selected) for the ABWR, ESBWR, AP1000, IRIS, GT-MHR, PBMR and ACR-700 designs. A composite PPE should be used for the actual set of plant designs under consideration for the site.

b. The values in brackets reflects the values corresponding to a plant that is twice the vendor's specified standard size plant, i.e., two ABWR units, two ESBWR units, two AP1000 units, six IRIS units, two sets of four GT-MHR modules, two sets of eight PBMR modules and two ACR-700 twin unit plants.

c. Visual resources impacts.

d. Applicants must identify main condenser cooling system alternatives (e.g., mechanical or natural draft cooling towers, cooling ponds, or once-through cooling). To maintain multiple options, the most restrictive value for each cooling system PPE section should be used in the ESP application (e.g., 550-foot cooling tower height selected if both mechanical and natural draft towers are being considered).

e. Construction impacts on ecological resources.

f. Operational impacts on water quality and ecological resources.

g. Operational impacts on water quality and ecological resources. An NPDES permit must be obtained for this blowdown rate, blowdown temperature, withdrawal rate or temperature rise.

h. Operational impacts on water quality and local climatology.

i. Noise impacts.

j. Visual impacts.

k. Impacts of the main condenser cooling system will usually bound impacts from operation of the Ultimate Heat Sink.

l. Operational impacts on water quality and aquatic ecological resources.

m. The atmospheric dispersion values presented in PPE Sections 9.1 and 9.2 represent typical site parameter values assumed by reactor vendors.

n. Values listed for Section 9.3 are regulatory standards for effluent concentrations, doses from routine operations, and doses from postulated accidents. The applicant must demonstrate that the plant is capable of meeting these standards considering the plant design and, for the dose standards, dilution and dispersion conditions at the site.

o. Release point characteristics (Section 9.4.1 - Section 9.4.6) are used to calculate atmospheric dispersion factors used: S - In the Site SAR to demonstrate compliance with requirements listed in Section 9.3, and, E - In the ER to estimate impacts from routine and accident-scenario atmospheric releases.

p. Source term data (Section 9.5.1 -Section 9.5.3) are used to calculate dose consequences used: S - In the Site SAR to demonstrate compliance with requirements listed in Section 9.3, and, E - In the ER to estimate impacts from routine and accident-scenario atmospheric releases.

q. See Section 9.5. Tables in Chapter 15 of RG 1.70 list the design and accident sequence parameters necessary to derive these source terms. Applicants must obtain calculated release values from the vendor/A-E for designs under consideration.

r. Values listed for Section 10.1 are regulatory standards for effluent concentrations, doses from routine operations, and doses from postulated accidents. The applicant must demonstrate that the plant is capable of meeting these standards considering the plant design and, for the dose standards, dilution and dispersion conditions at the site.

s. Flow rate and dilution characteristics (Section 10.2) are used to calculate dilution factors used: S - In the Site SAR to demonstrate compliance with requirements listed in Section 10.1, and, E - In the ER to estimate impacts from liquid effluents.

t. Liquid discharge data (Section 10.3.1 - Section 10.3.2) are used to calculate dose consequences used: S - In the Site SAR to demonstrate compliance with requirements listed in Section 10 1, and, E - In the ER to estimate impacts from liquid effluents.

u. Environmental effects of the uranium fuel cycle, including solid waste management, are set forth in Table S-3 of 10 CFR 51.20. Reference to this Table is made in the applicant's ER.

v. Operational impacts of non-radiological atmospheric emissions.

w. Transport requirements for component delivery.

x. Total acreage footprint for site facilities is used to estimate construction impacts on ecological resources.

y. Socio-economic impacts of plant construction and operation.

NRC FORM 335 (9-2004) NRCMD 3.7 U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET** *(See instructions on the reverse)*		1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) NUREG 1811	
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Same as above.

10. SUPPLEMENTARY NOTES

Docket No. 52-0008

11. ABSTRACT *(200 words or less)*

This report has been prepared in response to an application submitted to the NRC by Dominion Nuclear North Anna LLC, for an early site permit (ESP) for the North Anna ESP site. The ESP does not authorize construction and operation of a nuclear power plant. However, the application did include a site redress plan that if approved would allow limited site preparation work.

The staff's preliminary recommendation is that the ESP should be issued. This preliminary recommendation is based on (1)the Environmental Report submitted by Dominion, as revised; (2) consultation with Federal, State, Tribal and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments received during the public scoping process and; (5) the assessments summarized in this draft EIS, including the potential mitigation measures identified in the ER and in the EIS. In addition, in making its preliminary recommendation, the staff has concluded that there are no environmentally preferable or obviously superior sites. Finally, the staff has preliminarily concluded that the site preparation and preliminary construction activities allowed by 10 CFR 50.10(e)(1) will not result in any significant adverse environmental impact that cannot be redressed.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*	13. AVAILABILITY STATEMENT unlimited
North Anna Early Site Permit ESP National Environmental Policy Act NEPA Dominion	14. SECURITY CLASSIFICATION *(This Page)* unclassified *(This Report)* unclassified
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