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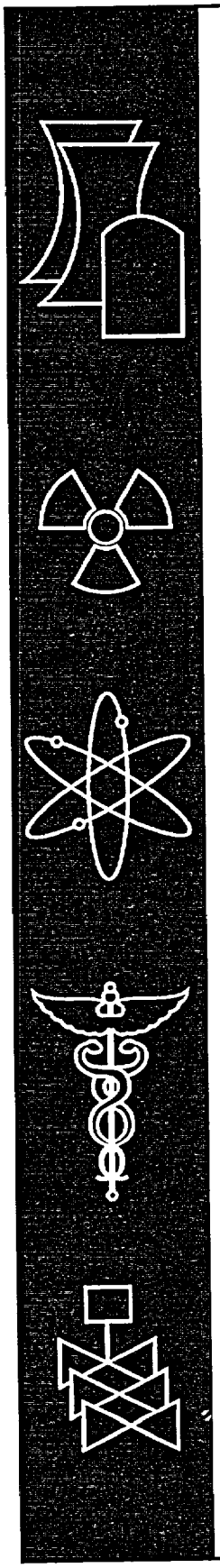

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 8

Regarding
McGuire Nuclear Station, Units 1 and 2

Final Report

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

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NUREG-1437
Supplement 8

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 8

Regarding McGuire Nuclear Station, Units 1 and 2

Final Report

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Office of Nuclear Reactor Regulation
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Abstract

The U.S. Nuclear Regulatory Commission (NRC) has considered the environmental impacts of renewing nuclear power plant operating licenses (OLs) for a 20-year period in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, and codified the results in 10 CFR Part 51. The GEIS (and its Addendum 1) identifies 92 environmental issues and reaches generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. Additional plant-specific review is required for the remaining 23 issues. These plant-specific reviews are to be included in a supplement to the GEIS.

This Supplemental Environmental Impact Statement (SEIS) has been prepared in response to an application submitted to the NRC by Duke Energy Corporation (Duke) to renew the OLs for McGuire Nuclear Station, Units 1 and 2 (McGuire) up to an additional 20 years under 10 CFR Part 54. This SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither Duke nor the staff has identified information that is both new and significant for any of these issues that apply to McGuire. In addition, the staff determined that information provided during the environmental review did not call into question the conclusions in the GEIS. Therefore, the staff concludes that the impacts of renewing the McGuire OLs will not be greater than impacts identified for these issues in the GEIS. For each of these issues, the GEIS conclusion is that the impact is of SMALL[(a)] significance (except for collective offsite radiological impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned single significance levels).

Regarding the remaining 23 issues, those that apply to McGuire are addressed in this SEIS. For each applicable issue, the staff concludes that the significance of the potential environmental impacts of renewal of the OLs is SMALL. The staff also concludes that additional mitigation measures are not likely to be sufficiently beneficial as to be warranted. The staff determined that information provided during the environmental review did not identify any new issue that has a significant environmental impact.

The NRC staff's recommendation is that the Commission determine that the adverse environmental impacts of license renewal for McGuire are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental

(a) Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource.

Abstract

Report submitted by Duke; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review, and (5) the staff's consideration of public comments.

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Executive Summary

By letter dated June 13, 2001, Duke Energy Corporation (Duke) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses (OLs) for McGuire Nuclear Station, Units 1 and 2 (McGuire) for up to an additional 20-year period. If the OLs are renewed, State regulatory agencies and Duke will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OLs are not renewed, the plant must be shut down at or before the expiration dates of the current OLs, which are June 12, 2021, for Unit 1, and March 3, 2023, for Unit 2.

Section 102 of the National Environmental Policy Act (NEPA; 42 USC 4321) directs that an environmental impact statement (EIS) be prepared for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. Part 51 identifies licensing and regulatory actions that require an EIS. In 10 CFR 51.20(b)(2), the Commission requires preparation of an EIS or a supplement to an EIS for renewal of a reactor OL; 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a]

Upon acceptance of the Duke application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping. The staff visited the McGuire site in September 2001 and held public scoping meetings on September 25, 2001, in Huntersville, North Carolina. In preparing this Supplemental Environmental Impact Statement (SEIS) for McGuire, the staff reviewed the McGuire Environmental Report (ER) and compared it to the GEIS, consulted with other agencies, conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*, and considered the public comments received during the scoping process. The public comments received during the scoping process that were considered to be within scope of the environmental review are provided in Appendix A, Part I, of this SEIS. A draft SEIS was published for comment in May 2002. The staff held two public meetings in Huntersville, North Carolina, on June 12, 2002, to describe the preliminary results of the NRC environmental review, to answer questions, and to provide members of the public with information to assist them in formulating comments on the draft SEIS. All of the comments received on the draft SEIS were considered by the staff in developing the final SEIS. These comments are addressed in Appendix A, Part II, of this SEIS.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

This SEIS includes the staff's analysis in which the staff considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures for reducing or avoiding adverse effects. It also includes the staff's recommendation regarding the proposed action.

The Commission has adopted the following statement of purpose and need for license renewal from the GEIS:

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

The goal of the staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

> ... whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OLs.

NRC regulations (10 CFR 51.95(c)(2)) contain the following statement regarding the content of SEISs prepared at the license renewal stage:

> The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and the alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) ["Temporary storage of spent fuel after cessation of reactor operations–generic determination of no significant environmental impact"] and in accordance with § 51.23(b).

The GEIS contains the results of a systematic evaluation of the consequences of renewing an OL and operating a nuclear power plant for an additional 20 years. In the GEIS, the staff evaluated 92 environmental issues using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using the Council on Environmental Quality guidelines. The following definitions of the three significance levels are set forth in footnotes to Table B-1 of 10 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 resources.
>
> 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.

For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS led to the following conclusions:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the staff relied on conclusions as amplified by supporting information in the GEIS for issues designated Category 1 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized. Environmental justice was not evaluated on a generic basis and must be addressed in a plant-

specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

This SEIS documents the staff's evaluation of all 92 environmental issues considered in the GEIS. The staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the OLs for McGuire, Units 1 and 2) and alternative methods of power generation. Based on projections made by the U.S. Department of Energy's Energy Information Administration, gas- and coal-fired generation appear to be the most likely power-generation alternatives if the power from Units 1 and 2 is replaced. These alternatives are evaluated assuming that the replacement power generation plant is located at either the McGuire site or some other unspecified location.

Mitigation measures were considered for each Category 2 issue. Current measures to mitigate the environmental impacts of plant operation were found to be adequate, and no additional mitigation measures were deemed sufficiently beneficial to be warranted.

If the McGuire OLs are not renewed and the units cease operation on or before the expiration of their current OLs, then the adverse impacts of likely alternatives will not be smaller than those associated with continued operation of McGuire. The impacts may, in fact, be greater in some areas.

| The recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for McGuire are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the ER submitted by Duke; (3) consultation with other Federal, State, and local agencies; (4) the staff's own
| independent review; and (5) the staff's consideration of public comments.

Abbreviations/Acronyms

°	degree
μm	micrometer
μCi	microcurie
AADT	Annual Average Daily Traffic
ac	acre
ac.	Alternating current
ACC	averted cleanup and decontamination costs
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AOC	averted offsite property damage costs
AOE	averted occupational exposure
AOSC	averted onsite cleanup costs
APE	averted public exposure
APRC	averted power replacement cost
ATWS	anticipated transient without scram
Bq	becquerel
Btu	British thermal unit
Btu/kWh	British thermal units per kilowatt hour
Btu/lb	British thermal units per pound
BWR	boiling water reactor
°C	Celsius
C	candidate for Federal or State listing
CAA	Clean Air Act
CDC	Center for Disease Control and Prevention
CDF	core damage frequency
CEQ	Council on Environmental Quality
CET	containment event tree
CFR	Code of Federal Regulations
Ci	curie
CMUD	Charlotte-Mecklenburg Utilities District
COE	Cost of enhancement
CWA	Clean Water Act
DBA	design-basis accident
DCH	direct containment heating
DG	diesel generator
DOE	U.S. Department of Energy

DSM	demand-side management
Duke	Duke Energy Corporation
E	endangered
ECCS	emergency core cooling system
EIA	Energy Information Agency
EIS	Environmental Impact Statement
ELF	extremely low frequency
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
ER	Environmental Report
ESA	Endangered Species Act
ESRP	Environmental Standard Review Plan
EX	extirpated
°F	Fahrenheit
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FES	Final Environmental Statement
FR	Federal Register
FSAR	Final Safety Analysis Report
FSC	Federal species of concern
ft	feet
ft/s	feet per second
ft^3	cubic feet
F-V	Fussell-Vesely
FWPCA	Federal Water Pollution Control Act
FWS	U. S. Fish and Wildlife Service
FWST	refueling water storage tank
gal	gallon
GEIS	Generic Environmental Impact Statement
gpd	gallons per day
gpm	gallons per minute
GSI	Generic Safety Issue
ha	hectare
HEPA	high-efficiency particulate air (filter)
HLW	high-level waste

hr	hour(s)
Hz	hertz
I&C	instrumentation and control
IBA	Important Bird Area
IEEE	Institution of Electrical and Electronic Engineers
IPE	individual plant examination
IPEEE	individual plant examination for external events
ISFSI	Independent Spent Fuel Storage Installation
ISLOCA	interfacing loss of coolant accident
J	joule
km	kilometer
km^2	square kilometers
kV	kilovolt
kWh	kilowatt-hour
L	liter
L/s	liters per second
LNG	liquefied natural gas
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LOS	level of service
LWR	light-water reactor
m	meter
M	million
m/s	meter per second
m^3	cubic meters
m^3/d	cubic meters per day
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
McGuire	McGuire Nuclear Station
mgd	million gallons per day
mGy	milligray
mi	mile
mi^2	square miles
MJ/kg	million joules per kilogram
mL	milliliter
mph	miles per hour

mrad	millirad
mrem	millirem
mSv	millisievert
MT	metric ton
MTHM	metric tonnes of heavy metal (uranium, etc.)
MUMPO	Mecklenburg-Union Metropolitan Planning Organization
MW	megawatt
MW(e)	megawatts electric
MW(t)	megawatts thermal
MWd/MTU	megawatt days per metric ton uranium
MWh	megawatt hour
NA	not applicable
NAS	National Academy of Sciences
NC	North Carolina
NCDCR	North Carolina Department of Cultural Resources
NCDENR	North Carolina Department of Environmental and Natural Resources
NCDHHS	North Carolina Department of Health and Human Services
NCDNRCD	North Carolina Department of Natural Resources and Community Development
NCDOT	North Carolina Department of Transportation
NCWRC	North Carolina Wildlife Resource Commission
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
ng/J	nanograms per joule
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
NWPPC	Northwest Power Planning Council
ODCM	Offsite Dose Calculation Manual
OL	operating license
PAME	primary ameobic meningoencephalitis
PAR	passive autocatalytic recombiner
PDS	plant damage state
PM	particulate matter

$PM_{2.5}$	particulate matter having aerodynamic diameter less than or equal to 2.5 μm
PM_{10}	particulate matter having aerodynamic diameter less than or equal to 10μm
PRA	Probabilistic Risk Assessment
PSD	prevention of significant deterioration
PW	present worth
PWR	pressurized water reactor
PU_{RP}	present value replacement power cost
RAI	request for additional information
RCRA	Resource Conservation and Recovery Act
REMP	radiological environmental monitoring program
RN	service water
RPV	reactor pressure vessel
RV	reactor vessel
RV	containment ventilation cooling water system
SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternatives
SBO	station blackout
SAR	Safety Analysis Report
SC	State species of concern
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SHPO	State Historical Preservation Officer
SR	significantly rare
SR	state route
SGTR	steam generator tube rupture
SS	safe shutdown
SSF	standby shutdown facility
Sv	sieverts
T	threatened
TBq	terabecquerel
UFSAR	Updated Final Safety Analysis Report
U_{RP}	long term replacement power cost
U.S.	United States
yr	year

1.0 Introduction

Under the Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10 of the Code of Federal Regulations (CFR) Part 51, which implement the National Environmental Policy Act (NEPA), renewal of a nuclear power plant operating license (OL) requires the preparation of an environmental impact statement (EIS). In preparing the EIS, the NRC staff is required first to issue the statement in draft form for public comment and then issue a final statement after considering public comments on the draft. To support the preparation of the EIS, the staff prepared a *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a] The GEIS is intended to (1) provide an understanding of the types and severity of environmental impacts that may occur as a result of license renewal of nuclear power plants under 10 CFR Part 54, (2) identify and assess the impacts that are expected to be generic to license renewal, and (3) support 10 CFR Part 51 to define the number and scope of issues that need to be addressed by the applicants in plant-by-plant renewal proceedings. Use of the GEIS guides the preparation of complete plant-specific information in support of the OL renewal process.

Duke Energy Corporation (Duke)[b] operates McGuire Nuclear Station, Units 1 and 2 (McGuire) in southwestern North Carolina under OLs NPF-9 and NPF-17, which were issued by the NRC. These OLs will expire in June 2021 for Unit 1 and in March 2023 for Unit 2. On June 13, 2001, Duke submitted an application to the NRC to renew the McGuire OLs up to an additional 20 years under 10 CFR Part 54 (Duke 2001b). The application also included renewal for Catawba Nuclear Station in Rock Hill, South Carolina. A separate environmental evaluation is being conducted for Catawba Nuclear Station. Duke is a *licensee* for the purposes of its current OLs and an *applicant* for the renewal of the OLs. Pursuant to 10 CFR 54.23 and 51.53(c), Duke submitted an Environmental Report (ER; Duke 2001a) in which Duke analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects.

This report is the final plant-specific supplement to the GEIS (the supplemental EIS [SEIS]) for the McGuire license renewal application. This SEIS is a supplement to the GEIS because it relies, in part, on the findings of the GEIS. The staff has also prepared a separate safety evaluation report in accordance with 10 CFR Part 54.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

(b) Duke Energy Corporation has held the license for McGuire Units 1 and 2 since September 16, 1997. Before this date, Duke Power Company held the license. Duke Power Company remains a division of Duke Energy Corporation.

1.1 Report Contents

The following sections of this introduction (1) describe the background for the preparation of this SEIS, including the development of the GEIS and the process used by the staff to assess the environmental impacts associated with license renewal; (2) describe the proposed Federal action to renew the OLs for McGuire; (3) discuss the purpose and need for the proposed action; and (4) present the status of Duke's compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies that are responsible for environmental protection.

The ensuing chapters of this SEIS closely parallel the contents and organization of the GEIS. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 and 4, respectively, discuss the potential environmental impacts of plant refurbishment and plant operation during the renewal term. Chapter 5 contains an evaluation of potential environmental impacts of plant accidents and includes consideration of severe accident mitigation alternatives. Chapter 6 discusses the uranium fuel cycle and solid waste management, Chapter 7 discusses decommissioning, and Chapter 8 discusses alternatives to license renewal. Finally, Chapter 9 summarizes the findings of the preceding chapters and draws conclusions about the adverse impacts that cannot be avoided (the relationship between short-term uses of the human environment and the maintenance and enhancement of long-term productivity, and the irreversible or irretrievable commitment of resources). Chapter 9 also presents the staff's recommendation with respect to the proposed license renewal action.

Additional information is included in appendixes. Appendix A contains public comments received on the environmental review for license renewal and staff responses to those comments. Appendixes B through F, respectively, list the following:

- the preparers of the supplement
- the chronology of correspondence between NRC and Duke with regard to this SEIS
- the organizations contacted during the development of this SEIS
- Duke's compliance status in Table E-1 (this appendix also contains copies of consultation correspondence prepared and sent during the evaluation process)
- GEIS environmental issues that are not applicable to McGuire.

1.2 Background

Use of the GEIS, which examines the possible environmental impacts that could occur as a result of renewing individual nuclear power plant OLs under 10 CFR Part 54, and the established license renewal evaluation process supports the thorough evaluation of the impacts of renewal of the OLs.

1.2.1 Generic Environmental Impact Statement

The NRC initiated a generic assessment of the environmental impacts associated with the license renewal term to improve the efficiency of the license renewal process by documenting the assessment results and codifying the results in the Commission's regulations. This assessment is provided in the GEIS, which serves as the principal reference for all nuclear power plant license renewal EISs.

In the GEIS, the staff documented the results of the systematic approach that was taken to evaluate the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. For each potential environmental issue in the GEIS, the staff (1) described the activity that affects the environment, (2) identified the population or resource that is affected, (3) assessed the nature and magnitude of the impact on the affected population or resource, (4) characterized the significance of the effect for both beneficial and adverse effects, (5) determined whether the results of the analysis apply to all plants, and (6) considered whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants.

The NRC's standard of significance was established using the Council on Environmental Quality (CEQ) terminology for "significantly" (40 CFR 1508.27, which requires consideration of both "context" and "intensity"). Using the CEQ terminology, the NRC established three significance levels—SMALL, MODERATE, or LARGE. The definitions of the three significance levels are set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, as follows:

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.

- In the GEIS, the staff assigned a significance level to each environmental issue, assuming that ongoing mitigation measures would continue.

- In the GEIS, the staff included a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, **Category 1** issues are those that meet all of the following criteria:

  (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

  (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

  (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely to not be sufficiently beneficial to warrant implementation.

  For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in the SEIS unless new and significant information is identified.

  Category 2 issues are those that do not meet one or more of the criteria of Category 1, and therefore, additional plant-specific review for these issues is required.

In the GEIS, the staff assessed 92 environmental issues and determined that 69 qualified as Category 1 issues, 21 qualified as Category 2 issues, and 2 issues were not categorized. The latter 2 issues, environmental justice and chronic effects of electromagnetic fields, are to be addressed in a plant-specific analysis. Of the 92 issues, 11 are related only to refurbishment, 6 are related only to decommissioning, 67 apply only to operation during the renewal term, and 8 apply to both refurbishment and operation during the renewal term. A summary of the findings for all 92 issues in the GEIS is codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

1.2.2 License Renewal Evaluation Process

An applicant seeking to renew its OLs is required to submit an ER as part of its application. The license renewal evaluation process involves careful review of the applicant's ER and assurance

that all new and potentially significant information not already addressed in or available during the GEIS evaluation is identified, reviewed, and assessed to verify the environmental impacts of the proposed license renewal.

In accordance with 10 CFR 51.53(c)(2) and (3), the ER submitted by the applicant must

- provide an analysis of the Category 2 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, in accordance with 10 CFR 51.53(c)(3)(ii).
- discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action.

In accordance with 10 CFR 51.53(c)(2), the ER does not need to

- consider the economic benefits and costs of the proposed action and alternatives to the proposed action except insofar as such benefits and costs are either (1) essential for making a determination regarding the inclusion of an alternative in the range of alternatives considered or (2) relevant to mitigation.
- consider the need for power and other issues not related to the environmental effects of the proposed action and the alternatives.
- discuss any aspect of the storage of spent fuel within the scope of the generic determination in 10 CFR 51.23(a) in accordance with 10 CFR 51.23(b).
- contain an analysis of any Category 1 issue unless there is significant new information on a specific issue—this is pursuant to 10 CFR 51.53(c)(3)(iii) and (iv).

New and significant information is (1) information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or (2) information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

In preparing to submit its application to renew the McGuire OLs, Duke developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for McGuire would be properly reviewed before submitting the ER and to ensure that such new and potentially significant information related to renewal of the licenses for McGuire would be identified, reviewed, and assessed during the period of NRC review. Duke reviewed the Category 1 issues that appear in Table B-1 of

10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to McGuire. This review was performed by personnel from Duke and its support organization who were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

The NRC staff also has a process for identifying new and significant information. That process is described in detail in *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (ESRP), NUREG-1555, Supplement 1 (NRC 2000). The search for new information includes (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies; and (5) review of the technical literature. New information discovered by the staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of the issue that are not affected by the new information.

Chapters 3 through 7 discuss the environmental issues considered in the GEIS that are applicable to McGuire. At the beginning of the discussion of each set of issues, there is a table that identifies the issues to be addressed and lists the sections in the GEIS where the issue is discussed. Category 1 and Category 2 issues are listed in separate tables. For Category 1 issues for which there is no new and significant information, the table is followed by a set of short paragraphs that state the GEIS conclusion codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, followed by the staff's analysis and conclusion. For Category 2 issues, in addition to the list of GEIS sections where the issue is discussed, the tables list the subparagraph of 10 CFR 51.53(c)(3)(ii) that describes the analysis required and the SEIS sections where the analysis is presented. The SEIS sections that discuss the Category 2 issues are presented immediately following the table.

The NRC prepares an independent analysis of the environmental impacts of license renewal and compares these impacts with the environmental impacts of alternatives. The evaluation of the Duke license renewal application began with publication of a notice of acceptance for docketing and opportunity for a hearing in the *Federal Register* (FR) cited as 66 FR 42893 on August 15, 2001 (NRC 2001a). On August 23, 2001, the staff published a notice of intent to prepare an EIS and conduct scoping cited as 66 FR 44386 (NRC 2001b). Two public scoping meetings were held on September 25, 2001, in Huntersville, North Carolina. Comments received during the scoping periods were summarized in the *Environmental Impact Statement*

Scoping Process: Summary Report – McGuire Units 1 and 2, Huntersville, North Carolina (NRC 2002a). Comments that are applicable to this environmental review are presented in Part I of Appendix A.

The staff followed the review guidance contained in NUREG-1555, Supplement 1, in the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 2000). The staff and its contractors retained to assist the staff visited the McGuire site on September 24, 2001, to gather information and to become familiar with the site and its environs. The staff also reviewed the comments received during scoping and consulted with Federal, State, regional, and local agencies. A list of the organizations consulted is provided in Appendix D of this SEIS. Other documents related to McGuire were reviewed and are referenced.

On May 10, 2002, the NRC published the Notice of Availability of the draft SEIS in 67 FR 31846 (NRC 2002b). A 75-day comment period began on the date of publication of the U.S. Environmental Protection Agency (EPA) Notice of Filing of the draft SEIS, to allow members of the public to comment on the preliminary results of the NRC staff's review. During this comment period, two public meetings were held in Huntersville, North Carolina, on June 12, 2002. During these meetings, the staff described the preliminary results of the NRC environmental review and answered questions related to it to provide members of the public with information to assist them in formulating their comments. The comment period for the McGuire draft SEIS ended August 2, 2002. Comments made during the 75-day comment period, including those made at the two public meetings, are presented in Part II of Appendix A of this SEIS. The NRC responses to those comments are also provided.

This SEIS presents the staff's analysis that considers and weighs the environmental effects of the proposed renewal of the OLs for McGuire, the environmental impacts of alternatives to license renewal, and mitigation measures available for avoiding adverse environmental effects. Chapter 9, Summary and Conclusions, provides the NRC staff's recommendation to the Commission on whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the OLs for McGuire, Units 1 and 2. McGuire is located in southwestern North Carolina, in northwestern Mecklenburg County on the shore of Lake Norman, approximately 27 km (17 mi) north-northwest of Charlotte and 10 km (6 mi) west of Huntersville. The current OL for Unit 1 expires on June 12, 2021, and the current OL for Unit

2 on March 3, 2023. By letter dated June 13, 2001, Duke submitted an application to the NRC (Duke 2001b) to renew these OLs for up to an additional 20 years of operation.

The plant has two Westinghouse-designed, pressurized, light-water reactors, each with a design rating for a net electrical power output of approximately 1129 megawatts electric (MW[e]). Water for the plant's once-through cooling system is drawn from and discharged back into Lake Norman. McGuire produces electricity to supply the needs of more than 619,000 homes.

1.4 The Purpose and Need for the Proposed Action

Although a licensee must have a renewed license to operate a reactor beyond the term of the existing OL, the possession of that license is just one of a number of conditions that must be met for the licensee to continue plant operation during the term of the renewed license. Once an OL is renewed, State regulatory agencies and the owners of the plant will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners.

Thus, for license renewal reviews, the NRC has adopted the following definition of purpose and need (NRC 1996, Section 1.3):

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and where authorized, Federal (other than NRC) decisionmakers.

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate. From the perspective of the licensee and the State regulatory authority, the purpose of renewing an OL is to maintain the availability of the nuclear plant to meet system energy requirements beyond the current term of the plant's license.

1.5 Compliance and Consultations

Duke is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In the McGuire ER, Duke provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with license renewal of McGuire. Authorizations and consultations most relevant to the proposed OL renewal action are summarized in Table 1-1. The full list of authorizations and consultations provided by Duke is included in Appendix E.

Table 1-1. Federal, State, and Local Authorizations and Consultations

Agency	Authority	Requirement	Number	Permit Expiration or Consultation Date	Activity Covered
NRC	Atomic Energy Act, 10 CFR Part 50	Operating license	NPF-9 (Unit 1) NPF-17 (Unit 2)	June 12, 2021 (Unit 1) March 3, 2023 (Unit 2)	Operation of McGuire Units 1 and 2
FWS	Endangered Species Act, Section 7	Consultation	NA	Consultation initiated October 10, 2001	Operation during renewal term
NCDENR	Clean Water Act, Section 402	NPDES wastewater permit	NCOO24392	February 28, 2005	Permit for discharge of wastewater and once-through cooling water to discharge canal that empties into Lake Norman
NCDENR	Clean Water Act, Section 402	NPDES stormwater permit	NCS000020	Pending NCDENR approval	Collection, treatment, and discharge of stormwater
Mecklenburg County Department of Environmental Protection	Clean Air Act, Section 112	Air emissions permit	00-019-269	Renewed annually	Emissions from diesel emergency generators, miscellaneous diesel engines, and other miscellaneous units
NCDCR	National Historic Preservation Act, Section 106	Consultation	NA	Consultation initiated January 31, 2000	Impact on sites listed or eligible for listing in the National Register of Historic Places

FWS - U.S. Fish and Wildlife Service.
NCDCR - North Carolina Department of Cultural Resources.
NCDENR - North Carolina Department of Environment and Natural Resources.
NPDES - National Pollutant Discharge Elimination System.
NA - Not applicable.

The staff has reviewed the list and consulted with the appropriate Federal, State, and local agencies to identify any compliance or permit issues or significant environmental issues of concern to the reviewing agencies. These agencies did not identify any new and significant environmental issues. The McGuire ER states that Duke is in compliance with applicable environmental standards and requirements for McGuire. The staff has also not identified any environmental issues that are both new and significant.

1.6 References

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 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

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

Atomic Energy Act of 1954 (AEA). 42 USC 2011, et seq.

Clean Air Act (CAA). 42 USC 7401, et seq.

Duke Energy Corporation (Duke). 2001a. *Applicant's Environmental Report – Operating License Renewal Stage — McGuire Nuclear Station.* Charlotte, North Carolina.

Duke Energy Corporation (Duke). 2001b. *Application to Renew the Operating Licenses of McGuire Nuclear Station, Units 1 and 2 and the Catawba Nuclear Station, Units 1 and 2.* Charlotte, North Carolina.

Endangered Species Act (ESA). 16 USC 1531, et seq.

Federal Water Pollution Control Act. 33 USC 1251, et seq. (Also known as the Clean Water Act [CWA]).

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

National Historic Preservation Act of 1966 (NHPA). 16 USC 470, et seq.

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). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 - Transportation, Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal.* NUREG-1555, Supplement 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001a. "Duke Energy Corporation, McGuire, Units 1 and 2, and Catawba, Units 1 and 2; Notice of Acceptance for Docketing of the Application and Notice of Opportunity for a Hearing Regarding Renewal of Facility Operating License Nos. NPF-9, NPF-17, NPF-35, and NPF-52 for an Additional 20-Year Period." 66 FR 42893. August 15, 2001.

U.S. Nuclear Regulatory Commission (NRC). 2001b. "Duke Energy Corporation, McGuire Nuclear Station, Units 1 and 2; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." 66 FR 44386. August 23, 2001.

U.S. Nuclear Regulatory Commission (NRC). 2002a. *Environmental Impact Statement Scoping Process: Summary Report — McGuire Nuclear Station Units 1 & 2, Huntersville, North Carolina.* Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002b. "Duke Energy Corporation; McGuire Nuclear Station, Units 1 and 2; Notice of Availability of the Draft Supplement 8 to the Generic Environmental Impact Statement and Public Meetings for the License Renewal of McGuire Units 1 and 2." 67 FR 31846. May 10, 2002.

2.0 Description of Nuclear Power Plant and Site and Plant Interaction with the Environment

The Duke Energy Corporation's (Duke's) McGuire Nuclear Station, Units 1 and 2 (McGuire) is located on the shore of Lake Norman in North Carolina's Mecklenburg County approximately 27 km (17 mi) north-northwest of Charlotte, North Carolina. The plant consists of two units (Units 1 and 2) that are the subject of this action. Each unit is a pressurized light-water reactor (LWR) with four steam generators producing steam that turns turbines to generate electricity. Lake Norman is used as the sources of cooling and process water for McGuire. The plant and its environs are described in Section 2.1, and the plant's interaction with the environment is presented in Section 2.2.

2.1 Plant and Site Description and Proposed Plant Operation During the Renewal Term

McGuire is located on 234 ha (577 ac) of Duke-owned land in southwestern North Carolina. Figures 2-1 and 2-2 show the site location and features within 80 km and 10 km (50 mi and 6 mi), respectively. The site is surrounded by an exclusion area whose radius measures 0.76 km (0.47 mi) and covers 182.4 ha (450.5 ac) (Duke 2001a).

The McGuire site is bounded to the west by the Catawba River and to the north by Lake Norman. Lake Norman is a 13,156-ha (32,510-ac) lake that was formed by the impoundment of the Catawba River by the Cowan's Ford Dam hydroelectric station (owned and operated by Duke Power). Lake Norman achieved full pond level in 1964. Cowan's Ford Dam is immediately west of the site and on the Catawba River channel.

The region surrounding McGuire is considered to have a high population density based on the definitions applied to case study sites in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999b).[a] The area around McGuire is experiencing a rapid change from a rural to a suburban environment (Duke 2001a). Huntersville (population 25,000), North Carolina, is the nearest town (Duke 2001a). The town center is located approximately 10 km (6 mi) east of the plant.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

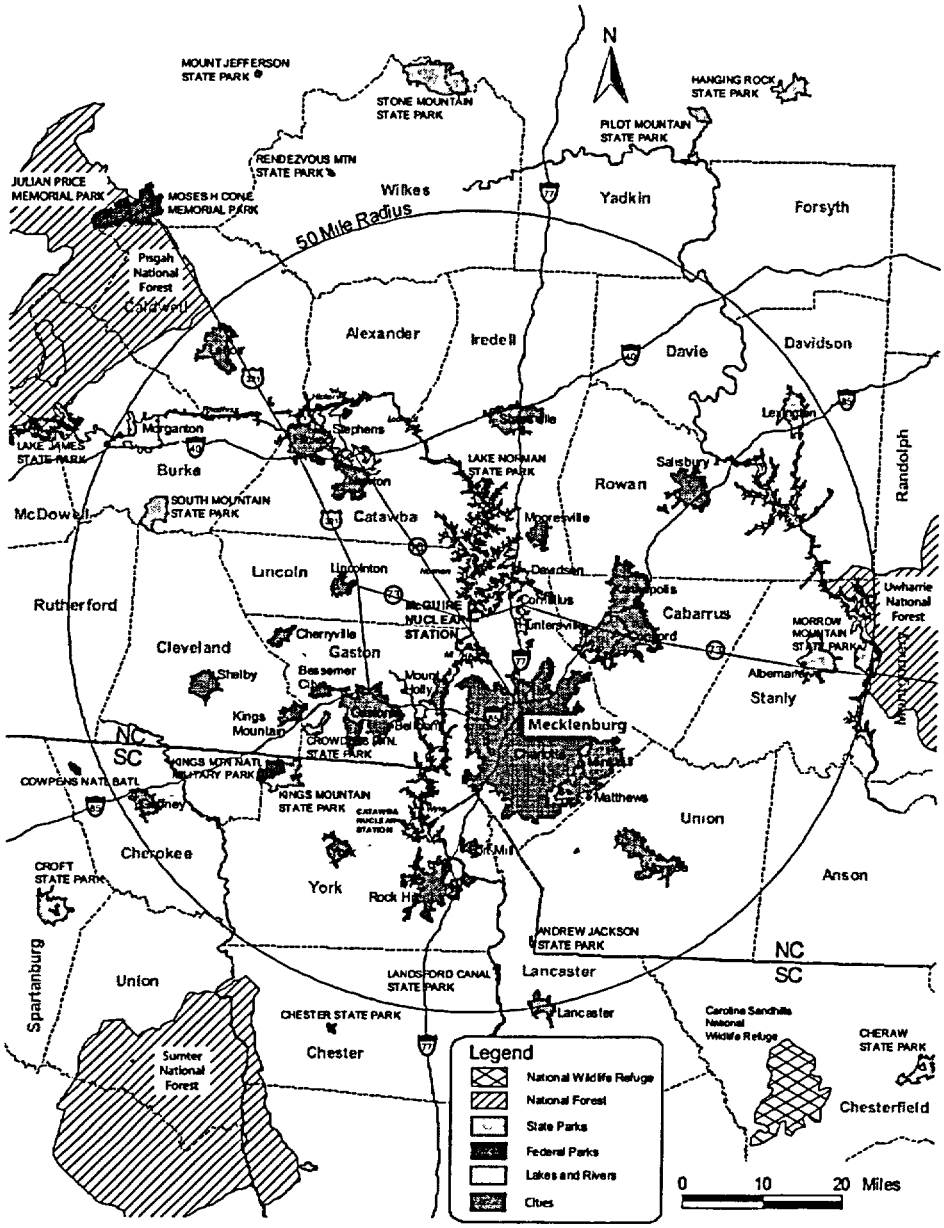

Figure 2-1. Location of McGuire Nuclear Station, Units 1 and 2, 80-km (50-mi) Region

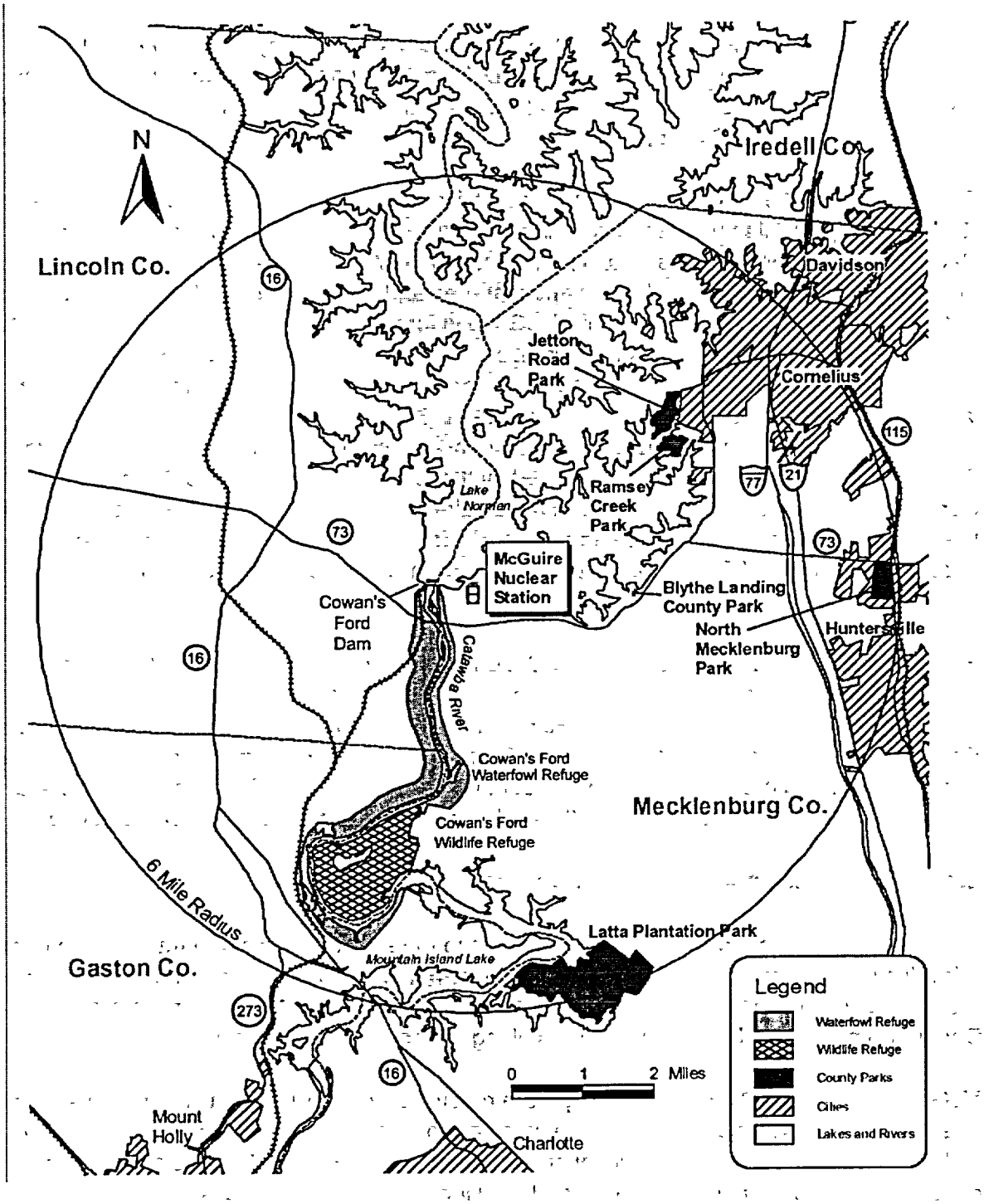

Figure 2-2. Location of McGuire Nuclear Station, Units 1 and 2, 10-km (6-mi) Region

The McGuire site has approximately 1345 full-time workers employed by Duke and site contractors during normal plant operations. Duke refuels each reactor unit at McGuire on an 18- to 24-month schedule, when site employment increases by as many as 1015 workers for temporary duty (30 to 40 days).

The elevation of the McGuire exclusion area varies from 198 m to 244 m (650 to 800 ft) (Duke 2001a), and its topography is rolling (NRC 1996). The exclusion area is dominated by Cecil sandy loam and harbors typical piedmont plant communities and cover types, predominantly hardwood-pine forests and marshes and wetlands (Duke 2001a). The majority of land in the area immediately around McGuire is forested, pasture, cropland, or residential developments, each contributing significant proportions to the total land use. The shoreline of Lake Norman is developed with vacation and permanent residences, campgrounds, boat launches, marinas, and golf courses. The 270-ha (668-ac) Cowan's Ford Wildlife Refuge (owned and operated by Mecklenburg County Parks and Recreation Department) and the Cowan's Ford Waterfowl Refuge (managed by the North Carolina Wildlife Resources Commission) are located just south of the McGuire exclusion area along the shores of Mountain Island Lake. These areas, as well as adjacent lands, have been officially designated as Important Bird Areas (IBAs) by the National Audubon Society because of their rich avian diversity (Duke 2001a).

Five parks (Blythe Landing County Park, Jetton Road Park, Latta Plantation Park, North Mecklenburg Park, and Ramsey Park), located in and owned by Mecklenburg County, are within a 10-km (6-mi) radius of the McGuire plant. Five state parks (Andrew Jackson State Park, Crowders Mountain State Park, Lake Norman State Park, Morrow Mountain State Park, and South Mountain State Park), Kings Mountain National Military Park, and the Catawba Indian Reservation are located within 80 km (50 mi) of the McGuire plant (Duke 2001a).

2.1.1 External Appearance and Setting

Because of the large amount of timber adjacent to the site, the nuclear plant is visible from only a few locations on the land. It is readily visible from many locations along the lake shore. The most obvious structures are the transmission towers and lines that are visible from North Carolina Highway 73 (NC-73), which runs along the southern edge of the site.

McGuire Units 1 and 2 each have a separate reactor building, turbine building, and switchyard. The following buildings and features are common to both units: service building, auxiliary building, intake structures (upper level and lower level), discharge structure and discharge canal, standby nuclear service water pond, and independent spent fuel storage installation (ISFSI; Duke 2001a).

An ISFSI was added at McGuire to expand the storage capacity for spent fuel. The initial loading of spent fuel into the dry storage facility took place in 2001. The storage of spent fuel in the ISFSI is conducted under a general permit issued in accordance with 10 CFR 72.210. The ISFSI is outside the scope of this review.

The McGuire site lies near the center of the Piedmont physiographic province. The Piedmont is characterized by rolling hills and numerous small streams and rivers. It is a northeast-trending zone from Georgia through Virginia that varies in width from about 130 to 190 km (80 to 120 mi) (Duke 2001a). The Fall Line, which divides the Piedmont from the Coastal Plain physiographic province to the southeast, lies 100 km (65 mi) downstream from the site.

The Piedmont province is underlain by five narrow northeast-trending belts of metamorphosed sedimentary rock. The McGuire site is within the Charlotte Belt. These rocks, originally formed during the lower Paleozoic, are now in the form of mica schist and gabbro. Although there are numerous faults in the Piedmont region, there are no identifiable faults or other geological structures that could be expected to localize earthquakes in the immediate vicinity of the McGuire site (NRC 1976).

2.1.2 Reactor Systems

The McGuire site is shown in Figure 2-3. Each unit is a pressurized LWR with four steam generators that produce steam that turns turbines to generate electricity. Each unit, designed and fabricated by the Westinghouse Electric Corporation, is designed to operate at core power levels up to 3411 megawatts thermal (MW[t]), with a corresponding net electrical output of approximately 1129 megawatts electric (MW[e]) (Duke 2001a).

The nuclear steam supply system for each unit is housed in a separate free-standing steel containment structure within a reinforced concrete shield building. The containment employs the ice condenser pressure-suppression concept. The containment is designed to withstand environmental effects and the internal pressure and temperature accompanying a postulated loss-of-coolant accident or steam-line break. Together with its engineered safety features, the containment structure for each unit is designed to adequately retain fission products that escape from the reactor coolant system.

McGuire is licensed for fuel that is slightly enriched uranium dioxide, up to 4.75 percent by weight uranium-235 (Duke 2001a). McGuire has several different fuel designs that are used for the production of electricity. The Mark-BW design has a maximum fuel assembly burnup of 55,000 megawatt days/metric tons of uranium (MWd/MTU) and a maximum licensed fuel pin

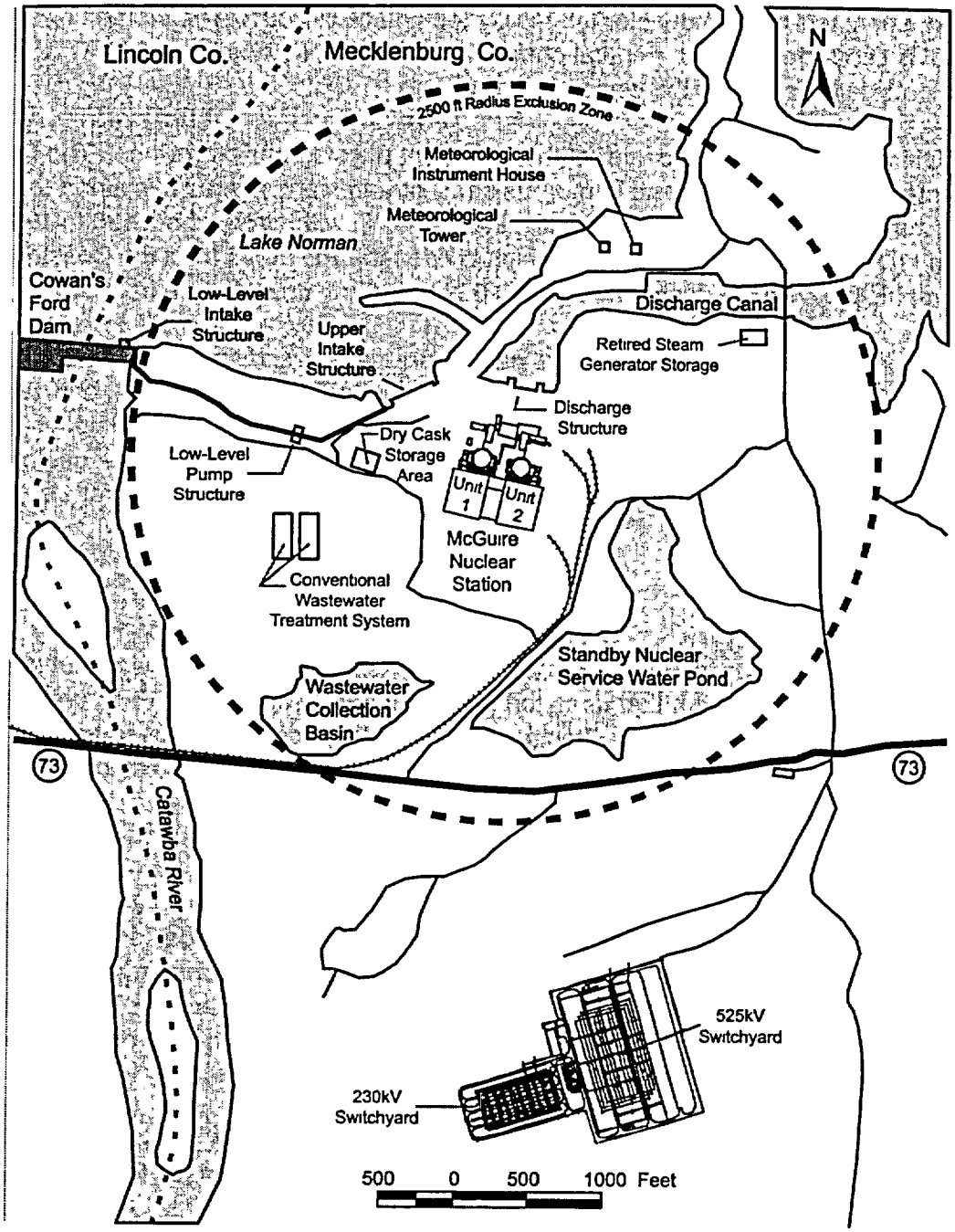

Figure 2-3. McGuire Nuclear Station

burnup of 60,000 MWd/MTU. The Westinghouse Robust Fuel Assembly design does not have a maximum fuel assembly burnup limit; however, this burnup value would be limited by the maximum licensed fuel pin burnup limit of 60,000 MWd/MTU (Duke 2001a).

2.1.3 Cooling and Auxiliary Water Systems

The site currently uses water from Lake Norman for main condenser cooling and process water. Water is withdrawn from the lake at an average daily rate (two-unit operation) of about 111 m^3/s (2530 million gpd), circulated through the two units and discharged back into the lake through the discharge canal. The plant has an upper-level intake and a separate, lower-level intake structure.

For most of the year, cooling and process water is withdrawn from Lake Norman through the upper-level intake structure. The upper-level intake structure is located at the lake surface at the end of the intake channel. It withdraws from the surface water layers of the lake (epilimnion). The water in the intake channel flows through trash bars and through 1-cm (3/8-in.) mesh vertical traveling screens before entering the McGuire plant. Water velocity in the upper intake channel is less than 0.3 m/s (1 ft/s).

During periods of high lake-surface temperature, cooler water (hypolimnion) is withdrawn from the lake bottom through the lower-level intake structure. The lower-level intake structure is located west of the upper intake structure and approximately 30 m (100 ft) below the lake surface. Cooler water from the lower intake structure is pumped and discharged in front of the upper intake structure. The water from the lower intake structure supplements, but cannot completely replace, the surface water flow from the upper intake channel. Thus, water from the lower intake structure drawn primarily during the hot summer months reduces the temperature of the water that is drawn into the plant for cooling. This results in a lower station discharge water temperature. There are no traveling screens on the lower-level intake structure. Water velocity through the lower-level intake structure, when operating, can be as high as 0.43 m/s (1.4 ft/s).

Operation of the rotating vertical traveling screens can be in either automatic or manual mode. Automatic rotation of the screens is controlled by differential pressure across the screen surface. Manual operation and cleaning of the traveling screens is prescribed weekly. Backwash water and screen debris are discharged into a refuse removal trench, which drains into a debris retention basket.

The increase in temperature of cooling system water discharged back into Lake Norman is related to flow and intake water temperature. During the winter, when the incoming water is the

coolest and the flow is the lowest, the increase in temperature is 13.7°C (24.7°F). During the summer, when the intake temperatures are the warmest and the flow is the highest, the temperature increase is 8.6°C (15.5°F).

Potable water at McGuire is supplied by the Charlotte-Mecklenburg Utilities Department (CMUD) water supply system. Six groundwater wells provide specific low-volume uses (e.g., irrigation, remote restrooms) with a combined maximum pumping rate of 4.3 L/s (68 gpm).

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

McGuire uses liquid, gaseous, and solid radioactive waste management systems to collect and process the liquid, gaseous, and solid wastes that are the by-products of McGuire operation. These systems process radioactive liquid, gaseous, and solid effluents before they are released to the environment. The waste disposal systems for McGuire meet the design objectives of 10 CFR Part 50, Appendix I (Numerical Guides for Design Objectives and Limiting Conditions for Operations to Meet the Criterion "As Low As Reasonably Achievable" for Radioactive Material in Light-Water Cooled Nuclear Power Reactor Effluents), and control the processing, disposal, and release of radioactive liquid, gaseous, and solid wastes. Radioactive material in the reactor coolant is the 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 from the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system also is responsible for coolant contamination.

Nonfuel solid wastes result from treating and separating radionuclides from gases and liquids and from removing contaminated material from various reactor areas. Solid wastes also consist of reactor components, equipment, and tools removed from service, as well as contaminated protective clothing, paper, rags, and other trash generated from plant design modifications and operations and routine maintenance activities. Solid wastes are shipped to a waste processor for volume reduction before disposal at a licensed burial site (Duke 2001a). Spent resins and filters are stored or packaged for shipment to a licensed offsite processing or disposal facility (Duke 2001a).

Fuel rods that have exhausted a certain percentage of their fuel and are removed from the reactor core for disposal are called spent fuel. Each unit is refueled approximately every 18 to 24 months. Refueling outages are staggered so both units are not in an outage at the same time (Duke 2001a). Spent fuel is stored onsite in one of the two spent fuel pools or in containers in the McGuire ISFSI (Duke 2001a). Each unit has its own spent fuel pool located in the auxiliary building. Spent fuel storage in the McGuire ISFSI was initiated in 2001.

The waste disposal system used for processing liquid, gaseous, and solid wastes is common to Units 1 and 2, with the exception of the reactor coolant drain tanks located in each reactor containment (Duke 2000a).

The offsite dose calculation manual (ODCM) for McGuire (Duke 2001e) describes the methods used for calculating radioactivity concentrations in the environment and the estimated potential offsite doses associated with liquid and gaseous effluents from McGuire. The ODCM also specifies controls for release of liquid and gaseous effluents to ensure compliance with the following:

- The concentration of radioactive liquid effluents released from the site to the unrestricted area will not exceed 10 times the concentration specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained gases. For dissolved or entrained noble gases, the concentration shall not exceed 7.4 Bq/mL (0.0002 µCi/mL).

- The dose or dose commitment per reactor to a member of the public from any radioactive materials in liquid effluents released to unrestricted areas shall be limited to the design objectives of 10 CFR Part 50, Appendix I: (1) less than or equal to 0.015 mSv (1.5 mrem) to the total body and less than or equal to 0.05 mSv (5 mrem) to any organ during any calendar quarter, and (2) less than or equal to 0.03 mSv (3 mrem) to the total body and less than or equal to 0.1 mSv (10 mrem) to any organ during any calendar year.

- The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to (1) less than or equal to 5 mSv/yr (500 mrem/yr) to the total body and less than or equal to 30 mSv (3000 mrem/yr) to the skin due to noble gases and (2) less than or equal to 15 mSv/yr (1500 mrem/yr) to any organ due to iodine-131, iodine-133, tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days per NUREG-1301 (NRC 1991).

- The air dose per reactor to areas at and beyond the site boundary due to noble gases released in gaseous effluents shall be limited to the design objectives of 10 CFR Part 50, Appendix I (i.e., less than or equal to 0.1 mGy [10 mrad] for gamma radiation and less than or equal to 0.2 mGy [20 mrad] for beta radiation during any calendar year).

- The dose to any individual member of the public from the nuclear facility operations will not exceed the maximum limits of 40 CFR Part 190 (i.e., less than 0.25 mSv [25 mrem])

and 10 CFR Part 20 (i.e., less than or equal to 5 mSv [0.5 rem] in a year and less than or equal to 0.02 mSv [2 mrem] in any hour).

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

All radioactive and potentially radioactive liquids generated in the plant are collected, segregated, and processed. Most reactor- or primary-grade liquids are recycled. Potentially contaminated radioactive liquid wastes in the plant are collected in tanks in the auxiliary building and processed by filtration, demineralization, or evaporation prior to their monitoring and discharge to Lake Norman (Duke 2001a). Liquid wastes from the auxiliary building floor drains, sumps, and equipment drains, as well as from the plant's containment sumps, laboratory drains, and waste evaporator feed tank drainage are collected in the floor drain tank (Duke 2000a). Dependent on the activity of liquid wastes in the floor drain tank, further processing (i.e., filtering, chemical treatment, demineralization) may be required prior to collection in one of two waste monitor tanks (Duke 2000a). Liquid wastes from the laundry hot shower tank also are collected in the waste monitor tanks after filtering (Duke 2000a). From the waste monitor tanks, liquid wastes are sampled and monitored. When they are found to be within the regulated levels, they then are discharged into the condenser cooling water system (i.e., condenser circulating water) that flows into Lake Norman (Duke 2000a). Condensate from the containment ventilation units is collected in the ventilation unit condensate drain tank (Duke 2000a). Liquid wastes from this tank are monitored and discharged into the condenser cooling water system (i.e., condenser circulating water) flowing into Lake Norman similar to the discharge from the waste monitor tanks.

Liquid wastes from the turbine building sump (typically not contaminated) are monitored and released to the conventional wastewater system and the wastewater collection basin discharge point to the Catawba River downstream of Cowan's Ford Dam (Duke 2001e). If monitoring shows elevated radioactivity levels in the Turbine Building sump, liquid waste is routed into the floor drain tank for processing as described above and eventual discharge to Lake Norman (Duke 2001e).

The ODCM prescribes the alarm/trip setpoints for the liquid effluent radiation monitors; the setpoints are derived from 10 times the effluent concentration limits provided in 10 CFR Part 20, Appendix B, Table 2, Column 2. Liquid effluent radiation monitors are located on the waste monitor tank release line, the containment ventilation unit condensate drain tank release lines, and the turbine building sump release line (Duke 2001e). The alarm/trip setpoint for each liquid effluent monitor is based on the measurements of radioactivity in a batch of liquid to be released or in the continuous liquid discharge (Duke 2001e).

During 2000, there were 246 batch releases of liquid effluents for the two units in a total volume of 1.37×10^7 L (3.62×10^6 gal) prior to dilution (Duke 2001c). The combined liquid waste volume prior to dilution for batch and continuous releases for 2000 was 3.35×10^8 L (8.84×10^7 gal) (Duke 2001c). The liquid waste holdup capacity for the plant is approximately 1.48×10^6 L (390,000 gal) (Duke 2001a). The actual liquid waste generated is reported in the *McGuire Nuclear Station Annual Radioactive Effluent Release Report* (Duke 2001c).

Duke does not anticipate any increase in liquid waste releases during the renewal period.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

The waste gas system is designed to remove fission gases from radioactive contaminated fluids and contain these gases. Fission gases are removed from other systems to the maximum extent possible and contained in the waste gas system. The system is designed so that storage and subsequent decay of these gases can eliminate, to a large extent, the need for regularly scheduled discharge of these radioactive gases from the system into the atmosphere during normal plant operation. There are times, however, when the release of radioactive gas may become necessary. As a result, there are provisions to sample and isolate each of the decay tanks.

The waste gas system, containment and auxiliary building ventilation, and flow from the condenser air ejectors exhaust into the unit vents (Duke 2001e). These four contributors to the unit vent exhaust are discussed below. The unit vents are the primary (major) gaseous release points from the plant (Duke 2001e).

- Waste Gas System. The waste gas system in the auxiliary building (Duke 2000a) is shared between the two reactor units and consists of two waste gas compressors, two catalytic hydrogen recombiners, six gas decay storage tanks for use during normal power generation, and two gas decay storage tanks for use during shutdown and startup operations (Duke 2001e). Letdown flow from the reactor coolant system is processed through the waste gas system, and the resultant gases (hydrogen, nitrogen, and small quantities of the fission products xenon and krypton) are collected in the waste gas decay storage tanks. Gases are allowed to decay in these tanks, then are released at permissible rates and activity to the Unit 1 vent as prescribed by the ODCM (Duke 2001e).
- Containment Ventilation. The containment ventilation includes atmosphere from the containment purge, containment air release and addition, and containment annulus (Duke 2000a). The containment atmosphere will pass through a charcoal adsorber and a high-efficiency particulate air (HEPA) filter prior to being exhausted into either the Unit 1 or Unit 2 vent (Duke 2001e).

- Auxiliary Building Ventilation. Radioactive gases generated within the auxiliary building will be exhausted through the building's ventilation system. Exhausted air is monitored and, upon radiation monitor alarm, the exhaust air is diverted through a charcoal adsorber and a HEPA filter prior to being released to the Unit 1 or Unit 2 vent (Duke 2001e).

- Condenser Air Ejectors. Gases from the condenser air ejectors are monitored continuously and discharged into either the Unit 1 or Unit 2 vent (Duke 2000a, 2001a).

Secondary (minor) release points include the waste management facility, the waste handling area, and the Unit 2 staging building (Duke 2001e). Exhausts from these three areas are monitored continuously and, upon a high radiation alarm, the supply and exhaust ventilation fans are stopped (Duke 2000a).

Radioactive gaseous wastes from McGuire are released primarily through the Unit 1 and 2 vents. The exhaust streams that flow into the unit vents (i.e., waste gas decay storage tanks, containment ventilation, auxiliary building ventilation, and condenser air ejectors) are monitored for radioactivity. The vents for each unit are continuously monitored for noble gases, radioiodines, and particulate activity (Duke 2000a). The ODCM prescribes alarm/trip setpoints for these effluent monitors and control instrumentation to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20 for gaseous effluents (Duke 2001e).

Duke does not anticipate any increase in gaseous releases during the renewal period.

2.1.4.3 Solid Waste Processing

Solid radioactive wastes from McGuire consist of spent resin, spent (contaminated) filter elements, contaminated oils and sludges, and miscellaneous solid materials (Duke 2000a, 2001a). Spent resin is flushed from plant demineralizers into spent resin storage tanks. The spent resin then is processed by dewatering or solidification and packaged in a cask liner, which is placed in a shielded cask truck (Duke 2000a). Spent filter elements are removed from their housing using filter-handling tools and filter transfer shields. They are transferred to a shielded filter storage bunker in the waste drumming area (Duke 2000a). Contaminated oils and sludges either are pumped to a processing area for solidification or are shipped to an offsite vendor for processing (Duke 2001a). Miscellaneous solid materials include rubber gloves, plastic bags, contaminated clothing, contaminated rags, and contaminated tools (Duke 2001a).

Lower-activity wastes (i.e., miscellaneous solid materials) are processed at an offsite waste processing facility for volume reduction or segregation prior to disposal at a licensed facility

such as Barnwell, South Carolina, or Envirocare of Utah (Duke 2001a). Higher-activity wastes (i.e., spent resins) are typically sent directly to a licensed disposal facility such as Barnwell, South Carolina (Duke 2001a).

Disposal and transportation of solid wastes are performed in accordance with the applicable requirements of 10 CFR Part 61 and 10 CFR Part 71, respectively. There are no releases to the environment from radioactive solid wastes created at McGuire.

In 2000, McGuire Units 1 and 2 made eight shipments of solid waste with a volume of 47 m^3 (1650 ft^3) and a total activity of 0.19 TBq (5 Ci) (Duke 2001c). These shipments are representative of the shipments made in the past several years and are not expected to change appreciably during the license renewal period.

2.1.5 Nonradioactive Waste Systems

Nonradioactive solid wastes from McGuire are disposed of in the onsite landfill or in one of several offsite landfills operated by Mecklenburg County (Duke 2001a). The onsite landfill typically handles the following types of wastes: asbestos, empty containers and drums, insulation (nonasbestos), nonhazardous-spill cleanup, conventional wastewater sludge, alkaline batteries, and oil-contaminated materials. This landfill is permitted by the North Carolina Department of Environmental and Natural Resources (NCDENR), Solid Waste Section (Duke 2001a). General office trash is disposed in one of several offsite landfills operated by Mecklenburg County (Duke 2001a).

Nonradioactive liquid wastes are sampled and treated according to the site National Pollutant Discharge Elimination System (NPDES) permits issued to McGuire by the North Carolina Department of Environmental and Natural Resources (Duke 2001a). These wastes originate from system drainage/leakage, water treatment activities, housekeeping/cleaning wastes, stormwater runoff, and floor and yard drains (Duke 2001a). Sanitary wastes are treated offsite by the CMUD (Duke 2001a).

2.1.6 Plant Operation and Maintenance

Routine maintenance performed on plant systems and components is necessary for safe and reliable operation of a nuclear power plant. Maintenance activities conducted at McGuire include inspection, testing, and surveillance to maintain the current licensing basis of the plant and to ensure compliance with environmental and safety requirements. Certain activities can be performed while the reactor is operating. Others require that the plant be shut down. Long-term outages are scheduled for refueling and for certain types of repairs or maintenance, such as replacement of a major component. Duke refuels each of the McGuire units every 18 to 24 months (Duke 2001a). Each outage is typically scheduled to last approximately 30 to

40 days; the outage schedules are staggered so that both units are not in an outage at the same time (Duke 2001a). One-third of the core is offloaded at each refueling. Approximately 1015 additional workers are onsite during a typical outage (Duke 2001a).

Duke provided an appendix in *Duke Energy Company McGuire Nuclear Station Updated Final Safety Analysis Report* regarding the aging management review to manage the effects of aging on systems, structures, and components in accordance with 10 CFR Part 54 (Duke 2000a). Chapter 3 and Appendix B of the McGuire license renewal application specifies the programs and activities that will manage the effects of aging during the license renewal period (Duke 2001b). Duke expects to conduct the activities related to the management of aging effects during plant operation or normal refueling and other outages but plans no outages specifically for refurbishment activities. Duke has no plans to add additional full-time staff (nonoutage workers) at the plant during the period of the renewed licenses.

2.1.7 Power Transmission System

Two switchyards connect the McGuire plant transmission lines to the transmission system: a 230-kV switchyard for Unit 1 and a 525-kV switchyard for Unit 2. The switchyards are located south of Highway NC-73 (see Figure 2-4). Power from Unit 1 is transmitted to the 230-kV switchyard over two separate three-phase 230-kV transmission lines with an average length of 1.2 km (4000 ft) (Figure 2-4). Power from Unit 2 is transmitted to the 525-kV switching station over two separate three-phase 525-kV transmission lines with an average length of 1 km (3300 ft) (Figure 2-4). The 230- and 525-kV lines are designed to meet the heavy loading condition as defined in the National Electrical Safety Code, 7th Edition (Duke 2001). The 230-kV switching station is tied into the Duke 230-kV network by seven double-circuit overhead lines. The 525-kV switching station is east of the 230-kV switching station and is tied into the Duke 525-kV network by four single-circuit overhead lines.

The right-of-way for the 525-kV lines is 151.5 m (500 ft) wide. The right-of-way for the 230-kV lines is 60.6 m (200 ft) wide (Gaddy 2001). Duke has a well established set of management practices for right-of-way maintenance. These best management practices include vegetation management, erosion and sediment control, soil stabilization, stream and wetland protection, and protection of sensitive areas and sensitive species. Vegetation management consists of mowing and herbicide application (Gaddy 2001). Arsenal and Accord with Garlon 4A or Krenite are used for stump treatments and basal applications. Each of these products has been evaluated for safety and environmental concerns. In particular, Arsenal and Accord are approved for use in wetland areas. Following initial treatment with Arsenal and Accord, rights-of-way are maintained thereafter on an approximate 3-year rotation. Subsequent herbicide applications are limited primarily to trees that could grow into transmission lines (Duke 2001a).

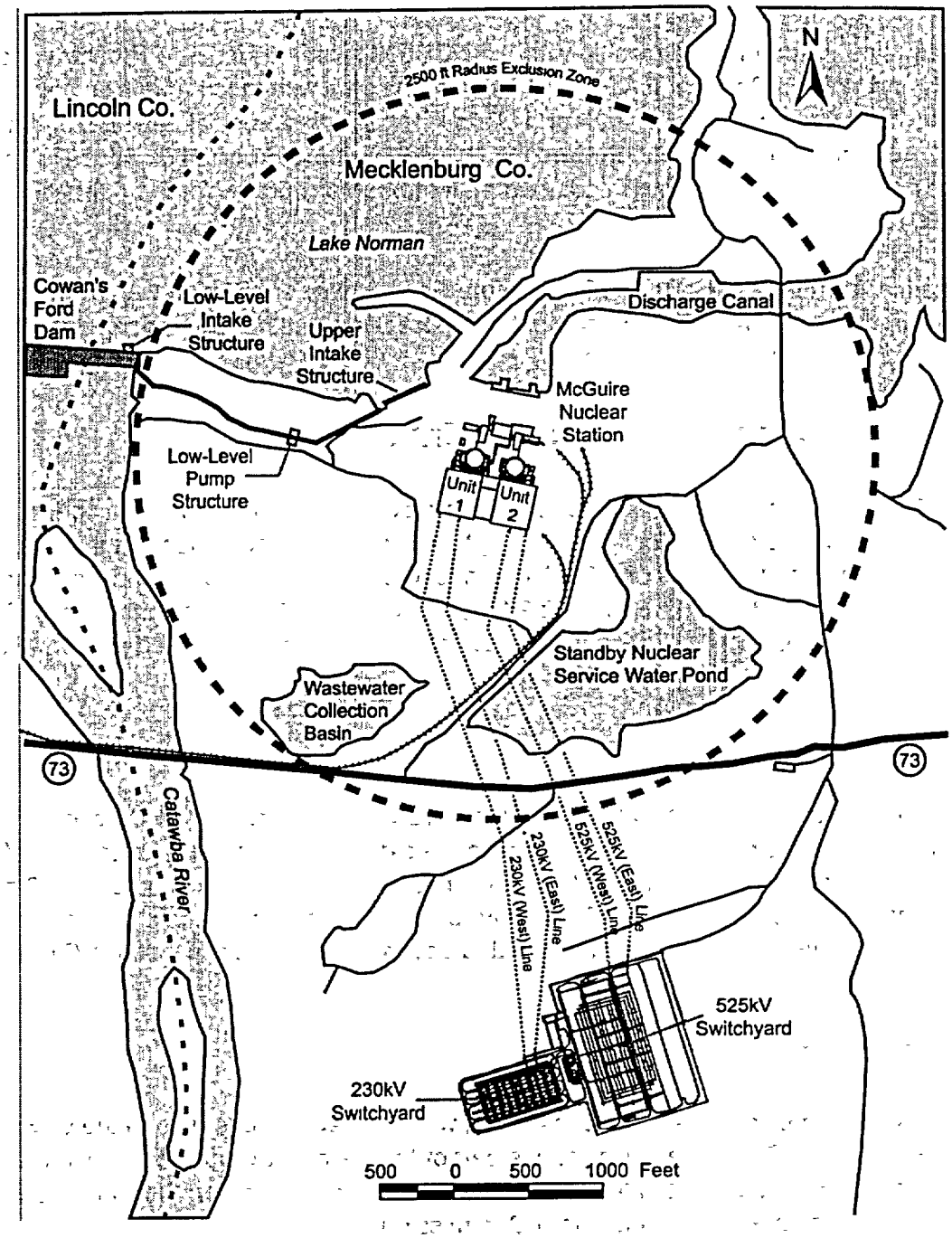

Figure 2-4. Transmission Lines Attributable to McGuire Nuclear Station

Duke maintains a working relationship with the NCDENR Natural Heritage Program and the U.S. Fish and Wildlife Service (FWS). Duke communicates with these agencies about pertinent natural heritage data such as Federal- and State-listed species, special habitats, and new findings. Information from the North Carolina Natural Heritage Program database is used to establish new and review existing vegetation management programs for the rights-of-way (Duke 2001a).

The transmission line connecting McGuire to the Oconee Nuclear Station was evaluated previously in the Supplemental Environmental Impact Statement for license renewal of the Oconee Nuclear Station (NRC 1999a).

2.2 Plant Interaction with the Environment

Sections 2.2.1 through 2.2.8 provide general descriptions of the environment as background information. They also provide detailed descriptions where needed to support the analysis of potential environmental impacts of refurbishment and operation during the renewal term, as discussed in Chapters 3 and 4. Section 2.2.9 describes the historic and archaeological resources in the area, and Section 2.2.10 describes possible impacts on other Federal project activities.

2.2.1 Land Use

Although the McGuire site is not within the town limits of Huntersville North Carolina (the nearest incorporated town), the site is subject to the extraterritorial zoning jurisdiction of Huntersville. Exercise of extraterritorial jurisdiction is authorized by Section 160A-360 of the General Statutes of North Carolina. The McGuire site is located in a special-purpose zoning district. Power generation plants are a permitted use in special-purpose districts (Town of Huntersville 2001).

2.2.2 Water Use

Lake Norman, North Carolina's largest reservoir, was created by constructing the Cowan's Ford Dam on the Catawba River. Lake Norman is part of the Catawba-Wateree Project, which consists of 11 reservoirs operated for hydroelectric power generation on the Catawba River and licensed by the Federal Energy Regulatory Commission.

In addition to supplying the cooling water for the McGuire plant, Lake Norman also supplies water for Duke Power's coal-fired Marshall Steam Station on the western shore of the lake, approximately 26 km (16 mi) upstream from McGuire. Lake Norman also is a source of

municipal drinking water for several cities in the region. Lake Norman supports extensive recreational use by fishermen, boaters, water skiers, and swimmers.

Construction of the Cowan's Ford Dam and impoundment of the Lake Norman reservoir to serve a variety of purposes, including providing cooling water for McGuire, have considerably altered the regional water resources environment. Lake Norman represents the critical landscape feature to lakeside development and regional recreation.

McGuire employs a once-through cooling system. The average daily withdrawal from Lake Norman for the cooling water and other service water systems is 9580 million L/d (2530 million gpd). The average daily discharge to Lake Norman from McGuire also is approximately 9580 million L/d (2530 million gpd). Approximately 4090 m^3/d (1.08 million gpd) from the conventional wastewater treatment system and from the wastewater collection basin are discharged to the Catawba River.

Potable water at McGuire is supplied by the CMUD water supply system. McGuire has six groundwater wells with a combined maximum pumping rate of 4.3 L/s (68 gpm).

2.2.3 Water Quality

Lake Norman provides water of sufficiently high quality to serve a variety of needs, including propagation of fish and wildlife and contact recreation. The NCDENR Division of Water Quality found Lake Norman fully supportive of all uses (NCDENR 1999).

Pursuant to the Federal Water Pollution Control Act of 1977, also known as the Clean Water Act, the water quality of the plant effluents is regulated through the NPDES. The Division of Water Quality within the NCDENR is delegated to issue NPDES permits. The current permit (NC0024392) was issued February 28, 2000, and is due to expire February 28, 2005. Any new regulations promulgated by the U.S. Environmental Protection Agency (EPA) or the State of North Carolina would be reflected in future permits.

2.2.4 Air Quality

The McGuire site is located in the Piedmont of the Carolinas, a transitional region between the Blue Ridge Mountains to the west and the Coastal Plain to the east. The region has a moderate climate with cool winters and warm summers. Climatological records for Charlotte, North Carolina (NCDC 2001), are generally representative of the McGuire site. Normal daily maximum temperatures for Charlotte range from about 9°C (49°F) in January to a high of

about 32°C (89°F) in July. Normal daily minimum temperatures range from about -1°C (30°F) in January to about 21°C (70°F) in July. The average precipitation of about 109 cm (43.1 in.) per year is rather evenly distributed through the year. Normal monthly precipitation ranges from 7 to 11 cm (2.7 to 4.4 in.).

The wind energy resource in the Piedmont of the Carolinas is limited. The annual average wind power in the region is rated 1 on a scale of 1 through 7 (Elliott et al. 1986). Wind turbines are economical in wind power classes 4 through 7 (average wind speeds of 5.6 to 9.4 m/s [12.5 to 21.1 mph]) (DOE 2001). The average wind power of exposed coastal areas of North Carolina is rated 3, and the wind power rating for mountain summits and ridges to the west generally varies from 3 to 6.

Thunderstorms can occur in any month and occur on an average of more than 3 days per month from April through August. Hurricanes that strike the Carolina coast may produce heavy rains but seldom cause high winds at the site (NCDC 2001). Statistics for the 30 years from 1954 through 1983 indicate that the probability of a tornado striking the site is expected to be about 2×10^{-4} per year (Ramsdell and Andrews 1986).

The McGuire site is located within the Metropolitan Charlotte Interstate Air Quality Control Region. This region is designated as in attainment or unclassified for criteria pollutants in 40 CFR 81.334 except for the EPA's reinstated 1-hr ozone standard. Mecklenburg County is a maintenance area for the 1-hr ozone standard. The State of North Carolina and Mecklenburg County have adopted EPA's proposed 8-hr ozone standard. This standard was exceeded on 32 days in 1999 (Mecklenburg County Department of Environmental Protection [MCDEP] 2000). Monitoring data for Mecklenburg County also indicate that the annual average concentration of fine particles ($PM_{2.5}$) for 1999 exceeded the $PM_{2.5}$ standard adopted by EPA in 1997. After several years of litigation, new $PM_{2.5}$ and 8-hr ozone standards have been upheld. EPA is taking steps to implement the new standards (e.g. developing its approach and collecting the data necessary to designate which areas are non-attainment). Six areas in North and South Carolina are designated in 40 CFR 81.422 and 40 CFR 81.426 as mandatory Class I Federal areas in which visibility is an important value. All of these Class I areas are more than 80 km (50 mi) from the site.

Diesel generators and other activities and facilities associated with McGuire emit various pollutants. Emissions from these sources are regulated under Air Quality Permit to Construct/Operate 00-019–269 issued by the MCDEP on February 23, 2000.

2.2.5 Aquatic Resources

Aquatic resources in the vicinity of the McGuire site are associated with the southernmost portion of Lake Norman, North Carolina's largest man-made reservoir. In addition to serving McGuire, Lake Norman also provides water to Duke Power's Marshall Steam Station and the Cowan's Ford Dam hydroelectric station. The lake also is a source of drinking water for several cities in the region. Boaters, fishermen, swimmers, and water skiers use the lake for recreation. Centers for tourism and conservation in the vicinity include Lake Norman State Park and three county parks on the shores of the lake. The Cowan's Ford Wildlife Refuge (owned and operated by Mecklenburg County Parks and Recreation Department) and the Cowan's Ford Waterfowl Refuge (managed by North Carolina Wildlife Resources Commission) are located along the shores of Mountain Island Lake, south of the McGuire site and immediately downstream of the Cowan's Ford Dam.

Lake Norman's major tributaries include the Catawba River, Lyle Creek, and Buffalo Shoals Creek. The lake itself covers 13,150 ha (32,500 ac) and averages 10 m (33 ft) deep, with a maximum 36.6-m (120-ft) depth.

Pelagic fish species are primarily forage fish, including threadfin shad (*Dorosoma petenense*), gizzard shad (*D. cepedianum*), and alewife (*Alosa aestivalis*). Game fish include black crappie (*Pomoxis nigromaculatus*) and white crappie (*P. annularis*), largemouth bass (*Micropterus salmoides*), white perch (*Morone americana*), white bass (*M. chrysops*), striped bass (*M. saxatilis*), and some spotted bass (*Micropterus punctulatus*). The primary fish caught in the nearshore littoral zone include sunfish (*Lepomis* spp.), largemouth bass, crappie and carp (*Cyprinus carpio*). Numbers of previously abundant catfish species like snail bullhead (*Ameiurus brunneus*), white catfish (*Ictalurus catus*), and flat bullhead (*I. platycephalus*) have dwindled significantly due to suspected predation by blue catfish (*I. furcatus*) and flathead catfish (*Pylodictis olivaris*). The Blue catfish, white perch, threadfin shad, white bass, spotted bass, and alewife are introduced species, some of which may impact native species populations. In addition, striped bass are not indigenous to Lake Norman and do not reproduce naturally. Instead, they are stocked on an annual basis to provide a resource for sport fishermen.

In addition to finfish, numerous aquatic invertebrate and plant species are found in the vicinity of McGuire. These include diverse phytoplankton, zooplankton, periphyton and benthic macroinvertebrates. In 1999, 135 varieties and forms of phytoplankton were collected, the dominant types being cryptophytes and diatoms (Duke 2001a). Zooplankton communities in Lake Norman also are diverse and tend to fluctuate seasonally and spatially. Since 1987, Duke researchers have recorded 108 zooplankton taxa (Duke 2001a). Most recently (1999), immature copepods dominated the zooplankton standing crop during most of the year, while rotifers and cladocerans had the highest densities in February and August, respectively.

Information from 1977 through 1984 indicates that benthos at sublittoral locations was dominated by chironomids, chaoborids, *Corbicula* sp., *Hexagenia* spp., and oligochaetes (Duke Power Company 1985). Since 1989, benthic macroinvertebrate studies have been limited to determining seasonal densities of *Corbicula* sp. in front of the McGuire intake structures. Recent studies indicate that the potential for biofouling from these organisms is moderate to high, but population numbers in front of the intake structures vary widely from year to year (Hall and Wilda 2000, 2001; Duke 2001a). Adult clams capable of reproduction generally comprise 10 percent or less of the samples (Duke 2001a).

The McGuire site lies entirely in Mecklenburg County. However, Lincoln County, immediately west of the site, also could harbor species that would be affected by plant refurbishment or continued operation. A search through the FWS database and the North Carolina National Heritage Program for Federally and State-listed species indicated that two fish – Carolina darter (*Ethostoma collis collis*) and highfin carpsucker (*Carpoides velifer*) – and three mussel species – Carolina heelsplitter (*Lasmigona decorata*), dwarf threetooth (*Triodopsis fulciden*), and Carolina creekshell (*Villosa vaughnaniana*) – could inhabit the region around McGuire (Table 2-1), though the probability is low based on the lack of lotic environment. In addition, a summer 2000 biological assessment of species associated with McGuire and related power transmission lines (Gaddy 2001) indicated that three other important species, including two mussels – the Carolina elktoe (*Alasmidonta robusta*) and Eastern creekshell (*V. delumbis*) – and one fish – the Santee chub (*Cyprinella zanema*) – could also inhabit the region around McGuire (Table 2-1).

Gaddy (2001) inventoried the site environs, excluding the industrial areas in the center of the site, using aerial photographs supplemented by field work. Gaddy also walked the four power line rights-of-way in their entirety. Areas that appeared to be reasonable habitat for Federally and State-listed species were inventoried in the summer and the early autumn. Despite an extensive survey program conducted by the State and licensee, no Federal- or State-listed species or critical habitat for such species was found within the McGuire site exclusion area (see Figure 2-4) or along related power transmission rights-of-way (Gaddy 2001).

Of the species mentioned, only the Carolina heelsplitter is listed as endangered. The other species are considered species of concern or "significantly rare." The Carolina heelsplitter was known historically in the Catawba River system in Mecklenburg County. However, recent collection records indicate the Carolina heelsplitter has been eliminated from all but one of the streams where it was originally known to exist. In North Carolina, the only remnant populations appear to exist in Union County, far to the southeast of the site (Fridell 2001). All of the streams supporting this species are free-flowing and natural (EPA 2002) and no longer occur in the vicinity of the plant. The last known occurrence in Mecklenburg County was more than 20 years ago (Fridell 2001).

Table 2-1. Federal and State of North Carolina Listed Aquatic Species Potentially Occurring in Lincoln and Mecklenburg Counties

Scientific Name	Common Name	Federal Status[a]	State Status[a]	County
Ethostoma collis collis	Carolina darter	FSC	–	Mecklenburg
Carpoides velifer	highfin carpsucker	–	SC	Mecklenburg
Cyprinella zanema	Santee chub	–	SR	Mecklenburg or Lincoln
Lasmigona decorata	Carolina heelsplitter	E	E	Mecklenburg
Triodopsis fulciden	dwarf threetooth	–	SC	Lincoln
Villosa vaughnaniana	Carolina creekshell	FSC	SC	Mecklenburg
Villosa delumbis	Eastern creekshell	–	SR	Mecklenburg or Lincoln
Alasmidonta robusta	Carolina elktoe	–	EX	Mecklenburg or Lincoln

(a) E = endangered; EX = extirpated (no longer found in the area); FSC = Federal species of concern; SC = State species of concern but not protected under State regulations; SR = significantly rare but not protected under State regulation; – = no listing.

Menhinick (1991) lists the highfin carpsucker from Lake Norman considerably north of the study area and lists only historic records of the Santee chub in Lake Norman but north of the study area (Gaddy 2001). However, detailed and thorough historical documentation on both species in the North Carolina Natural Heritage Program records is incomplete or non-existent, and there have been no recorded observations of these species in the recent past.

The three freshwater mussel species – dwarf threetooth, Eastern creekshell, and Carolina creekshell – are not reported from the Lake Norman South quadrangle, according to the North Carolina Natural Heritage Program database <http://www.ncsparks.net/nhp/search.html>.

2.2.6 Terrestrial Resources

Forest is the primary land cover near the McGuire site, with pasture, cropland, and residential development each contributing substantially to total land use. Noteworthy natural habitats outside the McGuire site include the 270-ha (668-ac) Cowan's Ford Wildlife Refuge (owned and operated by Mecklenburg County Parks and Recreation Department) and the Cowan's Ford Waterfowl Refuge (managed by the North Carolina Wildlife Resources Commission) to the south along the shores of Mountain Island Lake (Figure 2-2). These areas, as well as adjacent

lands, are occupied by bottomland hardwood forests and other habitats that support nearly 200 species of birds, 54 of which are neotropical migrants. Because of this rich avian diversity, the lands from Cowan's Ford to Mountain Island Lake have been officially designated as IBAs by the National Audubon Society. In addition, wildlife such as wild turkey *(Meleagris gallopavo)*, numerous raptor species, whitetail deer *(Odocoileus virginianus)*, and red fox *(Vulpes vulpes)* use these IBAs and the properties around the McGuire site to move freely along the Catawba River corridor (Duke 2001a).

The McGuire exclusion area is a circle with a 760-m (2500-ft) radius (Figure 2-5) that covers 182 ha (450 ac). Two man-made water bodies, the standby nuclear service water pond (13.3 ha [32.9 ac]) and the wastewater collection basin (4.13 ha [10.2 ac]), are located within the exclusion area (Figure 2-5). The exclusion area includes portions of Lake Norman and the McGuire discharge canal. Approximately 58.7 ha (145 ac) of the exclusion area are composed of generation and maintenance facilities, parking lots, roads, storage yards, and mowed grass. The remaining 41.3 ha (102 ac) consist of forest communities (Duke 2001a). In addition, 4.5 km (2.8 mi) of transmission line right-of-way connects the exclusion area to the McGuire switching station via nonforested terrestrial habitat.

The exclusion area harbors typical Piedmont plant communities (Duke 2001a) and land cover types. As shown in Figure 2-5, seven plant communities or cover types have been identified at the McGuire site: (1) marsh; (2) marsh/wetland mixed hardwood/open water; (3) mixed hardwood-pine; (4) pine; (5) wetland mixed hardwood; (6) wetland mixed hardwood/marsh; and (7) open water (Gaddy 2001). Cecil sandy loam dominates the site, with some Monacan clay loam found along the Catawba River. The more rare and more alkaline Mecklenburg and Iredell soils, which often support prairie plant species, are absent from the site (Duke 2001a; Gaddy 2001).

Marshes are nonforested and found along the margin of the floodplain of the Catawba River. Dominant marsh species include black willow (*Salix nigra*), tag alder (*Alnus serrulata*), a mallow (*Hibiscus* sp.), false nettle (*Boehmeria cylindrica*), fringed sedge (*Carex crinita*), cattail (*Typha latifolia*), rice cut-grass (*Leersia oryzoides*), and the exotic Asiatic dayflower (*Analeima keisak*) (Gaddy 2001).

Marsh/wetland mixed hardwood/open water describes a small wetland altered by beavers (*Castor canadensis*) found along the eastern edge of the exclusion area boundary. Common needlerush (*Juncus effusus*), sedges (*Carex* spp.), and false nettle occur in the backwaters of a small pond on the site. Black willow, tag alder, and sycamore (*Platanus occidentalis*) are found in the wetland mixed hardwood community upstream from the pond (Gaddy 2001).

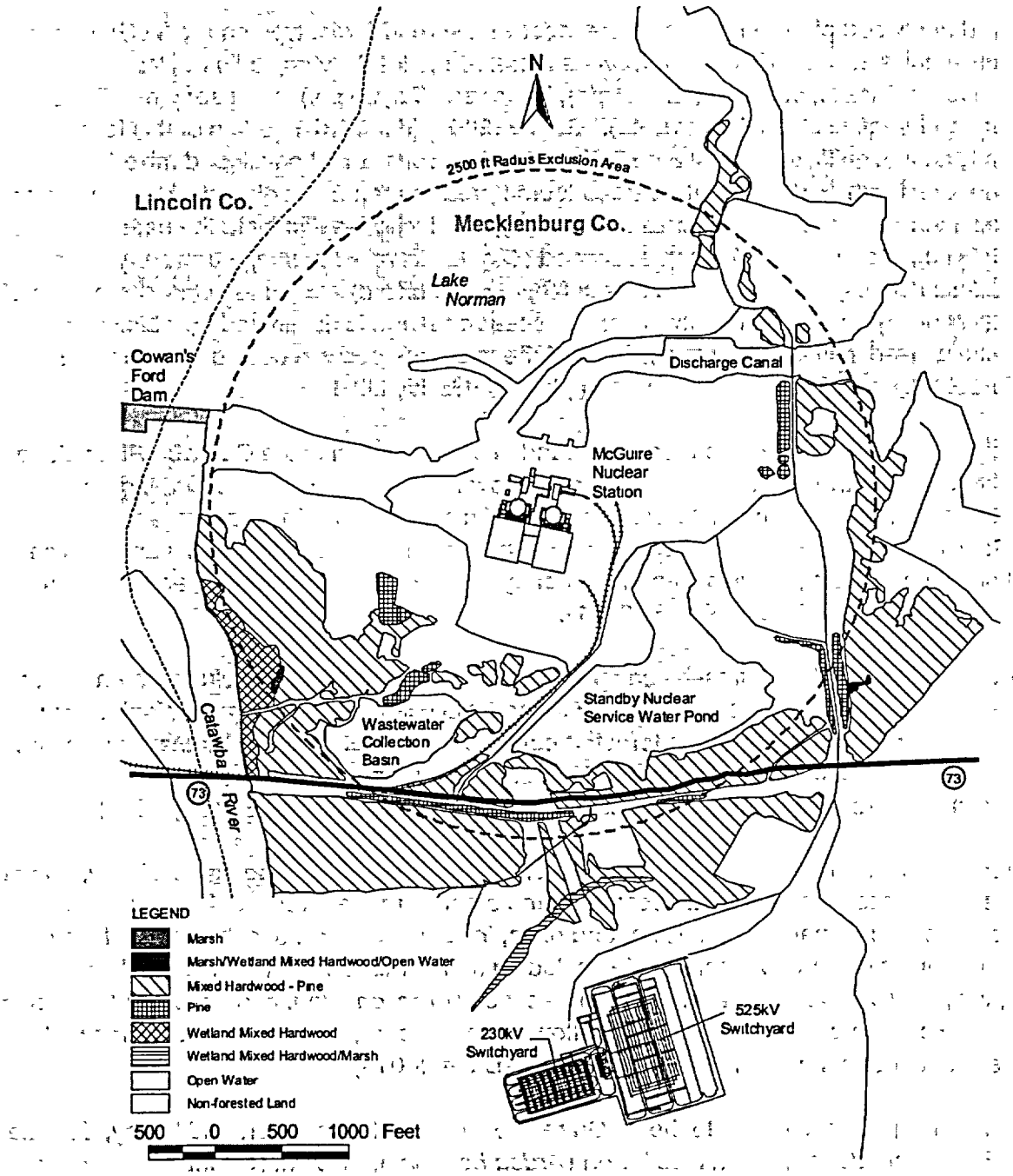

Figure 2-5. McGuire Site Vegetation Types

The mixed hardwood-pine community is the most widespread forest type on the McGuire site. Dominant species include white oak (*Quercus alba*), red oak (*Q. rubra*), tulip poplar (*Liriodendron tulipifera*), post oak (*Q. stellata*), hickories (*Carya* spp.), shortleaf pine (*Pinus echinata*), and Virginia pine (*P. virginiana*). Gaddy (2001) identified a portion of this forest community as a "significant natural area." This area supports a well-developed mixed hardwood forest with scattered mature trees (some greater than 2 ft in diameter). Tulip poplar, white oak, red oak, white ash (*Fraxinus americana*), and hickories dominate the canopy of this area, while dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), strawberry bush (*Calycanthus floridus*), and big-leaved storax (*Styrax grandifolia*) are found in the shrub layer of the understory. The pine community is early successional and is dominated by loblolly pine (*P. taeda*) with a low-density groundcover. Most of these stands occur in disturbed areas and along forest edges and appear to have been planted (Gaddy 2001).

The wetland mixed hardwood community is found in the floodplain of the Catawba River along the western edge of the exclusion area. Dominant overstory species include sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), American elm (*Ulmus americana*), river birch (*Betula nigra*), and sycamore. Box elder (*A. negundo*) is the understory dominant. The forest floor is occupied by sedges, Japanese honeysuckle (*Lonicera japonica*), and Vietnam grass (*Microstegium vimineum*) (Gaddy 2001).

The wetland mixed hardwood/marsh community occurs just south of the exclusion area where transmission lines pass over a small tributary of the Catawba River. Sycamore, black willow, tag alder, and sweet gum grow in the forested portions of the wetland, with Vietnam grass and cutgrass (*Leersia* sp.) in the understory. False nettle, common needlerush (*Scirpus polyphyllus*), and groundnut (*Apios americana*) grow in marshy openings (Gaddy 2001).

The forested portion of the exclusion area, as well as the transmission line rights-of-way, do not provide significant terrestrial habitat because of the small acreage involved. However, the
| McGuire site contains man-made wildlife food plots, including strip plots in the rights-of-way, that attract whitetail deer and other wildlife, including songbirds, a variety of mice and voles, raptors, gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), and opossum (*Didelphis*
| *virginiana*). Food plots include sorghum, sunflowers, rye, clover, and wheat that are mowed selectively to further enhance wildlife habitat value (Duke 2001a).

Notable wildlife species common to the McGuire site include whitetail deer, wild turkey, Canada geese (*Branta canadensis*), great blue heron (*Ardea herodias*), muskrat (*Ondatra zibethicus*), and osprey (*Pandion haliaetus*). Whitetail deer numbers have increased since McGuire has been operating. This is attributable largely to forest fragmentation, which provides for more open area and an increase in the foraging area for the deer. Fifteen wild turkeys were released on the McGuire site in 1996, and this population is apparently increasing. Wild turkeys are

commonly observed frequenting the food plots, rights-of-way, and bottomland hardwood areas. Canada geese numbers around McGuire also are increasing. These, and to a lesser extent other waterfowl and birds, routinely travel between the McGuire site and Cowan's Ford Waterfowl Refuge on Mountain Island Lake. Year-round access to reliable food sources in agricultural settings, yards, golf courses, and other open spaces explains why many of these are nonmigratory. A great blue heron rookery exists on a Davidson Creek island in Lake Norman approximately 4.5 km (3 mi) north of McGuire. This rookery consists of approximately 30 nests and is protected under the North Carolina Wildlife Resources Commission Colonial Waterbird Nesting Area Program. Island access is prohibited from April 1 to August 31. Muskrats, osprey, and various salamanders, aquatic snakes, and turtles have commonly been observed in marshy lowland areas and near open water (Duke 2001a).

Duke has a progressive wildlife enhancement program for which it received WAIT (Wildlife and Industry Together) certification from the North Carolina Wildlife Federation in 2001. This program is implemented both in the relatively unused portions of the plant site and offsite on nearby properties. It includes establishment and maintenance of food plots in the exclusion area and the rights-of-way; introduction of wild turkeys in cooperation with the Wild Turkey Federation; establishment of an osprey hacking (feed and release) site near Cowan's Ford Dam in cooperation with the Carolina Raptor Center; designation of a Davidson Creek island for heron management under the North Carolina Wildlife Resources Commission for management under the Colonial Waterbird Nesting Area Program; and establishment of bluebird houses.

Eight Federally listed and 10 State-listed threatened or endangered species, candidate species, or species of special concern are known to occur or may potentially occur in Mecklenburg County (Table 2-2) (Cole 2001; NCDENR 2001). Bald eagles (*Haliaeetus leucocephalus*) are known to nest at Lake Wylie (downstream of McGuire) and Lake James (upstream of McGuire) and are known from the Catawba River area (Cole 2001). The eagles are observed occasionally along Lake Norman (Cole 2001; Duke 2001a; Gaddy 2001), but sightings are rare and there are no known nest sites within 100 km (60 mi) of the McGuire site. Except for the bald eagle, no Federally or State-listed species are known to occur within the McGuire exclusion area or associated transmission line rights-of-way (Duke 2001a; Gaddy 2001). However, Schweinitz's sunflower (*Helianthus schweinitzii*) and Georgia aster (*Aster georgianus*) are known to occur on adjacent property (Cole 2001). No areas designated by the FWS as critical habitat for threatened/endangered species are known to exist within the McGuire exclusion area or associated transmission line rights-of-way (Duke 2001a; Gaddy 2001).

Table 2-2. Federal and State of North Carolina Listed Terrestrial Species Potentially Occurring in Mecklenburg County.

Scientific Name	Common Name	Federal Status[a]	State Status[a]
BIRDS			
Haliaeetus leucocephalus	bald eagle	T	E
Lanius ludovicianus ludovicianus	loggerhead shrike		SC
MAMMALS			
Condylura cristata	star-nosed mole - coastal plain population		SC
PLANTS			
Aster georgianus	Georgia aster	C	T
Delphinium exaltatum	tall larkspur	FSC	E
Echinacea laevigata	smooth coneflower	E	E
Helianthus schweinitzii	Schweinitz's sunflower	E	E
Isoetes virginica	Virginia quillwort	FSC	C
Lotus helleri	Carolina birdfoot-trefoil	FSC	C
Rhus michauxii	Michaux's sumac	E	E

(a) E = endangered; T = threatened; FSC = Federal species of (special) concern; C = candidate for Federal or State listing; SC = State species of special concern, but not protected under State regulations.

2.2.7 Radiological Impacts

Duke has conducted a radiological environmental monitoring program (REMP) around the McGuire site since 1977 (Duke 2001d). The radiological impacts to workers, the public, and the environment have been routinely monitored, documented, and compared to the appropriate standards. The REMP has four key objectives:

- Provide assurance that McGuire's contribution of radioactivity to the environment is and remains within applicable limits (Duke 2000a).

- Detect and identify changes in environmental levels as a result of station operations (Duke 2001d).

- Provide representative measurements of radiation and radioactive materials in the exposure pathways for the radionuclides that have the highest potential for radiation exposures of members of the public.
- Supplement the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways (Duke 2001d).

Radiological releases are summarized in the annual reports – *McGuire Nuclear Station Units 1 and 2 – Annual Radiological Environmental Operating Report* (Duke 2001d) and *McGuire Nuclear Station Annual Radioactive Effluent Release Report* (Duke 2000b, 2001c). The limits for all radiological releases are specified in the McGuire ODCM (Duke 2001e), and these limits are designed to meet Federal standards and requirements. The REMP includes monitoring of the air, direct radiation, surface water, drinking water, shoreline sediment, milk, fish, broadleaf vegetation, and food products.

Review of historical data on releases and the resultant dose calculations revealed that the doses to maximally exposed individuals in the vicinity of the McGuire site were a small fraction of the limits specified in the EPA's environmental radiation standards 40 CFR Part 190 as required by 10 CFR 20.1301(d). For 2000 (the most recent year for which data were available), dose estimates were calculated based on actual liquid and gaseous effluent release data (Duke 2001c) and on measured concentrations of radionuclides from the REMP (Duke 2001d). Dose estimates based on effluent data were performed using the plant effluent release data, onsite meteorological data, and appropriate pathways identified in the ODCM.

A breakdown of maximum dose to an individual located at the McGuire site boundary from effluent-based releases and environmental-based releases for the year 2000 is as follows:

- Total body dose from liquid effluent-based estimates was 0.001 mSv (0.102 mrem) compared to 0.00056 mSv (0.056 mrem) from environmental-based estimates. These estimates were between 1 and 2 percent of the 0.06-mSv (6-mrem) dose limit.[a] The maximum total organ dose for the liquid effluent-based estimates was 0.0013 mSv (0.13 mrem) to the child liver compared to 0.00064 mSv (0.064 mrem) to the child liver from the environmental-based estimates. These estimates were between 0.32 and 0.65 percent of the 0.20 mSv (20-mrem) dose limit (Duke 2001d).

(a) The dose limit is twice the dose limit in 10 CFR Part 50, Appendix I, because the limit is per reactor unit and McGuire has two operating reactor units.

- The air dose due to noble gases in gaseous effluents was 0.00084 mSv (0.084 mrad) gamma (0.42 percent of the 0.20-mGy [20-mrad] gamma dose limit)[a] and 0.00031 mGy (0.031 mrad) beta (0.08 percent of the 0.40-mGy [40-mrad] beta dose limit)[a] (Duke 2001d). Noble gases are not collected as part of the REMP; therefore, an environmental-based estimate was not calculated (Duke 2001d).

- The critical organ dose from gaseous effluents due to iodine-131, iodine-133, tritium, and particulates with half-lives greater than 8 days is 0.0055 mSv (0.55 mrem), which is approximately 2 percent of the 0.30-mSv (30-mrem) dose limit[a] (Duke 2001d).

Duke does not anticipate any significant changes to the radioactive effluent releases or exposures from McGuire operations during the renewal period; therefore, the impacts to the environment are not expected to change.

2.2.8 Socioeconomic Factors

The staff reviewed the McGuire Environmental Report (ER) and information obtained from several county, city, and economic development staff during a site visit from September 24 to 28, 2001. The following information describes the economy, population, and communities near the McGuire site.

2.2.8.1 Housing

Approximately 1345 full-time workers employed by Duke or site contractors work at McGuire during normal plant operations. Approximately 23 percent of these employees live in Mecklenburg County, 22 percent live in Lincoln County, 13 percent live in Gaston County, 11 percent live in Iredell County, and the rest live elsewhere in the region (see Table 2-3).

Duke refuels each nuclear unit at the McGuire site every 18 to 24 months. During these refueling outages, site employment increases by approximately 1015 temporary workers for 30 to 40 days. No major plant refurbishment activities were identified as necessary beyond routine replacement of components as part of normal plant maintenance (Duke 2001a). Duke has no plans to augment its current work force during the term of the license renewal period (Duke 2001a).

Table 2-4 provides the number of housing units, vacancies, vacancy percentages, and 10-year census percentage change for the seven counties in which 90 percent of McGuire employees reside. The vacancy rate for the principal counties of residence is similar, between 5 and 9 percent.

Table 2-3. McGuire Employee Residence Information by County

County	Number of Personnel	Percent	Cumulative Percent
Mecklenburg	318	24	23
Lincoln	305	23	47
Gaston	180	13	60
Iredell	155	11	71
Catawba	121	8	79
Cabarrus	93	7	86
Rowan	63	5	91
South Carolina	41	3	94
Other North Carolina	48	4	98
Other States	21	2	100
Total	1345	100	–

Source: Duke (2001a)

Table 2-4. Housing Units and Housing Units Vacant by County During 1990 and 2000

	1990	2000	Approximate Percentage Change
MECKLENBURG COUNTY			
Housing Units	216,416	292,780	35
Occupied Units	200,219	273,416	37
Percent Vacant	7	7	0
LINCOLN COUNTY			
Housing Units	20,189	25,717	27
Occupied Units	18,764	24,041	28
Percent Vacant	7	7	0
GASTON COUNTY			
Housing Units	69,133	78,842	14
Occupied Units	65,347	73,936	13
Percent Vacant	5	6	20
IREDELL COUNTY			
Housing Units	39,191	51,918	32
Occupied Units	35,573	47,360	33
Percent Vacant	9	9	0
CATAWBA COUNTY			
Housing Units	49,192	59,919	22
Occupied Units	45,700	55,533	22
Percent Vacant	7	7	0
CABARRUS COUNTY			
Housing Units	39,713	52,848	33
Occupied Units	37,515	49,519	32
Percent Vacant	6	6	0
ROWAN COUNTY			
Housing Units	46,264	53,980	17
Occupied Units	45,512	49,940	10
Percent Vacant	8	7	-13

2.2.8.2 Public Services

Public services include water supply, education, and transportation.

- **Water Supply**

The CMUD, the largest public water and wastewater utility in the Carolinas, provides drinking water to more than 700,000 people via an estimated 192,000 active water service connections in the City of Charlotte and greater Mecklenburg County – including the towns of Matthews, Mint Hill, Pineville, Huntersville, Davidson, and Cornelius. The drinking water is pumped from the Catawba River – either at Mountain Island Lake or Lake Norman – to one of three treatment plants where the water is cleaned, tested, and pumped into the distribution system. The three plants treat and deliver an average of roughly 386 million L/day (102 million gpd) of water or about half the system's capacity.

Six groundwater wells at McGuire supply specific low-volume needs totaling less than 0.0063 m^3/s (100 gpm). The site also has a passive dewatering system for the reactor building and auxiliary buildings. The total water usage at McGuire from CMUD for the year 2000 was 71.4 million liters (18.9 million gallons). Based on this figure, McGuire's average daily consumption of CMUD-supplied potable water was 0.0023 m^3/s (0.052 million gpd). CMUD estimates that the average annual system demand will be 7.14 m^3/s (163 million gpd) through the year 2030. McGuire's usage is 0.03 percent of the total system usage.

- **Education**

The Charlotte-Mecklenburg schools serve about 106,000 students in 86 elementary, 27 middle, and 16 high schools, as well as 9 special programs, not counting an extensive pre-kindergarten program. There is excess capacity in general for all grade levels except high school, for which enrollment equals capacity. This does not include local school or individual classroom-level allocations, for which there may be space/teacher/resource shortfalls.

- **Transportation**

The McGuire vicinity is served by Interstate 77 (I-77), which enters Mecklenburg County from the north and proceeds southwest through the city of Charlotte and south to Columbia, South Carolina. North Carolina Highway 16 (NC-16) provides north-south travel on the west side of the Catawba River. Sixteen miles west of McGuire, U.S. Highway 321 (US 321) runs north and south through the city of Gastonia.

Highway NC-73 runs east and west and passes McGuire at the south end of Lake Norman. Interstate 85 (I-85) is a major east-west highway that traverses the middle of the county through the city of Charlotte.

The plant is located approximately halfway between NC-16 and I-77. Road access to the McGuire site is via NC-73, a two-lane road for most of its length between NC-16 and I-77. An access railroad enters the site from the south along NC-73.

Duke contacted the North Carolina Department of Transportation (NCDOT) Statewide Planning Branch for information on traffic counts near McGuire. The NCDOT provided Average Annual Daily Traffic (AADT) count data and Level of Service (LOS)[a] designations for the requested locations (Duke 2001a). The AADTs and LOS designation for roads in the vicinity of McGuire are shown in Figure 2.6. The highest AADT counts are south on NC-16 to NC-73, and then along NC-73 to SR 2145. NC-16 is a major corridor for traffic to and from the Charlotte area. The portion of NC-73 between NC-16 and SR 2145 is a major corridor of travel to Interstate I-77. In summary, the LOS on NC-73 in the vicinity of McGuire is D—a high-density, stable flow in which speed and freedom to maneuver are severely restricted and where small increases in traffic will generally cause operational problems.

Continued growth in population, unrelated to McGuire operations, will likely occur in the area through the period of the extended license. This growth will necessitate increases in traffic capacity to accommodate the population increase. Traffic planning for the region is conducted by the Mecklenburg-Union Metropolitan Planning Organization (MUMPO). The MUMPO maintains a 20-year planning horizon for transportation improvements in the region (MUMPO 1999). The most recent plan extends to the year 2020 and is reviewed and revised on a 5-year cycle. The current plan does not include improvements to the road system near McGuire.

2.2.8.3 Offsite Land Use

The majority of the land area in the region near McGuire is a mixture of pasture, cropland, forest, and residential development. The shoreline of Lake Norman is developed with both vacation and permanent residences, along with campgrounds, boat launch areas, marinas, golf courses, and small retail establishments. The dominant land uses are residential housing (38 percent) and vacant (44 percent).

Two wildlife refuges are close to the plant site. Cowan's Ford Waterfowl Refuge abuts the plant site beginning at the Cowan's Ford Dam and extends south about 11 km (7 mi) along the

(a) LOS is a qualitative measure describing operational conditions within a traffic stream and their perception by motorists (NRC 1996).

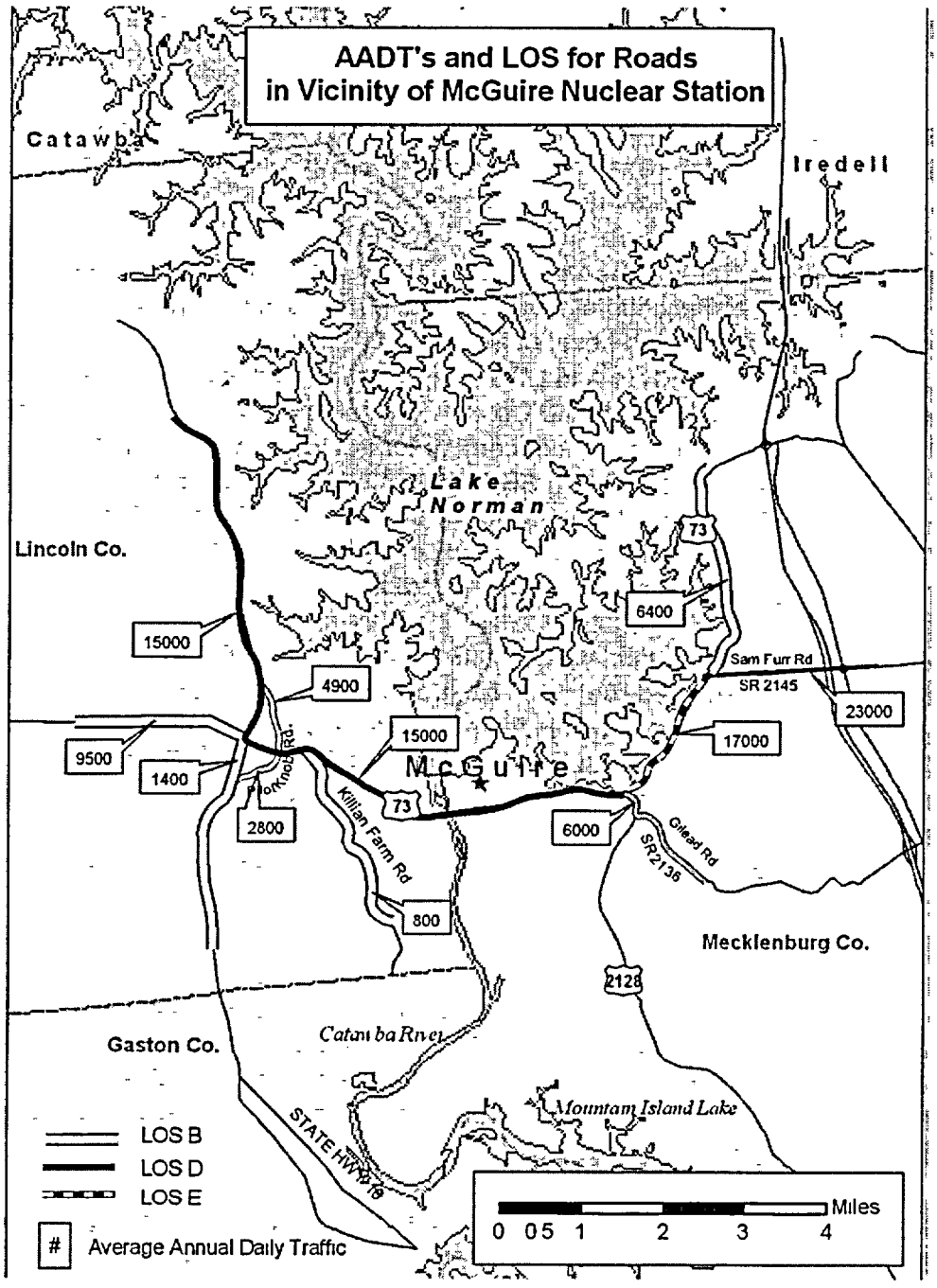

Figure 2-6. Traffic Counts and Level of Service on Roads Surrounding McGuire Nuclear Station

Catawba River. The Cowan's Ford Wildlife Refuge is about 7 km (4 mi) south of the plant site, within an oxbow bend in the riverine section of Mountain Island Lake. Kings Mountain National Military Park and Kings Mountain State Park are about 48 km (30 mi) southwest of McGuire. South Mountain State Park is approximately 64 km (40 mi) to the west-northwest. Crowder's Mountain State Park is approximately 39 km (24 mi) southwest of McGuire. Morrow Mountain State Park and a small portion of the Uwharrie National Forest are to the east within an 80-km (50-mi) radius of the McGuire site. The Catawba Indian Reservation occupies several sites south of the plant near Rock Hill, South Carolina. The nearest of these sites is approximately 48 km (30 mi) from the McGuire site.

2.2.8.4 Visual Aesthetics and Noise

McGuire is visible from a few vantage points on adjoining roads and from Lake Norman. However, its presence does not seem to affect the many recreational boaters or the relatively expensive homes that dot the shoreline. Very little noise from the nuclear station is evident from offsite.

2.2.8.5 Demography

Population was estimated in the region of McGuire in an 80-km (50-mi) zone in 16-km (10-mi) concentric rings. Population estimates for the 80-km (50-mi) area surrounding the site are based on information from the *Updated Final Safety Analysis Report* for McGuire (Duke 2000a).

- **Resident Population Within 80 km (50 mi)**

  In 2000, an estimated 2,425,097 people lived within 80 km (50 mi), and 904,943 lived within 32 km (20 mi) of McGuire.

  Within 80 km (50 mi) of McGuire are located all or parts of 23 counties in North Carolina and 6 in South Carolina. Within this circle, Charlotte, North Carolina, is the only major city with a population over 500,000 (2000 Census). The next largest city is Gastonia, North Carolina, to the southwest, with a population of 66,277 (2000 Census) and Rock Hill, South Carolina, on Highway 21, with a population of 49,765 (2000 Census). Population data for the counties surrounding McGuire (in which 90 percent of McGuire employees live) are shown in Table 2-5.

- **Transient Population**

  There is very little transient population, either from seasonal travelers or migrant workers, in the vicinity of McGuire (personal communication with Richard W. Jacobsen, Jr., Director, Mecklenburg County Department of Social Services, October 2001; personal

Table 2-5. Historic and Projected Population in the Principal McGuire Area of Impact –The Seven Counties with 90 Percent of the McGuire Employees

County	1980	1990	2000	2010	2020
Mecklenburg	404,270	511,481	695,454	888,137	1,089,258
Lincoln	42,372	50,319	63,780	77,234	90,778
Gaston	162,568	175,093	190,365	203,623	215,587
Iredell	82,538	92,935	122,660	152,177	182,758
Catawba	105,208	118,412	141,685	163,889	186,058
Cabarrus	85,895	98,935	131,063	164,700	200,092
Rowan	99,186	110,605	130,340	150,599	171,889

Source: 1980 census data available at http://www.nationalatlas.gov/census1980m.html. 1990 and 2000 census data available at http://factfinder.census.gov. Projections for 2010 and 2020 are available at http://demog state.nc.us/.

communications with Steve Patterson, Charlotte–Mecklenburg Planning Commission, March 2002; personal communication with Donny Hicks, Executive Director, Gaston County Economic Development Commission, March 2002). McGuire is actually in a relatively affluent part of Mecklenburg and surrounding counties, in part because the homes and lots on Lake Norman are considered very desirable.

2.2.8.6 Economy

According to the North Carolina Department of Commerce, Economic Development Information System (available at http://cmedis.commerce.state.nc.us/region/carolinas.asp), Mecklenburg County is in the Charlotte Regional Partnership, one of seven economic development regions in North Carolina. Charlotte is the hub of this economic development region. Population growth in Mecklenburg County over the past 20 years is shown in Table 2-5. This region's population and employment grew more rapidly than the state totals in recent years. The largest employment sectors in this region are manufacturing and wholesale/retail trade, while the fastest-growing sectors are construction and services. The business failure rate and business startup rate are slightly below the state average. Per-capita income and average wages are approximately 7 percent above the statewide levels. The unemployment rate is lower than the state average, and the region's poverty rate is the lowest in North Carolina.

Charlotte, the Piedmont Triad, and the Research Triangle region are the state's economic "hot spots," with growth predicted at 19 percent, 17 percent, and 15 percent, respectively, by the year 2005. Firms such as Hilton Hotels, Marriott Hotels, Hannaford Brothers, Coltec, SeaLand, Omni Hotels, Nations Bank, Hearst Corp., Black & Decker, and Canteen are located in Charlotte. Charlotte's financial sector is also growing and includes Nations Bank and First Union Bank.

Table 2-6 shows the employment by sector and wages in the Mecklenburg area. Table 2-7 shows the employment of the 20 largest manufacturing companies, as reported by the North Carolina Department of Commerce, Economic Development Information System. McGuire's 1370 employees would place it sixth among public and private concerns behind Mecklenburg County itself.

The unemployment rates for Mecklenburg County and surrounding localities are shown in Table 2-8. Most are below the North Carolina State average of 3.6 percent (U.S. Department of Labor 2001), with the notable exception of Gaston County, reflecting the diverse and healthy economy of the region.

McGuire paid about $8.5 million in property taxes to both Mecklenburg County and the town of Huntersville in fiscal year 1998-99. This represents about 2 percent of the property tax revenue and about 1 percent of the total operating budget of Mecklenburg County. McGuire also pays $333,333 per year to Huntersville, representing 7 percent of its property tax and 4 percent of its operating budget, as shown in Table 2-9.

Table 2-6. Employment and Earnings in Key Economic Sectors in Mecklenburg County, North Carolina

	Workforce		Average Weekly Earnings ($)	
	Number	Percent	County	State
Agriculture	4,864	0.90	472.16	383.00
Construction	32,622	6.30	690.74	571.00
Finance/Insurance/Real Estate	58,199	11.30	1,124.78	844.00
Government	48,103	9.40	724.07	621.00
Manufacturing	49,765	9.70	855.04	689.00
Retail Trade	84,054	16.40	409.79	334.00
Wholesale Trade	45,101	8.80	870.05	733.00
Service	145,914	28.40	676.46	550.00
Transportation/Communications/ Public Utilities	45,150	8.80	945.34	757.00
Total Workforce[a]	513,722	100.00		

(a) Mining is excluded because of its very small share of employment in NC and for confidentiality reasons.
Source: North Carolina Department of Commerce, Economic Development Information System available at http://cmedis.commerce.state.nc.us/countyprofiles/county.profile.asp?county=Mecklenburg

Table 2-7. Twenty Largest Manufacturers in Mecklenburg County

Company	Primary Product Category	Staff
IBM Corp.	Electronic Computers	3000
Solectron Technology Inc.	Printed Circuit Boards	2500
Continental General Tire Inc.	Tires and Inner Tubes	1700
Lance Inc.	Potato Chips and Similar Products	1600
Microsoft Corp.	Prepackaged Software	1300
Knight Publishing Co.	Newspapers: Publishing and Printing	1000
Interstate Brands Corp.	Bread, Bakery Products Except Cookies and Crackers	900
Frito-Lay Inc.	Potato Chips and Similar Products	720
Clariant Corp.	Cyclic-Crudes, Intermediates, Dyes and Org. Pigments	650
Siemens Westinghouse Power	Steam, Gas, and Hydraulic Turbines and Engines	610
Charlotte Pipe and Foundry Co.	Gray Iron Foundries	520
Blythe Construction Inc.	Commercial Physical and Biological Research	500
Connor, Wilton Packaging Limited Liability Company	Corrugated and Solid Fiber Boxes	500
Hoechst Celanese Corp.	Commercial Physical and Biological Research	500
Continental General Tire Inc.	Tires and Inner Tubes	400
Compass Group North America	Food Preparations	400
Carolina Tractor/Equipment Co.	Machinery and Equipment, Industrial and Commercial	400
AmeriSteel Corp.	Blast Furnaces, Coke Ovens, Steel and Rolling Mills	400
Okuma Machine Tools Inc.	Machine Tool Accessories	400
Conbraco Industries Inc.	Valves and Pipe Fittings	350

Source: North Carolina Department of Commerce, Economic Development Information System available at http://cmedis.commerce.state.nc.us/countyprofiles/countyprofile.asp?county=Mecklenburg

Table 2-8. Unemployment in Counties Surrounding McGuire

County	2000 Annual Unemployment Rates (%)
Cabarrus	2.6
Catawba	2.2
Gaston	6.1
Iredell	3.3
Lincoln	4.1
Mecklenburg	2.5
Rowan	4.8
State of North Carolina	3.6

Source: U.S. Department of Labor, Bureau of Labor Statistics, 2000 data (DOL 2001)

Table 2-9. Property Tax Revenues Generated in Mecklenburg County: 1998-2001[a]

Tax or Fiscal Year	Total Mecklenburg County Property Tax Revenues ($)[b]	Property Tax Paid to Mecklenburg County by McGuire ($)[c]	McGuire Property Taxes as a Percentage of Total County Property Tax Revenue	Total County Operating Budget ($)[b]	McGuire Property Taxes as a Percentage of Total County Operating Budget
1998	385,673,079	8,100,866	2	760,190,762	1
1999	399,009,088	7,624,712	2	850,502,587	1
2000	445,135,437	7,421,517	2	940,575,290	1
2001	473,588,913	9,311,874	2	1,029,528,662	1

(a) In addition, McGuire pays $333,333 a year to the town of Huntersville, a part of an agreement for payments in lieu of annexation of the McGuire site by the town of Huntersville. The payments will be made on an annual basis until the year 2027, when the agreement expires. The total revenues received in 1999 by the town of Huntersville were $9,462,699, of which $4,832,573 were revenues from property taxes (Duke 2001a, Section 4.18) The payment by McGuire represents about 7 percent of Huntersville's property tax revenue and 4 percent of its total operating budget.
(b) Source: Personal communication from Mecklenburg-Charlotte Tax Assessor, February 2002
(c) Source: Personal communication from North Carolina Department of Revenue, Property Tax Division, March 2002

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at McGuire and in the surrounding area. This section draws on information contained in the McGuire ER (Duke 2001a) and from archives and records stored at the North Carolina Department of Cultural Resources, Office of Archives and History, as well as published literature that treats the history of the North Carolina Piedmont (Piedmont).

2.2.9.1 Cultural Background

McGuire is in the southwest section of the Piedmont geologic province. The Piedmont is a large, highly dissected plateau covering some 58,000 km^2 (20,000 mi^2) between the coastal plain and the foothills of the Blue Ridge Mountains (Ward 1983). The Piedmont has an archaeological sequence that extends back at least 12,000 years before the present.

The Piedmont's cultural history can be divided into five major periods: Paleoindian (10,000 B.C., and perhaps as early as 13,000 B.C., to around 8000 B.C.), Archaic (8000 to 500 B.C.), Woodland (500 B.C. to around A.D. 1000), Mississippian (A.D. 1000 to around 1500), and Historic and Modern (A.D. 1500 to the present).

During the Paleoindian period, the native peoples seemingly were organized into small mobile bands with a hunting- and a fishing-based economy. Animals hunted included megafauna, such as the now extinct mammoth. The environment of the Paleoindian period was significantly different from the present. This was at the end of the last ice age, in which the climate was cooler than at present and glaciers covered much of the northern portion of North America.

The transition between the Paleoindian and Archaic periods was accompanied by substantial environmental change. As glaciers began to melt, sea level began to rise. These changing environmental conditions led to a greater dependance on river systems and the beginnings of the use of domesticated plants. Middle Archaic sites in the Piedmont are numerous and likely reflect small groups of socially noncomplex peoples widely ranging across the landscape (Anderson 1996). Middle and Late Archaic archaeological sites typically exhibit greater evidence of sedentary economies, such as the presence of storage pits, extensive refuse middens, and large quantities of fire-cracked rock. Archaic period habitation sites appear to have been divided into base camps used during the the spring, summer, and winter months, and smaller upland sites used during the fall for deer hunting and nut gathering.

In the Woodland period, Native American cultures reached their modern configurations as noted at the time of initial European contact in the 16th and 17th centuries. The middle of the Woodland period witnessed the establishment of large sedentary base camps in river valleys, with associated smaller resource-gathering sites being established in surrounding areas.

Toward the end of the Woodland period and during the subsequent Mississippian period, Native American villages throughout the Midwest and much of the Southeast apparently were organized into chiefdom-level societies (Bense 1994; Perdue 1985). The use of long-houses, palisades, earth lodges, mounds and other earthen works, and designated burial grounds are hallmarks of the Mississippian period.

The staff assumes that the ancestors of the modern Catawba Indians lived in the region surrounding McGuire and the Catawba River at the time of historic contact with the Europeans (Perdue 1985; Merrell 1989; Lee 1997; De Vorsey 1998). The Catawba are an eastern Siouan-speaking tribe who likely lived in the Carolinas for several hundred years before European contact.

The Historic period in North Carolina began in the early 16th century with the first incursions of European explorers along the Carolina Coast (Bense 1994; Cumming 1998; De Vorsey 1998). Beginning around 1660, a steady stream of Euroamericans began moving from Virginia into the coastal sounds and rivers of North Carolina (Perdue 1985; Lee 1997). In 1670, the Carolina colony was established by the British at Charles Town (modern Charleston). The stream of settlers finally led to a series of conflicts between the tribes and the settlers, with the most

serious being the Tuscarora, Yamassee, and Cheraw Wars of 1711-1718. In these wars, the Catawba first assisted the Euroamericans against Tuscarora and then turned on the Euroamericans, particularly in the Yamassee War. Ultimately, the Catawba joined the Cherokee in making peace.

In 1701, the surveyor John Lawson reported that several thousand Catawba Indians were observed living in many different villages (Perdue 1985; Lee 1997). By 1738, smallpox and other diseases had reduced the tribe to around 1000 people living in six villages in proximity along the Catawba River in the area around the present border between South and North Carolina. A second smallpox epidemic in 1759-1760 further reduced the Catawba population.

By 1750, so many Euroamericans had moved into the Piedmont that Anson County was created, a county which then covered roughly the western half of North Carolina. Mecklenburg County itself was carved out from Anson County and established in 1763. The current county boundaries were set up in 1842. Treaties in 1760 and 1763 set up an approximately 39-km^2 (15-mi^2) reservation for the Catawba tribe at the eastern edge of South Carolina; however, these lands were soon overrun by Euroamerican colonists. In 1768, the town of Charlotte was incorporated at the juncture of two major transportation and trade routes (Rogers and Rogers 1996). John Collet's detailed 1770 map of North Carolina depicts Charlotte (Charlottesburgh) and the small nearby Catawba Tribal Reservation but depicts no settlements, mills, or transportation corridors in the general vicinity of the current McGuire site (Cumming 1998).

In early 1779, the British concentrated on consolidating their power in the southern states during the American Revolution. Charles, First Lord Cornwallis, entered Charlotte on September 28, 1780; however, his reception was so contested that he retreated from Charlotte to Charleston on October 14, 1780.

In December 1780, Nathanael Greene, the commanding general for the Continental Army in the South, arrived in Charlotte. Greene decided that the Charlotte area did not contain enough provisions to satisfactorily supply his army, so he removed the majority of the Army to the Pee Dee River to the east of Charlotte. Some 1000 men under the command of General Daniel Morgan were sent to northwest South Carolina. Lord Cornwallis began to pursue Morgan, who was fleeing east to attempt to rejoin with Greene. Greene, riding west from his camp, met Morgan at the Catawba River, and was joined by General William Lee Davidson, the local militia commander for the area.

Because there were no bridges crossing the Catawba River, Davidson and a small force were tasked to slow the advance of the British Army so that Morgan's forces would have time to join up with those of Greene. Just before daybreak the next morning, the British Army led by Cornwallis surprised Davidson's sleeping militia at Cowan's Ford. This action was to prove the last that occurred in the Charlotte area during the American Revolution.

During the period between the American Revolution and the Civil War, the Piedmont was divided into regions devoted to the cultivation of tobacco (north and east of Charlotte) and cotton (around and to the south of Charlotte). The period of 1789 through 1860 saw the development of plantations (primarily using African slaves for labor), independent farms, and small towns through the Piedmont, in which agriculture dominated local economies. This agriculture-based economy was facilitated by the invention of the cotton gin in 1793, which allowed short-fiber cotton to be grown virtually anywhere in the region.

The Catawba Indians were active resisters to the forced relocation plans of the Federal government during the 1820s to 1850s, such as President Andrew Jackson's Indian Removal Act of 1830 (Bense 1994). The Catawba attempted to hang onto their old reservation lands ceded in the 18th century, but in 1840 were finally forced to sell most of them to South Carolina. The Catawba then variously lived with the North Carolina Cherokee and the Oklahoma Choctaw and then surreptitiously returned to South Carolina.

The Charlotte area and the Mecklenberg County portion of the Catawba River did not play a major role in the battles and strategy of the Civil War (Barrett 1987). Some Catawba soldiers fought for the Confederacy during the Civil War.

Due to the physical effects of the Civil War and to the abolishment of slavery, the economic basis of the Southeast was fundamentally changed between 1865 and 1917 (Bense 1994). While plantations typically were returned to their former owners, plant operations became dependent on voluntary contracts or tenant farming with their labor force. Over time, plantations became smaller, averaging less than 40 ha (100 ac) by 1920. The expansion of the railroads, the rebuilding of basic infrastructure, and the Industrial Revolution all led to major changes.

The period between World War I and World War II saw the continued growth of small towns and the continuation of the use of small plantations and independent farms. In 1941, the Catawba Tribe first received Federal recognition but petitioned to terminate their status in 1959, with lands being distributed among tribal members (Merrell 1989). After a period of reassessing this decision to divest, the tribal council was reorganized and in 1973 was given state recognition by South Carolina. After a lengthy court process, Federal recognition was reinstated in 1993.

The period since the end of World War II has witnessed the creation of Lake Norman, North Carolina's largest man-made lake, which reached full capacity in 1964. As a consequence, numerous residential developments have blossomed around its margins, a trend that is ongoing. Construction began in the mid-1970s on McGuire Units 1 and 2, and in 1981 and 1984, respectively, the units were put into operation.

2.2.9.2 Historic and Archaeological Resources at the McGuire Site

Historic and archaeological site file searches were conducted at the North Carolina Department of Cultural Resources, Office of Archives and History, to determine what specific historic cultural resources may be present at the McGuire site. In addition, record searches were conducted for nearby locations to gain a perspective on the types of historic resources that may be present in the previously undeveloped and unsurveyed portions of the grounds of the McGuire Nuclear Station.

These record searches revealed that there are no known historic and archaeological resources at McGuire. During the construction of McGuire, a forgotten historic marker commemorating the death of General Davidson at Cowan's Ford was discovered (Duke 2001a). Cowan's Ford and the location of Davidson's death are now inundated. General Davidson's body was interred at the Hopewell Church cemetery about 8 km (5 mi) away. In 1971, Duke incorporated this marker, as well as a new marker provided by the North Carolina Department of Archives and History, into a public area adjacent to McGuire. The markers were dedicated in 1971 and are still maintained by Duke.

An archaeological survey was not conducted at McGuire before construction activities. However, based on the records of nearby sites and properties, it is unlikely that significant Native American resources were present. A number of Native American archaeological sites were identified and recorded in the early 1960s just north of McGuire before the creation of Lake Norman. These sites were poorly defined and described but appear to represent Archaic, Woodland, and Mississippian period occupations. Most consisted of a few scattered stone and ceramic artifacts in areas heavily disturbed by historic agriculture, specifically from the cultivation of cotton. Erosion caused by cotton farming was a major impact in virtually every site, with many of the sites being exposed to bedrock.

No structures or buildings at McGuire are 50 years of age or older. A number of structures and buildings within a 5.0-km (3.1-mi) radius of McGuire have been evaluated for historic significance; however, only three of these have been determined eligible for listing in the National Register of Historic Places (Duke 2001a). These include the Ingleside house, which was built in the 1850s, and is about 3.7 km (2.3 mi) from McGuire; the Rural Hill Plantation, which has features dating to the late 18th century, and is about 4.6 km (2.8 mi) from McGuire; and the Holly Bend house, which was built at the end of the 18th century, and is about 4.9 km (3.0 mi) from McGuire. The Gilead Associated Reformed Presbyterian church and cemetery and the Caldwell-Rosenwald School are currently pending evaluation.

The Catawba Indian Reservation (in three separate parcels) is situated in South Carolina about 48 km (30 mi) south of McGuire.

2.2.10 Related Federal Project Activities and Consultations

The staff reviewed the possibility that activities of other Federal agencies might impact the renewal of the OLs for McGuire. Any such activities could result in cumulative environmental impacts and the possible need for the Federal agency to become a cooperating agency in preparing the SEIS (10 CFR 51.10(b)(2)).

The Federal Power Commission, now the FERC, issued a license (FERC Project No. 2232) to Duke Power Company on September 17, 1958, for the Catawba-Wateree hydroelectric project (FERC 2001a). One component of the project is the Cowan's Ford Dam hydroelectric station. The Cowan's Ford Dam impounds Lake Norman. The license for the Catawba-Wateree project will expire August 31, 2008 (FERC 2001a). Under current FERC rules, Duke Power will need to file a notice of intent with FERC by August 2003 declaring whether or not it intends to seek a new license for the Catawba-Wateree hydroelectric project (18 CFR 16.6). Assuming that Duke Power intends to seek a new license, it will need to file an application for the relicensing of the project at least 2 years before the license expires. FERC will prepare an environmental assessment or an EIS under NEPA in conjunction with reviewing the application. FERC's procedures for processing a license application are set out in a handbook (FERC 2001b).

The Federal lands closest to McGuire are within the Kings Mountain National Military Park. The park is located near Blacksburg, South Carolina, and is operated by the National Park Service. The park is approximately 48 km (30 mi) southwest of McGuire.

The Native American land closest to the McGuire site is the Catawba Indian Reservation. The tribe occupies a 260-ha (640-ac) reservation in York County, South Carolina, near the city of Rock Hill. The reservation is approximately 48 km (30 mi) south of McGuire.

Duke's Catawba Nuclear Sation is located approximately 48 km (30 mi) south of McGuire. Duke has requested that the NRC renew the OLs for the Catawba plant also.

After reviewing the Federal activities in the vicinity of McGuire, the staff determined that no Federal project activities could result in cumulative impacts or would make it desirable for another Federal agency to become a cooperating agency for preparing the SEIS.

The NRC is required under Section 102 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. During the preparation of this SEIS, the NRC staff consulted with the FWS. The consultation correspondence is included in Appendix E.

2.3 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 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

10 CFR Part 61. Code of Federal Regulations, Title 10, *Energy*, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

10 CFR Part 71. Code of Federal Regulations, Title 10, *Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

10 CFR Part 42. Code of Federal Regulations, Title 10, *Energy*, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste."

18 CFR Part 16. Code of Federal Regulations, Title 18, *Conservation of Power and Water Resources*, Part 16, "Procedures Relating to Takeover and Relicensing of Licensed Projects."

40 CFR Par 81. Code of Federal Regulations, Title 40, *Protection of Environment*, 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 Operations."

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3.0 Environmental Impacts of Refurbishment

Environmental issues associated with refurbishment activities are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a] The GEIS included a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues were assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that did not meet one or more of the criteria of Category 1 and, therefore, additional plant-specific review of these issues is required.

License renewal actions may require refurbishment activities for the extended plant life. These actions may have an impact on the environment that requires evaluation, depending on the type of action and the plant-specific design. Environmental issues associated with refurbishment that were determined to be Category 1 issues are listed in Table 3-1.

Environmental issues related to refurbishment considered in the GEIS for which these conclusions could not be reached for all plants, or for specific classes of plants, are Category 2 issues. These are listed in Table 3-2.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SURFACE-WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Impacts of refurbishment on surface-water quality	3.4.1
Impacts of refurbishment on surface-water use	3.4.1
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Refurbishment	3.5
GROUNDWATER USE AND QUALITY	
Impacts of refurbishment on groundwater use and quality	3.4.2
LAND USE	
Onsite land use	3.2
HUMAN HEALTH	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	3.7.4; 3.7.4.3; 3.7.4.4; 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Category 1 and Category 2 issues related to refurbishment that are not applicable to McGuire Nuclear Station, Units 1 and 2 (McGuire) because they are related to plant design features or site characteristics not found at McGuire are listed in Appendix F.

10 CFR 54.21 describes a required review to demonstrate that the effects of aging will be managed such that the structure and component intended functions will be maintained consistent with the current licensing basis during the period of extended operations. Duke Energy Corporation (Duke) provided this review in the Technical Information portion of its application for license renewal (Duke 2001). Duke stated that, "Based on this review, no major plant refurbishment activities were identified as necessary to maintain the structure and component intended functions consistent with the current licensing basis during the period of extended operations." Therefore, the staff does not further consider refurbishment in this Supplemental Environmental Impact Statement.

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53 (c)(3)(ii) Subparagraph
TERRESTRIAL RESOURCES		
Refurbishment impacts	3.6	E
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)		
Threatened or endangered species	3.9	E
AIR QUALITY		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
SOCIOECONOMICS		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services: transportation	3.7.4.2	J
Historic and archaeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed[a]	Not addressed[a]

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. If an applicant plans to undertake refurbishment activities for license renewal, environmental justice must be addressed in the applicant's environmental report and the staff's environmental impact statement.

3.1 References

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 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

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4.0 Environmental Impacts of Operation

Environmental issues associated with plant operations during the renewal term are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)*, NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999b).[a] The GEIS included a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues were assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that did not meet one or more of the criteria of Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues related to operation during the renewal term that are listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, and are applicable to McGuire Nuclear Station, Units 1 and 2 (McGuire). Section 4.1 addresses the issues applicable to the McGuire cooling water systems. Section 4.2 addresses issues related to transmission lines and land use. Section 4.3 addresses the radiological impacts of normal operation. Section 4.4 addresses issues related to the socioeconomic impacts of normal operation during the renewal term. Section 4.5 addresses issues related to groundwater use and quality. Section 4.6 discusses the impacts of renewal-term operations on threatened and endangered species. Section 4.7 addresses new information that was raised during the scoping period. The results of the evaluation of environmental issues related to operation during the renewal term are

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

summarized in Section 4.8. Finally, Section 4.9 lists the references for Chapter 4. Appendix F lists Category 1 and Category 2 issues that are not applicable to McGuire Nuclear Station, Units 1 and 2 because they are related to plant design features or site characteristics not found at McGuire.

4.1 Cooling System

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that are applicable to cooling system operation for McGuire during the renewal term are listed in Table 4-1. Duke Energy Corporation (Duke) stated in its environmental report (ER) that "no new information existed for the issues that would invalidate the GEIS conclusions" (Duke 2001a). The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001a), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Altered current patterns at intake and discharge structures. Based on information in the GEIS, the Commission found that

  > Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of altered current patterns during the renewal term beyond those discussed in the GEIS.

- Altered thermal stratification of lakes. Based on information in the GEIS, the Commission found that

  > Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

Table 4-1. Category 1 Issues Applicable to the Operation of the McGuire Cooling System During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Altered current patterns at intake and discharge structures	4.2.1.2.1; 4.3.2.2; 4.4.2
Altered thermal stratification of lakes	4.2.1.2.3; 4.4.2.2
Temperature effects on sediment transport capacity	4.2.1.2.3; 4.4.2.2
Scouring caused by discharged cooling water	4.2.1.2.3; 4.4.2.2
Eutrophication	4.2.1.2.3; 4.4.2.2
Discharge of chlorine or other biocides	4.2.1.2.4; 4.4.2.2
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4; 4.4.2.2
Discharge of other metals in wastewater	4.2.1.2.4; 4.3.2.2; 4.4.2.2
Water use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4; 4.3.3; 4.4.3; 4.4.2.2
Entrainment of phytoplankton and zooplankton	4.2.2.1.1; 4.3.3; 4.4.3
Cold shock	4.2.2.1.5; 4.3.3; 4.4.3
Thermal plume barrier to migrating fish	4.2.2.1.6; 4.4.3
Distribution of aquatic organisms	4.2.2.1.6; 4.4.3
Premature emergence of aquatic insects	4.2.2.1.7; 4.4.3
Gas supersaturation (gas bubble disease)	4.2.2.1.8; 4.4.3
Low dissolved oxygen in the discharge	4.2.2.1.9; 4.3.3; 4.4.3
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10; 4.4.3
Stimulation of nuisance organisms	4.2.2.1.11; 4.4.3
HUMAN HEALTH	
Microbial organisms (occupational health)	4.3.6
Noise	4.3.7

The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of altered thermal stratification of Lake Norman during the renewal term beyond those discussed in the GEIS.

- Temperature effects on sediment transport capacity. Based on information in the GEIS, the Commission found that

  > These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of temperature on sediment transport capacity during the renewal term beyond those discussed in the GEIS.

- Scouring caused by discharged cooling water. Based on information in the GEIS, the Commission found that

  > Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of scouring during the renewal term beyond those discussed in the GEIS.

- Eutrophication. Based on information in the GEIS, the Commission found that

  > Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of eutrophication during the renewal term beyond those discussed in the GEIS.

- Discharge of chlorine or other biocides. Based on information in the GEIS, the Commission found that

  > Effects are not a concern among regulatory and resource agencies and are not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its evaluation of other available information including the National Pollutant Discharge Elimination System (NPDES) permit for McGuire or discussion with the NPDES compliance office. Therefore, the staff concludes that there are no impacts of discharge of chlorine or other biocides during the renewal term beyond those discussed in the GEIS.

- Discharge of sanitary wastes and minor chemical spills. Based on information in the GEIS, the Commission found that

  > Effects are readily controlled through NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its evaluation of other available information including the NPDES permit for McGuire or discussion with NPDES compliance office. Therefore, the staff concludes that there are no impacts of discharges of sanitary wastes and minor chemical spills during the renewal term beyond those discussed in the GEIS.

- Discharge of other metals in wastewater. Based on information in the GEIS, the Commission found that

  > These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its evaluation of other available information including the NPDES permit for McGuire or discussion with NPDES compliance office. Therefore, the staff concludes that there are no impacts of discharges of other metals in wastewater during the renewal term beyond those discussed in the GEIS.

- Water-use conflicts (plants with once-through cooling systems). Based on information in the GEIS, the Commission found that

  > These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.

The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no water-use conflicts during the renewal term beyond those discussed in the GEIS.

- Accumulation of contaminants in sediments or biota. Based on information in the GEIS, the Commission found that

  > Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of available information. Therefore, the staff concludes that there are no impacts of accumulation of contaminants in sediments or biota during the renewal term beyond those discussed in the GEIS.

- Entrainment of phytoplankton and zooplankton. Based on information in the GEIS, the Commission found that

  > Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of entrainment of phytoplankton and zooplankton during the renewal term beyond those discussed in the GEIS.

- Cold shock. Based on information in the GEIS, the Commission found that

  > Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of cold shock during the renewal term beyond those discussed in the GEIS.

- Thermal plume barrier to migrating fish. Based on information in the GEIS, the Commission found that

  > Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of thermal plumes to migrating fish during the renewal term beyond those discussed in the GEIS.

- Distribution of aquatic organisms. Based on information in the GEIS, the Commission found that

  > Thermal discharge may have localized effects but is not expected to effect the larger geographical distribution of aquatic organisms.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on the distribution of aquatic organisms during the renewal term beyond those discussed in the GEIS.

- Premature emergence of aquatic insects. Based on information in the GEIS, the Commission found that

  > Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of premature emergence during the renewal term beyond those discussed in the GEIS.

- Gas supersaturation (gas bubble disease). Based on information in the GEIS, the Commission found that

  > Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of gas supersaturation during the renewal term beyond those discussed in the GEIS.

- Low dissolved oxygen in the discharge. Based on information in the GEIS, the Commission found that

  > Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of low dissolved oxygen during the renewal term beyond those discussed in the GEIS.

- Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses. Based on information in the GEIS, the Commission found that

  > These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses during the renewal term beyond those discussed in the GEIS.

- Stimulation of nuisance organisms. Based on information in the GEIS, the Commission found that

> Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of stimulation of nuisance organisms during the renewal term beyond those discussed in the GEIS.

- Microbiological organisms (occupational health). Based on information in the GEIS, the commission found that

> Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposure.

The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's onsite visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there is no impacts of microbiological organisms during the renewal term beyond those discussed in the GEIS.

- Noise. Based on information in the GEIS, the Commission found that

> Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.

The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of noise during the renewal term beyond those discussed in the GEIS.

The Category 2 issues related to cooling system operation during the renewal term that are applicable to McGuire are discussed in the section that follows, and are listed in Table 4-2.

Table 4-2. Category 2 Issues Applicable to the Operation of the McGuire Cooling System During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY (FOR PLANTS WITH ONCE-THROUGH AND COOLING POND HEAT-DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	4.2.2.1.2; 4.4.3	B	4.1.1
Impingement of fish and shellfish	4.2.2.1.3; 4.4.3	B	4.1.2
Heat shock	4.2.2.1.4; 4.4.3	B	4.1.3
HUMAN HEALTH			
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge into a small river)	4.3.6	G	4.1.4

4.1.1 Entrainment of Fish and Shellfish in Early Life Stages

For plants with once-through cooling systems, entrainment of fish and shellfish in early life stages into cooling water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment prior to license renewal.

The staff independently reviewed the McGuire ER (Duke 2001a), visited the site, and reviewed the application for NPDES Permit No. NC0024392, which was issued by the North Carolina Department of Environment and Natural Resources (NCDENR) and expires February 28, 2005.

In response to requirements set by the North Carolina Department of Natural Resources and Community Development (NCDNRCD), Division of Environmental Management, Duke submitted a Clean Water Act (CWA) Section 316(b) demonstration for McGuire in October 1978 (Duke Power Company 1978).

The 316(b) study conclusions related to entrainment of juvenile fish were based on determinations of larval fish species composition and abundance evaluated on a biweekly basis when larval fish were present between 1974 and 1977 (Duke Power Company 1978). Species known to spawn in the McGuire intake cove are the introduced forage fish—threadfin shad (*Dorosoma petenense*), yellow perch (*Perca flavescens*), bluegill sunfish (*Lepomis macrochirus*), and crappie (*Poxomis* spp). The collection site was in the upper intake area, at a depth of 15 m (49 ft). Icthyoplankton losses to entrainment were primarily threadfin shad eggs and larvae. Because of the rapid threadfin shad reproduction rate and the presence of more suitable spawning habitat outside the influence of the intake structures, losses do not have a

measurable effect on the standing crop of shad. Most fish species that reside in the vicinity of McGuire spawn in shallow shoreline areas and produce demersal, adhesive eggs that would not be subject to entrainment. In addition, during summer up to 45 percent of the intake water is predicted to come from the low-level intake, which pulls water from the hypolimnion at a depth of approximately 30 m (100 ft). Because there are few plankton of any sort in this cold, low-oxygen water, opportunities for larval fish entrainment are expected to be further reduced during the summer period.

After reviewing Duke's submittal, the NCDNRCD concurred with the conclusions of the study (NCDNRCD 1984) and re-issued the site's NPDES permit (dated September 1, 1984) with no additional monitoring or studies required.

The staff has reviewed the available information, the results of entrainment studies, and operating history of the intake and concludes that the potential impacts of the cooling-water-intake system's entrainment of fish and shellfish in the early life stages are SMALL, and additional mitigation is not warranted.

4.1.2 Impingement of Fish and Shellfish

For plants with once-through cooling systems, impingement of fish and shellfish on debris screens of cooling water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment prior to license renewal.

The staff independently reviewed the McGuire ER (Duke 2001a), visited the site, and reviewed the application for NPDES Permit No. NC0024392, which was issued by the NCDENR and expires February 28, 2005.

In response to requirements set by the NCDNRCD, Division of Environmental Management, Duke submitted a CWA Section 316(b) demonstration for McGuire in October 1978 (Duke Power Company 1978).

The 316(b) study conclusions related to impingement of fish and shellfish were based on studies of fish species composition and abundance evaluated on a monthly, quarterly, or annual basis using electrofishing, gillnetting, and rotenone sampling techniques between 1974 and 1977 (Duke Power Company 1978). Based on studies conducted in the 1970s, most fish impinged at McGuire were threadfin shad, especially during the fall and winter when the introduced species is susceptible to low-temperature stress and exhibits high mortality associated with cool water temperatures. Fish swimming between the trash racks and screens were predicted to be most susceptible to impingement. However, it was predicted that fish approaching the upper-level trash racks when the low-level pumps were operating could be

repelled by the low temperature and oxygen levels associated with water drawn from the hypolimnion by the low-level pumps.

After reviewing Duke's submittal, the NCDNRCD concurred with the conclusions of the study (NCDNRCD 1984) and re-issued the site's NPDES permit (dated September 1, 1984), with no additional monitoring or studies required.

An in-house impingement sampling program that began in December 2000 and is scheduled to continue through November 2002 incorporates a full count of all fishes impinged on condenser cooling water intake screens for Units 1 and 2 through a weekly sampling program (Duke 2001b). Preliminary results indicate that impingement rates at McGuire are very low. Between December 2000 and December 2001, a total of 1746 fish were impinged. Weekly impingement ranged from a low of 5 fish to a high of 455 fish. Threadfin shad was the species most commonly impinged (50 percent). Seventy-one percent of these threadfin shad were observed during a 14-day period between December 29, 2000, and January 12, 2001, when the water temperature reached a low of 10°C. Threadfin shad are a nonindigenous, temperate species with documented potential for cold shock morbidity and mortality when water temperatures drop below 9°C (Strawn 1963). These data suggest that the high impingement rate for threadfin shad during the 14-day period resulted from a natural die-off in the vicinity of the intake. Other species observed on the intake screens were bluegill sunfish (*Lepomis macrochirus*; 9 percent), alewife (*Alosa pseudoharengus*; 8 percent), and a combination of other species that individually comprised less than 5 percent of the total number impinged (30 percent).

Impacts to shellfish from impingement are not considered important because adult shellfish are not motile and susceptible to impingement.

The staff has reviewed the available information relative to potential impacts of the cooling water intake on the impingement of fish and shellfish and, based on this data, concludes that the impacts are SMALL, and additional mitigation is not warranted.

4.1.3 Heat Shock

For plants with once-through cooling systems, the effects of heat shock are listed as a Category 2 issue and require plant-specific evaluation before license renewal.

The staff independently reviewed the McGuire ER (Duke 2001a), visited the site, and reviewed the application for NPDES Permit No. NC0024392, which was issued by the NCDENR and expires February 28, 2005.

Duke submitted a CWA Section 316(a) demonstration for McGuire to the NCDNRCD, Division of Environmental Management, in June 1985 (Duke 1985). In summary, the NCDNRCD indicated that "the effects of the discharge from the McGuire Nuclear Station is such that the protection and propagation of a balanced indigenous aquatic community is assured in Lake Norman and that interaction of the two thermal plumes of McGuire and Marshall do not occur" (NCDNRCD 1985). Thus, the 316(a) submittal was successful and suggested that the limits in the NPDES permit were sufficient to protect the aquatic environment of Lake Norman.

Studies performed for the 316(a) submittal were initiated in 1973 and continued through submission of the document. Physical and mathematical models were developed to determine Lake Norman hydrodynamics and thermal plume characteristics in relation to station operation (Duke Power Company 1985). Both models were validated with surface-temperature data and were found to predict surface thermal plume size with a high degree of confidence. Both predicted that operation of McGuire would not result in discharge temperatures outside those allowed in the NPDES permit. Fish species collected during preoperational and operational studies indicated no substantial change in species composition over time (Duke Power Company 1985). The most significant changes were increases in specific fish taxa abundance in winter at the McGuire discharge, associated with fish congregating in the discharge plume due to increased water temperature.

McGuire currently operates under thermal limits established in its NPDES permit issued February 1, 1990. Annual aquatic monitoring to assess impacts of current thermal limits on the aquatic biota of Lake Norman is required. Results of the monitoring studies conducted in support of this requirement are reported annually to the NCDENR (formally NCDNRCD).

Monitoring of fish populations in and around the McGuire mixing zone is coordinated with the North Carolina Wildlife Resource Commission (NCWRC). The latest report covers data collected in 1999 (Duke 2000). Observed striped bass mortalities during the summer of 1999 included one mortality within the mixing zone and five mortalities in the main channel outside the mixing zone which may or may not have been related to heat shock. Shoreline electrofishing catches at the McGuire mixing zone area were only slightly lower than a reference area in total biomass and taxa composition. Hydroacoustic and purse seine sampling were also conducted in 1999, in cooperation with the NCWRC, to evaluate Lake Norman forage fish populations. According to the applicant, "fisheries data to date indicate that the Lake Norman fishery is consistent with the trophic status and productivity of the reservoir" (Duke 2000).

Based on its review of available information, the staff concludes that the potential heat shock impacts resulting from operation of the plant's cooling water discharge system to the aquatic environment on or in the vicinity of the site are SMALL, and additional mitigation is not warranted.

4.1.4 Microbiological Organisms (Public Health)

McGuire has a once-through cooling system that uses the Catawba River as the cooling source. The Catawba River, which was impounded to form Lake Norman, has an annual average flow rate of 2.38×10^9 cubic meters per year (8.42×10^{10} cubic feet per year). This flow rate is lower than the 9×10^{10} cubic meters per year (3.15×10^{12} cubic feet per year) specified in 10 CFR 51.53 (c)(3)(ii)(G), which requires an evaluation of potentially harmful thermophylic (heat-loving) microorganisms on human health. The flow rate raises a concern from the standpoint of the potential for enhancement of thermophylic microorganisms such as *Naegleria fowleri*. This type of organism could be a potential health concern for members of the public swimming in the cooling source and can under certain conditions cause a fatal condition called primary ameobic meningoencephalitis (PAME).

Lake Norman is a popular site for a variety of water-based recreational activities, including boating, fishing, water skiing, and swimming. All of these activities are dispersed throughout the lake, rather than being concentrated in certain areas. Swimming occurs from private boat docks and piers located around the lake shoreline and from boats anchored offshore.

McGuire uses Lake Norman as a source for condenser cooling water. The heated effluent from the condenser discharge enters Lake Norman through a discharge canal that is 1 km (0.6 mi) long and has an average depth of 12.2 m (40 ft). The heated effluent mixes initially in the canal with surface waters of the main lake before stabilizing vertically and spreading over the lake surface, ultimately dissipating its heat to the atmosphere.

No swimming or boating is allowed in the canal, although fishing is permitted from its banks. Boating, fishing, and water contact activities take place at the confluence of the canal and the lake. The closest privately owned dock is located outside the 760-m (2500-ft) exclusion zone and is approximately 150 m (495 ft) from the confluence of the canal and the lake.

The state agency responsible for public health is the North Carolina Department of Health and Human Services (NCDHHS), Division of Public Health. Duke consulted with this agency to determine if there is a concern about the potential existence and concentration of *N. fowleri* in the receiving waters for the plant cooling discharge waters. By letter dated June 12, 2000, the Division of Public Health summarized the agency's position and opinion regarding the risk to individuals using Lake Norman for recreational activities. The Division of Public Health concluded that only a small percentage of cases of PAME have been associated with thermally enhanced waters and the disease is exceedingly rare given the millions of swimming events in warm fresh water bodies in the United States. Therefore, the NCDHHS feels the risk to individuals utilizing Lake Norman for recreational activities is extremely low (Duke 2001a).

There has been no known impact of operation of McGuire on public health related to thermophylic microorganisms. These data indicate that the impact of deleterious microbiological organisms during continued operation of the plant during the renewal term is low.

Based on its review of the above information, the staff concludes that the potential impacts to public health from microbiological organisms resulting from operation of the plant's cooling water discharge system to the aquatic environment on or in the vicinity of the site are SMALL, and additional mitigation is not warranted.

4.2 Transmission Lines

The McGuire ER (Duke 2001a) describes four transmission lines with a total length of 4.5 km (2.8 mi) that connect the McGuire plant to two substations within the local transmission system. These lines are situated on 2.2 km (1.4 mi) of corridor on approximately 22.8 ha (56.2 ac). Transmission corridor rights-of-way are generally maintained on a 3-year cycle. Mechanical mowing and selective herbicide application are the standard methods of corridor maintenance. Duke cooperates with the U.S. Fish and Wildlife Service (FWS) and North Carolina Natural Heritage Program to identify Federally-and State-listed species, special habitats, new findings, and other pertinent factors. This information is used to establish new and review existing vegetation management programs for the rights-of-way so that adverse impacts to these may be avoided during corridor maintenance. As noted in Section 2.1.7, the NRC staff conducted a separate evaluation of the rights-of-way from the McGuire station to the Oconee Nuclear Station, in South Carolina, under the Supplemental Generic Environmental Impact Statement for Oconee Nuclear Station (NRC 1999a).

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to the McGuire transmission lines are listed in Table 4-3. Duke stated in its ER that "no new information existed for the issues that would invalidate the GEIS conclusions" (Duke 2001a). The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001a), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the GEIS concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-3. Category 1 Issues Applicable to the McGuire Nuclear Station Transmission Lines During the Renewal Term

ISSUE - 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
Terrestrial Resources	
Power line right-of-way management (cutting and herbicide application)	4.5.6.1
Bird collisions with power lines	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, and livestock)	4.5.6.3
Floodplains and wetlands on power line right-of-way	4.5.7
Air Quality	
Air quality effects of transmission lines	4.5.2
Land Use	
Onsite land use	4.5.3
Power line right-of-way	4.5.3

A brief description of the staff's review and GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Power line right-of-way management (cutting and herbicide application). Based on information in the GEIS, the Commission found that

  > The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, discussions with the FWS, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of power line right-of-way maintenance during the renewal term beyond those discussed in the GEIS.

- Bird collisions with power lines: Based on information in the GEIS, the Commission found that

  > Impacts (of bird collisions with power lines) are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, discussions with the FWS, or its evaluation of other available information. Therefore, the staff concludes that there are no

impacts of bird collisions with power lines during the renewal term beyond those discussed in the GEIS.

- Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock): Based on information in the GEIS, the Commission found that

  > No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of electromagnetic fields on flora and fauna during the renewal term beyond those discussed in the GEIS.

- Floodplains and wetlands on power line right-of-way: Based on information in the GEIS, the Commission found that

  > Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, discussions with the FWS, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on floodplains and wetlands on the power line rights-of-way during the renewal term beyond those discussed in the GEIS.

- Air quality effects of transmission lines: Based on information in the GEIS, the Commission found that

  > Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no air quality impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

- Onsite land use: Based on information in the GEIS, the Commission found that

  > Projected onsite land use changes required during ... the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no onsite land-use impacts during the renewal term beyond those discussed in the GEIS.

- Power line right-of-way (land use). Based on information in the GEIS, the Commission found that

  > Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on use of power line rights-of-way during the renewal term beyond those discussed in the GEIS.

There is one Category 2 issue related to transmission lines, and another issue related to transmission lines is being treated as a Category 2 issue. These issues are listed in Table 4-4 and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-4. Chronic Effects of Electromagnetic Fields and Category 2 Issue Applicable to the McGuire Transmission Lines During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
HUMAN HEALTH			
Electromagnetic fields, acute effects (electric shock)	4.5.4.1	H	4.2.1
Electromagnetic fields, chronic effects	4.5.4.2	NA	4.2.2

4.2.1 Electromagnetic Fields—Acute Effects

In the GEIS (NRC 1996), the staff found that without a review of the conformance of each nuclear plant transmission line with *National Electrical Safety Code* (NESC) criteria, (Institute of Electrical and Electronic Engineers [IEEE] 1997) it was not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is

necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed specifically to connect the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

Two 230-kV transmission lines and two 525-kV transmission lines connect McGuire Nuclear Station to the transmission system. The 230-kV lines connect McGuire Unit 1 to a 230-kV switchyard and have a length of approximately 1200 m (4000 ft). Similarly, the 525-kV lines connect Unit 2 to a 525-kV switchyard and have a length of approximately 1000 m (3300 ft). The two switchyards are adjacent to each other. I

The transmission lines were constructed to meet the 1973 NESC requirements. Duke (2001a) has compared the clearances calculated using the 1973 NESC with clearance requirements of the 1997 NESC and found the 1973 NESC clearance requirements to be greater. Duke further states that measured clearances from the sagged plan and profile of each bus line indicate that the designed clearances of the transmission lines exceed the 1997 NESC vertical clearance requirements and that there have been no changes in the design voltages of the lines. Therefore, the staff concludes that the impact of the potential for electric shock is SMALL, and additional mitigation is not warranted.

4.2.2 Electromagnetic Fields—Chronic Effects

In the GEIS, the chronic effects of 60-Hz electromagnetic fields from power lines were not designated as Category 1 or 2 and will not be until a scientific consensus is reached on the health implications of these fields.

The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (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 therefore is routinely 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 exposures. 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 change its position with respect to the chronic effects of electromagnetic fields. The staff considers the GEIS finding of "not applicable" still appropriate and will continue to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to McGuire in regard to radiological impacts are listed in Table 4-5. Duke stated in its ER (Duke 2001a) that "no new information existed for the issues that would invalidate the GEIS conclusion." The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001a), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-5. Category 1 Issues Applicable to Radiological Impacts of Normal Operations During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
HUMAN HEALTH	
Radiation exposures to public (license renewal term)	4.6.2
Occupational radiation exposures (license renewal term)	4.6.3

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Radiation exposures to public (license renewal term). Based on information in the GEIS, the Commission found that

  > Radiation doses to the public will continue at current levels associated with normal operations.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of radiation exposures to the public during the renewal term beyond those discussed in the GEIS.

- Occupational radiation exposures (license renewal term). Based on information in the GEIS, the Commission found that

  > Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of occupational radiation exposures during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to radiological impacts of routine operations.

4.4 Socioeconomic Impacts of Plant Operations During the License Renewal Period

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to socioeconomic impacts during the renewal term are listed in Table 4-6. Duke stated in its ER (Duke 2001a) that "no new information existed for the issues that would invalidate the GEIS conclusions." The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001a), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For all of those issues, the staff concluded in the GEIS that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Public services–public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found that

  > Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on public safety,

social services, and tourism and recreation during the renewal term beyond those discussed in the GEIS.

Table 4-6. Category 1 Issues Applicable to Socioeconomics During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6
Public services: education (license renewal term)	4.7.3.1
Aesthetic impacts (license renewal term)	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	4.5.8

- Public services–education (license renewal term). Based on information in the GEIS, the Commission found that

  Only impacts of small significance are expected.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on education during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts (license renewal term). Based on information in the GEIS, the Commission found that

  No significant impacts are expected during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no aesthetic impacts during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts of transmission lines (license renewal term). Based on information in the GEIS, the Commission found that

  No significant impacts are expected during the license renewal term.

  The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available

information. Therefore, the staff concludes that there are no aesthetic impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

Table 4-7 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and environmental justice, which was not addressed in the GEIS.

Table 4-7. Environmental Justice Analysis and GEIS Category 2 Issues Applicable to Socioeconomics During the License Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
SOCIOECONOMICS			
Housing impacts	4.7.1	I	4.4.1
Public services: public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public Services, transportation	4.7.3.2	J	4.4.4
Historic and archaeological resources	4.7.7	K	4.4.5
Environmental Justice	Not Addressed[a]	Not Addressed[a]	4.4.6

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice is to be addressed in the licensee's ER and the staff's SEIS.

4.4.1 Housing Impacts During Operations

10 CFR Part 51, Subpart A, Appendix B, Table B-1, states that impacts on housing availability are expected to be of small significance at plants located in a high-population area where growth-control measures are not in effect. SMALL impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing construction or conversion is required to meet new demand (NRC 1996). Increases in rental rates or housing values in these areas would be expected to equal or slightly exceed the statewide inflation rate. No extraordinary construction or conversion of housing would occur where small impacts are foreseen.

The impacts on housing are considered to be of MODERATE significance when there is a discernible but short-lived reduction in available housing units because of project-induced in-migration. The impacts on housing are considered to be of LARGE significance when project-related demand for housing units would result in very limited housing availability and would increase rental rates and housing values well above normal inflationary increases in the

state. MODERATE and LARGE impacts are possible at sites located in rural and remote areas, at sites located in areas that have experienced extremely slow population growth (and thus slow or no growth in housing), or where growth control measures that limit housing development are in existence or have been recently lifted. Because impact significance depends on local conditions, housing is a Category 2 issue (NRC 1996).

The NRC has developed a method of characterizing population that is based on two factors: "sparseness" and "proximity" (NRC 1996). "Sparseness" measures population density and city size within 32-km (20-mi) of the site. "Proximity" measures population density and city size within 80 km (50 mi). In these calculations, the density is averaged over the land area covered by the ring; large water bodies are excluded. Each factor has categories of density and city size and a matrix is used to rank the population category as low, medium, or high.

An analysis of the 2000 census data indicates that 781,783 people live within a 32-km (20-mi) radius of McGuire with an average population density of 240 persons/km^2 (622 persons/mi^2). There are also four communities of 25,000 or more in this area (Table 4-8). This population density and number of cities correspond to "sparseness" Category 4, "least sparse." An analysis of the 2000 census data also indicates that 2,309,976 people live within 80 km (50 mi) of McGuire, with an average population density of 114 persons/km^2 (294 persons/mi^2). There is one city, Charlotte, with a population of 100,000 or more in this area. This population density and number of cities correspond to "proximity" Category 4 "in close proximity." According to the GEIS, these "sparseness" and "proximity" sources indicate that McGuire is located in a high-population area.

Table 4-8. Analysis of Population "Sparseness" and "Proximity" in the Vicinity of McGuire

Radial Distance from McGuire	2000 Census Population	Population Density persons/km^2 (persons/mi^2)	Communities of 25,000 or More Persons	Cities of 100,000 or More Persons
32 km (20 mi)	781,783	240 (622)	3	1
80 km (50 mi)	2,309,976	114 (294)	6	1

McGuire is located in northwestern Mecklenburg County, approximately 27 km (17 mi) north-northwest of Charlotte, North Carolina, within the rapidly developing Charlotte metropolitan area. There are no prohibitions on the development of residential housing within Iredell, Mecklenburg, Gaston, or Lincoln counties. In the McGuire ER, Duke made the case for considering no further employment increases for its operating Units 1 and 2 rather than the standard GEIS assumption of 60 new employees per unit (Duke 2001a). Adding full-time employees to the plant workforce for the license renewal operating term would have the potential indirect effect of creating additional jobs and related population growth in the

community. Section 4.14.2 of Supplement 1 to Regulatory Guide 4.2 (NRC 2000) states: "If additional workers are not anticipated there will be no impact on housing and no further analysis is required." McGuire has approximately 1345 full-time workers employed by Duke or site contractors during normal plant operations. Duke does not anticipate that additional full-time workers will be employed during the license renewal period. Therefore, no analysis is required for this issue.

Duke has concluded that the impact on housing from the continued operation of McGuire will be SMALL and that no mitigation is required. This conclusion is based on the following:

(1) Duke does not anticipate an increase in employment during the license renewal period.

(2) The number of McGuire employees will continue to be a small percentage of the population in the adjacent counties during the period of the extended license.

The staff reviewed the available information relative to housing impacts and Duke's conclusions. Based on this review, the staff concludes that the impact on housing during the license renewal period will continue to be SMALL, and additional mitigation is not warranted.

4.4.2 Public Services: Public Utility Impacts During Operations

Impacts on public utility services are considered SMALL if there is little or no change in the ability of the system to respond to the level of demand, and thus there is no need to add capital facilities. Impacts are considered MODERATE if overtaxing of service capabilities occurs during periods of peak demand. Impacts are considered LARGE if existing levels of service (e.g., water or sewer services) are substantially degraded and additional capacity is needed to meet ongoing demands for services. In the GEIS, the staff concluded that, in the absence of new and significant information to the contrary, the only impacts on public utilities that could be significant are impacts on public water supplies (NRC 1996).

There are no identified increases in demand of the water supplied by the Charlotte-Mecklenburg Utilities District (CMUD) during the period of extended operation at McGuire. The current water use at McGuire, from water supplied by CMUD, is 0.03 percent of the average daily demand on the CMUD system. Duke does not anticipate that additional workers will be employed during the period of extended operations. Therefore, there will be no impact to public utilities from additional plant workers.

The staff reviewed the available information relative to impacts on public utility services and Duke's conclusions. Based on this review, the staff concludes that the impact on public utilities during the license renewal period would be SMALL, and additional mitigation is not warranted.

4.4.3 Offsite Land Use During Operations

Offsite land use during the license renewal term is a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 of 10 CFR Part 51 Subpart A, Appendix B notes that "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal."

The GEIS (NRC 1996) defines the magnitude of land-use changes as a result of plant operation during the license renewal term as follows:

SMALL – Little new development and minimal changes to an area's land-use pattern.

MODERATE – Considerable new development and some changes to the land-use pattern.

LARGE – Large-scale new development and major changes in the land-use pattern.

Based on predictions for the case study plants, the staff projected that all new population-driven land-use changes during the license renewal term at all nuclear plants will be small because population growth caused by license renewal will represent a much smaller percentage of the local area's total population than has operations-related growth. Also, any conflicts between offsite land use and nuclear plant operations are expected to be small (NRC 1996).

Duke concluded (Duke 2001a) that there will be no adverse impact to the offsite land use from plant related population growth because they do not anticipate that additional workers will be employed at McGuire during the period of extended operations.

Tax revenue can affect land use because it enables local jurisdictions to be able to provide the public services (e.g., transportation and utilities) necessary to support development. In the GEIS, the staff states that the assessment of tax-driven land-use impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues, (2) the nature of the community's existing land-use pattern, and (3) the extent to which the community already has public services in place to support and guide development (NRC 1996).

In general, if a plant's tax payments are projected to be small relative to the community's total revenue, new tax-driven land-use changes during the plant's license renewal term would be SMALL. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land-use charges would be MODERATE. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use changes would be LARGE.

In the GEIS, the staff states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdictions revenue, the significance level would be SMALL, MODERATE if the plant tax payments represent 10 to 20 percent, and LARGE if the payments are over 20 percent of the jurisdiction's revenues.

The payments made by McGuire represented 7 percent of the property tax revenues and 4 percent of the total revenues collected by the town of Huntersville; the percentages are 2 percent and 1 percent for Mecklenburg County (Table 2.11). No major refurbishment activities are anticipated during the period of license renewal at McGuire. The relative importance of tax payments to Mecklenburg County would slowly decline as other development occurs.

The impacts from tax driven offsite land-use changes will be SMALL for the following reasons:

(1) The significance of tax payments made by Duke for McGuire to local governments will continue to be SMALL.

(2) The area around McGuire has pre-established land patterns of development, such as land use plans and controls. McGuire is located within the town of Huntersville's planning zone.

(3) The area around McGuire has public services in place to support and guide development. Therefore, the impact to tax-driven land-use changes from the continued payment of property taxes at McGuire is SMALL and no mitigation is required.

The staff reviewed the available information relative to land use impacts and Duke's conclusions. Based on this review, the staff concludes that the impact on land use during the license renewal period would be SMALL, and additional mitigation is not warranted.

4.4.4 Public Services: Transportation Impacts During Operations

On October 4, 1999, 10 CFR 51.53(c)(3)(ii)(J) and 10 CFR Part 51, Subpart A, Appendix B, Table B-1 were revised to clearly state that "Public Services: Transportation Impacts During Operations" is a Category 2 issue (see NRC 1999 for more discussion of this clarification). The issue is treated as such in this SEIS.

Approximately 1345 full-time workers are employed by Duke or site contractors at McGuire during normal plant operations (non-outage periods). These workers reside primarily in Mecklenburg County and in adjoining counties. An average of 1015 additional workers are onsite during plant outage periods. The plant outages last from 30 to 40 days and occur about every 18 to 24 months. There are no identified increases in the total number of employees that will be onsite during the term of the renewed license. As shown in Table 2-3, the workers

employed at McGuire reside in locations that are well distributed geographically. Therefore, with the exception of travel along North Carolina Highway 73 (NC-73), the workers would travel to the plant along many different routes.

The North Carolina Department of Transportation classifies some of the segments of NC-73 in the vicinity of McGuire as having Level of Service (LOS) D. This is a regional growth and transportation planning issue. However, Duke has taken the following steps to minimize the impacts to local traffic:

(1) The starting times for workers at the station has been staggered to minimize the impact of plant workers entering and leaving the site.

(2) Turn lanes have been added on NC-73 for plant traffic. Traveling east to west on NC-73, there are right turn lanes into the plant site at both entrances. Traveling west to east on NC-73, there is a left turn lane at the east plant entrance.

There are no identified increases in the total number of employees that will be onsite during the term of the renewed license. Increases in traffic capacity will be required to accommodate the projected growth in the population in the areas adjacent to McGuire. The growth in population in the area near McGuire will not be attributed to increases in employment at McGuire. Therefore, the impact of continued operation of McGuire on any future degradation in traffic service will be SMALL, and no mitigation measures are warranted.

The staff reviewed Duke's assumptions and resulting conclusions. The staff concludes that any impact of McGuire on transportation service degradation is likely to be SMALL and would not require additional mitigation.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires that Federal agencies take into account the effects of their undertakings on historic properties. The historic preservation 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 as amended. Renewal of an operating license (OL) is an undertaking that could potentially affect historic properties. Therefore, according to the NHPA, the NRC is 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 (SHPO) before proceeding. If it is determined that historic properties are present, the NRC is required to assess the possible adverse effects of the undertaking.

On January 26, 2000, Duke wrote to the North Carolina SHPO, requesting its comment on the McGuire license renewal process and on the determination by Duke that the continued operation of McGuire will have no effect on historic properties (Huff 2000). In a response dated January 31, 2000, the North Carolina SHPO stated that the extension of the operating license was not an undertaking that is likely to affect historic properties; thus, no further compliance with Section 106 was required (Brook 2000).

Due to disturbance by historic agriculture and the original construction of McGuire, it is unlikely that significant historic resources are present on the McGuire site. Major refurbishment of McGuire is not required during the license renewal period, and it is anticipated that there will be no need to utilize the few currently undeveloped portions of the McGuire site for operations during the renewal period. Continued operation of McGuire would have a beneficial effect on any potential unknown or undiscovered historic or archaeological resources in undisturbed areas for the duration of the license renewal period by protecting the natural landscape and vegetation and by providing restricted access to the plant.

However, care should be taken by the licensee while undertaking normal operational and maintenance activities to ensure that historic properties are not inadvertently impacted. These activities may include not only operation of the plant itself, but also land management-related actions such as recreation, wildlife habitat enhancement, or maintaining/upgrading plant access roads through the plant site.

Based on the staff's cultural resources analysis and consultation, the staff concludes that the potential impacts on historic and archaeological resources are SMALL, and no additional mitigation is warranted.

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy that requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its actions on minority[a] or low-income populations. The memorandum accompanying Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act of 1969 (NEPA). The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice (CEQ 1997). Although the Executive Order is not mandatory for independent agencies,

(a) The NRC guidance for performing environmental justice reviews defines "minority" as American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; or Black races; or Hispanic ethnicity. "Other" races and multi-racial individuals may be considered a separate minority category as well as multi-racial individuals (NRC 2001).

the NRC has voluntarily committed to undertake environmental justice reviews. Specific guidance is provided in NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-203, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues" (NRC 2001).

The environmental justice review involves identifying offsite environmental impacts, their geographic locations, minority and low-income populations that may be affected, the significance of such effects, and whether they are disproportionately high and adverse compared to the population at large within the geographic area, and if so, what mitigative measures are available and which will be implemented.

For the purpose of the staff's review, a minority population is defined to exist if the percentage of each minority, or aggregated minority category within the census block groups[a] potentially affected by the license renewal of the McGuire OLs, exceeds the corresponding percentage of minorities in a comparison area (by convention, the state) 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 comparison area (again by convention, the state) 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 McGuire, the percentage of minority and low-income populations is comparable to the percentage of minority and low-income populations in North and South Carolina, as applicable.

Within a 80 km (50-mi) radius of McGuire, 24.5 percent of the population are minorities. Also within that 80 km (50-mi) radius, 284 block groups with minority populations meet the definition outlined in the NRC review guidance (NRC 2001). This represents 11.5 percent of the total number of block groups within the 80-km (50-mi) radius. These populations are shown in Figure 4-1. The majority of these block groups are located in urban areas associated with Charlotte, Gastonia, Statesville, and Salisbury, North Carolina, and Rock Hill, South Carolina. There are no known environmental pathways by which these minority populations would be disproportionately and adversely affected by the renewal of the McGuire license.

(a) 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 of 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.

Low-income households comprise 11 percent of all households located within a 80-km (50-mi) radius of McGuire. Within the 80-km (50-mi) radius, there are 88 low-income block groups. This represents 5.5 percent of the total number of block groups within the 80-km (50-mi) radius. These populations are shown in Figure 4-2.[a] The majority of these block groups are located in the urban areas of Charlotte and Gastonia, North Carolina, and Gaffney, South Carolina. There are no known environmental pathways by which these low-income populations would be disproporionately and adversely affected by the renewal of the McGuire license.

As part of its environmental assessment of this proposed action, Duke has determined that no significant offsite environmental impacts will be created by the renewal of the McGuire OLs. This conclusion is supported by the review performed of the Category 2 issues defined in Section 51.53(c)(3)(ii) presented in the McGuire ER (Duke 2001a). As the NRC review guidance recognizes, if no significant offsite impacts occur in connection with the proposed action, then no member of the public will be substantially affected. Therefore, there can be no disproportionately high and/or adverse impacts or effects on any member of the public, including minority and low-income populations, resulting from the renewal of the McGuire licenses.

The staff found no unusual resource dependencies or practices, such as subsistence agriculure, hunting, or fishing, through which minority or low-income populations could be disproporionately adversely impacted. In addition, the staff did not identify any location-dependent disproportionately adverse impacts affecting these minority and low-income populaions. The staff concludes that offsite impacts from McGuire to minority and low-income populations would be SMALL, and no additional mitigation actions are warranted.

4.5 Groundwater Use and Quality

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to McGuire groundwater use and quality are listed in Table 4-9. Duke stated in its ER that "no new information existed for the issues that would invalidate the GEIS conclusions" (Duke 2001a). The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001a), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS. For this issue, the GEIS concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

(a) Figure 4-2 was prepared using 1990 income data because the 2000 census income data were not yet available.

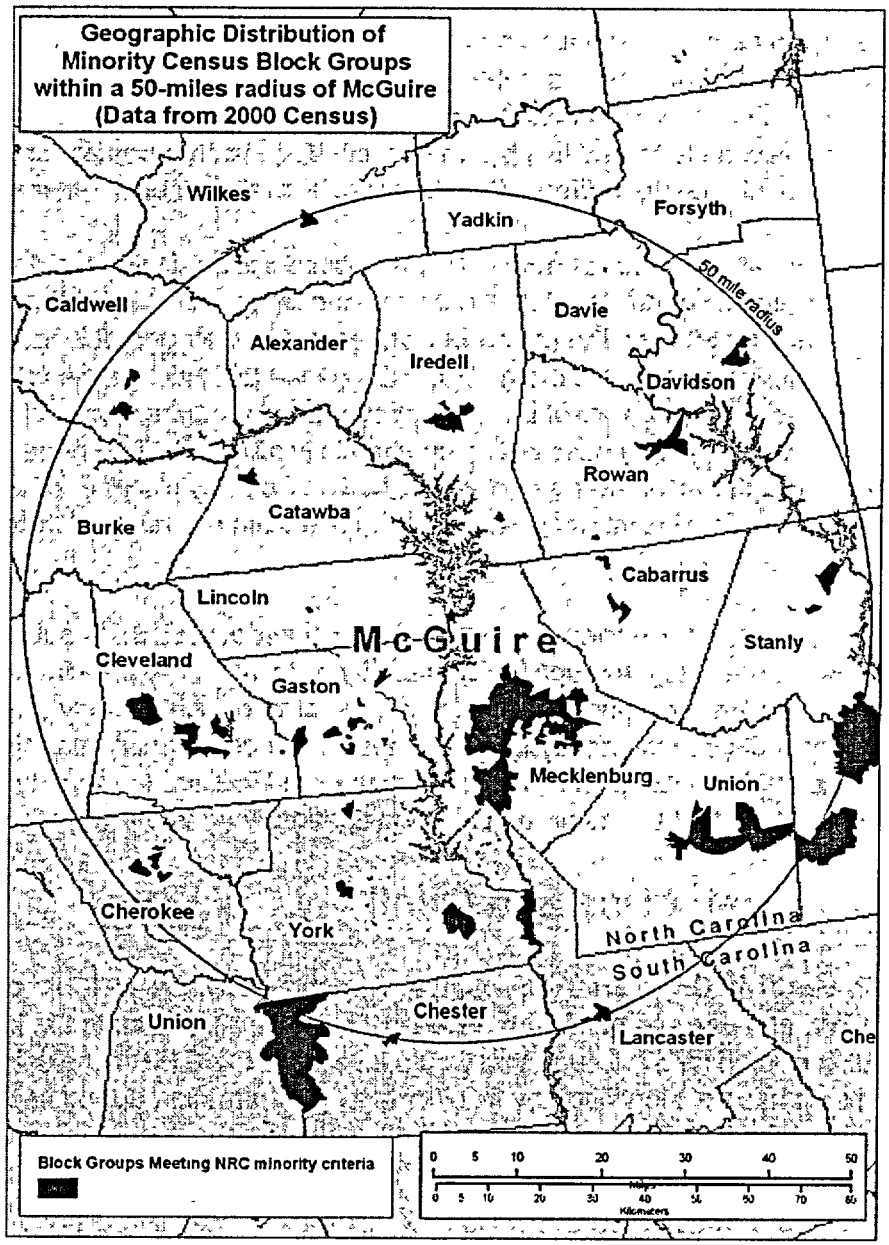

Figure 4-1. Census 2000 Block Groups Identified as Meeting NRC Criteria for Minority Status in an 80-km (50-mi) Area Around McGuire

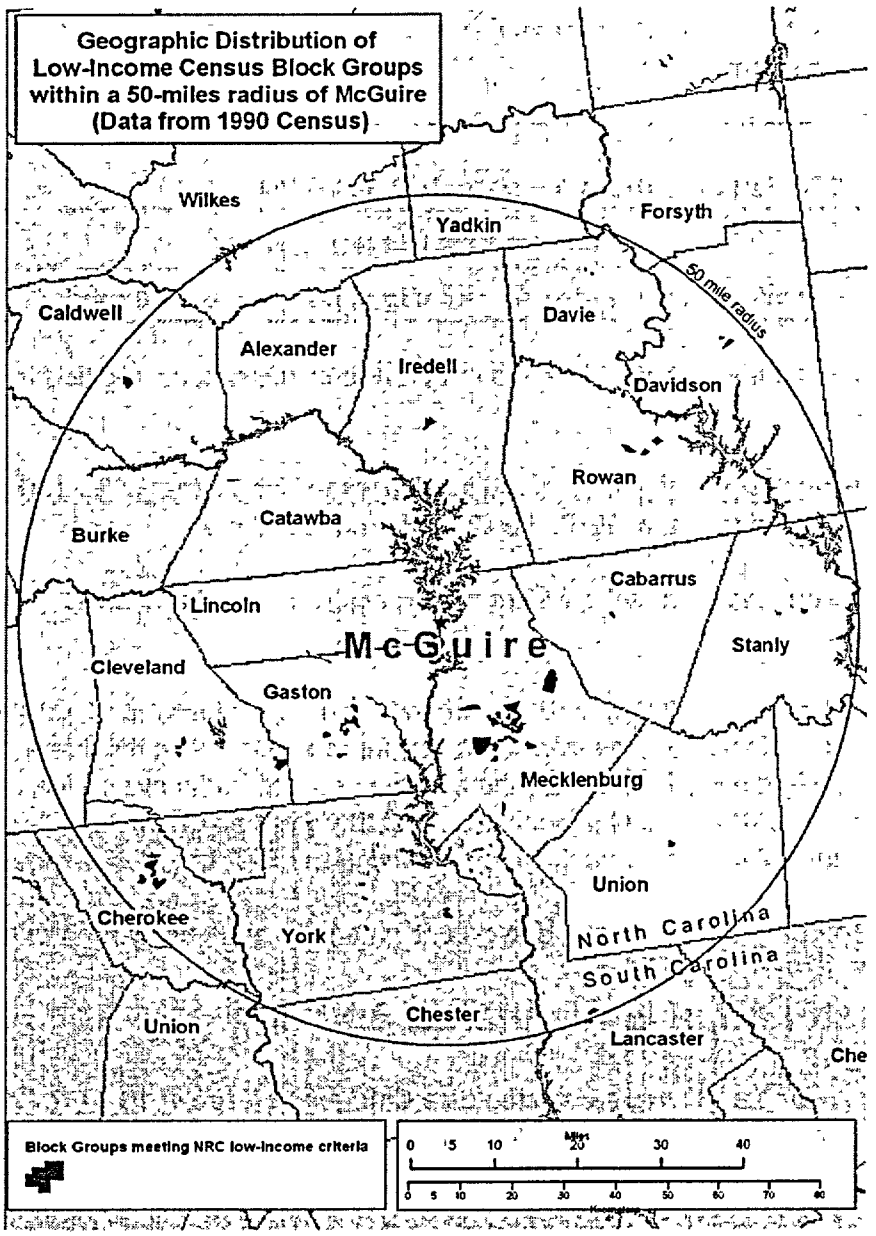

Figure 4-2. Census 1990 Block Groups Identified as Meeting NRC Criteria for Low-Income Status in an 80-km (50-mi) Area Around McGuire

Table 4-9. Category 1 Issue Applicable to Groundwater Use and Quality During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
GROUNDWATER USE AND QUALITY	
Groundwater-use conflicts (potable and service water; plants that use <100 gpm).	4.8.1.1

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for this issue follows.

- Groundwater-use conflicts (potable and service water; plants that use <100 gpm). Based on information in the GEIS, the Commission found that

  > Plants using less than 100 gpm are not expected to cause any ground-water use conflicts.

  As discussed in Section 2.2.2, McGuire groundwater use is less than 0.068 m^3/s (100 gpm). The staff has not identified any significant new information during its independent review of the McGuire ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no groundwater-use conflicts during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to groundwater use and quality for McGuire.

4.6 Threatened or Endangered Species

Threatened or endangered species is listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-10.

This issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of the nuclear plant during the license renewal term. NRC Staff initiated informal consultation with the FWS by letter requesting information on species protected under the Endangered Species Act that occur in the vicinity of the McGuire site. The FWS responded by letter (Cole 2001) indicating no known occurrences on the McGuire site. The presence of threatened or endangered species in the vicinity of the McGuire site is discussed in Sections 2.2.5 and 2.2.6.

Table 4-10. Category 2 Issue Applicable to Threatened or Endangered Species During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
Threatened or endangered species	4.1	E	4.6

4.6.1 Aquatic Species

As described in Section 2.2.5, the only Federally or State-listed threatened or endangered aquatic species with potential to inhabit waters near McGuire, the Carolina heelsplitter (*Lasmigona decorata*), is not present in the vicinity of the plant (Fridell 2001) and does not occur in impounded water. Thus, continued operation of the plant should not result in impacts to threatened or endangered aquatic species.

Based on these considerations, the staff has determined that the continued operation of McGuire and the continued maintenance of the transmission lines will not impact listed aquatic species.

4.6.2 Terrestrial Species

A field survey for species of concern was conducted within the McGuire exclusion area and on the related transmission line rights-of-way in summer and fall 2000. During this survey, no Federally listed threatened or endangered species were located (Gaddy 2001). In a letter dated November 1, 2001, the FWS (Cole 2001) concurred with the findings of the survey report (Gaddy 2001).

However, the bald eagle is known to infrequently visit the shore of Lake Norman. Based on a review of the applicant's report and the staff's independent analysis, the NRC staff concluded that continued operation of the McGuire site under license renewal will not adversely impact the bald eagle.

Schweinitz's sunflower (*Helianthus schweinitzii*) (Federal endangered) occurs in relatively open habitats, such as road and power line rights-of-way, early successional fields, forest ecotonal margins, and forest clearings. Georgia aster (*Aster georgianus*) (Federal threatened) occurs in dry open woods along roadsides, woodland borders, old fields, and pastures (Cole 2001). Neither of these species is currently known to occur on the McGuire site nor is expected to colonize this area due to lack of appropriate soils (Gaddy 2001).

Based on a review of the applicant's report and the staff's independent analysis, the NRC staff concluded that continued operation of the McGuire site and related transmission corridors under license renewal will not adversely impact Schweinitz's sunflower and Georgia aster.

It is the staff's determination that the impact to threatened or endangered species of an additional 20 years of operation on aquatic and terrestrial listed species would be SMALL, and additional mitigation is not required.

4.7 Evaluation of Potential New and Significant Information on Impacts of Operations During the Renewal Term

The staff has not identified new and significant information on environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, related to operation during the renewal term. The staff reviewed the discussion of environmental impacts associated with operation during the renewal term in the GEIS and conducted its own independent review, including the public scoping meetings, to identify issues with significant new information. Processes for identification and evaluation of new information are described in Chapter 1.0 under License Renewal Evaluation Process.

4.8 Summary of Impacts of Operations During the Renewal Term

Neither Duke nor the staff is aware of information that is both new and significant related to any of the applicable Category 1 issues associated with McGuire operation during the renewal term. Consequently, the staff concludes that the environmental impacts associated with these issues are bounded by the impacts described in the GEIS. For each of these issues, the GEIS concluded that the impacts would be SMALL and that "plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation."

Plant-specific environmental evaluations were conducted for 11 Category 2 issues applicable to McGuire operation during the renewal term and for environmental justice. For all 11 issues and environmental justice, the staff concluded that the potential environmental impact of renewal term operations of McGuire would be of SMALL significance in the context of the standards set forth in the GEIS and that mitigation would not be warranted. In addition, the staff determined that a consensus has not been reached by appropriate Federal health agencies that there are adverse effects from electromagnetic fields. Therefore, the staff did not conduct an evaluation of this issue.

4.9 References

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

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property,* Part 800, "Advisory Council on Historic Preservation." I

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5.0 Environmental Impacts of Postulated Accidents

Environmental issues associated with postulated accidents were discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999a).[a] The GEIS included a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues were assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term.

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents (DBAs) and severe accidents, as discussed in the following sections.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Design-Basis Accidents

To receive NRC approval to operate a nuclear power facility, an applicant for an initial operating license must submit a Safety Analysis Report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The staff reviews the application to determine whether the plant design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50 and 10 CFR Part 100.

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license (OL). The results of these evaluations are found in license documentation such as the applicant's Final Safety Analysis Report (FSAR), the staff's Safety Evaluation Report (SER), and the Final Environmental Statement (FES). A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the license renewal period. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, design-basis events are designated as a Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to McGuire Nuclear Station, Units 1 and 2 (McGuire), is listed in Table 5-1. The early resolution of the DBAs makes them a part of the current licensing basis of the plant; the current

licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal.

Table 5-1. Category 1 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
POSTULATED ACCIDENTS	
Design-basis accidents (DBAs)	5.3.2; 5.5.1

Based on information in the GEIS, the Commission found that

> The NRC staff has concluded that the environmental impacts of design-basis accidents are of small significance for all plants.

In its Environmental Report (ER), Duke Energy Corporation (Duke) stated that "no new information existed for the issues that would invalidate the GEIS conclusions (Duke 2001)." The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS.

Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the staff assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, and fires have not traditionally been discussed in quantitative terms in FESs and were not considered specifically for the McGuire site in the GEIS (NRC 1996). However, in the GEIS, the staff did evaluate existing impact assessments performed by the NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is SMALL. Additionally, the staff concluded that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents.

Based on information in the GEIS, the Commission found that

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to McGuire, is listed in Table 5-2.

Table 5-2. Category 2 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
POSTULATED ACCIDENTS			
Severe Accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	L	5.2

The staff has not identified any significant new information with regard to the consequences from severe accidents during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(ii)(L), the staff has reviewed severe accident mitigation alternatives (SAMAs) for McGuire. The results of its review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives (SAMAs)

10 CFR 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an EIS or related supplement or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for McGuire; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

Duke submitted an assessment of SAMAs for McGuire as part of the ER (Duke 2001). The assessment was based on Revision 2 of the McGuire Probabilistic Risk Assessment (McGuire PRA, Revision 2) (Duke 1998), which is a full scope Level 3 PRA that includes the analysis of both internal and external events. The internal events analysis is an updated version of the Individual Plant Examination (IPE) model (Duke Power 1991), and the external events analysis is based on the Individual Plant Examination for External Events (IPEEE) model (Duke Power 1994). In identifying and evaluating potential SAMAs, Duke took into consideration the insights from the McGuire PRA, as well as other studies, such as the Watts Bar Severe Accident Mitigation Design Alternatives (SAMDA) Analysis (NRC 1995a) and NUREG-1560 (NRC 1997c). Duke concluded that none of the candidate SAMAs evaluated were cost effective for McGuire.

Based on a review of the initial SAMA assessment, the staff issued a request for additional information (RAI) to Duke by letter dated November 19, 2001 (NRC 2001). Key questions concerned (1) further information on several candidate SAMAs, especially those that mitigate the consequences of a station blackout (SBO) event; (2) details on the PRA used for the SAMA analysis, including results as they pertain to containment failure and releases; and (3) the impact of including elements of averted risk that were omitted in the ER. By a letter dated January 31, 2002, Duke submitted additional information (Duke 2002a), which provided details on the updated PRA, the requested PRA results, and other information identified in the RAI (NRC 2001). Duke provided additional clarification in a conference call on February 25, 2002 (NRC 2002a). In these responses, Duke included supplemental tables showing the impacts of including averted replacement power costs for SAMAs that have the potential to reduce core damage frequencies and averted offsite property damage costs for SAMAs that have the potential to improve containment performance, both of which were omitted in the original analysis. Also, Duke presented its position on the value of providing back-up hydrogen control capability during SBO events. Duke's responses addressed the staff's concerns and reaffirmed that none of the SAMAs would be cost-beneficial. However, based on review of the cost and benefit information provided by Duke, the staff concludes that one SAMA is cost-beneficial under the assumptions presented. This SAMA, which involves plant and procedure modifications to enable the existing hydrogen control (igniter) system to be powered from an ac-independent power source in SBO events, has not been implemented at McGuire. This issue is currently being addressed by the NRC as part of the resolution of Generic Safety Issue 189 – Susceptibility of Ice Condenser and Mark III Containments to Early Failure from Hydrogen Combustion During a Severe Accident (NRC 2002b).

The staff's assessment of SAMAs for McGuire is presented below.

5.2.2 Estimate of Risk for McGuire Units 1 and 2

Duke's estimates of offsite risk at McGuire are summarized below. The summary is followed by the staff's review of Duke's risk estimates.

5.2.2.1 Duke's Risk Estimates

The McGuire PRA model, which forms the basis for the SAMA analysis, is a Level 3 risk analysis; i.e., it includes the treatment of core damage frequency, containment performance, and offsite consequences. The model, which Duke refers to as PRA, Revision 2 (Duke 1998), consists of an internal events analysis based on an updated version of the original IPE (McGuire PRA, Revision 1) (Duke Power 1991) and an external events analysis based on the current version of the IPEEE (Duke Power 1994). The calculated total core damage frequency (CDF) for internal and external events in Revision 2 of the McGuire PRA is 4.9×10^{-5} per year.

The McGuire PRA is a "living" PRA. The original version of the IPE has been updated to reflect various design and procedural changes, such as those related to the improvements identified in the IPE, and to reflect operational experience since 1991. The CDF for internal and external events was reduced from 7.4×10^{-5} per year (Revision 1) to 4.9×10^{-5} per year (Revision 2). The Level 1 PRA changes associated with the McGuire PRA Revision 2 model included

- incorporation of updated data for component reliability, unavailabilities, initiating event frequencies, common cause failures, and human error probabilities
- conversion from a sequence based solution to a single top fault tree
- modifications to reflect changes to the plant configuration.

The most significant data changes are those related to diesel generator (DG) performance. Following the IPE, Duke proceeded with a program to improve the DG reliability at McGuire. The reliability improvement that occurred significantly reduced the CDF contributed by the loss of offsite power (LOOP) and tornado initiators. To a lesser extent, the seismic results are also impacted by the DG reliability data. The net effect is that the total CDF for SBO sequences (internal and external events) was reduced from approximately 4.1×10^{-5} per year in the IPE and IPEEE to 2.3×10^{-5} per year in PRA Revision 2. Another important change occurred in the interfacing system loss-of-coolant accident (ISLOCA) evaluation. The generic database adopted for the Revision 2 analysis had significantly higher failure rates for valve ruptures. This resulted in a significant increase in the CDF contributed by the ISLOCA, an important risk contributor.

The breakdown of the CDF from Revision 2 to the PRA is provided in Table 5-3. Internal event initiators represent about 57 percent of the total CDF and are composed of transients (31 percent of total CDF), loss-of-coolant accidents (LOCAs) (22 percent of total CDF), and reactor pressure vessel rupture (2 percent of total CDF). Remaining contributors together account for less than 3 percent of total CDF. External event initiators represent about 43 percent of the total CDF and are composed of seismic initiators (22 percent of total CDF), tornado initiators (13 percent of total CDF), and fire initiators (6 percent of the total CDF). Although not explicitly reported in Table 5-3, SBO events account for 47 percent of the total CDF for internal and external events in Revision 2 of the PRA.

Table 5-3. McGuire Core Damage Frequency (Revision 2 of PRA)

Initiating Event	Frequency (per year)	% of Total CDF
Transients	1.5×10^{-5}	31
Loss-of-coolant accident (LOCA)	1.1×10^{-5}	22
Internal flood	8.7×10^{-7}	2
Anticipated transient without scram (ATWS)	1.5×10^{-7}	<1
Steam generator tube rupture (SGTR)	7.8×10^{-10}	<1
Reactor pressure vessel rupture (RPV)	1.0×10^{-6}	2
Interfacing system LOCA (ISLOCA)	2.2×10^{-7}	<1
CDF from internal events	**2.8×10^{-5}**	**57**
Seismic	1.1×10^{-5}	22
Tornado	6.5×10^{-6}	13
Fire	2.9×10^{-6}	6
CDF from external events	**2.1×10^{-5}**	**43**
Total CDF	**4.9×10^{-5}**	**100**

The Level 2 (also called containment performance) portion of the McGuire PRA model, Revision 2, is essentially the same as the IPE Level 2 analysis. However, the following changes were made:

- modifications to reflect an emergency operating procedure change that reduced the likelihood of restarting a reactor coolant pump following core damage, thus reducing the potential for thermally induced steam generator tube rupture

- modification of the containment event tree (CET) logic regarding the potential for corium contact with the containment liner

- modification of the CET logic and quantification to reflect that the refueling water storage tank inventory would drain through a failed reactor vessel in some sequences (e.g., SBO).

These changes resulted in a large decrease in the potential for thermally-induced steam generator tube ruptures, a slight increase in the potential for early containment failure as a result of corium contact with the containment liner and a reduction in basemat melt-through due to reactor cavity flooding via the reactor vessel breach.

The offsite consequences and economic impact analyses (i.e., Level 3 PRA Analyses) were carried out using the NRC-developed MELCOR Accident Consequence Code System 2 (MACCS2) code. Inputs for this analysis include plant and site specific input values for core radionuclide inventory, source term and release fractions, meteorological data, projected population distribution, and emergency response evacuation modeling.

Duke estimated the dose to the population within 80 km (50 mi) of the McGuire site from all initiators (internal and external) to be about 0.135 person-sieverts (Sv) (13.5 person-rem) per year (Duke 2001). The breakdown of the total population dose by containment end-state is summarized in Table 5-4. Internal events account for approximately 0.060 person-Sv (6.0 person-rem) per year, and external events account for approximately 0.075 person-Sv (7.5 person-rem) per year. As can be seen from this table, early and late containment failures account for the majority of the population dose.

Table 5-4. Breakdown of Population Dose by Containment End-State (Total dose = 0.135 person-Sv [13.5 person-rem] per year)

Containment End State	% of Total Dose Internal Initiators	% of Total Dose External Initiators	% of Total Dose All Initiators
SGTR[a]	<0.1	<0.1	<0.1
ISLOCA[a]	19.4	0.0	19.4
Containment isolation failure	0.1	0.3	0.4
Early containment failure	8.5	32.1	40.6
Late containment failure	15.9	23.3	39.2
Basemat melt-through	<0.1	<0.1	<0.1
No containment failure	0.3	0.1	0.4
Total	**44.2**	**55.8**	**100**

(a) Containment bypass events

5.2.2.2 Review of Duke's Risk Estimates

Duke's estimate of offsite risk at McGuire is based on the Revision 2 of the McGuire PRA and a separate MACCS2 analysis. For the purposes of this review, the staff considered the following major elements:

- the Level 1 and 2 risk models that form the bases for the November 1991 IPE submittal (Duke 1991)
- the major modifications to the IPE models that have been incorporated in Revision 2 of the PRA (Duke 1998)
- the external events models that form the basis for the June 1994 IPEEE submittal (Duke 1994)
- the analyses performed to translate fission product release frequencies from the Level 2 PRA model into offsite consequence measures (Duke 2001).

The staff reviewed each of these analyses to determine the acceptability of Duke's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the McGuire IPE is described in a staff report dated June 30, 1994 (NRC 1994). In that review, the staff evaluated the methodology, models, data, and assumptions used to estimate the CDF and characterize containment performance and fission product releases. The staff concluded that Duke's analysis met the intent of Generic Letter 88-20 (NRC 1988), which means the IPE was of adequate quality to be used to look for design or operational vulnerabilities. The staff's review primarily focused on the licensee's ability to examine McGuire for severe accident vulnerabilities and not specifically on the detailed findings or quantification estimates. Overall, the staff concluded that the McGuire IPE was of adequate quality to be used as a tool in searching for areas with high potential for risk reduction and to assess such risk reductions, especially when the risk models are used in conjunction with insights, such as those from risk importance, sensitivity, and uncertainty analyses.

The staff's review of the McGuire IPEEE is described in an evaluation report dated February 16, 1999 (NRC 1999b). Duke did not identify any fundamental weaknesses or vulnerabilities to severe accident risk with regard to the external events. In the safety evaluation report, the staff concluded that the IPEEE met the intent of Supplement 4 to Generic Letter 88-20 (NRC 1991) and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities.

Environmental Impacts of Postulated Accidents

In a RAI (NRC 2001), the staff questioned why the CDF for steam generator tube rupture events in Revision 2 to the PRA is so low relative to other pressurized-water reactor (PWR) PRAs. In response (Duke 2002a), Duke stated that

> The McGuire SGTR model incorporated in both the IPE and in the 1997 update relied upon success criteria established during the IPE development. Where applicable, the system success criteria were established with the then current version of the MAAP [Modular Accident Analysis Program] code. Furthermore, a sequence was categorized as a success because core damage occurred beyond 24 hours, even though a safe stable state had not been attained, this is inconsistent with what is now the generally accepted industry practice. As a result of comments received during the McGuire peer review process, these success criteria were revisited. The new MAAP results showed core damage to occur where the original analysis did not. The outdated success criteria are judged to be the most significant contributors to the comparatively low SGTR initiated CDF previously reported. The SGTR analysis is being completely revisited in Revision 3 to the McGuire PRA, which is still in development. This new analysis estimates the CDF for SGTR at 5.3×10^{-7} per year, which is more in line with similar plants.

In a February 7, 2002, telephone conference with Duke, the staff questioned the impact that other Revision 3 PRA results might have on the conclusions drawn in the McGuire ER, because the change for the SGTR event was not trivial. In response (Duke 2002b), Duke provided the CDF values from Revision 3 of the McGuire Level 1 PRA, broken out by the major contributors. Peer review of the Level 2 and 3 portions of the PRA Revision 3 had not yet been completed. Thus, revised Level 2 and 3 information was not provided. A comparison of the CDF results from the various versions of the McGuire PRA is provided in Table 5-5. Duke's SAMA assessment was based on PRA Revision 2 since the Revision 3 results available at the time of the analysis (and reported in the draft SEIS) were preliminary. Results from the final approved version of Revision 3, completed subsequent to the draft SEIS, were provided by Duke by letter dated August 2, 2002 (Duke 2002b) and are included in Table 5-5. The differences between the final Revision 3 results and the preliminary Revision 3 results reported in the draft SEIS are not significant and do not have any impact on the staff's analysis or conclusions. The staff based its assessment on the CDF and offsite doses derived from PRA Revision 2, but also considered the impact that the use of CDF estimates from Revision 3 of the PRA might have on the risk results. Note that the CDF values for Revision 1 were not broken out for the individual internal event categories in Table 5-5 because Revision 2 was used as the basis of the staff's evaluation.

Based on a comparison of the frequency of major contributors to CDF, the following key differences were noted:

- The SGTR frequency in Revision 3 is more than a factor of 600 larger than in Revision 2 (5.3×10^{-7} per year versus 7.8×10^{-10} per year). This increase is due to the use of revised, more technically-supported success criteria as discussed above.

- The SBO frequency in Revision 3 is more than a factor of two smaller than in Revision 2 (1.0×10^{-5} per year versus 2.3×10^{-5} per year). This reduction is due to credit taken for installing improved reactor coolant pump O-ring seals that would be capable of withstanding higher temperatures and would have a higher likelihood of remaining intact under loss of seal-cooling conditions.

Table 5-5. Comparison of CDF Results by Accident Initiator or Sequence

Accident Initiator/Sequence	PRA, Rev. 1 (IPE)	PRA, Rev. 2	PRA, Rev. 3
Internal Floods	--	8.7×10^{-7}	5.4×10^{-6}
Transients	--	1.5×10^{-5}	2.9×10^{-6}
LOCAs	--	1.1×10^{-5}	8.8×10^{-6}
RPV	--	1.0×10^{-6}	1.0×10^{-6}
SGTR	--	7.8×10^{-10}	5.3×10^{-7}
ATWS	--	1.5×10^{-7}	5.3×10^{-7}
ISLOCA	--	2.2×10^{-7}	9.8×10^{-7}
CDF from internal events	**4.0×10^{-5}**	**2.8×10^{-5}**	**2.0×10^{-5}**
	(IPEEE)		
Seismic	1.1×10^{-5}	1.1×10^{-5}	8.9×10^{-6}
Tornado	1.9×10^{-9}	6.5×10^{-6}	1.6×10^{-6}
Fire	2.3×10^{-7}	2.9×10^{-6}	6.3×10^{-6}
CDF from external events	**3.0×10^{-5}**	**2.0×10^{-5}**	**1.7×10^{-5}**
Total CDF	**7×10^{-5}**	**4.8×10^{-5}**	**3.7×10^{-5}**
SBO (internal & external events)[(a)]	4.1×10^{-5}	2.3×10^{-5}	1.0×10^{-5}

(a) the internal and external event frequencies above include contributions from SBO events; the CDF for SBO events is broken out here separately for illustrative purposes.

The impact of the revised SGTR and SBO frequencies on the risk reduction estimates for related SAMAs was considered in the staff's review (see Sections 5.2.4 and 5.2.6.2). The frequency of other CDF contributors was impacted to a much lesser degree, and these changes are not expected to alter results of the SAMA analysis.

The staff reviewed the process used by Duke to extend the containment performance (Level 2) portion of the IPE to the offsite consequence (Level 3) assessment. This included consideration of the source terms used to characterize fission product releases for each

containment release category and the major input assumptions used in the offsite consequence analyses. This information is provided in Section 6 of Duke's IPE submittal. Duke used the MAAP code to analyze postulated accidents and develop radiological source terms for each of 31 containment release categories used to represent the containment end-states. These source terms were incorporated as input to the MACCS2 analysis. The MACCS2 code is the current standard for assessing consequences of accidents at nuclear power plants. The staff reviewed Duke's source term estimates for the major release categories and found these predictions to be in reasonable agreement with estimates from NUREG-1150 (NRC 1990) for the closest corresponding release scenarios. The staff concludes that the assignment of source terms is acceptable.

The plant-specific input to the MACCS2 code includes the McGuire reactor core radionuclide inventory, emergency response evacuation modeling based on McGuire evacuation time estimate studies, release category source terms from the McGuire PRA, Revision 2 analysis (same as the source terms used in the IPE), site-specific meteorological data, and projected population distribution within a 80 km (50 mi) radius for the year 2040.

MACCS2 requires a file of hourly meteorological data consisting of wind speed, wind direction, atmospheric stability category, and precipitation. For the McGuire SAMA analysis, meteorological data was obtained from the meteorological tower located on the McGuire site; the meteorological data used in MACCS2 contained data for one year, January 1 through December 31, 1999.

The McGuire PRA, Revision 2 and the SAMA offsite consequence analyses use three distinct evacuation schemes in order to adequately represent evacuation time estimates for the permanent resident population, the transient population, and the special facility population (e.g., schools, hospitals, etc.). The three groups are defined by the time delay from initial notification to start of evacuation. For each evacuation scheme, the fraction of the population starting their evacuation is included. For the permanent resident evacuation schemes, it was assumed that 5 percent of the population would delay evacuation for 24 hours after being warned to evacuate. The delay time and fraction of population for the remaining two schemes were developed from information given in the latest update to the McGuire evacuation time estimate study for the 16-km (10-mi) Emergency Planning Zone (EPZ). The evacuation schemes include additional information such as evacuation distance, average evacuation speed, sheltering, and shielding considerations. In the McGuire evacuation model, only the 10-mile EPZ is assumed to be involved in the initial evacuation. The MACCS2 model assumes that persons outside of the 10-mile EPZ will wait 24 hours before evacuating (provided that radiological conditions warrant evacuation).

The staff reviewed the Duke responses (Duke 2002a) to questions regarding meteorological data, population data and emergency planning. Those responses confirmed that Duke used appropriate values for the consequence analysis.

The staff concludes that the methodology used by Duke to estimate the CDF and offsite consequences for McGuire provides an acceptable basis from which to proceed with an assessment of the risk reduction potential for candidate SAMAs. Additionally, the risk profile used is similar to other PWRs with ice condenser containments. The staff based its assessment of offsite risk on the CDF and offsite doses reported by Duke, but also considered the impact that the use of CDF estimates from Revision 3 of the PRA might have on the risk results.

5.2.3 Potential Plant Improvements

This section discusses the process for identifying potential design improvements, the staff's evaluation of this process, and the design improvements evaluated in detail by Duke.

5.2.3.1 Process for Identifying Potential Plant Improvements

Duke's process for identifying potential plant improvements consisted of the following elements:

- The core damage cut sets from Revision 2 of the McGuire PRA were reviewed to identify potential SAMAs that could reduce CDF.
- The Fussell-Vesely (F-V) importance measures were evaluated for the basic events (including initiating events, random failure events, human error events, and maintenance and testing unavailabilities), and the importance ranking was examined to identify any events of significant F-V importance.
- Potential enhancements to reduce containment failure modes of concern for McGuire (including early containment failure, containment isolation failure, and containment bypass) were reviewed for possible implementation.

In addition, Duke reviewed the Watts Bar SAMDA analysis (NRC 1995a) and insights from the staff's report on the IPE (NRC 1997c) to identify additional SAMAs.

As a starting point for the core damage cut set review, Duke developed a listing of the top 100 cut sets (severe accident sequences) based on internal initiators and the top 100 cut sets for external initiators. These 200 sequences include all potential core damage sequences with at least a 0.06 percent contribution to the total CDF. Additionally, some cut sets contributing as little as 0.05 percent to the total CDF were considered. Duke reviewed the cut sets to identify potential SAMAs that could reduce CDF. A cutoff value of 3.5×10^{-7} per year (for internal and

external event initiators) was used to screen events. To account for the cumulative effect of cut sets below this cutoff value, the basic events importance measure was also used to identify potential enhancements, as discussed below. Duke indicated in responses to the RAIs (Duke 2002) that the estimated CDF for the 200 cut sets is 4.4×10^{-5} per year, which is about 90 percent of the total CDF.

For each seismic initiator cut set, Duke calculated the associated offsite risk based on the population dose and CDF for the plant damage states (PDSs) attributable to the seismic initiator. Duke conservatively assumed that the implementation of plant enhancements for seismic events would completely eliminate the seismic risk and calculated the present worth of the averted risk based on a $200,000 per person-Sv ($2000 per person-rem) conversion factor, a discount factor of 7 percent, and an additional 20-year license renewal period. This process was repeated for each of the remaining seismic initiator cutsets above the cutoff frequency. The present worth of averted risk for all of the seismic cutsets combined was estimated to be about $275,000 (not including the cost of replacement power and offsite property damage, the significance of which is discussed in Section 5.2.6.2). On the basis of the small risk reduction achievable [0.041 person-Sv (4.1 person-rem)] and the large costs associated with substantial seismic upgrades (estimated at several million dollars), Duke eliminated seismic SAMAs from further consideration.

Duke reviewed the F-V Basic Event Importance Ranking presented in the McGuire PRA report, Revision 2, and identified several basic events for further consideration. These included internal event initiators, seismic-related events, equipment failures, and human-error events. Seismic-related events were not evaluated further for the reasons discussed above. Seven potential enhancements to reduce CDF were identified through this process and are presented in Table 5-6.

In the ER, Duke identified the installation of back-up power to the igniters and the installation of back-up power to air return fans as two separate SAMAs. However, in responses to staff RAIs, Duke indicated that the availability of air return fans would be essential to the effective operation of igniters in an SBO; therefore, Duke treated the combined modification as a single SAMA. Accordingly, these two hydrogen control related SAMAs are shown as a single SAMA in Table 5-7. This effectively reduces the number of containment-related SAMAs to eight.

Duke also considered potential alternatives to reduce containment failure modes of concern for McGuire. These alternatives included nine containment-related improvements evaluated as part of the staff's assessment of SAMDAs for Watts Bar (NRC 1995a) and five containment-related improvements (e.g., procedures for reactor coolant system depressurization and procedures to cope with and reduce induced SGTR) derived from the staff's generic report on the individual plant examination program (NRC 1997c). Duke eliminated those alternatives that are either (1) already implemented at McGuire or (2) not applicable to the McGuire containment

Table 5-6. SAMA Cost/Benefit Screening Analysis – SAMAs That Reduce CDF

Potential Alternative	Sequences/Failures Addressed	Risk Reduction		Total Benefit	Cost of Enhancement
		CDF[a]	Population Dose[b] (person-rem[c])		
Man standby shutdown facility (SSF) 24 hours/day with trained operator	Loss of service water (RN), failure of operators to align safe shutdown (SS) system for operation, filter (standby makeup pump) restricts flow, failure to align containment ventilation cooling water system (RV) cooling/other Unit RN Vital instrumentation and control (I&C) Fire causes a Loss of RN, failure of operators to align SS system for operation, failure to use other Unit or remote control during fire Loss of 4160V essential bus and failure to align SS system for operation AND Tornado causes LOOP, DG 1A and 1B fail to fun, operators fail to initiate SS system operation	1.1×10^{-5}	3.2	$380,000	>$2.5 M[d][e]

(a) Total CDF = 4.9×10^{-5} per year
(b) Total population dose = 13.5 person-rem per year
(c) One person-Sv = 100 person-rem
(d) Cost estimates for manning the standby shutdown system apply on a per-site rather than a per-unit basis. To provide a consistent basis for comparison with the estimated benefits (which are per unit), the estimated site costs were divided by two.
(e) M =millions

Table 5-6. (contd)

Potential Alternative	Sequences/Failures Addressed	Risk Reduction		Total Benefit	Cost of Enhancement
		CDF[a]	Population Dose[b] (person-rem[c])		
Install automatic swap over to high-pressure recirculation	LOCA cut sets with failure of operators to establish high pressure recirculation	1.0×10^{-5}	0.4	$291,000	>$1 M[e]
Install automatic swap to RV/other unit RN system upon loss of RN	Loss of RN, failure of operators to align SS system for operation, filter (Standby Makeup Pump) restricts flow, failure to align RV/other Unit RN	8.8×10^{-6}	1.2	$275,000	>$1 M
Install third diesel generator	Tornado causes LOOP, DG 1A and 1B fail, and operators fail to initiate SS system operation	8.4×10^{-6}	3.1	$304,000	>$2 M
Install automatic swap to other unit	Vital I&C Fire causes a Loss of RN, failure of operators to align SS system for operation, failure to use other Unit or remote control during fire	2.9×10^{-6}	1.1	$106,000	>$1 M
Increase test frequency of standby makeup pump flow path (currently tested quarterly)	Loss of RN, failure of operators to align SS system for operation, filter (Standby Makeup Pump) restricts flow, failure to align RV cooling/other Unit RN	1.8×10^{-6}	0.5	$62,000	>$0.4 M
Replace reactor vessel with stronger vessel	Failure of reactor pressure vessel with failure to prevent core damage following a reactor pressure vessel breach	1.0×10^{-6}	<0.1	$30,000	>$1 M

(a) Total CDF = 4.9×10^{-5} per year
(b) Total population dose = 13.5 person-rem per year
(c) One person-Sv = 100 person-rem
(e) M = millions

Table 5-7. SAMA Cost/Benefit Screening Analysis – SAMAs That Improve Containment Performance

Potential Alternative	Risk Reduction		Total Benefit (per unit)	Cost of Enhancement (per unit)
	CDF	Population Dose (person-rem[a])		
Install independent containment spray system	NA	10.8	$349,000[b]	>$1 M[c]
Install filtered containment vent system	NA	10.8	$349,000[b]	>$1 M
Install back-up power to igniters and install back-up power to air return fans	NA	10.8	$349,000[b]	$540,000
Install containment inerting system	NA	10.8	$349,000[b]	>$1 M
Install additional containment bypass instrumentation	NA	2.6	$84,000	>$1 M
Add independent source of feedwater to reduce induced SGTR	NA	< 0.1	< $3,200	>$1 M
Install reactor cavity flooding system	NA	5.6	$181,000	>$1 M
Install core retention device	NA	< 0.1	< $3,200	>$1 M

(a) One person-Sv = 100 person-rem
(b) Total benefit based on eliminating all early and late containment failures
(c) M = millions

design. Based on the screening, Duke designated nine of the containment- related SAMAs for further study. The list of the potential enhancements to improve containment performance is presented in Table 5-7.

5.2.3.2 Staff Evaluation

It should be noted that Duke has made extensive use of PRA methods to gain insights regarding severe accidents at McGuire. Risk insights from various McGuire risk assessments have been identified and implemented to improve both the design and operation of the plant. For example, using the IPE process, Duke (1) modified procedures to better cope with a loss of nuclear service water event and to better prioritize operator actions in a loss of alternating current (ac) power event; (2) added procedures to exercise the nuclear service water cross-connect valves between Unit 1 and 2 during each refueling outage; (3) fitted expansion joints in the nuclear service water piping located in the auxiliary feedwater pump room with a collar to limit the leak rate; (4) made a number of changes to enhance the reliability of the Emergency Diesel Generator System; (5) performed training exercises to ensure that the operators can

activate the standby shutdown facility (SSF) within 10 minutes; and (6) expanded the refueling water storage tank (FWST) level instrumentation span to the full range to reduce the potential for operator error during switchover to sump recirculation. Examples of plant improvements being planned for implementation by Duke based on IPEEE findings include:

(1) adding spacers between the Unit 1 DG batteries and racks

(2) adding grout between component cooling heat exchangers saddle base and concrete curb

(3) trimming the grating around the steam vent valves

(4) replacing some missing bolts on the Unit 2 upper surge tanks

(5) adding some additional procedural guidelines to secure movable equipment and structures to prevent potential seismic interactions.

The implementation of such improvements reduced the risk associated with the major contributors identified by the McGuire PRA and contributed to the reduced number of candidate SAMAs identified as part of Duke's application for license renewal.

Duke's effort to identify potential SAMAs focused on areas found to be risk-significant in the McGuire PRA. The SAMAs listed generally coincide with accident categories that are dominant CDF contributors or with issues that tend to have a large impact on a number of accident sequences at McGuire. Duke made a reasonable effort to use the McGuire PRA to search for potential SAMAs and to review insights from other plant-specific risk studies and previous SAMA analyses for potential applicability to McGuire. The staff reviewed the set of potential enhancements considered in Duke's SAMA identification process. These include improvements oriented toward reducing the CDF and risk from major contributors specific to McGuire and improvements identified in the previous SAMDA review for Watts Bar (NRC 1995a) that would be applicable to McGuire.

The staff notes that most of the SAMAs involve major modifications and significant costs and that less expensive design improvements and procedure changes could conceivably provide similar levels of risk reduction. The staff requested additional information (NRC 2001) from Duke on less expensive alternatives that would yield similar benefits. In response, Duke provided additional information on alternative power to hydrogen igniters for SBO and passive autocatalytic recombiners (PARs) as an alternative to igniters. Duke also provided an estimate of the cost to install a dedicated line from the Cowan's Ford hydroelectric station, as an alternative source of ac power. This information was responsive to the staff's requests and provided additional depth to the SAMAs considered. These additional alternatives are further evaluated, along with the other SAMAs, in the sections that follow.

The staff concludes that Duke has used a systematic process for identifying potential design improvements for McGuire and that the set of potential design improvements identified by Duke is reasonably comprehensive and, therefore, acceptable.

5.2.4 Risk Reduction Potential of Plant Improvements

Section 4.3 of Attachment K to the ER describes the process used by Duke to determine the risk reduction potential for each enhancement.

For each seismic initiator cut set, Duke calculated the associated offsite risk based on the population dose and CDF for the PDSs attributable to the seismic initiator. Implementation of the plant enhancement was assumed to completely eliminate the seismic risk associated with the cut set. For each (non-seismic) sequence/enhancement, Duke evaluated the severe accident sequences. In general, where an alternative impacted more than one severe accident sequence, Duke determined the cumulative risk reduction achievable by each SAMA. This was performed by identifying which basic events in the cut sets would be affected by the implementation of the particular SAMA and assuming that the implementation of the SAMA would eliminate the basic event. For each containment-related improvement, Duke assumed that all of the population dose associated with the release categories impacted by the SAMA would be eliminated. For those alternatives that benefit more than one containment failure mode (i.e., independent containment spray system, filtered containment vent, back-up power to igniters and air return fans, containment inerting system, and reactor cavity flooding system), the total population dose for all affected failure modes was assumed to be completely eliminated by implementing the alternative. For example, installation of a standpipe in containment for reactor cavity flooding, which could reduce the likelihood of both early containment failure associated with reactor vessel breach and late containment failure due to basemat melt-through, was assumed to completely eliminate the associated early and late containment failures.

In responses to follow-up RAIs (NRC 2002a), Duke noted that the risk reduction estimates had changed in some instances when the PRA was updated to Revision 3. The final Revision 3 CDF results are summarized in Section 5.2.2.2 (Duke 2002b). One significant change was an increase in the CDF for SGTR events. According to Duke, this change yielded an estimated increase in population dose of approximately 0.04 person-Sv (4 person-rem). Duke reassessed the benefits of completely eliminating SGTR based on this new information, and calculated a maximum benefit of approximately $101,000 (present worth for the 20-year license renewal period). It is Duke's position that it is unlikely that a cost-beneficial alternative could be implemented to further reduce the SGTR risk based on such a low benefit estimate. The staff concurs with this assessment. Use of the PRA Revision 3 CDF estimates in lieu of the PRA Revision 2 CDF values would not appear to introduce any other significant changes to the risk profile that would make any of the other candidate SAMAs more cost-beneficial and might make some SAMAs less cost-beneficial, particularly SAMAs related to SBO events.

The staff questioned Duke regarding why the SAMA involving addition of a third DG was estimated to provide only a small (about 36 percent) reduction in the CDF for SBO sequences (NRC 2001). Duke indicated that the risk reduction was based on eliminating all failures to start, failures to run, and common-cause failures of the existing two diesels. However, it was assumed that the third DG would not be seismically qualified; therefore, it would not be effective in seismic events. Because seismic events account for approximately half of the SBO CDF, the limited risk reduction estimated for the third DG appears reasonable. Duke also considered the additional benefit if the third DG were seismically qualified, similar to the existing DGs. Duke estimated that an additional reduction in CDF of about 1.3×10^{-6} per year would be achieved by eliminating all random failures of DGs in seismic events. This risk reduction is limited because the seismic results are dominated by seismic failures in the 4-kV power system for which improving DG availability provides no benefit. The staff concludes that Duke's risk reduction estimates for this SAMA are reasonable.

An estimate of the risk reduction for the SAMA involving installation of a dedicated power line from the Cowan's Ford hydroelectric station was not provided in Duke's RAI response. However, the risk reduction would be comparable to that for adding a third DG, because the seismic fragility of the hydroelectric unit is expected to be similar to that for the seismically qualified DGs.

The staff notes that Duke evaluated the risk reduction potential for each SAMA, including the dedicated power line, in a bounding fashion. Each SAMA was assumed to completely eliminate all sequences that the specific enhancement was intended to address; therefore, the benefits are generally overestimated and conservative. The staff also notes that use of the PRA Revision 3 CDF estimates in lieu of the PRA Revision 2 CDF values would not appear to introduce any significant changes to the risk profile that would make any of the candidate SAMAs cost-beneficial, including SAMAs related to SGTR events. Accordingly, the staff based its estimates of averted risk for the various SAMAs on Duke's risk reduction estimates.

5.2.5 Cost Impacts of Candidate Plant Improvements

Duke's estimated costs for each potential design enhancement are provided in Table 4-2 and Section 5.3 of Attachment K to the ER. For most of the SAMAs, Duke estimated the cost of implementation to be greater than $1 million based on cost estimates developed in previous industry studies. For two SAMAs, Duke developed plant-specific cost estimates because there was no readily available information on the estimated cost to implement similar alternatives and because the basic events associated with these alternatives were found to have a high importance in the McGuire PRA. These SAMAs involve (1) installing a third DG, and (2) increasing the test frequency of the standby makeup pump flow path. The costs to implement these SAMAs were estimated to be on the order of $2 million and $435,000, respectively. Because the benefits of the potential SAMAs were significantly less than their estimated implementation costs (by a factor of three or more), none of the cost estimates were further

refined. Specifically, the benefit of adding a third DG was about $304,000 while the benefit of increasing the test frequency was about $62,000 (see Table 5-6).

The staff compared Duke's cost estimates with estimates developed elsewhere for similar improvements, including estimates developed as part of the evaluation of SAMDAs for operating reactors and advanced light-water reactors (LWRs). The staff notes that Duke's estimated implementation costs of $1 million dollars or greater are consistent with the values reported in previous analyses for major hardware changes of similar scope and are not unreasonable for the SAMAs under consideration, given that these enhancements involve major hardware changes and impact safety-related systems. For example, Duke estimated the cost to install a third DG to be approximately $2 million; this value is less than the cost estimates reported in previous SAMDA analyses for a similar design change.

Duke's estimate of the cost to install a dedicated line from the Cowan's Ford hydroelectric station as an alternate source of ac power also appears reasonable. This line would be buried to eliminate weather-related common-cause failures. The estimated cost ($3 million) is comparable to the cost estimate provided by Dominion Power (NRC 2002c) for a similar modification at the Surry Nuclear Power Station ($2 million to $5 million), but is far greater than the calculated benefit of $300K for McGuire.

The staff questioned Duke regarding the costs of less expensive alternatives that could offer similar risk reduction benefits, particularly with regard to hydrogen control in SBO events. In a January 31, 2002, response to staff RAIs (Duke 2002a), Duke provided additional information on the costs associated with installing a passive hydrogen control system based on the use of PARs in lieu of the present ac-dependent hydrogen igniters, and the costs of powering a subset of the current hydrogen igniters from a back-up generator. For scoping purposes, Duke provided supplementary information regarding the cost of back-up power to the igniters and air return fans in response to a follow-up RAI (NRC 2002a).

Duke's estimate of the cost to establish a capability to power a subset of igniters from a back-up generator was $205,000 for each unit. This modification, as defined by Duke, would involve prestaging a single, dedicated generator for each unit outdoors on a concrete pad (for ventilation and exhaust considerations) and supplying the necessary power cables and circuit breakers to enable connection to the igniter branch circuits. The breakdown of this cost is: $5,000 for engineering, $50,000 for materials, $110,000 for installation labor, and $40,000 for maintenance and operation. This cost estimate does not include an enclosure, tornado protection for the generator, or any seismic design. Duke further noted that providing electric power to hydrogen igniters during a SBO will not be effective without also powering at least one of the containment air return fans and that this will further increase the cost of this option. When one air return fan is added to this estimate, the combined cost is $540,000. The breakdown of this cost is: $50,000 for engineering, $210,000 for materials $240,000 for installation labor, and $40,000 for maintenance and operation. Duke points out there will be additional costs not included in these estimates.

The staff requested additional information on PARs, because PARs are to be installed in French PWRs by 2007 to mitigate the consequences of hydrogen combustion events. In response (Duke 2002a), Duke estimated that the installation of PARs would cost more than $750,000 per unit, which is well above the estimated benefit (see Table 5-8, Section 5.2.6.2). This cost estimate is consistent with independent staff cost estimates for installing PARs.

The staff asked for further information on the basis for the greater than $1 million cost estimate for two other SAMAs: (1) install automatic swap-over to high pressure recirculation, and (2) install automatic swap-over to the containment ventilation cooling water system or the other unit's service water system upon loss of the service water system. Duke (NRC 2002a) referenced NUREG-0498, Supp. 1 (NRC 1995a), which estimated a cost of about $2.1 million for a similar alternative, i.e., "automate the alignment of emergency core cooling system (ECCS) recirculation to the high-pressure charging and safety injection pumps." This would reduce the potential for related human errors made during manual realignment. This cost estimate applies to both of these candidate SAMAs and is considerably higher than the estimated averted risk benefits for McGuire of about $291,000 and $275,000 respectively. (Benefits are discussed further in Section 5.2.6.)

The staff concludes that the cost estimates provided by Duke are reasonable and adequate for the purposes of this SAMA evaluation. As noted in Section 5.2.6.2, further attention will be placed on the costs associated with SBO-related plant improvements by the NRC as part of the resolution of Generic Safety Issue 189 - Susceptibility of Ice Condenser and Mark III Containments to Early Failure from Hydrogen Combustion During a Severe Accident (NRC 2002b).

5.2.6 Cost-Benefit Comparison

The cost-benefit comparison as evaluated by Duke and the staff evaluation of the cost-benefit analysis are described in the following sections.

5.2.6.1 Duke Evaluation

In the analysis provided in the McGuire ER, Duke did not include the following factors in its cost-benefit evaluation: replacement power costs for SAMAs that have the potential to reduce CDF and averted offsite property damage costs for SAMAs that have the potential to improve containment performance. In view of the significant impact of these averted costs on the estimated benefit for a SAMA, the staff requested that Duke include these factors in the cost-benefit analysis for each affected SAMA. In response to the RAI (Duke 2002a), Duke updated the benefit estimates to include averted replacement power costs (ARPC) and averted offsite property damage costs (AOC).

The methodology used by Duke was based primarily on NRC's guidance for performing cost-benefit analysis in NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997b). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) - COE

where APE = present value of averted public exposure ($)
AOC = present value of averted offsite property damage costs ($)
AOE = present value of averted occupational exposure costs ($)
AOSC = present value of averted onsite costs ($)
COE = cost of enhancement ($)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. Duke's derivation of each of the associated costs is summarized below.

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δ person-rem/reactor year)
x monetary equivalent of unit dose ($2000 per person-rem)
x present value conversion factor (10.76 based on a 20-year period with a 7-percent discount rate)

As stated in NUREG/BR-0184 (NRC 1997b), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. Duke used the following expression when calculating the APE for the 20-year license renewal period:

APE = $\$2.20\times10^4$ x (Change in public exposure)

Averted Offsite Property Damage Costs (AOC)

For SAMAs that reduce CDF, the AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor

Duke derived the values for averted offsite property damage costs based on information provided in Section 5.7.5 of NUREG/BR-0184 (NRC 1997b). A discount factor of 7 percent and a 4-percent rate of inflation were used. Duke used the following expression when calculating the AOC for the 20-year license renewal period:

$$AOC = \$3.92 \times 10^{9} \times (\text{Change in annual CDF})$$

Originally, as part of the ER, Duke did not include the AOC for containment-related SAMAs. In response to staff RAIs, Duke incorporated AOC as follows (Duke 2002a).

For containment-related SAMAs (which impact population dose but not CDF), Duke estimated the combined AOC and averted public exposure costs (APE) based on a conversion factor of $3000/person-rem, which was attributed to NUREG/CR-6349 (NRC 1995b). Duke used the following expression when calculating these costs (for containment-related SAMAs) for the 20-year license renewal period:

$$AOC + APE = \$3.23 \times 10^{4} \times (\text{Change in public exposure})$$

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
x occupational exposure per core damage event
x monetary equivalent of unit dose
x present value conversion factor

Duke derived the values for averted occupational exposure based on information provided in Section 5.7.3 of NUREG/BR-0184 (NRC 1997b). Best-estimate values provided for immediate occupational dose [33 person-Sv (3300 person-rem)] and long-term occupational dose [200 person-Sv (20,000 person-rem) over a 10-year cleanup period] were used. The present value of these doses was calculated using the equations provided in NUREG/BR-0184 in conjunction with a monetary equivalent of unit dose of $2000 per person-rem, a discount rate of 7 percent, and a time period of 20 years to represent the license-renewal period. Duke used the following expression when calculating the AOE for the 20-year license renewal period:

$$AOE = \$3.1 \times 10^{8} \times (\text{Change in annual CDF})$$

Averted Onsite Costs (AOSC) (Not Including Replacement Power Costs)

The AOSCs, as calculated by Duke, include averted cleanup and decontamination costs. NUREG/BR-0184, Section 5.7.6.2, states that long-term replacement power costs must also be

considered (NRC 1997b). Duke did not include this cost in the ER. However, Duke did add this cost in the responses (Duke 2002a) to the staff's RAIs.

Averted cleanup and decontamination costs (ACC) were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
x present value conversion factor

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 (NRC 1997b) as $\$1.5\times10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. Duke used the following expression when calculating the ACC for the 20-year license renewal period:

$$ACC = \$1.18\times10^{10} \times (\text{Change in annual CDF})$$

Averted Power Replacement Cost (APRC)

The Duke estimate of the annual power replacement cost for McGuire is based on an assumed discount rate of 7 percent for the 20-year license renewal period.

The estimated present power replacement costs of a severe accident occurring in each year of the license renewal period is given by (equation from NUREG/BR-0184):

$$PV_{RP} = [\$1.2\times10^8/0.07][1 - \exp(-0.07 \times 20)]^2$$

$$PV_{RP} = \$9.73\times10^8$$

Then, to estimate the net present value of power replacement over the 20-year license renewal (equation from NUREG/BR-0184, p. 5.44):

$$U_{RP} = [PV_{RP}/0.07][1 - \exp(-0.07 \times 20)]^2$$

$$U_{RP} = \$7.89\times10^9$$

$$APRC = URP \times (\text{Change in annual CDF})$$

Because the averted power replacement cost from the NUREG is in 1990 dollars, an assumption is made to include a 4 percent inflation rate over 11 years to bring the value into 2001 dollars; therefore,

$$APRC = \$1.21\times10^{10} \times (\text{Change in annual CDF})$$

Duke Results

The total benefit associated with each of the 15 SAMAs evaluated by Duke (seven that reduce CDF and eight that improve containment performance) is provided in Tables 5-6 and 5-7. One of the SAMAs has a positive net value (i.e., the total benefit is greater than the cost of the enhancement). All of the remaining SAMAs have a negative net value, even given the bounding risk-reduction benefits inherent in these estimates.

5.2.6.2 Staff Evaluation

The cost-benefit analysis provided by Duke (Duke 2001, 2002) was based primarily on NRC's *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997b). In the original ER, Duke did not include averted replacement power costs for SAMAs that reduce CDF or averted offsite property damage costs for SAMAs that improve containment performance. However, the impact of these factors was included in supplemental analyses provided by Duke in response to the staff's RAIs (Duke 2002a; NRC 2002a). The averted replacement power costs were assessed appropriately and the values calculated by Duke are consistent with independent staff assessments.

Duke used a conversion factor of $3,000/person-rem to determine the averted offsite property damage and averted public exposure costs. This effectively assumes a $1,000/person-rem conversion factor as a surrogate for averted offsite property damage, in addition to the accepted $2,000/person-rem conversion factor for averted offsite public exposure costs. Because offsite property damage costs are plant- and site-specific, it would be more consistent with standard practice to actually calculate the property damage using the MACCS code. Nevertheless, the averted offsite costs values (for health effects and property damage) calculated by Duke provide reasonably good agreement with typical site values and are acceptable for purposes of estimating the value of containment-related SAMAs. Inclusion of averted replacement power and offsite property damage costs did not result in identification of any additional cost-beneficial SAMAs, and would not call into question Duke's decision to eliminate seismic SAMAs from consideration, given the large costs associated with seismic SAMAs.

For most of the candidate SAMAs, the staff agrees with Duke that the SAMAs would clearly not be cost-beneficial because they have costs that are substantially (typically a factor of three or more) higher than the dollar equivalent of the associated benefits. This difference is considered to provide ample margin to cover uncertainties in the risk and cost estimates because estimates for these factors were generally evaluated in a conservative manner. This is true even when considering the 3 percent versus 7 percent discount rate sensitivity case or the use of a 40-year versus 20-year time period. However, the cost-benefit analyses for the some of the SAMAs related to hydrogen control in SBO events have benefits that are similar in magnitude to the costs. The frequency of SBO events for McGuire account for 47 percent of the total CDF of

4.9×10^{-5} per year based on Revision 2 of the PRA and 27 percent of the total CDF of 3.7×10^{-5} per year based on Revision 3 of the PRA. Also, ice condenser containments have a higher degree of vulnerability to hydrogen combustion in SBO events, as described in NUREG/CR-6427 (NRC 2000).

NUREG/CR-6427 provided a simplified Level 2 analysis that studied the direct containment heating (DCH) issue for plants with ice condenser containments (NRC 2000) and found that early containment failure is dominated by hydrogen combustion events rather than DCH events, and that no ice condenser plant is inherently robust to all credible DCH or hydrogen combustion events in station blackout. The study concluded that all plants, especially McGuire, would benefit from reducing SBO frequency or from providing some means of hydrogen control that is effective in SBO events. It should be noted that the NUREG contains several assumptions that may be justified for purposes of dispositioning the DCH issue but are not necessarily consistent with the best-estimate philosophy or PRA (such as a bounding assumption that random ignition prior to vessel breach will not occur). Accordingly, the NUREG is useful for understanding the uncertainties associated with early containment failure probabilities, but should not be interpreted as providing a realistic or best-estimate evaluation of the potential for early containment failure as a result of hydrogen combustion during SBO events.

In light of the issues raised in NUREG/CR-6427 concerning the likelihood of early containment failure in SBO events, the staff requested Duke to provide a reevaluation of the benefits associated with the hydrogen control measures (install back-up power to igniters and air return fans) assuming a containment response consistent with the findings in NUREG/CR-6427 (i.e., using the containment failure probabilities for DCH and non-DCH events reported in the study, in place of the conditional failure probabilities implicit in the baseline PRA). Under these assumptions, Duke estimated that the averted population dose risk from eliminating early containment failures would rise from a base case value of 0.055 person-Sv (5.5 person-rem) per year to 0.21 person-Sv (21 person-rem) per year. The benefit values based on use of the NUREG/CR-6427 containment failure probability for McGuire are reported in Table 5-8. Also shown are the benefits values for the sensitivity cases involving use of a 3-percent discount rate compared to a 7-percent discount rate in the base case and use of the SBO CDF estimates from Revision 3 of the PRA rather than Revision 2. All of the values in Table 5-8 include averted offsite property damage.

A number of points are worth noting regarding the Duke base case results and these sensitivity assessments:

- Not all early and late releases can be eliminated by providing hydrogen control. For example, late failures due to long-term containment over-pressure could still occur. Also, the non-safety related, non-seismic back-up power source may not be available in large seismic and tornado events, if it is not designed to withstand such events. An upper bound estimate can be provided by assuming that all containment failures – early and late – would be eliminated. More realistically, most of the early and some of

the late releases would be eliminated. The assumption that hydrogen control would eliminate all early failures is considered to provide a reasonable estimate of the risk reduction benefit. Accordingly, the estimated benefits shown in Table 5-8 are based on eliminating all early containment failures.

Table 5-8. Sensitivity Results for Hydrogen Control SAMAs (all benefits based on eliminating early failures only)

SAMA	Estimated Cost (per unit)	Estimated Benefits for Hydrogen Control SAMAs Under Various Assumptions			
		Based on Revision 2 of the PRA	Based on conditional containment failure probabilities from NUREG/CR-6427	Based on a 3% discount rate compared to a 7% discount rate in the base case	Based on SBO values from Revision 3 of the PRA
Back-up power to igniters & air return fans	$540,000	$178,000	$678,000	$248,000	$76,000
PARs	$750,000	$178,000	$678,000	$248,000	$76,000
Back-up power to igniters only	$205,000	Duke: no benefit, since air-return fans are needed	Duke: no benefit, since air-return fans are needed	Duke: no benefit, since air-return fans are needed	Duke: no benefit, since air-return fans are needed

- It is Duke's position that powering the igniters without also powering the air-return fans would not achieve effective hydrogen control. According to Duke, in order to realize the stated benefits, the air-return fans must also have a back-up power source. More than half of the cost of the SAMA to provide back-up power to igniters and air-return fans comes from powering the fans. Based on available technical information, it is not clear that operation of an air-return fan is necessary to provide effective hydrogen control. If only the igniters need to be powered during SBO, a less expensive option of powering a subset of igniters from a back-up generator, addressed by Duke in responses to RAIs (Duke 2002a; NRC 2002a), is within the range of averted risk benefits and would warrant further consideration.

- If a 3-percent discount rate is assumed in contrast to the 7-percent discount rate assumed in the base case analysis, the benefits are similar in magnitude to the costs if

back-up power to the air-return fans is not needed. This further supports the position that the benefits are large and that a hydrogen-related SAMA may be cost-beneficial.

- The effect of implementing the SAMA in the near term rather than delaying implementation until the start of the license renewal period (i.e., use of a 40-year rather than a 20-year, period in the value impact analyses) is bounded by the sensitivity study that assumed a 3-percent discount rate.

- The Revision 3 PRA results would reduce the averted risk benefits by about half. While this is a substantial reduction, it does not eliminate the generic concern that the benefits of additional hydrogen control are large.

The NRC has recognized that ice condenser containments like McGuire's are vulnerable to hydrogen burns in the absence of power to the hydrogen ignitor system. This issue is sufficiently important for all PWRs with ice condenser containments that NRC has made the issue a Generic Safety Issue (GSI), GSI-189 – Susceptibility of Ice Condenser and Mark III Containments to Early Failure from Hydrogen Combustion During a Severe Accident (NRC 2002b). As part of the resolution of GSI-189, NRC is evaluating potential improvements to hydrogen control provisions in ice condenser plants to reduce their vulnerability to hydrogen-related containment failures in SBO. This will include an assessment of the costs and benefits of supplying igniters from alternate power sources, such as a back-up generator, as well as containment analyses to establish whether air-return fans also need an ac-independent power source, as part of this modification. The need for plant design and procedural changes will be resolved as part of GSI-189 and addressed for McGuire and other ice condenser plants as a current operating license issue.

5.2.7 Conclusions

Duke completed a comprehensive effort to identify and evaluate potential cost-beneficial plant enhancements to reduce the risk associated with severe accidents at McGuire. As a result of this assessment, Duke concluded that no additional mitigation alternatives are cost-beneficial and warrant implementation at McGuire.

Based on its review of SAMAs for McGuire, the staff concurs that none of the candidate SAMAs are cost-beneficial with the possible exception of one SAMA related to hydrogen control in SBO events. This conclusion is consistent with the low level of risk indicated in the McGuire PRA and the fact that Duke has already implemented numerous plant improvements identified from previous plant-specific risk studies. Duke's position is that SAMAs that provide hydrogen control in SBO events are not cost-effective because back-up power would also need to be supplied to the air-return fans from ac-independent power sources in order to ensure mixing of the containment atmosphere; the cost of powering both the igniters and the air-return fans would exceed the expected benefit. However, based on available technical information, it is not clear that operation of an air-return fan is necessary to provide effective hydrogen control. If

only the igniters need to be powered during SBO, a less-expensive option of powering a subset of igniters from a back-up generator, addressed by Duke in responses to RAIs (Duke 2002a; NRC 2002a), is within the range of averted risk benefits and would warrant further consideration. Even if air-return fans are judged to be necessary to ensure effective hydrogen control in SBOs, the results of sensitivity studies suggest that this combined SAMA might also be cost-beneficial.

The staff concludes that one of the SAMAs related to hydrogen control in SBO sequences (supplying existing hydrogen igniters with back-up power from an independent power source during SBO events) is cost-beneficial under certain assumptions, which are being examined in connection with resolution of GSI-189. However, this SAMA does not relate to adequately managing the effects of aging during the period of extended operation. Therefore, it need not be implemented as part of license renewal pursuant to 10 CFR Part 54. The need for plant design and procedural changes will be resolved as part of GSI-189 and addressed for McGuire and all other ice condenser plants as a current operating license issue.

5.3 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 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

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

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U.S. Nuclear Regulatory Commission (NRC). 1997b. *Regulatory Analysis Technical Evaluation Handbook.* NUREG/BR-0184, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997c. *Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance.* NUREG-1560, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999a. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* "Section 6.3—Transportation, Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

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6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid Waste Management

Environmental issues associated with the uranium fuel cycle and solid waste management were discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999a).[a] The GEIS included a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management during the license renewal term that are listed in 10 CFR Part 51, Subpart A, Appendix B, and are applicable to McGuire Nuclear Station, Units 1 and 2 (McGuire). The generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS, based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Power Reactor." The GEIS also addresses the impacts from radon-222 and technetium-99. There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.1 The Uranium Fuel Cycle

Category 1 issues from 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to McGuire from the uranium fuel cycle and solid waste management are listed in Table 6-1.

Table 6-1. Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste Management During the Renewal Term

ISSUE–10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste [HLW])	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4, 6.6
Offsite radiological impacts (spent fuel and HLW)	6.1; 6.2.2.1; 6.2.3; 6.2.4, 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6, 6.6
Mixed waste storage and disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4, 6.6
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1

In its environmental report (ER; Duke 2001), Duke stated that "no new information existed for the issues that would invalidate the GEIS conclusions." No significant new information has been identified by the staff in the review process and in the staff's independent review.

Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of those GEIS issues, the staff concluded that the impacts are SMALL except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, as discussed below, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of these issues follows.

- Offsite radiological impacts (individual effects from other than the disposal of spent fuel and HLW). Based on information in the GEIS, the Commission found that

  > Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part [10 CFR 51.51(b)]. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

  The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (collective effects). Based on information in the GEIS, the Commission found that

  > The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem [148 person Sv], or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations.

> Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA [National Environmental Policy Act] implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (spent fuel and HLW disposal). Based on information in the GEIS, the Commission found that

> For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) 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 [1 mSv] per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem [1 mSv] per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem [1 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual dose limit is about 3×10^{-3}.
>
> Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously

compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 [DOE 1980]. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's [Environmental Protection Agency] generic repository standards in 40 CFR part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM) repository.

Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

Since the GEIS was originally issued in 1996, the EPA has published radiation protection standards for Yucca Mountain, Nevada, at 40 CFR Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada," on June 13, 2001

(66 FR 32132). The Energy Policy Act of 1992 (42 USC 10101 et seq) directed that the NRC adopt these standards into its regulations for reviewing and licensing the repository. The NRC published its regulations at 10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada," on November 2, 2001 (66 FR 55792). These standards include the following: (1) 0.15 mSv/year (15 mrem/year) dose limit for members of the public during the storage period prior to repository closure, (2) 0.15 mSv/year (15 mrem/year) dose limit for the reasonably maximally exposed individual for 10,000 years following disposal, (3) 0.15 mSv/year (15 mrem/year) dose limit for the reasonably maximally exposed individual as a result of a human intrusion at or before 10,000 years after disposal, and (4) a groundwater protection standard that states for 10,000 years of undisturbed performance after disposal, radioactivity in a representative volume of ground-water will not exceed (a) 0.19 Bq/L (5 pCi/L) (radium-226 and radium-228), (b) 0.56 Bq/L (15 pCi/L) (gross alpha activity), and (c) 0.04 mSv/year (4 mrem/year) to the whole body or any organ (from combined beta and photon emitting radionuclides).

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 U.S. Congress approved this recommendation on July 9, 2002. This development does not represent new and significant information with respect to the offsite radiological impacts related to spent fuel and HLW disposal during the renewal term.

The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts related to spent fuel and HLW disposal during the renewal term beyond those discussed in the GEIS.

- Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS, the Commission found that

  > The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be SMALL.

The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found that

> The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found that

> The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and non-radiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of mixed waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Onsite spent fuel. Based on information in the GEIS, the Commission found that

  > The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

  The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

- Nonradiological waste. Based on information in the GEIS, the Commission found that

  > No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.

  The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

- Transportation. Based on information contained in the GEIS, the Commission found that

  > The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4--Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in Sec. 51.52.

  McGuire meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. In recent years, licensees have requested authorization to increase fuel enrichment and fuel burnup. In its letter dated September 22, 1999 (NRC 1999b), the staff approved a maximum burnup rate of 60,000 MWd/MTU. Based on a reassessment of the impacts

resulting from the transportation of spent fuel (NRC 2001), the staff's preliminary determination is that the environmental impacts at a burnup rate of 62,000 MWd/MTU are unchanged from those summarized in Table S-4. The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

6.2 References

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

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." I

10 CFR Part 63. Code of Federal Regulations. Title 10, *Energy*, Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada." I

40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste." I

40 CFR Part 197. Code of Federal Regulations. Title 40, *Protection of Environment*, Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada." I

Duke Energy Corporation (Duke). 2001. *Applicant's Environmental Report - Operating License Renewal Stage - McGuire Nuclear Station.* Charlotte, North Carolina.

Energy Policy Act of 1992. 42 USC 10101 et seq.

U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste.* DOE/EIS 00046-G, Vols. 1-3, 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). 1999a. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* "Section 6.3 - Transportation, Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999b. Letter from F. Rinaldi, NRC, to H.B. Barron, Vice President, McGuire Site, Duke Energy Corporation. Subject: McGuire Nuclear Station, Units 1 and 2 Re: ISSUANCE OF AMENDMENTS.

U.S. Nuclear Regulatory Commission (NRC). 2001. Environmental Effects of Extending Fuel Burnup Above 60 GWd/MTU, NUREG/CR-6703, Washington D.C.

7.0 Environmental Impacts of Decommissioning

Environmental issues associated with decommissioning, which result from continued plant operation during the renewal term, were discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a] The GEIS included a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues were assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that did not meet one or more of the criteria of Category 1, and therefore, additional plant-specific review of these issues is required. No Category 2 issues are related to decommissioning McGuire Nuclear Station, Units 1 and 2 (McGuire).

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that are applicable to McGuire decommissioning following the renewal term are listed in Table 7-1. In its environmental report (ER; Duke 2001), Duke Energy Corporation (Duke) stated "no new information exists for the issues that would invalidate the GEIS conclusions." The staff has not identified any significant new information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Table 7-1. Category 1 Issues Applicable to Decommissioning of McGuire Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
DECOMMISSIONING	
Radiation Doses	7.3.1; 7.4
Waste Management	7.3.2; 7.4
Air Quality	7.3.3; 7.4
Water Quality	7.3.4; 7.4
Ecological Resources	7.3.5; 7.4
Socioeconomic Impacts	7.3.7; 7.4

information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the staff concluded in the GEIS that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found that

  > Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem [0.01 person-Sv] caused by buildup of long-lived radionuclides during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no radiation doses associated with decommissioning following license renewal beyond those discussed in the GEIS.

- Waste management. Based on information in the GEIS, the Commission found that

  > Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

  The staff has not identified any new and significant information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality. Based on information in the GEIS, the Commission found that

  > Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

  The staff has not identified any new and significant information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of license renewal on air quality during decommissioning beyond those discussed in the GEIS.

- Water quality. Based on information in the GEIS, the Commission found that

  > The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

  The staff has not identified any new and significant information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of the license renewal term on water quality during decommissioning beyond those discussed in the GEIS.

- Ecological Resources. Based on information in the GEIS, the Commission found that

  > Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

The staff has not identified any new and significant information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of the license renewal term on ecological resources during decommissioning beyond those discussed in the GEIS.

- Socioeconomic Impacts. Based on information in the GEIS, the Commission found that

  > Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

  The staff has not identified any new and significant information during its independent review of the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of license renewal on the socioeconomic impacts of decommissioning beyond those discussed in the GEIS.

7.1 References

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

Duke Energy Corporation (Duke). 2001. *Applicant's Environmental Report – Operating License Renewal Stage – McGuire Nuclear Station.* Charlotte, North Carolina.

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). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.