NUREG-1437
Supplement 7

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 7

Regarding North Anna Power Station, Units 1 and 2

Final Report

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Abstract

The U.S. Nuclear Regulatory Commission (NRC) 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 the Virginia Electric and Power Company (VEPCo) to renew the OLs for North Anna Power Station, Units 1 and 2, for an additional 20 years under 10 CFR Part 54. This SEIS includes the NRC staff's analysis in which the staff 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 VEPCo nor the staff has identified information that is both new and significant for any of these issues that apply to North Anna. In addition, the staff determined that information provided during the scoping process did not call into question the conclusions in the GEIS. Therefore, the staff concludes that the impacts of renewing the North Anna Power Station 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 from high-level waste and spent fuel, which were not assigned a single significance level).

Regarding the remaining 23 issues, those that apply to North Anna Power Station, Units 1 and 2, 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 scoping process 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 North Anna Power Station, Units 1 and 2, are not so great

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

that preserving the option of license renewal for energy-planning decision-makers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by VEPCo; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review, and (5) the staff's consideration of public comments.

Contents

Figures

Tables

Executive Summary

By letter dated May 29, 2001, the Virginia Electric and Power Company (VEPCo) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses (OLs) for North Anna Power Station, Units 1 and 2, for an additional 20-year period. If the OLs are renewed, State regulatory agencies and VEPCo will ultimately decide whether the plants 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, then the plants must be shut down at or before the expiration dates of the current OLs, which are April 1, 2018, for Unit 1 and August 21, 2020, for Unit 2.

Section 102 of the National Environmental Policy Act (NEPA) (42 USC 4321), directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. 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 Plant*s (GEIS), NUREG-1437, Volumes 1 and 2.[(a)]

Upon acceptance of the VEPCo 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 North Anna in October 2001 and held public scoping meetings on October 18, 2001, in Louisa, Virginia. In preparing this Supplemental Environmental Impact Statement (SEIS) for North Anna, the staff reviewed the VEPCo 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 the scope of the environmental review are provided in Appendix A, Part I, of this SEIS.

On May 17, 2002, the U.S. Environmental Protection Agency (EPA) published the Notice of Availability of the draft SEIS (67 FR 35108). A 75-day comment period began on that date, during which members of the public could comment on the preliminary results of the NRC staff's review. Two public meetings were held near North Anna Power Station on June 25, 2002, to describe the preliminary results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on

(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.

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 the SEIS.

This SEIS includes the NRC 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, even if an OL is renewed, there are other factors that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OL.

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 operation–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. It evaluates 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 a footnote 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 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.

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 not likely 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 as 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 North Anna) and alternative methods of power generation. Based on projections made by the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), gas- and coal-fired generation appear to be the most likely power-generation alternatives if the power from North Anna is replaced. These alternatives are evaluated assuming that the replacement power generation plant is located at either the North Anna site or some other unspecified alternate location.

VEPCo and the staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither VEPCo nor the staff has identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither VEPCo nor the staff has identified any new issue applicable to North Anna that has a significant environmental impact. These determinations include the consideration of public comments. Therefore, the staff relies upon the conclusions of the GEIS for all of the Category 1 issues that are applicable to North Anna.

VEPCo's license renewal application presents an analysis of the Category 2 issues that are applicable to North Anna. In addition, the staff has evaluated the two uncategorized issues, environmental justice and chronic effects from electromagnetic fields. The staff has reviewed the VEPCo analysis for each issue and has conducted an independent review of each issue. Five Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at North Anna. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. VEPCo has stated that its evaluation of structures and components, as required by 10 CFR 54.21, did not identify any major plant refurbishment activities or modifications as necessary to support the continued operation of North Anna for the license renewal period. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant component replacement, and therefore, are not expected to affect the environment outside of the bounds of the plant operations evaluated in the *Final Environmental Statement Related to the Continuation of Construction and the Operation of North Anna Power Station, Units 1 and 2 and the Construction of Units 3 and 4*, issued by the U.S. Atomic Energy Commission in 1973, and two addenda to the final environmental statement related to the operation of North Anna Power Station, Units 1 and 2, issued by the NRC in 1976 and 1980.

Twelve Category 2 issues related to operational impacts and postulated accidents during the renewal term, as well as environmental justice and chronic effects of electromagnetic fields, are discussed in detail in this SEIS. Five of the Category 2 issues and environmental justice apply to both refurbishment and to operation during the renewal term and are only discussed in this SEIS in relation to operation during the renewal term. For all 12 Category 2 issues and environmental justice, the staff concludes that the potential environmental effects are of SMALL significance in the context of the standards set forth in the GEIS. In addition, the staff determined that appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for North Anna and the plant improvements already made, the staff concludes that none of the candidate SAMAs are cost-beneficial.

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 North Anna 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 North Anna. 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 North Anna 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 VEPCo; (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

µCi	microcurie(s)
μm	micrometer(s)
AAC	alternate alternating current
ac	acre(s)
AC	alternating current
ACC	averted cleanup and decontamination costs
A.D.	Anno Domini
ADAMS	Agencywide Document Access and Management System
AEA	Atomic Energy Act of 1954, 42 USC 2011 et seq.
AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
AOC	averted offsite property damage costs
AOE	averted occupational exposure costs
AOSC	averted onsite costs
APE	averted public exposure costs
ATWS	anticipated transient(s) without scram
B.C.	before Christ
Bq	becquerel(s)
Btu	British thermal unit(s)
°C	degrees Celsius
CAA	Clean Air Act of 1970, as amended, 42 USC 7401, et seq.
CCW	component cooling water
CDF	core damage frequency
CEQ	Council on Environmental Quality
CET	containment event tree
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	curie(s)
cm	centimeter(s)
COE	cost of enhancement
COV	Code of Virginia
CW	circulating water
CWA	Clean Water Act of 1977 (also known as Federal Water Pollution Control Act)
CZMA	Coastal Zone Management Act, 16 USC 1451, et seq.
DBAs	design basis accidents
DC	direct current

DHR	decay heat removal
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DSM	demand-side management
EIA	Energy Information Administration (of DOE)
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
EPA	U.S. Environmental Protection Agency
EPZ	emergency planning zone
ER	Environmental Report
ESA	Endangered Species Act, 16 USC 1531, et seq.
ESGR	emergency switchgear room
°F	degrees Fahrenheit
FERC	Federal Energy Regulatory Commission
FES	Final Environmental Statement
FR	Federal Register
ft	foot/feet
FWPCA	Federal Water Pollution Control Act (also known as the Clean Water Act of 1977)
FWS	U.S. Fish and Wildlife Service
gal	gallon
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437
gpd	gallon(s) per day
gpm	gallon(s) per minute
Gy	Gray(s)
ha	hectare(s)
HEPA	high-efficiency particulate air (filter)
HLW	high-level waste
hp	horsepower
hr	hour(s)
HVAC	heating, ventilation and air conditioning
Hz	hertz
ICRP	International Commission on Radiological Protection
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory

IPA	integrated plant assessment
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination for External Events
ISFSI	independent spent fuel storage installation
ISLOCA	interfacing system loss-of-coolant accident
J	joule(s)
kg	kilogram(s)
km	kilometer(s)
kPa	kilopascal(s)
kV	kilovolt(s)
kW	kilowatt
kWh	kilowatt hour(s)
L	liter(s)
lb	pound(s)
LERF	large early release frequency
LHSI	low heat safety injection
LNG	liquefied natural gas
LOCAs	loss-of-coolant accidents
LOOP	loss of offsite power
m	meter(s)
mA	milliampere(s)
MACCS2	MELCOR Accident Consequence Code System 2
MFW	main feedwater
MG	motor generator
MGD	million gallons per day
mGy	milligray(s)
mi	mile(s)
min	minute(s)
MJ	megajoule(s)
mL	milliliter(s)
MOX	mixed-oxide fuel
mph	mile(s) per hour
mrad	millirad(s)
mrem	millirem(s)
MSIV	main steam isolation valve
MSLB	main steam line break
mSv	millisievert(s)

MT	metric ton(s) (or tonne[s])
MTHM	metric ton(s) (or tonne[s]) heavy metal
MW	megawatt(s)
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWh	megawatt hour(s)
NA	not applicable
NAPS	North Anna Power Station
NAS	National Academy of Sciences
n.d.	not dated
NEPA	National Environmental Policy Act of 1969
NESC	National Electrical Safety Code
ng	nanograms
NHPA	National Historic Preservation Act of 1966, 16 USC 470, et seq.
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NO_x	nitrogen oxide(s)
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NUG	non-utility generator
NWPPC	Northwest Power Planning Council
ODCM	Offsite Dose Calculation Manual
OL	operating license
PARS	Publicly Available Records portion of ADAMS
pCi	picocurie(s)
PM_{10}	particulate matter with aerodynamic diameter <10 mm
psig	pounds per square inch (gauge)
PRA	Probabilistic Risk Assessment
PWR	pressurized water reactor
RAI	request for additional information
RCP	reactor coolant pump
RCRA	Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.
rem	special unit of dose equivalent, equal to 0.01 Sv
REMP	radiological environmental monitoring program
rms	root mean square

RPC	replacement power cost
RRW	risk reduction worth
RSA	Rapidan Service Authority
s	second(s)
SAMA	severe accident mitigation alternative
SAR	safety analysis report
SBO	station blackout
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SG PORV	steam generator power-operated relief valves
SGTR	steam generator tube rupture
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SO_x	sulfur oxides
STC	source term category
Sv	sievert, special unit of dose equivalent
SW	service water
TBq	tera becquerel
TDAFW	turbine-driven auxiliary feedwater
UFSAR	Updated Final Safety Analysis Report
USC	United States Code
USCB	U.S. Census Bureau
VA	Virginia
VAC	Virginia Administrative Code
VDACS	Virginia Department of Agriculture and Consumer Services
VDCR	Virginia Department of Conservation and Recreation
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VDHR	Virginia Department of Historic Resources
VEPCo	Virginia Electric and Power Company
VMRC	Virginia Marine Resources Commission
VPDES	Virginia Pollution Discharge Elimination System
VSWCB	Virginia State Water Control Board
WHTF	Waste Heat Treatment Facility
yr	year(s)

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 has 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. The GEIS guides the preparation of complete plant-specific information in support of the OL renewal process.

The Virginia Electric and Power Company (VEPCo) operates North Anna Power Station, Units 1 and 2, in central Virginia, under OLs NPF-4 and NPF-7 issued by the NRC. These OLs will expire on April 1, 2018, for Unit 1 and August 21, 2020, for Unit 2. On May 29, 2001, VEPCo submitted an application to the NRC to renew the North Anna Power Station, Units 1 and 2, OLs for an additional 20 years under 10 CFR Part 54. The application also included renewal for Surry Power Station in Surry, Virginia. A separate environmental evaluation is being conducted for Surry Power Station. VEPCo 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), VEPCo submitted an Environmental Report (ER) (VEPCo 2001), in which VEPCo 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 plant-specific supplement to the GEIS (i.e., the supplemental EIS [SEIS]) for the VEPCo license renewal application. This SEIS is a supplement to the GEIS because it relies, in part, on the findings of the GEIS. The staff will also prepare 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.

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 North Anna Power Station, Units 1 and 2, OLs, (3) discuss the purpose and need for the proposed action, and (4) present the status of VEPCo'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 any adverse impacts that cannot be avoided; the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity; and any irreversible or irretrievable commitment of resources. The final chapter 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. Appendixes B through F, respectively, list the following:

- the preparers of the supplement
- the chronology of correspondence between NRC and VEPCo with regard to this SEIS
- the organizations contacted during the development of this SEIS
- VEPCo'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 North Anna Power Station, Units 1 and 2.

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 support 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.

The GEIS documents 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, the GEIS (1) describes the activity that affects the environment, (2) identifies the population or resource that is affected, (3) assesses the nature and magnitude of the impact on the affected population or resource, (4) characterizes the significance of the effect for both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants, and (6) considers 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 of impacts 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 a footnote 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.

The GEIS assigns a significance level to each environmental issue, assuming that ongoing mitigation measures would continue.

The GEIS includes 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 are 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 in this 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 last two 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 51.23(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 North Anna Power Station, Units 1 and 2, OLs, VEPCo developed a process to ensure that information not addressed in, or available, during the GEIS evaluation regarding the environmental impacts of license renewal for North Anna Power Station, Units 1 and 2, would be properly reviewed before submitting the ER and that such new and potentially significant information related to renewal of the licenses for Units 1 and 2 would be identified, reviewed, and assessed during the period of NRC review. VEPCo 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 North

Anna Power Station, Units 1 and 2. This review was performed by personnel from VEPCo 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*, 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 North Anna Power Station, Units 1 and 2. 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 VEPCo license-renewal application began with publication of a notice of acceptance for docketing and opportunity for a hearing in the Federal Register (FR; 66 FR 39213 [NRC 2001a]) on July 27, 2001. The staff published a notice of intent to prepare an EIS and conduct scoping (66 FR 46294 [NRC 2001b]) for North Anna on September 4, 2001. Two public scoping meetings were held on October 18, 2001, in Louisa, Virginia. Comments received during the scoping period were summarized in the *Environmental Impact Statement Scoping Process: Summary Report – North Anna Power Station, Units 1 and 2, Virginia* (NRC 2002). Comments that are applicable to this environmental review are presented in Part I of Appendix A.

The staff followed the review guidance contained in *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*, NUREG-1555, Supplement 1 (NRC 2000). The staff and its contractors retained to assist the staff visited the North Anna Power Station on October 17 and 18, 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. Other documents related to North Anna Power Station, Units 1 and 2, were reviewed and are referenced.

On May 17, 2002, the U.S. Environmental Protection Agency (EPA) published the Notice of Availability of the draft SEIS (67 FR 35108 [EPA 2002]). A 75-day comment period began on that date, during which members of the public could comment on the preliminary results of the NRC staff's review. During this comment period, two public meetings were held near North Anna on June 25, 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 North Anna Power Station, Units 1 and 2, draft SEIS ended on August 1, 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. The NRC responses to these comments are also provided.

This SEIS presents the staff's analysis in which the staff considers and weighs the environmental effects of the proposed renewal of the OLs for North Anna Power Station, Units 1 and 2, 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 North Anna Power Station, Units 1 and 2. The North Anna Power Station is located in Louisa County in rural central Virginia. The plant has two Westinghouse-designed light-water reactors, and each generating unit is designed to operate at core power levels up to a net electrical output of approximately 895 MW(e). Plant cooling is provided by a once-through cooling system to remove waste heat from the reactor-steam electric system. Cooling water is withdrawn from Lake Anna. Units 1 and 2 produce electricity to supply the needs of more than 450,000 homes. The current OL for Unit 1 expires on April 1, 2018, and the OL for Unit 2 expires on August 21, 2020. By letter dated May 29, 2001, VEPCo submitted an application to the NRC (VEPCo 2001) to renew

these OLs for an additional 20 years of operation (i.e., until April 1, 2038, for Unit 1 and August 21, 2040, for Unit 2).

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 (GEIS Section 1.3 [NRC 1996]):

> 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

VEPCo is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, VEPCo provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with North Anna Power Station, Units 1 and 2, license renewal. 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 VEPCo is included in Appendix E.

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 ER states that VEPCo is in compliance with applicable environmental standards and requirements for North Anna Power Station, Units 1 and 2. The staff has also not identified any environmental issues that are both new and significant.

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-4 (Unit 1) NPF-7 (Unit 2)	April 1, 2018 (Unit 1) August 21, 2020 (Unit 2)	Operation of North Anna Power Station, Units 1 and 2
FWS	Endangered Species Act, Section 7	Consultation	NA	NRC letter to FWS (January 24, 2002)	Operation during the renewal term
FWS	Migratory Bird Treaty Act	Permit	MB705136-0	March 31, 2003	Removal of osprey nests causing safety hazards
VDEQ	FWPCA	NPDES permit and FWPCA Section 401 certification	VA0052451	November 11, 2006	Permit for plant and storm water discharges
VDEQ	9 VAC 5-20-160	Registration	40726	Annual recertification	Annual recertification of air emissions sources
VDEQ	9 VAC 5-80-10	Permit	None	None	New source review, emergency blackout generator
VDEQ	9 VAC 5, Ch. 500	Exclusionary general permit	None	None	Annual emissions from boilers, diesel generators, and blackout generator
VDEQ	Coastal Zone Management Act, Section 307	Consistency determination	None	Letter from VDEQ to VEPCo (February 21, 2002)	Compliance with the Virginia Coastal Program
VDHR	National Historic Preservation Act, Section 106	Consultation	NA	NRC letter to VDHR (January 3, 2002)	Impact on sites listed or eligible for listing in the National Register of Historic Places

FWPCA - Federal Water Pollution Control Act (also known as the Clean Water Act)
FWS - U.S. Fish and Wildlife Service
NPDES - National Pollutant Discharge Elimination System
NA - Not applicable
VAC - Virginia Administrative Code
VDEQ - Virginia Department of Environmental Quality
VDHR - Virginia Division of Historic Resources

1.6 References

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

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

10 CFR Part 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.

Coastal Zone Management Act (CZMA). 16 USC 1451, et seq.

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] of 1977).

Migratory Bird Treaty Act of 1918. 16 USC 703, et seq.

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. Environmental Protection Agency (EPA). 2002. "Notice of Availability of Environmental Impact Statements". Federal Register, Vol. 67, No. 96, p. 35108 (May 17, 2002).

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. "Virginia Electric Power Company, North Anna, Units 1 and 2, and Surry, Units 1 and 2, Notice of Acceptance for Docketing of the Application and Notice of Opportunity for a Hearing Regarding Renewal of License Nos. NPF-4, NPF-7, DPR-32, and DPR-37 for an Additional 20-Year Period." Federal Register: Vol. 66, No. 145, pp. 39213-39214, July 27, 2001 (66 FR 39213).

U.S. Nuclear Regulatory Commission (NRC). 2001b. "Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." Federal Register: Vol. 66, No. 171, pp. 46294-46295, September 4, 2001 (66 FR 46294).

U.S. Nuclear Regulatory Commission (NRC). 2002. *Environmental Impact Statement Scoping Process: Summary Report – North Anna Power Station Units 1 & 2, Louisa, Virginia*. Washington, D.C.

Virginia Administrative Codes (VAC). 1991. State Air Pollution Control Board, "Registration." 9 VAC 5-20-160, Richmond, Virginia.

Virginia Administrative Codes (VAC). 1991. State Air Pollution Control Board, "Permits: New and Modified Stationary Sources." 9 VAC 5-80-10, Richmond, Virginia.

Virginia Administrative Codes (VAC). 1991. State Air Pollution Control Board, "Exclusionary General Permit." 9 VAC 5 Chapter 500, Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for North Anna Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

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

The North Anna Power Station, Units 1 and 2, are located in Louisa County in predominately rural central Virginia. The North Anna Power Station is situated on a peninsula on the southern shore of Lake Anna, a 27-km (17-mi) long reservoir. North Anna is situated approximately 64 km (40 mi) northwest of Richmond, Virginia. The plant consists of two units. Each unit is equipped with a nuclear steam unit supplied by Westinghouse Electric Corporation that uses a pressurized water reactor and once-through cooling system. The plant and its environs are discussed in Section 2.1, and the plant's interactions with the environment are presented in Section 2.2.

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

The North Anna Power Station is located in rural Louisa County, which had a population of about 25,000 in 2000. The plant is located in the triangle between the cities of Richmond, Charlottesville, and Fredericksburg. Figure 2-1 shows the location of the North Anna Power Station in relationship to the counties and important cities and towns within a 80-km (50-mi) radius. Interstate 95 passes within 26 km (16 mi) of North Anna, and Interstate 64 passes within 29 km (18 mi). The nearest community is the town of Mineral, approximately 10 km (6 mi) southwest of North Anna. Louisa, the County seat, is 19 km (12 mi) west of the site. The North Anna Power Station is situated on a peninsula on the southern shore of Lake Anna, approximately 8 km (5 mi) upstream from the North Anna Dam, at a minimum elevation of 83 m (271 ft) above mean sea level. The normal elevation of Lake Anna is 76 m (250 ft) above mean sea level. The station occupies approximately 422 ha (1043 ac) of land and its Waste Heat Treatment Facility covers about 1400 ha (3400 ac), as shown in Figure 2-2 and discussed in Section 2.1.3. All site land, subsurface lands, and mineral rights are owned by the Virginia Electric and Power Company (VEPCo). No public or commercial highways, railroads, or waterways traverse the site. VEPCo also owns and operates the North Anna Hydroelectric Project, an 855-kW capacity hydroelectric power plant at the base of the North Anna Dam.

Lake Anna, a man-made reservoir, was created in 1971 by erecting a dam on the main stem of the North Anna River. Impoundment of the reservoir started in January 1972 and was expected to continue until late 1973 or 1974; however, due to higher than expected precipitation, the reservoir was filled by December 1972 (AEC 1973). The lake is approximately 27 km (17 mi) long with 435 km (272 mi) of irregular shoreline and 3900 ha (9600 ac) of water surface. Lake Anna was created primarily as a source of cooling water for North Anna, although it has become a popular recreation area, while the dam provides downstream flood control. It is not

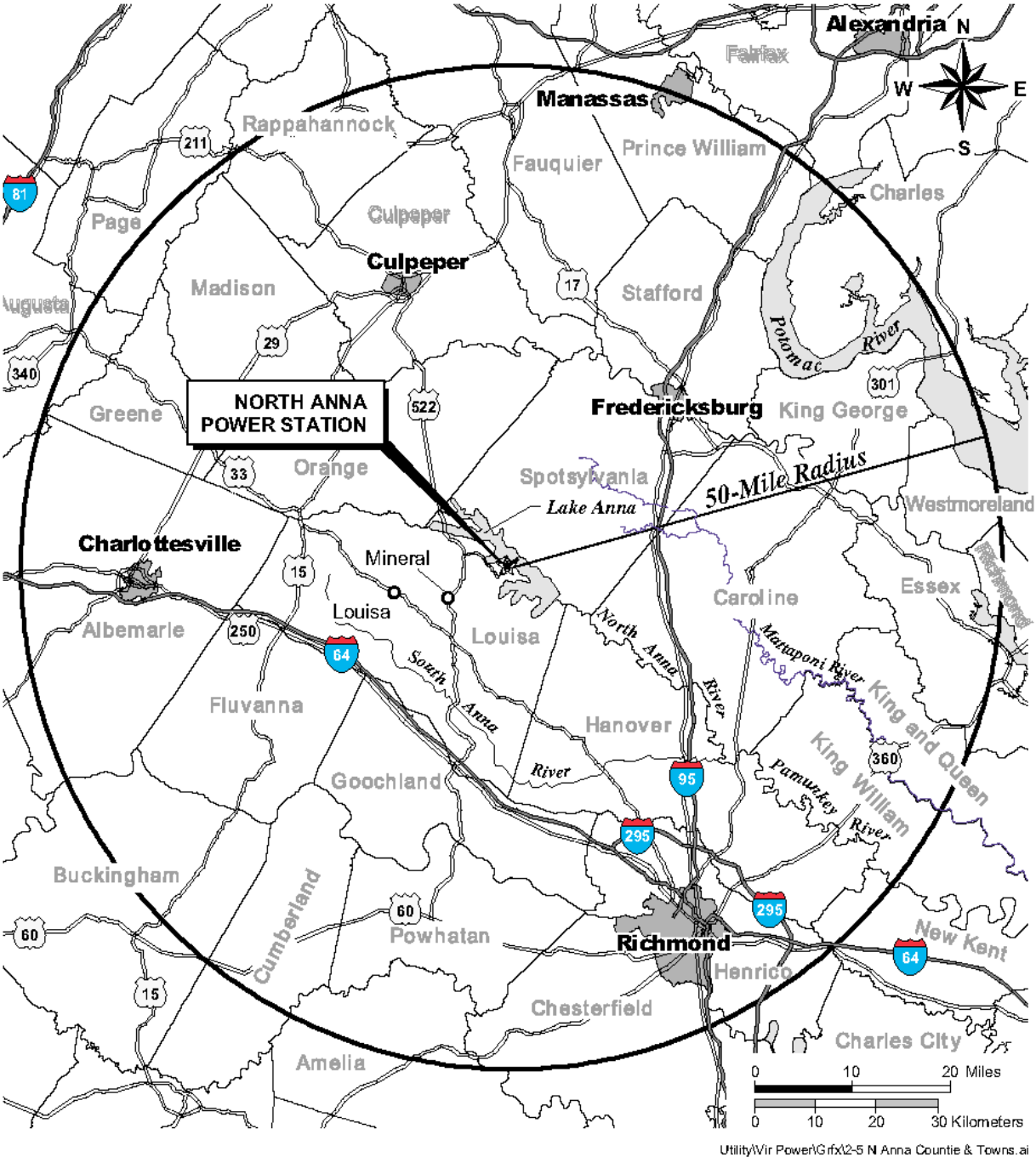

Figure 2-1. Location of North Anna Power Station, 80-km (50-mi) Region

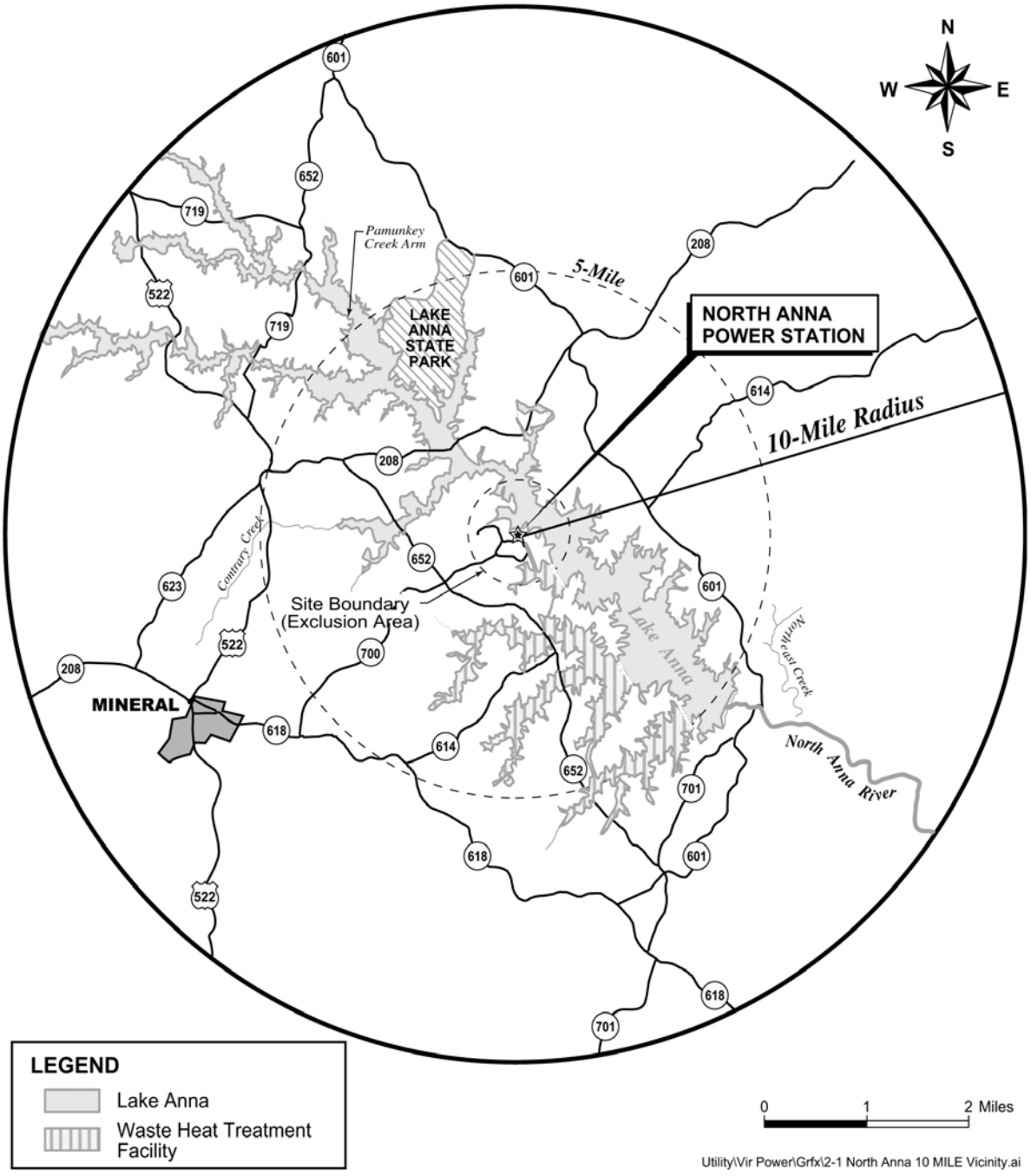

Figure 2-2. Location of North Anna Power Station, Units 1 and 2, 10-km (6-mi) Region

used as a source of potable or industrial water. VEPCo owns the land, above and below the surface, around the lake, up to the expected 78-m (255-ft) high-water mark above mean sea level. Recreational and retirement development has grown significantly around Lake Anna. Land between the many embayments remains privately held. A final Lake Anna Special Area Plan to coordinate planning efforts by the three counties for the Lake Anna region and watershed was released in March 2000 (Lake Anna 2000).

2.1.1 External Appearance and Setting

Distinctive features of the North Anna Power Station include the 41-m (135-ft) diameter cylindrical containment buildings with hemispherical domes. The domes are 0.76 m (2.5 ft) thick, and the overall height is approximately 58 m (191 ft). Another distinctive feature of North Anna is the 1400-ha (3400-ac) Waste Heat Treatment Facility (WHTF). The WHTF, formed by diking off the three southern-most arms of Lake Anna, consists of three cooling lagoons interconnected by canals (Figure 2-3). There is also an Independent Spent Fuel Storage Installation (ISFSI) located on the site (Figure 2-4).

The topography in the region of North Anna is characteristic of the central Piedmont Plateau of Virginia, with a gently undulating surface varying from 61 to 152 m (from 200 to 500 ft) above sea level. The surrounding region is covered with forest and cut-over second growth timber, interspersed with an occasional farm.

2.1.2 Reactor Systems

North Anna Power Station, Units 1 and 2, are shown in Figure 2-4. Each unit includes a three-coolant-loop pressurized light water reactor nuclear steam supply system and steam-driven turbine generator manufactured by Westinghouse. The balance of each unit was designed by VEPCo with the assistance of its architect-engineer, Stone & Webster Engineering Corporation. Each unit was designed for an output of 2775 MW(t), with corresponding gross electrical output of approximately 907 MW(e). Units 1 and 2 achieved commercial operation in June 1978 and December 1980, respectively. In 1986, based on an NRC-prepared environmental assessment and Finding of No Significant Impact, both units were uprated to a core power output of 2893 MW(t) with an expected gross output of 982 MW(e) and net capacity of 895 MW(e)[(a)] (VEPCo 2001b).

(a) Gross capacity is the output of the plant's generator. Net capacity is the gross capacity less the power used internally by the plant.

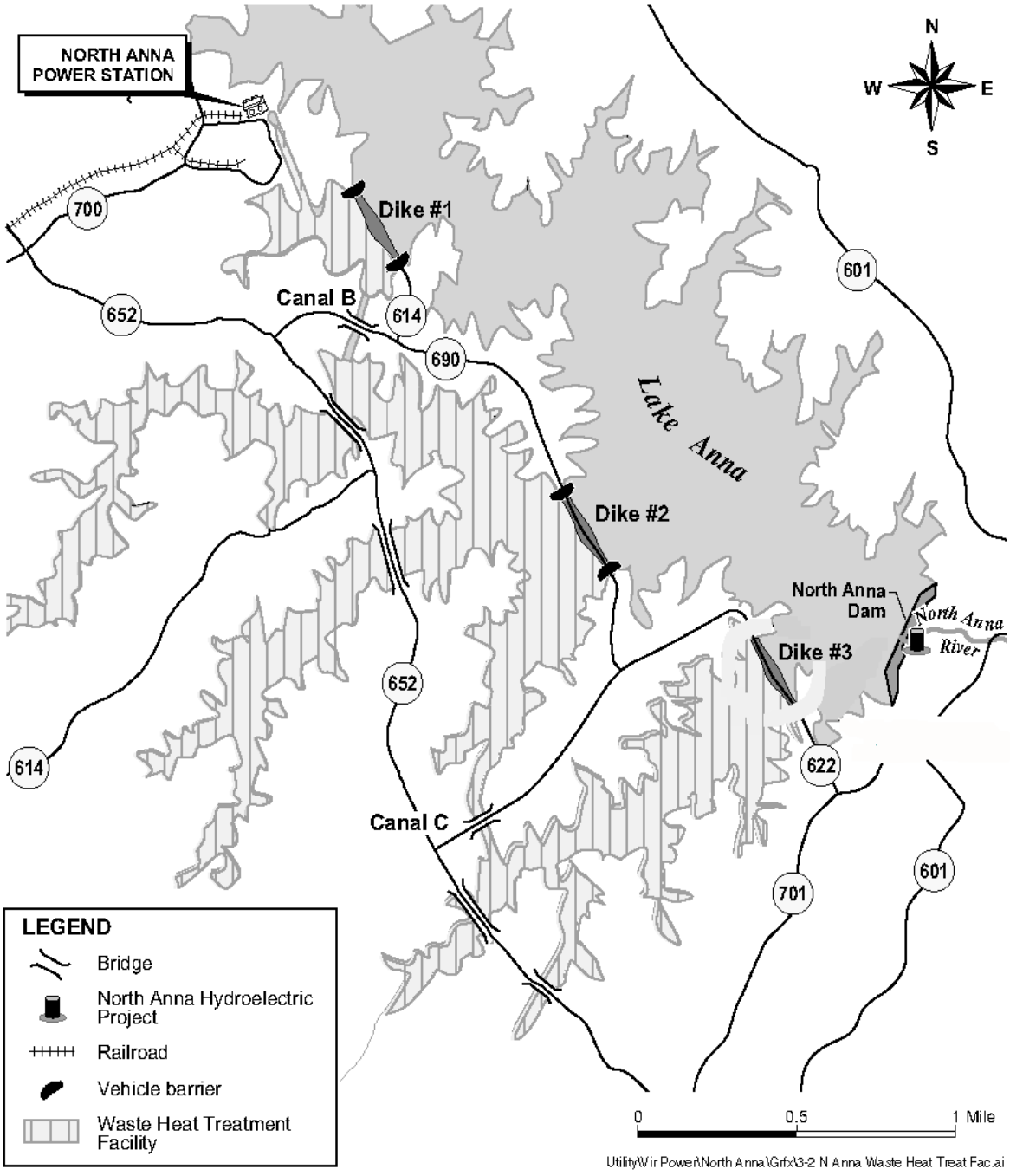

Figure 2-3. North Anna Power Station Waste Heat Treatment Facility

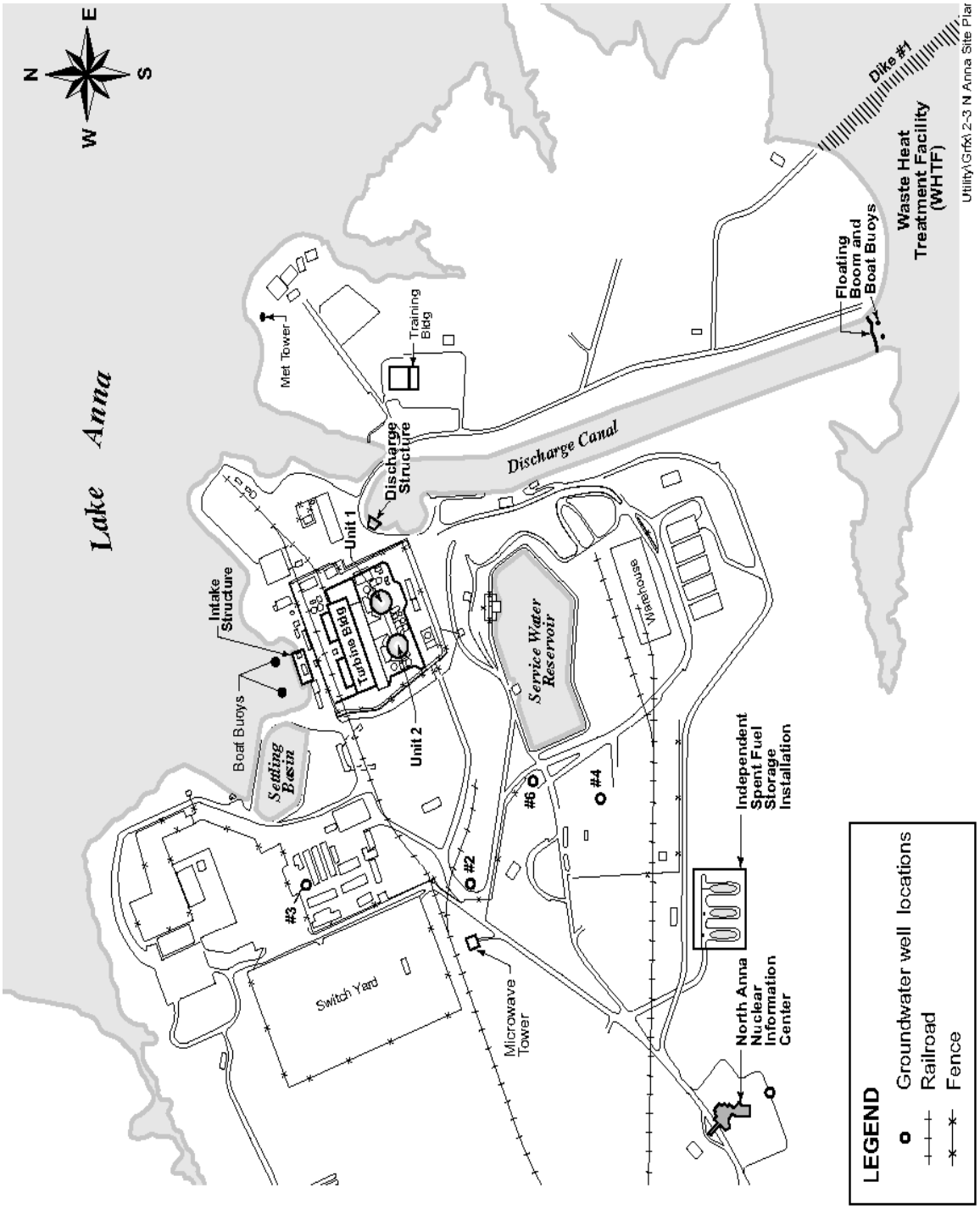

Figure 2-4. North Anna Power Station - Detail Map

Each reactor containment structure is a steel-lined, reinforced-concrete, 41-m (135-ft) diameter cylinder with a hemispheric dome and a flat reinforced-concrete foundation mat. The concrete vertical walls are 1.4 m (4.5 ft) thick, with an outside diameter of 41 m (135 ft). The dome is 0.76 m (2.5 ft) thick, and the overall height is approximately 58 m (191 ft). Air pressure inside each containment structure is maintained at 140 kPa (5 psig) below atmospheric pressure for routine operation. Together with its engineered safety features, each containment structure is designed to withstand an internal pressure of 410 kPa (45 psig) above atmospheric pressure accompanying the design-basis loss-of-coolant accident and provides radiation shielding for both normal operation and design-basis accident conditions (VEPCo 2001b).

2.1.3 Cooling and Auxiliary Water Systems

North Anna Power Station uses a once-through heat dissipation system that withdraws water from Lake Anna, pumps the water through the condenser, and returns heated water into the WHTF. When both units are operating at the design station load, 1.2×10^5 L/s (1.9×10^6 gpm) of water is withdrawn from Lake Anna and discharged into the WHTF with a temperature increase of approximately 8.1°C (14.5°F). This discharge is subject to the conditions of a National Pollutant Discharge Elimination System (NPDES) permit issued by the Virginia Department of Environmental Quality (VDEQ 2001).

Cooling water is withdrawn from Lake Anna through intakes located on a cove just north of North Anna (see Figure 2-4). Trash racks and traveling screens are used to prevent debris and fish from entering the cooling system.

After the water is used for condenser cooling, it is discharged into the 1400-ha (3400-ac) WHTF, formed before Lake Anna was filled by diking the three southern-most arms of Lake Anna. The WHTF consists of three cooling lagoons interconnected by canals (see Figure 2-3). Discharged cooling water moves from the first cooling lagoon in the WHTF to a second lagoon through Canal B, and from the second lagoon into the third lagoon through Canal C. The only discharge from the WHTF into Lake Anna is through Dike 3 near the dam. This discharge is also subject to the conditions of the NPDES permit issued by the VDEQ (VDEQ 2001).

The service water system, normally operated as a closed-loop system, uses a 4-ha (9-ac) reservoir and spray array to dissipate heat. Makeup water for the service water system is diverted and withdrawn from the cooling water system before the water enters the condensers. The service water system is used in a variety of applications, including component cooling (e.g., pump bearings and spent fuel pool) and air conditioning. Overflow from the service water reservoirs discharges into the WHTF. Finally, North Anna Power Station has ten groundwater withdrawal wells for domestic use.

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

VEPCo uses liquid, gaseous, and solid radioactive waste management systems to collect and treat the radioactive materials that are produced as a by-product of North Anna Power Station, Units 1 and 2, plant operations. These systems process radioactive liquid, gaseous, and solid effluents to maintain releases within regulatory limits and to levels as low as reasonably achievable (ALARA) before they are released to the environment. The North Anna Power Station waste processing systems meet the design objectives of 10 CFR Part 50, Appendix I ("Numerical guide for design objectives and limiting conditions for operation to meet the criterion 'As Low as is Reasonably Achievable' for Radiological Material in Light Water-Cooled Nuclear Power Reactor Effluents"). Radioactive material in the reactor coolant is the primary source of gaseous, liquid, and solid radioactive wastes in light water reactors. Radioactive fission products build up within the fuel as a consequence of the fission process. These fission products are contained in the sealed fuel rods, but small quantities escape the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system is also responsible for coolant contamination.

Non-fuel 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 or are sent directly to the licensed disposal facility. Spent resins and filters are dewatered and packaged for shipment to licensed offsite processing or disposal facilities. Currently, solid wastes are shipped to Barnwell, South Carolina.

Fuel rods that have exhausted a certain percentage of their fuel and are removed from the reactor core for disposal are called spent fuel. North Anna Power Station currently operates on a staggered 18-month refueling cycle per unit. The spent fuel assemblies are currently stored onsite in a spent fuel pool and in containers located in the ISFSI. The ISFSI operates under a separate license covering three dry storage pads. Each pad has space for up to 28 dry storage casks and currently 11 casks are filled and stored.

North Anna also provides for temporary onsite storage of mixed wastes, which contain both radioactive and chemically hazardous waste. Storage of radioactive material is regulated by the NRC under the Atomic Energy Act of 1954 (AEA), and accumulation and storage of hazardous wastes is regulated by the U.S. Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act of 1976 (RCRA).

The North Anna Offsite Dose Calculation Manual (ODCM) (VEPCo 2000b) describes the methods used for calculating radioactivity concentrations in the environment and the estimated

potential offsite doses associated with liquid and gaseous effluents from North Anna. 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 (i.e., 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 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 at and beyond the site boundary will be limited to (1) less than or equal to 5 mSv/yr (500 mrem/yr) to the whole body and less than or equal to 30 mSv/yr (3000 mrem/yr) to the skin for noble gases, and (2) less than or equal to 15 mSv/yr (1500 mrem/yr) to any organ for iodine-131, iodine-133, and 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 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 nuclear facility operations will not exceed the maximum limits of 40 CFR Part 190 (less than 0.25 mSv [25 mrem] in a year) and 10 CFR Part 20 (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). |

The systems used for processing liquid waste, gaseous waste, and solid waste are described in the following sections.

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

Radioactive liquids are collected and treated in the liquid waste disposal system common to both reactor units. This system accommodates the radioactive wastes produced during simultaneous operation of the two units. Potentially high-level liquid wastes from the chemical and volume control, boron recovery, steam generator blowdown, and vent and drain sump systems, and the hot laboratory drains, liquid waste disposal, and spent resin flush water are discharged to the high-level waste (HLW) drain tanks. The contents of these tanks are processed through the ion exchanger filtration system.

Low-level liquid wastes collected from the ion exchanger filtration system, vent and drain, boron recovery drain tanks and test tanks, and the fluid waste treatment tank are pumped to the waste header, through the clarifier, and are discharged either to the circulating water system or processed through the waste demineralizer. Laundry waste, cold laboratory drainage, and personnel decontamination area shower and sink drainages are discharged into the contaminated drain tanks and are filtered and clarified before release. The demineralizers also receive liquid from the contaminated drain tank, the steam generator blowdown tank, and blowdown from the service water reservoir.

The discharge flow from the liquid waste disposal system is combined and mixed with the water in the circulating-water system discharge tunnel. All liquid effluent discharges are monitored to ensure radiological control is maintained. Effluents downstream of the clarifier demineralizer filter are automatically isolated if their radioactivities exceed the alarm/trip setpoint for discharge release limits specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. The circulating-water system discharge canal releases the treated effluent to Lake Anna in accordance with a
| NPDES-permitted and -monitored outfall (VDEQ 2001).

| For the two units during 2000, a total volume of 6.48×10^8 L (1.71×10^7 gal) of liquid waste was released prior to dilution. In this liquid waste, there was a total fission and activation product activity of 0.014 TBq (0.38 Ci) and total tritium activities of 32 TBq (861 Ci). These volume and activities are typical of past years. The composition of the liquid waste generated is reported in the *Annual Radioactive Effluent Release Report for the North Anna Power Station* (VEPCo 2001a). See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual as a result of these releases.

| VEPCo does not anticipate any increase in liquid waste releases on an annual basis during the renewal period.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

The North Anna gaseous waste disposal system is common to both units and collects and treats radioactive gases released during simultaneous operation of Units 1 and 2. The system is designed to collect, treat, and discharge potentially radioactive gases, fission product gases, and uncondensed vapors from the vent and drain system, boron recovery system, primary coolant leakages, and the reactor plant. The closed-loop disposal system consists of two waste gas compressors, two waste gas decay tanks, and associated piping to collect and filter vapors.

Waste gases are regulated by the process vent subsystem and the ventilation vent subsystem of the gaseous waste disposal system. Gaseous wastes enter the process vent subsystem from the waste gas decay tanks, the vent and drain system, the containment purge system, and the containment vacuum system. The ventilation vent subsystem regulates discharge of air from the steam reliefs of the boron evaporators, the ion exchange filtration system, gas strippers, and waste gas decay tanks. After treatment, the gaseous effluents are discharged to the atmosphere through a process vent stack located on top of the Unit 1 containment structure (VEPCo 2001c).

Radioactive waste gases collected in the waste gas decay tanks include iodine, xenon, and krypton (VEPCo 2001c). These gases are allowed to decay in one of two double-walled underground waste decay tanks. Before the gases are released from the waste decay tanks to the process vent, the contents are sampled and discharged at a permissible rate and activity as prescribed by the ODCM (VEPCo 2000b).

After release to the process vent, these gases are mixed with dilution air and combined with gases from the other paths (i.e., boron recovery system, containment vacuum system, the vent and drain system, and various pressure relief valves). Prior to release to the environment, the gases are mixed with filtered air from the auxiliary building and are passed through a charcoal filter and high-efficiency particulate air (HEPA) filters. The gases then pass through a regenerative heat exchanger and are monitored by a particulate and gas monitor to ensure that they meet 10 CFR Part 20 release limits for gaseous effluents before being released to the atmosphere. Release is terminated automatically if the radioactivity of the gaseous effluents exceeds ODCM pre-set release limits.

During 2000, there was a total fission and activation gas activity released from the two units of 3.88 TBq (105 Ci), a total iodine activity of 1.8×10^{-5} TBq (4.8×10^{-4} Ci), a total particulate activity of 6.8×10^{-9} TBq (1.8×10^{-7} Ci), and a total tritium activity of 4.05 TBq (109 Ci) (VEPCo 2001a). See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual as a result of these releases.

| VEPCo does not anticipate any increase in gaseous releases on an annual basis during the renewal period.

2.1.4.3 Solid Waste Processing

Solid wastes from North Anna consist of spent resin slurries, spent filter cartridges, and miscellaneous materials from station and radwaste facility operation and maintenance such as contaminated rags, paper, and equipment parts (VEPCo 2000c). Spent resin slurries from the plant's ion exchangers are collected in a shielded resin holdup tank in the decontamination building and then dewatered and transferred to a high-integrity container for shipment for disposal (VEPCo 2000c). Spent filter cartridges are also placed in high-integrity containers in preparation for disposal. Miscellaneous solid waste material is placed in appropriate containers and shipped offsite for compacting and disposal.

Solid wastes from North Anna are either shipped directly to an offsite licensed disposal facility (i.e., spent resins) or consigned to a licensed processing facility for volume-reduction and decontamination activities (i.e., compactible trash). The material that remains after volume reduction is transported by the processing facility to a final disposal facility.

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

In 2000, North Anna made 14 shipments of solid waste with a volume of 227 m^3 (8029 ft^3) and a total activity of 10.6 TBq (285 Ci) (VEPCo 2001a). In 1999, North Anna made 20 shipments of solid waste with a volume of 187 m^3 (6610 ft^3) and a total activity of 994 TBq (26,845 Ci) (VEPCo 2000d). The large difference in total activity released from 1999 to 2000 was due to the disposal of irradiated components during 1999. 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

The primary nonradioactive chemical wastes generated at North Anna are the ion exchange resins used to treat the circulating water. The secondary source is blowdown from the steam generators that is discharged to the circulating water. Other sources are also generated, such as antifreeze, electrohydraulic fluid, fluorescent bulbs and batteries, wood, paper, and metal.

| Of the wastes generated, the hazardous wastes collected are shipped to a contractor for treatment or disposal. Waste lubricating oil is used as fuel in a fossil fuel plant for energy

recovery. An onsite paint shop recycles solvent. Electrohydraulic fluid is returned to the shipper to be recycled. Paper and metal are sent to a vendor for recycling or disposal. Wood is sent to a landfill. Sanitary wastes are treated by an onsite sewage treatment plant (regulated under a NPDES permit) (VDEQ 2001) and diverted to the head of the discharge canal for subsurface discharge.

Nonradioactive liquid waste produced as a result of plant operations and maintenance activities (e.g., water treatment activities, stormwater runoff) are sampled and treated in accordance with the site's NPDES Permit (VDEQ 2001) issued by VDEQ. Most of these streams are released to the WHTF. No chemical biocides are used (VEPCo 2001b).

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 plant. Some of the maintenance activities conducted at North Anna include inspection, testing, and surveillance to maintain the current licensing basis of the plant and to ensure compliance with environmental and public safety requirements. Certain activities can be performed while the reactor is operating. Others require that the plant be shut down. VEPCo refuels each North Anna unit on a staggered 18-month schedule, which means at least one refueling every year and two refuelings every other year. Up to 700 additional contract workers are employed for the 30- to 40-day refueling outage at each unit.

VEPCo performed an aging management review and developed an integrated plant assessment (IPA) for managing the effects of aging on systems, structures, and components in accordance with 10 CFR Part 54. The aging management program is described in Appendix B of the License Renewal Application (VEPCo 2001b). The IPA identified the programs and inspections that are managing the effects of aging at North Anna Power Station. Previously, VEPCo has performed some major construction activities at North Anna Power Station (e.g., steam generator replacement), and the IPA did not identify any need for refurbishment or replacement activities. VEPCo assumes that an additional 60 workers will be needed to perform all the necessary surveillance, monitoring, inspections, testing, trending, and record keeping activities during the license renewal period.

2.1.7 Power Transmission System

North Anna Power Station, Units 1 and 2, have three 500-kV transmission lines and one 230-kV transmission line leaving the site from the switchyard. Each transmission line occupies a separate right-of-way. The rights-of-way range from 37 to 84 m (from 120 to 275 ft) in width and from 24 to 66 km (from 15 to 41 mi) in length covering a total of approximately 1174 ha (2900 ac) (Table 2-1) (AEC 1973; VEPCo 2001b). The rights-of-way extend from the North

Anna site to the north, south, east, and west terminating in Morrisville, Midlothian, Ladysmith, and at the South Anna non-utility generator (Figure 2-5). The lines and rights-of-way were constructed between 1973 and 1984.

Table 2-1. North Anna Transmission Rights-of-Way

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

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

VEPCo owns approximately 1 percent of the rights-of-way and has easements for the remaining 99 percent (VEPCo 2001b). The vegetation in the rights-of-way is managed through a combination of mechanical and herbicide treatments conducted on a 3-year cycle.

Mowing is the primary mechanical treatment, while Accord and Garlon are the primary herbicides used in the rights-of-way. In some areas (e.g., wetlands, dense vegetation), hand-cutting is used. Rare and sensitive plant species areas are identified and avoided or modified treatment practices are used to avoid adverse impacts. These modified vegetation treatments are developed in cooperation with the Virginia Department of Conservation and Recreation's (VDCR's) Natural Heritage Program (VEPCo 2001b). In addition, wildlife food plots and Christmas tree plantations are located along the rights-of-way and supported through cost-sharing by VEPCo (VEPCo 2001b).

2.2 Plant Interaction with the Environment

Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near North Anna Power Station. 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.

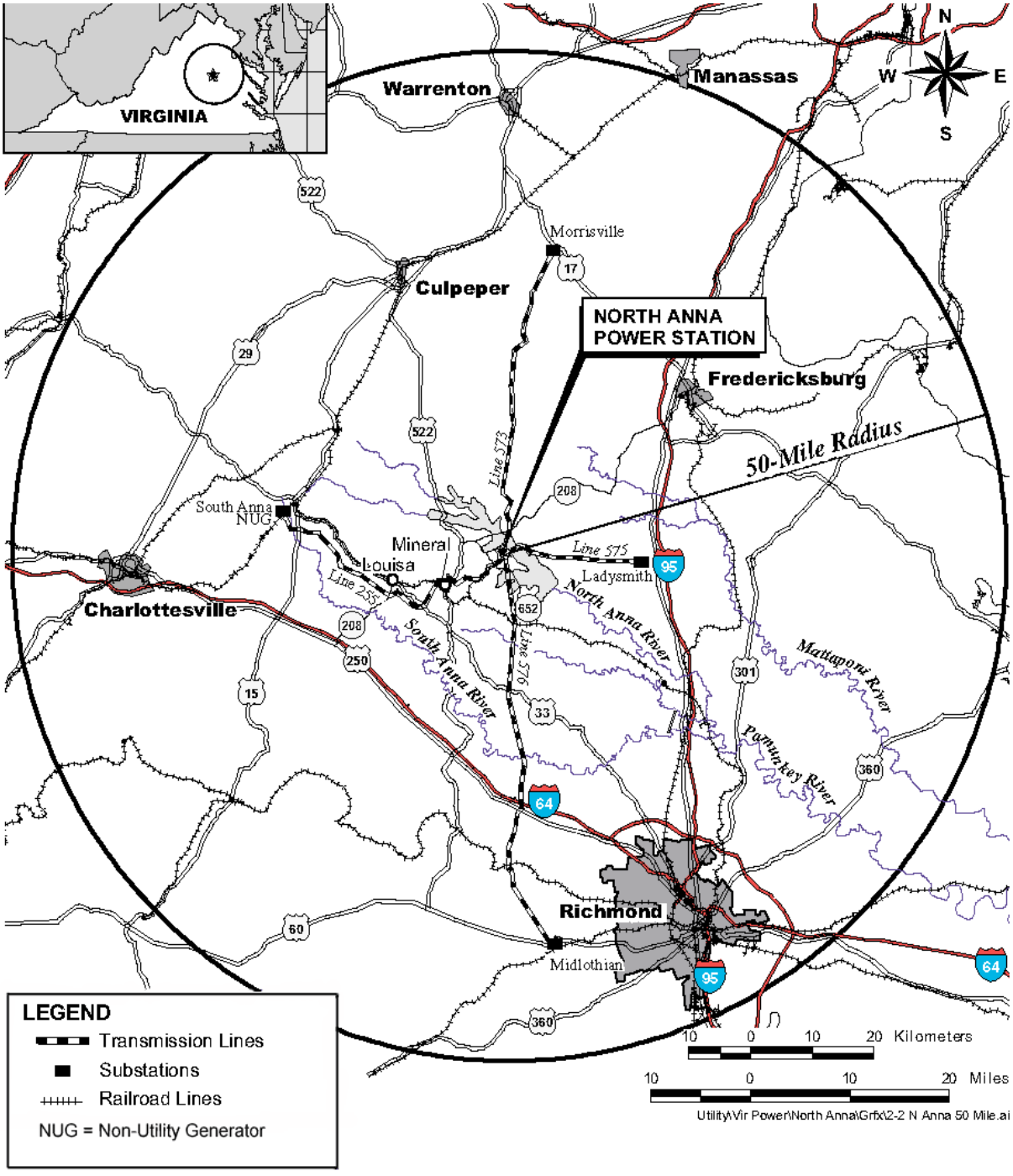

Figure 2-5. Location of Transmission Lines for North Anna Power Station, Units 1 and 2

2.2.1 Land Use

North Anna Power Station is located within the central Piedmont Plateau of Virginia. The topography is characterized as a gently undulating surface that varies from 60 m (200 ft) to 150 m (500 ft) above mean sea level. The North Anna site is on a peninsula on the southern shore of Lake Anna, a man-made reservoir, approximately 8 km (5 mi) upstream from the North Anna Dam. Forests comprising primarily pine and hardwoods cover the majority of the peninsula on which North Anna is sited. The predominant land use in Louisa County is forestry, a major contributor to the economy. Almost 70 percent of the total land area is forest interspersed with small farm agriculture.

North Anna Power Station covers approximately 422 ha (1043 ac) of land. The WHTF has a total surface area of 1400 ha (3400 ac) of water for heat dissipation behind three diked lagoons. VEPCo acquired 7550 ha (18,643 ac) of rural land for the development of the site including Lake Anna, the WHTF, and transmission line rights-of-way, as well as supporting facilities. VEPCo continues to own all land outside the site boundary that forms Lake Anna and the WHTF, up to the expected 78-m (255-ft) high-water mark above mean sea level, including approximately 2700 ha (6600 ac) that were not inundated.

The primary land cover is pine and pine-hardwood mixed forest (70 percent). The remainder of the land area is used for facility activities (20 percent) and as cleared areas (10 percent). Facility uses include generation, maintenance and distribution facilities, warehouses, training and administration buildings, lagoons and settling basin, parking lots, roads, a railroad line, information center, and the ISFSI. Cleared areas include the landscaped grounds, open areas, laydown areas, three historic cemeteries, security weapons range, and the John Goode Recreation Area, a VEPCo employee-only recreation and picnic area on a peninsula east of the station on the shore of Lake Anna.

VEPCo has granted easements to landowners abutting Lake Anna and the WHTF who request permission to use VEPCo property for the erection of piers, jetties, or other recreational structures for access to the lake waters. These structures require a reapproval by VEPCo with each property ownership transaction, and all permissions are expressly revocable. Boaters have access to the Lake and the cooling lagoons.

Louisa County is currently updating its comprehensive land use plan with the goal of preserving and protecting rural land for agriculture and forestry. The land adjacent to Lake Anna has become increasingly developed for primary, retirement, and vacation homes, as well as for commercial marinas. A final Lake Anna Special Area Plan was released in March 2000.

2.2.2 Water Use

North Anna Power Station uses water from Lake Anna for the once-through cooling system and service water system. Therefore, except for minor increases in evaporation due to the warmed discharge water, North Anna Power Station is not a consumptive user of water for cooling purposes. However, construction of the North Anna Dam and impoundment of the Lake Anna reservoir to provide cooling water for North Anna Power Station have considerably altered the regional water resources environment. Lake Anna represents the critical landscape feature to lakeside development and regional recreation. Instream flows downstream of the North Anna Dam are regulated by the Commonwealth of Virginia under the terms of the North Anna Power Station discharge permit (VDEQ 2001).

North Anna Power Station has ten groundwater withdrawal wells for domestic use. Six of these wells are permitted by VDEQ and are subject to withdrawal reporting requirements. The remaining four wells do not require permits due to their small size. The highest monthly average withdrawal reported for 1991 through 1999 was 2.6 L/s (41 gpm).

2.2.3 Water Quality

In addition to serving the cooling needs of North Anna Power Station, Lake Anna provides water of sufficiently high quality to serve a variety of needs including propagation of fish and wildlife and contact recreation. The formation of Lake Anna has mitigated some of the adverse water quality impacts upstream resulting from acid mine drainage from Contrary Creek, which flows into Lake Anna, providing a large volume of water to dilute the metals and pH associated with mine drainage and enabling sediments to deposit in the lake bottom.

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. EPA has delegated implementation of NPDES to VDEQ within the Commonwealth of Virginia. Discharge of cooling water from North Anna Units 1 and 2 is currently authorized under NPDES Permit No. VA0052451 (VDEQ 2001). The permit, which is renewed every 5 years, expires January 11, 2006. Any new regulations promulgated by EPA or VDEQ would be included in future permits.

2.2.4 Air Quality

The climate within the central Piedmont Plateau where the North Anna site is located is classified as continental; the summers are warm and the winters are generally mild. The Blue Ridge Mountains to the west of the site act as a partial barrier to approaching winter storms and on a annual basis tend to channel winds along a general north-south orientation. Temperatures in

the region of the North Anna site rarely exceed 35°C (95°F) or fall below -12°C (10°F). Extreme temperature data for the region (Richmond, Virginia) indicate the highest reported temperature is 40°C (105°F), and the lowest reported temperature is -24°C (-12°F).

Thunderstorms are occasional in the region; a normal occurrence is about 37 per year (NOAA 1987). The majority of these storms occur during May through August. From 1886 through 1987, 33 tropical storms and 7 hurricanes passed within 190 km (100 nautical mi) of the site (VEPCo 2000c). The most recent severe weather event was hurricane Charley in August 1986, which brought from 2.5 to 7.6 cm (from 1 to 3 in) of rain to the region. Based on statistics for the 30 years from 1954 through 1983 (Ramsdell and Andrews 1986), on average, only six tornadoes are expected to occur in the Commonwealth of Virginia during a year. The probability of a tornado striking North Anna is expected to be about 5×10^{-5} per year.

The wind energy resource in the vicinity of North Anna is limited, with the annual average wind power rated as 1 on a scale of 1 to 7 with 1 being the lowest (Elliott, et al. 1986). Areas suitable for wind turbine application (rated class 3 or higher) in Virginia are limited to the ridges along the Appalachian Mountains and exposed coastal areas.

North Anna is located within the Northeastern Virginia Intrastate Air Quality Control Region (40 CFR 81.145). This region is designated as in attainment or unclassified for all criteria pollutants (40 CFR 81.347). The Commonwealth of Virginia, however, has been designated as a nonattainment area for the 1-hour ozone standard. The Commonwealth of Virginia will also be subject to a revised 8-hour ozone standard (40 CFR 50.10; EPA 1997a) and a new ambient air standard for $PM_{2.5}$ (40 CFR 50.7; EPA1997b), both promulgated by EPA in 1997. $PM_{2.5}$ is an acronym for particles with a diameter of 2.5 micrometers or less. EPA is taking steps to implement the new standards (e.g., developing its approach and collecting the data necessary to designate which areas are in nonattainment). Louisa County is not expected to be designated as a nonattainment area for the 8-hour ozone standard.

Finally, within Virginia two areas (James River Face Wilderness and Shenandoah National Park) are designated in 40 CFR 81.433 as mandatory Class 1 Federal areas in which visibility is an important value. The boundary of the closer of these areas, Shenandoah National Park, is within 67 km (42 mi) of the site.

Airborne emissions at North Anna are regulated by VDEQ. VEPCo holds an Exclusionary General Permit from VDEQ under Title 9 of the Virginia Administrative Code (9 VAC 5, Chapter 500) for all nonradiological airborne emissions resulting from plant operations. Emission sources at North Anna include two auxiliary boilers, four emergency diesel generators (3840 hp rating each), and a blackout generator (4640 hp rating). There are no emissions monitors at North Anna. Compliance under the Exclusionary General Permit is based on fuel sulfur content and fuel consumption records. A fuel oil sample is taken from each shipment and

analyzed to determine actual sulfur content of the oil. Annual operation of the auxiliary boilers and the diesel generators is limited under the permit to 3000 and 500 hours, respectively. Under the terms of the permit, North Anna provides VDEQ with emissions update information and compliance certification annually.

2.2.5 Aquatic Resources

Aquatic resources in the vicinity of the North Anna Power Station are associated with Lake Anna, the WHTF, and the North Anna River. Lake Anna was created to serve as the cooling water source for North Anna (VEPCo 2001b). The lake was made in 1971 by erecting the North Anna Dam on the main stem of the North Anna River, just upstream of the confluence of the North Anna River and Northeast Creek. Lake Anna began filling in January 1972 and reached capacity in December of that year. Lake Anna is approximately 27 km (17 mi) long with 435 km (272 mi) of shoreline. It is relatively shallow (maximum depth 27 m [90 ft]; average depth approximately 8 m [25 ft] at full pool), with a surface area of 3900 ha (9600 ac). The normal elevation of the reservoir is 76 m (250 ft) above mean sea level, at which stage it holds 4×10^8 m^3 (3×10^5 acre-feet) of water. The WHTF, formed by diking off the three southernmost arms of Lake Anna, consists of three cooling lagoons interconnected by canals. These lagoons have a total surface area of 1400 ha (3400 ac). Lake Anna is used extensively for recreation and fishing. The aquatic resources of Lake Anna are managed cooperatively by VEPCo and State natural resource agencies including the Virginia Department of Game and Inland Fisheries (VDGIF) and VDCR.

The creation of Lake Anna mitigates the impacts to the North Anna River of sedimentation and acid mine drainage from Contrary Creek, a tributary to the North Anna River, which drains an area that had been used extensively for iron pyrite mining (Herlihy and Mills 1989, VEPCo 2001b). Prior to impoundment of Lake Anna, the density and diversity of fish and benthic macroinvertebrates had been markedly reduced in the North Anna River immediately downstream of its confluence with Contrary Creek. Reportedly, this damage precluded other potential uses of the river and was one reason the North Anna site was selected for impoundment of the lake (AEC 1973). Contrary Creek now flows directly into Lake Anna. Low-pH creek water is diluted as it mixes with higher-pH reservoir water. Heavy metals are removed from the water column by adsorption to clay particles and the subsequent settling of these particles. Chemical precipitation (and co-precipitation with iron) may also remove zinc and copper ions from Contrary Creek water when it mixes with Lake Anna water.

Lake Anna is typical of many shallow reservoirs found in the central Piedmont Plateau of Virginia. Since impoundment, Lake Anna has gone through the ecological succession experienced by man-made reservoirs. The initial biotic community was highly productive because initial nutrient levels were high, followed by decreased productivity and ultimate stability (Paterson and Fernando 1970, Voshell and Simmons 1978). Aquatic communities in Lake Anna experienced gradual post-impoundment changes from riverine to lake communities.

Some of these communities had stabilized in Lake Anna by 1975 (VEPCo 1986), and all have been relatively stable since 1985 (VEPCo 1986, VEPCo 2002).

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

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

Small numbers of Unionids (*Elliptio* sp.) and fingernail clams (*Sphaeriidae*) have also been collected. Acid drainage and sediment from the Contrary Creek mine site historically depressed mussel populations downstream from the Contrary Creek-North Anna River confluence, the first major mussel beds were not apparent until 100 m downstream of the confluence of the North and South Anna Rivers (Reed and Simmons 1972). There are indications that mussel populations (*Elliptio* sp.) are recovering in the lower North Anna River (VEPCo 1986).

Approximately 39 species of fish (representing 12 families) have been identified in Lake Anna (VEPCo 1986). Species include those historically found in the North Anna River, those that had been in local farm ponds inundated by the new reservoir, and species introduced by VDGIF. Recreational species include largemouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilis*), walleye (*Stizostedion vitreum*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), white perch (*Morone americana*), pumpkinseed (*L. gibbosus*), redear sunfish (*L. microlophus*), redbreast (*L. auritus*), channel catfish (*Ictalurus punctatus*) and white catfish (*Ameiurus catus*). Forage species include threadfin shad (*Dorosoma petenense*) and gizzard shad (*D. cepedianum)*. Striped bass and walleye are stocked annually by VDGIF. Striped bass provide a “put-grow-and-take” fishery. Streams, including the North Anna River, that flow into Lake Anna appear to lack the flow, depth, and length to support striped bass spawning runs (VEPCo 1986, VEPCo 2001b). VDGIF

also placed 20 underwater fish structures in the reservoir over the 1983-1990 period to provide additional fish habitat in areas with “clean” bottoms. These fish structures were intended primarily to provide habitat for largemouth bass, black crappie, and sunfish (bluegill in particular). Sterile triploid herbivorous grass carp (*Ctenopharyngodon idella*) was stocked by VEPCo in the WHTF in 1994 to control growth of a nuisance submersed aquatic plant, namely the water hyacinth (*Hydrilla verticillata*).

The North Anna River joins the South Anna River 37 km (23 mi) downstream from the North Anna Dam (Figure 2-1), forming the Pamunkey River. Another 56 km (35 mi) downstream, the Pamunkey River joins the Mattaponi River to form the York River. In the North Anna River downstream of the dam, the periphyton community (single-celled, filamentous or colonial algae and associated microfauna attached to underwater surfaces) is dominated by diatoms, as are many southeastern streams. Caddisflies (*Tricoptera*) that feed on seston (living and dead plankton, plus particulate matter) from Lake Anna dominate the benthic macroinvertebrate community. Farther downstream, macroinvertebrate communities show more diversity and are similar to those of the South Anna River (VEPCo 2001b).

Over the past 18 years, up to 49 fish species have been observed in the North Anna River in the area between the dam and approximately 12 km (7 mi) upstream from the confluence of the South Anna River (VEPCo 2002). Prior to full impoundment, fish abundance in the North Anna River was depressed downstream from the Contrary Creek inflow (Reed and Simmons 1972). Since impoundment, abundance and diversity have steadily increased (VEPCo 2001b). Commonly observed species are the redbreast sunfish, bluegill, various shiners (*Notropis* sp. and *Notemigonus* sp.), fallfish (*Semotilis corporalis*), margined madtom (*Noturus insignis*) and the diadramous American eel (*Anguilla rostrata*). Important game fish include largemouth bass and smallmouth bass (*M. dolomieu*). Anadramous fish have been observed about 64 km (40 mi) downstream of the dam in the Pamunkey River just before the confluence with the Mattaponi River. These include shad (*Alosa* sp.) (Reed and Simmons 1972) and Atlantic Sturgeon (*Acipenser oxyrhynchus*) (Burkhead and Jenkins 1991). Native anadramous fish are rarely observed in the area of North Anna River near the dam. Blueback herring (*Alosa aestivalis*) has been observed near the dam (VEPCo 2000a). This species was stocked in Lake Anna by VDGIF in 1980 and 1981 (VEPCo 1986). In a letter dated October 26, 2001, the U.S. Fish and Wildlife Service (FWS) expressed concern of the impact of fish passage through the dam on the fish distribution in the North Anna River. Some fish present in Lake Anna do pass through the dam into the North Anna River at a rate of 0.6 to 3.1 fish per day (VEPCo 1989b). Threadfin shad, bluegill, white perch and golden shiner have been observed in dam passage samples, with bluegill the most commonly collected species.

No Federal-listed threatened or endangered fish species occur in counties immediately adjacent to Lake Anna, the North Anna River immediately upstream or downstream from Lake Anna (Orange, Louisa, Spotsylvania, Hanover, and Caroline Counties) or tributary streams crossed by North Anna transmission lines (which also includes Goochland, Powhatan, Henrico,

Chesterfield, Culpeper, and Fauquier Counties) (VDCR 2001; VDGIF 2002; FWS 2002). One Commonwealth-listed threatened species, the emerald shiner (*Notropis atherinoides*), was identified in a final environmental impact statement list of fish collected in the North Anna River prior to its impoundment (AEC 1973). However, this species is known only from the Clinch and Powell Rivers in the extreme western part of the State (Jenkins and Burkhead 1994, Burkhead and Jenkins 1991). The emerald shiner is often confused with the closely related comely shiner (*N. amoenus*) that occurs throughout the York River drainage and has been documented from Lake Anna and the North Anna River (Jenkins and Burkhead 1994). The comely shiner was not listed in the final environmental impact statement (AEC 1973) but has been collected regularly by VEPCo biologists in post-operational monitoring of the lower North Anna River (VEPCo 1989a). The emerald shiner has not been collected in any of the post-operational surveys or monitoring studies. The fish species listed in 1973 (AEC 1973) as the emerald shiner was more likely to have been the comely shiner.

Three Commonwealth- and Federal-listed freshwater mussel species could occur in streams in counties adjacent to Lake Anna, the North Anna River immediately upstream and downstream of Lake Anna, or in counties crossed by North Anna transmission lines (VDCR 2001; VDGIF 2002; FWS 2002). These are the dwarf wedgemussel (*Alasmidonta heterodon*), the Alantic pigtoe (*Fusonaia masoni*), and the James spinymussel (*Pleurobema collina*) (Table 2-2). One occurrence of the fluted kidneyshell mussel (*Ptychobranchus subtentum*), a candidate for Federal listing, is reported by the VDGIF Fish and Wildlife Information Service database as occurring in streams in Louisa County (VDGIF 2002). All other confirmed accounts of this species are confined to mountain streams in southwestern Virginia that are tributaries of the Tennessee River several hundred miles away. The slippershell mussel (*Alasmidonta viridis*) and the brook floater (*Alasmidonta varicosa*), both Commonwealth-listed endangered mussels, appear to be erroneously placed on species lists in counties where they are not known to occur. The slippershell mussel is found on a list for Orange County obtained from the VDCR (VDCR 2002); however, there was no date for the occurrence. According to the VDCR, the occurrence is a specimen at a museum mentioned in a report and has not been verified in the field. The VDCR indicated they would not have considered the slippershell mussel to be present in Orange County due to the quality of the record. The mussel is not listed on the species list obtained from the VDGIF (VDGIF 2002), and further review of its distribution shows it to be limited to counties in the far southwestern portion of Virginia. The brook floater is found on a list for Goochland County obtained from the VDGIF (VDGIF 2002). Again, there is no occurrence date listed for this species in this County, and further review of its known distribution shows it to be limited to counties in the far southwestern portion and counties in the far northern tip of Virginia.

Thus, it is unlikely these two mussel species occur in the vicinity of North Anna or its transmission lines.

Table 2-2. Aquatic Species Potentially Occurring in Counties Immediately Adjacent to Lake Anna, the North Anna River Immediately Upstream or Downstream of Lake Anna, or Tributary Streams Crossed by North Anna Transmission Lines Listed by the U.S. Fish and Wildlife Service or the Commonwealth of Virginia

Scientific Name	Common Name	Federal Status[a]	Commonwealth Status[a]
Invertebrates			
Alasmidonta heterodon	dwarf wedgemussel	E	E
Fusconaia masoni	Atlantic pigtoe	SOC	T
Pleurobema collina[b]	James spinymussel	E	E

(a) E = Endangered, T = Threatened, SOC = Species of Concern.
(b) This species has occurred in a county adjacent to Powhutan County and, thus, may occur in this county (FWS 2002).

None of these mussel species has been observed as occurring in streams in the vicinity of North Anna or in streams crossed by its transmission lines, nor were any collected in pre-impoundment surveys of the North Anna River or more recent monitoring surveys.

2.2.6 Terrestrial Resources

North Anna is located in the Piedmont physiographic province (Fleming et al. 2001). Common vegetation types on the North Anna site and the transmission line rights-of-way include short-leaf pine (*Pinus echinata*), Virginia pine (*Pinus virginiana*), bottomland hardwoods, and shrub bogs. In addition, there are croplands, tree plantations, old fields (reverted croplands), and pastures (AEC 1973, VEPCo 2001b) within the transmission line rights-of-way.

Wetlands are found on portions of the transmission line rights-of-way and at North Anna. They are small and associated with Lake Anna and artificial ponds. Staff at North Anna avoid these areas when possible during vegetation management activities, transmission line maintenance, and site maintenance. They consult with the U.S. Army Corps of Engineers, as needed, to comply with Section 404 of the Clean Water Act when activities are conducted near wetlands. Twelve Federal- and Commonwealth-listed threatened and endangered species potentially could occur at the North Anna Power Station or along the transmission line rights-of-way (VEPCo 2001b). The bald eagle (*Haliaeetus leucocephalus*) and the loggerhead shrike (*Lanius ludovicianus*) are the only Federal- or Commonwealth-listed species known to occur at the North Anna Power Station or along the transmission line rights-of-way (VEPCo 2001b). Table 2-3 lists the protected species and their status.

Table 2-3. Terrestrial Species Listed, Proposed, or Candidates as Endangered or Threatened by the U.S. Fish and Wildlife Service or the Commonwealth of Virginia that Occur or Potentially Occur Within the North Anna Site or the Associated Transmission Line Rights-of-Way

Scientific Name	Common Name	Federal Status[a]	Commonwealth Status[a]
Amphibians			
Ambystoma tigrinum	tiger salamander	--	E
Hyla gratiosa	barking treefrog	--	T
Birds			
Aimophila aestivalis	Bachman's sparrow	--	T
Ammodramus henslowii	Henslow's sparrow	--	T
Bartramia longicauda	upland sandpiper	--	T
Falco peregrinus	peregrine falcon	--	E
Haliaeetus leucocephalus	bald eagle	T	T
Lanius ludovicianus	loggerhead shrike	--	T
Mammals			
Plecotus rafinesquii	eastern big-eared bat	--	E
Vascular Plants			
Helonias bullata	swamp pink	T	E
Isotria medeoloides	small whorled pogonia	T	E
Aeschynomene virginica[b]	sensitive joint-vetch	T	E

(a) E = Endangered, T = Threatened, -- = Not listed.
(b) Habitat for this species is likely not found along the transmission lines because the habitat required (tidally influenced fresh waters) is not known in these areas.

The bald eagle is the only Federal-listed animal species that has been identified on the North Anna site and the transmission line rights-of-way. It is listed as threatened; however, it was proposed for removal from the list on July 6, 1999 (FWS 1999). Eagles usually nest in pines near large water bodies in Virginia. They feed primarily on fish but also eat carrion, waterfowl, small mammals, and reptiles. This species is found infrequently in the vicinity of North Anna and the transmission lines, and no known nests are in the area.

Three Federal-listed plant species could occur at the North Anna Power Station or along the transmission line rights-of-way. The small whorled pogonia (*Isotria medeoloides*) is a perennial species from 9.5 to 25 cm (from 4 to 10 in) high terminating in a whorl of five or six light green, elliptical, and somewhat pointed leaves. This species generally is found in open, dry, deciduous woods with acid soil. It occurs in habitat of relatively high-density shrub cover or sapling trees (NatureServe 2001). It is not known to occur on the North Anna site or the transmission line rights-of-way.

Swamp pink (*Helonias bullata*) is an annual species that can grow from 20 to 89 cm (from 8 to 35 in) during flowering and up to 1.5 m (5.0 ft) during seed maturation. It has a basal rosette of light green, lance-shaped, and parallel-veined leaves. It is found in wetlands that are saturated but not flooded, including bogs and swamps, and is commonly associated with some evergreens (NatureServe 2001). It is not known to occur on the North Anna site or the transmission line rights-of-way.

Sensitive joint-vetch (*Aeschynomene virginica*) is a single-stemmed, annual plant that can grow up to 2.4 m (7.9 ft) high. The leaves fold slightly if touched. The plant's habitat is restricted to tidally-influenced fresh water including fresh to slightly brackish tidal river shores (NatureServe 2001). It is not known to occur at North Anna or the transmission line rights-of-way.

2.2.7 Radiological Impacts

VEPCo has conducted a radiological environmental monitoring program (REMP) around the North Anna site since 1976 (NRC 1976). The radiological impacts to workers, the public, and the environment have been routinely monitored, documented, and compared with the appropriate standards. The two-fold purpose of the REMP is to:

- 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.

Radiological releases are summarized in the annual reports titled *Radiological Environmental Operating Program* (VEPCo and Teledyne Brown Engineering Environmental Services 2001) and *Annual Radioactive Effluent Release Report* (VEPCo 2001a). The limits for all radiological releases are specified in the North Anna ODCM, and these limits are designed to meet Federal standards and requirements (VEPCo 2000b). The REMP includes monitoring of the airborne

exposure pathway, direct exposure pathway (i.e., ambient radiation), water exposure pathway (i.e., ground/well water, river water, and surface water), aquatic exposure pathway (i.e., silt and shoreline sediments) from Lake Anna and North Anna River, and ingestion exposure pathway (i.e, milk, fish, and vegetation) in a 40-km (25-mi) radius of the station (VEPCo and Teledyne Brown Engineering Environmental Services 2001). In addition, the Virginia Department of Health (VDH) conducts an environmental radiation program that includes continuous monitoring of the air and ambient radiation and periodic sampling of fish, milk, shellfish, silt, soil, vegetation, and river water (VDH 2001).

Review of historical data on releases and the resultant dose calculations revealed that the doses to maximally exposed individuals in the vicinity of the North Anna 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 that data were available), dose estimates were calculated based on actual liquid and gaseous effluent release data (VEPCo 2001a). Calculations were performed using the plant effluent release data, onsite meteorological data, and appropriate pathways identified in the ODCM. The maximum dose to an individual located at the station site boundary from liquid and gaseous effluents released during 2000 was 0.003 mSv (0.3 mrem) (VEPCo and Teledyne Brown Engineering Services 2001). Tritium was the major contributing radionuclide. A breakdown of doses in 2000 by pathway is provided below:

- Total body dose from liquid effluents was 0.003 mSv (0.3 mrem) for 2000, which is 5 percent of the 0.06 mSv (6 mrem) dose limit.[(a)] The critical organ dose from liquid effluents was 0.0034 mSv (0.34 mrem), 2 percent of the dose limit.

- The air dose due to noble gases in gaseous effluents was 4.3×10^{-5} mSv (4.3×10^{-3} mrad) gamma (0.02 percent of the 0.20 mGy [20 mrad] gamma dose limit)[(a)] and 1.4×10^{-4} mGy (1.4×10^{-2} mrad) beta (0.04 percent of the 0.40 mGy [40 mrad] beta dose limit).[(a)]

- The critical organ dose from gaseous effluents due to iodine-131, iodine-133, hydrogen-3, and particulates with half-lives greater than 8 days was 2.8×10^{-4} mSv (2.8×10^{-2} mrem), which is 0.09 percent of the 0.30 mSv (30 mrem) dose limit.[(a)]

The applicant does not anticipate any significant changes to the radioactive effluent releases or exposures from North Anna operations during the renewal period, and therefore, the impacts to the environment are not expected to change.

(a) The dose limit is twice the "10 CFR 50 Appendix I" dose limit because the limit is per unit and North Anna has two operating units.

2.2.8 Socioeconomic Factors

The region surrounding the North Anna site was identified in the Generic Environmental Impact Statement (GEIS, NRC 1996, 1999) as having a medium population density. The non-outage work force at North Anna comprises approximately 1000 persons, with as many as 700 additional contract workers arriving once or twice a year to participate in periodic refueling. An additional 60 full-time employees could be associated with the license renewal.

The staff reviewed the applicant's environmental report and information obtained from several county, city, and economic development staff during a site visit to Louisa County from October 15 through 19, 2001. The following information describes the economy, population, and communities near North Anna Power Station, Units 1 and 2.

2.2.8.1 Housing

Approximately 850 permanent employees and from 70 to 110 contract and licensee employees, assigned from other departments, work at North Anna Power Station, Units 1 and 2. Approximately 79 percent of these employees live in Henrico, Louisa, Orange, and Spotsylvania Counties, and in the City of Richmond.[(a)] The rest live in other locations. Table 2-4 presents the county of residence for 820 permanent employees.[(b)]

Table 2-4. North Anna Power Station—Permanent Employee Residence Information by Four-County Area of Potential Impact

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

Source: NRC 2001

(a) These counties and the City of Richmond together are collectively known as the area of potential impact. However, as is discussed subsequently in this section, Louisa County will have the majority of the impacts.

(b) The permanent work force is approximately 850; however, addresses were provided for only 820.

Table 2-5 presents a breakdown, by city and county, of the residency of the permanent North Anna Power Station, Units 1 and 2, employees. Table 2-5 does not include the residences of the contract employees. Given the number of VEPCo employees living in Henrico (including the City of Richmond), Louisa, Orange, and Spotsylvania Counties, and because the North Anna units are located in Louisa County, this SEIS focuses on these four counties with an emphasis on Louisa County since it will bear most of the impacts associated with relicensing.

Table 2-5. North Anna Power Station, Units 1 and 2 – Permanent Employee Residence Information by County and City

County and City[a]	VEPCo Employees
HANOVER COUNTY	
Ashland	10
Doswell	1
Hanover	1
Mechanicsville	11
Montpelier	20
Rockville	2
Total Hanover County	45
HENRICO COUNTY	
Glen Allen	39
Sandston	2
Total Henrico County	41
City of Richmond	63
LOUISA COUNTY	
Bumpass	48
Louisa	104
Mineral	84
Trevilians	1
Total Louisa County	237
ORANGE COUNTY	
Burr Hill	1
Barboursville	5
Gordonsville	35
Locust Grove	6
Mine Run	1
Orange	53
Rhoadesville	7
Somerset	1
Unionville	11
Total Orange County	120
SPOTSYLVANIA COUNTY	
Beaverdam	18
Fredericksburg	83
Partlow	7
Spotsylvania	77
Thornburg	1
Total Spotsylvania County	186
OTHER	
Other Counties and Cities	159
Grand Total	851

(a) Addresses are for unincorporated counties and incorporated areas (cities and towns).
Source: NRC 2001

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

Table 2-6 provides the number of housing units and housing unit vacancies for the area of potential impact for 1980, 1990, and 2000. Each county in the area of potential impact has a comprehensive land use plan. Louisa County updated its plan in September 2001 (Louisa County 2001). Louisa County is adding from 350 to 400 homes a year to its housing stock. This rate has been fairly constant over the last 3 to 4 years.[(a)]

Table 2-6. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990	2000	Approximate Percentage Change
HENRICO COUNTY			
Housing Units	94,540	112,570	19.1
Occupied Units	89,140	108,120	21.3
Vacant Units	5400	4450	-17.6
LOUISA COUNTY			
Housing Units	9080	11,855	30.6
Occupied Units	7425	9945	33.9
Vacant Units	1655	1910	15.5
ORANGE COUNTY			
Housing Units	9040	11,355	25.6
Occupied Units	7930	10,150	28.0
Vacant Units	1110	1205	8.7
SPOTSYLVANIA COUNTY			
Housing Units	20,485	33,330	62.7
Occupied Units	18,945	31,310	65.3
Vacant Units	1540	2020	31.4
CITY OF RICHMOND			
Housing Units	94,140	92,280	-2.0
Occupied Units	85,335	84,550	-0.1
Vacant Units	8805	7735	-12.2

Sources: U.S. Census Bureau (USCB) 2000a and 2000b.

Table 2-7 contains data on population, estimated population, and annual growth rates for the area of potential impact.

(a) Interview with Nancy Pleasants (Commissioner of Revenue) and Jerry Hall (Assessor; Commissioner of Revenue) Louisa County on October 15, 2001.

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

	Henrico County		Louisa County		Orange County		City of Richmond		Spotsylvania County	
	Population	Annual Growth Percent	Population	Annual Growth Percent	Population	Annual Growth Percent	Population	Annual Growth Percent	Population	Annual Growth Percent
1970	154,465	--	14,005	--	13,790	--	255,835	--	16,425	--
1980	180,735	1.6	17,825	2.4	18,065	2.7	226,165	-1.2	31,995	6.7
1990	217,880	1.9	20,325	1.3	21,420	1.7	210,330	-0.7	57,405	5.9
2000	262,300	1.9	25,625	2.3	25,880	1.9	206,600	-0.2	90,395	4.6
2010	277,000[(a)]	0.5	30,005	1.6	29,800	1.4	196,610	-0.5	111,000	2.1

Sources: USCB (1991, 1998, 2000b); Virginia Employment Commission (2001a); Virginia Statistical Abstract (2000).
(a) Projected population for 2010; values for 1970 through 2000 are actual census population numbers.

2.2.8.2 Public Services

- **Water Supply**

Table 2-8 summarizes the daily water consumption and areas served by each water system within the area of potential impact. Henrico County provides water to approximately 83,411[(a)] residential, commercial, and industrial customers. Currently, the county purchases its water supply from the City of Richmond and has no restrictions on amount. Henrico County's average daily water use is 130,000 m^3/day (35 MGD). The county also has service agreements to supply limited amounts of water to Hanover and Goochland Counties (Henrico County 2001b). Because of the rapid growth rate in Richmond and surrounding counties, a water supply treatment plant is under construction for Henrico County with a capacity of 210,000 m^3/day (55 MGD). It is scheduled to become operational in 2003. Permit negotiations are under way to enlarge the plant by 2010 (Claytor 2000).

Richmond's source of water is the James River. It supplies approximately 562,000 people in the City of Richmond and in Chesterfield, Hanover, and Henrico Counties. It has a maximum capacity of 500,000 m^3/day (132 MGD) and an average use of 310,000 m^3/day (83 MGD) (City of Richmond 2000). Richmond is upgrading the plant to treat 570,000 m^3/day (150 MGD).

About 80 percent of Louisa County's source of residential drinking water is from groundwater through individual wells. Twelve small private water supply systems exist in the county. The major treatment plant in the county is the Northeast Creek water treatment

(a) Personal communication from Mr. David Wallace, Customer Services Supervisor, Department of Public Utilities Henrico County, Virginia, August 9, 2002.

Table 2-8. Major Public Water Supply Systems in Henrico, Louisa, Orange, and Spotsylvania Counties

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

NA = not available.

plant that supplies the town of Louisa, part of the town of Mineral, and some county residents. The plant has a capacity of approximately 3800 m^3/day (1 MGD) and average use is 1100 m^3/day (0.3 MGD). To provide water for industrial users, two new groundwater wells and a storage tank are under construction at the Zion's Crossroads area in the western part of the county (Kincheloe 2000) in addition to the storage tank there that is already supplementing the existing water supply system.

Ninety percent of Orange County residents obtain their drinking water from individual groundwater wells. The town of Orange draws its water from the Rapidan River[(a)] and owns and operates a 7600 m^3/day (2 MGD)-capacity water treatment plant that supplies the town (Kendall 2000). Average daily use is around 5700 m^3/day (1.5 MGD) (Kendall 2000).

(a) The town of Orange does not draw from a reservoir on the river but directly from the river in what is known as a "run-of-the-river" withdrawal.

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

Spotsylvania County has a public water system suppling most residential, commercial, and industrial areas within the county. Rural areas of the county are served by wells and springs (Spotsylvania County 2000). The Ni River Treatment Plant, which draws water from the Ni River, has a capacity of 23,000 m^3/day (6 MGD) and average use of 17,000 m^3/day (4.5 MGD). Another larger treatment plant is under construction (Johnson 2000).

Public water supply is not a constraint to growth in the vicinity of North Anna. There are supply concerns in some individual municipalities and in some of the impact counties, where it is assumed the majority of new employees associated with license renewal would live. However, there are no limitations on new sources of water from groundwater. In addition, most treatment plants located in the area of potential impact have reserve treatment capacity. In cases where municipal systems are approaching the limits of their reserve capacities, plans are in place to address those limitations by constructing new treatment systems or expanding existing facilities.

- **Education**

Louisa County has one high school, one middle school, and three elementary schools. For the school year 2000 – 2001, there were 4232 students in the school system (Louisa County Public Schools 2001; Louisa County 2001). Orange County schools have a total enrollment of approximately 3800 students spread among five elementary schools, one middle school, and one high school (Orange County Public Schools 2001).

Spotsylvania County has 26 schools in its system (16 elementary schools, 6 middle schools, and 4 high schools). In addition, the County has one vocational school, and one special high school for intellectually gifted students (Spotsylvania County Schools 2001). Approximately 20,350 students are enrolled in the county school system[(a)], and an additional 350 are in the special high school (Spotsylvania County Schools 2001). Henrico County, which includes Richmond, has 41 elementary schools, 10 middle schools, 9 high schools,

(a) Personal communication (by telephone) with Ms. Gerry Calavetinos, Administrative Assistant for School Admissions, Spotsylvania Public Schools, Virginia, December 4, 2001.

and two technical centers (Henrico County Public Schools 2001). Total school enrollment is more than 41,000.

- **Transportation**

  There are 32 counties within the 80-km (50-mi) radius of the North Anna site (see Figure 2-1). One county is in Maryland while the remaining counties are in Virginia. The 31-county Virginia area is served by two major freeways. Interstate 95 (I-95) runs north-south through the region and connects it to Washington, D.C. on the north and Richmond, Virginia on the south. Interstate 64 lies in a northwest direction from Richmond on the east to Charlottesville on the west. Interstate 295 serves as a beltway around Richmond.

  The area is also traversed by several other Commonwealth and Federal highways including Highway 15 from the vicinity of Warrenton in the north, through Culpeper, and on southwards. Highway 29 runs more northeast to southwest from the vicinity of Manassas, through Culpeper, to Charlottesville and extends on to the southwest. Highway 33 passes through Louisa and on southeast to Richmond. Highway 250 runs between Charlottesville and Richmond. Numerous State highways traverse the area including Highways 700, 652, 208 and 522, among others.

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

2.2.8.3 Offsite Land Use

The predominant land use in Louisa County and a major contributor to the economy is forestry, which is approximately 68 percent of the County's land area. Most of the forested land is privately owned. Agricultural lands occupy 23.5 percent and water resources about 3 percent of land use. Developed uses occupy 6 percent, with residential development predominating with 5.5 percent. This rural county has recently experienced significant population growth but little industrial growth. Residential land use has increased from 1.8 percent in 1979 to 5.5 percent by 2000. The county has prepared over 50 industrial sites for development. Many have access to various combinations of rail, gas, water, and sewer (Louisa County, Virginia, n.d.).

Spotsylvania County (70 percent land use in forestry and agriculture) is fast-growing because of its proximity to Washington, D.C. and northern Virginia. Recreational and retirement develop-

ment is also growing significantly around Lake Anna. Orange County, with 95 percent of land use in forestry and agriculture, is beginning to be impacted by development.

Henrico County is adjacent to Richmond and is undergoing rapid development. Approximately 45 percent of Henrico County remains undeveloped. Most of the heavily developed part of the County is along I-95. The area east of I-95 is facing development pressures in the coming decade.

Lake Anna has influenced land use development in Louisa, Orange, and Spotsylvania Counties. Residential development of mid-to-upscale homes characterizes development around the lake. Prior to 1998, the three counties did not coordinate land use planning activities in the Lake Anna watershed. In 1998, a committee was formed to examine the watershed and develop a plan enabling the counties to coordinate their efforts to address growth and protect the Lake Anna region. The Lake Anna Special Area Plan was issued as final in March 2000 (Lake Anna 2000).

The Commonwealth of Virginia mandates that cities and counties have comprehensive land use plans, and all four counties (Henrico, Louisa, Orange, and Spotsylvania) have such plans. Table 2-9 shows land use in the four counties.

VEPCo pays annual property taxes to Louisa, Orange, and Spotsylvania Counties for North Anna (see Table 2-15). For 1995 to 2000, VEPCo's tax payments to Louisa County represented approximately 46 percent of the County's yearly property tax revenues and 22.5 percent of its annual budget. VEPCo's tax payment to Orange and Spotsylvania Counties represented approximately 1.4 and 1.5 percent of these Counties' property tax revenues, respectively, and 0.3 percent of their annual operating budgets. Based on total tax payments coming from the operation of North Anna, Louisa County could continue to maintain its current level of development and public services. Spotsylvania, Orange, and Henrico Counties would experience negligible land use impacts from operation of North Anna.

2.2.8.4 Visual Aesthetics and Noise

Access to the North Anna site is provided by Virginia Highway 700. The terrain is gently undulating and wooded. Most of the site structures are screened from public view up to the proximity of the plant boundary. Noise from plant operations is not noticeable. The exception is boiler blowdown, which lasts for only a short time.

Table 2-9. Land Use in Henrico, Louisa, Orange, and Spotsylvania Counties[a]

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

(a) The City of Richmond is heavily developed. For this reason, the land use of this jurisdiction is not discussed.
(b) Includes land being used for agricultural purposes.
(c) Includes public and semi-public (churches, schools, parks, etc.) and miscellaneous land classifications (rights-of-way, utilities, transportation and communications facilities).
(d) Includes commercial and industrial lands.
(e) Numbers have been adjusted to achieve a total of 100 percent.
(f) Developed land is defined to include residential, commercial, industrial and public use.
(g) Developed land is defined to include industrial and commercial.
N/A not available
Sources: Spotsylvania County (1999); Louisa County (2001); Henrico Planning Office (1999 and 2001); VEPCo (2001b).

From the waters of Lake Anna, North Anna Power Station, Units 1 and 2, and adjacent buildings are visible from Brumley's Point looking southeast to the North Anna site. Again, there is no perceptible noise, except during boiler blowdown.[(a)]

2.2.8.5 Demography

Population was estimated from North Anna out to 80 km (50 mi) in 16-km (10-mi) concentric rings. VEPCo's population estimates for the 80-km (50-mi) area surrounding the site are based on information from the Updated Final Safety Analysis Report (UFSAR) for Units 1 and 2 (VEPCo 2000c). NRC Guidance calls for the use of the most recent USCB decennial census data, which for North Anna is the 1990 census (USCB 1991).

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

  Table 2-10 presents the population distribution within 80 km (50 mi) of the North Anna site for population estimates in 10-year increments from 1990 to 2030.

  In 2000, an estimated 1,614,983 people lived within 80 km (50 mi) of North Anna. Between 1990 and 2000, the total population within the 80-km (50-mi) radius is projected to have increased by 25.6 percent. Between 2000 and 2010, the population is projected to increase by 17.7 percent followed by a slight downward trend through 2030. Growth between 2020 and 2030 is projected to be 13.0 percent (VEPCo 2000c).

Table 2-10. Population Distribution from 1990 to 2030 Within 80 km (50 mi) of the North Anna Site

Year	0 to 16 km (0 to 10 mi)	16 to 32 km (10 to 20 mi)	32 to 48 km (20 to 30 mi)	48 to 64 km (30 to 40 mi)	64 to 80 km (40 to 50 mi)	Total
1990	11,887	67,871	138,267	514,490	553,641	1,286,156
2000 (est.)	14,506	85,749	174,602	642,823	697,303	1,614,983
2010 (est.)	16,549	100,919	204,434	753,445	824,708	1,900,056
2020 (est.)	18,587	115,309	234,267	864,067	952,113	2,184,342
2030 (est.)	20,625	129,698	264,099	974,689	1,079,518	2,468,629

Source: VEPCo (2000c).

All or parts of 32 counties and five major cities are located within 80 km (50 mi) of North Anna. The largest population center within the 16-km (10-mi) area is the town of Mineral,

(a) Personal communication George D. O'Connell, Reservoir Coordinator, Nuclear Site Services, Dominion Generation November 5, 2001.

which lies to the southwest of North Anna. The population of Mineral for 2000 is 424 (USCB 2000b). Lake Anna State Park also lies within the 16-km (10-mi) radius to the northwest of the site.

The Town of Louisa, located to the southwest of the North Anna site, falls within the 32-km (20-mi) radius. It has a population of 1401 (USCB 2000b). The towns of Fredericksburg, population 19,279 (USCB 2000b), northeast of the site, and Culpeper, population 9,664 (USCB 2000b), to the north of the site, fall within or on the edge of the 48-km (30-mi) radius. Charlottesville, population 45,049 (USCB 2000b), located to the west of North Anna, and Richmond, population 197,790 (USCB 2000b), east of the site, lie within or on the edge of the 64-km (40-mi) radius.

Spotsylvania and Louisa are ranked among the fastest growing Counties in Virginia. Between 1990 and 1998, these counties experienced 45.4 and 21.8 percent increases in population, respectively. During the same time period, Henrico and Orange Counties had increases of 13.5 and 16.9 percent, respectively (VEPCo 2001b). Richmond's population decreased 2.5 percent during the same period (Virginia Statistical Abstract 2000).

Table 2-11 lists the age distribution of Henrico, Louisa, Orange, and Spotsylvania counties and City of Richmond in 2000 and compares it to Virginia's population. The counties' age-distributed populations closely track within 2 to 3 percent. The exceptions are Spotsylvania County's under-18 age group (30.0 percent versus 24.6 percent for Virginia) and Orange County's 25-to-44 age group (27.8 percent versus 31.6 percent for Virginia).

Table 2-11. Estimated Age Distribution of Population in 2000

	Henrico		Louisa		Orange		City of Richmond		Spotsylvania		Virginia	
Age Group	**People**	**%**	**People**	**%**	**People**	**%**	**People**	**%**	**People**	**%**	**People**	**%**
Under 18	64,702	24.7	6255	24.4	5955	23.0	44,795	21.7	27,108	30.0	1,738,262	24.6
18 to 24	20,553	7.8	1691	6.6	1678	6.5	26,640	12.9	6626	7.3	679,398	9.6
25 to 44	86,166	32.9	7656	29.9	7184	27.8	65,517	31.7	29,062	32.2	2,237,655	31.6
45 to 64	58,278	22.2	6710	26.2	6620	25.6	41,961	20.3	20,073	22.2	1,630,867	23.0
65 and over	32,601	12.4	3315	12.9	4444	17.2	27,686	13.4	7526	8.3	792,333	11.2
Totals	262,300	100.0	25,627	100.0	25,881	100.0	206,599	100.0	90,395	100.0	7,078,515	100.0

Source: USCB (2001).

- **Transient Population**

The area within the first 16 km (10 mi) of North Anna is predominately rural and characterized by farmland and wooded tracts. No significant industrial or commercial

facilities are in the area, and none are anticipated. As a result, transient employment is most likely to be out of, rather than into, the area.

Lake Anna and its recreational use is the greatest contributor to a transient population. Lake Anna is the cooling water source for the North Anna facility. Numerous recreational sites are located around the reservoir, consisting of boat ramps, wet slips, camping sites, picnic areas, etc. A central data collection site for recreational use of the lake does not exist. VEPCo developed an estimate of lake use on a peak weekend day in mid-summer based on representative usage of recreational facilities, e.g., boating, picnicking, and camping (VEPCo 2000c). Data for the estimate were provided by the Virginia State Department of Conservation and Recreation for the recreational facilities on Lake Anna. The estimate does not include use of the lake by local residents with their own private boat docks. Table 2-12 shows the estimated transient population in the vicinity of the lake.[(a)]

The resulting estimated total peak daily transient population on Lake Anna is 5900 for boating and other uses of the lake and 3000 for Lake Anna State Park. The use of the WHTF is limited to residents around the WHTF and their guests, thus, its peak use is less than 1000. Given the conservative assumptions and the potential for double-counting, these numbers may be high (VEPCo 2000c).

Table 2-12. Estimated Transient Population Recreating at Lake Anna Facilities

Facility	Daily Peak Transient Population	Annual Usage	Comments/Assumptions
Lake Anna	5900	530,000	Annual use based on 180 days @ 2950/average day.
Waste Heat Treatment Facility	<1000	90,000	Peak daily based on doubling the resident population in cooling lagoon sectors (one guest per resident). Annual use based on 180 days @ 500/average day.
Lake Anna State Park	3000	93,000	Peak daily use during summer. Annual use was 93,000 in 1991. Use in 1993 was 87,000. Park closes in winter. Usage includes occupants of boats launched at the park.

Source: VEPCo (2000c).

(a) The UFSAR VEPCo (2000c) discusses the methodology and assumptions for deriving the numbers shown in Table 2-12.

The annual transient population is less certain because of the dramatic drop in boating on weekdays and outside the summer months. Based on the Lake Anna State Park data, assuming 180 days of operation, the average daily attendance is less than one fifth of the peak daily attendance. Assuming that the average attendance, excluding the park, is one-half the peak daily figure, the total annual attendance in the vicinity of Lake Anna would be about 710,000, based on a 180-day use period.

- **Migrant Labor**

Migrant workers are typically members of minority or low-income populations. Because migrant workers travel and can temporarily spend a significant amount of time in an area without being an actual resident, they may be unavailable for census takers to count. If this occurs, migrant workers would be under-represented in USCB minority and low-income population counts.

In 1997, Louisa County had 385 individual farms. The main crops grown within Louisa County are legumes, grass hay, corn for grain, soybeans, corn for silage, and wheat. Beef cattle production is also important, with 71 percent of the farms holding cattle and calf inventories and 71 percent of the farms selling cattle and livestock (Louisa County 2001). Migrant workers do not harvest agricultural crops in Louisa County; however, they do re-plant forest land that has been harvested.[(a)]

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

(a) Personal communication with Don Gallihugh, Louisa County Farm Service Agency, October 18, 2001.

2.2.8.6 Economy

The communities potentially impacted socioeconomically by North Anna's license renewal activities are Henrico, Louisa, Orange, and Spotsylvania Counties, all in central Virginia. Louisa County, where North Anna Power Station, Units 1 and 2, are located, would see the greatest impact. All these counties have experienced steady growth in population and economic activity during the last decade. The economy of each of the counties is briefly discussed in the following.

Some comparative economic statistics for the four counties and Virginia are presented in Tables 2-13 and 2-14. Table 2-13 presents information on the unemployment rate (for October 2001), the percent of individuals below the poverty line for 1997, and median household income (estimated for 1997). On a comparative basis, Henrico and Spotsylvania Counties were relatively better off than the other counties and the Commonwealth.

Henrico County is part of the Richmond-Petersburg metropolitan statistical area, which is home to approximately 950,000 people. The Richmond-Petersburg area is the primary economic driving force within an 80-km (50-mi) radius of North Anna. The Richmond metropolitan statistical area is located approximately 161 km (100 mi) from Washington, D.C. and has a transportation network of trucking and railroad terminals and interstate highway access to main east-west and north-south routes. It also has an international airport and the western-most inland port in the Commonwealth of Virginia with direct access to the Atlantic Ocean, giving it access to both domestic and international markets (City of Richmond 2001). The Richmond

Table 2-13. Percent Unemployment, Individual Poverty, and Median Household Income

	Unemployment (% October 2001)	Poverty (% Estimated 1997)	Median Household Income (1997 $)
Henrico County	3.5	7.9	44,122
Louisa County	3.6	12.6	34,609
Orange County	3.1	10.6	39,156
City of Richmond	5.3	23.0[a]	N/A[b]
Spotsylvania County	1.6	6.8	51,218
Virginia	3.5	11.6	40,209

Sources: Virginia Employment Commission (2001b); USCB (1997, 2000b).
(a) Estimated for 1995.
(b) Not available.

Table 2-14. Major Employers in Louisa County, Virginia

Employer	Product	Number of Employees
VEPCo	Electric	900+
Kloeckner–Pentaplast	Rigid PVC	630
Klearfold, Inc.	Plastic packing	176
Louisa County	Government Services	250[(a)]
Louisa County Public Schools	Education	680
Tri-Dim	Filters	100

Sources: Louisa County Economic Development, and personal communication, Louisa County Government and public schools.
(a) Inclusive of full- and part-time employees (VEPCo 2001b).

area is headquarters for more than 35 major corporations including nine Fortune 500 companies, 16 Fortune 1000 headquarters, and three Forbes 500 largest private companies (Henrico County 2001a). Service is the largest employment sector, followed by retail and wholesale trade and government. Capital One Financial Corporation is the largest private employer in the area (Times Dispatch 2001). The unemployment rate in Henrico County was 3.5 percent in October 2001 (Virginia Employment Commission 2001b).

Louisa County is located in the triangle between Richmond, Fredericksburg, and Charlottesville. Interstate 64 runs east-west through the County, as does a CSX rail line. Because North Anna is located in Louisa County, it has benefitted more economically than have the other counties. Table 2-14 shows the top five employers in Louisa County.

Until the 1990s, Louisa County had been rural and dominated by farming and forestry, which are still economically important. In the 1990s, the County's population grew by 26 percent, without a comparable increase in industrial and commercial development (Louisa County 2001). The number of jobs in the county decreased from 5600 in 1990 to 5000 in 1996, a decrease of 11 percent. The reason for the decline was the closing of two clothing manufacturers located in the county (Louisa County 2001).

Since 1996, employment has been increasing but is not back to the 1990 level. By the first quarter of 1999, the number of jobs in Louisa County had increased to 5400, still 200 fewer than the 1990 high. One positive aspect of the county's economic development is the arrival of a Walmart Regional Distribution Center in Zion Crossroads in the western part of the county that will employ approximately 750 people.

More than half of Louisa County's 11,650 resident workers commute to jobs outside the county (Louisa County 2001, VEPCo 2001b). In many respects, Louisa County is a bedroom community for the larger metropolitan regions, particularly Richmond and, to a lesser extent, Fredericksburg and Charlottesville.

The construction of North Anna in Louisa County has kept the County's property tax assessment rates significantly below those of neighboring counties. It also enabled the county to begin an economic development program in the 1970s with the construction of its industrial park.[(a)] While recognizing that North Anna has been economically beneficial to it, Louisa County would like to become less dependent on North Anna through diversification of the local economy. Walmart is being looked upon to train and provide employment for labor at the lower end of the pay scale.[(b)] The County would like to diversify its economy by attracting technology and bio-research firms.[(c)]

Orange County's economy is led by agribusiness, manufacturing, and commercial retail services. Orange and Gordonsville are the only two incorporated towns in the County. A planned, gated residential community exists at Lake of the Woods (Orange County 2000).

Orange County's labor force was approximately 11,375 in 2000, with 45 percent of working adults commuting out of the County to work. The existing employment base in Orange County consists of approximately 7108 jobs generated by over 535 businesses and industries. The largest employer (600 people) is a textile plant (Liberty Fabrics). The second largest employer (300 people) is American Woodmark Corporation, a maker of cabinet components (Orange County 2001).

Spotsylvania County is located halfway between Washington, D.C., and Richmond, Virginia. Economically, it is more associated with the Washington, D.C., metropolitan area through the commuting patterns of its residents (Spotsylvania County 2000). It is estimated that 40 to 60 percent of the County's approximately 46,000 workers commute to jobs outside the County (Spotsylvania County Office of Economic Development 2001).

Historically, agriculture and forestry have been important components of the Spotsylvania County economy. The relative economic importance of agricultural and forest activities has declined as the commercial and industrial base of the County has grown. The fastest growing commercial and industrial sectors from 1990 to 2000, by employment, were retail trade

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(a) Interview with Mr. G. B. Duke, Duke Oil, Mineral, Virginia October 17, 2001.
(b) Defined as being substantially better than minimum wage (currently $5.50 per hour), but generally less than $10 per hour.
(c) Interview with Mr. Lee Lintecum, Louisa County Administrator, October 19, 2001.

(129 percent); state, local, and Federal government (approximately 129 percent); transportation, communications, and public utilities (136 percent); and manufacturing of nondurable goods (101 percent) (Spotsylvania County Office of Planning 2001).

VEPCo pays annual property taxes to Louisa, Orange, and Spotsylvania Counties for North Anna. Table 2-15 presents information on the property taxes North Anna pays to each County, the percent of total property taxes paid, and each County's total budget. The preponderance of taxes are paid to Louisa County, where North Anna is located. For the period 1995 to 2000, North Anna's property taxes averaged about 46 percent of Louisa County's,[(a)] 1.5 percent of Orange County's, and 1.5 percent of Spotsylvania County's total property tax revenues. VEPCo's annual property tax payments to Louisa County for the 6-year period averaged approximately 22.5 percent of the county's total annual budget. VEPCo projects that North Anna's annual property tax payments will continue to increase slightly (absolute amount) through the license renewal period (VEPCo 2001b). However, the percent such payments represent of the total county taxes paid will probably continue to decline. The potential effects of electric utility deregulation in Virginia are not yet fully known. Any changes to North Anna tax rates due to deregulation, however, would not be affected by license renewal.

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

Orange and Louisa Counties have also benefitted from the growth in neighboring Henrico and Spotsylvania Counties. In addition, both Louisa and Spotsylvania Counties have been impacted by Lake Anna. Orange County has been impacted to a lesser extent since it has fewer miles of shoreline on Lake Anna. Development around Lake Anna has been oriented toward upscale second and retirement homes. Land values around the lake have increased significantly. Starter homes are being built on Louisa County's eastern edge, closer to Richmond. Moderate income homes and developments are scattered across Louisa County, and upscale neighborhoods are being built in the western end of the county closest to Charlottesville and around Lake Anna.

(a) 1995 property tax data were not available for Louisa County. The 46 percent reflects the average of taxes paid for 1996-2000. The other county averages are based on 1995-2000 data.

Table 2-15. Property Tax Revenues Generated in Louisa, Orange, and Spotsylvania Counties; Property Taxes North Anna Paid to Louisa, Orange, and Spotsylvania Counties; and Louisa, Orange, and Spotsylvania Counties Operating Budgets 1995 – 2000

Year	Total Property Tax Revenues	Property Tax Paid to County for North Anna	Percent of Total Property Taxes	Total County Budget
		Louisa		
1995	N/A	10,683,585	N/A	61,218,248[a]
1996[b]	22,761,970	11,115,929	49	54,532,295
1997	24,082,838	11,361,154	47	41,908,510
1998	24,116,482	11,006,924	46	45,122,433
1999	25,118,670	11,145,065	44	44,965,205
2000	25,209,205	10,583,390	42	45,069,880
		Orange		
1995	7,811,992	119,713	1.5	32,212,892
1996	8,047,224	128,328	1.6	34,214,668
1997	8,662,086	125,590	1.4	35,679,113
1998	9,354,981	149,679	1.6	38,328,996
1999[c]	10,540,257	132,419	1.3	41,743,551
2000	11,163,897	133,099	1.2	44,931,523
		Spotsylvania		
1995[d]	30,676,005	466,998	1.5	123,703,715
1996	32,894,971	491,668	1.5	131,403,347
1997	35,742,696	519,070	1.5	152,712,966
1998	38,531,812	558,833	1.5	184,888,334
1999	43,606,652	628,429	1.4	189,744,780
2000	49,147,669	674,457	1.4	195,986,091

(a) The total County budget is higher during 1995 and 1996 because of school construction.
(b) 1996 through 2000 values provided by Marty McCloud, Director of Finance, Louisa County, Virginia (November 18, 2001).
(c) 1999 and 2000 values provided by Phyllis Yancey, Treasurer's Office, Orange County, Virginia (November 2, 2001).
(d) 1995 to 2000 total budget and property taxes collected from North Anna provided by Mary Sorrell, Budget Manager, Spotsylvania County, Virginia (November 6, 2001).
N/A = not available.

VEPCo has a significant impact on the economic well-being of Louisa County, paying 46 percent of the property taxes between 1996 and 2000. Louisa County schools have benefitted substantially from the taxes VEPCo pays for North Anna by being able to upgrade their infrastructure. If the County were to lose the North Anna tax base, the impacts would be substantial, and it might take from 5 to 10 years for the County to recover from such a loss.[(a)] However, over time the contribution of total North Anna property taxes payable to Louisa County will decline, assuming the current rate of economic growth in the County continues. Thus, while the economic importance of North Anna is expected to decline, it may decline even faster if Louisa County experiences substantial economic growth as have Spotsylvania and Henrico Counties during the 1990s.

2.2.9 Historic and Archaeological Resources

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

2.2.9.1 Cultural Background

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

Prehistoric Period

The prehistoric Native American occupation of the region around the North Anna site includes three general periods: the Paleo-Indian period (about 10,000 to 8000 B.C.), the Archaic period (about 8000 to 1000 B.C.), and the Woodland period (about 1000 B.C. to 1600 A.D.). Toward the end of the Woodland period, from 1500 to 1675 A.D., a transitional episode known as the

(a) Interview with Melvin Carter, Director of Planning and Community Development, Louisa County, October 16, 2001.

Protohistoric period occurred in which initial contacts were made with Europeans, and cultural changes associated with subsequent white settlement of the area took place.

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

Historic Period, Native American

At the time of European contact and subsequent intrusion into the area surrounding North Anna, the lands, including the piedmont and mountains of western Virginia, were occupied by several Siouan-speaking Indian groups. One of the Monacan Indian groups, part of the larger Monacan Confederacy, is commonly associated with the area of present-day Louisa County. Between 1607 and 1720, the Monacan were gradually displaced from their homelands through a series of encounters with the encroaching Europeans, and by the 1677 “Treaty Between Virginia and the Indians.” By 1700, the Monacan had left Louisa County (Cooke 1993). Although some of the Monacan left the area permanently, going as far away as Pennsylvania and Canada, a remnant group moved to the Bear Mountain area of Amherst County, Virginia around 1720. Today, the Virginia Monacan Tribe numbers about 900 individuals. In 1989, the Monacan Tribe was recognized by the Virginia General Assembly as one of the eight indigenous tribes in the state and became a member of the Virginia Council on Indians (Monacan Indian Nation Website).

Historic Period, Euro-American

Similar to the prehistoric period, the historic period in Virginia can be subdivided into sequential time periods that describe associated events. These include: European Settlement to Society Period (1607 – 1750), Colony to Nation Period (1750 – 1789), Early National Period (1789 – 1830), Antebellum Period (1830 – 1860), Civil War Period (1861 – 1865), Reconstruction and Growth Period (1865 – 1917), World War I to World War II Period (1939-1945), and The New Dominion Period (1945 – present).

European settlement of the area around the North Anna site began shortly after 1700, and Louisa County was formed in 1742. The earliest non-native economy of the area was based on growing tobacco in the fertile lands along the North and South Anna River valleys. In the early 1800s, production of tobacco resulted in severe soil exhaustion, and wheat and corn replaced it

as staple crops. Although the area remained largely rural and agricultural, mining and quarrying were important to the economy of Louisa County at various times in the 1800s. Iron, copper, sulfur, gold and other ores were mined, and whetstone materials were quarried. The area just upriver from North Anna was the scene of intensive gold mining from about 1830 to 1900.

2.2.9.2 Historic and Archaeological Resources at North Anna

To assess known and potential cultural resource sites at North Anna, several existing literature and database sources were consulted, and several organizations were contacted (Appendix D). Particularly useful in this regard was the recent cultural resource assessment for the plant site, commissioned by VEPCo (Ahlman and Mullin 2001).

Examination of archaeological and historical site files at the Virginia Department of Historic Resources Archives indicated that no recorded cultural resource sites are known to exist at North Anna Power Station. Similarly, review of historical documentation at the Louisa County Historical Museum, including historic maps dating between 1751 and 1863, indicates few historic resources in the vicinity of North Anna other than an early road paralleling the south side of the North Anna River that appears to be near the western boundary of the North Anna Power Station. An unpublished map based on county deeds from 1765 to 1815 shows the presence of the "Jerdones Mill" on the North Anna riverbank, just upriver from the North Anna Power Station, along with the associated "Jerdones Mill Road." The same map shows an "Old Mine Road" within the North Anna site area (Truce n.d.).

Background research undertaken by Ahlman and Mullin (2001) indicates that undisturbed lands within the North Anna boundary have the potential to contain both unrecorded prehistoric and historic archaeological properties. As a follow-up to the assessment, five known historic-period cemeteries were recorded, three of which lie within the administrative boundary of North Anna Power Station and two that are located just downriver from the North Anna Dam. Two of these cemeteries have associated archaeological remains of former structures.

Reconnaissance-level archaeological and historical investigations were also completed in 1969 and 1970 for both the North Anna site area and lake bed area, with few results (AEC 1973). A few Archaic-period artifacts were noted in the area, but the investigator did not deem them worthy of recording and evaluating. In addition, according to records in the Louisa County Historical Society files, a total of 33 historic-period cemeteries were identified in the area along the river that was to be inundated. Many of these were avoided by adjusting project boundaries, although some were removed prior to inundation. This total apparently includes at least four of the cemeteries recorded recently at North Anna Power Station. Finally, cultural resource surveys along transmission lines associated with the North Anna site have largely resulted in no significant findings for cultural resources (e.g., Saunders 1976; MacCord 1981).

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 operating license for North Anna. Any such activities could result in cumulative environmental impacts and the possible need for the Federal agency to become a cooperating agency for preparation of this SEIS [10 CFR 51.10 (b)(2)].

The North Anna Hydroelectric Project (Project No. 6335-001), a small, two-unit hydroelectric power plant of 855-kW capacity located in Louisa County, Virginia, is situated at the base of North Anna Dam, where Lake Anna discharges into the North Anna River. It is owned and operated by VEPCo. An Exemption From Licensing for the hydroelectric plant was filed with the Federal Energy Regulatory Commission in March 1984; an order granting the exemption was issued in September 1984.

The staff determined there were no Federal project activities in the vicinity of North Anna that could result in cumulative impacts or would make it desirable for another Federal agency to become a cooperating agency for preparing this SEIS.

NRC is required under Section 102 of the National Environmental Policy Act of 1969 (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. NRC is consulting with FWS. 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 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 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."

40 CFR Part 50. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 50, "National Primary and Secondary Ambient Air Quality Standards."

40 CFR Part 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 includes 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 are then 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.

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 Section
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 North Anna Power Station, Units 1 and 2, because they are related to plant design features or site characteristics not found at North Anna are listed in Appendix F.

The potential environmental effects of refurbishment actions would be identified, and the analysis would be summarized within this section, if such actions were planned. The Virginia Electric and Power Company (VEPCo) indicated that it has performed an evaluation of structures and components pursuant to 10 CFR 54.21 to identify activities that are necessary to continue operation of North Anna Power Station, Units 1 and 2, during the requested 20-year period of extended operation. These activities include replacement of certain components as well as new inspection activities and are described in the VEPCo Environmental Report (ER) (VEPCo 2001).

However, VEPCo stated that the replacement of these components and the additional inspection activities are within the bounds of normal plant component replacement and inspections; therefore, they are not expected to affect the environment outside the bounds of plant operations as evaluated in the final environmental statements (AEC 1973; NRC 1976;

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 licensee's environmental report and the staff's environmental impact statement.

NRC 1980). In addition, VEPCo's evaluation of structures and components as required by 10 CFR 54.21 did not identify any major plant refurbishment activities or modifications necessary to support the continued operation of North Anna Power Station, Units 1 and 2, beyond the end of the existing operating licenses. Therefore, refurbishment is not considered in this supplemental 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."

U.S. Atomic Energy Commission (AEC). 1973. *Final Environmental Statement Related to the Continuation of Construction and Operation of Units 1 and 2 and the Construction of Units 3 and 4 of the North Anna Power Station.* Docket Nos. 50-338 and 50-339, AEC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1976. *Addendum to the Final Environmental Statement Related to Operation of North Anna Power Station, Units 1 and 2*. Docket Nos. 50-338 and 50-339, NUREG-0134. USNRC, Washington, D.C.

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Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for North Anna Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

4.0 Environmental Impacts of Operation

Environmental issues associated with operation of a nuclear power plant 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; 1999).[(a)] The GEIS includes 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 are then 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 of the supplemental environmental impact statement (SEIS) 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 North Anna. Section 4.1 addresses issues applicable to the North Anna cooling system. Section 4.2 addresses issues related to transmission lines and onsite land use. Section 4.3 addresses the radiological impacts of normal operation, and 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 while 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

(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.

related to operation during the renewal term are summarized in Section 4.8. Finally, Section 4.9 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable to North Anna Power Station because they are related to plant design features or site characteristics not found at North Anna Power Station are listed in Appendix F.

4.1 Cooling System

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that are applicable to the operation of the North Anna Power Station, Units 1 and 2, cooling system during the renewal term are listed in Table 4-1. The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER) (VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of the North Anna Power Station operating licenses (OLs). The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), 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 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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.

Table 4-1. Category 1 Issues Applicable to the Operation of North Anna Power Station, Units 1 and 2, Cooling System During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
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	4.2.1.2.2; 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)[(a)]	4.3.6
Noise	4.3.7

(a) In its Environmental Report (VEPCo 2001b), VEPCo inadvertently stated that this issue was not considered to apply to North Anna. During discussions with the staff during the September visit to Surry and the October visit to North Anna, the staff established that this issue is applicable to North Anna.

- 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.

  The staff has not identified any significant new information on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 lake stratification 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information including the National Pollutant Discharge Elimination System (NPDES) permit for North Anna Power Station issued by the Virginia Department of Environmental Quality (VDEQ) (Permit No. VA0052451; VDEQ 2001), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information including the NPDES permit for North Anna Power Station issued by VDEQ (Permit No. VA0052451; VDEQ 2001), or discussion with the 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information including the NPDES permit for North Anna Power Station issued by VDEQ (Permit No. VA0052451; VDEQ 2001), or discussion with the 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 water use 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 sublethal 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 [referring to Oyster Creek Nuclear Generating Station]. It is not expected to be a problem during the license renewal term.

During its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information, the staff identified one potentially new issue associated with stimulation of nuisance organisms. See Section 4.7.2 for a discussion of this issue. However, 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).[(a)] 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 exposures.

  The staff has not identified any significant new information on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes

(a) In its Environmental Report (VEPCo 2001b), VEPCo inadvertently stated that this issue was not considered to apply to North Anna. During discussions with the staff during the September visit to Surry and the October visit to North Anna, the staff established that this issue is applicable to North Anna because North Anna has a small cooling tower associated with a cooling water system for pump bearings.

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 North Anna Power Station, Units 1 and 2, are listed in Table 4-2 and are discussed in Sections 4.1.1, 4.1.2, 4.1.3, and 4.1.4.

Table 4-2. Category 2 Issues Applicable to the Operation of the North Anna Power Station, Units 1 and 2, Cooling System 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
AQUATIC ECOLOGY (FOR PLANTS WITH ONCE-THROUGH HEAT-DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	4.2.2.1.2; 4.3.3	B	4.1.1
Impingement of fish and shellfish	4.2.2.1.3; 4.3.3	B	4.1.2
Heat shock	4.2.2.1.4; 4.3.3	B	4.1.3
HUMAN HEALTH			
Microbiological organisms (public health) (plants using lakes or canals or cooling towers 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 before license renewal.

The staff independently reviewed the VEPCo ER (VEPCo 2001b), visited the site, and reviewed the applicant's NPDES Permit No. VA0052451, issued by VDEQ, that expires on January 11, 2006 (VDEQ 2001). |

Section 316(b) of the Clean Water Act (CWA) requires that any standard established pursuant to Sections 301 or 306 of the CWA shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts (33 USC 1326). Entrainment through the condenser cooling system of fish and shellfish in the early life stages is one of the adverse environmental impacts

that the best technology available minimizes. Virginia State Water Control Board (VSWCB) regulations provide that compliance with a NPDES permit constitutes compliance with Sections 301 and 306 of the CWA (9 VAC25-31-60.A.1). In response to Board requirements, VEPCo submitted a CWA Section 316(b) demonstration for North Anna in May 1985 (VEPCo 1985a). Based on this and other input, the Board issued NPDES Permit No. VA0052451 for North Anna (VDEQ 2001).

When both units are operating, the North Anna station draws water from Lake Anna at a rate of about 1.2×10^5 L/s (1.9×10^6 gpm). The water is circulated through the turbine condensers and service water system and returned to Lake Anna via the Waste Heat Treatment Facility (WHTF). Cooling water for the circulating water system is withdrawn from Lake Anna through two screenwells (one per nuclear unit) located in a cove just north of the station. Each screenwell contains four intake bays. Each intake bay is equipped with a trash rack, a traveling screen, and a circulating water pump. The traveling screens have a screen mesh size of approximately 1 cm (3/8 in.) and are designed to rotate every 24 hours or when a predetermined pressure differential exists across the screens. Debris and fish collected from the traveling screens are washed into wire baskets for disposal as solid waste.

Entrainment refers to the process in which organisms that are smaller than the screen mesh pass through the cooling system. Entrainment can result in a reduction in the ichthyoplankton (fish eggs and larvae) populations. Entrainment studies were conducted for North Anna between 1978 and 1983 to determine the species and quantities of ichthyoplankton entrained into the intake cooling water flow and passed through the power station (VEPCo 1985a). Once a week, sampling was conducted in front of the intake forebays from March to July of each year. Samples were collected from the surface, at mid-depth, and bottom by placing paired conical fine mesh nets in front of a pre-selected intake forebay. Nets were retrieved after 10 minutes. Sampling was conducted four times over 6 hours. The volume of water filtered during the sampling period was determined using a digital flowmeter.

A total of 7908 fish larvae were collected in the entrainment samples. No fish eggs were collected. Most species reproducing in Lake Anna produce demersal, adhesive eggs that significantly reduce potential entrainment. The most commonly entrained larvae were gizzard shad (*Dorosoma petenense*) (65.7 percent), followed by white perch (*Morone americana*) (15 percent), sunfishes (*Lepomis* sp.) (13.3 percent), yellow perch (*Perca flavescens*) (4.9 percent) and black crappie (*Pomoxis nigromaculatus*) (1.0 percent). The channel catfish (*Ictalurus punctatus*) and largemouth bass (*Micropterus salmoides*) were each represented by only a single collected individual. There were no larvae collected from any threatened or endangered species. Seasonal variation was observed in the timing of collection and reflects the spawning characteristics of the species. The total estimated fish larvae entrained ranged from 8.4×10^7 in 1982 to 2.5×10^8 in 1981. The difference reflects the average number of

circulating water pumps running each year (3.2 for 1982 and 6.4 for 1981) and changes in the fish standing crop in Lake Anna.

Under natural conditions, only a very small percentage of fish larvae survive predation and other natural mortality factors to become adult, reproducing fish. To assess the impact of the loss of fish larvae due to entrainment on the fisheries of Lake Anna, the adult equivalent model of Goodyear (1978) was used. This model estimates the number of adult fish that would have resulted from the entrained larvae had they not been lost to entrainment. This results in an estimate of the potential percent reduction in the adult fish population as a consequence of entrainment. Values ranged from a low of 0.01 percent for black crappie in 1978 and 1979 and sunfishes in 1982, to a high of 4.13 percent for gizzard shad in 1980. These reductions in adult recruitment would not be expected to significantly impact the Lake Anna fishery. This conclusion is supported by data from the annual fish monitoring conducted by VEPCo (VEPCo 2002).

The staff has reviewed the available information and based on the results of entrainment studies and the operating history of the North Anna intake structure, concludes that the potential impacts of entrainment of fish and shellfish in the early life stages in the cooling water intake system are SMALL. Therefore, no additional mitigation is 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 is considered a Category 2 issue, requiring a site-specific assessment before license renewal.

The staff independently reviewed the North Anna ER (VEPCo 2001b), visited the site, and reviewed the applicant's NPDES Permit No. VA0052451, issued by VDEQ, that expires on January 11, 2006 (VDEQ 2001).

Section 316(b) of the CWA requires that any standard established pursuant to Sections 301 or 306 of the CWA shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts (33 USC 1326). Impingement on the intake screens of fish and shellfish in the early life stages is one of the adverse environmental impacts that the best technology available minimizes. VSWCB regulations provide that compliance with a NPDES permit constitutes compliance with Sections 301 and 306 of the CWA (9 VAC25-31-60.A.1). In response to Board requirements, VEPCo submitted a CWA Section 316(b) demonstration for North Anna in May 1985 (VEPCo 1985a). Based on this and other input, the Board issued NPDES Permit No. VA0052451 (VDEQ 2001) for North Anna.

Impingement is the process in which fish that are too large to pass through the intake screen mesh stay in front of the screens, eventually tire, are retained on the screens and eventually die. Impingement studies were conducted from April 1978 through December 1983 to determine the species and number of fish retained upon the traveling screens of the water intake structure (VEPCo 1985a). Samples were collected on a four-week cycle. Sampling during the first three weeks consisted of two 24-hour sample periods on non-consecutive days. During the fourth week, a composite sample was taken consisting of 12 continuous 2-hour samples.

Samples were collected by first washing the screens for ½ hour prior to the beginning of a 24-hour sampling period. During sampling, each screen was washed for a minimum of 10 minutes, and fish were caught in a basket at the end of a sluiceway.

Impingement rates generally declined with time, corresponding with a reduction in overall fish population associated with stabilization of the lake. Over the course of the study, a total of 2.4×10^5 fishes weighing 5.7×10^3 kg (1.3×10^4 lb) were collected, representing 34 species and 13 families. This extrapolates to an estimated total number of fishes impinged of 9.6×10^5 with an estimated total weight of 2.3×10^4 kg (5.1×10^4 lb). Total impingement estimates per year ranged from 4.8×10^4 in 1983 to 5.9×10^5 in 1979. Of the study total, 61 percent of the impinged fish (5.9×10^5) were collected in 1979. After 1979, the impingement quantity, as a percentage of the overall total estimated impinged, generally declined with each year, with 13 percent (1.25×10^5) for 1981, 12 percent (1.2×10^5) for 1980, 7 percent (6.7×10^4) for 1982 and 5 percent (4.8×10^4) for 1983. The fish most commonly impinged during the study was gizzard shad (61 percent of total). In 1979, it comprised 77.6 percent of the total, of which 64 percent (2.9×10^5 total estimated impinged) were impinged between February 20 and March 20 of that year. High rates of impingement in 1979 corresponded to the lowest water temperature recorded between 1975 and 1983 in the intake area 1.2°C (34.1°F). Low water temperatures reduce shad mobility (Griffith 1978; McLean, et al. 1982), and winter kills are common for this species when the water temperature falls below 3.3°C (37.9°F) (Jester and Jensen 1972). The higher estimated annual impingement rates in 1979 were likely influenced by the extreme cold experienced that year. Other fish commonly impinged during the study were black crappie (16 percent, 1.5×10^5 total estimated impinged), yellow perch (16 percent, 1.5×10^5), bluegill (*Lepomis macrochirus*) (4 percent, 3.8×10^4) and white perch (1 percent, 9.6×10^3). No other species comprised more than 1 percent of the total.

A comparison of the impingement numbers to Lake Anna's standing crop estimates indicated a low percentage of the population was affected by impingement. The average estimated percentage of the gizzard shad standing crop that was removed annually by impingement was 0.38 percent (number) and 0.32 percent (weight). For crappie, the estimated percentages averaged 3.1 percent (number) and 3.8 percent (weight), respectively. Black crappie creel harvest estimates declined sharply in 1979, when it was 5.7×10^4 compared to the 1978

estimate of 1.1 x 10^5, a 48 percent reduction (VEPCo 1989a). A comparison of the size and age structure of black crappie impinged between 1979 and 1983 to those found in Lake Anna showed a similar range, indicating impingement affected no specific size or age class selectively. In addition, the amount of black crappie impinged in subsequent years declined following the decline in the overall lake population (VEPCo 1986). Therefore, it is highly unlikely that the large decline in black crappie populations was related to the relatively small loss of fish due to impingement. A large standing crop of black crappie immediately post-impoundment may have been due to increases in food as a consequence of the increased nutrient supply. As nutrient loads decreased and stabilized, black crappie may have been attracted to the intake structure to feed on the smaller fish feeding on the planktonic food organisms near the structure. Black crappie may also be attracted to structures in deeper water (Pflieger 1975). The lake was completely clear-cut prior to impoundment and thus lacks a deep, submerged structure, possibly making the intake structure attractive to black crappie (VEPCo 2001b). Between 1983 and 1990, the Virginia Department of Game and Inland Fisheries (VDGIF) placed 20 artificial structures in the lake to provide additional habitat in areas with "clean" bottoms. The percentage of black crappie by number in gill net samples since 1987 fluctuated between 18.8 percent and 5 percent (VEPCo 1989a -1995; 2000a; 2002) and was 13 percent in the most recent report available (VEPCo 2002).

The mean standing crop of fishes was relatively stable from 1978 through 1983 (VEPCo 1989a). The Section 316(a) demonstration and most recent monitoring data also show the Lake Anna fish populations to be diverse and relatively stable (VEPCo 1986; 2002).

The staff has reviewed the available information relative to potential impacts of the cooling water intake on the impingement of fish and shellfish, as set forth above, and based on these data, concludes that the potential impacts are SMALL, and no additional mitigation is 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 North Anna ER (VEPCo 2001b), visited the site, and reviewed the applicant's NPDES Permit No. VA0052451 (VDEQ 2001). This permit does not require reporting of discharge temperatures from the WHTF to Lake Anna; it limits the heat rejection rate to the lake to a calculated maximum of 1.354 × 10^{10} Btu/hr. However, Part I.E.6 of the current NPDES permit does require temperature monitoring in two quarters during the year at locations throughout Lake Anna and the WHTF.

The temperature of the cooling water increases by as much as 8.1°C (14.5°F) as it moves through the condensers. The heated cooling water is discharged into the WHTF. The cooling water residence time in the WHTF is approximately 14 days, and more than half of the station's waste heat is dissipated during this time. High-velocity jets discharge water from the WHTF into Lake Anna. This enhances the mixing of the heated effluent in the Lower Lake, resulting in nearly uniform temperatures across horizontal layers and preventing the formation of a clearly defined thermal plume in the Lower Lake (VEPCo 2001b). According to the CWA Section 316(a) demonstration report produced by VEPCo in 1986, the North Anna thermal contribution to Lake Anna corresponds to about 10 percent of the solar heat that enters the reservoir (VEPCo 1986).

VEPCo submitted a CWA Section 316(a) demonstration for North Anna to VSWCB on June 24, 1986 (VEPCo 1986). Although the most recent NPDES permit (VDEQ 2001) does not reference the Section 316(a) report, Item 12 on page 28 of Part I in the previous permit (issued November 18, 1997) refers to the submittal of the Section 316(a) report. It indicated that the Board found that "effluent limitations more stringent than the thermal limitations included in this permit are not necessary to assure the protection and propagation of a balanced indigenous community of shellfish, fish and wildlife in Lake Anna and the North Anna River downstream of the lake."

VEPCo conducted pre-operational studies from 1972 to 1977 and operational studies from 1978 through 1985 on the aquatic community in Lake Anna and the North Anna River downstream of Lake Anna (VEPCo 1986). Upon impoundment, Lake Anna developed three distinct ecological zones. The Upper Lake is essentially riverine and shallow (average depth 4 m [13 ft]), and shows some evidence of temperature stratification in summer. The Mid-Lake is deeper and stratifies in summer. The Lower Lake is the deepest portion of the lake (average depth of 11 m [36 ft]), clearer (with more light penetration), and shows pronounced annual patterns of winter mixing and summer stratification. During pre-operational years, the summer epilimnion (the warm upper layer of water) was generally from 2 to 5 m (7 to 16 ft) deep. This increased to 8 to 10 m (26 to 33 ft) during operational years. The highest recorded hourly and mean monthly daily maximum temperatures during pre-operational monitoring were in July in the Upper Lake (hourly, 33.7°C [92.7°F]; and mean monthly, 30.2°C [86.4°F]; both during 1977) and during operational monitoring in the Mid-Lake region (hourly, 33.5°C [92.3°F]; and mean monthly, 30.8°C [87.4°F], both during 1983). In the North Anna River, summer water temperatures from 1970 to 1985 were higher near the dam than downstream, reflecting temperatures in the reservoir. The highest water temperature recorded in pre-operational years was 31.9°C (89.4°F), and the highest temperature recorded in operational years was 32.7°C (90.9°F), recorded in August 1983 at the same monitoring station.

Biological monitoring was conducted in the upper, middle, and lower portions of the reservoir and in the North Anna River below the reservoir during the pre-operational and operational

periods as part of the Section 316(a) demonstration. The phytoplankton, macrophyte, periphyton, benthic, zooplankton, bottom-feeding fish, planktivorous, and piscivorous fish communities were studied to determine if the thermal effluent of North Anna caused appreciable harm. Abundance and distribution of fish were evaluated using a variety of sampling methods over a period from 1975 to 1985. Larval fish studies and creel surveys were also conducted. Special studies were conducted that focused on the reproduction and growth of largemouth bass and striped bass (*Morone saxatilis*). Striped bass seasonal movement and habitat preferences were also investigated using ultrasonic tags. Since the Section 316(a) demonstration was completed, monitoring of fish populations has continued as part of an agreement with the VDEQ to conduct a post-Section 316(a) demonstration environmental monitoring program. As part of this agreement, monitoring data are reviewed every 3 years and monitoring requirements are adjusted accordingly. In 1991, the age and growth studies of largemouth and striped bass and habitat availability studies for striped bass were discontinued due to the relatively little change in year-to-year data (VEPCo 1992).

Data presented in the Section 316(a) demonstration, in addition to recent monitoring data (VEPCo 2002), showed Lake Anna to contain a highly abundant and diverse population of fish species. Lake Anna supports a higher standing crop of fishes compared to similar southeastern reservoirs (VEPCo 1986). The community structure has remained relatively stable since 1975, with some year-to-year variation in species composition. The Section 316(a) studies indicated that striped bass grow and provide a substantial “put-grow-and-take” recreational fishery in Lake Anna but adults are subject to late-summer habitat restrictions (limited to cooler-water refuge areas) and growth limitations. By late summer, habitat was shown to be only marginally suitable for striped bass without North Anna operations, and this marginally suitable habitat became somewhat more restricted due to North Anna operations. Threadfin shad, introduced in 1983 to provide additional forage to upper trophic level game fish, is vulnerable to cold shock and winter die-off and would likely not survive in Lake Anna if it were not for the operation of North Anna. Recent monitoring data are consistent with historical data and continue to show a diverse and abundant fish community. In 1999 and 2000, the lake ranked third in the Commonwealth as a trophy bass lake (VEPCo 2000a; 2002).

The fish community in the North Anna River downstream of the dam appears to be diverse and typical of a community that is in dynamic equilibrium (VEPCo 1986). Species abundance and diversity change from near the dam to farther downstream, paralleling changes in physical features of the river. Underwater observations of largemouth bass and smallmouth bass in 1999 showed largemouth bass to be more abundant in the upper reaches of the river below Lake Anna and smallmouth bass to be more abundant in the lower reaches (VEPCo 2000a), although observations made in 2000 showed a more even distribution of both species throughout the river (VEPCo 2002).

Based on the foregoing, the staff concludes that the potential heat shock impacts resulting from operation of North Anna's cooling water discharge system to the aquatic environment on or in the vicinity of the site are SMALL, and no additional mitigation is warranted.

4.1.4 Microbiological Organisms (Public Health)

For plants discharging cooling water to cooling ponds, lakes, canals, or small rivers, the effects of microbiological organisms on human health is listed as a Category 2 issue and requires plant-specific evaluation before license renewal.

North Anna Power Station, Units 1 and 2, use an open-cycle cooling system in which cooling water is withdrawn from Lake Anna, heated in the condensers, and returned to Lake Anna through a series of lagoons, referred to as the WHTF. The public has access to areas that might be impacted by the heated water from the cooling system, including Lake Anna and the WHTF. Activities in these areas include swimming, recreational boating, fishing, and residential housing.

The thermophilic pathogen amoeba *Naegleria fowleri*, found in freshwater throughout the United States, was found in the WHTF following start up of North Anna Unit 1 in June 1978. In 1981, VEPCo environmental personnel met with the Virginia Epidemiologist to determine whether *N. fowleri* at North Anna represented a public health risk. Following consultation with other State and Federal agencies, the risk of contracting primary amoebic meningoencephalitis was determined to be too low to justify any action by VEPCo or State agencies (VEPCo 1985b).

Wastewater is the principal source of pathogens in natural waters. The sewage treatment plant at North Anna disinfects wastewater to reduce coliform bacteria and other microoganisms to levels that meet state water quality standards. In addition, VEPCo monitors temperatures in the cooling water discharge and the WHTF. The cooling water discharge temperatures during the summer are within the range of those known to permit the growth and reproduction of thermophilic pathogenic microorganisms, but are below those considered optimal for thermophilic organisms. Temperatures in the WHTF immediately downstream of the discharge structure are several degrees cooler than those in the immediate outfall and, under normal circumstances, would not support the growth and reproduction of thermophilic pathogenic organisms. Temperatures in Lake Anna and in the North Anna River below the dam are almost always too low to support thermophilic pathogens (VEPCo 2001b).

Consequently, the staff concludes that the potential impacts of microbiological organisms on public health are SMALL, and no additional mitigation beyond current wastewater treatment is warranted.

4.2 Transmission Lines

North Anna Power Station has three 500-kV transmission lines and one 230-kV transmission line leaving the site from the switchyard. Each transmission line occupies a separate right-of-way. The rights-of-way range in width from 37 to 84 m (from 120 to 275 ft) and in length from 24 to 66 km (from 15 to 41 mi) covering a total of approximately 1174 ha (2900 ac) (Table 2-1) (AEC 1973; VEPCo 2001b). The rights-of-way extend from North Anna to the north, south, east, and west terminating in Morrisville, Midlothian, Ladysmith, and at the South Anna non-utility generator (Figure 2-5). The transmission lines and rights-of-way were constructed between 1973 and 1984. The vegetation in the rights-of-way is managed through a combination of mechanical and herbicide treatments conducted on a 3-year cycle. Mowing is the primary mechanical treatment, and Accord and Garlon are the primary herbicides used in the rights-of-way. In some areas (e.g., wetlands, dense vegetation), hand-cutting treatments are used. Vegetation treatments are developed in cooperation with the Virginia Department of Conservation and Recreation (VDCR) Natural Heritage Program (VEPCo 2001b). Rare and sensitive plant species areas are identified and avoided, or modified treatment practices are used to avoid adverse impacts. In addition, wildlife food plots and Christmas tree plantations are located along the corridors and supported through cost-sharing by VEPCo (VEPCo 2001b).

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to transmission lines from North Anna Power Station, Units 1 and 2, are listed in Table 4-3. The

Table 4-3. Category 1 Issues Applicable to the North Anna 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, livestock)	4.5.6.3
Flood plains 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 rights-of-way	4.5.3

VEPCo ER (VEPCo 2001b) states that it is not aware of any new or significant information associated with the license renewal of North Anna Power Station, Units 1 and 2. The staff has not identified any significant new information on these issues during its independent review of the VEPCo ER (VEPCo 2001b), 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 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 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, discussions with the U.S. Fish and Wildlife Service (FWS) and VDGIF, or its evaluation of other 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 are expected to be of small significance at all sites.

  The staff has not identified any significant new information on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, discussions with FWS and VDGIF, or its evaluation of other 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, discussions with FWS and VDGIF, or its evaluation of other 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.

- Flood plains 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, discussions with FWS and VDGIF, or its evaluation of other information. Therefore, the staff concludes that there are no impacts on flood plains and wetlands on the power line right-of-way during the renewal term beyond those discussed in the GEIS.

- Air-quality effects of transmission lines. Based on the 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other 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 the 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other 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. Category 2 and Uncategorized Issues Applicable to the North Anna 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 the National Electrical Safety Code (NESC) criteria (NESC 1997), it is not possible to determine the significance of the potential for electric shock. 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 the transmission lines may have changed or the power distribution companies may have upgraded the line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), an applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

The NESC specifies that transmission lines be designed to limit the steady-state current due to the electrostatic effects to 5 mA root mean square (rms). There is one 230-kV line and three 500-kV transmission lines that distribute power from North Anna to the VEPCo grid. The 230-kV line was designed using the 5 mA rms limit prescribed in the NESC, while the other lines were constructed before the standard was first established in 1977. Therefore, VEPCo performed an analysis to confirm that all of these transmission lines conform to the current NESC clearance requirements for limiting electric shock hazard.

VEPCo calculated field strength and induced current using a computer code called ENG01814 that was developed by Cincinnati Gas & Electric Company (1991). The results of the code have been verified by taking actual field measurements under energized transmission lines. The input parameters for this code include the minimum vertical clearance to the roadbed with line sag determined at 49°C (120°F) conductor temperature, and maximum vehicle size under the line being a semi-tractor trailer.

The analysis determined that none of the four transmission lines has the capacity to induce currents to the level of 5 mA rms in a vehicle parked beneath the lines. Therefore, the staff concludes the expected impact of the potential for electric shock is SMALL, and further 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 so designated 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 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 exposure. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the staff to 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 North Anna Power Station, Units 1 and 2, in regard to radiological impacts are listed in Table 4-5. VEPCo stated in its ER (VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of the North Anna OLs. No significant new information on these issues has been identified by the staff during its independent review. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For the 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.

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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 Term

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. VEPCo stated in its ER (VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of North Anna Power Station, Units 1 and 2, OLs. No significant new information on these issues has been identified by the staff in its independent review. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For the issues in the GEIS, the staff concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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 Section
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

A brief description of the staff's review and the GEIS conclusions for each of these issues, as codified in Table B-1, 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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.

- 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 that require plant-specific analysis and environmental justice, an issue that was not generically resolved in the GEIS.

Table 4-7. Environmental Justice and GEIS Category 2 Issues Applicable to Socioeconomics 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
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 must be addressed in the licensee's ER and the staff's environmental impact statement.

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, Section C.1.4). 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) of the site. 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 size (NRC 1996, Table C.1), and a matrix is used to rank the population category as low, medium, or high (NRC 1996, Figure C.1).

In 2000, the population living within 32 km (20 mi) of North Anna Power Station, Units 1 and 2, is estimated to be approximately 100,255 (Table 2-10). This translates to around 30 persons/ km^2 (80 persons/mi^2) living on the land area present within a 32-km (20-mi) radius of the North Anna site. This concentration falls into the GEIS sparseness Category 3 (i.e., having greater than or equal to 25 to approximately 45 persons/km^2 [60 to 120 persons/mi^2]).

In 2000, an estimated 1,614,983 people lived within 80 km (50 mi) of the North Anna site (Table 2-10), equating to a population density of around 80 persons/km^2 (205 persons/mi^2) on the available land area. Applying the GEIS proximity measures (NRC 1996), the North Anna site is classified as Category 4 (i.e., having greater than or equal to 73 persons/km^2 [190 persons/mi^2]) within 80 km (50 mi) of the site. Also, the City of Richmond (population 197,790 [USCB 2000]) is located within the 80-km (50-mi) radius of North Anna. Even though Louisa County, where North Anna is located, has a population of only 25,625 (see Table 2-7) (USCB 2000), these sparseness and proximity scores identify the nuclear units as being located in a high-population area.

Henrico, Louisa, Orange, and Spotsylvania counties and the City of Richmond are expected to bear the brunt of potential impacts (especially Louisa County). They do not have growth-control measures that would limit housing development. Based on the NRC criteria, VEPCo expects housing impacts to be SMALL during refurbishment and continued operations (VEPCo 2001b).

In the GEIS, staff assumed that an additional 60 permanent workers per unit might be needed during the license renewal period to perform routine maintenance and other activities. Although VEPCo expects to perform these routine activities during scheduled outages, it assumes that no more than 60 total employees would be added to its permanent staff during the license renewal period (VEPCo 2001b). The addition of 60 permanent employees, plus 223 indirect workers, would result in an increased demand for a total of 283 housing units[(a)] (VEPCo 2001b). The 283 housing units represent an “upper bound” on the additional housing units required. Of

(a) VEPCo assumes that all direct and indirect jobs would be filled by in-migrating residents (VEPCo 2001b).

these, approximately 207 housing units would be scattered across the four impact counties.[(a)] Within the four-county area, the 2000 census estimated that there are approximately 169,000 housing units (see Table 2-6). The estimated 207 housing units required to house the additional employees represents 0.12 percent of the total housing available. The potential increased demand for housing units could be met with the construction of new housing or use of existing, unoccupied housing in the four-county area. While all four counties are experiencing steady growth, the increased demand for housing would not create a discernible change in housing availability, impact rental rates or housing values, or spur new housing construction or the conversion of existing housing to rental units.

As set forth above, the staff reviewed the available information relative to housing impacts and VEPCo's conclusions. Because the bounding number of new housing units needed is a very small percentage of the available units, the staff concludes that the impact on housing during the license-renewal period would be SMALL, and further 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. The staff indicates in the GEIS 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).

Analysis of impacts on the public water supply system considered plant demand and plant-related population growth. Section 2.2.2 describes the North Anna permitted withdrawal rate and actual use of water. North Anna does not use water from a municipal system and is planning no major refurbishment, so plant demand would not change beyond current demands (VEPCo 2001b).

VEPCo assumed an increase of 60 employees during the license renewal period, the generation of 283 new jobs, and a net overall population increase of approximately 722 as a result of those jobs,[(b)] all of which, VEPCo concludes, would create SMALL impacts.

(a) This assumes that 79 percent of the 283 new workers would locate in the impact county area.
(b) Calculated by using the average number of persons per household in Virginia, which in Virginia is estimated to be 2.55. Thus (283 jobs X 2.55 = 721.65 or 722) (VEPCo 2001b).

The plant-related population increase of 722 would require an additional 220 m^3/day (0.06 MGD) of potable water (VEPCo 2001b).[(a)] All public water supply systems in the area of potential impact are below their current maximum daily capacity (see Table 2-8). There is no moratorium in any part of the area of potential impact on drilling new wells or otherwise finding new or expanding existing water resources and infrastructure. The staff assumed that any increase in demand for water use would be distributed across the area of potential impact, consistent with the assumption that 79 percent of new employees would live in the area of potential impact. The increased demand would represent an insignificant percentage of capacity for the water supply systems in that area. In addition, in Louisa and Orange counties the majority of the population uses groundwater wells as a source of drinking water.

The staff independently reviewed available information and VEPCo's analysis, as set forth above. Because the increase in water use is such a small percentage of the available capacity in the area, the staff concludes that the impact of increased water use is 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."

In Section 4.7.4 of the GEIS, the staff define 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.

VEPCo has identified a maximum of 60 additional employees during the license renewal term plus an additional 223 indirect jobs (total 283) in the community (VEPCo 2001b). In Section 3.7.5 of the GEIS (NRC 1996) the staff found that if plant-related population growth is less than 5 percent of the study area's total population, offsite land-use changes would be

(a) Calculated by assuming that the average American uses 80 gallons of water for personal use per day; 722 people x 80 gpd = 0.06 MGD or 220 m^3/day.

small, especially if the study area has established patterns of residential and commercial development, a population density of at least 23 persons/km^2 (60 persons/mi^2), and at least one urban area with a population of 100,000 or more within 80 km (50 mi). In this case, population growth will be less than 5 percent of the area's total population, the area has established patterns of residential and commercial development, a population density of well over 23 persons/km^2 (60 persons/mi^2), and one urban area (Richmond) with a population of 100,000 or more within 80 km (50 mi). Consequently, the staff concludes that population changes resulting from license renewal are likely to result in SMALL offsite land-use impacts.

Tax revenue can also affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities, etc.) necessary to support development. In Section 4.7.4.1 of 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. If the plant's tax payments are projected to be small relative to the community's total revenue, tax-driven land-use changes during the plant's license renewal term would be SMALL, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level 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 changes would be moderate.

Louisa County receives the majority of property taxes paid on North Anna Power Station, Units 1 and 2, directly. As these payments amount to 42 percent of the total tax revenue collected by Louisa County (year 2000, see Table 2-15), new tax-driven land-use changes could be moderate (NRC 1996). The other counties (Orange and Spotsylvania) receive more modest amounts, on the order of 1.5 percent. Since no major refurbishment activities are planned at North Anna during the license renewal term, no new sources of plant-related tax payments are expected that could significantly influence land use in Louisa County. Notwithstanding the high proportion of tax revenue VEPCo paid to Louisa County and the County's relatively high population growth during the 1990s, there are no growth-control measures that would limit new housing and land developments in the County.

Louisa County's continued receipt of taxes from North Anna keeps tax rates lower in the County than they might be otherwise. This has enabled the County government and schools to provide a higher level of public infrastructure and services than would be possible otherwise. Louisa County's property tax rates are significantly lower than those of any of the surrounding counties because of North Anna's presence in Louisa County. Continued operation of North Anna provides significant economic stability to Louisa County. Other jurisdictions in the area of

potential impact benefit from North Anna through its employees who live in the area of potential impact. Orange and Spotsylvania Counties also receive a limited amount of property taxes from VEPCo for land around Lake Anna that VEPCo owns and that is within those counties' jurisdiction. Based on the information given above, the staff concludes that tax-related land-use impacts are likely to be SMALL.

Based on a review of the issues related to land use and the criteria in the GEIS, for the reasons set forth below, the staff also concludes that the net impact of plant-related population changes on land use is likely to be SMALL. There are three reasons for this conclusion. First, VEPCo does not expect major refurbishment activities for Units 1 and 2 in conjunction with license renewal. Thus, there will be no increase in employment at the North Anna site as a result of license renewal activities. Second, VEPCo envisions that its permanent work force will remain stable during the license renewal operation period of up to 20 years. Third, the population increase in Louisa County during the 1990s, not related to North Anna, was approximately 26 percent. While this rate of growth may continue during the first decade of the new century, it is expected to be the result of economic activity not related to North Anna's continued operation. Thus, additional mitigation of land-use impacts during the license renewal term does not appear to be 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.

In 2001, most of the roadways within Louisa County were operating at acceptable levels of service.[(a)] As shown in Table 2-7, the population in Louisa County, the county most impacted by the presence of North Anna, is projected to increase from approximately 25,625 to 30,005, or by approximately 26 percent, from 2000 to 2010 (Virginia Employment Commission 2001). It is expected to increase by another 15 percent between 2010 and 2020 (Louisa County Planning Department 2001). While such growth would put pressure on the local transportation system, it probably would not overwhelm the system. An adequate transportation system exists, and the

(a) This conclusion is based on several interviews conducted with persons located in Louisa County during a site visit October 15 through October 19. The major bottleneck, mentioned by a number of interviewees, is where State Highway 208 leaves U.S. Route 33 in downtown Louisa. There is a very sharp curve at this intersection that semi-trucks have trouble negotiating. The proposed solution is a bypass highway around Louisa. Funding for the project is currently in question (personal communication with Mr. Lee Lintecum, County Administrator, Louisa County, October 19, 2001).

population projection increases are based on a small population; i.e., a large percentage increase but small increase in absolute numbers. Also, several improvements are planned in Louisa County over the next 15 years for primary and secondary roads to maintain a specific level of service (Louisa County Planning Department 2001).

However, none of the expected growth and projected improvements to the transportation system are directly due to increases in North Anna's employment. The permanent employment associated with North Anna is currently 851 employees and from 70 to 110 contract and licensee employees assigned from other departments (VEPCo 2001b). During periods of refueling, once or twice a year, an additional 700 temporary workers are hired to participate in refueling and other maintenance activities. The "upper bound" potential increase in permanent staff during the license renewal term is 60 additional workers, or approximately 6 percent of the current permanent and contract work force of 921 to 961 (permanent plus contract employees). Access to North Anna is over secondary, as opposed to primary, roads (State Highways 700 and 652) that carry a level of service designation of "B." In the GEIS (Section 3.7.4.2) the staff concludes that impacts to roads with a level of service designation of "B" are small (NRC 1996). The rationale is that individual users are not substantially affected by the presence of other users. At this level of service, no delays occur and no improvements are needed. Based on these facts, VEPCo concludes that the impacts on transportation during the license-renewal term would be SMALL, and no further mitigation would be warranted (VEPCo 2001b).

The staff reviewed VEPCo's assumptions and resulting conclusions and conducted independent onsite interviews and observation of transportation conditions around North Anna during the week of October 14, 2001. The staff found that the bases for the VEPCo conclusions were sound. Therefore, the staff concludes that any impact of North Anna Power Station, Units 1 and 2, license renewal on transportation service degradation is likely to be SMALL and would not require any additional mitigation.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA), as amended through 1992, 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 through 1999. Renewal of an OL could potentially affect historic properties that may be located at the site. Therefore, according to the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effects. If no historic properties are present or affected, the 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 and resolve possible adverse effects of the undertaking.

VEPCo has stated in the ER (VEPCo 2001b) that no additional land-disturbing activities at the plant or along the existing transmission line rights-of-way are planned for the North Anna Power Station, Units 1 and 2, license-renewal period. VEPCo has recently taken an aggressive approach to recording and protecting known cultural resource sites, as in the case of the five cemeteries at the North Anna site. As part of the cultural resource assessment effort, the entire plant site has been classified into one of three categories, based on the potential for undiscovered historic properties to be present, including recommendations for responding to inadvertent discovery and possible adverse effects to resources. These include the following:

- Areas with No Potential for archaeological resources. These areas include lands where past disturbances related to construction of the power station and appurtenant facilities have taken place to such an extent that any cultural resources that once existed are no longer present. No further archaeological investigations are recommended for these areas.

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

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

In addition to assessing the known and potential occurrence for cultural resources and classifying plant lands according to resource potential, VEPCo includes cultural resource-specific written directions in their sitewide excavation and backfill work procedures involving an immediate stop work order should archaeological, historical, or other cultural resources be uncovered during excavation. The Construction Supervisor is responsible for ensuring the work stoppage and for notifying the Environmental Compliance Coordinator of the inadvertent discovery.

Based on the staff's cultural resources analysis and VEPCo's conclusion that major refurbishment activities are not needed to support the renewal of the North Anna Units 1 and 2 OLs and

that operation will continue within the bounds of plant operations as evaluated in the Final Environmental Statement (FES) and its addendums (AEC 1973, NRC 1976 and 1980), the staff concludes that the potential impacts on historic and archaeological resources are expected to be SMALL, and further mitigation is not warranted. The staff also concludes that it is unnecessary at this time to enter into a cultural resources programmatic agreement pursuant to Section 106 (NRC 2002a).

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority[(a)] or low-income populations. 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 it is not subject to the Executive Order, the Commission has voluntarily committed to undertake environmental justice reviews. NRC staff used the guidance in NRC Office of Nuclear Reactor Regulation office instruction number LIC-203 (NRC 2001) for its review.

The staff examined the geographic distribution of minority and low-income populations within 80 km (50 mi) of North Anna, employing the 1990 Census (USCB 1990a) for low-income populations and the 2000 Census (USCB 2000) for minority populations. The radius within 80 km (50 mi) of North Anna encompassed counties in Virginia and Maryland. The analysis was also supplemented by field inquiries to the planning department and social service agencies in Louisa County.[(b)]

For the purpose of the staff's review, a minority population is defined to exist if the percentage of any minority or aggregated minority category within the census block groups[(c)] potentially

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(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 as separate minority categories. (NRC 2001).

(b) Louisa County was the focus of this inquiry because North Anna is located there. The staff concluded that any findings of environmental justice issues in the county would warrant further investigation in the neighboring counties. For reasons stated later in this section, further investigation was not warranted.

(c) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the Census Bureau collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census data

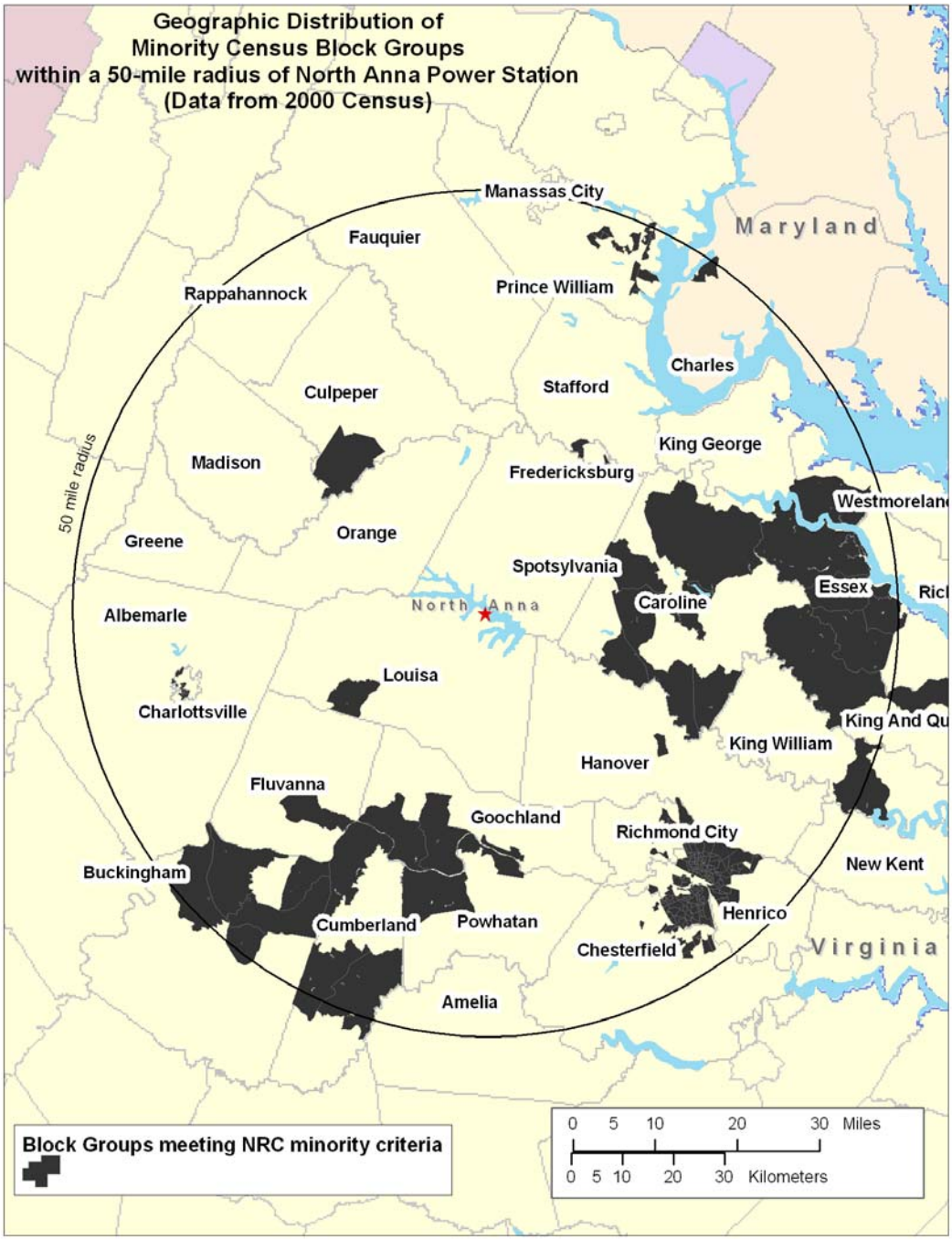
affected by the license renewal of North Anna exceeds the corresponding percentage of minorities in the entire Commonwealth of Virginia and State of Maryland (for Charles County, Maryland) by 20 percent, or if the corresponding percentage of minorities within the census block group is at least 50 percent. A low-income population is defined to exist if the percentage of low-income population within a census block group exceeds the corresponding percentage of low-income population in the entire Commonwealth of Virginia/State of Maryland by 20 percent, or if the corresponding percentage of low-income population within a census block group is at least 50 percent. For counties and census block groups within an 80-km (50-mi) radius of North Anna, the percentage of minority and low-income populations is compared to the percentage of minority and low-income populations in Virginia or Maryland, as applicable.

VEPCo followed the convention of including census tracts. It included the census tracts where at least 50 percent of their area lies within 80 km (50 mi) of North Anna (VEPCo 2001b). Using this convention, the 80-km (50-mi) radius includes 351 census tracts. The "more than 20 percentage points above the comparison area" criterion was used to determine whether a census tract should be counted as containing a minority or low-income population (VEPCo 2001b). Because the 20 percentage points is a lower threshold, the 50 percent criteria was not needed.

The staff followed the convention of employing census block groups and counts of individuals in minority or low-income status. Figure 4-1 shows the distribution of minority populations (shaded areas) within the 80-km (50-mi) radius. Within 32 km (20 mi) of North Anna, a minority population is concentrated to the southwest of the site in Louisa County.

Black minority populations exist within approximately 24 km to 48 km (15 mi to 30 mi) east-southeast of the site on Caroline County's boundary with Hanover County and extending to King William County. Between approximately 64 km (40 mi) and 80 km (50 mi) distance east of the North Anna site, minority populations exist in Essex and Westmoreland counties. A concentration of minority census block groups exists in Charles County (Maryland) and Prince William County in Virginia, east-northeast of the site. Between 64 km (40 mi) and 80 km (50 mi) southeast of North Anna, there is a concentration of minority census block groups in the City of Richmond, and to the south – southwest, a concentration in Buckingham, Fluvanna, Goochland and Cumberland Counties. Minority populations also appear northwest of North Anna in Culpeper County. All minority block groups are more than approximately 16 km (10 mi) from North Anna.

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 (USCB 2001).



| **Figure 4-1**. Geographic Distribution of Minority Populations (shown in shaded areas) Within
| 80 km (50 mi) of North Anna. Based on Census Block Group Data and
| Individual Counts.

Data from the 1990 census characterize 11 percent of Virginia (Weldon Cooper Center for Public Service 1990) and 8 percent of Maryland households as low-income (USCB 1990b). Applying the NRC criterion of "more than 20 percent greater," the census block groups were identified to contain low-income populations. Census block groups containing low-income populations are concentrated in the City of Richmond, and Henrico and Chesterfield Counties to the southeast between approximately 65 km and 80 km (40 mi and 50 mi) from the site. Other areas of low-income populations include Buckingham County, southwest of the site, and Charlottesville. Figure 4-2 shows the locations of the low-income populations within 80 km (50 mi) of North Anna.

With the locations of minority and low-income populations identified, the staff proceeded to evaluate whether any of the environmental impacts of the proposed action could affect these populations in a disproportionately high and adverse manner. Consistent with staff guidance (NRC 2001), air, land, and water resources within about 80 km (50 mi) of the North Anna site were examined. Within that area, potential environmental impacts that could affect human populations were evaluated. All of these were considered SMALL for the general population.

The pathways through which the environmental impacts associated with North Anna Power Station, Units 1 and 2, license renewal can affect human populations are discussed in each associated section. The staff then evaluated whether minority and low-income populations could be disproportionately affected by these impacts. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately affected. In addition, the staff did not identify any location-dependent disproportionate impacts affecting these minority and low-income populations. Accordingly, the staff concludes that offsite impacts from North Anna Power Station, Units 1 and 2, license renewal to minority and low-income populations would be SMALL, and no additional mitigation actions are warranted.

4.5 Groundwater Use and Quality

One Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that is applicable to North Anna Power Station groundwater use and quality, is listed in Table 4-8. VEPCo stated in its ER (VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of the North Anna OLs. The staff has not identified any significant new information on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 staff concludes that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

| **Figure 4-2**. Locations of the Low-Income Populations (shown in shaded areas) Within 80 km
| (50 mi) of North Anna. Based on Census Block Group Data and Individual Counts.

Table 4-8. 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, 10 CFR Part 51, 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, North Anna Power Station groundwater use is less than 0.068 m^3/s (100 gpm). The staff has not identified any significant new information on this issue during its independent review of the VEPCo ER (VEPCo 2001b), 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 North Anna.

4.6 Threatened or Endangered Species

Threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-9.

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 North Anna during the license-renewal term. The presence of threatened or endangered species in the vicinity of the North Anna site is discussed in Sections 2.2.5 and 2.2.6. The NRC initiated consultation under Section 7 of the Endangered Species Act in January 2002 with a request for information to the FWS concerning species potentially occurring near the North Anna site and related transmission line rights-of-way (NRC 2002b).

Table 4-9. 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

VEPCo maintains contacts with agencies responsible for protected and sensitive species to ensure compliance of its activities. In addition to its ongoing discussions, on April 12, 2000, VEPCo initiated correspondence with the FWS Virginia Field Office and VDGIF concerning threatened and endangered species (VEPCo 2000b and 2000c). FWS requested further review of the project by VDGIF, the Virginia Department of Agriculture and Consumer Service (VDACS), and the VDCR Natural Heritage Program (FWS 2000). According to VEPCo correspondence, a meeting was held with these agencies to provide initial information on the project (VEPCo 2000d and 2000e). On January 25, 2001, VEPCo submitted a copy of the draft ER to FWS for review (VEPCo 2001a). A second meeting was held with the agencies to obtain the results of their review of the draft ER. In a letter dated March 13, 2001, to the FWS Chesapeake Bay Field Office, the FWS Virginia Field Office found that the North Anna license renewal would not impact Federal-listed species (FWS 2001a). At this point, the FWS Chesapeake Bay Field Office took the FWS lead for review of the North Anna license renewal project.

In a letter dated October 26, 2001, to the NRC, the FWS Chesapeake Bay Field Office provided comments on its detailed review of the licensee's ER (FWS 2001b). In these comments, FWS included information regarding aquatic and terrestrial species that may be in the vicinity of North Anna, Lake Anna, and the transmission line rights-of-way. In a letter dated May 22, 2002, the FWS Virginia Field office, in response to the NRC's January 2002 letter, provided information on threatened or endangered species for counties immediately upstream and downstream of Lake Anna or crossed by North Anna transmission lines (FWS 2002). These species are addressed in Sections 2.2.5 and 2.2.6.

4.6.1 Aquatic Species

As described in Section 2.2.5, no listed threatened or endangered species have been observed in Lake Anna, the portion of the North Anna River immediately upstream and downstream of Lake Anna, or in streams or tributaries crossed by North Anna transmission lines. As indicated above, VEPCo initiated correspondence with FWS and VDGIF regarding potential effects of license renewal on Federal- and Commonwealth-listed species. VEPCo did not consult with the

National Marine Fisheries Service (NMFS) because species under the jurisdiction of NMFS are not known to be in the vicinity of North Anna.

As also mentioned above, the FWS Chesapeake Bay Field Office provided comments to the NRC on its review of the VEPCo ER (FWS 2001b). Included in those comments, the FWS requested that clarification of information on some fish and mussel species be made in the SEIS. This is addressed in Section 2.2.5.

Based on these considerations, the staff has determined that endangered, threatened, proposed or candidate aquatic species would not be adversely affected by an additional 20 years of operation of North Anna Power Station, Units 1 and 2, and continued maintenance of the transmission lines. The impacts would be SMALL, and no additional mitigation warranted.

4.6.2 Terrestrial Species

The bald eagle (*Haliaectus leucocephalus*) and loggerhead shrike (*Lanius lvdovicianus*) are the only Federal- or Commonwealth-listed terrestrial animal species known to occur at North Anna or along the transmission line rights-of-way. A number of other listed species could occur at the North Anna Power Station or along the transmission line rights-of-way. They are listed in Table 2-3. The small whorled pogonia (*Isotria medeoloides*) and swamp pink (*Helonias bullata*) are two Federal- and Commonwealth-listed species known to occur in Carolina County, which contains a portion of the Ladysmith transmission line right-of-way; however, neither species was observed during plant surveys of the lines. Vegetation management protocols for the transmission lines have been developed in cooperation with the VDCR Natural Heritage Program (VEPCo 2001b). In addition, rare plant species surveys are conducted annually along the transmission line rights-of-way. In addition, VEPCo has a program that requires submission of an incident report when raptor injuries or mortalities occur as a result of collision with the North Anna Power Station transmission lines. Finally, the staff did not find any evidence that the operation and maintenance of the plant or the transmission lines were adversely affecting protected animal species.

The staff has reviewed the information provided by the applicant and has contacted FWS and VDGIF. Based on the site visit, review of the VEPCo ER, other reports, and consultation with FWS and VDGIF, it is the staff's conclusion that the impacts on endangered, threatened, proposed, or candidate species of an additional 20 years of operation and maintenance of North Anna Power Station, Units 1 and 2, and associated transmission lines would be SMALL, and additional mitigation is not warranted.

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

During the scoping period, comments were received that indicated concerns related to the North Anna Dam. In addition, the staff identified an issue for consideration that was not specifically addressed in the GEIS. These issues are addressed in the following sections.

4.7.1 Evaluation of Potential New and Significant Information Received from the FWS Chesapeake Bay Field Office

On October 26, 2001 (during the scoping period), the staff received a letter from the FWS Chesapeake Bay Field Office (FWS 2001b) containing comments on their review of VEPCo's ER (VEPCo 2001b). Among the comments, FWS raised concerns that "the [North Anna] dam may be causing significant impacts to the North Anna River," particularly with respect to the distribution of fish (both anadromous and riverine) and mussel species.

The North Anna Dam was licensed by the Commonwealth of Virginia (Commonwealth of Virginia State Corporation Commission 1969), and it had already been constructed before the Atomic Energy Commission (AEC, predecessor to the NRC) performed its environmental review for North Anna. At the time of initial licensing of North Anna Power Station, Units 1 and 2, the AEC considered the construction impacts of the project on the environment in an FES (AEC 1973). Operational impacts were discussed in the 1973 FES and the 1976 and 1980 addenda (NRC 1976; NRC 1980). The two licensing actions (the dam and the power station) were separate actions, although the power station relies on the reservoir (Lake Anna) for cooling water.

In 1984, VEPCo applied for and received a licensing exemption from the Federal Energy Regulatory Commission (FERC) for the construction of the hydroelectric unit (FERC 1984). The exemption was applicable to this project because of its small size (design power output of 855 kW). As a result of comments from FWS, VEPCo was required to perform a fish passage study after the hydroelectric unit was built (VEPCo 1989b). Therefore, while AEC/NRC licensed North Anna Power Station, Units 1 and 2, the dam and the hydroelectric unit were licensed by other government agencies in separate actions.

In addition to providing cooling water for the North Anna Power Station, the impoundment also provides flood control to the lower North Anna River, recreational opportunities, hydroelectric power, water quality improvement, and the opportunity for lakefront residential property.

As noted in Section 2.2.5, the current Lake Anna fish populations are diverse and relatively stable. Since impoundment, the abundance and diversity of fish and mussel populations in the

North Anna River below the dam have steadily increased. These increases are largely a consequence of the improvement in water quality in this portion of the river because the lake dilutes and neutralizes the pollutants coming from Contrary Creek.

In the process of evaluating whether the dam was within the scope of the current action, the staff visited the site and reviewed VEPCo's license-renewal ER as well as numerous supporting documents and literature concerning aquatic resources in Lake Anna and the North Anna River, as cited in sections 2.2.5, 4.1.1, 4.1.2 and 4.1.3. The supporting documents included, among others, VEPCo's ER for initial licensing (VEPCo 1972) and NRC's FES for construction of North Anna (AEC 1973), which described the potential impacts associated with the impoundment of the North Anna River.

Based on its review, the NRC staff considers the impacts associated with the operation of the North Anna Dam to be outside the scope of the current proposed action (license renewal for North Anna Power Station, Units 1 and 2). However, the staff informed VEPCo of the comments provided by FWS and recommended that VEPCo contact FWS to open a further dialogue about these concerns outside the context of license renewal for North Anna Power Station, Units 1 and 2.

4.7.2 Evaluation of Potential New and Significant Information Related to Water Hyacinth

During its review, the staff identified a potential issue related to the nuisance species water hyacinth (*Hydrilla verticillata*). Water hyacinth is a submerged, aquatic macrophyte that inhabits many freshwater rivers, lakes, and ponds in North America (Overton 1995). Higher water temperatures can increase the growing season of water hyacinth. By 1994, water hyacinth covered more than 304 ha (750 ac) in Lake Anna and about 405 ha (1000 ac) in the WHTF. In 1994, VEPCo stocked the triploid (sterile) herbivorous grass carp (*Ctenopharyngoden idella*) in Lake Anna and the WHTF, with the approval of VDGIF, to control the growth of the water hyacinth. As a result, the area covered by water hyacinth has been reduced. In 2000, water hyacinth occupied 38 ha (94 ac) in Lake Anna and 12 ha (29 ac) in the WHTF (VEPCo 2002). This represents 2 percent of the maximum available habitat both in the lake and WHTF, respectively. The grass carp appears to be effectively controlling the growth and biomass of water hyacinth. Therefore, the staff concludes that this issue is not significant and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

4.8 Summary of Impacts of Operations During the Renewal Term

Neither VEPCo nor the staff is aware of information that is both new and significant related to any of the applicable Category 1 issues associated with the North Anna 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 additional 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 the North Anna operation during the renewal term and for environmental justice and chronic effects of electro-magnetic fields. For the 11 issues and environmental justice, the staff concluded that the potential environmental impact of renewal term operations of North Anna would be of SMALL significance in the context of the standards set forth in the GEIS and that further mitigation would not be warranted. In addition, the staff determined that a consensus has not been reached by appropriate Federal health agencies regarding chronic adverse effects from electromagnetic fields. Therefore, no evaluation of this issue is required.

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."

36 CFR Part 800. Code of Federal Regulations, Title 36, Part 800, "Protection of Historic Properties"

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5.0 Environmental Impacts of Postulated Accidents

Environmental issues associated with postulated accidents are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996b; 1999).[(a)] The GEIS includes 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 are then 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 off site 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 below.

(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 Addendum 1.

5.1.1 Design-Basis Accidents

In order to receive NRC approval to operate a nuclear power facility, an applicant 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 NRC 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 NRC 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 staff's Safety Evaluation Report (SER), the Final Environmental Statement (FES), the licensee's Updated Final Safety Analysis Report (UFSAR), and Section 5.1 of this Supplemental Environmental Impact Statement (SEIS). The 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 maximally exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirement that aging management programs be in effect for license renewal, and the requirement that the consequences of any DBA remain below specified acceptable levels at all times during plant operation, 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 period of extended operation 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. The early resolution of the DBAs make 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. This issue, applicable to North Anna Power Station, Units 1 and 2, is listed in Table 5-1.

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 Section
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.

The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER; VEPCo 2001a) that it is not aware of any new and significant information associated with the renewal of the North Anna, Units 1 and 2 OLs. The staff has not identified any significant new information on this issue during its independent review of the VEPCo 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 related to this issue beyond those discussed in the GEIS.

5.1.2 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. The GEIS 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.

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 ground water, 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 North Anna Units 1 and 2, 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 VEPCo ER (VEPCo 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 of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the staff has reviewed severe accident mitigation alternatives (SAMAs) for North Anna Units 1 and 2. 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 environmental impact statement (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 North Anna Power Station, Units 1 and 2; therefore, the following addresses those alternatives.

5.2.1 Introduction

VEPCo submitted an assessment of SAMAs for North Anna Units 1 and 2 as part of the ER (VEPCo 2001a). The assessment was based on the North Anna Probabilistic Risk Assessment (PRA), which is an updated version of the North Anna Individual Plant Examination (IPE) for internal events (VEPCo 1992), the North Anna Individual Plant Examination for External Events (IPEEE) (VEPCo 1994), and supplemental analyses of offsite consequences and economic impacts performed specifically for the SAMA analysis. VEPCo generated a list of 158

candidate SAMAs based on a review of previous SAMA analyses in support of original plant licensing and license renewal, NRC and industry reports discussing potential plant improvements, dominant risk contributors in the plant-specific risk study, and insights provided by VEPCo's PRA staff. VEPCo assessed the costs and benefits associated with each of the potential SAMAs and concluded that none of the candidate SAMAs evaluated were cost-beneficial for North Anna Power Station.

Based on a review of the applicant's SAMA assessment, the NRC issued a request for additional information (RAI) to VEPCo by letter dated October 17, 2001 (NRC 2001). Key questions concerned the modifications to the North Anna PRA made subsequent to the IPE, treatment of external events in the SAMA analysis, the use of the plant-specific risk study in the SAMA identification process, and the evaluation of costs and benefits for certain SAMAs. VEPCo submitted additional information by letter dated December 10, 2001 (VEPCo 2001b) and by emails dated January 15 and 22, 2002 (NRC 2002a), and February 4 and 6, 2002 (NRC 2002b), in response to the staff's RAIs. As set forth below, these responses addressed the staff's concerns and reaffirmed the conclusion that none of the SAMAs would be cost-beneficial.

An assessment of SAMAs for North Anna Power Station follows.

5.2.2 Estimate of Risk for North Anna, Units 1 and 2

VEPCo's estimates of offsite risk at North Anna Power Station are summarized below. The summary is followed by an evaluation of VEPCo's risk estimates.

5.2.2.1 VEPCo's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the North Anna level 1 and 2 PRA model, which is an updated version of the IPE, and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a level 3 PRA model) developed specifically for the SAMA analysis. The North Anna PRA level 1 and 2 models were originally developed in response to the request for an IPE contained in Generic Letter 88-20 (NRC 1988). The level 1 model was updated in 1994 before performing the IPEEE fire analysis, in 1996 to add the system model for the station blackout (SBO) diesel, and in the 1997-1998 time period to support implementation of the maintenance rule. The third update, referred to as the N7B model, is the most up-to-date model and was used for the SAMA analysis. The level 2 model was slightly updated for the SAMA analysis.

The baseline core damage frequency (CDF) for the purpose of SAMA evaluation is approximately 3.5×10^{-5} per reactor-year, based on the risk assessment for internally initiated events.

Although VEPCo did not include the contribution of risk from external events within the North Anna Power Station risk estimates, it did account for the potential risk reduction benefits associated with external events by doubling the estimated benefits for internal events. This is discussed further in Section 5.2.2.2. A breakdown of the CDF is provided in Table 5-3. As shown in this table, loss-of-coolant accidents (LOCAs) contribute about 47 percent, while SBO and loss of offsite power (SBO/LOOP) contribute about 24 percent of the total internal events CDF. Anticipated transients without scram (ATWS) are negligible contributors to CDF for North Anna Power Station. The frequency associated with the largest releases (i.e., interfacing system LOCA [ISLOCA] and steam generator tube rupture [SGTR]) for North Anna Power Station is estimated to be about 5.8×10^{-6} per reactor-year (i.e., about 17 percent of the internal events CDF). The CDFs that were used in the SAMA analysis and that are cited here are best-estimate values. The uncertainty analysis for the updated PRA indicates a 95 percent confidence level (upper) CDF value 1.84×10^{-4} per reactor-year, or about five times the best-estimate value. The impact of this uncertainty on the SAMA analysis is discussed in Section 5.2.6.2.

Table 5-3. North Anna Power Station Core Damage Frequency (CDF)

Initiating Event	Frequency (per reactor-year)
Loss-of-coolant accident (LOCA)	1.6×10^{-5}
Station blackout/loss of offsite power (SBO/LOOP)	8.5×10^{-6}
Other electrical transients	5.6×10^{-7}
Steam generator tube rupture (SGTR)	4.2×10^{-6}
General transients	3.2×10^{-6}
Interfacing system LOCA (ISLOCA)	1.6×10^{-6}
Anticipated transient without scram (ATWS)	4.4×10^{-7}
Total CDF from internal events	3.5×10^{-5}

The offsite consequences and economic impact analyses use the MELCOR Accident Consequence Code System 2 (MACCS2) code, Version 1.12, to determine the offsite risk impacts on the surrounding environment and public. Inputs for this analysis include plant/site-specific input values for core radionuclide inventory, source term and release fractions, meteorological data, projected population distribution, emergency response evacuation modeling, and economic data. The magnitude of the onsite impacts (in terms of clean-up and

decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997b).

VEPCo estimates the dose to the population within 80 km (50 mi) of the North Anna Power Station from the risk of severe accidents caused by internal initiators to be about 0.25 person-Sv (25 person-rem) per year. Table 5-4 shows the contributions to population dose by containment release mode. SGTRs and ISLOCAs together account for practically all (99 percent) of the population dose, although they collectively comprise only about 17 percent of the total internal events CDF. This is due to the relatively high fission product releases in these sequences. Early and late containment failure contribute about 1 percent of the population dose. About 68 percent of the core melt accidents at North Anna Power Station do not result in containment failure and have only a minimal contribution to population dose.

Table 5-4. North Anna Power Station Risk Profile

Containment Release Mode	Contribution to Release Frequency[(a)] (percent)	Contribution to Population Dose[(b)] (percent)
Containment intact	68	<0.1
Early containment failure	<1	<1
Late containment failure	14	1
Containment bypass - SGTR	12	80
Containment bypass - ISLOCA	5	19

(a) Total release frequency for internal events = 3.5×10^{-5} per reactor-year.
(b) Total population dose = 0.25 person-Sv (25 person-rem) per reactor-year.

5.2.2.2 Review of VEPCo's Risk Estimates

VEPCo's determination of offsite risk at North Anna Power Station is based on the following three major elements of analysis:

- the level 1 and 2 risk models for North Anna Power Station that form the basis for the 1992 IPE submittal and the 1994 IPEEE submittal
- the modifications to the risk model subsequent to the IPE that distinguish the current PRA from the IPE
- the MACCS2 analyses performed to translate fission product release frequencies from the level 2 PRA model into offsite consequence measures.

Each of these analyses was reviewed to determine the acceptability of VEPCo's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the North Anna IPE is described in a staff report dated March 5, 1996 (NRC 1996a). 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 VEPCo's analysis met the intent of Generic Letter 88-20 (NRC 1988); that is, the IPE was of adequate quality to be used to look for design or operational vulnerabilities. Although the staff reviewed certain aspects of the IPE in more detail than others, it primarily focused on the licensee's ability to examine North Anna Power Station for severe accident vulnerabilities and not specifically on the detailed findings or quantification estimates. Overall, the staff believed that the North Anna 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, sensitivity, and uncertainty analyses. It is important to note that some changes have been made to the North Anna risk model since the original IPE was completed and reviewed by the NRC staff. These include both modifications to the models and changes due to plant modification, as discussed below.

A comparison of CDF profiles between the original IPE and the current PRA indicates that the estimate of the CDF for internal events has been reduced from 7.1×10^{-5} per reactor-year to about 3.5×10^{-5} per reactor-year. The lower values in the current PRA are attributed to plant and modeling improvements that have been implemented at North Anna Power Station since the IPE was submitted.

The original level 1 model, documented in the 1992 North Anna IPE submittal, had a CDF of 7.1×10^{-5} per reactor-year (from internal initiating events and internal flooding). A minor update to the level 1 model was performed before the licensee completed the IPEEE fire analysis in June 1994. A significant update to the level 1 model occurred in 1996 to add the system model for the SBO diesel generator as part of a risk-informed technical specification allowed outage time submittal. Another significant update occurred in the 1997-1998 time period to support implementation of the maintenance rule. These updates were performed to incorporate significant plant modifications, correct model errors, and enhance the model with state-of-the-art improvements. Among the individual fault tree models changed or added were those involving the emergency diesel generator, alternate alternating current (AAC) diesel, charging pumps (including Unit 1 and Unit 2 cross-tie), reactor coolant pumps, and service water (SW) system. The circulating water (CW) system fault tree was modified to include the dependency of the steam dumps on CW. The modified baseline CDF as of the most recent model changes is 3.5×10^{-5} per reactor-year.

The updated CDF value is lower than most of the original IPE values estimated for other pressurized water reactors (PWRs) with large dry containments. Figure 11.6 of NUREG-1560 (NRC 1997c) shows that the IPE-based total internal events CDF for Westinghouse 3-loop plants ranges from 6×10^{-5} to 4×10^{-4} per reactor-year. However, many of these CDF estimates have similarly been reduced due to modeling and hardware changes subsequent to the respective IPE submittals. Thus, a reduction in CDF from the IPE value is not unexpected.

As noted in Table 5-4, SGTR and ISLOCA contribute 12 percent and 5 percent, respectively, to the total release frequency for internal events. Because of the large fission product releases for bypass sequences relative to other release modes, these sequences dominate the North Anna Power Station risk profile. The conditional probability of early containment failure is 0.4 percent, and about 14 percent of core damage sequences are expected to lead to late containment failure. Due to the sub-atmospheric design of the containment, containment isolation failures are relatively insignificant (about 0.3 percent of CDF). With the exception of the somewhat high CDF associated with bypass of the containment, and the lack of credit in the PRA for scrubbing releases from SGTRs (both of which make the analysis conservative), the results of the updated North Anna PRA appear to be consistent with those of other IPEs for PWRs with large dry or sub-atmospheric containments insofar as the general CDF, the containment response, and release and risk profiles are concerned.

VEPCo submitted an IPEEE by letter dated June 28, 1994 (VEPCo 1994). VEPCo did not identify any fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events related to seismic, fire, high winds, floods, transportation and nearby facility accidents, and other external hazards. In the associated safety evaluation report (NRC 2000), the staff concluded that the IPEEE met the intent of Supplement 4 to Generic Letter 88-20 (NRC 1991).

Although VEPCo used probabilistic risk methods for the seismic and fire portions of the IPEEE, in their SAMA analysis they chose to capture the potential risk benefits associated with external events by doubling the calculated internal events benefits for each SAMA. In assessing the reasonableness of this assumption, the staff considered the relative contribution to the total risk from the various external events based on best available information. The North Anna Power Station high winds and external flooding analyses showed that the plant is adequately designed to protect against the effects of these natural events. Transportation and nearby facility accidents were not considered to be potential sources of damage at the plant because of the plant's rural locale. Other external events were evaluated and found to be insignificant contributors to CDF. Even though VEPCo's doubling of CDF to account for the benefits of a SAMA in external events provides a reasonable numerical estimate of the potential impact of external events, this approach may potentially fail to capture the benefits that could result from specific SAMAs that would be aimed at particular external events. In response to an RAI,

VEPCo reasoned that since no external events vulnerabilities in terms of containment bypass or isolation failure were identified in the IPEEE, the offsite consequences can be bounded by the use of an internal events profile. In addition, the CDF from external events – approximately 3.9×10^{-6} per reactor-year – is considerably lower than the CDF for internal events (3.5×10^{-5} per reactor-year). Therefore, the approach used by VEPCo is considered to be acceptable.

The North Anna Power Station level 2 IPE submittal (VEPCo 1992) that was reviewed by NRC in 1996 (NRC 1996a) has been modified to make the North Anna and Surry models consistent. Both plants' models were converted to large early release frequency (LERF) models shortly after the IPE/IPEEE process was completed. The models remained so until the beginning of the SAMA analysis, at which time a unified source term category (STC) grouping was implemented. This was essentially the same approach used in the original North Anna IPE. The general containment event tree (CET) was also modified to reflect recent experimental results in severe accident analysis research (e.g., the resolution of the direct containment heating issue). The revision in the level 2 PRA model, as a result of the aforementioned changes, resulted in a reduction in the overall contribution to early containment failure. This has a relatively small impact on the overall risk of severe accidents at North Anna Power Station since the contribution to risk from early containment failure was already small. The staff concludes that the use of the North Anna Power Station level 2 model provides a sufficiently detailed characterization of containment response to support a license renewal SAMA analysis.

The staff reviewed the process used by VEPCo to extend the containment performance (level 2) portion of the PRA to an assessment of offsite consequences (essentially a level 3 PRA). This included consideration of the source terms used to characterize fission product releases for each of 24 STCs and consideration of the major inputs and assumptions used in the offsite consequence analyses. VEPCo used the severe accident source terms presented in the North Anna IPE as input to the NRC-developed MACCS2 code. For radionuclides not reported in the IPE, releases were set to zero. VEPCo's source terms were reviewed and found to be consistent with the source terms provided in other plants' submittals, and are considered reasonable.

The applicant used site-specific meteorological data processed from hourly measurements for one full year (1998) as input to the MACCS2 code. All data was collected at the North Anna Power Station meteorology tower. Hourly meteorological data for two additional years (1996 and 1997) were also used for sensitivity comparison. The use of data from either 1996 or 1997 results in only a few percent change in the total benefit of the candidate SAMAs. Year-to-year weather variations are not significant in the SAMA analysis because: (1) weather variations are diminished in the MACCS2 analyses due to its weather sampling scheme, and (2) the same meteorological assumptions are used in estimating both the base-case consequences and the SAMA-case consequences.

The population distribution the applicant used as input to the MACCS2 analysis was initially prepared using the computer program SECPOP90 (NRC 1997a). The output from SECPOP90 is a file based on a reference data base for the specified site. The SECPOP90-prepared population data was then modified and updated using the North Anna Power Station UFSAR, Section 2.1.3, 50-mile population distribution for the year 2030 in place of the SECPOP90 1990 Census data. The methods and assumptions for estimating population are considered reasonable and acceptable for purposes of the SAMA evaluation.

The applicant's emergency evacuation modeling was based on a single evacuation zone extending out 16 km (10 mi) from the plant. The applicant assumed that the people within the evacuation zone would move at an average evacuation speed of 1.8 m/s (4 mph) with a 5400-second delay between the alarm and start of evacuation. The applicant's base case analysis assumed 100 percent of the population within the emergency planning zone participate in the evacuation. In contrast, in NUREG-1150 (NRC 1990a) the staff assumed evacuation of 99.5 percent of the population. As part of the Surry SAMA analysis, VEPCo performed a sensitivity analysis in which only 95 percent of the population evacuates. The result was only about a 1 percent change in the total benefit of the candidate SAMAs. The staff concludes that the applicant's assumption regarding the percentage population participating in the evacuation at North Anna Power Station similarly would not substantially change the total benefit of the candidate SAMAs. VEPCo also performed sensitivity analyses in which MACCS2 parameters relating to the timing and energy of release were varied. The results of the analyses are reported in Table G.2-3 of the ER (VEPCo 2001a). The change in the total benefit of the candidate SAMAs was typically only about 10 percent, and in all cases was less than a factor of two. This change is small and would not alter the outcome of the SAMA analysis. Accordingly, the evacuation assumptions and analysis are deemed reasonable and acceptable for purposes of the SAMA evaluation.

Much of the site-specific economic data were provided by SECPOP90 (NRC 1997a) and used in the MACCS2 analyses. SECPOP90 contains a database extracted from U.S. Census Bureau CD-ROMs (1990 census data), the 1992 Census of Agriculture CD-ROM Series 1B, the 1994 U.S. Census County and City Data Book CD-ROM, the 1993 and 1994 Statistical Abstract of the United States, and other sources. These regional economic values were updated to 1999 using cost of living and other data from the Bureau of the Census and the Department of Agriculture. VEPCo performed a sensitivity analysis in which the farmland and non-farmland decontamination costs were increased by 25 percent. The result was about a 5 percent or less increase in the total benefit of the candidate SAMAs.

The staff concludes that the methodology used by VEPCo to estimate the CDF and offsite consequences for North Anna Power Station provides an acceptable basis from which to

proceed with an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDF and offsite doses reported by VEPCo.

5.2.3 Potential Design Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by VEPCo are discussed in this section.

5.2.3.1 Process for Identifying Potential Design Improvements

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

- a review of SAMA analyses submitted in support of original licensing and license renewal activities for other operating nuclear power plants and advanced light water reactor plants,
- a review of other NRC and industry reports discussing potential plant improvements, e.g., NUREG-1560 (NRC 1997c), and NUREG/CR-5575 (NRC 1990b),
- a review of plant-specific improvements identified in the North Anna IPE and IPEEE,
- a review of the top 100 cutsets of the updated North Anna PRA, and survey of North Anna PRA staff for additional insights.

VEPCo's initial list of 158 candidate improvements was extracted from the process and is reported in Table G.2-1 in Appendix G of the ER (VEPCo 2001a).

VEPCo performed a qualitative screening on the initial list of 158 SAMAs using the following criteria:

- The SAMA is not applicable to North Anna Power Station either because (1) the enhancement is only for boiling water reactors, the Westinghouse AP600 design, or ice condenser containments, or (2) it is a plant-specific enhancement that does not apply at North Anna Power Station, or the SAMA has already been implemented at North Anna Power Station (or the North Anna Power Station design meets the intent of the SAMA), or
- The SAMA is related to a reactor coolant pump (RCP) seal vulnerability at many PWRs, stemming from charging pump dependency on component cooling water (CCW). The

North Anna plants do not have this vulnerability because the charging pumps do not rely on CCW. However, other RCP seal LOCA improvements are considered, such as installing improved RCP seals.

Based on the qualitative screening, 107 SAMAs were eliminated. Of these 107 SAMAs, 37 were eliminated because they had already been implemented at North Anna Power Station (or the design met the intent of the SAMA). The 51 remaining SAMAs are listed in Table G.2-2 of Appendix G of the ER (VEPCo 2001a), and were subjected to a final screening and evaluation process. The final screening process involved identifying and eliminating those SAMAs whose cost exceeded their benefit by at least a factor of two. All of the 51 remaining SAMAs were eliminated in this final screening.

5.2.3.2 Staff Evaluation

The preliminary review of VEPCo's SAMA identification process raised several questions regarding the set of SAMAs identified. The staff requested clarification regarding the portion of risk represented by the top 100 cutsets, and whether an importance analysis was used to confirm the adequacy of the SAMA identification process, since a review of the importance ranking of basic events in the PRA has the potential to identify SAMAs that may not be apparent from a review of the top cutsets.

VEPCo chose to review the top 100 cutsets for identification of potential SAMAs because they contain the dominant contributors to risk. The applicant stated that the top 100 cutsets examined account for the majority (about 70 percent) of the CDF for internal events, and contain all of the ISLOCA and much of the SGTR contribution to offsite consequences. The cutsets appearing below the 100th cutset have an individual frequency of 4.9×10^{-8} per reactor-year or less, and a collective frequency of approximately 1×10^{-5} per reactor-year. VEPCo also noted that since none of the SAMAs identified from the top 100 cutsets were found to be cost beneficial, it is not likely that SAMAs from the cutsets below the top 100 would be either.

VEPCo indicated that an importance analysis was not used in the initial SAMA identification process. However, an importance analysis was performed as part of the model update. The importance list contained 110 basic events with a risk reduction worth (RRW) above 1.005. VEPCo performed a limited review of the importance list and verified that the risk significant basic events were contained in the top 100 cutsets (NRC 2002b).

The staff notes that SAMAs with greatest risk reduction potential should be revealed through the cutset screening because the top cutsets include the majority of the CDF and the risk significant sequences, and all elements of their contribution are examined. Further, since the individual frequency of cutsets below the cutoff is 4.9×10^{-8} per reactor-year or less, and the

collective frequency of cutsets below the cutoff is about 1 x 10^{-5} per reactor-year, it is unlikely that consideration of additional cutsets or further importance analyses would identify additional SAMAs that offer similar or greater risk reduction potential than those identified through cutset screening. The staff concludes that the process used to identify candidate SAMAs is sufficient to identify potential plant improvements that can significantly reduce risk.

VEPCo's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. This is reasonable, since external events only contribute a small amount to the total CDF, and the containment response to external events was found to be similar to that from internal events in the IPE. The list of 51 SAMAs generally addressed the accident categories that are dominant CDF contributors or issues that tend to have a large impact on a number of accident sequences at North Anna Power Station. The potential SAMA candidates included a balance of both hardware, procedure, and training enhancements, e.g;

- for loss of offsite power sequences, SAMAs included providing a hardwired connection to an alternate offsite power (SAMA 77), and a lower cost alternative of developing procedures to repair or change out failed 4kV breakers (SAMA 69)

- for sequences with loss of heating ventilation and air conditioning (HVAC), SAMAs included providing a non-safety related, redundant train of switchgear ventilation (SAMA 25), and a lower cost alternative of developing procedures for opening doors and using fans to limit temperature increases (SAMA 26), the latter of which is already implemented at North Anna Power Station

- for sequences involving loss of support systems, the SAMAs included adding a third component cooling water pump (SAMA 15) and a lower cost alternative of enhancing training and procedures for loss of component cooling water or service water (SAMA 21).

The set of SAMAs submitted is not all inclusive because additional, possibly even less expensive, design alternatives can always be postulated. However, the staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The staff concludes that VEPCo used a systematic and comprehensive process for identifying potential plant improvements for North Anna Power Station. While explicit treatment of external events in the SAMA identification process was limited, VEPCo doubled the estimated benefit for

internal events to account for any unmodelled risk reduction that could be attributed to external events. Therefore, the staff concludes that this limited treatment of external events is acceptable.

5.2.4 Risk Reduction Potential of Design Improvements

VEPCo evaluated each of the 51 SAMAs remaining after the qualitative screening using a bounding technique. Twenty-seven bounding analysis cases were developed to accomplish this effort. Table 5-5 lists the remaining SAMAs, the bounding analyses performed to estimate the risk reduction for each SAMA, the estimated risk reduction in terms of percent reduction in CDF and person-sievert (person-rem) dose, and the estimated total benefit (present value) of the averted risk. As discussed previously, VEPCo doubled the estimated benefit for internal events to account for any unmodelled risk reduction that could also occur in external events. The total benefit values reported in Table 5-5 incorporate this doubling. The determination of the benefits for the various SAMAs is discussed in Section 5.2.6.

The staff has reviewed VEPCo's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on VEPCo's risk reduction estimates. The estimated risk reduction for several of the SAMAs was negligible or zero. In these instances, the SAMA either affects sequences or phenomena that do not contribute to risk at North Anna Power Station, or represents an ineffective plant improvement. As such, a minimal impact on risk is not unreasonable in those cases.

5.2.5 Cost Impacts of Candidate Design Improvements

VEPCo estimated the costs of implementing each SAMA through the application of engineering judgment, estimates from other applicants' submittals, and site-specific cost estimates. The SAMA cost analyses were prepared by VEPCo staff experienced in estimating the cost of performing work at a nuclear plant. Cost estimates were made as order of magnitude approximations. The depth of analysis performed varied depending on magnitude of the expected benefit. For most of the SAMAs considered, the cost estimates were sufficiently greater than the benefits calculated such that no detailed evaluation was required. In these cases, the applicant indicated that the implementation costs would exceed twice the benefit. Detailed cost estimating was only applied in those situations in which the benefit is significant and application of judgement would be questioned. Detailed cost estimates were developed for the nine SAMAs listed in Table 5-6.

Table 5-5. SAMA Cost/Benefit Screening Analysis

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
Improvements Related to Ex-Vessel Accident Mitigation/Containment Phenomena				
Qualitative Assessment 39-create a giant concrete crucible with heat removal potential under the basemat to contain molten debris 40-create a water cooled rubble bed on the pedestal 47-create a core melt source reduction system 55-create another building, maintained at a vacuum to be connected to containment	Eliminate all offsite releases.	0.0	100	2.2M
SCB 42-enhance fire protection system and/or standby gas treatment system hardware and procedures 54-provide a reactor vessel exterior cooling system	Set the frequencies for STC frequencies 1 through 16, 19 and 20 to zero.	0.0	1.1	14K
HYD 37-install hydrogen igniters with independent power supply 38-create a passive hydrogen ignition system 48-provide containment inerting capability	Set the probability of late containment failure due to hydrogen burn to zero.	0.0	0.1	2K
DEB 43-create reactor cavity flooding system 44-create other options for reactor cavity flooding 152/153-create/enhance reactor coolant system depressurization ability	Modify the CET failure probabilities for debris cooling.	0.0	0.0	0
No analysis case 46-provide core debris control system	This failure mode was zero in the North Anna Level 2 analysis, so no further calculation was required.	0.0	0.0	0

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
CSP 30-install containment spray throttle valves 32-develop an enhanced containment spray system 33-provide a dedicated existing containment spray system 49-use fire water spray pump for containment spray 50-install a passive containment spray system	Replace event tree functional equations related to containment and recirculation sprays with an event that has an unavailability of zero.	0.2	0.1	4K
Improvements Related to RCP Seal LOCAs				
SLO 10-create independent RCP seal injection system with dedicated diesel 11-create independent RCP seal injection system without dedicated diesel 14-install improved RCP seals	Change event tree functional equations to eliminate the RCP seal LOCA contribution.	9.6	0.3	140K
No analysis case 21-enhance training and procedures for loss of CCW or SW	Utilize results from Surry analysis that show negligible benefit for Surry and North Anna plant design.	0.0	0.0	0
Improvements Related to Secondary/Support Systems				
SWH 23-improve SW pump alignments when a header is out for maintenance	Set service water header test and maintenance basic events to zero.	0.2	0.02	3K
Improvements in Alternating Current (AC)/Direct Current (DC) Power Reliability and Availability				
BCH 61-use fuel cells instead of lead-acid batteries 64-alternate battery charging capability 113-provide portable generators to be hooked into the turbine-driven auxiliary feedwater (TDAFW) after battery depletion	Set battery failures in long-term SBO to zero.	2.0	0.1	29K

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit
		CDF	Dose	
OSP 73-install gas turbine generator 77-provide a connection to alternate offsite power source	Reduce loss of offsite power frequency by a factor of five.	19.6	1.8	318K
OPR 70-emphasize steps in recovery of offsite power after SBO	Reduce offsite power recovery basic events by 25 percent.	4.4	0.4	72K
4KV 69-develop procedures for repair or change-out of failed 4kV breakers	Reduce basic events for all 4 kV breaker failures by a factor of two.	0.7	3.6	88K
BAT 60-provide additional DC battery capability(1)	Set battery failures in long-term SBO to zero.	2.0	0.1	29K
Improvements Related to HVAC				
HVC 25-provide a non-safety related, redundant train of emergency switchgear room (ESGR) ventilation	Change the initiating events frequency of the loss of HVAC to zero, and eliminate conditional ESGR failure by setting unavailability to zero.	7.4	1.0	123K
HVA 27-add a switchgear room high temperature alarm	Reduce operator error for failure to recover HVAC by a factor of ten.	0.9	0.1	14K

(1) The total benefit reported in the ER for this SAMA is $876K. However, in their December 10, 2001, response to RAIs, VEPCo indicated that a more detailed evaluation in which battery failures in long-term SBO events were set to zero indicates the total benefit to be $29K.

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit
		CDF	Dose	
Improvements Related to Decay Heat Removal (DHR) Capability				
DHR 34-install a containment vent large enough to remove anticipated transient without scram (ATWS) decay heat 35-install a filtered containment vent to remove decay heat 36-install an unfiltered containment vent to remove decay heat	Replace event tree functional equations related to containment heat removal with an event that has an unavailability of zero.	0.7 0.7 0.7	0.04 1.2 0.04	11K 25K 11K
DFW 106-digital feedwater upgrade	Reduce transient and loss of main feedwater (MFW) initiating event frequencies by a factor of three.	4.5	0.6	76K
FDW 120-create passive secondary side coolers	Modify event tree functional equations related to MFW or auxiliary feedwater to use a basic event whose unavailability is zero.	16.8	2.5	294K
SGP 121-automate air bottle swap for steam generator power-operated relief valves (SG PORVs)	Set basic event REC-INAIR-LOCAL to zero.	0.0	0.0	0
CND 122-utilize bypass around the main steam trip valves to use condenser dump after safety injection	Remove house event XHOS-NO-CND-DUMP from five fault trees and gates.	0.3	0.0	5K
No analysis case 156-install secondary side guard pipes up to the main steam isolation valves (MSIVs)	Set the main steam line break (MSLB) initiating event frequencies to zero.	0.0	0.0	0

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit
		CDF	Dose	
Improvements Related to Emergency Core Cooling System				
ISS 99-add remotely-operated firewater line that could be used to scrub ISLOCA releases	Transfer the entire frequency of CET endstate 23 (unscrubbed ISLOCA) to CET endstate 22 (scrubbed LOCA).	0.0	3.5	38K
ISL 101-add a check valve downstream of the low head safety injection (LHSI) pumps on cold leg injection line to reduce ISLOCA frequency	Reduce ISLOCA frequency to zero.	4.6	18.7	220K
LHI 123-provide capability for diesel-driven, low pressure vessel makeup	Use unavailability of zero for all “late” low head safety injection and recirculation events in the event trees, and credit the fire protection connection to low head safety injection and recirculation in the fault trees.	5.6	0.0	82K
HPI 124/125-provide an additional high pressure injection pump with independent diesel	Add new pump logic to all charging and high head safety injection fault trees.	0.03	0.0	<1K
Improvements Related to Reducing Initiating Event Frequency				
ATW 143/144-install motor generator (MG) set trip breakers in control room	Set the frequency of the ATWS initiating events to zero.	1.3	0.1	20K
LLO 157-add digital large break LOCA protection	Reduce the large LOCA initiating event frequency by 25 percent.	2.9	0.01	22K
MGB 81-install fast acting MG breaker	Reduce the transient initiating event frequency by 25 percent.	1.7	0.2	29K

Table 5-6. North Anna Power Station SAMAs with Detailed Cost Estimates

SAMA No.	Description	Cost ($)
60	Provide additional DC battery capability	2-5 M
64	Provide a portable, diesel-driven battery charger and associated disconnects	1.5-3 M
73	Install a combustion turbine generator	20-30 M
77	Provide a connection to alternate offsite power source (the nearby dam), and associated switchgear and disconnects	2-5 M
84	Provide improved instrumentation and control circuits to detect and respond to SGTR	1.5-3 M
99	Add remotely operated firewater line that could be used to scrub ISLOCA releases	125 K
101	Add check valve in each cold leg injection path to reduce ISLOCA frequency	750 K-1.25M
106	Upgrade feedwater instrumentation to digital	4-7 M
123	Add a line to permit low-pressure vessel makeup from firewater header	350-600 K

VEPCo assumed the minimum cost of generating a new procedure, including its implementation, to be $30,000. If the SAMA involved a hardware modification, it was assumed that the cost would be at least $100,000.

The staff requested additional justification for several of the detailed cost estimates provided by VEPCo, including SAMAs 64, 77, and 84. VEPCo provided this information by email dated January 22, 2002 (NRC 2002a). The staff reviewed the bases for the applicant's cost estimates. For certain improvements, the staff also compared the quantitative or qualitative cost estimates provided in Table 4-6 of the ER to estimates developed elsewhere for similar improvements, including estimates developed as part of other applicants' analyses of SAMAs for operating reactors and advanced light water reactors. Based on this audit, the detailed cost estimates were judged to reflect valid bases and assumptions with the exception of some labor estimates, which appear high. However, even if such estimates were lowered by an order of magnitude, the cost of the alternative would not be altered to the extent that it would become cost beneficial given the relatively small total benefits of the SAMAs. The qualitative cost

estimates in Table 4-6 of the ER were found to be consistent with previous estimates and reasonable for the SAMAs under consideration. The staff concludes that the cost estimates are sufficient and appropriate for use in the SAMA evaluations.

5.2.6 Cost-Benefit Comparison

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

5.2.6.1 VEPCo Evaluation

The methodology used by VEPCo was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., 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:

$$\text{Net Value} = (\$APE + \$AOC + \$AOE + \$AOSC) - COE$$

where $APE = present value of averted public exposure ($)
$AOC = present value of averted offsite property damage costs ($)
$AOE = present value of averted occupational exposure ($)
$AOSC = present value of averted onsite costs ($)
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. VEPCo'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 (Δperson-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. For the purposes of determining the maximum attainable benefit, VEPCo calculated an APE of $547,000.

Averted Offsite Property Damage Costs (AOC).

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.

VEPCo cited an annual offsite economic risk of $48,846 based on the Level 3 risk analysis. This value appears to be higher than values for other sites and those presented in NUREG/BR-0184 (NRC 1997b). This higher value is primarily due to the high contribution to CDF from SGTRs in the North Anna PRA (4.29×10^{-6} per reactor-year, including both SGTR initiators and induced ruptures), which contribute 84 percent of the total offsite economic risk. For the purposes of determining the maximum attainable benefit, VEPCo calculated an AOC of $526,000.

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.

VEPCo 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 (3300 person-rem) and long-term occupational dose (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 real discount rate of 7 percent, and a time period of 20 years to represent the license-renewal period. For the purposes of determining the maximum attainable benefit, VEPCo calculated an AOE of $13,000.

Averted Onsite Costs (AOSC).

The AOSCs include averted cleanup and decontamination costs, and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. VEPCo derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184 (NRC 1997b).

Averted cleanup and decontamination costs (ACC) are 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 $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension.

Averted power replacement costs RPC are calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
x factor to account for remaining service years for which replacement power is required
x reactor power scaling factor.

Each of the units at North Anna Power Station has a gross electrical rating of 982 MWe, which is higher than the reference rating in NUREG/BR-0184. Thus, a scaling factor (982/910) of 1.08 was applied to the corresponding formula. For the purposes of determining the maximum attainable benefit, VEPCo calculated an AOSC (combination of ACC and RPC) of $683,000.

Using the above equations, VEPCo estimated the total present dollar value equivalent associated with completely eliminating internally initiated severe accidents at North Anna Power Station to be $1,770,000 for each unit. This value was then doubled to account for additional risk reduction associated with also eliminating external events. This results in a maximum attainable benefit of $3.5 million for eliminating all severe accident risk.

VEPCo Results.

The total benefit associated with each of the 51 SAMAs remaining after the initial screening is provided in column 5 of Table 5-5. These values were determined based on the above equations for the various averted costs together with the estimated annual reductions in CDF and person-rem dose (columns 3 and 4 of Table 5-5). The estimated benefits were then doubled to account for additional risk reduction in external events. The values for total benefit reported in Table 5-5 include this doubling.

In determining the net value of each SAMA, VEPCo applied an additional factor of two multiplier to account for uncertainties in the cost-benefit methodology. Specifically, for each SAMA, they compared the total benefit[(a)] (which had been doubled to account for external events) to the estimated cost of the enhancement, and screened out the SAMA only if the cost of the enhancement was at least twice the benefit. All 51 SAMAs were eliminated because the estimated costs are expected to exceed the total benefit by at least a factor of two. The end result was that no SAMA candidates were found to be cost-beneficial.

VEPCo performed sensitivity analyses to evaluate the impact of parameter choices on the analysis results. The sensitivity analyses included the calculation of candidate SAMA benefits using a 3-percent discount rate as recommended in NUREG/BR-0184 (NRC 1997b). The sensitivity cases resulted in less than a factor of two increase in the benefit calculation, and therefore, all SAMAs were still screened out. Thus, the conclusion that none of the candidate SAMAs would be cost-beneficial remains unchanged.

5.2.6.2 Staff Evaluation

The cost-benefit analysis performed by VEPCo was based primarily on NUREG/BR-0184 (NRC 1997b) and was executed appropriately. The risk profile for North Anna Power Station is observed to be dominated by containment bypass events (primarily SGTRs). With the exception of seven costly modifications that are not properly applicable to an existing plant (e.g., redesign of the reactor cavity to accommodate a water-cooled rubble bed), the analysis found a maximum benefit of $318K, with most changes resulting in a benefit of less than about $100K.

The staff questioned the evaluation of several SAMAs that appeared to be cost-beneficial, in particular, SAMAs 69 and 70. SAMA 69 involves developing procedures to repair or change out failed 4kV breakers. This offers a recovery from SBO sequences involving a failure of the

(a) The benefit can be due to a reduction in CDF and/or a reduction in person-Sv (person-rem) dose resulting from the alternative being implemented.

breakers that transfer the 4.16 kV non-emergency buses from unit station service transformers to system station service transformers. According to Table 4-6 of the ER (VEPCo 2001a), a benefit of $88K was calculated. VEPCo estimated the minimum cost of a procedure change to be $30K. Because this amount is less than the estimated benefit, the SAMA appears to be cost-beneficial. In their RAI response (NRC 2002a), VEPCo noted that this SAMA is applicable to seven non-safety 4 kV breakers associated with the alternate AAC diesel, and that the benefit of the SAMA was conservatively calculated by reducing the failure probability of all (21) 4 kV breakers, including the seven AAC breakers, by 50 percent. If the change in failure probability were applied only to the seven AAC breakers, the reduction in CDF would be at most 1/3 of the bounding benefit reported in Table 4-6 of the ER. Based on this assessment, VEPCo estimated the bounding benefit to more realistically be on the order of $30K for North Anna Power Station. VEPCo further stated that the implementation of SAMA 69 would primarily involve the cost of purchasing, sheltering, and maintaining multiple, pre-staged 4 kV breakers, and that the material cost alone for two non-safety-related breakers would be $60K. The associated procedures, maintenance, and sheltering would increase the implementation cost. Based on this rationale, the staff agrees that this SAMA is not cost-beneficial and does not appear to be warranted.

SAMA 70 involves a change to procedures for recovery of offsite power after a SBO. According to Table 4-6 of the ER (VEPCo 2001a), a benefit of $72K was calculated. VEPCo estimated the minimum cost of a procedure change to be $30K. Because this amount is less than the estimated benefit, the SAMA appears to be cost-beneficial. However, in their RAI response (NRC 2002a), VEPCo indicated that the benefit was calculated assuming a 25 percent reduction in the offsite power non-recovery terms, and that this is very optimistic because training for offsite power recovery is already given, and failure to recover offsite power is more likely attributed to actual failures of the grid and not personnel error. Operator training has no impact on these types of failure. VEPCo indicated that the benefit in this area is actually quite small and would realistically be 1 percent or 2 percent as opposed to the 25 percent presented in the SAMA analysis. Based on this assessment, the total benefit would be at least an order of magnitude less than that provided in Table 4-6 of the ER. VEPCo further stated that it would not be practical to eliminate or trade off any of the current training material given the heavily loaded training schedule. Based on this rationale, the staff agrees that this SAMA does not appear to be warranted.

The staff concludes that the costs of the 51 candidate SAMAs assessed would be considerably higher than the associated benefits. This conclusion is upheld despite a number of uncertainties and non-quantifiable factors in the calculations, noted as follows:

- External events were accounted for in the analysis by doubling the risk-benefits found considering internal events only. This was justified on the basis of the fact that the

externally initiated CDF at North Anna Power Station (3.9×10^{-6} per reactor-year for fires, and a seismic CDF that is also likely to be relatively small by analogy with Surry) is much less than the internally initiated CDF (3.5×10^{-5} per reactor-year), and the observation that there are no particular containment vulnerabilities in the external event risk profile.

- Uncertainty in the internal events CDF was not explicitly included in the calculations, which employed best-estimate values. The 95 percent confidence level for the internal events CDF is approximately five times the best estimate. The results of the SAMA analysis show that no SAMA is found to be cost-beneficial within a factor of three or four at the North Anna Power Station. This would suggest that, when considering the CDF at the 95 percent confidence level, some candidate SAMAs might be assessed as being cost-beneficial. However, the risk reduction and cost estimates used in the cost-benefit assessment were generally found to be conservative. Therefore, consideration of CDF uncertainty is not expected to alter the conclusions of the analysis.

- A number of sensitivity risk-benefit calculations were performed with respect to the discount rate (as low as 3 percent) and various MACCS2 parameters, including evacuation time and completeness, meteorological data, source term energy, and sheltering time. The results of these calculations showed that none of the risk benefits were increased by more than a factor of two. Because this is less than the margin between cost and benefit for the most mitigative SAMA considered, the staff concludes that uncertainties in these parameters would not alter the conclusions.

5.2.7 Conclusions

VEPCo compiled a list of 158 SAMA candidates using the SAMA analyses as submitted in support of licensing activities for other nuclear power plants, NRC and industry documents discussing potential plant improvements, and the plant-specific insights from the VEPCo IPE, IPEEE, and PRA model. Candidate SAMAs were identified by a thorough and systematic process that included examination of the North Anna IPE and IPEEE, the top cutsets from the updated North Anna PRA, and review of SAMA analyses for other operating nuclear power plants and other NRC and industry documentation. While few SAMAs were identified with a view towards external events, the IPEEE revealed no containment vulnerabilities particular to external events, and the staff judges that the process could be effectively carried out by considering primarily internal events. A qualitative screening removed SAMA candidates that did not apply to North Anna Power Station for various reasons. A total of 107 SAMA candidates were either eliminated or combined with other potential improvements during the initial screening process, leaving only 51 SAMA candidates subject to the final screening process.

Using guidance in NUREG/BR-0184 (NRC 1997b), the updated North Anna PRA model, and a level 3 analysis developed specifically for SAMA evaluation, VEPCo estimated the total benefits for each of the 51 remaining SAMAs based on consideration of internal events, and doubled the benefits for each SAMA to account for additional risk reduction in external events. In determining the net value of each SAMA, VEPCo applied an additional factor of two multiplier to account for uncertainties in the cost-benefit methodology. Specifically, for each SAMA they compared the total benefit (which had been doubled to account for external events) to the estimated cost of the enhancement, and screened out the SAMA only if the cost of the enhancement was at least twice the benefit. All 51 SAMAs were eliminated because the estimated costs are expected to exceed the total benefit by at least a factor of two. The end result was that no SAMA candidates were found to be cost-beneficial.

The staff reviewed the VEPCo analysis and concluded that the methods used and the implementation of those methods were sound. Based on its review, the staff concludes that none of the candidate SAMAs are cost-beneficial. This conclusion is consistent with the low residual level of risk indicated in the North Anna PRA and the fact that VEPCo has already implemented many plant improvements identified from the IPE and IPEEE process at the North Anna Power Station.

5.3 References

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10 CFR Part 51, Subpart A, Appendix B, Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants."

10 CFR 51.53(c), "Operating license renewal stage."

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). 2002a. Note to file from Andrew Kugler, Nuclear Regulatory Commission. Subject: Requests for Additional Information Regarding SAMA Analysis for Surry and North Anna Power Stations, Units 1 and 2. January 23, 2002.

U.S. Nuclear Regulatory Commission (NRC). 2002b. Note to file from Andrew Kugler, Nuclear Regulatory Commission. Subject: Requests for Additional Information Regarding SAMA Analysis for North Anna Power Stations, Units 1 and 2. February 11, 2002.

Virginia Electric and Power Company (VEPCo). 1992. Letter from W. L. Stewart, Virginia Electric and Power Company, to U.S. Nuclear Regulatory Commission. Subject: PRA North Anna Power Station Units 1 and 2 Individual Plant Examination in Response to Generic Letter 88-20 Supplement, December 14, 1992.

Virginia Electric and Power Company (VEPCo). 1994. Letter from J.P. O'Hanlon, Virginia Electric and Power Company, to U.S. Nuclear Regulatory Commission. Subject: Individual Plant Examination of Non-Seismic External Events and Fires, June 28, 1994.

Virginia Electric and Power Company (VEPCo). 2001a. *Applicant's Environmental Report–Operating License Renewal Stage, North Anna Power Station Units 1 and 2*. Glen Allen, Virginia, May 2001.

Virginia Electric and Power Company (VEPCo). 2001b. Letter from David A. Christian, VEPCo, to U.S. Nuclear Regulatory Commission. Subject: Request for Additional Information, License Renewal Applications, December 10, 2001.

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 are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437 (NRC 1996; 1999).[(a)] The GEIS includes 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 are then 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 [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 for 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 Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that are applicable to North Anna Power Station, Units 1 and 2. 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 in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to North Anna Power Station, Units 1 and 2, 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 disposal)	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

The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER) (VEPCo 2001) that it is not aware of any new and significant information associated with the

renewal of the North Anna Power Station, Units 1 and 2, operating licenses. No significant new information on these issues 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 issues, the staff concludes in the GEIS 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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 (individual effects from other than the disposal of spent fuel and HLW) 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 one 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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 radioactive nuclides 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 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 DOE 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 the 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 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 worldwide 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, EPA 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 directs the NRC to adopt these standards into its regulations for reviewing and licensing the repository. NRC published its regulations at 10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in Geologic Repository at Yucca Mountain, Nevada," on November 2, 2001 (66 FR 55792). These standards include the following: (1) a 0.15 mSv/yr (15 mrem/yr) dose limit for members of the public during the storage period prior to repository closure, (2) a 0.15 mSv/yr (15 mrem/yr) dose limit for the reasonably maximally exposed individual from the undisturbed repository for 10,000 years following disposal, (3) a 0.15 mSv/yr (15 mrem/yr) 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 that for 10,000 years of undisturbed performance after disposal, radioactivity in a representative volume of groundwater will not exceed (a) 0.2 Bq/L (5 pCi/L) for radium-226 and radium-228, (b) 0.56 Bq/L (15 pCi/L) for gross alpha activity, and (c) 0.04 mSv/yr (4 mrem/yr) to the whole body or any organ (from combined beta- and photon-emitting radionuclides, assuming consumption of 2 Lpd of the affected water).

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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 nonradiological 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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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 § 51.52.

North Anna Power Station, Units 1 and 2, meet the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The staff has not identified any new and significant information on this issue during its independent review of the VEPCo ER (VEPCo 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."

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 63. Code of Federal Regulations, Title 10, *Energy,* Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

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."

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."

Energy Policy Act of 1992. 42 USC 10101, et seq.

National Academy of Sciences (NAS). 1995. *Technical Bases for Yucca Mountain Standards*. Washington, D.C.

National Environmental Policy Act (NEPA) of 1969, as amended, 42 USC 4321, 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, 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*. NUREG-1437, Vol. 1, Addendum 1, Washington, D.C.

Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for North Anna Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

7.0 Environmental Impacts of Decommissioning

Environmental issues associated with decommissioning, which result from continued plant operation during the renewal terms are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC1996; 1999).[(a)] The GEIS includes 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 are then 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. There are no Category 2 issues related to decommissioning North Anna Power Station, Units 1 and 2.

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B that are applicable to North Anna Power Station, Units 1 and 2, decommissioning following the renewal term are listed in Table 7-1. The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER) (VEPCo 2001) that it is aware of no new and significant information regarding the environmental impacts of North Anna Power Station, Units 1 and 2, license renewal. The staff has not identified any significant new information on these issues during its independent review of the VEPCo ER (VEPCo 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 these issues beyond those discussed in the GEIS. For all of these issues,

(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 the Decommissioning of North Anna Power Station, Units 1 and 2, Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
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

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 on this issue during its independent review of the VEPCo ER (VEPCo 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 on this issue during its independent review of the VEPCo ER (VEPCo 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 on this issue during its independent review of the VEPCo ER (VEPCo 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 on this issue during its independent review of the VEPCo ER (VEPCo 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 on this issue during its independent review of the VEPCo ER (VEPCo 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 on this issue during its independent review of the VEPCo ER (VEPCo 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."

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.

Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for North Anna Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

8.0 Environmental Impacts of Alternatives to Operating License Renewal

This chapter examines the potential environmental impacts associated with denying the renewal of the operating licenses (OLs) (i.e., the no-action alternative), the potential environmental impacts from electric generating sources other than North Anna Power Station, Units 1 and 2, the possibility of purchasing electric power from other sources to replace power generated by Units 1 and 2 and the associated environmental impacts, the potential environmental impacts from a combination of generating and conservation measures, and other generation alternatives that were deemed unsuitable for replacement of power generated by Units 1 and 2. The environmental impacts were evaluated using the U.S. Nuclear Regulatory Commission's (NRC's) three-level standard of significance–SMALL, MODERATE, or LARGE–developed using the Council on Environmental Quality guidelines and set forth in a footnote 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 resource.
>
> MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource.
>
> LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999)[(a)] with the additional impact categories of environmental justice and transportation.

8.1 No-Action Alternative

NRC's regulations implementing the National Environmental Policy Act (NEPA) (42 USC 4321) specify that the no-action alternative be discussed in an NRC EIS [10 CFR Part 51, Subpart A, Appendix A(4)]. For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the North Anna Power Station, Units 1 and 2, OLs, and the Virginia Electric and Power Company (VEPCo) would then decommission North Anna, Units 1 and 2, when plant operations cease. Replacement of North Anna, Units 1 and 2, electricity generation

(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.

capacity would be met by (1) demand-side management and energy conservation, (2) power purchased from other electricity providers, (3) generating alternatives other than North Anna Power Station, Units 1 and 2, or (4) some combination of these options.

VEPCo will be required to comply with NRC decommissioning requirements whether or not the OLs are renewed. If the North Anna Power Station, Units 1 and 2 OLs are renewed, decommissioning activities may be postponed for up to an additional 20 years. If the OLs are not renewed, VEPCo would conduct decommissioning activities according to the requirements in 10 CFR 50.82.

The environmental impacts associated with decommissioning under both license renewal and the no-action alternative would be bounded by the discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this Supplemental Environmental Impact Statement (SEIS), and the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NRC 1988).[(a)] The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those occurring after 40 years of operation.

The environmental impacts for the socioeconomic, historic and archaeological resources, and environmental justice impact categories are summarized in Table 8-1 and discussed in the ensuing paragraphs. The no-action alternative would also have certain positive impacts in that adverse environmental impacts associated with current operation of North Anna Power Station, Units 1 and 2, for example, solid waste impacts and effects on aquatic life, would be eliminated.

Table 8-1. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Socioeconomic	SMALL to MODERATE	Decrease in employment, higher-paying jobs and tax revenues. Most adverse impacts would be on Louisa County.
Historic and Archaeological Resources	SMALL	Land occupied by Units 1 and 2 could be developed after decommissioning.
Environmental Justice	SMALL to MODERATE	Loss of employment opportunities and social programs, particularly in Louisa County.

- Socioeconomic: When North Anna Power Station, Units 1 and 2, cease operation, there will be a decrease in employment and tax revenues associated with the closure. These impacts

(a) The NRC staff is supplementing NUREG-0586 for reactor decommissioning. In October 2001, the staff issued draft Supplement 1 to NUREG-0586 dealing with Decommissioning of Nuclear Power Reactors (66 FR 56721, NRC 2001a) for public comment. The staff is currently finalizing the draft Supplement for publication as a final document.

would be felt in Henrico, Orange, and Spotsylvania Counties, and the City of Richmond. Louisa County would be more adversely impacted than the other counties in both employment and tax revenue. Most secondary employment impacts and impacts on population would also be felt in the preceding locations. Approximately 80 percent of the employees who work at North Anna Power Station, Units 1 and 2, live in these counties.

The no-action alternative would result in the loss of the taxes attributable to North Anna Power Station, Units 1 and 2, as well as the loss of plant payrolls 20 years earlier than if the OLs were renewed. As previously mentioned, most of the tax revenue losses resulting from closure of North Anna Power Station, Units 1 and 2, would occur in Louisa County. In 2000, VEPCo paid $10.58 million in property taxes to Louisa County for the nuclear generation units at North Anna, or about 42 percent of all property taxes collected by the County (see Table 2-15).[(a)] For the remaining two counties to which property taxes are paid, the loss in real property tax would not be significant, amounting to 1.2 and 1.4 percent for Orange and Spotsylvania Counties, respectively, in 2000.

Loss of the property tax revenue could have a significant, short-term negative impact on the ability of Louisa County to provide public services such as schools and road maintenance. There could also be an adverse, short-term impact on housing values, the local economy in Louisa County and surrounding areas, and employment if North Anna Power Station, Units 1 and 2, were to cease operations.

VEPCo employees working at North Anna Power Station, Units 1 and 2, currently contribute time and money toward community involvement, including schools, churches, charities, and other civic activities. It is likely that with a reduced presence in the community following decommissioning, community involvement efforts by VEPCo and its employees in the region would be reduced.

The degree and extent of such adverse impacts would depend on the economic development taking place in Louisa County and the other counties and cities over the next 20 years. If the Richmond area continues its growth and diversification into the first quarter of the 21st century as it has for the last decade, and assuming that the economic growth spills over to surrounding counties such as Louisa, Spotsylvania, and Orange, then the consequences of not renewing the OLs could be partially or entirely offset by the new jobs created by such growth. While many of the jobs from past economic development are higher-paying, white-collar positions (e.g., banking and financial service centers), it is not known if these types of jobs and the pay scale of the projected employment increase will be maintained. If the new jobs are skilled, higher-paying jobs, then the impacts of nonrenewal of the North Anna

(a) Information obtained during an interview of Ms. Nancy Pleasants, Commissioner of Revenue, Louisa County October 15, 2001.

Power Station, Units 1 and 2, OLs could be significantly mitigated, and the socioeconomic consequence of plant closure would be SMALL. If the jobs are less-skilled and lower-paying, then the impact of plant closure could be only partially offset and impacts could be MODERATE, particularly in Louisa County.

- Historic and Archaeological Resources: The potential for future adverse impacts to known or unrecorded cultural resources at North Anna following decommissioning of Units 1 and 2 will depend on the future use of the land occupied by the two units. Following decommissioning, land occupied by Units 1 and 2 would likely be retained by VEPCo for other corporate purposes, including potential development of the site given its location on Lake Anna. Eventual sale or transfer of the land occupied by Units 1 and 2, however, could result in adverse impacts to cultural resources if land-use patterns of the site, and lands surrounding the site, change dramatically. Notwithstanding this possibility, the impacts of this alternative on historic and archaeological resources are considered SMALL.

- Environmental Justice for No-Action: Current operations at North Anna Power Station, Units 1 and 2 have no disproportionate impacts on the minority and low-income populations of the surrounding counties, and no environmental pathways have been identified that would cause disproportionate impacts. Closure of Units 1 and 2 could result in decreased employment opportunities in Henrico, Orange, and Spotsylvania Counties and the City of Richmond, with Louisa County potentially seeing the greatest impact. Real property tax revenues lost in Louisa County would be large, with possible negative and disproportionate impacts on minority or low-income populations depending on the County's ability to continue providing services to these populations. The environmental justice impacts under the no-action alternative are considered SMALL to MODERATE.

Impacts for all other impact categories would be SMALL, as shown in Table 9-1.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with alternative sources of electric power to replace the power generated by North Anna Power Station, Units 1 and 2, assuming that the OLs for Units 1 and 2 are not renewed. The order of presentation of alternative energy sources in Section 8.2 does not imply which alternative would most likely occur or have the least environmental impacts. The following generation alternatives are considered in detail:

- coal-fired generation at the North Anna site and at an alternate greenfield site (Section 8.2.1)

- natural gas-fired generation at the North Anna site and at an alternate greenfield site (Section 8.2.2)

- nuclear generation at the North Anna site and an alternate greenfield site (Section 8.2.3).

The alternative of purchasing power from other sources to replace power generated at North Anna Power Station, Units 1 and 2 is discussed in Section 8.2.4. Other power generation alternatives and conservation alternatives considered by the staff and found not to be reasonable replacements for Units 1 and 2 are discussed in Section 8.2.5. Section 8.2.6 discusses the environmental impacts of a combination of generation and conservation alternatives.

Each year the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an Annual Energy Outlook. In the *Annual Energy Outlook 2002*, issued in December 2001 (DOE/EIA 2001a), EIA projects that combined-cycle or combustion turbine technology fueled by natural gas is likely to account for approximately 88 percent of new electric generating capacity between the years 2001 and 2020. Both technologies are designed primarily to supply peak and intermediate capacity, but combined-cycle technology also can be used to meet baseload[(a)] requirements. Coal-fired plants are projected by EIA to account for approximately 9 percent of new capacity during this period. Coal-fired plants are generally used to meet baseload requirements. Renewable energy sources, primarily wind, geothermal, and municipal solid waste units, are projected by EIA to account for the remaining 3 percent of capacity additions. The EIA's projections are based on the assumption that providers of new generating capacity will seek to minimize cost while meeting applicable environmental requirements. Combined-cycle plants are projected by EIA to have the lowest generation cost in 2005 and 2020, followed by coal-fired plants and then wind generation (DOE/EIA 2001a).

EIA also projects that new nuclear power plants will not account for any new generation capacity in the United States during the 2000 to 2020 time period because natural gas and coal-fired plants are projected to be more economical (DOE/EIA 2001a). In spite of this projection, a new nuclear plant alternative for replacing power generated by North Anna Power Station, Units 1 and 2, is considered in Section 8.2.3. Since 1997, the NRC has certified three new standard designs for nuclear power plants under the procedures in 10 CFR Part 52, Subpart B. These designs are the U.S. Advanced Boiling Water Reactor (10 CFR Part 52, Appendix A), the System 80+ Design (10 CFR Part 52, Appendix B), and the AP600 Design (10 CFR Part 52, Appendix C). The submission to the NRC of these three applications for certification indicates continuing interest in the possibility of licensing new nuclear power plants.

(a) A baseload plant normally operates to supply all or part of the minimum continuous load of a system and consequently produces electricity at an essentially constant rate. Nuclear power plants are commonly used for baseload generation; i.e., these units generally run near full load.

The NRC has recently established a New Reactor Licensing Program to prepare for and manage future reactor and site licensing applications (NRC 2001b).

North Anna Power Station, Units 1 and 2, have a combined average net capacity of 1,790 megawatts electric (MW(e)). For the coal and natural gas alternatives, VEPCo's environmental report (ER) assumes three standard 508-MW(e) units[(a)] as potential replacements for Units 1 and 2 (VEPCo 2001). The staff used this assumption in their evaluation, although it results in some environmental impacts that are roughly 17 percent lower than if full replacement capacity were constructed. VEPCo's reasoning is that although custom-sized units can be built, use of standardized sizes is more economical. Moreover, using four 508-MW(e) units for the analysis would overestimate environmental impacts and tend to make the fossil fuel alternatives less attractive.

8.2.1 Coal-Fired Generation

The coal-fired alternative is analyzed at both the North Anna site and at an alternate site. As discussed in Section 8.2, the staff assumed construction of three 508-MW(e) units.

The VEPCo ER (VEPCo 2001) assumes that coal and lime or limestone for a coal-fired plant sited at North Anna would be delivered by a CSX rail line to an existing 11-km (7-mi) rail spur that leads to North Anna. The rail system at North Anna would require modifications to handle the increased traffic (VEPCo 2001). Lime[(b)] or limestone is used in the scrubbing process for control of sulfur dioxide (SO_2) emissions.

While construction at an alternate, greenfield site is not specifically discussed in VEPCo's ER, rail delivery would be the most likely option for delivering coal and lime/limestone to an alternate inland site for the coal-fired plant. Barge delivery of coal and lime/limestone is potentially feasible for a coastal site. A coal slurry pipeline is also a technically feasible delivery option; however, the associated cost and environmental impacts make a slurry pipeline an unlikely transportation alternative. Construction at an alternate site could necessitate the construction of a new transmission line to connect to existing lines and a rail spur to the plant site.

The coal-fired plant would consume approximately 4.4 million MT (4.9 million tons) per year of pulverized bituminous coal with an ash content by weight of approximately 10.7 percent

(a) Each of the coal-fired units would have a rating of 538 gross MW and 508 net MW. Each of the gas-fired units would have a rating of 528 gross MW and 508 net MW. The difference between "gross" and "net" is the electricity consumed onsite.

(b) In a typical wet scrubber, lime (calcium hydroxide) or limestone (calcium carbonate) is injected as a slurry into the hot effluent combustion gases to remove entrained sulfur dioxide. The lime-based scrubbing solution reacts with sulfur dioxide to form calcium sulfite, which precipitates out and is removed in sludge form.

(VEPCo 2001). The ER assumes a heat rate[(a)] of 3 J fuel/J electricity (10,200 Btu/kWh) and a capacity factor[(b)] of 0.85 (VEPCo 2001). After combustion, 99.9 percent of the ash (approximately 474,000 MT/yr [522,000 tons/yr]) would be collected and disposed of at the plant site. In addition, approximately 221,000 MT/yr (244,000 tons/yr) of scrubber sludge would be disposed of at the plant site based on annual lime usage of approximately 76,000 MT (84,000 tons) (VEPCo 2001).

Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.1 are from the VEPCo ER (VEPCo 2001). The staff reviewed this information and compared it to environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the coal-fired alternative for 40 years is considered (as a reasonable projection of the operating life of a coal-fired plant).

8.2.1.1 Once-Through Cooling System

For purposes of this SEIS, the staff assumed that a coal-fired plant located at North Anna would use the existing once-through system as a source of cooling. An alternate greenfield site could use either a closed-cycle or a once-through cooling system.

The overall impacts of the coal-fired generating system are discussed in the following sections and summarized in Table 8-2. The extent of impacts at an alternate site would depend on the location of the particular site selected.

- **Land Use**

  The North Anna site is approximately 422 ha (1043 ac). Construction of the power block and coal storage area would impact some land area and associated terrestrial habitat. However, in the ER VEPCo states it will make maximum use of existing facilities and infrastructure, limiting the amount of new construction that would be required (VEPCo 2001). Specifically, the staff assumed that the coal-fired replacement plant alternative would use the existing once-through cooling system, switchyard, offices, and transmission line right-of-way.

(a) Heat rate is a measure of generating station thermal efficiency. In English units, it is generally expressed in British thermal units (Btu) per net kilowatt-hour (kWh). It is computed by dividing the total Btu content of fuel burned for electric generation by the resulting net kWh generation.

(b) The capacity factor is the ratio of electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.

Table 8-2. Summary of Environmental Impacts of Coal-Fired Generation at North Anna Power Station and an Alternate Greenfield Site Using Once-Through Cooling

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	Extensive use of existing infrastructure. Uses 172 ha (425 ac) of undeveloped portion of North Anna for waste disposal of coal ash and scrubber sludge over 40-year plant life. Additional offsite land impacts for coal and limestone mining.	SMALL to LARGE	Uses up to 1100 ha (2600 ac) for plant, offices, parking, and waste disposal; additional offsite land impacts for coal and limestone mining; possible impacts for transmission line and rail spur. Degree of impact dependent on whether alternate site is disturbed: SMALL to MODERATE impact previously developed site, LARGE impact greenfield site.
Ecology	SMALL to MODERATE	Uses previously developed areas except for waste disposal of coal ash and scrubber sludge. Potential habitat loss and fragmentation and reduced productivity and biological diversity could result from disturbing lands not previously disturbed.	SMALL to LARGE	Impact depends on whether site is previously developed (SMALL to MODERATE) or greenfield (MODERATE to LARGE), location and ecology of the site, surface water body used for intake and discharge, transmission line route; potential habitat loss and fragmentation, reduced productivity, and biological diversity.
Water Use and Quality				
Surface Water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body at the alternate site.
Groundwater	SMALL	Groundwater use is <1000 gpm; once-through cooling is employed.	SMALL	Groundwater use similar to impacts at North Anna site; impacts depend on groundwater use and availability.

Table 8-2. (contd)

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Air Quality	MODERATE	Sulfur oxides • 4130 MT/yr (4550 tons/yr) Nitrogen oxides • 1075 MT/yr (1185 tons/yr) Particulates • 237 MT/yr (261 tons/yr) of total suspended particulates, which would include 54 MT/yr (60 tons/yr) of PM_{10}. Carbon monoxide • 1100 MT/yr (1215 tons/yr) Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials – mainly uranium and thorium.	MODERATE	Potentially same impacts as at North Anna, although pollution-control standards may vary.
Waste	MODERATE	Total waste volume would be approximately 695,000 MT/yr (765,000 tons/yr) of ash and scrubber sludge requiring approximately 172 ha (425 ac) for disposal during the 40-year life of the plant.	MODERATE	Same impacts as at North Anna; waste disposal constraints may vary.
Human Health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data.	SMALL	Same impact as at North Anna.

Table 8-2. (contd)

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 2500 workers during the peak period of the 5-year construction period, followed by reduction of current North Anna, Units 1 and 2 work force from approximately 921 to 961 permanent and contractor employees to 200. Tax base preserved. Impacts during operation would be SMALL to MODERATE due to loss of employment in Louisa County, which may be offset by future economic growth in the County and surrounding Richmond metropolitan area.	SMALL to LARGE	Construction impacts depend on location, but could be LARGE if plant is located in a rural area. Louisa County would experience loss of Units 1 and 2 tax base and employment with potentially LARGE impacts. Impacts during operation at alternate site would be SMALL to MODERATE, depending upon the economy at the alternate site.
	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Transportation impacts during operation would be SMALL due to decreased work force.	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE, depending on the transportation infrastructure at the alternate site. Transportation impacts during operation would be SMALL due to the decreased work force.
		For rail transportation of coal and lime/limestone, the impact is considered SMALL.		For rail transportation of coal and lime/limestone, the impact is considered SMALL in a rural area and MODERATE in a more crowded, suburban area. For barge transportation, the impact is considered SMALL.

Table 8-2. (contd)

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Aesthetics	SMALL to MODERATE	Three coal-fired power plant units and exhaust stacks would be visible in daylight hours from offsite. The plant would also be visible at night because of outside lighting. Rail transportation of coal and lime/limestone would also have a SMALL to MODERATE aesthetic impact. Coal-fired generation would introduce mechanical sources of noise audible offsite. These impacts are SMALL to MODERATE.	SMALL to LARGE	Impact would depend on the site selected and the surrounding land features and could be LARGE if a greenfield site is selected. If needed, a new transmission line or rail spur would add to the aesthetic impact. Rail transportation of coal and lime/limestone would be SMALL to MODERATE, again depending on the characteristics of the alternate site. Barge transportation of coal and lime/limestone would have a SMALL to MODERATE esthetic impact. Noise impact would be SMALL to MODERATE.
Historic and Archaeological Resources	SMALL	Some construction would affect previously undeveloped parts of North Anna; cultural resource inventory should minimize any impacts on undeveloped lands. Studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on undeveloped land on cultural resources, even at a developed site.	SMALL	Alternate location would necessitate cultural resource studies. Studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on undeveloped sites on cultural resources.
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of from 721 to 761 operating jobs (permanent and contractor) at North Anna could reduce employment prospects for minority and low-income populations. Dependent, to some extent, on the economic vitality/expansion of the Richmond metropolitan and surrounding area.	SMALL to LARGE	Impacts at alternate site vary depending on population distribution and makeup. Could be SMALL to LARGE. Louisa County would lose significant revenue, which could have MODERATE to LARGE impacts on minority and low-income populations in terms of services the County could provide with the smaller property tax and employment base.

The coal-fired generation alternative would necessitate converting some of the unused land at North Anna to coal storage and ash and scrubber sludge disposal. VEPCo estimates that ash and scrubber waste disposal over a 40-year plant life would require approximately 172 ha (425 ac) (VEPCo 2001).[a] Approximately 86 ha (213 ac) of second-growth mixed pine hardwoods would be converted to waste disposal facilities during the 20-year license renewal term. VEPCo believes that there is space within the existing North Anna footprint to accommodate waste disposal. After closure, the waste site would be re-vegetated and the land would become available for other uses. Additional land-use changes would occur offsite in an undetermined coal-mining area to supply coal for the plant. The GEIS estimates that approximately 8900 ha (22,000 ac) would be affected for mining the coal and disposing of the waste to support a 1000 MW(e) coal plant during its operational life (NRC 1996). A replacement coal-fired plant for North Anna Power Station, Units 1 and 2, would be 1524 MW(e) and would affect proportionately more land. Partially offsetting this offsite land use would be the elimination of the need for uranium mining to supply fuel for Units 1 and 2. The GEIS states that approximately 405 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant (NRC 1996).

The impact of a coal-fired generating unit on land use at North Anna is best characterized as SMALL to MODERATE. The impact would definitely be greater than the OL renewal alternative.

In the GEIS, NRC staff estimated that a 1000-MW(e) coal-fired plant would require approximately 700 ha (1700 ac) (NRC 1996). Construction of a 1524 MW(e) coal-fired generation alternative at an alternate site could impact proportionately more land. The degree to which the land use would be impacted depends on whether the alternate site is a greenfield site or previously developed industrial site. Additional land could be needed for a transmission line and for a rail spur to the plant site. Depending on transmission line and rail line routing requirements, this alternative would result in SMALL to LARGE land-use impacts.

- **Ecology**

Locating a coal-fired plant at the North Anna site would have some impact on ecological and terrestrial resources because of the need to convert 86 ha (213 ac) of undisturbed land for ash and scrubber sludge disposal. In addition, construction of the power block and coal storage area would impact some land area and associated terrestrial habitat. Operation of the coal-fired plant would use the existing cooling system, which would minimize impacts to

(a) While only half of the 172 ha (425 ac) would be attributable to the 20-year license renewal alternative, the total numbers are pertinent as a cumulative impact (VEPCo 2001).

aquatic resources. In summary, because the coal-fired alternative is developed on a previously disturbed area, is at an existing industrial site, and makes maximum use of existing facilities, it is expected that the ecological impacts would be SMALL to MODERATE, but still greater than renewal of the North Anna Power Station, Units 1 and 2, OLs.

At an alternate site, the coal-fired generation alternative would introduce construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts could alter the ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface water body could have adverse aquatic resource impacts. If needed, construction and maintenance of a transmission line and a rail spur would have ecological impacts. Overall, the ecological impacts at an alternate site would be SMALL to MODERATE (previously developed site) or MODERATE to LARGE (greenfield site).

- **Water Use and Quality**

  Surface water. The coal-fired generation alternative at the North Anna site is assumed to use the existing once-through cooling system, which would minimize incremental water use and quality impacts. Operation using the existing cooling system should minimize any impacts on water quality. Thus, surface water impacts are expected to remain SMALL; the impacts would be sufficiently minor that they would not noticeably alter any important attribute of the resource.

  For a coal-fired plant located at an alternate site, the impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the Commonwealth of Virginia or another state. Some erosion and sedimentation would also likely occur during construction (NRC 1996). The impacts could range between SMALL to MODERATE.

  Groundwater. The staff assumed that a coal-fired plant located at North Anna would obtain potable, process, and fire-protection water from the series of groundwater wells that currently supply Units 1 and 2 (see Section 2.2.2). Groundwater withdrawals would be less than no-action and license renewal alternatives because of the reduced work force. Hence, impacts are considered SMALL. Use of groundwater for a coal-fired plant sited at an alternate site is a possibility. Groundwater withdrawal at an alternate site would likely require a permit from the Virginia Department of Environmental Quality (VDEQ). The impacts are considered SMALL.

- **Air Quality**

  The air-quality impacts of coal-fired generation vary considerably from those of nuclear generation due to emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide, hazardous air pollutants such as mercury, and naturally occurring radioactive materials.

  Louisa County is in the Northeastern Air Quality Control Region (40 CFR 81.145). Louisa County is in compliance with the national ambient air quality standards for particulate matter, carbon monoxide, nitrogen dioxide, lead, sulfur dioxide, and ozone (40 CFR 81.347).

  A new coal-fired generating plant located at North Anna would likely need a prevention of significant deterioration permit and an operating permit under the Clean Air Act (CAA). The plant would need to comply with the new source performance standards for such plants set forth in 40 CFR Part 60, Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42a), SO_2 (40 CFR 60.43a), and NO_x (40 CFR 60.44a).

  Section 169A of the CAA (42 USC 7401) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. If a coal-fired plant were located close to a mandatory Class I area, additional air pollution control requirement could be imposed. However, the mandatory Class I Federal areas closest to the North Anna site are the Swanquarter Wilderness Area in eastern North Carolina, located approximately 312 km (194 mi) southeast of North Anna; Shenandoah National Park, located approximately 177 km (110 mi) northwest of North Anna; and the James River Face Wilderness located approximately 166 km (103 mi) west of North Anna. The U.S. Environmental Protection Agency (EPA) has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified under the CAA. Louisa County is classified as attainment or unclassified for criteria pollutants.[(a)] EPA issued a new regional haze rule in 1999 (64 FR 35713, July 1,1999 [EPA 1999]). The rule specifies that for each mandatory Class I Federal area located within a state, the state must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period [40 CFR 51.308(d)(1)].

(a) Existing criteria pollutants under the CAA are ozone, carbon monoxide, particulates, sulfur dioxide, lead, and nitrogen oxide. Ambient air standards for criteria pollutants are set out at 40 CFR Part 50.

In 1998, EPA issued a rule requiring 22 eastern states, including Virginia, to revise their state implementation plans to reduce nitrogen oxide emissions (63 FR 49442, EPA 1998). Nitrogen oxide emissions contribute to violations of the national ambient air quality standard for ozone. The total amount of nitrogen oxides that can be emitted by each of the 22 states in the year 2007 ozone season (May 1 - September 30) is set out at 40 CFR 51.121(e). For Virginia, the amount is 163,470 MT (180,195 tons). Any new coal-fired plant in Virginia would be subject to this limitation.

Impacts for particular pollutants are as follows:

Sulfur oxides emissions. VEPCo states in its ER that an alternative coal-fired plant located at North Anna would use wet scrubber-lime/limestone for flue gas desulfurization (VEPCo 2001).

A new coal-fired power plant would be subject to the requirements in Title IV of the Clean Air Act. Title IV was enacted to reduce emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances but are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore acquire allowances from owners of other power plants by purchase or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, a new coal-fired power plant would not add to net regional SO_2 emissions, although it might do so locally.

VEPCo estimates that by using the best technology to minimize SO_x emissions, the total annual stack emissions would be approximately 4130 MT (4548 tons) of SO_x (VEPCo 2001). This level of SO_x emission would be greater than the OL renewal alternative.

Nitrogen oxides emissions. Section 407 of the CAA establishes technology-based emission limitations for NO_x emissions. The market-based allowance system used for SO_2 emissions is not used for NO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants in 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (EPA 1998), limits the discharge of any gases that contain nitrogen oxides (expressed as NO_x) in excess of 200 ng/J of gross energy output (1.6 lb/MWh), based on a 30-day rolling average.

VEPCo estimates that by using low NO_x burners with overfire air and selective catalytic reduction the total annual NO_x emissions for a new coal-fired power plant would be

approximately 1075 MT (1185 tons) (VEPCo 2001). This level of NO_x emissions would be greater than the OL renewal alternative.

Particulate emissions. VEPCo estimates that the total annual stack emissions would include 237 MT (261 tons) of filterable total suspended particulates (particulates that range in size from less than 0.1 μm up to approximately 45 μm). The 237 MT would include 54 MT (60 tons) of PM_{10} (particulate matter having an aerodynamic diameter less than or equal to 10 μm). Fabric filters or electrostatic precipitators would be used for control. In addition, coal-handling equipment would introduce fugitive particulate emissions. Particulate emissions would be greater under the coal alternative than the OL renewal alternative.

During construction of a coal-fired plant, fugitive dust would be generated. In addition, exhaust emissions would come from vehicles and motorized equipment used during the construction process.

Carbon monoxide emissions. VEPCo estimates that the total carbon monoxide emissions would be approximately 1110 MT (1221 tons) per year. This level of emissions is greater than the OL renewal alternative.

Hazardous air pollutants including mercury. In December 2000, EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam generating units (65 FR 79825, EPA 2000b). EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants. Coal-fired power plants were found by EPA to emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000b). EPA concluded that mercury is the hazardous air pollutant of greatest concern. EPA found that (1) there is a link between coal consumption and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures resulting from consumption of contaminated fish (EPA 2000b). Accordingly, EPA added coal- and oil-fired electric utility steam-generating units to the list of source categories under Section 112(c) of the CAA for which emission standards for hazardous air pollutants will be issued (EPA 2000b).

Uranium and thorium. Coal contains uranium and thorium. Uranium concentrations are generally in the range of 1 to 10 parts per million. Thorium concentrations are generally about 2.5 times greater than uranium concentrations (Gabbard 1993). One estimate is that a typical coal-fired plant released roughly 4.7 MT (5.2 tons) of uranium and 11.6 MT (12.8 tons) of thorium in 1982 (Gabbard 1993). The population dose equivalent from the

uranium and thorium releases and daughter products produced by the decay of these isotopes has been calculated to be significantly higher than that from nuclear power plants (Gabbard 1993).

Summary. The GEIS analysis does not quantify emissions from coal-fired power plants, but implies that air impacts would be substantial. The GEIS also mentions global warming from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). Adverse human health effects, such as cancer and emphysema, have been associated with the products of coal combustion. The appropriate characterization of air impacts from coal-fired generation would be MODERATE. The impacts would be clearly noticeable but would not destabilize air quality.

Siting a coal-fired generation plant at a site other than North Anna would not significantly change air-quality impacts, although it could result in installing more or less stringent pollution-control equipment to meet applicable local requirements. Therefore, the impacts would be MODERATE.

- **Waste**

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates spent selective catalytic reduction catalyst, additional ash, and scrubber sludge. Three 508-MW(e) coal-fired plants would generate approximately 695,000 MT (766,060 tons) of this waste annually for 40 years. The waste would be disposed of onsite, accounting for approximately 172 ha (425 ac) of land area over the 40-year plant life. Waste impacts to groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs. Disposal of the waste could noticeably affect land use and groundwater quality, but with appropriate management and monitoring it would not destabilize any resources. After closure of the waste site and revegetation, the land could be available for other uses. Construction-related debris would also be generated during construction activities.

In May 2000, EPA issued a Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels (65 FR 33213, EPA 2000a). EPA concluded that some form of national regulation is warranted to address coal combustion waste products because (1) the composition of these wastes could present danger to human health and the environment under certain conditions; (2) EPA has identified 11 documented cases of proven damages to human health and the environment by improper management of these wastes in landfills and surface impoundments; (3) present disposal practices are such that, in 1995, these wastes were being managed in 40 to 70 percent of landfills and surface impoundments without reasonable controls in place, particularly in the area of groundwater monitoring; and

(4) EPA identified gaps in state oversight of coal combustion wastes. Accordingly, EPA announced its intention to issue regulations for disposal of coal combustion waste under subtitle D of the Resource Conservation and Recovery Act (RCRA 1976, 42 USC 6901).

For these reasons, the appropriate characterization of impacts from waste generated from burning coal is MODERATE; the impacts would be clearly noticeable but would not destabilize any important resource.

Siting the facility at a site other than the North Anna would not alter waste generation, although other sites might have more constraints on disposal locations. Therefore, the impacts would be MODERATE.

- **Human Health**

Coal-fired power generation introduces worker risks from coal and limestone mining, and worker and public risks from coal and lime/limestone transportation and inhalation of stack emissions. Emission impacts can be widespread and health risks difficult to quantify. The coal alternative also introduces the risk of coal pile fires and attendant inhalation risks.

The staff stated in the GEIS that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates from coal-fired plants, but does not identify the significance of these impacts (NRC 1996). In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including EPA and State agencies, set air emission standards and requirements based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. As discussed previously, EPA has recently concluded that certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures from sources such as coal-fired power plants. However, in the absence of more quantitative data, human health impacts from radiological doses and inhaling toxins and particulates generated by burning coal are characterized as SMALL.

- **Socioeconomics**

Construction and Operation. Construction of the coal-fired alternative would take approximately 5 years. The staff assumed that construction would take place while North Anna Power Station, Units 1 and 2, continue operation and would be completed by the time

Units 1 and 2 permanently cease operations. The construction work force would be expected to vary between 1200 and 2500 workers during the 5-year construction period (NRC 1996). These workers would be in addition to the approximately 851 permanent and 70 to 110 contract workers employed at Units 1 and 2. During construction of the new coal-fired plant, communities near North Anna would experience demands on housing and public services that could have SMALL to MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from outside the immediate area of the site, including the Richmond metropolitan area, Fredericksburg, and Charlottesville, among others. Nearby communities to North Anna would be impacted by the loss of the construction jobs once construction is completed.

If the coal-fired replacement plant were constructed at North Anna and Units 1 and 2 were decommissioned, there would be a loss of approximately 721 to 761 permanent and contract employees, as VEPCo estimates that the completed coal-fired plant would employ approximately 200 workers (VEPCo 2001). There would be a commensurate reduction in demand on socioeconomic resources and contribution to the regional economy. The coal-fired plants would provide a new tax base to offset the loss of tax base associated with decommissioning of the nuclear units. For all of these reasons, the appropriate characterization of non-transportation socioeconomic impacts for a coal-fired plant constructed at the North Anna site would be SMALL to MODERATE; the socioeconomic impacts would be noticeable, but would be unlikely to destabilize the area. The impacts could be mitigated by the site's proximity to the Richmond metropolitan area and may be additionally offset if economic growth in Richmond and surrounding areas continues as during the last decade.

Construction of a replacement coal-fired power plant at an alternate site would relocate some socioeconomic impacts but would not eliminate them. Louisa County would experience the brunt of North Anna Power Station, Units 1 and 2, operational job loss and would lose a significant tax base. These losses could have potentially LARGE socioeconomic impacts to the County, particularly over the short to intermediate term (from 5 to 10 years following plant closure). Communities around the new site would have to absorb the impacts of a large, temporary work force (up to 2500 workers at the peak of construction) and a permanent work force of approximately 200 workers. The staff stated in the GEIS that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction work force would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis. Socioeconomic impacts at or near an urban, previously developed industrial area would be SMALL. Socioeconomic impacts at a rural site could be MODERATE to LARGE, depending on the relative location of the site to towns and cities that might be able to accommodate such impacts.

Transportation. During the 5-year construction period of replacement coal-fired units, up to 2500 construction workers would be working at the site in addition to the 921 to 961 permanent and contract workers employed at Units 1 and 2. The addition of these workers could place significant traffic loads on existing highways near North Anna. Such impacts would be MODERATE to LARGE.

For transportation related to the commuting of plant operating personnel, the impacts are considered SMALL. The maximum number of plant operating personnel would be approximately 200 compared to the current commuting work force of approximately 921 to 961 permanent and contract workers. Therefore, traffic impacts associated with plant personnel commuting to a coal-fired plant would be expected to be SMALL compared to the current impacts from Unit 1 and 2 operations.

At North Anna, coal and lime/limestone likely would be delivered by rail. Each train would have approximately 115 rail cars. Each open-top rail car holds about 90 MT (100 tons) of coal. Additional rail cars would be needed for lime/limestone delivery. In all, approximately 425 trains per year would deliver the coal and lime/limestone for the three units. An average of roughly 16 train trips per week would be needed to transport the coal and lime/limestone. For each full train delivery, an empty train would return. On several days per week, there could be two to three trains per day using the rail spur to North Anna, resulting in blocking at grade crossings. North Anna is located in a semi-rural area, and the roads are lightly traveled during most parts of the day except at shift changes at the site. Therefore, the effect of the increased rail traffic on residents and vehicular traffic in the North Anna area is considered SMALL.

Transportation-related impacts associated with commuting construction workers at an alternate rural site are also site-dependent and could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site-dependent but can be characterized as SMALL.

At an alternate site, coal and limestone delivery likely would be delivered by rail, although barge delivery would be feasible at a coastal location. Impacts of rail transportation would be SMALL in a rural area and MODERATE in a more crowded, suburban area. Barge delivery of coal and lime/limestone would likely have SMALL socioeconomic impacts.

- **Aesthetics**

The three coal-fired power plant units could be as high as 60 m (200 ft) and be visible in daylight hours from offsite. The three exhaust stacks would be as high as 185 m (600 ft) (VEPCo 2001). The stacks would be visible in daylight hours. The plant units and

associated stacks also would be visible at night because of outside lighting. Visual impacts of a new coal-fired plant could be mitigated by landscaping and selecting building color consistent with the environment. Visual impact at night could be mitigated by reducing lighting and using shielding appropriately.

Coal-fired generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to total noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to coal and lime/limestone delivery, use of outside loudspeakers, and the commuting of plant employees. The incremental noise impacts of a coal-fired plant compared to existing North Anna Power Station, Units 1 and 2, operations are considered to be SMALL to MODERATE.

At an alternate site, there would be an aesthetic impact from the buildings and exhaust stacks. This impact could be LARGE if a greenfield site is used. There would also be an aesthetic impact if construction of a new transmission line and/or rail spur is needed. Noise impacts associated with rail delivery of coal and lime/limestone would be most significant for residents living in the vicinity of the facility and along the rail route. Although noise from passing trains significantly raises noise levels near the rail corridor, the short duration of the noise reduces the impact. In a more suburban location, the impacts are considered MODERATE. This is due to the frequency of train transport, the fact that many people are likely to be within hearing distance of the rail route, and the impacts of noise on residents in the vicinity of the facility and the rail line. At a more rural location, the impacts could be SMALL. Noise and light from the plant would be detectable offsite. Aesthetic impacts at the plant site would be mitigated if the plant were located in an industrial area adjacent to other power plants or industrial facilities, in which case the impacts could be SMALL. Overall, the aesthetic impacts associated with locating at an alternate site can be categorized as SMALL to LARGE, depending on the characteristics of the alternate site.

- **Historic and Archaeological Resources**

At the North Anna site or an alternate site, a cultural resource inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at North Anna or an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction

on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission line rights-of-way, rail lines, or other rights-of-way). Historic and archaeological resource impacts can generally be effectively managed and as such are considered SMALL.

- **Environmental Justice**

  No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement coal-fired plant were built at the North Anna. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect the minority and low-income populations to the extent housing frequented by these populations could come into increased demand. Closure of North Anna, Units 1 and 2, would result in a decrease in employment of approximately 721 to 761 permanent and contract employees at the site. Resulting economic conditions could reduce employment prospects for minority or low-income populations. Overall, impacts are expected to be SMALL to MODERATE and may be mitigated by the economic vitality/expansion of the Richmond metropolitan and surrounding area.

  Impacts at other sites would depend on the site chosen and the nearby population distribution. If a replacement coal-fired plant were constructed at an alternate site, Louisa County would experience a significant loss of property tax revenue that would affect the County's ability (at least in the short- to mid-term following plant closure) to provide services and programs. Impacts to minority and low-income populations in Louisa County could be SMALL to LARGE. Impacts at the alternate site would vary between MODERATE to LARGE, depending on the population makeup and distribution and the economy.

8.2.1.2 Closed-Cycle Cooling System

This section discusses the environmental impacts of constructing a coal-fired generation system at an alternate site using closed-cycle cooling with cooling towers. The impacts (SMALL, MODERATE, or LARGE) of this option are essentially the same as the impacts for a coal-fired plant using the once-through system. However, there are some environmental impact differences between the closed-cycle and once-through cooling systems. Table 8-3 summarizes the incremental differences.

Table 8-3. Summary of Environmental Impacts of Coal-Fired Generation at an Alternate Greenfield Site with Closed-Cycle Cooling System Utilizing Cooling Towers

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 - 12 additional ha (25 - 30 ac) required for cooling towers and associated infrastructure.
Ecology	Impact would depend on ecology at the site. Additional impact to terrestrial ecology from cooling tower drift. Reduced impact to aquatic ecology.
Surface Water Use and Quality	Discharge of cooling tower blowdown containing dissolved solids. Discharge would be regulated. Decreased water withdrawal and less thermal load on receiving body of water. Consumptive use of water due to evaporation.
Groundwater Use and Quality	No change
Air Quality	No change
Waste	No change
Human Health	No change
Socioeconomics	No change
Aesthetics	Introduction of cooling towers and associated plume. Natural draft towers could be up to 158 m (520 ft) high. Mechanical draft towers could be up to 30 m (100 ft) high and also have an associated noise impact.
Historic and Archaeological Resources	No change.
Environmental Justice	No change

8.2.2 Natural Gas-Fired Generation

The environmental impacts of the natural gas-fired alternative are examined in this section for both the North Anna site and an alternate site. For the North Anna site, the staff assumed that the plant would use the existing once-through cooling system.

North Anna is not served by natural gas pipelines. A dedicated, high-pressure 6-m (2-ft) pipeline would have to be constructed to North Anna from Gordonsville, Virginia, a distance of approximately 65 km (40 mi). The pipeline right-of-way would require 295 ha (729 ac).[(a)] VEPCo also notes in its ER that in the winter, when demand for natural gas is high, it may become necessary for a replacement natural gas-fired plant to operate on fuel oil due to lack of gas supply. Operation with oil would result in more stack emissions (VEPCo 2001).

If a new natural gas-fired plant were built elsewhere to replace North Anna Power Station, Units 1 and 2, a new transmission line would need to be constructed to connect to existing lines. In addition, construction or upgrade of a natural gas pipeline from the plant to a supply point where a firm supply of gas would be available could be needed. One potential source of natural gas is liquefied natural gas (LNG) imported to either the Cove Point facility in Maryland or the Elba Island facility in Georgia. Both facilities are expected to be reactivated in 2002 (DOE/EIA 2001a). LNG imported to either facility would need to be vaporized and transported to the plant via pipeline.

The staff assumed that a replacement natural gas-fired plant would use combined-cycle combustion turbines (VEPCo 2001). In a combined-cycle unit, hot combustion gases in a combustion turbine rotate the turbine to generate electricity. Waste combustion heat from the combustion turbine is routed through a heat-recovery boiler to make steam to generate additional electricity.

The following additional assumptions are made for the natural gas-fired plants (VEPCo 2001):

- three 508-MW(e) units will be needed, each consisting of two 168-MW combustion turbines and a 172-MW heat recovery boiler
- natural gas with an average heating value of 39 MJ/m^3 (1059 Btu/ft^3) will be the primary fuel
- low-sulfur number 2 fuel oil will be used as backup fuel
- heat rate will be 2 J fuel/J electricity (6,700 Btu/kWh)
- capacity factor will be 0.85
- gas consumption will be 2.11 billion m^3/yr (74.7 billion ft^3/yr).

Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.2 are from the VEPCo ER. The staff reviewed this information and compared it to environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the natural gas-fired alternative for 40 years is considered because this is a reasonable projection of the operating life of the plant.

(a) Calculated as follows: 40 mi X 150 ft easement = 295 ha or 727 ac.

8.2.2.1 Once-Through Cooling System

The overall impacts of the natural gas-generating system are discussed in the following sections and summarized in Table 8-4. The extent of impacts at an alternate site will depend on the location of the particular site selected.

- **Land Use**

  For siting at North Anna, existing facilities and infrastructure would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that the natural gas-fired replacement plant alternative would use the existing once-through cooling system, switchyard, offices, and transmission line rights-of-way. In the GEIS staff estimated that 45 ha (110 ac) are needed for a plant site (NRC 1996). At North Anna, this much previously disturbed land is available within the boundaries of the plant site (VEPCo 2001). Additional land for backup oil storage facilities is required. There would be an additional impact of up to approximately 295 ha (729 ac) for construction of a natural gas pipeline to the North Anna site (VEPCo 2001). VEPCo states it would apply best management practices during construction of the pipeline such as minimizing soil loss, restoring vegetation immediately after the excavation is backfilled, and constructing the pipeline adjacent to existing, previously disturbed easements, if possible (VEPCo 2001). Land-use impacts of siting at North Anna would be SMALL to MODERATE and depend on the extent to which ecological damage could be minimized in the construction of the natural gas pipeline.

  For construction at an alternate site, the staff assumed that 45 ha (110 ac) would be needed for the plant and associated infrastructure (NRC 1996). A previously developed site with substantial infrastructure in place (e.g., gas line and transmission line), would be characterized as having SMALL impacts. For any new natural gas plant, additional land could be impacted for construction of a transmission line and/or natural gas pipeline to serve the plant and for backup oil facilities, in which case the impacts could be MODERATE. Land-use impacts at a greenfield site could be considered LARGE.

  Offsite of the North Anna or alternate site, additional land would be required for natural gas wells and collection stations. NRC staff estimated in the GEIS that approximately 1500 ha (3600 ac) would be needed for a 1000 MW(e) plant. A replacement gas-fired plant for North Anna Power Station, Units 1 and 2, would be 1524 MW(e) and would affect proportionately more land. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Units 1 and 2. The staff estimated in the GEIS (NRC 1996) that approximately 400 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000 MW(e) nuclear power plant. Because the assumed replacement units for North Anna would generate

Table 8-4. Summary of Environmental Impacts of Natural Gas-Fired Generation at North Anna Power Station and an Alternate Greenfield Site Using Once-Through Cooling

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	45 ha (110 ac) of previously disturbed land needed for plant site. Additional impact of up to approximately 295 ha (729 ac) for construction of an underground gas pipeline. Maximum use of existing infrastructure at the site.	SMALL to LARGE	SMALL if infrastructure in place, 45 ha (110 ac) for power- block, offices, roads, and parking areas. MODERATE if additional land needed for transmission line and/or natural gas pipeline. LARGE if greenfield site and transmission lines required.
Ecology	SMALL to MODERATE	Uses undeveloped areas at North Anna plus land for a new gas pipeline.	SMALL to LARGE	Impact depends on whether a greenfield or previously developed site. Also, impacts depend on ecology of the site, surface water body used for intake and discharge, possible transmission and pipeline routes, potential habitat loss and frag-mentation, reduced productivity, and biological diversity.
Water Use and Quality				
Surface Water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact depends on volume of water withdrawal and discharge and characteristics of surface water body.
Groundwater	SMALL	Reduced groundwater withdrawals due to reduced work force.	SMALL	Groundwater impacts would depend on use and availability.
Air Quality	SMALL to MODERATE	Sulfur oxides • 122 MT/yr (134 tons/yr) Nitrogen oxides • 459 MT/yr (506 tons/yr) Carbon monoxide • 602 MT/yr (664 tons/yr) PM_{10} particulates • 180 MT/yr (198 tons/yr) Some hazardous air pollutants.	SMALL to MODERATE	Same emissions as at North Anna site.
Waste	SMALL	Small amount of ash produced.	SMALL	Small amount of ash produced.
Human Health	SMALL	Impacts considered to be minor.	SMALL	Impacts considered to be minor.

Table 8-4. (contd)

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 1200 additional workers during the peak of the 3-year construction period, followed by reduction from current North Anna, Units 1 and 2 work force from 921 to 961 (permanent and contract) to 150; tax base preserved. Impacts during operation would be SMALL to MODERATE, due to loss of employment in Louisa County which may be offset by proximity to Richmond economy.	SMALL to LARGE	Impacts depend on site characteristics. During construction, impacts would be SMALL to MODERATE. Tax impacts on receiving county could be SMALL to LARGE. Up to 1200 additional workers during the peak of the 3-year construction period. Louisa County would experience loss of North Anna, Units 1 and 2 tax base and employment with potentially MODERATE to LARGE associated impacts.
	SMALL to MODERATE	Transportation impacts associated with construction workers would be SMALL to MODERATE. Transportation impacts during operation would be SMALL due to smaller work force.	SMALL to LARGE	Transportation impacts associated with construction workers would be SMALL to LARGE and would depend on population density and road infrastructure at alternate site. Impacts during operation would be SMALL due to smaller work force.
Aesthetics	SMALL	Some visibility of structures offsite.	SMALL to LARGE	SMALL if previously developed site and site disturbance minimal. SMALL to MODERATE impact from plant and stacks and whether site is previously developed. Impacts increased to strongly MODERATE with construction of a transmission line to previously developed site. LARGE if greenfield site developed.
Historic and Archaeological Resources	SMALL	Any potential impacts likely can be managed effectively.	SMALL	Same as at North Anna Power Station site; any potential impacts likely can be managed effectively.

Table 8-4. (contd)

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of 771 to 811 permanent and contract operating jobs at North Anna could reduce employment prospects for minority and low-income populations. Proximity to Richmond economic area may mitigate impacts.	SMALL to LARGE	Impacts at alternate site vary depending on population distribution and makeup at site could be SMALL to LARGE. Louisa County would lose significant revenue, which could have MODERATE to LARGE impacts on minority and low-income populations. Proximity to Richmond economic area may mitigate Louisa impacts.

1524 MW(e), the land needed for gas wells and collection stations (and the land not needed for nuclear fuel) would be proportionately higher.

- **Ecology**

  At North Anna, there would be ecological land-related impacts for siting of the gas-fired plant. There would also be moderate ecological impacts associated with bringing a new underground gas pipeline to North Anna. There would be losses to less mobile animals such as toads and turtles. Because these animals are fairly common throughout the area, VEPCo expects negligible reduction in their population resulting from construction of the pipeline and does not expect that pipeline construction would create any long-term reduction in the local or regional diversity of plants and animals (VEPCo 2001). Overall, the ecological impacts are considered SMALL to MODERATE.

  Ecological impacts at an alternate site would depend on the nature of the land converted for the plant and the possible need for a new transmission line and/or gas pipeline. At a greenfield site, construction of a transmission line and a gas pipeline to serve the plant could be expected to have ecological impacts. Whether these impacts are temporary or permanent and the extent to which ecological resources are impacted is highly dependent on the location of the alternative site. Ecological impacts resulting from plant siting and utility easements could impact threatened or endangered species. There could be wildlife habitat loss and reduced productivity, habitat fragmentation, and a local reduction in biological diversity. The cooling water intake and discharge could have aquatic resource impacts. Hence, at a greenfield site the ecological impacts are expected to be MODERATE to LARGE. If the alternative site selected already has been developed, then the ecological impacts would be SMALL if the required infrastructure is already in place. Overall, the

ecological impacts at an alternate site are considered SMALL to LARGE, depending on the characteristics of the site selected.

- **Water Use and Quality**

  Surface water. Overall, water-use and quality impacts at the North Anna site are considered SMALL as operation impacts are minimized by use of the existing intake/discharge system. Water-quality impacts from sedimentation during construction of a natural gas-fired plant is characterized by the staff in the GEIS as SMALL (NRC 1996). The staff also note that operational water quality impacts would be similar to, or less than, those from other generating technologies.

  For alternate sites, the impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the Commonwealth of Virginia or another state. Water use and quality impacts at an alternate site are considered SMALL to MODERATE, depending on the characteristics of the alternate site.

  Groundwater. The staff assumed that a natural gas-fired plant located at North Anna would obtain potable, process, and fire-protection water from the series of groundwater wells that currently supply Units 1 and 2 (see Section 2.2.2). Groundwater withdrawals would be less than the no-action and license renewal alternatives because of the reduced work force. Hence, impacts are considered SMALL.

  It is possible that a gas-fired plant sited at an alternate site could use groundwater. Groundwater withdrawal at an alternate site would likely require a permit. For alternate greenfield sites, the impact to groundwater would depend on the site characteristics, including the amount of groundwater available. Overall, the impacts are considered SMALL.

- **Air Quality**

  Natural gas is a relatively clean-burning fuel. The gas-fired alternative would release similar types of emissions but in lesser quantities than the coal-fired alternative. Hence, it would be subject to the same air quality regulations as a coal-fired plant.

VEPCo projects the following emissions for the natural gas-fired alternative (VEPCo 2001):

Sulfur oxides - 122 MT/yr (134 tons/yr)
Nitrogen oxides - 459 MT/yr (506 tons/yr)
Carbon monoxide - 602 MT/yr (664 tons/yr)
PM_{10} particulates - 180MT/yr (198 tons/yr).

A natural gas-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

As previously discussed, in December 2000, EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (EPA 2000b). Natural gas-fired power plants were found by EPA to emit arsenic, formaldehyde, and nickel (EPA 2000b). Unlike coal and oil-fired plants, EPA did not determine that emissions of hazardous air pollutants from natural gas-fired power plants should be regulated under Section 112 of the CAA.

In addition, construction activities would result in temporary fugitive dust. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process. These would be similar to the coal-fired alternative, but smaller due to the smaller construction work force.

Air emissions from the burning of natural gas would likely be the same at North Anna or at an alternate site. Impacts from the emissions would be clearly noticeable, but would not be sufficient to destabilize air resources as a whole. The overall air quality impact for a new natural gas-generating plant sited at North Anna or at an alternate site is considered SMALL to MODERATE, depending on the state of air quality at the alternate, greenfield site and the amount of number 2 fuel oil that may be needed to substitute for natural gas in winter months should a natural gas shortage develop–a situation applicable to both sites.

- **Waste**

There will be small amounts of solid-waste products (i.e., ash) from burning natural gas. In the GEIS the staff concluded that waste generation from gas-fired technology would be minimal (NRC 1996). Gas firing results in very few combustion by-products because of the clean nature of the fuel. Waste generation at a gas-fired plant would be largely limited to typical office wastes. Waste generation impacts would be so minor that they would not noticeably alter any important resource attribute. Construction-related debris would be generated during construction activities. Overall, the waste impacts would be SMALL for a natural gas-fired plant sited at North Anna or at an alternate site.

In the winter, it may become necessary for a replacement baseload natural gas-fired plant to operate on fuel oil due to shortages of natural gas. Oil combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash and scrubber sludge. The amount of ash and sludge generated would depend on the quantity of fuel oil combusted. Overall, the waste impacts associated with fuel oil combustion at a combined cycle plant are expected to be SMALL because the amount of oil combusted is expected to be relatively small. When natural gas is available, fuel oil is generally not price-competitive with gas.

- **Human Health**

  In the GEIS the staff identified cancer and emphysema as potential health risks from gas-fired plants (NRC 1996). The risk may be attributable to NO_x emissions that contribute to ozone formation, which in turn contribute to health risks. NO_x emissions from the plant would be regulated. Human health effects would not be detectable or would be sufficiently minor that they would neither destabilize nor noticeably alter any important attribute of the resource. Overall, the impacts on human health of the natural gas-fired alternative sited at North Anna or at an alternate site are considered SMALL.

- **Socioeconomics**

  Construction and Operation. Construction of a natural gas-fired plant would take approximately 3 years. Peak employment could be up to 1200 workers (NRC 1996). The staff assumed that construction would take place while Units 1 and 2 continue operation and would be completed by the time they permanently cease operations. During construction, the communities surrounding North Anna would experience demands on housing and public services that could have SMALL to MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from cities such as Richmond, Fredericksburg, and Charlottesville, among others. After construction, the communities would be impacted by the loss of jobs. The current North Anna Power Station, Units 1 and 2, work force (approximately 921 to 961 permanent and contract workers) would decline through a decommissioning period to a minimal maintenance size. Approximately 150 workers would be needed to operate the natural gas-fired plant. The new natural gas-fired plant would replace the nuclear tax base in Louisa County. The impacts could be SMALL to MODERATE and may be moderated by Louisa County's proximity to Richmond.

  Siting at an alternate site would result in the loss of the nuclear tax base and associated employment in Louisa County with potentially MODERATE to LARGE socioeconomic impacts. Socioeconomic impacts from locating the facilities at an alternate site would depend on the characteristics of the site. Impacts of construction could range between SMALL to MODERATE. Impacts during plant operation would be SMALL (smaller work

force), and the tax impacts could be SMALL to LARGE, depending on the relative proportion of taxes paid by the plant to total county taxes. In the GEIS (NRC 1996), the staff concluded that socioeconomic impacts from constructing a natural gas-fired plant would not be very noticeable and that the small operational work force would have the lowest socio-economic impacts of any nonrenewable technology. Compared to the coal-fired and nuclear alternatives, socioeconomic impacts would be mitigated by the smaller construction work force and the shorter construction time frame, and the smaller operations work force.

Overall, socioeconomic impacts resulting from construction of a natural gas-fired plant at North Anna would be SMALL to MODERATE and may be offset by the continued growth of the economy in Richmond and the surrounding area. For construction at an alternate site, socioeconomic impacts would be SMALL to LARGE, depending on the site characteristics at the alternate site.

Transportation. Transportation impacts associated with construction and operating personnel commuting to North Anna would be SMALL to MODERATE. The impacts can be classified as SMALL to LARGE for siting at an alternate site and would depend on the characteristics of the alternate site, including transportation infrastructure.

- **Aesthetics**

The turbine buildings and stacks (approximately 60 m [200 ft] high) would be visible during daylight hours from offsite, creating incremental visual impacts to those from existing North Anna facilities. The gas pipeline compressors would also be visible. Noise and light from the plant would be detectable offsite. At North Anna, these impacts would result in a SMALL aesthetic impact.

At an alternate site, the buildings and stacks could be visible offsite. Aesthetic impacts could be mitigated if the plant were located in an industrial area adjacent to other power plants or industrial facilities. Overall, the aesthetic impacts associated with a replacement natural gas-fired plant at an alternate site are categorized as SMALL. The impacts would be greater if a new transmission line is needed and could be considered MODERATE. The impacts could be LARGE if a greenfield site is developed.

- **Historic and Archaeological Resources**

At both North Anna and an alternate site, a cultural resource inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and

possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at North Anna or at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated rights-of-way where new construction would occur (e.g., roads, transmission and pipeline rights-of-way, or other rights-of-way). Hence, impacts to cultural resources can be effectively managed under current laws and regulations and kept SMALL at either the existing North Anna site or at an alternate site.

- **Environmental Justice**

No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement natural gas-fired plant were built at North Anna. Some impacts on housing availability and prices during construction might occur in Louisa County, which could disproportionately affect minority and low-income populations. Closure of North Anna, Units 1 and 2, would result in a decrease in employment of approximately 771 to 811 permanent and contract operating employees. Resulting economic conditions could reduce employment prospects for minority or low-income populations in Louisa County. The impacts could be offset by projected economic growth and the ability of affected workers to commute to other jobs in the County or nearby Richmond. Overall, impacts are expected to be SMALL to MODERATE.

Impacts at an alternate site would depend on the site chosen and the nearby population distribution. Minority and low-income populations at the alternate site could benefit from the plant's relocation through improved job prospects and the increased tax base that could enable more services to be provided. These impacts could be SMALL to LARGE. However, if a replacement natural gas-fired plant were constructed at an alternate site, Louisa County would experience a significant loss of property tax revenue, as well as jobs, which would affect the County's ability to provide services and programs. Impacts to minority and low-income populations in Louisa County could be MODERATE to LARGE, again potentially offset by other economic growth in the area not related to North Anna.

8.2.2.2 Closed-Cycle Cooling System

This section discusses the environmental impacts of constructing a natural gas-fired generation system at an alternate location using a closed-cycle cooling system with cooling towers. The impacts (SMALL, MODERATE, or LARGE) of this option are essentially the same as the

impacts for a natural gas-fired plant using once-through cooling. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-5 summarizes the incremental differences.

Table 8-5. Summary of Environmental Impacts of Natural Gas-Fired Generation at an Alternate Greenfield Site with Closed-Cycle Cooling Utilizing Cooling Towers

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 - 12 additional ha (25 - 30 ac) required for cooling towers and associated infrastructure.
Ecology	Impact would depend on ecology at the site. Additional impact to terrestrial ecology from cooling tower drift. Reduced impact to aquatic ecology.
Surface Water Use and Quality	Discharge of cooling tower blowdown containing dissolved solids. Discharge would be regulated. Decreased water withdrawal and less thermal load on receiving body of water. Consumptive use of water due to evaporation.
Groundwater Use and Quality	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Aesthetics	Introduction of cooling towers and associated plume. Possible noise impact from operation of cooling towers.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

8.2.3 Nuclear Power Generation

Since 1997, the NRC has certified three new standard designs for nuclear power plants under 10 CFR Part 52, Subpart B. These designs are the U.S. Advanced Boiling Water Reactor (10 CFR Part 52, Appendix A), the System 80+ Design (10 CFR Part 52, Appendix B), and the AP600 Design (10 CFR Part 52, Appendix C). All of these plants are light water reactors. Although no applications for a construction permit or a combined license based on these certified designs have been submitted to NRC, the submission of the design certification applications indicates continuing interest in the possibility of licensing new nuclear power plants.

In addition, recent escalation in prices of natural gas and electricity have made new nuclear power plant construction potentially more attractive from a cost standpoint. Consequently, construction of a new nuclear power plant at North Anna using the existing once-through cooling system and at an alternate site using both closed- and open-cycle cooling are considered in this section. The staff assumed that the new nuclear plant would have a 40-year lifetime.

The NRC has summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10 CFR 51.51. The impacts shown in Table S-3 are representative of the impacts that would be associated with a replacement nuclear power plant built to one of the certified designs sited at North Anna or an alternate site. The impacts shown in Table S-3 are for a 1000-MW(e) reactor and would need to be adjusted to reflect replacement of Units 1 and 2, which have a net total capacity of 1790 MW(e) (VEPCo 2001). The environmental impacts associated with transporting fuel and waste to and from a light water cooled nuclear power reactor are summarized in Table S-4 of 10 CFR 51.52. The summary of NRC's findings on NEPA issues for license renewal of nuclear power plants in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B is also relevant, although not directly applicable, for consideration of environmental impacts associated with the operation of a replacement nuclear power plant. Additional environmental impact information for a replacement nuclear power plant using once-through cooling is presented in Section 8.2.3.1, and environmental impact information for using closed-cycle cooling is presented in Section 8.2.3.2.

8.2.3.1 Once-Through Cooling System

The overall impacts of the nuclear generating system are discussed in the following sections. The impacts are summarized in Table 8-6. The extent of impacts at an alternate site will depend on the location of the particular site selected.

- **Land Use**

  The existing facilities and infrastructure at North Anna would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that a replacement nuclear power plant would use the existing cooling system, switchyard, offices, and transmission line rights-of-way. Approximately 200 ha (500 ac) would be needed for the construction of the new plant, which might be accommodated within the existing North Anna plant site. Undisturbed industrial land on the site is in second-growth mixed pine hardwoods (VEPCo 2001), which may need to be disturbed to accommodate two new nuclear units. North Anna Power Station, Units 1 and 2, would continue to operate as the new nuclear power facilities are being constructed.

Table 8-6. Summary of Environmental Impacts of New Nuclear Power Generation at North Anna Power Station and an Alternate Greenfield Site Using Once-Through Cooling

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	MODERATE	Requires approximately 200 ha (500 ac) for the plant.	MODERATE to LARGE	Requires approximately 200 to 400 ha (500 to 1000 ac) for the plant. Possible additional land if a new transmission line is needed.
Ecology	MODERATE	Uses undeveloped areas at current North Anna site plus additional offsite land. Potential habitat loss and fragmentation, and reduced productivity and biological diversity on offsite land.	MODERATE to LARGE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and transmission line route; potential habitat loss and fragmentation, reduced productivity, and biological diversity.
Water Use and Quality				
Surface water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Groundwater	SMALL		SMALL	Impacts will depend on site characteristics and availability of groundwater.
Air Quality	SMALL	Fugitive emissions and emissions from vehicles and equipment during construction. Small amount of emissions from diesel generators and possibly other sources during operation.	SMALL	Same impacts as at North Anna site.
Waste	SMALL	Waste impacts for an operating nuclear power plant are set out in 10 CFR 51, Appendix B, Table B-1. Debris would be generated and removed during construction.	SMALL	Same impacts as at North Anna site.
Human Health	SMALL	Human health impacts for an operating nuclear power plant are set out in 10 CFR 51, Appendix B, Table B-1.	SMALL	Same impacts as at North Anna site.

Table 8-6. (contd)

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 2500 workers during peak period of the 6-year construction period. Operating work force assumed to be similar to Units 1 and 2. Louisa County tax base preserved. Impacts during operation would be SMALL.	SMALL to LARGE	Construction impacts depend on location. Impacts at a rural location could be LARGE. Louisa County would experience loss of tax base and employment, potentially offset by projected economic growth of Richmond metropolitan area. Operation impacts at an alternate site would SMALL to MODERATE.
	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Operation impacts would be SMALL.	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Transportation impacts of operating the plant would be SMALL to MODERATE.
Aesthetics	SMALL	No exhaust stacks or cooling towers would be needed. Daytime visual impact could be mitigated by landscaping and appropriate color selection for buildings. Visual impact at night could be mitigated by reduced use of lighting and appropriate shielding. Noise impacts would be relatively SMALL and could be mitigated.	SMALL to LARGE	Impacts would depend on the characteristics of the alternate site. Impacts would be SMALL if the plant were located adjacent to an industrial area. New transmission lines would add to the impact and would be SMALL to MODERATE depending on the alternate site's characteristics. If a greenfield site is selected, then the impacts could be LARGE.
Historic and Archaeological Resources	SMALL	Any potential impacts likely can be managed effectively.	SMALL	Any potential impacts likely can be managed effectively .
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction.	SMALL to LARGE	Impacts will vary depending on population distribution and makeup at the site. Impacts to minority and low-income residents of Louisa County associated with closure of North Anna, Units 1 and 2 could be significant – MODERATE to LARGE. Impacts to receiving County is site-specific and could range from SMALL to LARGE.

The impact of a replacement nuclear generating plant on land use at the North Anna site is best characterized as MODERATE. The impact would be greater than the OL renewal alternative.

Land-use impacts at an alternate site would be greater than at North Anna, including the possible need for a new transmission line. In addition, it may be necessary to construct a rail spur to an alternate site to bring in equipment during construction. Depending particularly on transmission line routing and whether an existing industrial site is used as the alternate site, siting a new nuclear plant at an alternate site could result in MODERATE to LARGE land-use impacts.

- **Ecology**

Locating a replacement nuclear power plant at the North Anna site would alter ecological resources because of the need to convert land to an industrial use. Some of this land, however, would have been previously disturbed. Potential habitat loss and fragmentation and reduced productivity and biological diversity could result. Siting at North Anna would have a MODERATE ecological impact that would be greater than renewal of Units 1 and 2 OLs.

At an alternate site, there would be construction impacts and new incremental operational impacts. The impacts would be the greatest at an alternate greenfield site. Even assuming siting at a previously disturbed area, the impacts would alter the ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling water from a nearby surface water body could have adverse aquatic resource impacts. If needed, construction and maintenance of the transmission line would have ecological impacts. Overall, the ecological impacts at an alternate site could be MODERATE to LARGE.

- **Water Use and Quality**

Surface water. The staff assumed that a replacement nuclear power plant at North Anna would use the existing cooling system, which would minimize incremental water-use and quality impacts. Surface-water impacts are expected to remain SMALL; the impacts would be sufficiently minor that they would not noticeably alter any important attribute of the resource.

For alternate sites, the impact on the surface water would depend on the volume of water needed for makeup, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the Commonwealth of Virginia or another state. The impacts would be SMALL to MODERATE.

Groundwater. The staff assumed that a new nuclear power plant located at North Anna would obtain potable, process, and fire-protection water from onsite groundwater wells similarly to the current practice for Units 1 and 2 (see Section 2.2.2). The impacts are considered SMALL.

A nuclear power plant sited at an alternate site may use groundwater. Groundwater withdrawal at an alternate site would likely require a permit. The impacts would depend on availability and how water is withdrawn, but overall are considered SMALL.

- **Air Quality**

  Construction of a new nuclear power plant sited at the North Anna site or an alternate site would result in fugitive emissions during construction. Exhaust emissions would also emanate from vehicles and motorized equipment used during construction. An operating nuclear power plant would have minor air emissions associated with diesel generators. These emissions would be regulated by VDEQ or another state. Overall, emissions and associated impacts are considered SMALL.

- **Waste**

  The waste impacts associated with operation of a nuclear power plant are set out in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, Table B-1. In addition to the impacts shown in Table B-1, construction-related debris would be generated during construction activities and removed to an appropriate disposal site. Overall, waste impacts are considered SMALL.

  Siting the replacement nuclear power plant at a site other than North Anna would not alter waste generation. Therefore, the impacts would be SMALL.

- **Human Health**

  Human health impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Overall, human health impacts are considered SMALL.

  Siting the replacement nuclear power plant at a site other than North Anna would not alter human health impacts. Therefore, the impacts would be SMALL.

- **Socioeconomics**

  Construction and Operation. The construction period and the peak work force associated with construction of a new nuclear power plant are currently unquantified (NRC 1996). In

the absence of quantified data, the staff assumed a construction period of 5 years and a peak construction work force of 2500. The staff assumed that construction would take place while the existing North Anna Power Station, Units 1 and 2 continue operation and would be completed by the time Units 1 and 2 permanently cease operations. During construction, the communities surrounding North Anna would experience demands on housing and public services that could have SMALL to MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from more distant communities outside of Louisa County. After construction, the communities would be impacted by the loss of the construction jobs.

The replacement nuclear units are assumed to have an operating work force comparable to the 921 to 961 permanent and contract workers currently working at North Anna Power Station, Units 1 and 2. The replacement nuclear units would provide a new tax base to offset the loss of tax base associated with decommissioning of North Anna Power Station, Units 1 and 2. For all of these reasons, the appropriate characterization of non-transportation socioeconomic impacts for replacement nuclear units constructed at North Anna would be SMALL to MODERATE; the socioeconomic impacts would be noticeable, but would be unlikely to destabilize the area.

Socioeconomic impacts at alternate sites would need to be analyzed on a case-by-case basis. In the GEIS (NRC 1996), the staff noted that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction work force would need to move to the area to work. Construction of a replacement nuclear power plant at an alternate site would relocate some socioeconomic impacts, but would not eliminate them. Louisa County would experience the impact of North Anna Power Station, Units 1 and 2, operational job loss and loss of tax base, and the communities around the new site would have to absorb the impacts of a large, temporary work force (up to 2500 workers at the peak of construction) and a permanent work force of up to 961 workers. For Louisa County, the socioeconomic impacts could be LARGE. The socioeconomic impacts to the county at the alternate location could be SMALL to LARGE depending on the degree of economic development, the proportion of the county's property tax base represented by the new plant, etc.

Transportation. The addition of up to 2500 construction workers to the 921 to 961 permanent and contract workers at Units 1 and 2 could place significant traffic loads on existing highways, particularly those leading to North Anna. Such impacts would be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would be similar to current impacts associated with operation of Units 1 and 2 and are considered SMALL.

Transportation impacts associated with commuting workers at an alternate site are site-dependent but could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site-dependent but can be characterized as SMALL to MODERATE.

- **Aesthetics**

The containment buildings for a replacement nuclear power plant sited at North Anna and other associated buildings would likely be visible in daylight hours from offsite. Visual impacts could be mitigated by landscaping and selecting a color for buildings that is consistent with the environment. The visual impact could also be mitigated by below-grade construction. Visual impact at night could be mitigated by reducing lighting and using shielding appropriately. No exhaust stacks would be needed. No cooling towers would be needed, assuming use of the existing once-through cooling system.

Noise from operation of a replacement nuclear power plant would potentially be audible offsite in calm wind conditions or when the wind is blowing from the direction of the plant. Mitigation measures such as reducing or eliminating use of outside loudspeakers could reduce the noise level and keep the impact SMALL.

At an alternate site, there would be an aesthetic impact from the buildings. There would also be a significant aesthetic impact if a new transmission line were needed. Noise and light from the plant would be detectable offsite. The impact of noise and light could be mitigated if the plant is located in an industrial area adjacent to other power plants, in which case the impacts could be SMALL. The impact could be MODERATE if a new transmission line is needed to connect the plant to the power grid, or LARGE if a greenfield site is selected. Overall, the aesthetic impacts associated with locating at an alternate site can be categorized as SMALL to LARGE, depending on the characteristics of the alternate site.

- **Historic and Archaeological Resources**

At both the North Anna site and an alternate site, a cultural resource inventory likely would be needed for any onsite property not previously surveyed. Other lands, if any, that are acquired to support the plant likely would also need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at North Anna or another site, studies likely would be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies likely would be needed for all areas of potential disturbance

at the proposed plant site and along associated rights-of-way where new construction would occur (e.g., roads, transmission line rights-of-way, rail lines, or other rights-of-way). Historic and archaeological resource impacts generally can be managed effectively and as such are considered SMALL.

- **Environmental Justice**

  No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement nuclear power plant were built at North Anna. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect minority and low-income populations. However, this is expected to be mitigated by North Anna's proximity to Richmond. After completion of construction, it is possible that the local government's ability to maintain social services could be reduced at the same time that diminished economic conditions reduce employment prospects for minority and low-income populations. However, Louisa County's economic health should improve as the tax base of the older nuclear units are replaced by the new, higher-valued (i.e., less-depreciated) plant. Hence, the ability of the County to provide social services should improve because of the higher tax base, assuming assessment rates remain stable. Overall, socioeconomic impacts are expected to be SMALL.

  Impacts at an alternate site would depend on the site chosen and the nearby population distribution. If a replacement nuclear power plant were constructed at an alternate site, Louisa County would experience a significant loss of property tax revenue which could affect the county's ability to provide services and programs. Impacts to minority and low-income populations in Louisa County could be MODERATE to LARGE but potentially offset by other related economic growth in the area. Impacts to the receiving county could be SMALL to LARGE and depend on the relative increase to the tax base resulting from the new plant's construction.

8.2.3.2 Closed-Cycle Cooling System

This section discusses the environmental impacts of constructing a nuclear power plant at an alternate site using closed-cycle cooling with cooling towers. The impacts (SMALL, MODERATE, or LARGE) of this option are essentially the same as the impacts for a nuclear power plant using the once-through cooling system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-7 summarizes the incremental differences.

Table 8-7. Summary of Environmental Impacts of a New Nuclear Power Plant Sited at an Alternate Greenfield Site with Closed-Cycle Cooling

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 - 12 additional ha (25 - 30 ac) required for cooling towers and associated infrastructure.
Ecology	Impact would depend on ecology at the site. Additional impact to terrestrial ecology from cooling tower drift. Reduced impact to aquatic ecology.
Surface Water Use and Quality	Discharge of cooling tower blowdown containing dissolved solids. Discharge would be regulated. Decreased water withdrawal and less thermal load on receiving body of water. Consumptive use of water due to evaporation.
Groundwater Use and Quality	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Aesthetics	Introduction of cooling towers and associated plume. Natural draft towers could be up to 158 m (520 ft). Mechanical draft towers could be up to 30 m (100 ft) high and also could have an associated noise impact.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

8.2.4 Purchased Electrical Power

If available, purchased power from other sources could potentially obviate the need to renew the North Anna Power Station, Units 1 and 2, OLs. VEPCo currently has purchase agreements for 145 MW from the Southeastern Power Administration and approximately 3500 MW of non-utility generation (VEPCo 2001). Overall, Virginia is a net importer of electricity.

To replace North Anna Power Station, Units 1 and 2, capacity with imported power, VEPCo would need to construct a new 500-kV transmission line that VEPCo estimates would be approximately 160 km (100 mi) long (VEPCo 2001). Assuming a 0.09-km (300-ft) easement width, the transmission line would impact approximately 15 km^2 (6 mi^2).

Imported power from Canada or Mexico is unlikely to be available for replacement of North Anna Power Station, Units 1 and 2, capacity. In Canada, 62 percent of the country's electricity capacity is derived from renewable energy sources, principally hydropower (DOE/EIA 2001b). Canada has plans to continue developing hydroelectric power, but the plans generally do not

include large-scale projects (DOE/EIA 2001b). Canada's nuclear generation is projected to increase by 1.7 percent by 2020, but its share of power generation is projected to decrease from 14 percent currently to 13 percent by 2020 (DOE/EIA 2001b). EIA projects that total gross U.S. imports of electricity from Canada and Mexico will gradually increase from 47.9 billion kWh in 2000 to 66.1 billion kWh in 2005 and then gradually decrease to 47.4 billion kWh in 2020 (DOE/EIA 2001a). On balance, it is unlikely that electricity imported from Canada or Mexico would be able to replace the North Anna Power Station, Units 1 and 2, capacity.

If power to replace North Anna Power Station, Units 1 and 2, capacity were to be purchased from sources within the United States or a foreign country, the generating technology would likely be one of those described in this SEIS and in the GEIS (probably coal, natural gas, or nuclear). The description of the environmental impacts of other technologies in Chapter 8 of the GEIS is representative of the purchased electrical power alternative to renewal of North Anna Power Station, Units 1 and 2, OLs. Thus, the environmental impacts of imported power would still occur, but would be located elsewhere within the region, nation, or another country.

8.2.5 Other Alternatives

Other generation technologies are discussed in the following sections.

8.2.5.1 Oil-Fired Generation

EIA projects that oil-fired plants will account for very little of the new generation capacity in the United States from 2000 to 2020 because of higher fuel costs and lower efficiencies (DOE/EIA 2001a). Oil-fired operation is more expensive than nuclear or coal-fired operation. Future increases in oil prices are expected to make oil-fired generation increasingly more expensive than coal-fired generation. The high cost of oil has prompted a steady decline in its use for electricity generation. Construction and operation of an oil-fired plant would also have environmental impacts. For example, in Section 8.3.11 of the GEIS, the staff estimated that construction of a 1,000-MW(e) oil-fired plant would require about 50 ha (120 ac). Additionally, operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant.

8.2.5.2 Wind Power

The Commonwealth of Virginia is in a wind power Class 1 region (average wind speeds at 10-m [30-ft] elevation of 0 to 4.4 m/s [9.8 mph]). Class 1 has the lowest potential for wind energy generation (DOE 2001a). 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 2001a]). Consequently, the staff concludes that locating a wind-energy facility on or near the North Anna site would not be economically feasible given the current state of wind energy generation technology.

8.2.5.3 Solar Power

Solar power technologies, photovoltaic and thermal, cannot currently compete with conventional fossil-fueled technologies in grid-connected applications due to the higher capital costs per kilowatt of capacity. The average capacity factor of photovoltaic cells is about 25 percent, and the capacity factor for solar thermal systems is about 25 to 40 percent (NRC 1996). Energy storage requirements limit the use of solar-energy systems as a baseload electricity supply.

There are substantial impacts to natural resources (wildlife habitat, land-use, and aesthetic impacts) from construction of solar-generating facilities. As stated in the GEIS, land requirements are high—14,000 ha (35,000 ac) per 1000 MW(e) for photovoltaic and approximately 6000 ha (14,000 ac) per 1000 MW(e) for solar thermal systems. Neither type of solar electric system would fit at the North Anna site, and both would have large environmental impacts at a greenfield site.

The North Anna site receives approximately 4 kWh of solar radiation per m^2 per day, compared to 7 to 8 kWh of solar radiation per m^2 per day in areas of the western United States, such as California, which are the most promising for solar technologies (DOE/EIA 2000a). Because of the natural resource impacts (land and ecological), the area's relatively low rate of solar radiation, and high cost, solar power is not deemed a feasible baseload alternative to renewal of the North Anna Power Station, Units 1 and 2 OLs. Some solar power may substitute for electric power in rooftop and building applications. Implementation of nonrooftop solar generation on a scale large enough to replace North Anna Power Station, Units 1 and 2, would likely result in LARGE environmental impacts.

8.2.5.4 Hydropower

Virginia has an estimated 617 MW of undeveloped hydroelectric resource (INEEL 1997). This amount is less than needed to replace the 1790 MW(e) capacity of North Anna Power Station, Units 1 and 2. As stated in Section 8.3.4 of the GEIS, hydropower's percentage of U.S. generating capacity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern about flooding, destruction of natural habitat, and alteration of natural river courses. In the GEIS, estimated land requirements for hydroelectric power are approximately 400,000 ha (1 million ac) per 1000 MW(e) (NRC 1996). Replacement of North Anna Power Station, Units 1 and 2, generating capacity would require flooding more than this amount of land. Due to the relatively low amount of undeveloped hydropower resource in Virginia and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to replace North Anna Power Station, Units 1 and 2, the staff concludes that local hydropower is not a feasible alternative to renewal of the North Anna Power Station, Units 1 and 2, OLs. Any attempts to site hydroelectric

facilities large enough to replace North Anna Power Station, Units 1 and 2, would result in LARGE environmental impacts.

8.2.5.5 Geothermal Energy

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal technology is not widely used as baseload generation due to the limited geographical availability of the resource and immature status of the technology (NRC 1996). As illustrated by Figure 8.4 in the GEIS, geothermal plants are most likely to be sited in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent. There is no feasible eastern location for geothermal capacity to serve as an alternative to North Anna Power Station, Units 1 and 2. The staff concludes that geothermal energy is not a feasible alternative to renewal of the North Anna Power Station, Units 1 and 2, OLs.

8.2.5.6 Wood Waste

A wood-burning facility can provide baseload power and operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency (NRC 1996). The fuels required are variable and site-specific. A significant barrier to the use of wood waste to generate electricity is the high delivered fuel cost and high construction cost per MW of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in the GEIS suggest that the overall level of construction impact per MW of installed capacity should be approximately the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996). Like coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

Due to uncertainties associated with obtaining sufficient wood and wood waste to fuel a base-load generating facility, ecological impacts of large-scale timber cutting (e.g., soil erosion and loss of wildlife habitat), and high inefficiency, the staff has determined that wood waste is not a feasible alternative to renewing the North Anna Power Station, Units 1 and 2, OLs.

8.2.5.7 Municipal Solid Waste

Municipal waste combustors incinerate the waste and use the resultant heat to generate steam, hot water, or electricity. The combustion process can reduce the volume of waste by up to 90 percent and the weight of the waste by up to 75 percent (EPA 2001). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (DOE/EIA 2001c). Mass burning technologies are most commonly used in the United States. This group of technologies process raw municipal solid waste “as is,” with little or no sizing,

shredding, or separation before combustion. The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at wood-waste facilities. This is due to the need for specialized waste-separation and waste-handling equipment for municipal solid waste (NRC 1996).

Growth in the municipal waste combustion industry slowed dramatically during the 1990s after rapid growth during the 1980s. The slower growth was due to three primary factors: (1) the Tax Reform Act of 1986, which made capital-intensive projects such as municipal waste combustion facilities more expensive relative to less capital-intensive waste disposal alternatives such as landfills; (2) the 1994 Supreme Court decision (*C&A Carbone, Inc. v. Town of Clarkstown*), which struck down local flow-control ordinances that required waste to be delivered to specific municipal waste combustion facilities rather than at landfills that may have had lower fees; and (3) increasingly stringent environmental regulations that increased the capital cost necessary to construct and maintain municipal waste combustion facilities (DOE/EIA 2001c).

Municipal solid waste combustors generate an ash residue that is buried in landfills. The ash residue is composed of bottom ash and fly ash. Bottom ash refers to that portion of the unburned waste that falls to the bottom of the grate or furnace. Fly ash represents the small particles that rise from the furnace during the combustion process. Fly ash is generally removed from flue gases using fabric filters and/or scrubbers (DOE/EIA 2001c).

Currently, there are approximately 102 waste-to-energy plants operating in the United States. These plants generate approximately 2800 MW(e), or an average of approximately 28 MW(e) per plant (Integrated Waste Services Association 2001). The staff concludes that generating electricity from municipal solid waste would not be a feasible alternative to replace the 1790 MW(e) baseload capacity of North Anna Power Station, Units 1 and 2, and, consequently, would not be a feasible alternative to renewal of the North Anna Power Station, Units 1 and 2, OLs.

8.2.5.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid waste fuels, there are several other concepts for fueling electric generators including burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). In the GEIS, the staff stated that none of these technologies has progressed to the point of being competitive on a large scale or being reliable enough to replace a baseload plant such as North Anna Power Station, Units 1 and 2 (NRC 1996). For these reasons, such fuels do not offer a feasible alternative to renewal of the North Anna Power Station, Units 1 and 2, OLs.

8.2.5.9 Fuel Cells

Fuel cells work without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air over a cathode and separating the two by an electrolyte. The only by-products are heat, water, and carbon dioxide. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Phosphoric acid fuel cells are generally considered first-generation technology. Higher-temperature, second-generation fuel cells achieve higher fuel-to-electricity and thermal efficiencies. The higher temperatures contribute to improved efficiencies and give the second-generation fuel cells the capability to generate steam for cogeneration and combined-cycle operations. DOE projects that by 2003, two second-generation fuel cell technologies using molten carbonate and solid oxide technology, respectively, will be commercially available in sizes up to 2 MW at a cost of $1000 to $1500 per kW of installed capacity (DOE 2001b). For comparison, the installed capacity cost for a natural gas-fired combined-cycle plant is on the order of $500 to $600 per kW (NWPPC 2000). As market acceptance and manufacturing capacity increase, natural gas-fueled fuel cell plants in the 50- to 100-MW range are projected to become available (DOE 2001b). Presently, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Fuels cells are, consequently, not a feasible alternative to renewal of the North Anna Power Station, Units 1 and 2, OLs.

8.2.5.10 Delayed Retirement

The only VEPCo generating plants currently scheduled for retirement are Possum Point, Units 1 and 2, located about 40 km (25 mi) south of Washington, D.C. These oil-fired units each have a nameplate-generating capacity[(a)] of 69 MW (DOE/EIA 2000b). Delayed retirement of Possum Point, Units 1 and 2, would not come close to replacing the 1790 MW(e) capacity of North Anna Power Station, Units 1 and 2. For this reason, delayed retirement of VEPCo generating units would not be a feasible alternative to renewal of the North Anna Power Station, Units 1 and 2, OLs.

8.2.5.11 Utility-Sponsored Conservation

VEPCo has developed residential, commercial, and industrial programs to reduce both peak demands and daily energy consumption. These programs are commonly referred to as demand-side management (DSM). VEPCo currently operates the following DSM programs: Rate Schedule SG (standby generation), Rate Schedule CS (curtailable service), Rider J (interruptible electric water heater service), and the Real Time Pricing Rate. VEPCo projects

(a) The nameplate-generating capacity is the full-load, continuous rating of a generating plant.

that by 2007, its DSM programs will reduce peak power requirements in the summer and winter by 74 and 130 MW, respectively (VEPCo 2001). VEPCo also projects that energy requirements in 2007 will be reduced by 14 gigawatt hours, 99 percent of which would be from load management programs (VEPCo 2001).

Historic and projected reduction in generation needs as a result of DSM programs have been credited in VEPCo's planning to meet projected customer demand. Because these DSM savings are part of the long-range plan for meeting projected demand, they are not available offsets for North Anna Power Station, Units 1 and 2. Therefore, the conservation option is not considered a reasonable replacement for the OL renewal alternative.

8.2.6 Combination of Alternatives

Although individual alternatives to North Anna Power Station, Units 1 and 2, might not be sufficient on their own to replace the capacity of these units due to size or cost, it is conceivable that a combination of alternatives might be cost-effective.

As discussed in Section 8.2, North Anna Power Station, Units 1 and 2, have a combined average net capacity of 1790 MW(e). For the coal and natural gas alternatives, VEPCo assumes in its ER three standard 508-MW(e) units as potential replacements for Units 1 and 2 (VEPCo 2001). This approach is followed in this SEIS, although it results in some environmental impacts that are roughly 17 percent lower than if full replacement capacity were constructed.

There are many possible combinations of alternatives. Table 8-8 summarizes the environmental impacts of an assumed combination of alternatives consisting of 1016 MW(e) of combined-cycle natural gas-fired generation at North Anna using the existing once-through cooling system, and at an alternate location using closed-cycle cooling, with 387 MW(e) purchased from other generators and 387 MW(e) gained from additional DSM measures. The impacts associated with the combined-cycle natural gas-fired units are based on the gas-fired generation impact assumptions discussed in Section 8.2.2, adjusted for the reduced generating capacity. While the DSM measures would have few environmental impacts, operation of the new gas-fired plant would result in increased emissions and environmental impacts. The environmental impacts of imported power would still occur but would be located elsewhere within the region, nation, or another country as discussed in Section 8.2.4. The environmental impacts associated with purchased power are not shown in Table 8-8. The staff concludes that it is very unlikely that the environmental impacts of any reasonable combination of generating and conservation options could be reduced to the level of impacts associated with renewal of the North Anna Power Station, Units 1 and 2, OLs.

Table 8-8. Summary of Environmental Impacts for an Assumed Combination of Generating and Acquisition Alternatives

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	9 ha (23 ac) for powerblock, offices, roads, and parking areas. Additional impact of up to approximately 295 ha (729 ac) for construction of an underground gas pipeline.	SMALL to LARGE	30 ha (74 ac) for powerblock, offices, roads, and parking areas. Additional impact for construction of an underground natural gas pipeline and a transmission line – MODERATE. Greenfield site increases impact to LARGE.
Ecology	SMALL to MODERATE	Uses undeveloped areas at the North Anna site plus land for a new gas pipeline.	SMALL to LARGE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and transmission and pipeline routes; potential habitat loss and fragmentation, reduced productivity, and biological diversity. Greenfield site increases impact.
Water Use and Quality				
Surface water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact depends on volume of water withdrawal and discharge and characteristics of surface water body.
Groundwater	SMALL	Reduced groundwater withdrawals due to reduced work force.	SMALL	Groundwater impacts would depend on use and available supply.
Air Quality	SMALL to MODERATE	Sulfur oxides • 81 MT/yr (89 tons/yr) Nitrogen oxides • 306 MT/yr (337 tons/yr) Carbon monoxide • 402 MT/yr (443 tons/yr) PM_{10} particulates • 120 MT/yr (132 tons/yr) Some hazardous air pollutants.	SMALL to MODERATE	Same as siting at North Anna Power Station.
Waste	SMALL	Small amount of ash produced.	SMALL	Same as siting at North Anna Power Station.
Human Health	SMALL	Impacts considered to be minor.	SMALL	Impacts considered to be minor.

Table 8-8. (contd)

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 1200 additional workers during the peak of the 3-year construction period, followed by reduction from current North Anna Power Station, Units 1 and 2, work force of 921 to 961 (permanent and contract) to approximately 150; tax base preserved. Impacts during operation would be SMALL to MODERATE due to loss of employment to Louisa County.	SMALL to LARGE	Construction impacts depend on location, but could be significant if location is in a rural area. Louisa County would experience loss of tax base and employment with potentially LARGE impacts. Impacts during operation at an alternate site would be SMALL to MODERATE depending on economy at alternate site and relative impact of plant to tax base.
	SMALL to MODERATE	Transportation impacts associated with construction workers would be SMALL to MODERATE. Transportation impacts during operation would be SMALL due to smaller work force.	SMALL to LARGE	Transportation impacts associated with construction workers would be SMALL to LARGE and dependent on population density at alternative site. Impacts during operation would be SMALL due to smaller work force.
Aesthetics	SMALL	Some visibility of structures offsite.	SMALL to LARGE	SMALL if alternate site previously developed. MODERATE impact from plant, stacks, cooling tower plumes, and new transmission lines. LARGE if greenfield site.
Historic and Archaeological Resources	SMALL	Any potential impacts likely can be managed effectively.	SMALL	Any potential impacts likely can be managed effectively.
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of approximately 750 operating jobs at North Anna could reduce employment prospects for minority and low-income populations.	SMALL to LARGE	Impacts at alternate site vary depending on population distribution and makeup at site. Louisa County would lose significant revenue, which could have MODERATE to LARGE impacts to minority and low-income populations. Impacts to receiving County could be SMALL to MODERATE.

8.3 Summary of Alternatives Considered

The environmental impacts of the proposed action, license renewal, are SMALL for all impact categories (except collective offsite radiological impacts from the fuel cycle and from high level waste and spent fuel disposal, for which a single significance level was not assigned). The alternative actions, i.e., no-action alternative (discussed in Section 8.1), new generation alternatives (from coal, natural gas, and nuclear, discussed in Sections 8.2.1 through 8.2.3,

respectively), purchased electrical power (discussed in Section 8.2.4), alternative technologies (discussed in Section 8.2.5), and the combination of alternatives (discussed in Section 8.2.6) were considered.

The no-action alternative would result in decommissioning North Anna Power Station, Units 1 and 2, and would require replacing electrical generating capacity by (1) DSM and energy conservation, (2) power purchased from other electricity providers, (3) generating alternatives other than North Anna Power Station, Units 1 and 2, or (4) some combination of these options. For each of the new generation alternatives (coal, natural gas, and nuclear), the environmental impacts would not be less than the impacts of license renewal. For example, the land-disturbance impacts resulting from construction of any new facility would be greater than the impacts of continued operation of North Anna Power Station, Units 1 and 2. The impacts of purchased electrical power (imported power) would still occur, but would occur elsewhere. Alternative technologies are not considered feasible at this time, and it is very unlikely that the environmental impacts of any reasonable combination of generation and conservation options could be reduced to the level of impacts associated with renewal of the OLs for North Anna Power Station, Units 1 and 2.

The staff concludes that the alternative actions, including the no-action alternative, may have environmental effects in at least some impact categories that reach MODERATE or LARGE significance.

8.4 References

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

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

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

40 CFR Part 50. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 50, “National Primary and Secondary Ambient Air Quality Standards.”

40 CFR Part 51. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 51, “Requirements for Preparation, Adoption, and Submittal of Implementation Plans.”

40 CFR Part 60. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 60, "Standards of Performance for New Stationary Sources."

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

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9.0 Summary and Conclusions

By letter dated May 29, 2001, the Virginia Electric and Power Company (VEPCo) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses (OLs) for North Anna Power Station, Units 1 and 2, for an additional 20-year period (VEPCo 2001). If the OLs are renewed, State regulatory agencies and VEPCo will ultimately decide whether the plants 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, then the plants must be shut down at or before the expiration date of the current OLs, which is April 1, 2018, for Unit 1 and August 21, 2020, for Unit 2.

Section 102 of the National Environmental Policy Act (NEPA) (42 USC 4321), directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. 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 Plant*s (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[(a)]

Upon acceptance of the VEPCo 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 (66 FR 46294 [NRC 2001]) for North Anna on September 4, 2001. The staff visited North Anna in October 2001 and held public scoping meetings on October 18, 2001, in Louisa County, Virginia. The staff reviewed the VEPCo Environmental Report (ER) (VEPCo 2001) and compared it to the GEIS, consulted with other agencies, and 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* (NRC 2000). The staff also considered the public comments received during the scoping process for preparation of this Supplemental Environmental Impact Statement (SEIS) for North Anna Power Station, Units 1 and 2. The public comments received during the scoping process that were considered to be within the scope of the environmental review are provided in Appendix A, Part I, of this SEIS.

On May 17, 2002, the U.S. Environmental Protection Agency (EPA) published the Notice of Availability of the draft SEIS (67 FR 35108 [EPA 2002]). A 75-day comment period began on that date, during which members of the public could comment on the preliminary results of the NRC staff's review.

(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.

The staff held two public meetings near North Anna Power Station on June 25, 2002 to describe the preliminary results of the NRC environmental review and to answer questions and provide members of the public with information to assist them in formulating their comments. At the end of comment period, the staff considered all of the comments received for revision of the SEIS. These comments are addressed in Appendix A, Part II, of the final SEIS.

This SEIS includes the NRC 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 available for reducing or avoiding adverse effects. It also includes the staff's recommendation regarding the proposed action.

The NRC 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, even if an OL is renewed, there are other factors that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OL.

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) and in accordance with § 51.23(b).[(a)]

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. It evaluates 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 a footnote 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 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.

For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS shows the following:

(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 [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.

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

(a) The title of 10 CFR 51.23 is "Temporary storage of spent fuel after cessation of reactor operations-generic determination of no significant environmental impact."

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 also 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 North Anna Power Station, Units 1 and 2) and alternative methods of power generation. These alternatives were evaluated assuming that the replacement power generation plant is located at either the North Anna site or some other unspecified location.

9.1 Environmental Impacts of the Proposed Action—License Renewal

VEPCo and the staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither VEPCo nor the staff has identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither VEPCo nor the staff has identified any new issue applicable to North Anna Power Station that has a significant environmental impact. These determinations include the consideration of public comments. Therefore, the staff relies upon the conclusions of the GEIS for all Category 1 issues that are applicable to North Anna Power Station, Units 1 and 2.

VEPCo's license-renewal application presents an analysis of the Category 2 issues that are applicable to North Anna Power Station, Units 1 and 2. In addition, the staff has evaluated the two uncategorized issues, environmental justice and chronic effects from electromagnetic fields. The staff has reviewed the VEPCo analysis for each issue and has conducted an independent review of each issue. Five Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at North Anna. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. VEPCo (VEPCo 2001) has stated that its evaluation of structures and components, as required by 10 CFR 54.21, did not identify any major plant refurbishment activities or modifications as

necessary to support the continued operation of North Anna Power Station, Units 1 and 2, for the license renewal period. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant component replacement and, therefore, are not expected to affect the environment outside of the bounds of the plant operations evaluated in the *Final Environmental Statement Related to the Continuation of Construction and the Operation of North Anna Units 1 and 2 and the Construction of Units 3 and 4* (AEC 1973), and the two addenda to the final environmental statements related to the operation of North Anna Power Station, Units 1 and 2 (NRC 1976 and NRC 1980).

Twelve Category 2 issues related to operational impacts and postulated accidents during the renewal term, as well as environmental justice and chronic effects of electromagnetic fields, are discussed in detail in this SEIS. Five of the Category 2 issues and environmental justice apply to both refurbishment and to operation during the renewal term and are discussed in this SEIS only in relation to operation during the renewal term. For all 12 Category 2 issues and environmental justice, the staff concludes that the potential environmental effects are of SMALL significance in the context of the standards set forth in the GEIS. In addition, the staff determined that appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for North Anna Power Station, Units 1 and 2, and the plant improvements already made, the staff concludes that none of the candidate SAMAs are cost-beneficial.

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.

The following sections discuss unavoidable adverse impacts, irreversible or irretrievable commitments of resources, and the relationship between local short-term use of the environment and long-term productivity.

9.1.1 Unavoidable Adverse Impacts

An environmental review conducted at the license renewal stage differs from the review conducted in support of a construction permit because the plant is in existence at the license-renewal stage and has operated for a number of years. As a result, adverse impacts associated with the initial construction have been avoided, have been mitigated, or have already occurred. The environmental impacts to be evaluated for license renewal are those associated with refurbishment and continued operation during the renewal term.

The adverse impacts of continued operation identified are considered to be of SMALL significance, and none warrants implementation of additional mitigation measures. The adverse impacts of likely alternatives if North Anna Power Station, Units 1 and 2, cease operation at or before the expiration of the current OLs will not be smaller than those associated with continued operation of these units, and they may be greater for some impact categories in some locations.

9.1.2 Irreversible or Irretrievable Resource Commitments

The commitment of resources related to construction and operation of North Anna Power Station, Units 1 and 2, during its current license period was made when the plant was built. The resource commitments to be considered in this SEIS are associated with continued operation of the plant for an additional 20 years. These resources include materials and equipment required for plant maintenance and operation, the nuclear fuel used by the reactors, and ultimately, permanent offsite storage space for the spent fuel assemblies.

The most significant resource commitments related to operation during the renewal term are the fuel and the permanent offsite storage space. North Anna Power Station, Units 1 and 2, replace approximately one-third of the fuel assemblies in each of the two units during every refueling outage, which occurs on an 18-month cycle.

If North Anna Power Station, Units 1 and 2, cease operation on or before the expiration of the current OLs, the likely power generation alternatives will require a commitment of resources for construction of the replacement plants as well as for fuel to run the plants.

9.1.3 Short-Term Use Versus Long-Term Productivity

An initial balance between short-term use and long-term productivity of the environment at the North Anna Power Station site was set when the plants were approved and construction began. That balance is now well established. Renewal of the OLs for North Anna Power Station, Units 1 and 2, and continued operation of the plants will not alter the existing balance, but may postpone the availability of the site for other uses. Denial of the application to renew the OLs will lead to shutdown of the plants and will alter the balance in a manner that depends on subsequent uses of the site. For example, the environmental consequences of turning the North Anna Power Station site into a park or an industrial facility are quite different.

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives

The proposed action is renewal of the OLs for North Anna Power Station, Units 1 and 2. Chapter 2 describes the site, power plants, and interactions of the plants with the environment. As noted in Chapter 3, no refurbishment and no refurbishment impacts are expected at North Anna Power Station, Units 1 and 2. Chapters 4 through 7 discuss environmental issues associated with renewal of the OLs. Environmental issues associated with the no-action alternative and alternatives involving power generation and use reduction are discussed in Chapter 8.

The significance of the environmental impacts from the proposed action (approval of the application for renewal of the OLs), the no-action alternative (denial of the application), alternatives involving nuclear, coal, or gas generation of power at North Anna Power Station, Units 1 and 2, an unspecified "greenfield site," and a combination of alternatives are compared in Table 9-1.

Table 9-1 shows that the significance of the environmental effects of the proposed action are SMALL for all impact categories (except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, for which a single significance level was not assigned [see Chapter 6]). The alternative actions, including the no-action alternative, may have environmental effects in at least some impact categories that reach MODERATE or LARGE significance.

9.3 Staff Conclusions and Recommendations

Based on (1) the analysis and findings in the GEIS (NRC 1996; 1999), (2) the ER submitted by VEPCo (VEPCo 2001), (3) consultation with Federal, State, and local agencies, (4) the staff's own independent review, and (5) the staff's consideration of public comments, the recommendation of the staff is that the Commission determine that the adverse environmental impacts of license renewal for North Anna Power Station, Units 1 and 2, are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Table 9-1. Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Methods of Generation

	Proposed Action	No-Action Alternative	Coal-Fired Generation		Natural Gas-Fired Generation		New Nuclear Generation		Combination of Alternatives	
Impact Category	**License Renewal**	**Denial of Renewal**	**North Anna Site**	**Alternate Greenfield Site**	**North Anna Site**	**Alternate Greenfield Site**	**North Anna Site**	**Alternate Greenfield Site**	**North Anna Site**	**Alternate Greenfield Site**
Land Use	SMALL	SMALL	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	MODERATE	MODERATE to LARGE	SMALL to MODERATE	SMALL to LARGE
Ecology	SMALL	SMALL	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	MODERATE	MODERATE to LARGE	SMALL to MODERATE	SMALL to LARGE
Water Use and Quality	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE
Air Quality	SMALL	SMALL	MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE
Waste	SMALL	SMALL	MODERATE	MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE
Aesthetics	SMALL	SMALL	SMALL to MODERATE	SMALL to LARGE	SMALL	SMALL to LARGE	SMALL	SMALL to LARGE	SMALL	SMALL to LARGE
Historic and Archaeological Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental Justice	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE

(a) Except for collective offsite radiological impacts from the fuel cycle and from HLW and spent-fuel disposal, for which a significance level was not assigned. See Chapter 6 for details.

9.4 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."

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

U.S. Atomic Energy Commission (AEC). 1973. *Final Environmental Statement Related to the Continuation of Construction and Operation of Units 1 and 2 and the Construction of Units 3 and 4 of the North Anna Power Station.* Docket Nos. 50-338 and 50-339, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 2002. "Notice of Availability of Environmental Impact Statements". Federal Register, Vol. 67, No. 96, p. 35108 (May 17, 2002).

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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). 2001. "Notice of Intent To Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register*. Vol. 66, No. 171, pp. 46294 - 46295 (September 4, 2001).

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