NUREG-1437, Supplement 30
Vol. 1

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 30

Regarding
Vermont Yankee Nuclear Power Station

Final Report – Main Report

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

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Office of Nuclear Reactor Regulation
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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 Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51). In the GEIS (and its Addendum 1), the NRC staff 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 Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy), to renew the OL for Vermont Yankee Nuclear Power Station (VYNPS) for an additional 20 years under 10 CFR Part 54. This SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC staff's recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither Entergy nor the NRC staff has identified information that is both new and significant for any issue that applies to VYNPS. In addition, the NRC staff determined that information provided during the scoping process and the public comments on the draft SEIS did not call into question the conclusions in the GEIS. Therefore, the NRC staff concludes that the impacts of renewing the VYNPS OL would not be greater than the impacts identified for these issues in the GEIS. For each of these issues, the NRC staff's conclusion in the GEIS is that the impact is of SMALL[a] significance (except for collective offsite radiological impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned a single significance level).

Regarding the remaining 23 issues, those that apply to VYNPS are addressed in this SEIS. For each applicable issue, the NRC staff concludes that the significance of the potential environmental impacts of renewal of the OL is SMALL. The NRC staff also concludes that no additional mitigation is warranted. However, under the provisions of the Clean Water Act 316(b) regulations, the Vermont Department of Environmental Conservation may impose further restrictions or require modifications to the cooling system to reduce the impacts on aquatic

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

resources from entrainment and impingement under the National Pollutant Discharge Elimination System permitting process. The NRC staff determined that information provided during the scoping process and the public comments on the draft SEIS 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 VYNPS are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by Entergy; (3) consultation with Federal, State, and local agencies; (4) the NRC staff's own independent review; and (5) the NRC staff's consideration of public comments received during the scoping process and the draft SEIS public comment period.

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Executive Summary

By letter dated January 25, 2006, Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc. (Entergy), submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license (OL) for Vermont Yankee Nuclear Power Station (VYNPS) for an additional 20 years. If the OL is renewed, State regulatory agencies and Entergy will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OL is not renewed, then the plant must be shut down at or before the expiration date of the current OL, which is March 21, 2012. Should the NRC staff's license renewal review not be completed by this date, the plant may continue to operate past that date until the NRC staff has taken final action to either approve or deny the license renewal.

The NRC has implemented Section 102 of the National Environmental Policy Act (NEPA), Title 42, Section 4321, of the *United States Code* (42 USC 4321) in Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51). In 10 CFR 51.20(b)(2), the Commission requires preparation of an Environmental Impact Statement (EIS) or a supplement to an EIS for renewal of a reactor OL. In addition, 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 Entergy 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 on April 21, 2006. The NRC staff visited the VYNPS site in May 2006, conducted an open house on June 6, 2006, at which comments were accepted, and held public scoping meetings on June 7, 2006, in Brattleboro, Vermont. In the preparation of this Supplemental Environmental Impact Statement (SEIS) for VYNPS, the NRC staff reviewed the Entergy Environmental Report (ER) and compared it with the GEIS, consulted with other agencies, conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, *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 1, of this SEIS.

The draft SEIS was published in December 2006. The NRC staff held two public meetings in Brattleboro, Vermont, on January 31, 2007, to describe the preliminary results of the NRC environmental review, to answer questions, and to provide members of the public with

(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.

information to assist them in formulating comments on the draft SEIS. On February 27, 2007, members of the NRC staff met with members of the Vermont State Legislature in Montpelier, Vermont, to present the findings of the draft SEIS. No formal comments were received from the legislators at this meeting based on their oral statements because no transcript was recorded. The NRC staff did, however, receive written comments for formal consideration from some of the legislators and members of the public who observed the meeting.

When the comment period ended on March 7, 2007, the NRC staff considered and addressed all of the comments received. These comments are addressed in Appendix A, Part 2, of this SEIS.

This SEIS includes the NRC staff's analysis that 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 NRC 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 evaluation criterion for the NRC staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

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

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current 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 footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the 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 reached 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 NRC 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 NRC staff's consideration of all 92 environmental issues identified in the GEIS. The NRC 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 OL for VYNPS) and alternative methods of power generation. Based on projections made by the U.S. Department of Energy's Energy Information Administration, gas- and coal-fired generation appear to be the most likely power-generation alternatives if the power from VYNPS is replaced. These alternatives are evaluated assuming that the replacement power-generation plant is located at either the VYNPS site or at some other unspecified alternate location.

Entergy and the NRC staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither Entergy nor the NRC 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 the scoping process nor the NRC staff has identified any new issue applicable to VYNPS that has a significant environmental impact. Therefore, the NRC staff relies upon the conclusions of the GEIS for all of the Category 1 issues that are applicable to VYNPS.

Entergy's license renewal application presents an analysis of the Category 2 issues. The NRC staff has reviewed the Entergy analysis for each issue and has conducted an independent review of each issue. Three Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at VYNPS. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. Entergy 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 VYNPS for the license renewal period. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant operation and are not expected to affect the environment outside of the bounds of the plant operations evaluated in the U.S. Atomic Energy Commission's 1972 *Final Environmental Statement*

Related to Operation of the Vermont Yankee Nuclear Power Station, Vermont Yankee Nuclear Power Corporation.

Fourteen 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 14 Category 2 issues and environmental justice, the NRC 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 NRC 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 NRC staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for VYNPS and the plant improvements already made, the NRC staff concludes that several candidate SAMAs are potentially cost-beneficial. However, none of these SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54.

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 is warranted. However, under the provisions of the Clean Water Act 316(b) Phase II regulations, the Vermont Department of Environmental Conservation[a] may impose further restrictions or require modifications to the cooling system to reduce the impacts on aquatic resources from entrainment and impingement.

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. For purposes of this analysis, where VYNPS license renewal impacts are deemed to be SMALL, the NRC staff concluded that these impacts would not result in significant cumulative impacts on potentially affected resources.

If the VYNPS OL is not renewed and the plant ceases operation on or before the expiration of its current OL, then the adverse impacts of likely alternatives would not be smaller than those associated with continued operation of VYNPS. The impacts may, in fact, be greater in some areas.

(a) The Vermont Department of Environmental Conservation is part of the Vermont Agency of Natural Resources.

The recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for VYNPS 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 Entergy; (3) consultation with other Federal, State, and local agencies; (4) the NRC staff's own independent review; and (5) the NRC staff's consideration of public comments.

Abbreviations/Acronyms

µg	microgram(s)
µm	micrometer(s)
ac	acre(s)
AC	alternating current
ACC	averted cleanup and decontamination costs
AD	Anno Domini
ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Act
AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
AOC	averted offsite property damage costs
AOE	averted occupational exposure
AOSC	averted onsite costs
APCD	Air Pollution Control Division
APE	averted public exposure
AQCR	Air Quality Control Region
ATWS	anticipated transient without scram
Btu	British thermal unit(s)
BWR	boiling water reactor
BWROG	Boiling Water Reactor Owners Group
°C	degrees Celsius
CAA	Clean Air Act
CBS	Connecticut Botanical Society
CDC	Centers for Disease Control and Prevention
CDF	core damage frequency or combined disposal facility
CDEP	Connecticut Department of Environmental Protection
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
Ci	curie(s)
cm	centimeter(s)
CO	carbon monoxide
CO_2	carbon dioxide
COE	cost of enhancement
CVDEM	Code of Virginia, Department of Emergency Management
CWA	Clean Water Act

d	day(s)
dBA	"A-weighted" decibel level
DBA	design-basis accident
DC	direct current
DDT	dichloro-diphenyl-trichloroethane
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
DOL	U.S. Department of Labor
Dominion	Dominion Nuclear North Anna, LLC
DOT	U.S. Department of Transportation
DPR	demonstration project reactor
DSM	demand-side management
EA	environmental assessment
EDG	emergency diesel generator
EFH	essential fish habitat
EIA	Energy Information Administration
EIS	Environmental Impact Statement
ELF-EMF	extremely low frequency-electromagnetic field
Entergy	Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc.
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute, Inc.
EPU	extended power uprate
ER	Environmental Report
ESA	Endangered Species Act
Exelon	Exelon Generation Company, LLC
°F	degrees Fahrenheit
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FES	Final Environmental Statement
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FSAR	Final Safety Analysis Report
ft	foot (feet)
FWS	U.S. Fish and Wildlife Service
g	gram(s)
gal	gallon(s)
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437

gpd	gallon(s) per day
gpm	gallon(s) per minute
HAC	hazardous air contaminant
HAP	hazardous air pollutant
HCLPF	high confidence low probability of failure
HEPA	high-efficiency particulate air
HLW	high-level waste
hp	horsepower
hr	hour(s)
Hz	Hertz
ICE	internal combustion engine
IEEE	Institute of Electrical and Electronic Engineers
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
ISLOCA	interfacing systems loss-of-coolant accident
J	joule(s)
kg	kilogram(s)
km	kilometer(s)
kV	kilovolt(s)
kW	kilowatt(s)
kWh	kilowatt hour(s)
L	liter(s)
lb	pound(s)
LLC	limited liability company
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mA	milliampere(s)
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
MDFW	Massachusetts Department of Fisheries and Wildlife
MEI	maximally exposed individual
mg	milligram(s)
mi	mile(s)

mi^2	square mile(s)
min	minute(s)
mm	millimeter(s)
mph	mile(s) per hour
mrem	millirem(s)
mR	milliRoentgen(s)
MSL	mean sea level
MTU	metric ton(s)-uranium
MW	megawatt(s)
MWd	megawatt-day(s)
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWh	megawatt hour(s)
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NCDC	National Climatic Data Center
NEC	New England Coalition
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
ng	nanogram(s)
NHDHR	New Hampshire Division of Historic Resources
NHFGD	New Hampshire Fish and Game Resources Department
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NRHP	*National Register of Historic Places*
NRO	Office of New Reactors
NYSDEC	New York State Department of Environmental Conservation
ODCM	Offsite Dose Calculation Manual
OL	operating license
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
pCi	picocurie(s)
PGQS	Primary Groundwater Quality Standards

$PM_{2.5}$	particulate matter, 2.5 microns or less in diameter
PM_{10}	particulate matter, 10 microns or less in diameter
PNNL	Pacific Northwest National Laboratory
ppm	part(s) per million
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
PSD	Prevention of Significant Deterioration
PTE	potential to emit
RAI	request for additional information
REMP	radiological environmental monitoring program
RM	river mile
ROI	region of interest
ROW(s)	right(s)-of-way
RPC	replacement power cost
RRW	risk reduction worth
s	second(s)
SAMA	severe accident mitigation alternative
SAR	Safety Analysis Report
SBO	station blackout
SCDHEC	South Carolina Department of Health and Environmental Control
SCR	selective catalytic reduction
SECA	Solid State Energy Conservation Alliance
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SERI	Systems Energy Resources, Inc.
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SO_x	sulfur oxides
SRHP	*State Register of Historic Places*
Sv	sievert
TBCCW	turbine building closed cooling water
TLAA	time-limited aging analysis
TLD	thermoluminescent dosimeter
UFSAR	Updated Final Safety Analysis Report
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	*United States Code*
USCB	U.S. Census Bureau

USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UST	underground storage tank
VANR	Vermont Agency of Natural Resources
VDEC	Vermont Department of Environmental Conservation
VDH	Vermont Department of Health
VELCO	Vermont Electric Power Company, Inc.
VOC	volatile organic compound
VYNPS	Vermont Yankee Nuclear Power Station
W	watt(s)
yr	year(s)

1.0 Introduction

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10, Part 51, of the *Code of Federal Regulations* (10 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 NRC 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. Use of the GEIS guides the preparation of complete plant-specific information related to the OL renewal process. |

Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc. (Entergy), | operates the Vermont Yankee Nuclear Power Station (VYNPS) in Vernon, Vermont, under OL DPR-28, which was issued by the NRC. This OL will expire in March 2012. By letter dated January 25, 2006, Entergy submitted an application to the NRC to renew the VYNPS OL for an additional 20 years under 10 CFR Part 54 (Entergy 2006a). Entergy is a *licensee* for the purposes of its current OL and an *applicant* for the renewal of the OL. Pursuant to 10 CFR 51.53(c) and 54.23, Entergy submitted an Environmental Report (ER) (Entergy 2006b) in which Entergy 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 (the supplemental EIS (SEIS)) for the | Entergy license renewal application. This SEIS is a supplement to the GEIS because it relies, | in part, on the findings of the GEIS. As part of the safety review, the NRC staff will also prepare | a separate Safety Evaluation Report in accordance with 10 CFR Part 54.

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 NRC staff to assess |

(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 environmental impacts associated with license renewal, (2) describe the proposed Federal action to renew the VYNPS OL, (3) discuss the purpose and need for the proposed action, and (4) present the status of Entergy's compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies that are responsible for environmental protection.

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

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

- The contributors to the supplement,
- A chronology of the NRC staff's environmental review correspondence related to this SEIS,
- The organizations contacted during the development of this SEIS,
- Entergy's compliance status in Table E-2 (this appendix also contains copies of consultation correspondence, including an Essential Fish Habitat Assessment, prepared and sent during the evaluation process),
- GEIS environmental issues that are not applicable to VYNPS, and
- Severe accident mitigation alternatives (SAMAs).

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 the thorough evaluation of the impacts of renewal of 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 for 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 presented in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, as follows:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
>
> LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

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 characteristics.

(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 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 NRC 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 two uncategorized issues are environmental justice and chronic effects of electromagnetic fields. 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.

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.

The NRC staff has identified a new issue that was not previously addressed in the GEIS related to essential fish habitat (EFH). The consultation requirements of Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the National Marine Fisheries Service Sustainable Fisheries Act of 1996, provide that Federal agencies must consult with the Secretary of Commerce on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. Therefore, concurrent with issuance of the draft SEIS, the NRC staff requested initiation of an EFH consultation with the National Marine Fisheries Service (NMFS). The EFH assessment to support this consultation was submitted to the NMFS on December 12, 2006, as part of Appendix E of this SEIS. The NRC requested that the NMFS concur on the EFH assessment. By letter dated January 4, 2007, NMFS stated that they would be unable to undertake an EFH consultation for the VYNPS renewal review.

1.2.2 License Renewal Evaluation Process

An applicant seeking to renew its OL 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), and

- 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); and

- 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 VYNPS OL, Entergy developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for VYNPS would be properly reviewed before submitting the ER, and to ensure that such new and potentially significant information related to renewal of the OL for VYNPS would be identified, reviewed, and assessed during the period of NRC review. Entergy 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 VYNPS. This review was performed by personnel from Entergy 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 NRC 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 VYNPS. 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 NRC 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 Entergy license renewal application began with publication of a Notice of Acceptance for docketing and opportunity for a hearing in the *Federal Register* (NRC 2006a) on March 27, 2006. The NRC staff published a Notice of Intent to prepare an EIS and conduct scoping (NRC 2006b) on April 21, 2006. An open house was held on June 6, 2006, at which comments were accepted, and two public scoping meetings were held on June 7, 2006, in Brattleboro Vermont. Comments received during the scoping period were summarized in the *Environmental Impact Statement Scoping Process: Summary Report – Vermont Yankee Nuclear Power Station, Windham County, Vermont* (NRC 2006c), dated October 30, 2006. Comments that are applicable to this environmental review are presented in Part 1 of Appendix A.

The NRC staff followed the review guidance contained in NUREG-1555, Supplement 1 (NRC 2000). The NRC staff and contractors retained to assist the NRC staff visited the VYNPS site on May 22 through 26, 2006, and again on August 8 through 10, 2006, to gather information and to become familiar with the site and its environs. The NRC staff also reviewed the comments received during scoping and consulted with Federal, State, regional, and local agencies. Appendix C contains a chronological listing of correspondences related to the license renewal process. A list of the organizations consulted is provided in Appendix D. Other documents related to VYNPS were reviewed and are referenced in this SEIS.

This SEIS presents the NRC staff's analysis that considers and weighs the environmental effects of the proposed renewal of the OL for VYNPS, 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.

A 75-day comment period began on the date of publication of the U.S. Environmental Protection Agency Notice of Filing of the draft SEIS to allow members of the public to comment on the preliminary results of the NRC staff's review. During this comment period, two public meetings were held in Brattleboro, Vermont, on January 31, 2007. During these meetings, the NRC 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. On February 27, 2007, members of the NRC staff met with members of the Vermont State Legislature in Montpelier, Vermont, to present the findings of the draft SEIS. No formal comments were received from the legislators at this meeting because no transcript was recorded. The NRC staff did, however, receive written comments for formal consideration from some of the legislators and members of the public who observed the meeting.

The comment period for the VYNPS draft SEIS ended on March 7, 2007. Comments made during the 75-day comment period, including those made at the two public meetings, are presented in Part II of Appendix A of this SEIS. The NRC responses to those comments are also provided. Changes made to the draft SEIS are indicated with a vertical line in the margins of the final SEIS.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the OL for VYNPS. The current OL for VYNPS expires on March 21, 2012. By letter dated January 25, 2006, Entergy submitted an application to the NRC (Entergy 2006a) to renew this OL for an additional 20 years of operation (i.e., until March 21, 2032).

VYNPS is located in the town of Vernon, Vermont, in Windham County on the west shore of the Connecticut River. The plant is situated approximately 5 mi southeast of Brattleboro, Vermont, and about 30 and 28 mi north of Northhampton and Amherst, Massachusetts, respectively. VYNPS is a single-unit plant with a boiling water reactor and steam turbine supplied by General Electric. The unit was originally licensed for a reactor core power of 1593 megawatts thermal (MW(t)), with a net electrical capacity of 540 megawatts electric (MW(e)). However, a recently approved power uprate has increased the power level to 1912 MW(t), with a corresponding output of 650 MW(e). Plant cooling is provided by a closed-cycle, open-cycle, or hybrid-cycle system that draws water from, and discharges water back to, the Connecticut River.

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):

> 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 of 1954 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

Entergy is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, Entergy (2006b) provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with VYNPS license renewal. The ER states that Entergy is in compliance with applicable environmental standards and requirements for VYNPS. Authorizations and consultations relevant to the proposed OL renewal action are included in Appendix E.

The NRC staff has reviewed the list of authorizations and consulted with the appropriate Federal, State, and local agencies to identify any compliance or environmental issues of concern to the reviewing agencies. These agencies did not identify any new and significant environmental issues. The NRC staff has not identified any environmental issues that are both new and significant.

1.6 References

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

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

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

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

Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy). 2006a. *License Renewal Application, Vermont Yankee Nuclear Power Station, Facility Operating License No. DPR-28*. Docket No. 50-271. Brattleboro, Vermont. (January 25, 2006). ADAMS No. ML06030085.

Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy). 2006b. *Applicant's Environmental Report – Operating License Renewal Stage, Vermont Yankee Nuclear Power Station*. Docket No. 50-271. Brattleboro, Vermont. (January 25, 2006). ADAMS No. ML06030086.

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

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Vols. 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, Vol. 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). 2006a. "Entergy Nuclear Operations, Inc., Vermont Yankee Nuclear Power Station; Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. DRP-28 for an Additional 20-Year Period." *Federal Register*, Vol. 71, No. 58, pp. 15220–15223. Washington, D.C. (March 27, 2006).

U.S. Nuclear Regulatory Commission (NRC). 2006b. "Entergy Nuclear Operations, Inc., Vermont Yankee Nuclear Power Station; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register*, Vol. 71, No. 77, pp. 20733–20735. Washington, D.C. (April 21, 2006).

U.S. Nuclear Regulatory Commission (NRC). 2006c. *Environmental Impact Statement Scoping Process: Summary Report – Vermont Yankee Nuclear Power Station, Windham County, Vermont*. Washington, D.C. (October 30, 2006). ADAMS No. ML063030576.

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

The Vermont Yankee Nuclear Power Station (VYNPS) is owned and operated by Entergy Nuclear Vermont Yankee, LLC (Entergy), a wholly owned subsidiary of Entergy Nuclear Operations, Inc. VYNPS is located on the shore of the Connecticut River in the town of Vernon, in Windham County, Vermont. The plant consists of a single boiling water reactor that produces steam that turns turbines to generate electricity. The site includes a reactor building, a turbine building, an office building, radioactive waste buildings, a stack, and several other support buildings. The plant and its environs are described in Section 2.1, and the plant's interaction with the environment is presented in Section 2.2.

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

This section provides a description of the VYNPS plant, the site on which it is located, and the regional setting. In addition, summary descriptions are provided for the reactor system, radioactive waste management and effluent control systems, the cooling and auxiliary water systems, the nonradioactive waste management systems, plant operation and maintenance, as well as the power transmission system.

2.1.1 External Appearance and Setting

The VYNPS is located on approximately 125 ac of land owned by Entergy and a narrow strip of land between the Connecticut River and the east boundary of the VYNPS property to which Entergy has perpetual rights and easements from its owner. The property is approximately 5 mi southeast of Brattleboro, Vermont, and about 28 mi north of Amherst, Massachusetts. Besides Brattleboro, Vermont, the only other settlement of any size within 5 mi of the site is the town of Hinsdale, New Hampshire, east of the Connecticut River. Figures 2-1 and 2-2 show the site location and features within 50 mi and 6 mi, respectively (Entergy 2006a).

The 125-ac VYNPS property boundaries are shown in Figure 2-3. The property is bounded on the north, south, and west by privately owned land and on the east by the Connecticut River. The site is surrounded by an exclusion area, as shown in Figure 2-4. No residences are permitted within this exclusion zone. During an accident condition of radiological significance, the licensee would possess the capability for exercising immediate and direct control over activities in the exclusion area for the purpose of radiological protection. The nearest residences lie outside the site boundary to the southwest at 0.26 mi. The areas adjacent to the site to the north, west, and south are primarily farm and pasture lands.

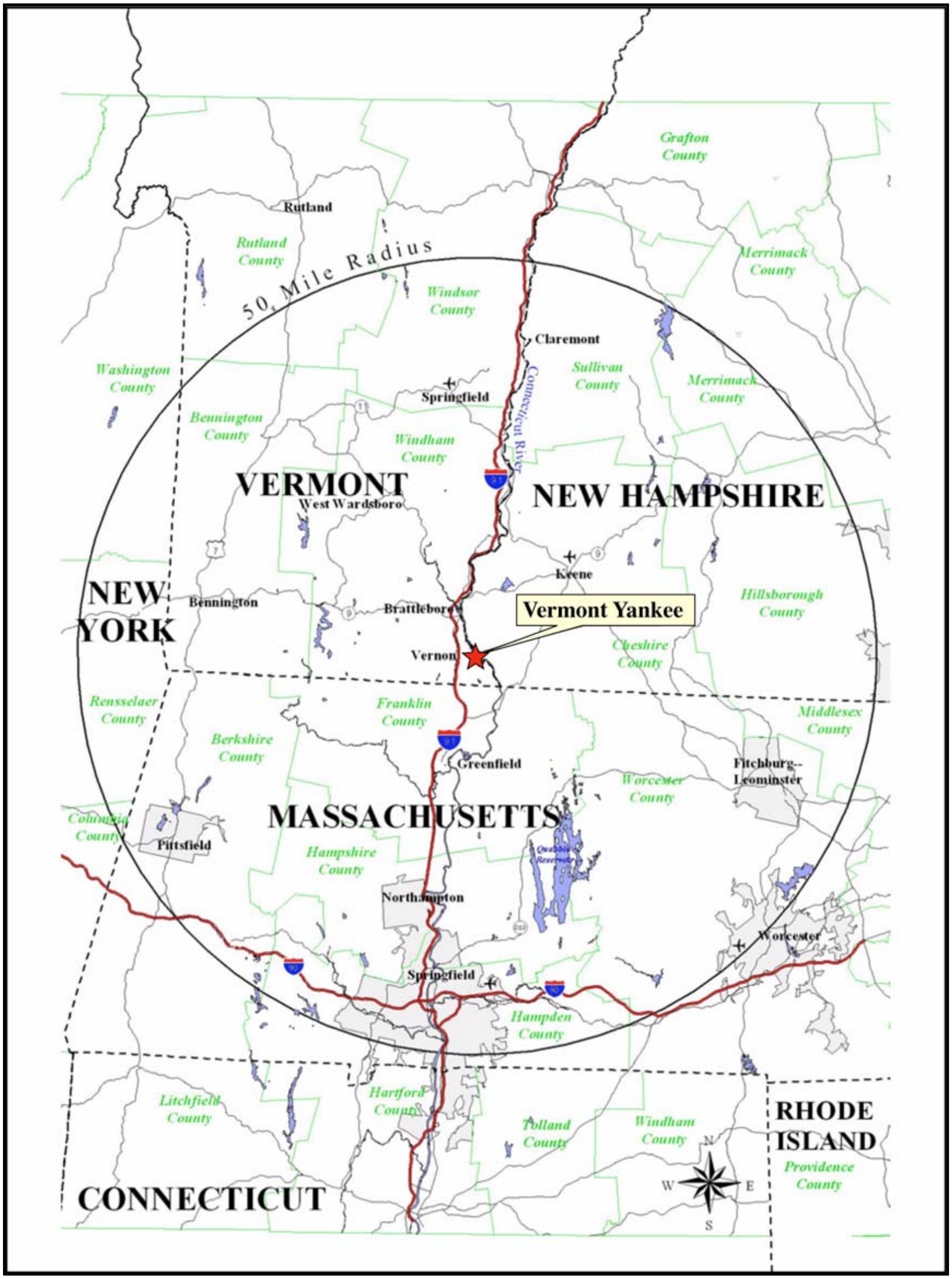

Figure 2-1. Location of Vermont Yankee Nuclear Power Station, 50-mi Region (Source: Entergy 2006a)

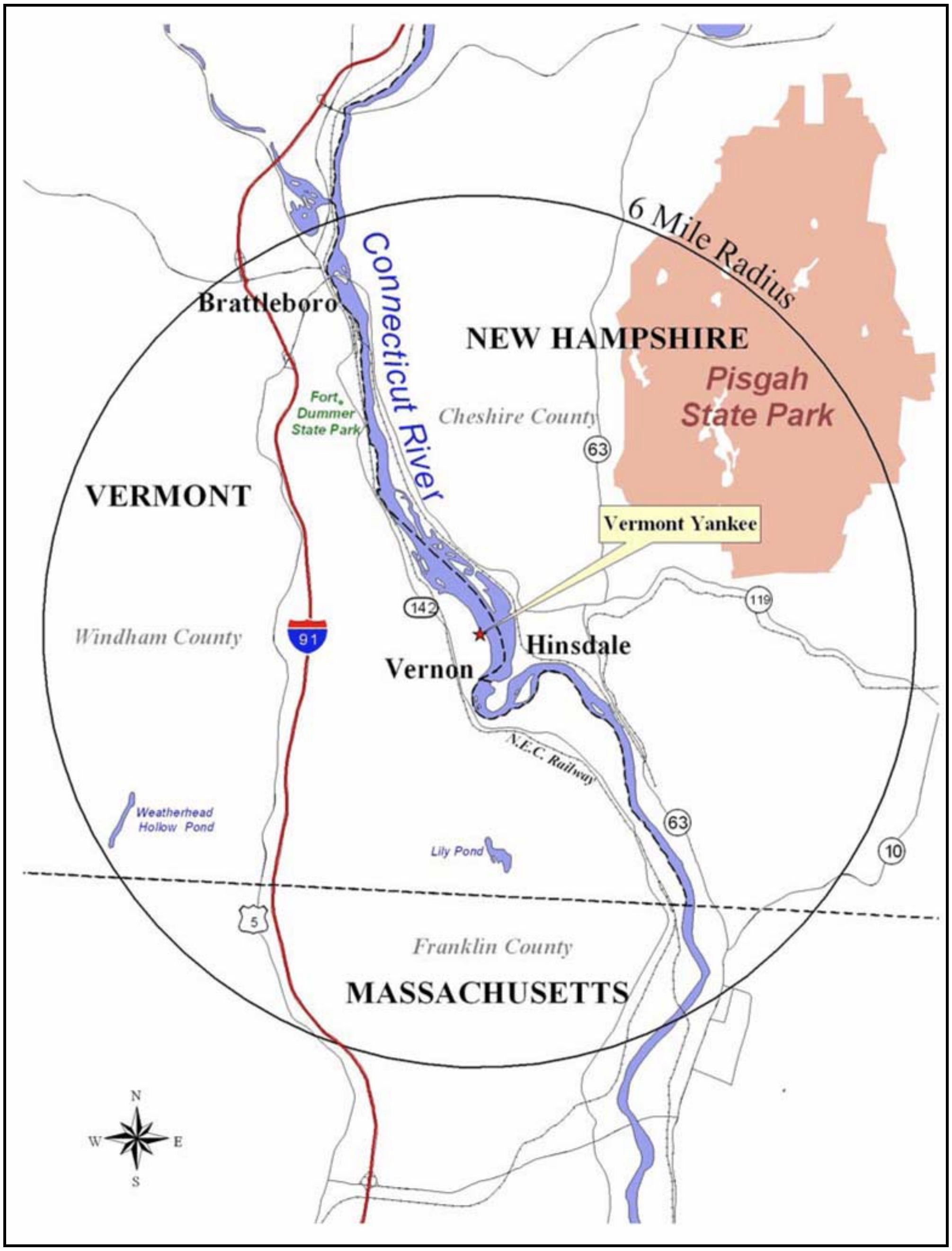

Figure 2-2. Location of Vermont Yankee Nuclear Power Station, 6-mi Region (Source: Entergy 2006a)

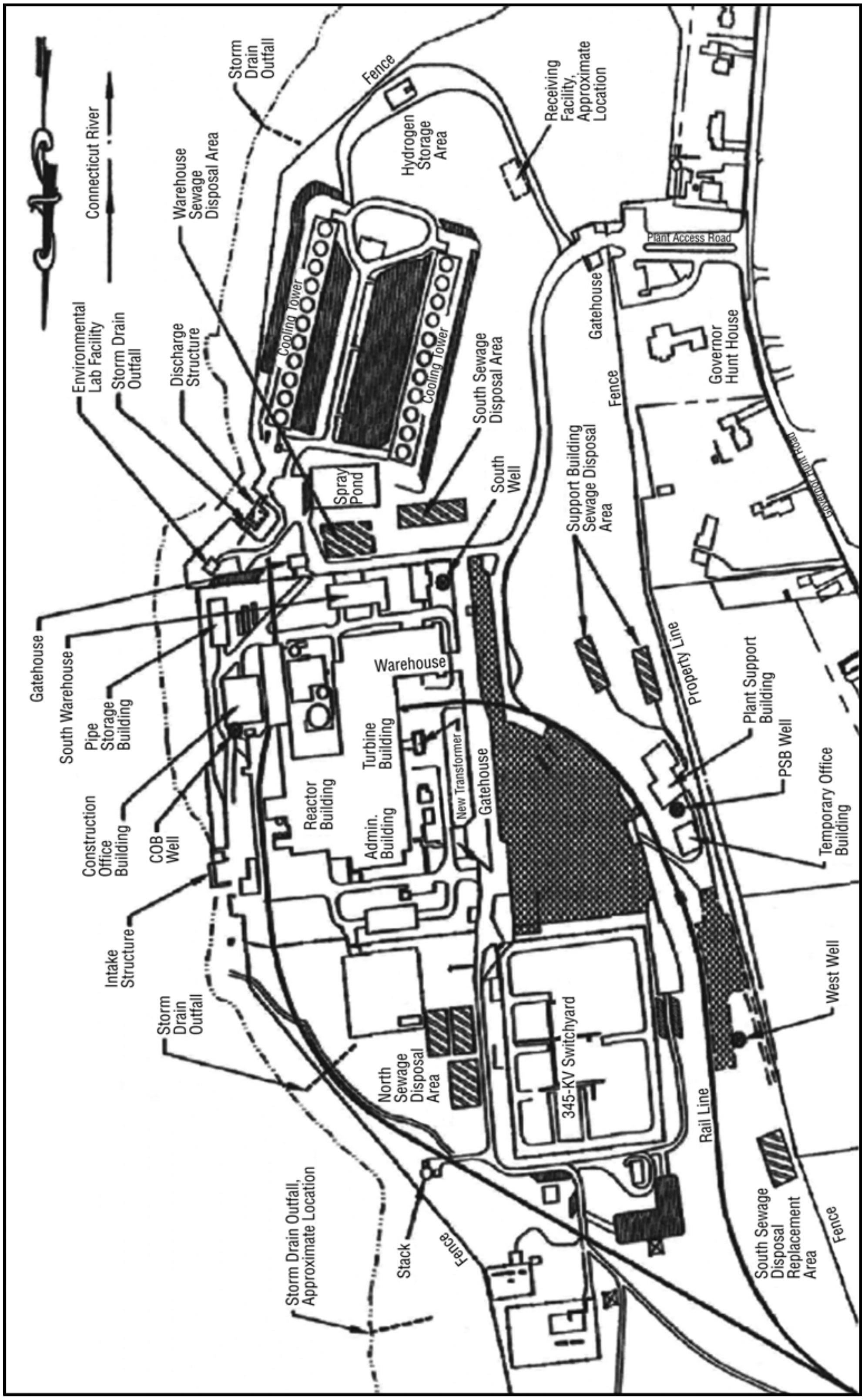

Figure 2-3. Vermont Yankee Nuclear Power Station Site Layout (Source: Entergy 2006a)

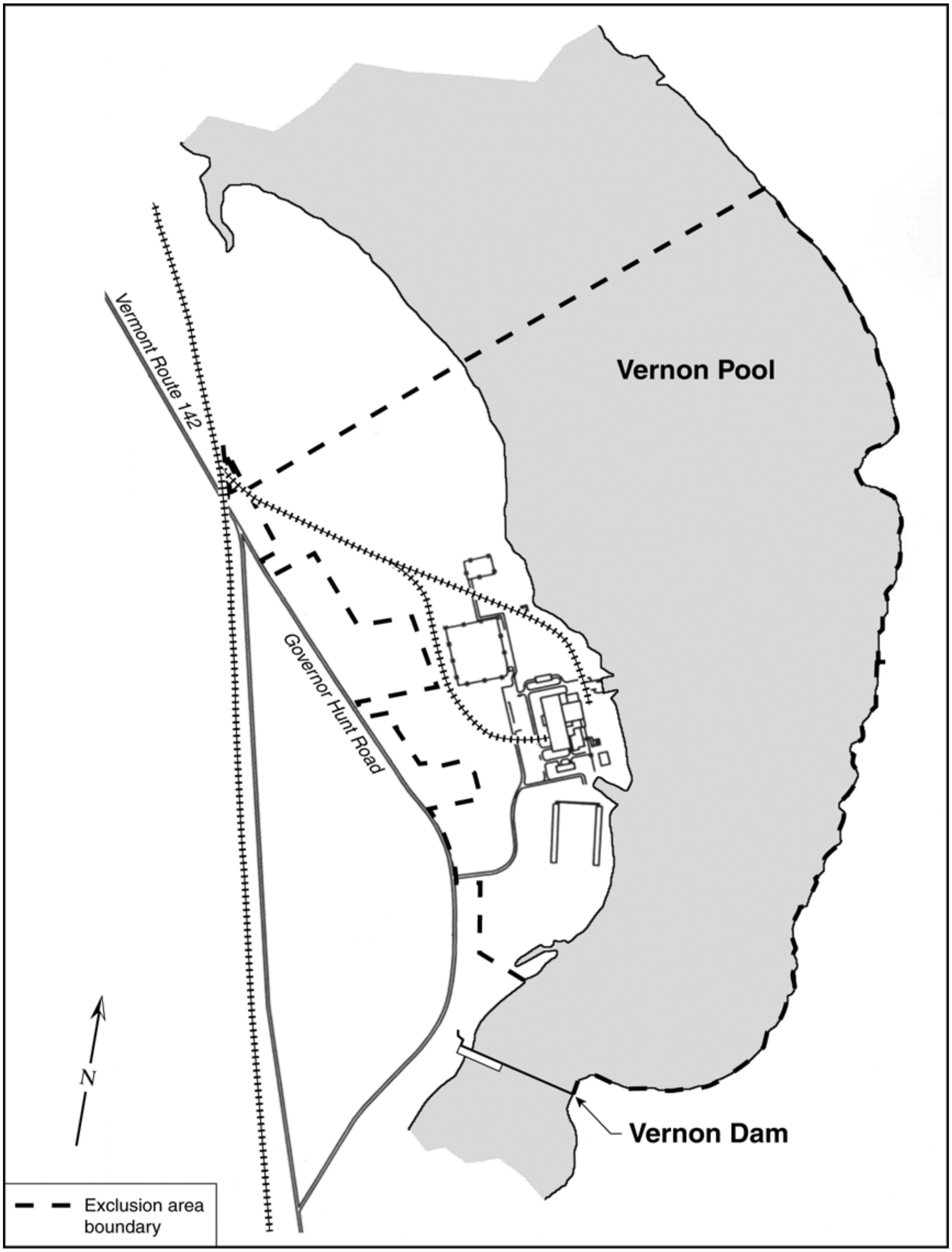

Figure 2-4. Vermont Yankee Nuclear Power Station Exclusion Zone (Source: Entergy 2006a)

The area within the 5-mi radius is predominantly rural with the exception of a portion of the town of Brattleboro, Vermont, and the town of Hinsdale, New Hampshire. Between 75 and 80 percent of the area within 5 mi of the station is wooded. The remainder is occupied by farms and small industries. Downstream of the plant on the Connecticut River is the Vernon Hydroelectric Station.

There are no Native American lands within a 50-mi radius of VYNPS. There are a number of Federal and State lands within the 50-mi radius of the VYNPS, as shown in Figure 2-5.

2.1.2 Reactor Systems

VYNPS is a nuclear-powered, steam electric-generating facility that began commercial operation on November 30, 1972. VYNPS is powered by a boiling water reactor manufactured by General Electric and features a Mark I containment. The unit was originally licensed for a reactor core power of 1593 megawatts-thermal (MW(t)), with a net electrical capacity of 540 MW(e). However, on March 2, 2006, the U.S. Nuclear Regulatory Commission (NRC) approved a power uprate to increase the maximum core power level from 1593 MW(t) to 1912 MW(t). The gross electrical output corresponding to 1912 MW(t) is approximately 650 MW(e).

The VYNPS site layout is shown in Figure 2-3. Major buildings and structures include the reactor building and primary containment, turbine building, control building, radioactive waste building, intake structure, cooling towers, and main stack. The site has begun construction of an independent spent fuel storage facility for dry storage of spent nuclear fuel onsite.

The reactor's primary containment is a pressure suppression system consisting of a drywell, a pressure-absorption chamber, and vent pipes connecting the drywell to the pressure-absorption chamber. The drywell is a steel pressure vessel with a spherical lower portion and a cylindrical upper portion. The pressure-absorption chamber is a steel pressure vessel in the shape of a torus, located below and encircling the drywell, and is approximately half-filled with water. The vent system from the drywell terminates below the water level in the torus, so that in the event of a pipe failure in the drywell, the released steam passes directly to the water where it is condensed (Entergy 2004c).

Secondary containment is provided by the reactor building, which is constructed of reinforced concrete to the refueling floor. Above the refueling floor, the structure is a steel framework with insulated, corrosion-resistant metal siding. The reactor building also houses all refueling equipment, including the spent fuel storage pool and the new fuel storage vault.

The reactor fuel is uranium dioxide pellets sealed in Zircaloy-2 tubes. The fuel is enriched to no more than 5 percent. The reactor is refueled on an 18-month refueling cycle. Spent fuel

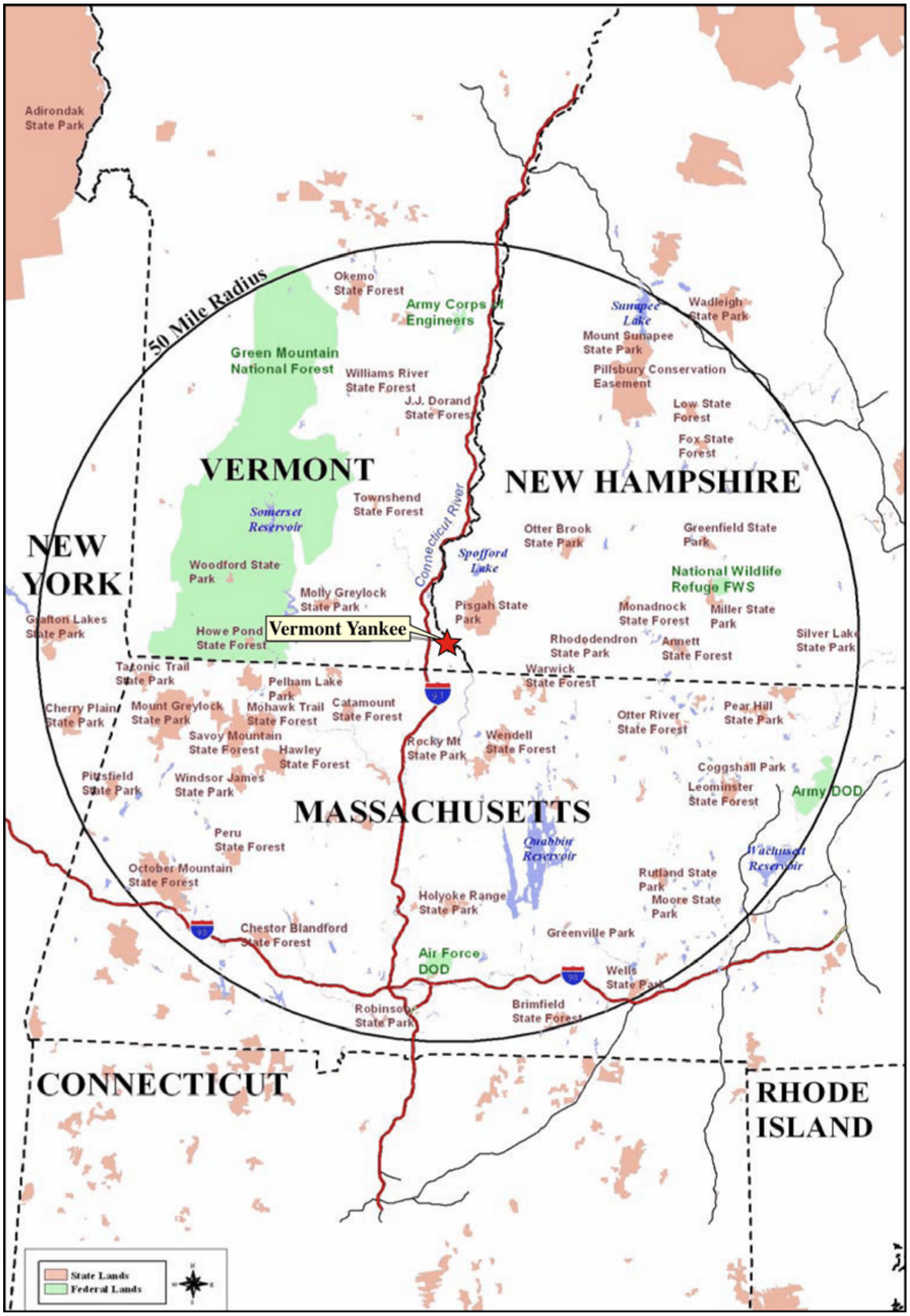

Figure 2-5. Major State and Federal Lands Within 50 mi of Vermont Yankee Nuclear Power Station (Source: Entergy 2006a)

is currently stored onsite in the storage pool. Some of the spent fuel currently stored in the spent fuel pool will be moved to the independent spent fuel storage facility being constructed onsite.

2.1.3 Cooling and Auxiliary Water Systems

The Connecticut River is the source for cooling water for the main condenser at the VYNPS. Cooling river water can be circulated through the station in one of three modes of operation: open-cycle (also called once-through cooling), hybrid-cycle, or closed-cycle. The mode of operation is selected by the applicant to limit the heat discharged to the river to ensure compliance with the thermal limits of the National Pollutant Discharge Elimination System (NPDES) permit (Entergy 2004c, NRC 2006a).

In all three modes, the circulating water exits the condenser and flows into the discharge structure. In the open-cycle mode, after entering the discharge structure the water returns to the river through an aerating structure. The cooling towers are not used in the open-cycle mode of operation. In both the closed-cycle and hybrid cycle, after entering the discharge structure, the circulating water is pumped up to the cooling towers. After being cooled, the water returns to a weir collection chamber in the discharge structure. A gate inside this chamber allows all or a portion of the water to return to the intake structure. In the closed-cycle mode all of the tower cooled water is returned to the intake structure for re-use in the condenser. In the hybrid cycle mode of operation a portion of the water returns to the intake structure while the remainder is returned to the river through the aerating structure. The exact amount of water returned to both the intake structure and the river in hybrid mode depends on seasonal variation in environmental parameters, particularly the flow rate and temperature of the Connecticut River. Blowdown from the circulating water system is discharged to the river through piping near the discharge structure. Make-up water lost from blowdown and evaporation from the cooling towers is withdrawn from the river. VYNPS has two mechanical draft cooling towers, one of which has a deep basin holding 1.4 million gal of water for emergency cooling (VDEC 2003; VDEC 2006a; Entergy 2004c).

The concrete intake structure, located on the west bank of Vernon Pool about 160 ft east of the Reactor Building, is approximately 114 ft long by 77 ft wide by 50 ft deep. It houses three pump bays for three circulating water pumps, two service water bays for four service water pumps and two fire water pumps, three 12 ft by 22 ft roller gates, and one 4 ft by 4 ft service gate. All bays are provided with trash racks and traveling water screens to remove debris in the intake water (Entergy 2004c).

Water treatment equipment at the intake structure delivers chlorine and bromine to both the circulating water and service water pump bays, to minimize marine growth and bacteria in the system. Corrosive control agents and chemicals to adjust pH are also added (see Table 2-3, Section 2.2.3.1) (Entergy 2004c).

Cooling water for the main condenser is drawn from the Connecticut River using three vertical circulating water pumps, which provide a total flow capacity of 360,000 gpm. Cooling water returns to the Connecticut River through the discharge structure near the riverbank southeast of the plant (at NPDES Outfall 1). The structure is approximately 199 ft long by 108 ft wide by 46 ft deep. The discharge structure consists of an aerating spillway that provides air entrainment, energy dissipation, and warm water dispersion of the discharged cooling water. Sheet piling is used to prevent scouring of the aerating apron (Entergy 2004c).

The thermal limits of the plant's discharge to Vernon Pool are regulated through Vermont's NPDES program (see also Section 2.2.3.1). During the NPDES winter period (October 15 through May 15), the NPDES permit requires that the plant-induced temperature at downstream River Monitoring Station 3 never exceed 65°F and that the increase in temperature above the ambient temperature at that station never exceeds 13.4°F (or a rate of increase of 5°F per hour). During the NPDES summer period (May 16 through October 14), the temperature increase at Station 3 is required to be less than 2°F above the ambient temperature for water that is above 63°F, less than 3°F for water between 59°F and 63°F, less than 4°F for water between 55°F and 59°F, and less than 5°F above the ambient temperature for water that is below 55°F (VDEC 2004).

Flow limitations for circulating water discharged at the discharge structure are 543 million gpd for open- and hybrid-cycle cooling modes and 12.1 million gpd for closed-cycle cooling modes (see Table 2-1, Section 2.2.2.1).

Water is also drawn from the Connecticut River for the plant's service water system, which provides water for turbine and reactor auxiliary equipment cooling, reactor shutdown cooling, and miscellaneous services. Four vertical, two-stage, turbine-like pumps, located at the north end of the intake structure, supply water to the service water system, providing a total flow capacity of 13,400 gpm. The service water system also provides water to the normal and standby fuel pool cooling subsystems for the reactor building's spent fuel pool (Entergy 2004c). Service water is returned to the river via the discharge structure.

Two pumps, with a total flow capacity of 5000 gpm, are located at the north end of the intake structure to withdraw water from the Connecticut River for fire protection. Water is drawn as needed to supply the automatic wet pipe sprinkler systems, standpipes, and hose stations throughout the plant (Entergy 2004c).

In its report to the State of air pollutant emissions for calendar year 2005, Entergy reported release of four Category III hazardous air contaminants (HACs) from the operation of its cooling tower (Entergy 2006b). The specific chemicals were components of two biocides in use during the period. Spectrus NX-1104, manufactured by Betzdearborn, a subsidiary of Hercules Canada, contains dodecylguanidine hydrochloride, ethyl alcohol, and isopropyl alcohol (Betzdearborn 2003). Nalco H-550, manufactured by Ondeo Nalco, contains glutaraldehyde (DeWald 2006a).

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

Radioactive wastes resulting from plant operations are classified as liquid, gaseous, and solid wastes. VYNPS uses liquid, gaseous, and solid radioactive waste management systems to collect and process these wastes before they are released to the environment or shipped to offsite disposal facilities. The waste disposal system meets the release limits as set forth in Title 10, Part 20, of the *Code of Federal Regulations* (10 CFR Part 20) and the dose 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"), and controls the processing, disposal, and release of radioactive wastes. Unless otherwise noted, the description of the radioactive waste management systems and effluent control systems for liquid, gaseous, and solid wastes presented here (Sections 2.1.4.1, 2.1.4.2, and 2.1.4.3, respectively) is based on information provided in the applicant's Environmental Report (ER) (Entergy 2006a) or the VYNPS Updated Final Safety Analysis Report (UFSAR) (Entergy 2004c) and was confirmed during the NRC staff's site visit May 22-25, 2006.

The liquid and gaseous radioactive waste systems are designed to reduce the radioactivity in the wastes such that the concentrations in routine discharges are below the applicable regulatory limits. If necessary, liquid waste releases to the Connecticut River occur in batches that are monitored during discharge and diluted by the circulating water. VYNPS has not had any radioactive liquid discharges to the Connecticut River over the last 5 years and does not plan to release radioactive liquids in the future. Gaseous wastes are processed and routed to a common tall stack for release to the atmosphere. The gaseous effluents are continuously monitored, and discharge is stopped if the effluent concentrations exceed predetermined levels.

The Offsite Dose Calculation Manual (ODCM) for VYNPS (Entergy 2002c) describes the methods used for calculating radioactivity concentrations in the environment and the estimated potential offsite doses associated with liquid and gaseous effluents from VYNPS. The ODCM also specifies controls for release of liquid and gaseous effluents to ensure compliance with NRC regulations.

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; however, as a result of fuel cladding failure and corrosion, small quantities escape from the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system is also responsible for coolant contamination. Nonfuel solid wastes result from treating and separating radionuclides from gases and liquids and from removing contaminated material from various reactor areas. Solid wastes also consist of reactor components, equipment, and tools removed from service as well as contaminated protective clothing, paper, rags, and other trash generated from plant operations, design modification, and routine maintenance activities. The solid waste disposal system is designed to package solid wastes for removal to offsite treatment or disposal facilities. Some solid low-level waste is stored onsite temporarily before offsite shipment.

Fuel assemblies that have exhausted a certain percentage of their fuel and that are removed from the reactor core for disposal are called spent fuel. VYNPS currently operates on an 18-month refueling cycle. Spent fuel is stored in a spent fuel pool in the reactor building. Some of the older spent fuel will also be stored in an onsite independent spent fuel storage installation.

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

The liquid radioactive waste system receives and processes all radioactive or potentially radioactive liquid wastes from multiple sources. These wastes are collected in sumps and drain tanks at various locations throughout the plant and then transferred to the appropriate collection tanks for treatment, storage, and disposal. Although VYNPS operates as a zero discharge plant relative to radioactive liquids, very low levels of radioactivity in liquid effluents from VYNPS could be released to the Connecticut River in accordance with limits specified in NRC regulations, VYNPS ODCM, and the NPDES permit.

Included in the liquid radioactive waste system are (1) floor and equipment drain systems for handling potentially radioactive wastes; and (2) tanks, piping, pumps, process equipment, instrumentation, and auxiliaries necessary to collect, process, store, and dispose of potentially radioactive wastes. The equipment used by the liquid radioactive waste system is located in the radioactive waste building, with the exception of the cleanup phase separator equipment (located in the reactor building), the condensate backwash receiving tank and pump (located in the turbine building), and waste sample tanks, floor drain sample tank, and waste surge tank (located outdoors at grade level).

The liquid wastes received are of different purities and chemical compositions. The liquid radioactive waste system is used to process these wastes to make them suitable for reuse within the plant or, if necessary, for release to the discharge structure where dilution occurs with the circulating water.

The principal sources of liquid wastes are equipment leakage, drainage, and process waste produced by plant operations. This is a batch-type system wherein the wastes are separately collected and processed. The liquid wastes are broadly categorized as high-purity, low-purity, chemical, or detergent wastes. The terms “high” and “low” purity refer to conductivity, not radioactivity.

High-purity (low-conductivity) liquid wastes are collected in the waste collector tank from a variety of sources, including the equipment drain sumps in the drywell, reactor building, radioactive waste building, and turbine building, and from decants from cleanup and condensate phase separators, resin rinse, and rapid dewatering systems. They are processed by filtration and ion exchange through waste collector filter or fuel pool filters and waste dimineralizers, as required. After processing, the liquid is pumped to the waste sample tank where it is sampled and either recycled for additional processing or transferred to the condensate storage tank for reuse in the nuclear system. VYNPS has operated as a zero radioactive liquid discharge facility over the last several years and intends to continue to operate in the same mode. However, should discharge be necessary, wastes would be sampled on a batch basis and analyzed for water quality and radioactivity. If high-purity requirements are met, the contents would be transferred to the condensate storage tank. If high-purity requirements are not met, the liquid wastes would be recycled through the radioactive waste system or could be discharged. Discharges would be monitored and the release would be automatically terminated if the monitor set points are exceeded.

Low-purity (high-conductivity) liquid wastes are collected in the floor drain collector tank, which receives wastes from the floor drains of the drywell, reactor building, radioactive waste building, and the turbine building. These wastes generally have low concentrations of radioactive impurities, and processing consists of filtration and combination with high-purity waste in the waste collector tank, with subsequent processing as high-purity waste.

Chemical wastes are collected in the chemical waste tank and are from the following sources: chemical laboratory waste, laboratory drains, and sample sinks. When the chemical concentrations are low enough, these wastes may be neutralized and processed by filtration in the same manner and with the same equipment as the low-purity wastes. When the chemical concentrations are too high, these wastes may receive additional processing.

Detergent wastes are collected in the detergent waste tank. These wastes are primarily from radioactive decontamination solutions that contain detergents. Because detergents will foul ion exchange resins, their use is minimized in the plant. VYNPS uses an offsite cleaning laundry, thus minimizing the quantity of detergent waste generated. Detergent wastes are normally dumped to the floor drain collector tank for processing with low-purity waste.

The NRC staff reviewed the annual liquid effluent releases reported in the VYNPS Annual Radioactive Effluent Release Reports for the years 2001 through 2005 (Entergy 2002b, 2003b, 2004b, 2005b, 2006c). During this 5-year period, there were no routine or unplanned liquid effluent releases from the liquid radioactive waste processing system. In 2006, NRC issued a license amendment to Entergy that allowed Entergy to increase the thermal power of the VYNPS by 20 percent (to 1912 MW(t)). In the environmental assessment (EA) and the Finding of No Significant Impact (FONSI) accompanying the license amendment (NRC 2006a), it is estimated that the volume of liquid radioactive waste generated could increase by 1.2 percent of the current total as a consequence of the 20-percent extended power uprate (EPU). It is also stated in the EA that this is an increase in the volume of radioactive waste that would require processing, not an increase in radioactive liquid effluent. It is also indicated that the liquid waste processing system at VYNPS was designed to handle the increased volume of radioactive waste. Entergy does not anticipate the discharge of any radioactive liquid waste during the renewal period.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

At VYNPS, the gaseous radioactive waste system includes subsystems that process gases from the main condenser air ejectors, the startup vacuum pump, and the gland seal condenser. This system also processes gases from the standby treatment system and most station ventilation exhausts including from portions of the turbine building, reactor building, and radioactive waste building. The processed gases are routed to the plant stack for dilution and elevated release (318 ft above grade) to the atmosphere. VYNPS ventilation systems are designed to maintain gaseous effluents at levels as low as reasonably achievable. This is done by a combination of holdups for decay of short-lived radioactive material, filtration, and monitoring. Continuous radiation monitoring is provided at various points in the system.

During normal operation, noncondensable gases are produced in the reactor coolant and must be continuously removed to maintain turbine efficiency. These gases include hydrogen and oxygen from radiolysis of water, gases introduced or generated as a result of chemical control in the primary system, mixed fission products, activation products, and air from condenser in-leakage. Off-gas is discharged from the condenser via steam-jet air ejectors and passed through holdup piping and high-efficiency particulate air (HEPA) filters. The off-gas is then passed through a hydrogen dilution and recombiner system where hydrogen and oxygen are catalytically recombined into water. After recombination, the off-gas is routed to a chiller to remove moisture, and then through seven charcoal delay beds that provide a long delay period for radioisotope decay as the off-gas passes through. The off-gas is then passed through HEPA filters and vacuum pumps before it is routed to the 318-ft plant stack for release to the environment. The effluent is continuously monitored and an alarm is activated in the control room if the monitor set points are exceeded. The operators would then take action to reduce or terminate the release.

A new gaseous radioactive waste subsystem was installed at VYNPS to permit the incineration of slightly radioactive waste oil for space heating purposes. This incinerator is located in the north warehouse on the site. The environmental releases listed below and the doses to receptors in the vicinity of the plant listed in Section 2.2.7 include the emissions from this incinerator.

The NRC staff reviewed the gaseous effluent releases reported in the VYNPS Annual Radioactive Effluent Release Reports for the years 2001 through 2005 (Entergy 2002b, 2003b, 2004b, 2005b, 2006c). During this 5-year period, the average annual release of radioactive effluents was about 40.2 Ci/yr, consisting of the following:

- 31.7 Ci/yr of fission and activation gases,
- 1.17×10^{-3} Ci/yr of iodines,
- 2.7×10^{-4} Ci/yr of beta and gamma emitters as particulates, and
- 8.55 Ci/yr of tritium.

In March 2006, the NRC issued a license amendment to Entergy that allowed Entergy to increase the thermal power of the VYNPS by 20 percent. In the EA and the FONSI accompanying the license amendment (NRC 2006a), it is estimated that the gaseous effluents from the VYNPS due to the EPU could increase by as much as 20 percent, consistent with the percent increase in power. However, it is estimated that the gaseous effluents will remain within the regulatory limits (NRC 2006a). Except for the impact of the EPU, no increases in radioactive gaseous releases are expected during the license renewal period. See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual (MEI) as a result of gaseous releases.

2.1.4.3 Solid Waste Processing

The solid waste management system at VYNPS is designed to collect, process, store, package, and prepare wet and dry solid radioactive waste materials for offsite shipment. Some solid waste is temporarily stored onsite in shielded structures prior to shipment from the plant. Solid wastes include wet wastes consisting of spent resins and filter sludges and dry wastes consisting of air filters from radioactive ventilation systems; miscellaneous paper, rags, shoe covers, etc., from contaminated areas; contaminated clothing, tools, and equipment parts, which cannot be effectively decontaminated; solid laboratory wastes; used reactor equipment such as spent control rod blades, fuel channels, and incore ion chambers; and large pieces of contaminated equipment.

The wet wastes are pumped from the phase separators or waste sludge tanks as a slurry to disposable liners preplaced within the licensed transportation casks. The slurry is then dewatered from within the liner using a remote controlled dewatering system. After filling and dewatering, the liner is closed and the cask is taken to a decontamination area in the radioactive waste building where the cask is wiped or washed down to remove external surface contamination. The cask is lifted to a truck for transportation to the onsite waste storage area or offsite to a waste disposal site.

The dry solid waste is normally stored temporarily in various work areas and then moved to the process area. Most waste of this type has relatively low radioactive content and may be handled manually. Used reactor equipment, because of its high radioactivity, is stored in the fuel storage pool for a sufficiently long time to allow for radioactive decay before packaging and shipment offsite. A hydraulic box compactor is used to compress and reduce the volume of compressible dry wastes. As an alternative, these types of wastes can be collected in shipping containers and sent to an offsite processor for volume reduction.

Transportation and disposal of solid radioactive wastes are performed in accordance with the applicable requirements of 10 CFR Part 71 and Part 61, respectively. There are no releases to the environment from solid radioactive wastes created at VYNPS. In 2005, 23 waste shipments were made from VYNPS to treatment or disposal facilities. The total volume and activity of the radioactive waste shipped offsite in 2005 were 619 m^3 and 229 Ci, respectively (Entergy 2006c). These values are representative of the quantities of radioactive waste generated and shipped from the site in previous years. However, the EPU granted in March 2006 is expected to result in an increase in the amount of radioactive waste generated annually. The increase is expected to be less than 18 percent (NRC 2006a). Except for the impact of the EPU, no increase in radiological solid waste is expected during the license renewal period.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 20.2002 (previously 10 CFR 20.302(a)), NRC has granted approval to VYNPS to dispose of slightly contaminated materials onsite (NRC 2005). The materials approved for disposal by land spreading include (1) septic waste; (2) cooling tower silt; (3) soil/sand generated from annual winter spreading on roads and walkways; and (4) soil resulting from onsite construction-related activities. The designated disposal locations for these materials are (a) an approximately 10-ac site about 2000 ft northwest of the reactor building, and (b) a 1.9-ac site approximately 1,500 ft south of the reactor building. Both locations are within the plant's site boundary. Only the 1.9-ac site south of the reactor building has been used to date. It is estimated that this 1.9-ac area will be sufficient to dispose of all approved materials through the end of the current licensing period for the VYNPS (NRC 2005). If the operating license of the VYNPS is renewed and the approval to dispose of the subject materials by land spreading onsite is continued beyond the current licensing period, it is likely that some or all of the materials generated after 2012 will be disposed in some portion of the currently approved 10-ac area northwest of the reactor building (Entergy 2004d). The radiological doses from these disposal operations are discussed in Section 2.2.7.

2.1.5 Nonradioactive Waste Systems

The principal nonradioactive wastes from VYNPS include various solid waste, chemical wastes, and sanitary waste. Noncontaminated solid waste is collected inside the restricted area in designated containers located throughout the plant. Once filled, the containers are surveyed for the presence of loose surface contamination and are then transported to the clean material processing facility. Noncontaminated chemicals, paint, oil, fluorescent bulbs, and other items that have either been used or exceeded their useful shelf life are collected in a central collection area. The materials are received in various forms and are processed to meet all regulatory requirements prior to final disposition. Most items are packaged and shipped to vendors for processing offsite.

Sanitary wastewater and laboratory wastewater from all plant locations are discharged to the onsite septic systems covered under a permit from the Vermont Department of Environmental Conservation (VDEC[a]). The solids from the septic tanks are periodically removed and spread in a land spreading area on the site (See Section 2.1.4.3). Monitoring of the groundwater around the septic tanks and around the land spreading area has showed no indication of radioactive contamination.

Entergy has a corporate policy and a plan for waste minimization at its nuclear power plants, including VYNPS. The plan provides a hierarchy of waste minimization options that emphasize: (1) source reduction, (2) reuse/recycling, (3) treatment to reduce volume and/or toxicity, and (4) disposal, in that order (Entergy 2006d). It is expected that Entergy would continue to maintain and implement its waste minimization policy and plan during the license renewal period.

2.1.6 Plant Operation and Maintenance

Routine maintenance performed on plant systems and components is necessary for the safe and reliable operation of a nuclear power plant. Maintenance activities conducted at VYNPS include inspection, testing, and surveillance to maintain the current licensing basis of the plant and to ensure compliance with environmental and safety requirements. Certain activities can be performed while the reactor is operating. Others require that the plant be shut down. Long-term outages are scheduled for refueling and for certain types of repairs or maintenance, such as the replacement of a major component. The reactor is refueled on an 18-month schedule.

As part of the License Renewal Application (Application), Entergy conducted an aging management review to manage the impacts of aging on systems, structures, and components in accordance with 10 CFR Part 54. Section 4 of the Application documents the evaluations of time-limited aging analyses (TLAAs) for the license renewal period. Appendix B of the Application provides descriptions of the programs and activities that would manage the impacts of aging for the renewal period. These summary descriptions of aging management program activities and TLAAs would be incorporated into the UFSAR for VYNPS following the issuance of the renewed operating license (OL). Entergy expects to conduct the activities related to the management of aging impacts during plant operation or normal refueling and other outages, but does not plan any outages specifically for the purpose of refurbishment.

(a) VDEC is part of the Vermont Agency of Natural Resources.

2.1.7 Power Transmission System

Transmission corridors considered in the scope for license renewal are those constructed specifically to connect the facility to the transmission system (10 CFR 51.53(c)(3)(ii)(H)). The Final Environmental Statement (FES) for VYNPS (AEC 1972) described two transmission lines that connected VYNPS with the regional transmission grid. Both of the lines described in the FES operated at 115-kV. The two lines described in the FES, the Chestnut Hill and Coolidge lines, are considered in the scope for the Supplemental Environmental Impact Statement (SEIS) because they connect VYNPS to the regional grid. Three other lines that connect to the VYNPS switchyard, the Amherst line, the Northfield line, and the Vernon Hydro line were not constructed in support of the VYNPS, and therefore are not considered in the scope for the SEIS. None of the transmission lines connecting to the VYNPS switchyard are owned, operated, or maintained by Entergy.

From the VYNPS switchyard, the 115-kV Chestnut Hill line runs east across the Connecticut River for 2 mi to the Chestnut Hill substation in Hinsdale, New Hampshire (Figure 2-6). The line crosses the Connecticut River on galvanized steel towers and then is carried on wooden H-pole structures to the substation. From the VYNPS switchyard to the New Hampshire State line, the lines are owned by Vermont Electric Power Company, Inc. (VELCO). From the State line to the Chestnut Hill substation, the line is owned by Public Service Company of New Hampshire (a subsidiary of the Northeast Utilities System). The right-of-way (ROW) is 300 ft wide and occupies approximately 73 ac. The 115-kV Keene Line is identified in Figure 2-6. The Keene line starts at the Chestnut Hill Substation and is out of scope.

The second transmission line, the Coolidge line, extends north from the VYNPS 345-kV substation for roughly 50 mi to the Coolidge substation located near Ludlow, Vermont (Figure 2-7). The line extends north from VYNPS on steel, single-pole structures for 2 mi and then on wooden H-pole structures to the Coolidge substation. The Coolidge line is owned and operated by VELCO. The line was built in 1971 to 345-kV standards but initially operated at 115 kV; in 1974, it began operating at 345 kV. The ROW is 200 ft wide and occupies approximately 1212 ac.

Two other 345-kV lines that enter the VYNPS 345-kV substation were not built to connect VYNPS to the grid. The Amherst 345-kV transmission line and the Northfield 345-kV transmission line were constructed in the 1970s as part of a regional 345-kV upgrade of the northeast grid. The Amherst line (also known as the Scobie line) is owned and operated by Public Service Company of New Hampshire. The Northfield line is owned and operated by Western Massachusetts Electric Company. The owners of the Amherst and Northfield lines are subsidiaries of the Northeast Utilities System. The final transmission line entering VYNPS is a buried 13.2-kV line from the Vernon Hydro Station that provides a source of offsite power for the plant.

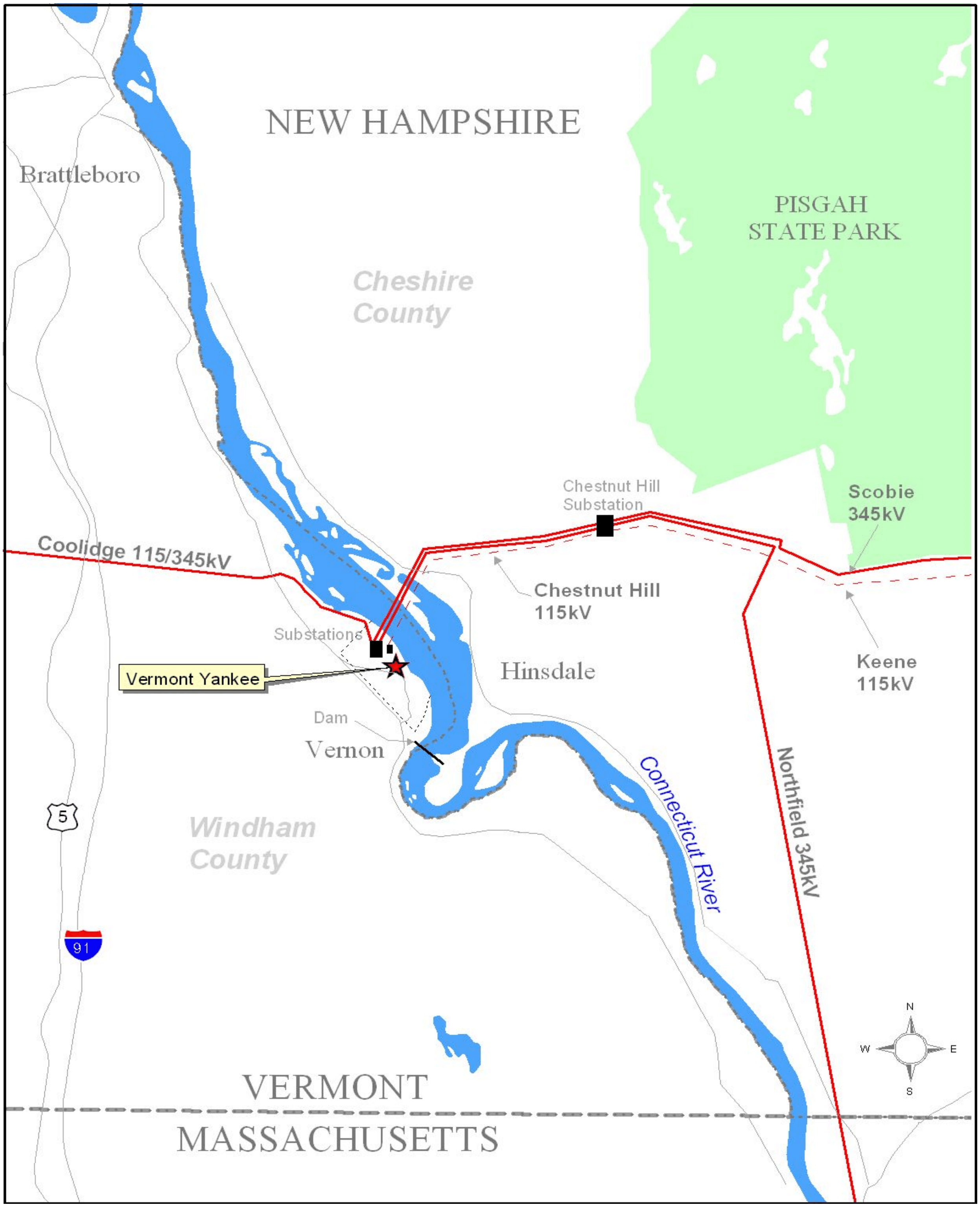

Figure 2-6. Location of the Chestnut Hill Transmission Line

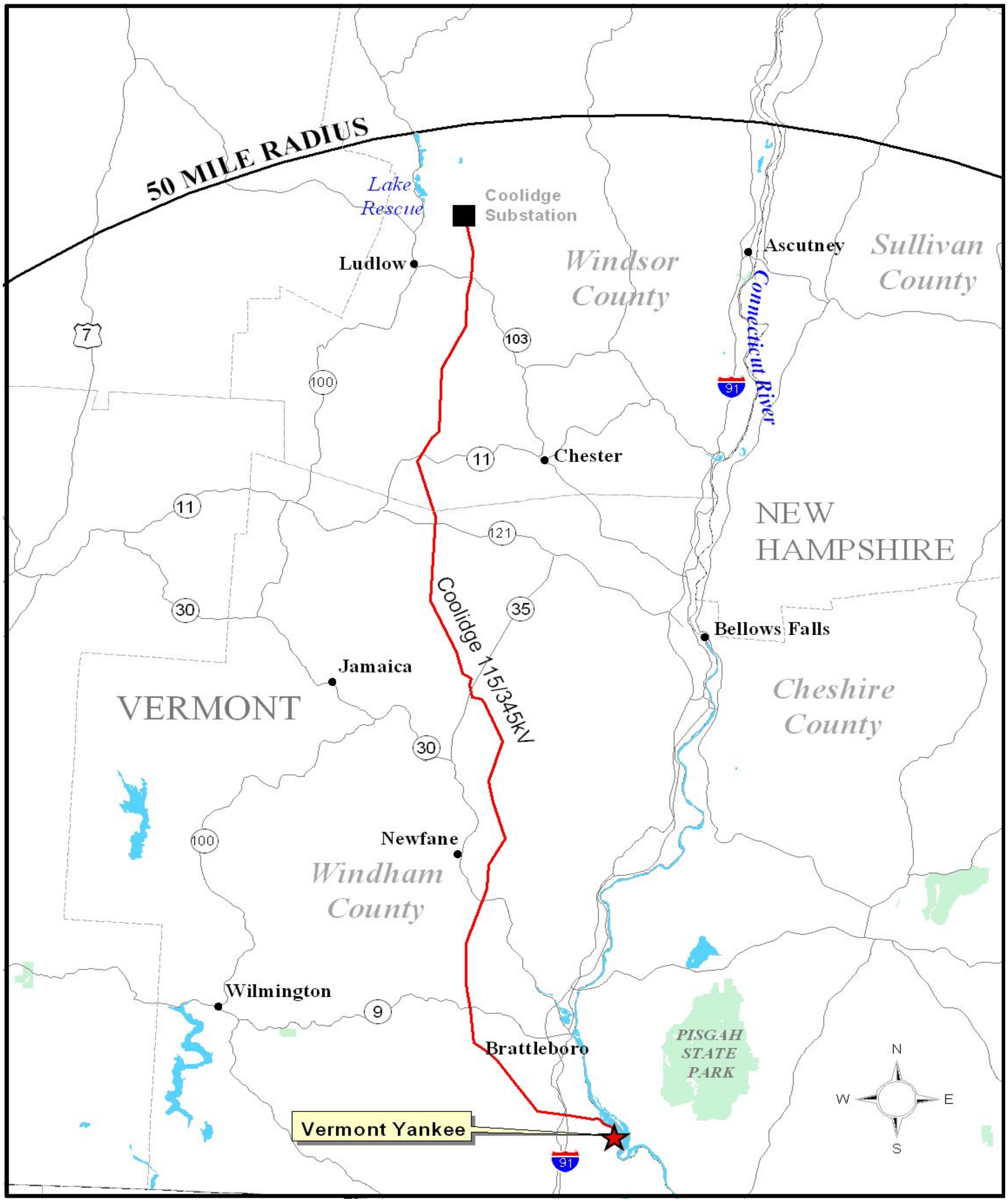

Figure 2-7. Location of the Coolidge Transmission Line

Maintenance and monitoring of the Coolidge and Chestnut Hill transmission line ROWs in Vermont are managed by VELCO. Right-of-way vegetation maintenance practices in Vermont include the use of mechanical clearing and hand-applied herbicides (Entergy 2006e). Regulated wetlands are avoided, and widespread application of herbicides is avoided. Wetlands, wildlife, aesthetics, erosion, and rare and uncommon natural areas and sites with rare plants or invasive nuisance plants are considered in the maintenance of the Coolidge line. Maintenance of the Chestnut Hill line in New Hampshire is by Northeast Utilities System. Vegetation control is achieved using only mechanical methods and vegetation planting practices (Entergy 2006e). No herbicides are used in maintenance of the ROW in New Hampshire. Monitoring of the transmission lines by the respective owners is accomplished through aerial inspection (Entergy 2006e). No changes in the design and operation of the transmission lines are anticipated during the VYNPS license renewal period.

2.2 Plant Interaction with the Environment

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

2.2.1 Land Use

The VYNPS site is located in the town of Vernon, Vermont, in Windham County, in the southeastern corner of the State and approximately 4 mi north of the Massachusetts state line (Figure 2-2). The 125-ac site, about 1 mi wide, is owned by Entergy Nuclear Vermont Yankee, LLC and is situated on the west shore of the Connecticut River across from Hinsdale, New Hampshire, on the east side of the river (Figure 2-3). Entergy has received perpetual rights and easements from the owner of a narrow strip of land between the Connecticut River and the east boundary of the VYNPS property. The property bounding the site to the north, south, and west is privately owned. VYNPS controls the river water between the northern and southern boundary fences extending out to the state border near the middle of the river. The site is located on Vernon Pond, formed by Vernon Dam and Hydroelectric Station located immediately downstream 0.75 mi from the VYNPS site (Entergy 2006a; Entergy 2004c).

The station site natural grade level is at an elevation of 250 ft mean sea level (MSL). It is situated on glacial deposits from the Pleistocene Age, with an average 30 ft of glacial overburden over local bedrock. Bedrock exists at or near the foundation grades of several structures. The land use within the site boundaries is characterized by grasslands and early succession areas (53 percent), developed areas (28 percent), mixed softwood and hardwood forested areas (16 percent), shrubs (2 percent), and wetlands (1 percent) (Entergy 2006a). The principal structures at VYNPS consist of a reactor building and primary containment, turbine building, control building, radioactive waste building, intake structure, cooling tower, and main stack. The Governor Jonathan Hunt house, built in the 1780s, is situated on the western boundary of the site and is maintained as an office and meeting facility. Entergy, with approval by the Vermont Public Service Board, is developing an independent spent fuel storage installation for dry cask storage using approximately 1 ac of site land to the north of the plant (Entergy 2004c, 2006a, 2006f).

The immediate area surrounding the VYNPS site is delineated by a 6-ft high-security perimeter fence topped by barbed wire and signs posted clearly informing an individual that the area is private property and unauthorized entry is strictly prohibited. Recreational users are precluded from landing on station waterfront property. Authorized access to the site is possible from either Governor Hunt Road through the main gate or from a spur of the New England Central Railroad. Vernon Pond to the south of the site is used to some extent for recreational purposes (Entergy 2004c, 2006a).

The town of Vernon has no zoning ordinances, subdivision ordinances, or development review board that would affect or determine the site's land use. The town prepared and officially adopted the 2003 Vernon Town Plan to chart a course for development that will benefit the town and its future generations and represent a conscious community decision about the town's future character and its priorities for land use and conservation of natural resources (Town of Vernon 2003a; Entergy 2006a).

2.2.2 Water Use

VYNPS does not use public water supplies for plant operations but instead relies on surface water from the Connecticut River and groundwater from onsite potable wells.

2.2.2.1 Surface Water

The VYNPS is located on the west bank of Vernon Pool on the Connecticut River, about 0.75 mi upstream of the Vernon Hydroelectric Dam (Vernon Dam), which is located at river mile (RM) 142. Vernon Pool is the impounded portion of the Connecticut River directly upstream of the dam; it is both the source and receiving water body for the plant's cooling system. The pond covers 2250 ac (at full-pool elevation of 220.13 ft behind Vernon Dam) and extends to Bellows Falls Dam at RM 174. It is about a half mile wide with a maximum depth of about 40 ft (AEC 1972; Entergy 2006a).

The Connecticut River has an average daily flow of 10,500 cubic feet per second (cfs) at Vernon Dam, based on flows measured from 1944 to 1988 (Entergy 2006a). During this period, monthly flow rate averages ranged from 4005 cfs in August to 30,799 cfs in April. The average daily flow from 2000 to 2005 was 11,101 cfs at Vernon Dam (based on measurements reported in Normandeau 2001, 2002, 2003, 2004b, 2005; DeWald 2006b). During this period, monthly flow rate averages ranged from 4525 cfs in September to 30,824 cfs in April (Figure 2-8). Figure 2-9 is a plot of the monthly flow rate averages for 2004 and 2005, illustrating the degree of variability that can occur from year to year. In 2004, the average daily flow was 9851 cfs at Vernon Dam, with monthly flow rate averages ranging from 3967 cfs in October to 23,570 cfs in April (Normandeau 2005). In 2005, the average daily flow was 14,334 cfs at Vernon Dam, with monthly flow rate averages ranging from 2661 cfs in August to 36,764 cfs in April (DeWald 2006b). According to the Indirect Discharge Permit (ID-9-0036), the low median monthly flow[(a)] at Vernon Pool is 3050 cfs; the flow under drought conditions[(b)] is 1523 cfs (VDEC 2005b).

The Vernon Dam, owned and operated by TransCanada, regulates the river discharge to maintain a minimum sustained flow of 1250 cfs, although under severe drought conditions, flow

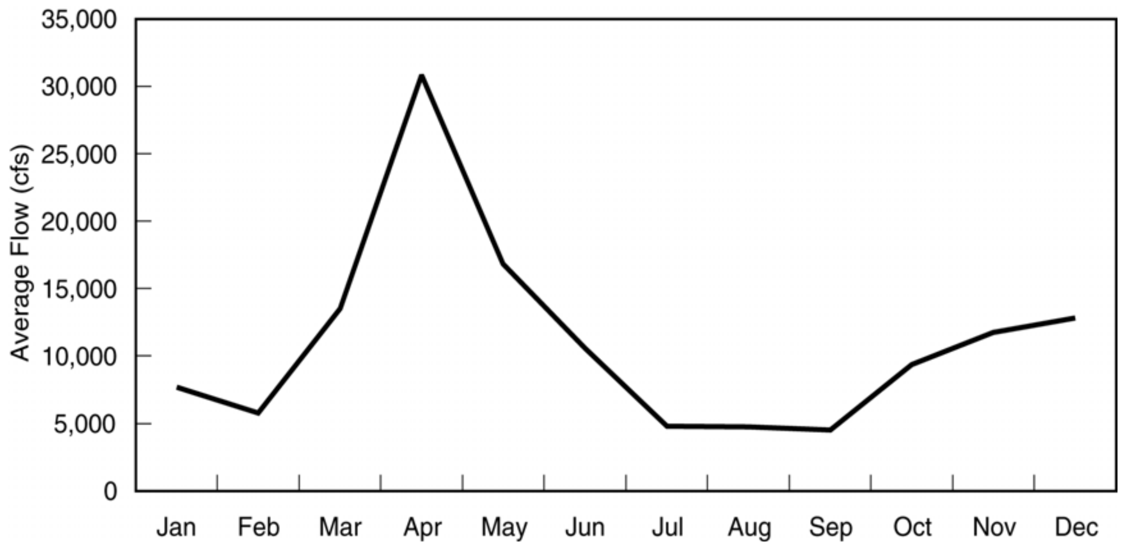

Figure 2-8. Average Monthly Flow Rates at Vernon Dam from 2000 to 2005 (Data sources: Normandeau 2001, 2002, 2003, 2004b, 2005; DeWald 2006a)

(a) According to the Vermont Water Quality Standards, Section 1-01.B.24, low median monthly flow is the median monthly flow for the month having the lowest median monthly flow in a given year (VWRB 2006).

(b) Drought flow is referred to as 7Q10 in Vermont Water Quality Standards, Section 3-01.C.1.b and is the 7-day average low flow over a 10-year return period, adjusted to nullify any effects of artificial flow regulation, that has a 10 percent chance of occurring in a given year (VWRB 2006).

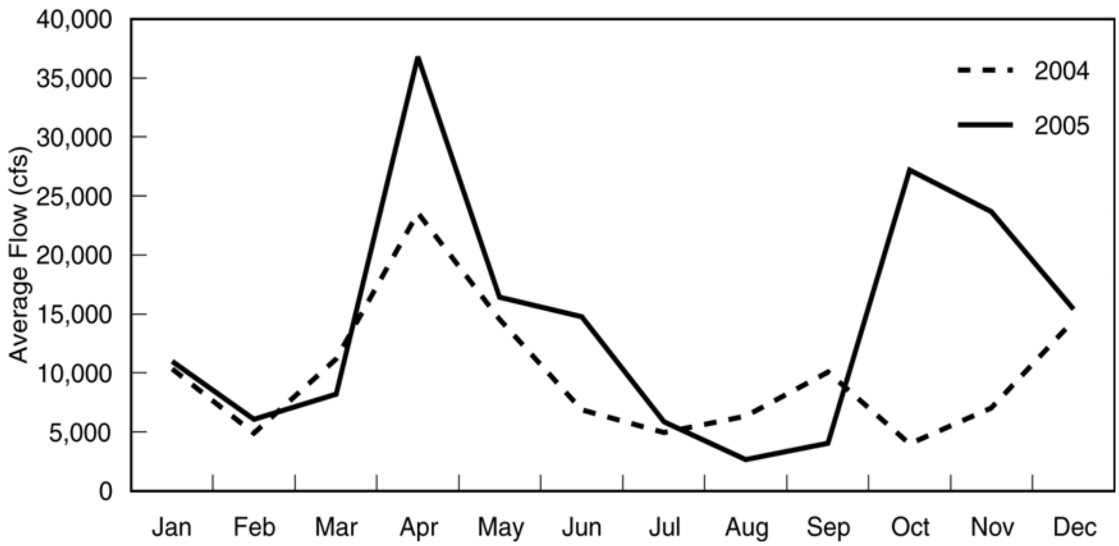

Figure 2-9. Average Monthly Flow Rates at Vernon Dam for 2004 and 2005 (Data sources: Normandeau 2005; DeWald 2006a)

rates may drop below 1250 cfs. There are a total of nine hydroelectric dams and three storage dams on the main stem of the Connecticut River upstream of the dam and three hydroelectric dams and one pumped-storage facility downstream of the dam (Normandeau 2004a). Impounded water in Vernon Pool allows for some flexibility in flow release from Vernon Dam; its surface elevation may fluctuate as much as 8 ft due to operations at upstream dams, Vernon Dam, and runoff inflow (Entergy 2006a).

Cooling Water Use

The VYNPS withdraws water for its variable cooling system from Vernon Pool on the Connecticut River. Cooling water can be circulated through the system in one of three modes of operation: open-cycle (also called once-through cooling), closed-cycle, or a combination hybrid-cycle (Entergy 2004c; NRC 2006a). The plant has the highest water usage in the open-cycle mode of operation, withdrawing up to 360,000 gpm (802 cfs) from Vernon Pond. In the closed-cycle mode, the rate of water pumped is reduced to about 10,000 gpm (22 cfs) (Entergy 2006a). The rate of water withdrawn from Vernon Pool in the hybrid-cycle mode falls between that of the open- and closed-cycle modes.

Cooling water is discharged back to Vernon Pool through NPDES Outfall 1 at the discharge structure about 1700 ft downstream of the intake structure, as shown in Figure 2-10. A description of the plant's outfalls and their daily flow rate limits is provided in Table 2-1. For

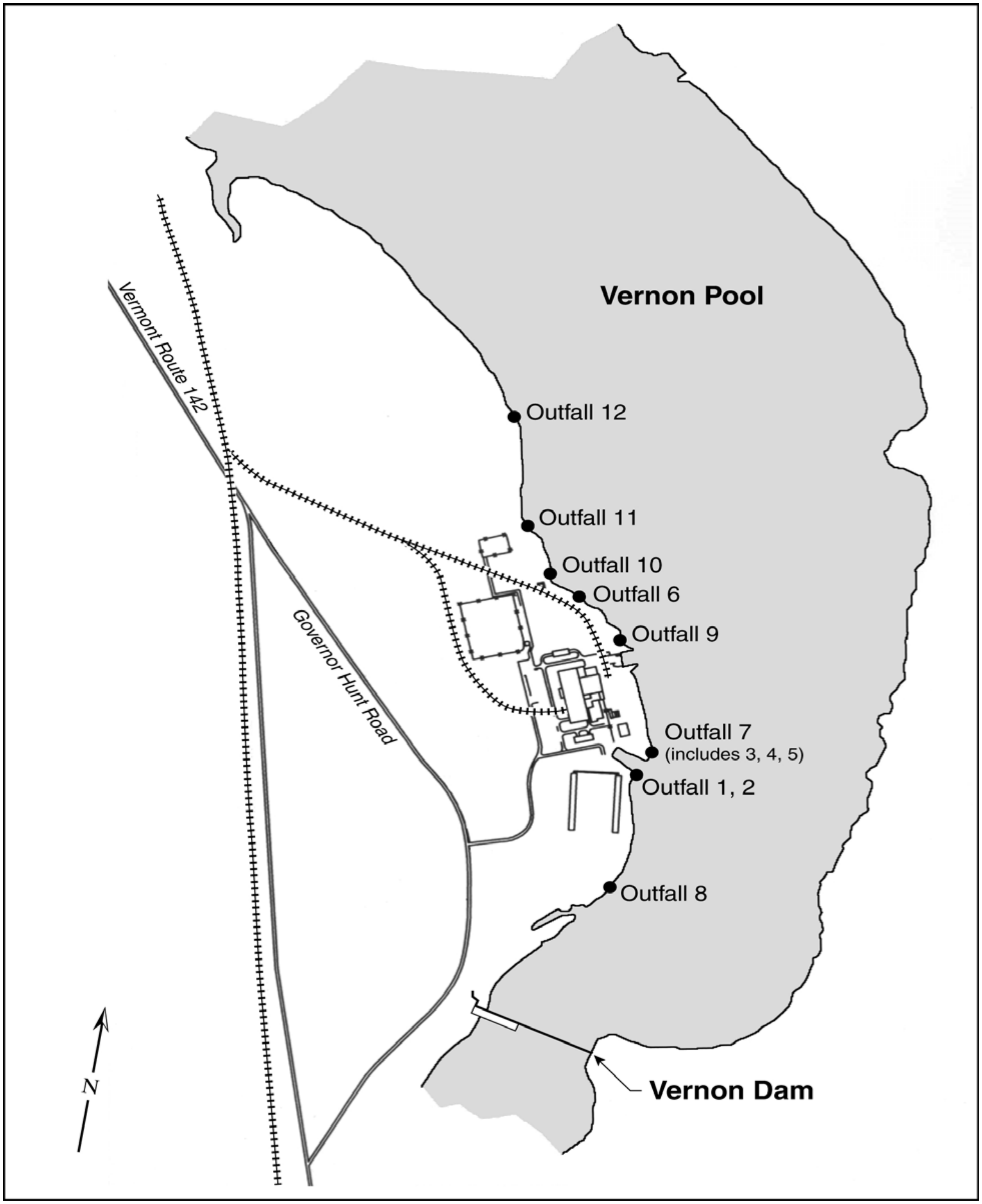

Figure 2-10. Locations of NPDES Outfalls at the VYNPS (Source: Entergy 2006a)

Table 2-1. VYNPS NPDES Discharge Locations

Outfall	Permitted Daily Flow Rate (gpd)	Description
S/N 001	543 million (Open/hybrid cycles) 12.1 million (Closed cycle)	Circulating water discharge – main condenser cooling water and service water. Discharged to the Connecticut River at discharge structure 1700 ft downstream from intake.
S/N 002	10,000	Radioactive high purity water; discharged to the Connecticut River at discharge structure. No discharge has occurred at this outfall since 1981.
S/N 003	1000	Plant heating boiler water (blowdown); discharged to the Connecticut River at discharge structure.
S/N 004	10,000	Water treatment carbon filter backwash; discharged to the Connecticut River at discharge structure.
S/N 005	46,500[(a)]	Cooling water discharge from the four residual heat removal (RHR) service water pumps; discharged to the Connecticut River at discharge structure.
S/N 006	10,000[(a), (b)]	Stormwater runoff and demineralized trailer rinse down water. North storm system discharge point, about 600 ft to the north of the intake structure.
S/N 007	–[(b)]	Stormwater runoff; south storm system discharge point to the forebay of the discharge structure (includes discharges from S/N 003, S/N 004, and S/N 005).
S/N 008	–[(b)]	Stormwater runoff; southeast storm system discharge point to the southeast of the east cooling tower, about 2100 ft downstream from discharge structure.
S/N 009	50,000	Strainer and traveling screen backwash; discharge to the Connecticut River at the intake structure.
S/N 010	–[(b)]	Stormwater runoff; 345-kV switchyard storm system discharge point about 900 ft north of the intake structure.
S/N 011	–[(b)]	Stormwater runoff; 115-kV switchyard storm system discharge point about 1200 ft north of the intake structure.
S/N 012[(c)]	–[(b)]	Stormwater runoff from new gravel parking lot; new outfall (as of 2005) about 1500 ft north of the intake structure.

(a) Permitted flow rate value for demineralized trailer rinse down water.
(b) Effluent limits and monitoring are not required for stormwater discharges.
(c) Outfall is a new stormwater discharge specified in the VYNPS NPDES permit renewal application, submitted on September 29, 2005.
Sources: Entergy 2005e; VDEC 2004; VDEC 2006a

open- and hybrid-cycle cooling, the daily discharge limit at NPDES Outfall 1 is 543 million gallons per day (gpd) (840 cfs); for closed-cycle cooling, it is 12.1 million gpd (19 cfs).

Maximum consumptive water use, which occurs through cooling tower evaporation when the plant is operating in a closed-cycle mode, is estimated to be about 5000 gpm (11 cfs) (AEC 1972). (Consumptive use refers to the amount of water withdrawn from the river that is not returned to the river because of evaporative losses.)

An extended power uprate at VYNPS was authorized on March 2, 2006. While the rate of river water withdrawal from Vernon Pool is not affected by the uprate, there may be a small increase in the amount of water consumed. This is due to the need to operate the plant in closed and hybrid-cycle cooling modes, using cooling towers more often to dissipate heat to the atmosphere rather than the river to meet the thermal limits set in the NPDES permit (see Section 2.2.3.1). During the NPDES summer period (May 16 to October 14), as defined in the NPDES permit currently in effect (VDEC 2004), the increased water consumption is estimated to be less than 0.1 percent of the average monthly river flow. During the NPDES winter period (October 15 to May 15), the increased water consumption will be less than 0.2 percent of the average monthly river flow (NRC 2006a).

Auxiliary Water Use

Additional pumps at the intake structure can also withdraw up to 5000 gpm (11 cfs) as needed for the plant's fire protection system. This water supplies the automatic wet pipe sprinkler systems, standpipes, and hose stations throughout the station (Entergy 2004c).

2.2.2.2 Groundwater

Groundwater at the site occurs under unconfined conditions within both unconsolidated glacial overburden sediments and the underlying fractured bedrock. In the vicinity of the major plant structures, groundwater is approximately 20 ft below ground surface. In the northern portion of the site, depth to groundwater varies from about 5 ft to 18 ft below ground surface. Along the southern portion of the site, depth to groundwater is approximately 30 ft below ground surface with some water table surfaces ranging between 8 and 16 ft, indicating perched groundwater in the area (Environmental Compliance Services, Inc. 2001; Battelle 1991).

At VYNPS, potable water is supplied to various locations from four onsite wells, as shown in Table 2-2. These wells are classified as nontransient, noncommunity public water systems and are permitted and regulated by the State of Vermont. Based on pump rates and measured water usage during 2002 and 2003, the maximum pump rate from all wells was 8.54 gpm; however, given the well rating capacities, the total pump rate could be as high as 123.2 gpm, if all the wells are operated simultaneously.

Table 2-2. VYNPS Potable Water Wells

Well	Areas Served	Well Depth (ft)	Well Rating (gpm)	Maximum Water Demand (gpm)
Construction Office Building	Construction Office Building	362	9	6.4
Southwest	Main Building complex; secondary/backup source for West Well	500	10.5	–[(a)]
West	Main Building complex; Gate House 1 and 2, South Warehouse, and Governor Hunt House	555	73.7	25
New Engineering Office Building	New Engineering Office Building	500	30	4
	Total rates (gpm):		123.2	35.4

(a) Not available.
Sources: Entergy 2004c, 2005d

The maximum groundwater demand on the VYNPS site would occur during a refueling outage and is estimated to be 35.4 gpm, as shown in Table 2-2.

2.2.3 Water Quality

2.2.3.1 Surface Water

The Vermont Water Resources Board classifies the Connecticut River at the station's point of discharge as a Class B water (VDEC 2006a). Class B waters are managed to achieve and maintain a level of quality that supports aquatic biota, wildlife, and aquatic habitat; have aesthetic value; and are suitable for public water supply with filtration and disinfection, for swimming and other water-based recreation, and for crop irrigation and other agricultural uses (VWRB 2006).

Surface water quality is regulated through the U.S. Environmental Protection Agency's (EPA) NPDES permit program. Section 402 of the Clean Water Act specifies that "NPDES prohibits [discharges] of pollutants [including heat] from any point source into the nation's waters except as allowed under an NPDES permit." Its purpose is to regulate the discharge of wastewater to maintain water quality of receiving water bodies. It also requires that the "location, design, construction, and capacity of cooling water intake structures reflect the best technology available" to minimize adverse impacts on the environment. The State of Vermont has been delegated responsibility by the EPA for administration of the NPDES program in Vermont. NPDES permits are issued by the VDEC on a five-year cycle (EPA 2006a).

VYNPS is currently operating under the NPDES permit issued on September 28, 2004 (VDEC Permit No. 3-1199, NPDES Number VT0000264; VDEC 2004). The permit specifies the discharge standards and monitoring requirements for effluents at the plant's 11 outfalls on the Connecticut River (an additional stormwater outfall, NPDES Outfall 12, was identified in the NPDES permit renewal application, submitted on September 29, 2005, approval pending; VDEC 2005a). The locations of the NPDES outfalls are shown on Figure 2-10; their monitoring requirements are summarized in Table 2-3.

In addition to the water quality parameters listed in Table 2-3, the plant is also required to monitor:

- River flow rates on an hourly basis at Vernon Dam,
- Temperatures on an hourly basis at River Monitoring Station 3 (0.65 mi downstream of dam) and River Monitoring Station 7 (4 mi upstream of plant), and
- Concentrations of three metals (copper, iron, and zinc) via monthly grab samples at NPDES Outfall 1 and at River Monitoring Stations 3 and 7.

Figure 2-11 shows the locations of Vernon Dam and River Monitoring Stations 3 and 7. River flow rates at Vernon Dam are discussed in Section 2.2.2; temperatures and metal concentrations are discussed in the following sections.

Temperature Requirements under the Current NPDES Permit

The current NPDES permit (VDEC 2004) defines two seasonal periods (winter, from October 15 through May 15; and summer, from May 16 through October 14) and sets limits for the increase in temperatures at River Monitoring Station 3, less than a mile downstream of Vernon Dam. These are presented in detail in Table 2-4.

NPDES permits are issued for five years at a time. On July 11, 2001, VDEC issued a renewed permit for VYNPS with an expiration date of March 31, 2006, and the permit was amended on June 9, 2003 (VDEC 2003) and again on September 28, 2004 (VDEC 2004). On February 20, 2003, Entergy applied to the VDEC to amend the permit for VYNPS to increase the temperature of the Connecticut River by 1°F as determined at River Monitoring Station 3 (downstream monitoring station) during the NPDES summer period (May 16 through October 14). On March 30, 2006, VDEC issued an amendment to the permit for VYNPS; however, the amended permit only authorized the requested temperature increase for the period from June 16 through

Table 2-3. Monitoring Requirements for Water Quality Parameters at NPDES Outfalls

Outfall Name	Parameter (Limits)	Monitoring Requirement
S/N 001	Free residual chlorine[a,b] (0.2 mg/L)	Chlorine/oxidant injection limited to closed-cycle cooling; daily grab samples required during period when treatment is occurring
	Total residual oxidant[b]	
	pH (6.5 to 8.5)	Daily grab samples
S/N 002	Radioactivity[c]	Daily when discharge occurs[d]
	pH (6.5-8.5)	Daily grab samples
S/N 003	Cortrol OS7700[e] (15 ppm hydroquinone)	No monitoring required
S/N 004	Total suspended solids (8.3 lb)	No monitoring required
S/N 005	No limits specified	No monitoring required
S/N 006	No limits specified	No monitoring required
S/N 007	No limits specified	No monitoring required
S/N 008	No limits specified	No monitoring required
S/N 009	Bulab 8006[e] (20 ppm within service water system)	No monitoring required
S/N 010	No limits specified	No monitoring required
S/N 011	No limits specified	No monitoring required
S/N 012	–[f]	–[f]

(a) Oxidant or chlorine injection is limited to discharge during a closed cycle or when the service water system is treated during open/hybrid-cycle operation; detectable residuals are not to exceed 2 hours/day.
(b) Total oxidant is chlorine, bromine, or a combination of the two.
(c) VYNPS is required to adhere to limits set in 10 CFR Parts 20.1001 through 20.2402.
(d) Vermont Wastewater Management Division must be notified prior to discharge or, if necessary, within 24 hr following the discharge.
(e) VYNPS is also authorized to use Bulab 8006, a penetrant/biodispersant to reduce fouling within service water system; Bulab 7034 or Depositrol BL5303 for corrosion control in service and circulating water with a maximum permitted concentration of 30 ppm; Bulab 9027 or Inhibitor AZ8103 for copper corrosion control in circulating water with maximum permitted concentrations of 10 ppm and 50 ppm, respectively; Dianodic DN2301, a dispersant for service and circulating water with a maximum permitted concentration of 20 ppm; Cortrol OS7700, an oxygen scavenger and pH control agent (containing hydroquinone) with a maximum permitted concentration of 15 ppm hydroquinone in boiler discharge; Ferroquest FQ7101 for biological and corrosion fouling control in service water system, with a maximum permitted concentration of 96 ppm for 1min eight times per year; and Ferroquest FQ7102 for pH control, with a maximum permitted concentration of 7 ppm for 1 min eight times per year.
(f) Outfall is a new discharge location (stormwater) specified in the VYNPS NPDES permit renewal application, submitted on September 29, 2005 (approval pending).

Source: VDEC 2003

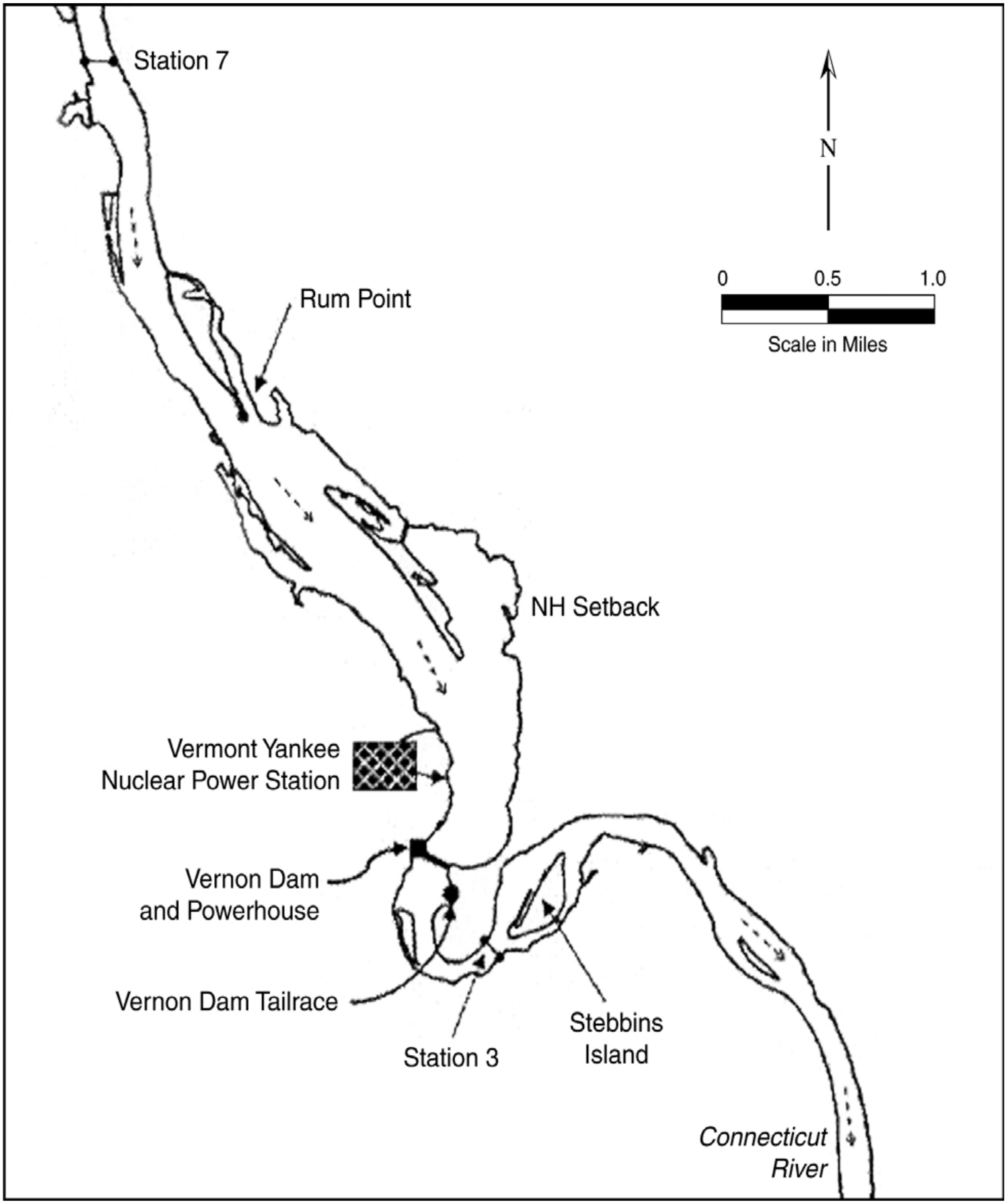

Figure 2-11. Locations of Vernon Dam and River Monitoring Stations 3 and 7 Relative to VYNPS (Source Entergy 2006a)

Table 2-4. Discharge Temperature Requirements Under the Current and Amended NPDES Permits for VYNPS

Currently Enforced NPDES Permit (September 28, 2004)	**Amended NPDES Permit (March 30, 2006)**
Winter (October 15 through May 15) at downstream Station 3[a]: • Temperature shall not exceed 65°F; • The rate of change of temperature (i.e., the mean difference between consecutive hourly average temperatures) shall not exceed 5°F per hour; • The plant-induced increase in temperature above ambient water temperature as measured at Station 7[b] shall not exceed 13.4°F.	Winter (October 15 through May 15) at downstream Station 3[a]: • Temperature shall not exceed 65°F; • The rate of change of temperature (i.e., the mean difference between consecutive hourly average temperatures) shall not exceed 5°F per hour; • The plant-induced increase in temperature above ambient shall not exceed 13.4°F.
Summer (May 16 through October 14): • The increase in river water temperature at Station 3 above ambient water temperature as measured at Station 7 shall not exceed the following:	Early Summer (May 16 through June 15): • The increase in river water temperature at Station 3 above ambient water temperatures as measured at Station 7 shall not exceed the following:
Upstream Station 7 temperatures — Temperature increase above Station 7 measured at Station 3 shall not exceed Above 63°F — 2°F >59°F, ≤63°F — 3°F ≥55°F, ≤59°F — 4°F Below 55°F — 5°F	Upstream Station 7 temperatures — Temperature increase above Station 7 measured at Station 3 shall not exceed Above 63°F — 2°F >59°F, ≤63°F — 3°F ≥55°F, ≤59°F — 4°F Below 55°F — 5°F
	Summer (June 16 through October 14): • The increase in river water temperature at Station 3 above ambient water temperatures as measured at Station 7 shall not exceed the following limits:
	Upstream Station 7 temperatures — Temperature increase above Station 7 measured at Station 3 Above 78°F — 2°F >63°F, ≤78°F — 3°F >59°F, ≤63°F — 4°F ≤59°F — 5°F
	• When the average hourly temperature at Station 3 equals or exceeds 85°F, the thermal output of the discharge must be reduced to the extent that the average hourly temperature at Station 3 does not exceed 85°F.

(a) Station 3 is located 1.4 mi downstream of VYNPS.
(b) Station 7 is located 3.7 mi upstream of VYNPS.

October 14 (VDEC 2006a). VDEC concluded that additional information was needed to evaluate the impacts of the temperature October 14 (VDEC 2006a). VDEC concluded that additional information was needed to evaluate the impacts of the temperature increase on migrating salmon smolt during the May 16 through June 15 portion of the NPDES summer period, since it marks the end of the smolt outmigration period. The permit would have expired on March 31, 2006; however, Entergy submitted an application for a renewed permit on September 29, 2005 (Entergy 2005e). By letter dated September 30, 2005, VDEC informed Entergy that the renewal application was timely and that the permit would remain valid under an administrative extension until VDEC completes the review of the permit renewal application (VDEC 2005a).

In May 2006, the New England Coalition (NEC), along with the Connecticut River Watershed Council, Trout Unlimited, and the Citizens Awareness Network, appealed the NPDES permit amendment that was issued on March 30, 2006. On June 13, 2006, Entergy challenged the State's denial of the 1°F increase for the period May 16 to June 15. The March 30, 2006, permit was stayed by the State of Vermont Environmental Court on August 28, 2006. As of the final publication date of this SEIS, VYNPS was operating under the NPDES permit as issued on September 28, 2004 (VDEC 2004). The temperature requirements of the current and amended NPDES permits are presented in Table 2-4. The future status of the permit depends on the outcome of the litigation. Potential outcomes include (1) no temperature increase in discharge for the entire period (May 16 through October 14); (2) temperature increase in discharge for the period June 16 through October 14 only; or (3) temperature increase in discharge for the entire period (May 16 through October 14).

Methods of Demonstrating Compliance

The permit requirements in effect at the time this SEIS was issued are described below. The NPDES permit requires that during the winter period (October 15 through May 15), the plant-induced temperature at downstream River Monitoring Station 3 shall not exceed 65°F (Table 2-4). The plant-induced temperature increase is calculated using the equation published in the executive summary of the 1978 demonstration report (Aquatec 1978). The equation is based on the principle of conservation of energy and takes into account the heat content of the plant's circulating water system and cooling towers, the heat content of the plant's cooling water discharge to the river, and the average discharge (flow) of the Connecticut River as measured at Vernon Dam[a]. Measurement and cooling system data are linked to a process computer that

(a) The heat content of the circulating water system and cooling towers is calculated on the basis of the change in condenser inlet temperatures over a specified time interval. The heat content of the cooling water discharge is calculated on the basis of the number and pumping capacity of circulating water intake pumps, the difference between condenser inlet and outlet temperatures, the number of circulating intake and cooling tower booster pumps, and the cooling tower outlet temperatures, all over a specified time interval (Normandeau 2005).

allows plant personnel to adjust operations on the basis of continual real-time data to meet the thermal requirements of the permit (Normandeau 2005).

The Vernon Dam regulates the river discharge to maintain a minimum sustained flow of 1250 cfs. At 1250 cfs, the permitted theoretical maximum increase in temperature at River Monitoring Station 3 due to the plant's thermal discharge is 12.9°F. In effect, the plant can operate in an open-cycle cooling mode (without cooling tower operation) when ambient river temperatures as measured at the upstream monitoring station (River Monitoring Station 7) are less than 52.1°F (i.e., 65°F minus 12.9°F) during the winter period. At ambient temperatures equal to or greater than 52.1°F, the plant's heat discharge can be reduced by using the cooling towers to dissipate heat to the atmosphere (especially during periods of low river flow) (Normandeau 2005). The NPDES permit requires that the plant-induced increase in temperature above the ambient temperature at River Monitoring Station 3 (downstream of VYNPS) never exceeds 13.4°F and that the rate of increase never exceeds 5°F per hour. These two limitations were included in NPDES permit dated July 11, 2001 and the amendments dated June 9, 2003, September 28, 2004, and March 30, 2006.

Table 2-5 summarizes the maximum simulated river temperature increases at River Monitoring Station 3 and the flows at which they occurred during the winter period (October 15 through May 15) for the years 2000 through 2006.

Table 2-5. Maximum Calculated River Temperature Increase at River Monitoring Station 3 During the NPDES Winter Period (October 15 through May 15)

Year	Day	Maximum Temperature Increase	Permit Limit	River Flow (cfs)	Exceeded 5°F/hr?[b]
2006[a]	March 12	6.03°F	13.4°F	2958	No
2005	February 10	12.91°F	13.4°F	1285	No
2004	February 2	12.9°F	13.4°F	1331	No
2003	January 25	13.16°F	13.4°F	1308	No
2002	January 23	12.7°F	13.4°F	1367	No
2001	December 21	12.67°F	13.4°F	1250	No
2000	November 26	12.6°F	13.4°F	1275	No

(a) Data through August 2006.
(b) The 5°F/hr limit pertains only to the NPDES winter period.
Sources: Normandeau 2001, 2002, 2003, 2004b, 2005; DeWald 2006c, 2006d

The limitations of the NPDES permit, dated June 9, 2003, for the plant-induced temperature increase at the downstream River Monitoring Station 3 during the summer period (May 16 through October 14) are shown in Table 2-4. Table 2-6 summarizes the maximum simulated river temperature increases at the station and the flows at which they occurred during the summer period for the years 2000 through 2006.

Table 2-6. Maximum Calculated River Temperature Increase at River Monitoring Station 3 During the NPDES Summer Period (May 16 through October 14)

Year	Day	Maximum Temperature Increase	Permit Limit	River Flow (cfs)
2006[(a)]	August 15	2.94°F	3.0°F	3168
2005	July 1	1.97°F	2.0°F	6760
2004	July 6	2.1°F	2.0°F	3483
2003	September 19	2.16°F	2.0°F	2802
2002	October 5	2.05°F	2.0°F	1697
2001	July 5	2.12°F	2.0°F	3923
2000	July 16[(b)]	2.74°F	2.0°F	6571

(a) Data through August 2006.
(b) July 21, 2000 was an exceedance but not the maximum exceedance for the year 2000.
Sources: Normandeau 2001, 2002, 2003, 2004b, 2005; DeWald 2006b, 2006d

Exceedences occurred in each of the years between 2000 and 2004, but in each case the exceedance was 1 hr or less in duration:

- On July 16 and 21, 2000, two 59-minute exceedences occurred (2.74°F and 0.03°F, respectively) when Vernon Dam went to minimum flow as a result of a loss of offsite power caused by a lightning strike (Normandeau 2001).

- On July 5, 2001, a 59-minute exceedence of 0.12°F occurred because plant operators did not shift to closed-cycle mode quickly enough to respond to changing river conditions.

- On October 5, 2002, a 60-minute exceedence of 0.05°F occurred because of unreliable automated input associated with new equipment (Normandeau 2003).

- On September 19, 2003, an 11-minute exceedence of 0.16°F occurred because plant operators shifted operating parameters in anticipation of an increase in river flow (reported by the Wilder Hydroelectric Dam). The increase in river flow occurred, but not to the degree anticipated (Normandeau 2004b).

- On July 6, 2004, a 45-minute exceedence of 0.06°F occurred when the plant was brought back on-line after an outage caused by a transformer fire (Normandeau 2005).

There were no exceedences from January 2005 through April 2007.

Temperatures in the Connecticut River

The monthly variation in river temperatures as measured at River Monitoring Stations 3 (downstream) and 7 (upstream) over a 5-year period (2000 to 2004) are shown in Figures 2-12 and 2-13, respectively. Over this period, monthly averages ranged from 34.5°F in January to 75.5°F in July at River Monitoring Station 3 and from 33.4°F in February to 73.3°F in August at River Monitoring Station 7.

Figure 2-14 is a plot of the temperature difference in average measured monthly temperatures between River Monitoring Stations 7 and 3 (i.e., Station 3 minus Station 7) in 2000 through 2004. There is an increasing trend throughout the spring, peaking in May, with Station 3 having an average temperature that was 5.9°F higher than that at Station 7, with a decreasing trend throughout the summer. In most months during this period, the average monthly temperatures at the downstream river monitoring Station 3 were greater than those at the upstream river monitoring Station 7. However, in September and December, the average monthly temperatures at Station 7 were higher than Station 3 (1.4°F and 0.4°F, respectively). The temperature difference between the stations was less than 1°F in January and March (Normandeau 2001, 2002, 2003, 2004b, 2005).

In June, July, and August 2002, temperature measurements were taken from thermistor stations along three bank-to-bank transects across Vernon Pool perpendicular to the river flow, as part of a study to characterize the circulation and distribution of heated water in the area between the VYNPS discharge structure and Vernon Dam (Figure 2-15; ASA 2004). Temperatures were measured at three depths at each of the three stations along each transect (Table 2-7). The June-July sampling period was chosen to represent expected conditions; August was chosen to represent low-flow, high-temperature conditions, usually considered the worst-case for potential impacts to aquatic biota.

The June-July measurements showed that temperature ranges were fairly similar along each transect between the VYNPS discharge structure and Vernon Dam: 67.1°F to 81.5°F at C stations, 67.3°F to 82.9°F at D stations, and 66.7°F to 81.9°F at E stations. Temperatures were generally lower at the F stations (67.1°F to 77.0°F), located upgradient of the VYNPS intake structure, during the same sampling period (Figure 2-15).

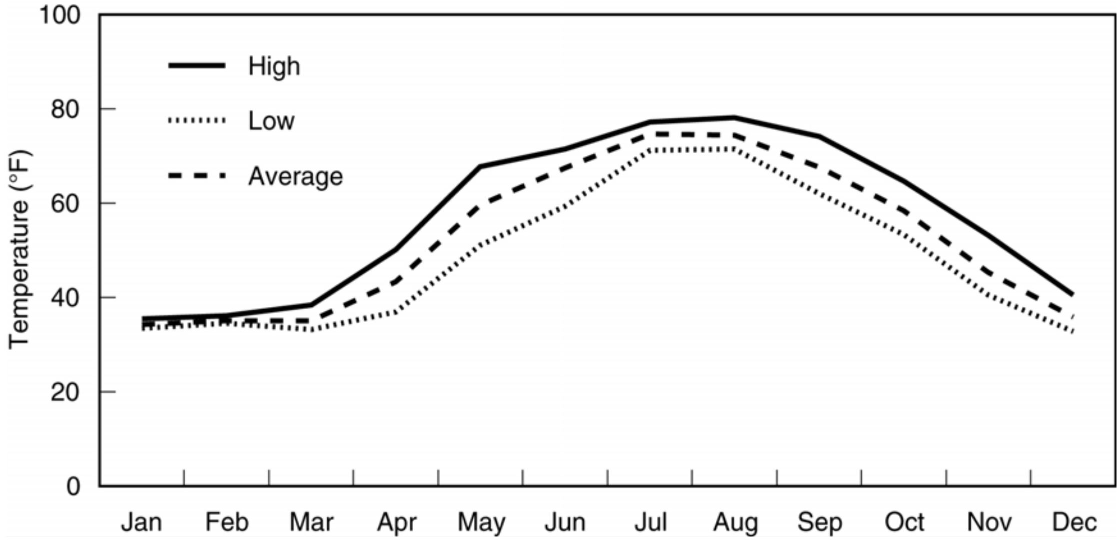

Figure 2-12. Seasonal Variation in Measured Temperature at River Monitoring Station 3, Located About 0.65 Miles Downstream of Vernon Dam (2000-2004) (Data sources: Normandeau 2001, 2002, 2003, 2004b, 2005)

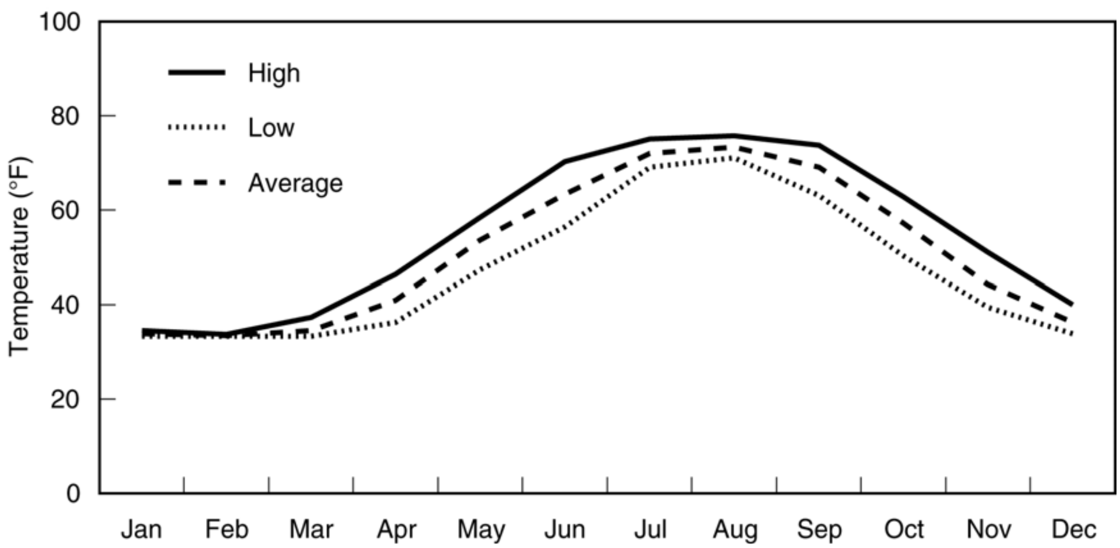

Figure 2-13. Seasonal Variation in Measured Temperature at River Monitoring Station 7, Located 4 Miles Upstream of VYNPS (2000-2004) (Data sources: Normandeau 2001, 2002, 2003, 2004b, 2005)

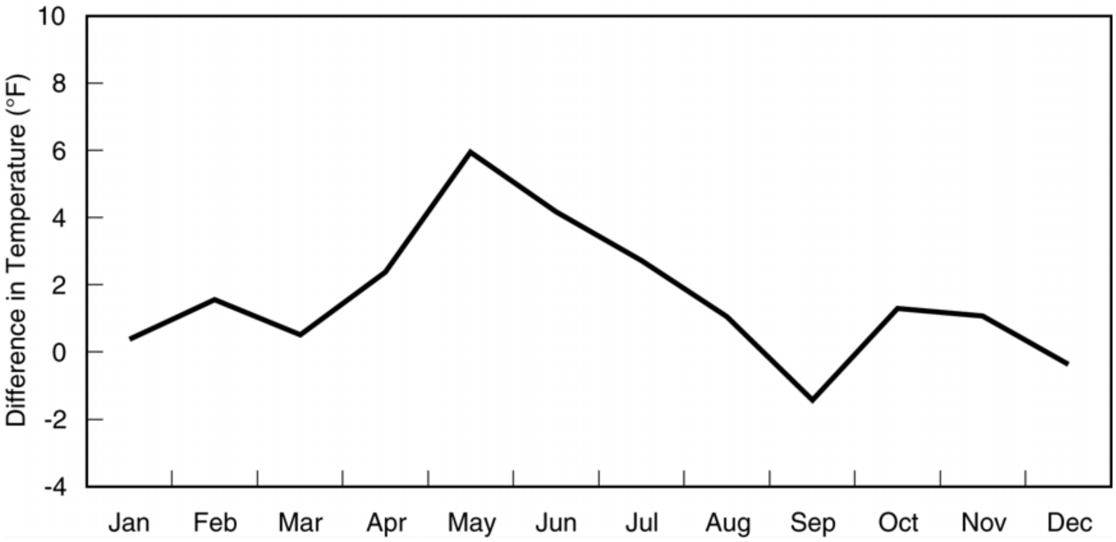

Figure 2-14. Difference in Average Measured Monthly Temperatures Between River Monitoring Stations 3 (downstream) and 7 (upstream) (Sources: Normandeau 2001, 2002, 2003, 2004b, 2005)

Table 2-7. Total Water Depth and Temperature Sampling Depths in Vernon Pool

Station Total	Water Depth (ft)	Surface Depth (ft)	Middle Depth (ft)	Bottom Depth (ft)
C1/C2	17	1	8.5	16
C3/C4	17	1	8.5	16
C5/C6	14	1	7	13
D1/D2	20	1	10	19
D3/D4	14.1	1	7	13
D5/D6	23	1	11.5	22
E1/E2	39	1	19.5	38
E3/E4	13	1	6.5	12
E5/E6	5	1	2.5	4
F1/F2	13	1	6.5	12
F3/F4	21	1	10.5	20

Source: ASA 2004

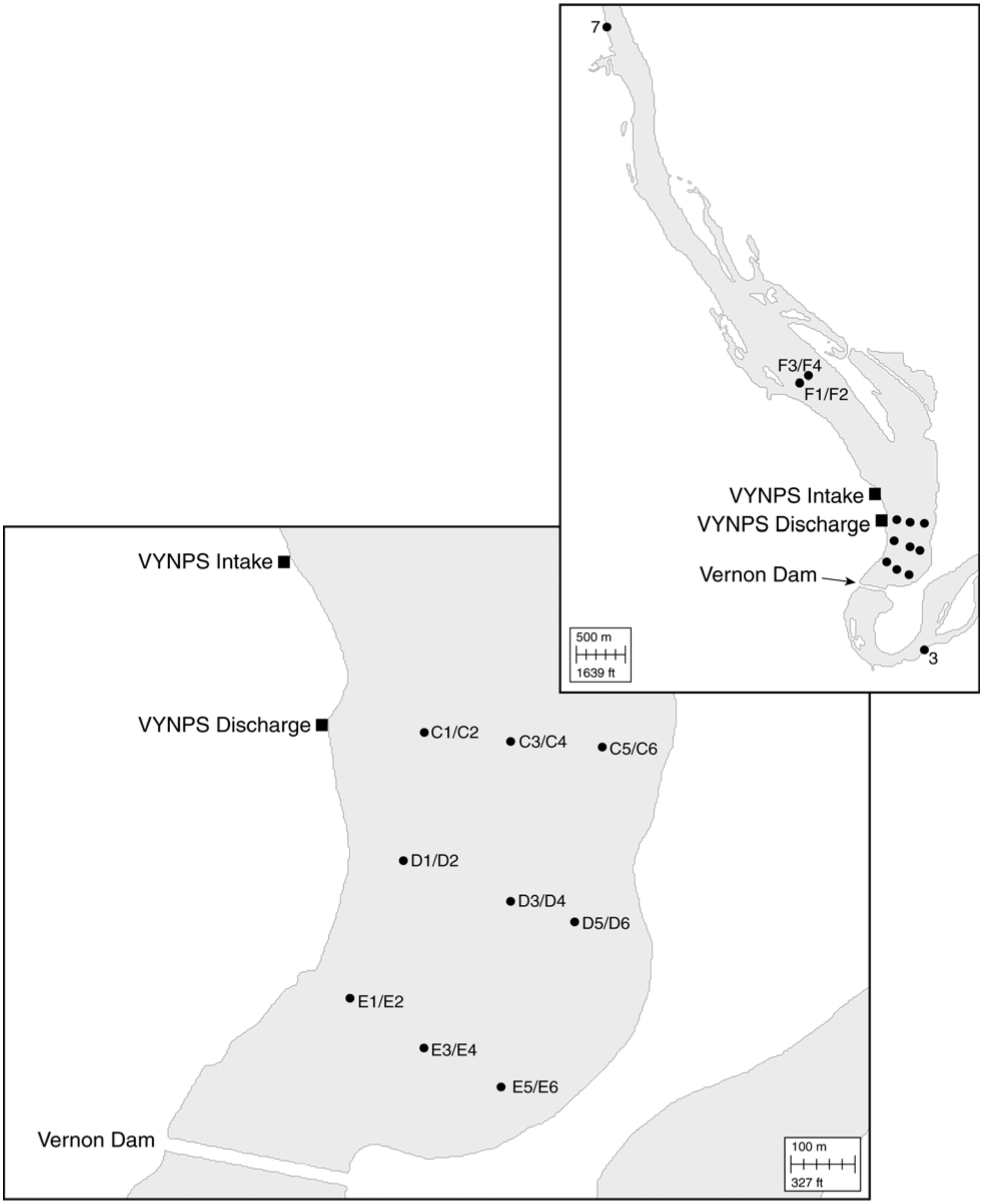

Figure 2-15. Locations of Thermistor Stations at Vernon Pool (Source: ASA 2004)

Table 2-7. Total Water Depth and Temperature Sampling Depths in Vernon Pool

Station Total	Water Depth (ft)	Surface Depth (ft)	Middle Depth (ft)	Bottom Depth (ft)
C1/C2	17	1	8.5	16
C3/C4	17	1	8.5	16
C5/C6	14	1	7	13
D1/D2	20	1	10	19
D3/D4	14.1	1	7	13
D5/D6	23	1	11.5	22
E1/E2	39	1	19.5	38
E3/E4	13	1	6.5	12
E5/E6	5	1	2.5	4
F1/F2	13	1	6.5	12
F3/F4	21	1	10.5	20

Source: ASA 2004

In the June-July sampling period, thermal stratification of the water column was highest (up to a 6.3°F difference across the thermocline) near the VYNPS discharge structure, and had a decreasing trend toward the dam. Measurements at the E stations near Vernon Dam showed little stratification of the water column; however, the diurnal variation in surface water temperature, due to fluctuations in river flow and the effects of solar heating, was as high as 1.8°F.

Significant gradients in the surface water temperature in Vernon Pool were also detected in the June-July sampling period. Temperatures across the transects varied as much as 5.4°F to 7.2°F, with the higher temperatures recorded near the west bank. Temperature variations were least pronounced during periods of high river flow. The average temperature difference between the upstream River Monitoring Station 7 and the downstream River Monitoring Station 3 during the June-July sampling period was 4.3°F.

The August temperature measurements also showed similarities along each transect between the VYNPS discharge structure and Vernon Dam: 75.2°F to 85.1°F at C stations, 75.2°F to 84.7°F at D stations, and 75.9°F to 86.6°F at E stations. Temperatures were generally lower at the F stations (74.8°F to 83.8°F), located upgradient of the VYNPS intake structure, during the same sampling period (Figure 2-15).

The diurnal variation in temperature due to fluctuations in river flow and the effects of solar heating was most pronounced at the surface (upper 1 ft) in Vernon Pool, with the highest variation (3.6°F) occurring near the VYNPS discharge structure (Station C1/C2); diurnal variation was less pronounced at the upstream location (Station F), with a variation of about 1.5°F at the surface. There was little spatial variation in temperature across the bank-to-bank transects in Vernon Pool during the August sampling period. Although temperatures were slightly higher near the VYNPS discharge structure, thermistor temperatures were within about 1.8°F of each other across a single transect at any given time. The average temperature difference between the upstream River Monitoring Station 7 and the downstream River Monitoring Station 3 during the August sampling period was 2.9°F (ASA 2004).

Copper, Iron, and Zinc in the Connecticut River

As part of the NPDES permit monitoring program, the VYNPS collects monthly grab samples from the Connecticut River at the discharge structure and at River Monitoring Stations 3 and 7 for total copper, zinc, and iron analyses.

In 2004, total copper concentrations ranged from <0.002 to 0.135 mg/L at Station 7, 0.003 to 0.011 mg/L at NPDES Outfall 1, and 0.001 to 0.123 mg/L at Station 3, with the highest concentration (0.135 mg/L) occurring at Station 7 in March. Total iron concentrations ranged from 0.10 to 117 mg/L at Station 7, 0.178 to 0.569 mg/L at NPDES Outfall 1, and 0.147 to 2.42 mg/L at Station 3, with the highest concentration (117 mg/L) occurring at Station 7 in March. Total zinc concentrations ranged from 0.004 to 0.425 mg/L at Station 7, <0.003 to 0.041 mg/L at NPDES Outfall 1, and 0.004 to 0.159 mg/L at Station 3, with the highest concentration (0.425 mg/L) occurring at Station 7 in March (Normandeau 2005).

It is likely that the higher concentrations in metals occurring at the upstream location (Station 7) relative to the plant's discharge location and the downstream Station 3 relate to the configuration of the sampling location. The station is located in shallow water (less than one foot deep) with a mud substrate that may be disturbed by wave action on occasion, thus creating suspended particulates that may contribute to the higher results at that station (Normandeau 2005).

2.2.3.2 Groundwater

An inventory of potential sources of groundwater contamination within the source protection area (defined as a 500-ft radius) of each potable water supply well at the VYNPS is provided in source water protection plans for each well (Entergy 2005d). The protection plans delineate management practices to reduce the potential risk of contamination of these wells and outline emergency response protocols for spills or other contamination events occurring within the source protection area.

VYNPS has several sewage treatment and disposal systems (leach fields, landfarm, and septic spreading field) that discharge to the subsurface under an Indirect Discharge Permit (ID-9-0036) issued by the VDEC. Systems regulated under the permit are: Main (North) System, Construction Office Building (South) System, New Office Building System, New Warehouse System, Governor Hunt House System, and Gatehouse #1 System. These systems have a combined total operation design capacity of 14,347 gallons per day (gpd) and a maximum design capacity of 26,297 gpd (VDEC 2005b). Regular (biannual) monitoring of groundwater quality around these systems is required by the permit. Groundwater levels are also monitored. Because the river-to-effluent flow ratio is extremely large at the VYNPS, Connecticut River water quality monitoring is not required by the Indirect Discharge Permit.

Groundwater is also monitored in the area of a former underground storage tank (UST), known as the No. 2 fuel oil release area, just west of the turbine building (Figure 2-3). This area is the site of a 1999 petroleum release from a former 10,000-gal No. 2 fuel oil UST, which resulted in the contamination of soil and groundwater in the surficial aquifer (SVE 1999). Contaminants released include a suite of fuel compounds (including benzene, toluene, ethylbenzene, and xylene, and naphthalene). Tetrachloroethylene (PCE), a metal degreasing agent, was also detected in this area; its source is unknown. Monitoring has shown the extent of contamination to be fairly limited, although low levels (below drinking water standards) of some volatile organic compounds (VOCs) were detected in the Construction Office Building well (also known as the "COB" well) in 1999, located about 750 ft south of the release area. Free product was found in one of the adjacent monitoring wells and recovered using sorbent pads (SVE 1999).

Monitoring wells near the release area were sampled on a quarterly basis from 1999 to 2002, and have been sampled annually since 2002. Over this period, four monitoring wells (located between the former UST site and the turbine building) have consistently had levels of petroleum hydrocarbons exceeding Vermont's Primary Groundwater Quality Standards (PGQS), including naphthalene (at concentrations up to 1300 μg/L; PGQS = 20 μg/L), 1,2,4-trimethylbenzene (at concentrations up to 640 μg/L; PGQS = 5 μg/L); and 1,3,5-trimethylbenzene (at concentrations up to 240 μg/L; PGQS = 4 μg/L). PCE was also detected in adjacent wells with concentrations up to 24 μg/L (PGQS = 5 μg/L). Contaminant concentrations in these wells were generally lower in 2005 than in previous years (Entergy 2006g).

Free product (i.e., light nonaqueous-phase liquid) monitoring and recovery continues on an as-needed basis. In 2005, free product, on the order of a few milliliters, was removed from four of the wells adjacent to the release area (Entergy 2006g).

2.2.4 Air Quality

2.2.4.1 Climate and Meteorology

The climate in southeastern Vermont is characterized as a highly variable continental climate, exhibiting a large range of diurnal and annual temperatures, significant differences in climate parameters between the same seasons in different years, and considerable diversity from place to place. Climate is heavily influenced by topography and distances to large bodies of water, primarily Lake Champlain and the Atlantic Ocean (Vermont State Climatologist 2006). Three climatological divisions have been defined for the State: Western, Northeastern, and Southeastern. VYNPS lies within the Southeastern Division, which is defined roughly as a portion of land adjacent to the south-flowing Connecticut River. Topography variations within the Southeastern Division range from the Wantastiguet Mountain east of Brattleboro, Vermont, with an elevation of 1351 ft (411 m) MSL to lowland areas along the Connecticut River near Northfield, Massachusetts (south of Vernon approximately 3 mi), with an elevation of 175 ft (53 m) MSL (Entergy 2006a). The average elevation within Vernon is 315 ft (96 m) MSL. The elevation at VYNPS is approximately 250 ft (76 m) MSL.

The predominating direction of wind throughout the State is from the west with some seasonal variation; north to northwesterly during the winter months and south-southwesterly during the summer months. However, notwithstanding these broad state-wide trends, predominating wind directions at the local level are also greatly influenced by topography. Thus, in the vicinity of the VYNPS, the predominating wind direction generally parallels the long axis of the north-south trending Connecticut River Valley. Wind roses developed for Westover Air Reserve Base,[a] due south of VYNPS, show the prevailing wind directions to be generally north or south, depending on the season, with an annual average wind speed of 19.1 knots (21.98 mph) (Entergy 2006h).

Weather systems in Vermont are influenced by air masses entering the State from three principal directions: cold, dry air from the North American Subartic region; warm, moist air from the Gulf of Mexico and other subtropical waters; and cool, damp air from the North Atlantic Ocean. Weather patterns are highly variable in both short and long time frames. Biweekly fluctuations of weather from fair to cloudy or stormy conditions, with abrupt changes in temperature, moisture, sunshine, wind direction, and wind speed are common, and monthly weather “averages” are typically the result of wide variations of each measured parameter throughout the month.

As documented by the National Climate Data Center (NCDC), average temperatures vary according to elevation, slope, and local features such as urban heat islands. Diurnal fluctuations of temperature range from 20 to 30°F, with the greatest fluctuations observed in the

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(a) Westover Air Reserve Base is located in Chicopee, Massachusetts, approximately 60 mi due south of Vernon, and also within the Connecticut River Valley.

southern portion of the State (including the area containing the VYNPS) (NCDC 2006a). Temperature records from Vernon over the period 1951 to 1960 revealed an annual average of 13 days with temperatures above 90°F and 175 days with temperatures below 32°F (Entergy 2006h).

Precipitation occurs throughout the State throughout the year, with precipitation in the Southeastern Division most influenced by weather systems originating in the North Atlantic Ocean. Freezing rain can occur throughout the State, but is least likely to occur in the Southeastern Division. Summer thunderstorms, however, are very possible at VYNPS and represent the most significant precipitation event. Snowfall totals vary considerably with elevation and also vary considerably from year to year. Blizzards involving very heavy winds and heavy snow totals within the Southeastern Division are generally the result of exceptionally low pressure weather systems moving into the State from the North Atlantic ("nor'easters"). On average, the southern portion of the State near Lake Champlain can expect to receive 60 in. of snow each winter. Snowfall records for Vernon show snow occurring in all months except June through September, with monthly averages as high as 16.4 in. and annual amounts averaging 60 in. However, annual totals have been as high as 118 in. (Entergy 2006h).

Other severe weather events are uncommon in the State, but have occurred in the past, including within the Southeastern Division. Over the period December 1995 through December 2005, the NCDC recorded 46 incidents of severe weather: 22 instances of severe winds associated with thunderstorms, 17 instances of flooding or flash flooding, 4 instances of hail, two tornadoes (F1 and F2 strengths), and one instance of damaging lightning. Over this period, property damage from severe weather throughout Windham County was estimated at $2.707 M. There were no weather-related fatalities over this period (NCDC 2006b). Based on the Index of Tornado Damage Potential, Entergy places the probability of a tornado striking the VYNPS as small (Entergy 2006h).

2.2.4.2 Air Quality Impacts

The entire State of Vermont is currently in attainment of primary and secondary standards for all six of the criteria pollutants for which National Ambient Air Quality Standards (NAAQS) have been established[a]. VYNPS, located in Windham County, lies within the Vermont Intrastate Air Quality Control Region (AQCR) 221. Other Vermont counties within AQCR 221 include Bennington, Caledonia, Essex, Lamoille, Orange, Orleans, and Washington. AQCR 221 is also

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(a) Criteria Pollutants include carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), and particulate matter with aerodynamic diameters <10 microns and <2.5 microns (PM_{10} and $PM_{2.5}$). Criteria pollutants are used to establish NAAQS. Primary standards are those necessary to protect public health. Secondary standards preserve the general welfare and quality of life.

comprised of counties in New Hampshire and Massachusetts. Air quality in a given area is a function of the emission sources within the area, the atmospheric conditions (climate and meteorology), features of the area (primarily size and topography), and the nature and amount of pollutants transported from outside the area. The influence of each local pollutant emission source on ambient air quality depends primarily on such factors as the type, rate, frequency, duration, and exit conditions (primarily thermal energy and exit velocity) of the emissions and the specific locations of each source within the area.

The Air Pollution Control Division (APCD) of VDEC has primary responsibility for regulating air emission sources within the State of Vermont. APCD also monitors the ambient air quality for conformance with the NAAQS at various monitoring stations throughout the State. The monitoring station closest to VYNPS is located in Brattleboro where only PM_{10} was monitored in 2004 (VDEC 2006b).

The VYNPS has a number of stationary sources of criteria pollutants, including external combustion sources such as comfort heat boilers and one used oil furnace and internal combustion engines (ICEs) (diesel) on emergency generators. Emission calculations and emission inventory reports for calendar years 2001 through 2005 demonstrate that all of these stationary sources qualify as insignificant sources with respect to their emission potentials (VYNPS 2001, 2002, 2003a, 2004, 2005, 2006e; Entergy 2006i). The VYNPS is correctly classified as a minor source with respect to its potential to emit (PTE) criteria pollutants and/or hazardous air pollutants (HAPs) and is therefore not required to secure a Title V operating permit for any of its stationary emission sources[a]. Documentation submitted to the VDEC/APCD claims exempt status for VYNPS (Entergy 1995) and VDEC/APCD concurs (VDEC 1995). Documentation showing the annual hours of operation of the emergency power generators demonstrates their continued eligibility for exempt status as emergency generators (VYNPS 2006a through d).

Used oil generated at VYNPS is consumed onsite for energy recovery (comfort heating). One oil burner is in service at the radioactive waste storage facility (the North Warehouse) and operates only during the heating season. Management of used oil, including its incineration in used oil burners, is the responsibility of the Hazardous Waste Coordinator. Sources of oil for this burner include used oil recovered from vacuum pump maintenance and repair activities, excess new diesel fuel remaining after quality control sampling/testing of the emergency generators' "day tanks," and used crankcase oil from maintenance of the emergency

(a) According to 40 CFR 70.2, a "major source" is any stationary source or collection of stationary sources within contiguous or adjacent areas and under common control whose PTE is equal to or greater than 10 tons per year of any hazardous air pollutant (HAP), 25 tons per year of any combination of HAPs, or 100 tons per year of any air pollutant, including fugitive dust. (Additional elements are added to this definition in nonattainment areas for ozone, CO, and PM_{10}.)

generators[a]. Used oil sources categorically excluded from consumption in the used oil burner include any oils recovered from electrical equipment (transformers, oil-filled circuit breakers and switches).

Used oil sampling and management protocols are established in written operating procedures and call for comprehensive analyses of oil for the presence of radionuclides as well as other hazardous chemicals and critical physical parameters such as flash point (VYNPS 2003b) to ensure proper operation of the burner and to preclude the atmospheric release of hazardous constituents. Likewise, operation of the used oil burner is also addressed in written operating procedures. These procedures require the operator to ensure that the required preliminary sampling of oil has been completed and that the burner is operated correctly. Procedures for used oil management and for used oil burner operations have been summarized by facility personnel (Entergy 2006j).

Vermont air quality regulations define hazardous air contaminants (HACs)[b]. There is very little potential for releases of HACs from VYNPS as a result of routine facility operation. However, some water treatment chemicals present in the cooling tower contain Vermont-listed HACs, and there is the potential for their release to the atmosphere as cooling tower drift[c]. Details regarding such releases are discussed in Section 2.1.3.

Sections 101(b)(1), 110, 169A(a)(2), and 301(a) of the Clean Air Act as amended (42 U.S.C. 7401(b), 7410, 7491(a)(2), 7601(a)) established Mandatory Class I Federal Areas where visibility is an important value[d]. There is one Mandatory Class I Federal Area in Vermont, the Lye Brook Wilderness Area, a 12,430-ac parcel maintained by the U.S. Forest Service and located approximately 35 mi northwest of VYNPS. The closest Class I areas in New Hampshire include the 5552-ac Great Gulf Wilderness Area, approximately 130 mi northeast of VYNPS, and the 27,380-ac Presidential Range – Dry River Wilderness Areas

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(a) To ensure reliability, diesel fuel for emergency generators is sampled monthly and analyzed for critical chemical and physical properties (VYNPS 2003b).

(b) A comprehensive listing of HACs is contained in Appendix B of the Vermont Air Quality Regulations (adopted December 31, 2003). Appendix C establishes air quality standards for HACs that display, or are suspected of, carcinogenicity (Category I HACs), for HACs believed to cause chronic systemic toxicity due to long-term exposure (Category II HACs), and for HACs believed to cause short-term irritant effects (Category III HACs).

(c) Cooling tower drift is the result of the entrainment of cooling water droplets in the air being exhausted from a wet counter-flow-designed cooling tower such as the one being operated by VYNPS.

(d) See also federal regulations at 40 CFR 81 et seq.

located approximately 120 mi northeast of VYNPS, all managed by the U.S. Forest Service. There are no Class I Areas in Massachusetts close to VYNPS[(a)]. Given the locations of the Class I areas, their distances from the VYNPS, prevailing wind directions, and the limited potential of the facility's stationary sources to emit criteria pollutants that could impact visibility, there is little likelihood that activities at the facility can adversely impact visibility in any of these Class I areas.

2.2.5 Aquatic Resources

2.2.5.1 Description of the Aquatic Resources in the Vicinity of VYNPS

The principal aquatic resource in the vicinity of the VYNPS is the Connecticut River, which is the source and receiving water body for the plant's cooling system. VYNPS is located on the western shoreline of the Connecticut River in Windham County, 0.75 mi upstream of the Vernon Dam, which is located at RM 142. The area upstream of the Vernon Dam is known as Vernon Pool. Vernon Pool covers 2250 ac at full-pond elevation of 220.13 ft behind the Vernon Dam. The next dam on the Connecticut River upstream of Vernon Dam is Bellows Falls Dam at RM 174. Maximum water depth at Vernon Dam is 40 ft (Entergy 2006a). The Connecticut River near Vernon Dam is about 0.5 mi wide (AEC 1972). The minimum sustained discharged flow from the Vernon Dam is 1250 cfs, or the pool inflow, if the river flow is less than 1250 cfs. Average daily flow is about 10,500 cfs with an average annual flow rate of 3.3×10^{11} ft^3 (Entergy 2006a). During 2004, the lowest daily river discharge at Vernon Dam was 1757 cfs and the highest was 50,618 cfs. Monthly flow rate averages ranged from 3,967 cfs in October to 23,570 cfs in April (Normandeau 2005).

Yearly river water temperatures upstream of VYNPS vary from 32 to 84°F with daily variations rarely exceeding 2°F. Winter water temperatures average 35°F, and summer temperatures average between 70 to 77°F (Entergy 2006a). During 2004, the monthly average daily river temperatures upstream of VYNPS ranged from a low of 32.5°F in February to 72.7°F in July. The lowest daily river temperature was 32.4°F on February 22, while the highest daily river temperature was 76.4°F on August 5 (Normandeau 2005). Between the summer seasons of 1998 to 2002, ambient river temperatures never exceeded 80°F (Normandeau 2004a).

The transmission lines within the scope of the license renewal review are the Coolidge 115/345-kV and Chestnut Hill 115-kV lines. The Coolidge 115/345-kV transmission line associated with VYNPS crosses several streams and rivers including the Black River, Williams River, Chase Brook, Potash Brook, Trout Brook, Middle Branch Williams River, Howe Brook, Stiles Brook, Mill Brook, Grassy Brook, West River, Stickney Brook, Halladay Brook, Whetstone Brook, Ames Hill Brook, and Broad Brook. The only river crossed by the Chestnut Hill 115-kV transmission line is the Connecticut River. In addition, the upper reach of an unnamed tributary

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(a) Additional information about the Class I areas within this region can be found on the USDA Forest Service website: http://www.fs.fed.us/r6/aq/natarm/r9/class1r9.htm.

of the Connecticut River is located within the Chestnut Hill transmission line right-of-way. Transmission line ROW maintenance activities in the vicinity of stream and river crossings employ methods to minimize erosion and shoreline disturbance while encouraging vegetative cover.

A number of physical and chemical stresses have caused major changes and modifications to the aquatic resources within the Connecticut River. These include dam construction and operation; urban, industrial, and agricultural contaminants; and land-use changes. Water withdrawal from the Connecticut River for municipal, agricultural, and industrial activities is minimal. There are no reported water availability issues concerning the river (Entergy 2006a). The major industrial use of the river is by the 12 hydroelectric dams. Three dams, Vernon (RM 142), Turners Falls (RM 123), and Holyoke (RM 86) are located downstream of VYNPS. The Connecticut River is also used for recreation, tourism, and conservation (e.g., the Silvio O. Conte National Fish and Wildlife Refuge).

Over 180 species of phytoplankton have been collected in the vicinity of VYNPS. The most abundant phytoplankton species include several species of green algae (*Microspora stagnorum*, *Pediastrum* spp., and *Scenedesmus* spp.); yellow-green algae (*Tribonema bomycinum*, *Dinopryon cylindricum*, and *Ceratium hirudinella*); and diatoms (*Melosira varians*, *Tabellaria* spp., *Fragillaria crotonensis*, and *Asterionella formosa*). Phytoplankton densities were highest in August through October (AEC 1972). Diatoms dominate the phytoplankton during most of the year (Aquatec 1978).

About 160 species of wetland and aquatic vascular plants were collected from Vernon Pool during preoperational studies (AEC 1972). Among the more abundant species collected from two marshes located near the plant were common marsh bedstraw (*Galium palustre*), hybrid cattail (*Typha glauca*), fringed sedge (*Carex crinita*), stalked bulrush (*Scirpus pedicellatus*), calamus (*Acorus calamus*), water horsetail (*Equisetum fluviatile*), and dotted smartweed (*Polygonum punctatum*) (AEC 1972).

Over 75 species of zooplankton were identified during preoperational and early postoperational studies. The zooplankton community density and diversity were highest in June through October, with rotifers, cladocerans, and unidentified nauplii (the first larval stage of crustaceans) being common (AEC 1972).

Over 200 macroinvertebrate taxa have been collected during studies associated with VYNPS (Aquatec 1990). The macroinvertebrate community near VYNPS is dominated by dipterans (true flies), caddisflies, and mayflies. Other groups of macroinvertebrates commonly collected included oligochaetes (aquatic worms), molluscs (mostly fingernail clams and snails), crustaceans, hydras, and flatworms (AEC 1972; Normandeau 2005). Few freshwater mussel species are expected to occur in the area of VYNPS due to impounded habitat conditions created by the Vernon Dam. Mussel species that have been collected include the triangle floater (*Alasmidonta undulata*) and Eastern elliptio (*Elliptio complanata*); both are common to abundant within the Connecticut River (Nadeau and Victoria 2003). Also collected were *Ligumia* sp. (probably *L. nasuta*, the Eastern pondmussel) and *Lampsilis* sp. (probably *L. radiata*, the Eastern lampmussel). Dams have been generally responsible for large losses of mussel habitat within the Connecticut River (Kart et al. 2004). No zebra mussels (*Dreissena polymorpha*) or Asiatic clams (*Corbicula fluminea*) have been collected in the area of VYNPS (Normandeau 2005).

Vernon Dam creates a lentic (lake-like) condition above the dam and a lotic (flowing) condition below the dam. The Vernon Dam was constructed in 1907. A fish ladder was constructed at Vernon Dam in 1981. Prior to that time, the dam was a barrier to fish movement. A downstream fish conduit was first operated in 1991 (Normandeau 2004a). Both warmwater and coolwater fish exist above and below Vernon Dam. Fish are routinely sampled upstream and downstream of Vernon Dam as part of the NPDES monitoring requirements. They are collected by electroshocking in May, June, September, and October (VANR 2006). In addition to the general fish collections, sampling is required for juvenile and adult American shad (*Alosa sapidissima*). They are collected by electroshocking, beach seining, trawling, and trapping at established locations upstream and downstream of Vernon Dam, as well as at the Vernon Dam fish ladder.

Over 60 species of fish, including 14 migratory species, have been reported from the Connecticut River (Connecticut River Atlantic Salmon Commission 1998). Thirty-one fish species were collected near VYNPS during preoperational studies. The most commonly collected species were smallmouth bass (*Micropterus dolomieu*), white sucker (*Catostomus commersoni*), yellow perch (*Perca flavescens*), rock bass (*Ambloplites rupestris*), walleye (*Sander vitreus*), white perch (*Morone americana*), common carp (*Cyprinus carpio*), bluegill (*Lepomis macrochirus*), and other sunfish. Recreational fishing occurs mostly for white perch, yellow perch, smallmouth bass, and largemouth bass (*Micropterus salmoides*) (AEC 1972). There are no commercial fisheries near the VYNPS (Entergy 2006a).

Between 1991 and 2004, 33 species of fish have been collected in electroshocking samples from upstream and downstream of Vernon Dam. Among the 28 species collected upstream of Vernon Dam, the predominant species collected were yellow perch (35.6 percent), bluegill (19.5 percent), pumpkinseed (*L. gibbosus*) (9.2 percent), spottail shiner (*Notropis hudsonius*) (8.6 percent), largemouth bass (6.7 percent), and white sucker (4.7 percent). Migratory species that were collected upstream of Vernon Dam included American eel (*Anguilla rostrata*) (0.2 percent), American shad (0.7 percent), gizzard shad (*Dorosoma cepedianum*) (<0.01 percent), and sea lamprey (*Petromyzon marinus*) (0.3 percent) (Normandeau 2005). Among the 33 species collected downstream of Vernon Dam, the most numerous species included smallmouth bass (27.2 percent), spottail shiner (17.7 percent), American shad (10.9 percent), rock bass (8.1 percent), white sucker (7.5 percent), fallfish (*Semotilus corporalis*) (6.2 percent), and bluegill (6.1 percent). In addition to the American shad, other migratory species that were collected downstream of Vernon Dam included American eel (0.8 percent), Atlantic salmon (*Salmo salar*) (<0.01 percent), blueback herring (*Alosa aestivalis*) (<0.01 percent), gizzard shad (0.1 percent), and sea lamprey (0.5 percent) (Normandeau 2005). The major differences in fish species composition that have been observed since preoperational years are primarily due to the addition of fish passage facilities at the dams, which has allowed migratory species to become reestablished in the area and allowed resident fish species to more readily traverse various reaches of the river.

Fish consumption guidelines for fish from the Connecticut River have been established due to high levels of mercury (Vermont and New Hampshire) or polychlorinated biphenyls (PCBs) (Massachusetts) found in some species. The guidelines are established for the general public and for a more restrictive group that includes pregnant women, women who may become pregnant, nursing mothers, and children. For Massachusetts, the general public are advised against eating channel catfish (*Ictalurus punctatus*), white catfish (*Ameiurus catus*), American eel, and yellow perch, while the more restrictive groups are advised not to eat any fish from the Connecticut River (Massachusetts Office of Health and Human Services 2006). The Vermont guidelines suggest no more than nine meals per month for the general public and no more than two to three meals a month for the more restrictive group for most fish species, while fewer meals per month are advised for one or both groups for walleye, smallmouth bass, largemouth bass, northern pike (*Esox lucius*), chain pickerel (*E. niger*), American eel, and yellow perch (VDH 2001). For New Hampshire, the general public are advised to limit themselves to four meals per month for most species while the more restrictive group should have only one meal per month. These limits also apply to bass and pickerel species, although only fish 12 in. or less should be consumed. For Atlantic salmon, adults 16 and older can eat 4 oz per month, while those under 16 and women from the restrictive group are advised against eating Atlantic salmon (NHFGD undated).

The Connecticut River Atlantic Salmon Commission establishes annual schedules for the passage of migratory fish species for a number of dams on the Connecticut River (FWS 2006a). The 2006 schedule for upstream fish passage operations at Vernon Dam was May 15 through July 15 and September 15 through November 15 for Atlantic salmon and May 15 through July 15 for American shad and blueback herring. The schedule for downstream fish passage operations for Vernon Dam was April 1 through June 15 for salmon smolts, October 15 through December 31 for salmon adults, June 1 through July 31 for adult shad, and September 1 through November 15 for juvenile shad (FWS 2006a).

Table 2-8 summarizes the passage of migratory fish species at Vernon Dam between 1981 and 2006. Prior to 1981, the lack of a fish passage facility at Vernon Dam prevented migratory species from moving into Vernon Pool. To illustrate how migrating species disperse throughout the mainstem of the Connecticut River, Table 2-9 presents the numbers of migratory fish species that have passed Holyoke, Turners Falls, Vernon, and Bellows Fall Dams during 2004 and 2005.

Table 2-8. Summary of Migratory Fish Passage at Vernon Dam, 1981 Through 2006

Year	Atlantic Salmon	American Shad	Blueback Herring	Gizzard Shad	Sea Lamprey	Striped Bass
1981 to 1985	2.4[a] (0-8)	784 (9-2597)	31.4 (7-56)	0.0	428 (5-1257)	2.6 (0-11)
1986 to 1990	5.6 (0-10)	3932 (982-10,894)	39.4 (0-94)	2.2 (0-7)	423 (205-667)	0.0
1991 to 1995	7.8 (5-13)	18,091 (2681-37,197)	112.6 (10-383)	7.6 (0-14)	680 (509-750)	0.6 (0-1)
1996 to 2000	7.6 (4-12)	8032 (1548-18,844)	3.8 (0-11)	25 (0-114)	4098 (836-16,438)	1 (0-5)
2001 to 2005	1.8 (0-4)	638 (167-1744)	0.0	1 (0-4)	4176 (2210-8119)	0.2 (0-1)
2006	4.0	133.0	0.0	0.0	2895.0	0.0

(a) Mean number (range).
Source: VDFW 2006a

Table 2-9. Summary of Migratory Fish Passage at Holyoke, Turners Falls, Vernon, and Bellows Falls Dams, 2004 and 2005[a]

Year/Location	Atlantic Salmon	American Shad	Blueback Herring	Gizzard Shad	Sea Lamprey	Striped Bass
2005						
Holyoke	132 (15)[b]	116,511	534	126	28,134	226
Turners Falls	5	1500	2	0	17,798	2
Vernon	5	167	0	0	3586	0
Bellows Falls	3	3	0	0	229	0
2004						
Holyoke	46 (6)	191,555	151	279	59,461	256
Turners Falls	1	2092	43	0	8229	9
Vernon	1	653	0	1	3668	0
Bellows Falls	1	0	0	0	0	0

(a) Only observed fish are counted, therefore the numbers presented do not represent all returns.
(b) Number in parentheses are those that were released above Holyoke Dam, the remainder were removed for the captive broodstock program.
Sources: FWS 2004, 2005b

Atlantic Salmon

Prior to damming of the Connecticut River watershed, Atlantic salmon spawning runs occurred as far upstream as Beecher Falls (near the Vermont-Canadian border, about RM 370) (NHFGD 2005). Spawning runs mostly occur in the spring, but a small number also migrate upriver in the early fall. Those that return in the spring spend the summer in deep, cold pools of their natal streams before spawning in fall (Connecticut River Atlantic Salmon Commission 1998). The optimal temperature range for migratory adults is 57.2 to 68°F (Krisweb.com undated). Since restoration efforts have begun, Atlantic salmon have reached as far upstream as the Ammonoosuc River, downstream of the Ryegate Dam (RM 273) (FWS undated). Spawning habitat primarily occurs in the Connecticut River tributaries, including the West River (which is crossed by the Coolidge transmission line) (Gephard and McMenemy 2004). Artificial barriers (e.g., dams and faulty culverts) and natural barriers (e.g., waterfalls >10 ft high) pose problems for adults migrating to their spawning areas (Kart et al. 2004). Most returning Atlantic salmon are captured for broodstock, although about 10 percent are released upstream of Holyoke Dam to spawn naturally (Connecticut River Atlantic Salmon Commission 1998). Optimal spawning temperature is 41 to 46.4°F (Krisweb.com undated). Spawning habitat consists of coarse, clean gravel stretches that are at least 6 to 9 ft long and 3 ft wide with water depths of 1 to 2 ft. Self-sustaining populations of Atlantic salmon do not currently occur within the Connecticut River watershed, and are therefore dependent on a multi-state stocking effort (Kart et al. 2004). Juvenile Atlantic salmon have been stocked in streams as far north as the Nulhegan River, Vermont, about 350 river miles above the mouth of the Connecticut River (FWS undated).

Adults that do not die after spawning will overwinter in the river before migrating back to sea. Salmon fry emerge from their nests in May or June. The young (parr) Atlantic salmon inhabit streams for 1 to 3 years (Kart et al. 2004) inhabiting cool, swift-flowing streams with riffles and gravel-cobble substrates. As they mature, they will also use slower-moving waters with pools and vegetation (NHFGD 2005). Optimal range for parr survival is 32.9 to 68°F (Krisweb.com undated). Most parr undergo physiological changes (smoltification) for adaptation for ocean life; however, some parr will become sexually mature before smoltification and are capable of fertilizing the eggs of returning females (Henry and Cragg-Hine 2003). The smolts outmigrate from the river and post-smolts migrate to feeding areas in the North Atlantic during late spring and summer (Kart et al. 2004). The optimal temperature range for migrating smolts is 44.6 to 57.7°F, although migration will occur at temperatures up to 66.2°F (Fay et al. 2006). Atlantic salmon spend at least 1 year in the ocean before returning to spawn (NHFGD 2005).

Outmigrating adults and smolts are subject to turbine mortality as they move downstream and pass the hydroelectric dams on the Connecticut River. They also can experience extended residency in impoundments (which can cause physiological stress or increased predatory pressure to smolts), and are susceptible to diseases through contact with commercial aquaculture salmon in estuary and marine habitats. Low water pH due to acid deposition appears to be detrimental to outmigrating smolts, while water temperature fluctuations in the Atlantic Ocean over the past 10 years may be contributing to reduced adult salmon returns throughout much of their range (Kart et al. 2004). Annual spawning runs in the Connecticut River in the 1980s and 1990s often numbered in the hundreds, with a high of 529 in 1981 and a low of 39 in 1983 (FWS 2007a). Spawning runs between 2000 and 2004 ranged from 40 (2001) to 77 (2000), while the spawning runs were 186 in 2005 and 214 in 2006 (FWS 2007a). Spawning run declines have been occurring throughout the species' range; thus, the decline is thought to be due to marine conditions (Gephard and McMenemy 2004). There is a no-take policy for Atlantic salmon in the Connecticut River (NHFGD 2005).

American Shad

The goal for the restoration of the American shad in the Connecticut River is to have a return of 2 million shad at the mouth of the river, a passage of 1 million at Holyoke Dam, 850,000 at Turners Falls, and 750,000 at Vernon Dam (Shad Studies Subcommittee 1992). To date, the maximum return occurred in 1992 with a river estimate of 1.63 million and the count at Holyoke Dam estimated at 720,000. Counts have generally been less than 50 percent of these numbers in the succeeding years (FWS 2007a). Table 2-10 provides counts for American shad at Holyoke, Turners Falls, and Vernon Dams.

The American shad is reasonably secure within the Connecticut River as long as access to spawning and nursery habitats is not obstructed (Kart et al. 2004). However, annual spawning runs into the river, including the Vermont-New Hampshire portion of the Connecticut River, have noticeably declined since the peak years of the early 1990s (Table 2-10). This may be attributable to the inefficiency of the fishways at Turners Falls and, in some years, high spring discharges from Vernon Dam. Other features that have an effect on American shad stocks throughout its range include turbine mortality of outmigrating adults and juveniles, habitat modification and fragmentation due to impoundments, improvements in striped bass (*Morone saxatilis*) stocks that may have increased predatory pressure on clupeids, and excessive commercial harvests within estuaries and the Atlantic seaboard (Kart et al. 2004). Dam passage facilities on the Connecticut River have allowed American shad to move further upriver. The facilities have resulted in greater adult American shad mortality and decreases in repeat spawners' mean size and age of adults. The loss in larger repeat-spawning females that has occurred since the construction and expansion of fishways in the 1970s and 1980s could account for a 14 percent reduction in the annual recruitment to the American shad population in the river (Leggett et al. 2004).

The American shad occurs upstream in the Connecticut River to at least Bellows Falls (RM 174), although a few fish have passed above this dam. It has also been observed in the West River (enters the Connecticut River at RM 149) (Kart et al. 2004). Bellows Falls is thought hydroelectric dams in the Connecticut River (FWS undated). Although American shad can climb the fish ladders at Turners Falls to the hydropower canal, the ladders are thought to be

Table 2-10. American Shad Counts at Holyoke, Turners Falls, and Vernon Dams from 1981 Through 2005

Year	River Estimate	Holyoke Dam	Turners Falls Dam	Vernon Dam
1981	910,000	380,000	200 (<0.1)[a]	97 (48.5)[b]
1982	940,000	290,000	11 (<0.1)	9 (81.8)
1983	1,570,000	530,000	12,705 (2.4)	2597 (20.4)
1984	1,230,000	500,000	4333 (0.9)	335 (7.7)
1985	730,000	480,000	3855 (0.8)	833 (21.6)
1986	750,000	350,000	17,858 (5.1)	982 (5.5)
1987	590,000	280,000	18,959 (6.8)	3459 (18.2)
1988	650,000	290,000	15,787 (5.4)	1370 (8.7)
1989	980,000	354,000	9511 (2.7)	2953 (31.0)
1990	820,000	363,788	27,908 (7.7)	10,868 (38.9)
1991	1,200,000	520,000	54,656 (10.5)	37,197 (68.1)
1992	1,630,000	720,000	60,089 (8.3)	31,155 (51.8)
1993	750,000	340,000	10,221 (3.0)	3652 (35.7)
1994	330,000	181,000	3729 (2.1)	2681 (71.9)
1995	300,000	190,000	18,369 (9.7)	15,771 (85.9)
1996	670,000	280,000	16,192 (5.8)	18,844 (116.4)
1997	660,000	300,000	9216 (3.1)	7475 (81.1)
1998	640,000	320,000	10,527 (3.3)	7239 (68.8)
1999	480,000	190,000	6751 (3.6)	5309 (78.6)
2000	428,000	230,000	2590 (1.1)	1548 (59.8)
2001	740,000	270,000	1540 (0.6)	1666 (108.2)
2002	687,000	370,000	2870 (0.8)	336 (11.7)
2003	527,000	290,000	NA[c]	267 (NA)
2004	531,000	192,000	2092 (1.1)	653 (31.2)
2005	NA	116,511	1500 (1.3)	167 (11.1)
2006	NA	154,745	1500 (1.0)	133 (8.9)

(a) Number (percent of Holyoke Dam count).
(b) Number (percent of Turners Falls Dam count).
(c) NA = not available.
Sources: Aquatec 1990; Connecticut River Atlantic Salmon Commission 2004; FWS 2005b, 2006d, 2007a,b; Gephard and McMenemy 2004

too long for many individuals, causing them to tire and not pass farther upstream (Castro-Santos et al. 2005). In some years, <1 percent pass Turners Falls Dam (Castro-Santos et al. 2005). Passage problems for American shad also occur at the Gatehouse fishway located at the upstream end of the hydropower canal at Turners Falls. Efforts are underway to modify these facilities to improve upstream fish passage. Between 1997 and 2002, only 2.45 percent of the American shad that passed Holyoke Dam passed Turners Falls Dam, while 73.3 percent that passed Turners Falls Dam passed Vernon Dam (Gephard and McMenemy 2004). However, only 17 percent of those that passed Turners Falls Dam between 2004 and 2006 passed Vernon Dam (FWS 2005b, 2006d, 2007a).

American shad spawning occurs in well-oxygenated areas in broad flats and shallow water. Spawning substrates vary but water velocities need to be sufficient to minimize sedimentation (Kart et al. 2004). Spawning occurs at a temperature range of 46.4 to 78.8°F with peak activity at 57.2 to 69.8°F (O'Leary and Kynard 1986). Repeat spawning individuals in the Connecticut River has been reported at 63 percent (MacKenzie et al. 1985). High flow rates during the spawning season (late May and June) prolong the development of eggs, and turbulent June flows can promote unfavorable feeding conditions for first-feeding larvae that can reduce American shad larval survival. Both factors can reduce year-class strength (Savoy et al. 2004). The fecundity of first-time spawners has been reported to average 256,000 eggs per female, with a lifetime fecundity per female average 384,000 eggs. However, many eggs are not fertilized and, additionally, fertilized egg mortality is high (e.g., only 5 to 19 percent of fertilized eggs survive) (MacKenzie et al. 1985; Savoy et al. 2004). Maximum egg hatch and survival occurs at a range of 59.9 to 78.8°F. Temperatures in excess of 80.1°F are unsuitable (O'Leary and Kynard 1986). The eggs are nonadhesive and most drift in the current until they hatch (NHFGD 2005). Substrate is a critical problem only in areas where silt or sand can smother eggs that have settled to the bottom (Atlantic States Marine Fisheries Commission 1999).

About 60 to 80 percent of newly hatched larvae die within 7 days after first-feeding begins (Savoy et al. 2004). Nursery habitat for American shad is generally deep pools away from the shoreline (Atlantic States Marine Fisheries Commission 1999). Larvae change into filter-feeding juveniles in July through August (Savoy et al. 2004). Juvenile shad are found at water temperatures of 50 to 87.8°F (O'Leary and Kynard 1986). Juvenile American shad form dense schools and outmigrate to the ocean in late fall (October to November) and mature at sea (Kart et al. 2004). Outmigration generally begins when water temperatures drop to 66.2°F, peak at 57.2 to 48.2°F, and end at 50 to 46.4°F (O'Leary and Kynard 1986). The lower lethal temperature for American shad is 39.2°F with sublethal effects occurring at 42.8°F (O'Leary and Kynard 1986). Average annual mortality of returning adults in the Connecticut River is about 70 percent (MacKenzie et al. 1985).

Blueback Herring

Historically, the blueback herring may have occurred as far upstream in the Connecticut River as Bellow Falls (Kart et al. 2004). Although blueback herring are currently common downstream of Turners Falls Dam and below the first dams on most tributaries, they are in decline throughout the watershed. Their numbers are low between Turners Falls Dam and Bellows Falls Dam (Gephard and McMenemy 2004). The blueback herring and alewife (*Alosa pseudoharengus*) are collectively referred to as river herring. Alewives rarely occur upstream of the Holyoke Dam (Connecticut River Atlantic Salmon Commission 2004). Spawning success and survival of juveniles and adults depends upon successful passage of the dams (FWS undated). Between 1981 and 1992, upstream passage at Holyoke Dam (RM 86) averaged 433,000 blueback herrings. Their upstream passage has decreased significantly in recent years (FWS undated, 2005c). The annual passage during the 1990s was 44,000, only 1939 were counted in 2002, and a few hundred in 2004. Due to significant declines in the blueback herring population within the Connecticut River over the past 20 years, blueback herring are rarely encountered in the Vermont-New Hampshire portion of the river (Kart et al. 2004). At Vernon Dam, no blueback herring have been counted in more than 5 years (Table 2-9).

The blueback herring spawns in swift flowing waters over substrates such as gravel, sand, detritus, and submersed aquatic vegetation (Kart et al. 2004). Spawning occurs between April and July at water temperatures ranging from 57 to 81°F (Connecticut River Atlantic Salmon Commission 2004). A female can produce around 200,000 eggs (Connecticut River Atlantic Salmon Commission undated). The eggs are released in the water column, but they settle and adhere to the substrate. Adults return to sea after spawning, while the young-of-the-year migrate to the ocean in the fall (Kart et al. 2004; NHFGD 2005). Juveniles begin their outmigration when water temperatures drop to 69.8°F, peak at 59 to 57.2°F, and end at 50°F (O'Leary and Kynard 1986). Fewer than 1 percent of the young-of-the-year survive to migrate to sea as juveniles, while as many as 90 percent of adults die after spawning (FWS 2002a). High mortality of outmigrating juveniles and adults is thought to occur due to turbine mortality during dam passage. Additionally, improvements in striped bass stocks have increased predatory pressure on clupeids (Kart et al. 2004). Other factors that may have contributed to a decline in blueback herring throughout the Atlantic Coast include their use as bait for the striped bass sport fishery and commercial harvest in the Atlantic Ocean (Gephard and McMenemy 2004).

Gizzard Shad

The gizzard shad is a relatively new addition to the Connecticut River, having been first observed from the mouth of the river in 1980 (FWS undated). Their occurrence in the Connecticut River is due to a natural northern range extension along the East Coast (Gephard and McMenemy 2004). As the gizzard shad has not fully adapted to New England winters, they can experience high mortalities during cold winters, which subsequently lowers spawning runs (Gephard and McMenemy 2004). While still sparse, they are now found as far upstream as Bellows Falls Dam. Fish passage facilities have benefitted the gizzard shad, although programs are not directly aimed at increasing the gizzard shad. Spawning runs include both anadromous and potamodromous individuals (Gephard and McMenemy 2004). The latter are those individuals that overwrinter in freshwater and subsequently migrate into smaller tributaries for spawning and rearing. They spawn in late spring and early summer (FWS undated). Gizzard shad spawning in a Vernon Pool was first documented in 1989 (Aquatec 1990).

Sea Lamprey

The sea lamprey was extirpated from Vermont about two centuries ago due to dams and degradation of spawning and nursery habitats (e.g., from excessive siltation). Although not designed to increase the sea lamprey population, retrofitting the dams with passage facilities has restored the sea lamprey. It now spawns in the Connecticut River at least as far upstream as Wilder Dam (RM 217) and in tributaries such as the West, Williams, Black, and White Rivers (Kart et al. 2004). While parasitic at sea, the adult sea lamprey does not feed during its freshwater spawning migration and is not a threat to other fishes in the river. It spawns over substrates of sand, gravel, and rubble at depths of 1.5 to 2.0 ft (Kart et al. 2004). Adults die after spawning (FWS undated). The larvae (called ammocoetes) burrow into rich organic stream bottoms and filter-feed at the streambed surface (Kart et al. 2004). They remain in freshwater for up to 10 years. After migrating to sea, they become parasitic, living in the ocean for 1 to 2 years before initiating their spawning migrations (FWS undated).

American Eel

The American eel spawns in the fall within the Sargasso Sea (a 2 million square-mile area of the North Atlantic Ocean between the West Indies and the Azores); each female can produce 20 to 40 million eggs (FWS 2005a). Adults die after spawning (FWS undated). After hatching, larvae (leptocephali) drift on currents to coastal areas where they transform into glass eels and then to elvers, which migrate to inland waters where they can live as immature yellow eels for 10 to 25 or more years before maturing and returning to the sea to spawn (silver eels) (Kart et al. 2004; NHFGD 2005). The American eel is common in many rivers and streams in Connecticut and Massachusetts, common to infrequent in southern Vermont/New Hampshire, and uncommon in the northern Connecticut River basin (FWS undated). The number of American eels has been decreasing coast-wide in recent years (FWS undated). Dams (even those with fish ladders designed for adult anadromous species) can block access of juveniles to their important rearing habitats (American Eel Plan Development Team 2000; FWS undated) and can cause a high rate of turbine mortality to adults outmigrating to the ocean. High commercial harvests of juveniles in coastal waters has also diminished population stocks (Kart et al. 2004; FWS 2005a).

Striped Bass

Although the striped bass is considered an anadromous species, they are also considered to be amphidromus within the Connecticut River watershed, as they will move into freshwater for purposes other than spawning (e.g., for feeding) (FWS undated). Spawning most often occurs in the estuary or tidal portion of rivers. A female can produce 0.5 to 3 million eggs (Connecticut

River Atlantic Salmon Commission undated). While the striped bass has been reported as far upstream as Bellows Falls Dam (FWS undated); there is little evidence that they spawn in the river (Gephard and McMenemy 2004). The numbers and size of striped bass in the Connecticut River, particularly below Holyoke Dam, have been increasing in recent years due to coast-wide stock recovery. The population of striped bass along the Atlantic coast has increased from about 5 million in 1982 to more than 41 million since 1995 (Massachusetts Division of Marine Fisheries undated). As previously discussed, the increase in the striped bass population in the Connecticut River, as well as other watersheds along the Atlantic coast, appear to coincide with declines in American shad populations. They generally occur in the river between April and early July, although some may exist in the river year-round (Gephard and McMenemy 2004). Since the mid-1990s, an average of over 300,000 striped bass larger than 2.5 ft long have occurred in the Connecticut River from April through June (Savoy and Crecco 2004). Striped bass of this size are large enough to consume adult male and first-spawning female American shad. This many striped bass could account for the marked decrease in American shad and blueback herring populations in the Connecticut River (Savoy and Crecco 2004).

2.2.5.2 Threatened or Endangered Aquatic Species

Few Federally or State-listed aquatic species are known to occur in the Connecticut River in the southeastern Vermont-southwestern New Hampshire-northern Massachusetts area or in the Connecticut River tributaries within the three Counties in which the VYNPS transmission lines of concern occur (i.e., Windham and Windsor Counties, Vermont, and Cheshire County, New Hampshire) (Table 2-11). The vicinity of VYNPS is encompassed within or upstream of the

Table 2-11. Federally and Vermont-Listed Aquatic Species Potentially Occurring in the Vicinity of VYNPS and Associated Transmission Lines

Scientific Name	Common Name	Federal Status(a)	State Status(a)	Habitat
Mussels				
Alasmidonta heterodon	dwarf wedgemussel	E	E	Large rivers in substrates of stable mud, silty sand, sand, or gravel.
Alasmidonta varicosa	brook floater	–	T	Small rivers in rocky or gravelly substrates and in sandy shoals.
Fish				
Acipenser brevirostrum	shortnose sturgeon	E	E	Large rivers; occasionally enters saltwater.

(a) E = endangered, T = threatened, – = not listed.
Sources: Kart et al. 2004; NHFGD 2005

range of two Federally endangered aquatic species, the dwarf wedgemussel (*Alasmidonta heterodon*) and the shortnose sturgeon (*Acipenser brevirostrum*), respectively. No federally listed aquatic species are known from the tributaries of the Connecticut River that are crossed by the transmission lines associated with VYNPS (FWS 2006a; NMFS 2006). The State-listed brook floater (*Alasmidonta varicosa*) is known from the West River, a Connecticut River tributary that is crossed by the Coolidge transmission line. The Federally and State-listed species are discussed in the remainder of this section.

Shortnose Sturgeon

The shortnose sturgeon was Federally listed as an endangered species on March 11, 1967. The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) is the lead agency for this species (FWS 2006b). A recovery plan for the shortnose sturgeon has been prepared (NMFS 1998). Decreases in the shortnose sturgeon were attributable to over-harvests, bycatch in the shad fishery, dams, and pollution (Suckling 2006; FWS undated). It inhabits freshwater rivers, but occasionally enters saltwater (NHFGD 2005). Where not blocked by dams or other barriers, the shortnose sturgeon is capable of migrating 124 mi upriver to spawn (NHFGD 2005). The historic range in the Connecticut River appears to be upstream to Turners Falls (RM 123) (Gephard and McMenemy 2004). Females reach sexual maturity at age 8 to 12 years, while males mature at age 6 to 10 years (CDEP 2004a). The shortnose sturgeon spawns during mid- to late-spring in areas containing boulder, cobble, and gravel substrates at water depths of 10 m or less. Spawning occurs at water temperatures of 48.2 to 64.4°F (NHFGD 2005). Females only spawn every three to 5 years, while males may spawn every year (CDEP 2004a). Shortnose sturgeon have been frequently collected from the Lower Connecticut River at temperatures up to 86°F (Dadswell et al. 1984).

Two populations of shortnose sturgeon occur in the Connecticut River, a partially landlocked population between the Holyoke and Turners Falls Dam in Massachusetts, and the second population between Holyoke Dam and Long Island Sound, which is amphidromus (moving between fresh and salt water) (FWS undated; CDEP 2004a). The upper Connecticut River population ranged from about 197 to 714 fish in the 1976 to 1978 period (Suckling 2006). There were 47 to 98 spawning fish in 1992 and 1993, respectively. The lower Connecticut River population has increased from about 875 in the 1988 to 1993 time period to about 1800 in 2003 (Suckling 2006). The Holyoke Dam fish lift passes an average of about four shortnose sturgeon per year (NMFS 1998). The population downstream of the Turners Falls Dam is at least 20 mi downstream of VYNPS (Entergy 2006a).

Dwarf Wedgemussel

The dwarf wedgemussel was Federally listed as an endangered species on March 14, 1990. The U.S. Fish and Wildlife Service (FWS) Northeast Region (Region 5) is the lead region for this species (FWS 2006b). A recovery plan for the dwarf wedgemussel has been prepared (FWS 1993). The reported distribution of the dwarf wedgemussel in the Connecticut River basin includes Hampshire and Franklin Counties, Massachusetts; Cheshire and Sullivan Counties, New Hampshire; and Windham and Windsor Counties, Vermont (Entergy 2006a). It has been documented from Brattleboro and further north in Vermont, but not in the Vernon area (VANR 2005). The dwarf wedgemussel has been impacted by riparian disturbance, pollution and sedimentation, stream fragmentation, impoundments, and altered flows (FWS 1990; NHFGD 2005). Generally, areas immediately upstream of dams can have conditions (e.g., siltation and low dissolved oxygen levels) that are unsuitable for mussels, while areas immediately downstream of dams can have daily water level and temperature fluctuations that can stress mussels (FWS 1993). Thus, the dwarf wedgemussel would not be expected to be present in the vicinity of the VYNPS, including the thermal plume area.

Less than 55 populations of the dwarf wedgemussel remain throughout its range. Forty-one of these populations contain less than 50 individuals, with 32 populations having less than 10 individuals or are possibly extirpated. Only 8 or 9 populations have 50 to 1000 individuals, and only 4 populations have 10,000 to 100,000 individuals (NHFGD 2005). In recent surveys, no specimens were found in Vernon Pool between Bellows Falls Dam and Vernon Dam (NHFGD 2005). The closest occurrence to the VYNPS in the Connecticut River is near Rockingham, Vermont, just north of Bellows Falls Dam, 30 mi upstream of the site (NHFGD 2005; Entergy 2006a).

The small (generally ≤1.5-in.) mussel inhabits primarily large rivers in substrates of stable mud, silty sand, sand, or gravel (CDEP 2004b; Kart et al. 2004). Water currents need to be sufficient to maintain the area free of surficial silt (Kart et al. 2004). Suitable fish hosts in the Connecticut River watershed for the glochidia of the dwarf wedgemussel include the tessellated darter (*Etheostoma olmstedi*), slimy sculpin (*Cottus cognatus*), and juveniles and parr of Atlantic salmon (Kart et al. 2004; NHFGD 2005). Healthy populations of tessellated darter and slimy sculpin in the Connecticut River and major tributaries such as the Ashuelot River contribute to the persistence of the dwarf wedgemussel (NHFGD 2005). Unlike many mussel species that may live 20 to 100 years, the dwarf wedgemussel only lives about 10 years. Thus, individuals must be constantly replaced to maintain viable populations (NYSDEC undated).

Brook Floater

Within Vermont, the State-threatened brook floater is currently known only from the West River (Kart et al. 2004). It occurs in small- and medium-sized streams to large rivers within rocky or gravel substrates and sandy shoals, often with rooted aquatic vegetation and in or adjacent to riffles and rapids (MDFW 1989; Kart et al. 2004; NHFGD 2005). The brook floater requires clean, well-oxygenated waters with moderate to high flows (NHFGD 2005). Suitable fish hosts for the glochidia of the brook floater include slimy sculpin, longnose dace (*Rhinichthys cataractae*), blacknose dace (*R. atratulus*), golden shiner (*Notemigonus crysoleucas*), pumpkinseed, yellow perch, and tessellated darter (Kart et al. 2004). Declines of the brook floater are due to dams and flow regulation, siltation, dredging, stream diversions and channelization, nutrient loading, and acid precipitation (MDFW 1989).

2.2.6 Terrestrial Resources

2.2.6.1 Description of Terrestrial Resources in the Vicinity of VYNPS

The 125-ac VYNPS site is located just west of the Connecticut River and within the Southern Vermont Piedmont, a region of low rolling foothills that are dissected by streams and rivers (Thompson and Sorenson 2005). The region is mostly forested, but small agricultural areas are interspersed among the hills and dominate the fertile floodplains. Sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), ash (*Fraxinus* spp.), and yellow birch (*Betula alleghaniensis*) occur at the higher elevations, and oak (*Quercus* spp.) and pine (*Pinus* spp.) become common in the Connecticut River Valley and on many south-facing slopes. The VYNPS site and the surrounding region are within the Adirondack-New England Mixed Forest–Coniferous Forest–Alpine Meadow Province of the Warm Continental Regime Mountains Division of the Humid Temperate Domain, using Bailey's delineation of ecoregions of North America (Bailey 1995, 1996, and 1998).

Common terrestrial vertebrate species in the region include wild turkey (*Meleagris gallopavo*), white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), porcupine (*Erethizon dorsatum*), eastern chipmunk (*Tamias striatus*), gray squirrel (*Sciurus carolinensis*), a variety of other small mammals, and numerous songbirds (Thompson and Sorenson 2005). Vernal pools provide habitat for a variety of species including spotted salamander (*Ambystoma maculatum*). Other species in the vicinity include green frog (*Rana clamitans*), wood frog (*R. sylvatica*), spring peeper (*Pseudacris crucifer*), red-backed salamander (*Plethodon cinereus*), red-spotted newt (*Notophthalmus viridescens*), Jefferson's salamander (*Ambystoma jeffersonianum*), ruffed grouse (*Bonasa umbellus*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), black bear (*Ursus americanus*), moose (*Alces alces*), snowshoe hare (*Lepus americanus*), and fisher (*Martes pennanti*) (VDFW 2006b).

About 35 ac (28 percent) of the VYNPS site currently is occupied by buildings and structures (Entergy 2006a). Prior to construction of the station, the site was primarily pasture land with a few mature trees (AEC 1972). The remainder of the site supports mowed grass and early successional habitat (66 ac; 53 percent), mixed deciduous and coniferous woodland (20 ac; 16 percent), shrubland (3 ac; 2 percent); and wetland (1 ac; 1 percent). A band of riparian vegetation parallels the western bank of the Connecticut River. About 1600 ft of the shoreline near the intake and discharge structures consists of rip-rap through which shrubs and small trees have grown. Mixed deciduous and coniferous riparian woodland parallels the river shore upstream and downstream of the rip-rap area for the remainder of the VYNPS property. This riparian woodland is up to 300 ft wide.

Eleven wetland areas have been delineated on the VYNPS site (SVE Associates 2005). All of these wetlands are dominated by herbaceous species, were described as depressions or swales, and are Vermont Category 3 wetlands, i.e., they are not considered significant for providing wetland functions (Smith 2004; Lattrell 2004, 2005). The largest of these wetlands is about 1.2 ac (0.5 ha), and was apparently affected by construction of stormwater retention areas associated with a new parking area (Smith 2004). Dominant plant species found in site wetlands include reed canary grass (*Phalaris arundinacea*), spike rush (*Eleocharis* spp.), field horestail (*Equisetum arvense*), dark green bulrush (*Scirpus atrovirens*), soft rush (*Juncus effusis*), sedges (*Carex* spp.), and sensitive fern (*Onoclea sensibilis*) (Smith 2004; Lattrell 2004; Lattrell 2005). In addition to the wetlands on the VYNPS site, there are several small marshes located on the western shore of the Connecticut River upstream and downstream of the VYNPS site (AEC 1972; Entergy 2006k). These marshes are dominated by common reed (*Phragmites communis*).

A number of migrant waterfowl and other birds occur in wetlands and aquatic habitats adjacent to the VYNPS site (Entergy 2006a). Migrant waterfowl species that occur in the area include mallard (*Anas platyrhynchos*), Canada goose (*Branta canadensis*), and American black duck (*Anas rubipres*). Osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*) forage and roost along the Connecticut River and occasionally roost in large riparian trees on the VYNPS site.

Several forested areas within the nearby 1401-ac Roaring Brook Wildlife Management Area are considered important deer wintering areas (Entergy 2006a). Many of the natural communities on the wildlife management area property are unique to Vermont and are more like those found in Massachusetts (VDFW 2006b). The wildlife management area is located about 1 mi to the west and south of VYNPS. It is mostly forested with a mixture of eastern hemlock (*Tsuga canadensis*) and hardwood trees, especially white oak (*Quercus alba*) and red oak (*Q. rubra*), which provide important food for many wildlife species.

2.2.6.2 Threatened or Endangered Terrestrial Species

Table 2-12 presents the scientific names, common names, listing status, and habitats of Federally and State-listed terrestrial species that could occur in the vicinity of the VYNPS site (Windham County, Vermont, and Cheshire County, New Hampshire). This information is also presented for species that could occur on or in the vicinity of transmission lines associated with VYNPS (VYNPS-to-Coolidge line in Windham and Windsor Counties, Vermont, and the VYNPS-to-Chestnut Hill line in Windham County, Vermont, and Cheshire County, New Hampshire).

The NRC contacted FWS to determine the presence of Federally listed threatened or endangered species in the vicinity of VYNPS or associated transmission lines (NRC 2006b, 2006c). The FWS determined that the bald eagle was the only Federally listed species known to occur in the vicinity of these facilities, and that bald eagles nest less than 1 mi downstream of VYNPS (FWS 2006e). In addition, FWS determined that no impacts to the eagles are known to occur at this site that could be attributed to VYNPS or its transmission lines, and that preparation of a Biological Assessment or further consultation under Section 7 of the Endangered Species Act is not required.

Entergy contacted the Vermont Agency of Natural Resources (VANR) to determine if important natural habitats occurred on or in the vicinity of the VYNPS site (Tucker 2005). VANR provided a list of State-listed species that are known to occur within 6 mi of the VYNPS site. These species and others determined to occur or potentially occur in the project area are presented in Table 2-12. Federally listed species with the potential to occur in the project area are discussed in the remainder of this section. Included are Jesup's milk-vetch, northeastern bulrush, bald eagle, and Indiana bat.

Jesup's Milk-Vetch

Jesup's milk-vetch (*Astragalus robbinsii* var. *jesupi*) was Federally listed as endangered in 1987. Critical habitat has not been designated for this species. The entire population of the species is thought to be less than 1000 individuals, and it is considered one of the rarest plants in New England; it is endemic to rock outcrops on the Connecticut River (Brackley 1989). Jesup's milk-vetch is a perennial herb, 20 to 60 cm tall, with blue-violet flowers that appear in late May or early June. The species has a 1.5- to 3.0-cm long seed pod with a conspicuous beak that can be used to distinguish the species.

Only three populations (one in Vermont, two in New Hampshire) are currently known for the Jesup's milk-vetch (Brackley 1989). All three occur along a 16-mi stretch of the Connecticut River about 50 mi upstream of VYNPS. The species is found primarily on partially shaded calcareous bedrock outcrops (primarily schist) that are ice-scoured annually. Most plants occur at the ice-scour line between barren rock and vegetated upper areas of the bank. Searches of other apparently suitable sites downstream to the Massachusetts border have failed to reveal additional populations of the species (Brackley 1989). None of the locations are in areas likely to be affected by operations of the VYNPS or its associated transmission lines.

Northeastern Bulrush

The northeastern bulrush (*Scirpus ancistrochaetus*) was Federally listed as endangered in 1991. Critical habitat has not been designated for this species. Thirty-three populations are currently known from seven eastern states. Two of these populations are located in Vermont (Windham County) and one in New Hampshire (Cheshire County). Most of these populations exist on private lands that are subject to habitat loss, modification, and degradation caused by residential and agricultural development (Copeyan 1993). Northeastern bulrush is a member of the sedge family (Cyperaceae) and is about 30 to 50 in. tall at maturity. Flowering occurs from mid-June to July, and fruit sets between July and September.

Table 2-12. Federally Listed and State-Listed Terrestrial Species Whose Ranges Include the VYNPS Site, Transmission Lines Within the Scope of License Renewal, and Vicinity

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat
Plants				
Allium canadense	wild garlic	NL	NH-E	Moist fields or open woods. Known to occur in Cheshire County, New Hampshire.
Astragalus robbinsii var. *jesupi*	Jesup's milk-vetch	E	VT-E	Connecticut River Valley. Confined to calcareous bedrock outcrops that are ice scoured annually. Nearest known population approximately 50 mi north of site. Known to occur in Windsor County, Vermont.
Aureolaria virginica	downy false-foxglove	NL	NH-T	Dry oak woods. Known to occur in Cheshire County, New Hampshire.
Aureolaria pedicularia var. *intercedens*	fern-leaved false-foxglove	NL	NH-E	Dry deciduous woods and clearings. In New Hampshire, it is found in partial to open canopy portions of oak-pine forest and woodlands on rocky slopes and ridges, outcrops, and summits. Known to occur in Cheshire County, New Hampshire.
Cornus florida	flowering dogwood	NL	VT-T	Mesic deciduous woods, on floodplains, slopes, bluffs, and in ravines. Found within 6 mi of VYNPS in Windham County, Vermont.
Crotalaria sagittalis	rattlebox	NL	VT-T	Sandy soils of open areas. Found within 6 mi of VYNPS in Windham County, Vermont.
Fimbristylis autumnalis	autumn fimbristylis	NL	VT-E	Moist to wet sands, peats, silts, or clays, primarily of disturbed, sunny ground such as seeps, ditches, savannas, stream banks, reservoir drawdowns, and pond shores. Found within 6 mi of VYNPS.

Table 2-12. (contd)

Scientific Name	Common Name	Federal Status[a]	State Status[a]	Habitat
Galearis spectabilis	showy orchis	NL	NH-T	Rich woods, primarily beech and maple woods with calcareous soils, and at the edges of swamps. Known to occur in Cheshire County, New Hampshire.
Helianthemum bicknellii	plains frostweed	NL	VT-T	Dry sandy or rocky soil in open woods, clearings, and grasslands. Found within 6 mi of VYNPS.
Helianthus strumosus	harsh sunflower	NL	VT-T	Openings or edges of woods. Found within 6 mi of VYNPS.
Hypericum ascyron	great St. John's-wort	NL	VT-T	Along streambanks, and in wet meadows and thickets. Found within 6 mi of VYNPS.
Isoetes engelmannii	Engelmann's quillwort	NL	VT-T	Open areas of shallow bodies of water; pond margins and ditches. Found within 6 mi of VYNPS.
Isotria verticillata	large whorled pogonia	NL	VT-T, NH-E	Acid woods and edges of fens. Found within 6 mi of VYNPS.
Lechea mucronata	hairy pinweed	NL	VT-E	Dry sandy soils in fields and open woods. Found within 6 mi of VYNPS.
Lespedeza hirta	hairy bush-clover	NL	VT-T	Dry sunny places and roadsides. Found within 6 mi of VYNPS.
Rhexia virginica	Virginia meadow-beauty	NL	VT-T	Wet sandy soil. Found within 6 mi of VYNPS.
Potamogeton zosteriformis	flatstem pondweed	NL	NH-T	Ponds and slow streams. Known to occur in Cheshire County, New Hampshire.
Polygonatum biflorum var. *commutatum*	giant Solomon's seal	NL	NH-E	Dry to moist sandy, loamy, or rocky soils in deciduous woods and thickets, usually in upland areas. Known to occur in Cheshire County, New Hampshire.

Table 2-12. (contd)

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat
Scirpus ancistrochaetus	northeastern bulrush	E	VT-E	Alluvial meadows and small headwater or coastal plains ponds characterized by seasonally variable water levels. Known to occur in Windham County, Vermont.
Solidago odora	sweet goldenrod	NL	VT-T	Dry openings in sandy or rocky acid soil; open woods, thinly wooded slopes, thickets, and clearings. Found within 6 mi of VYNPS.
Uvularia perfoliata	perfoliate bellwort	NL	NH-E	Moist woodland and scrub. Known to occur in Cheshire County, New Hampshire.
Viola lanceolata	lance-leaved violet	NL	VT-T	Wet open places often along streams and ponds, especially in sandy soils. Found within 6 mi of VYNPS.
Woodwardia virginica	Virginia chain-fern	NL	VT-T	Swamps and wet woods. Found within 6 mi of VYNPS.
Insects				
Cicindela puritana	puritan tiger beetle	E		Extirpated. Formerly sandy riverine beaches along the Connecticut River.
Amphibians				
Ambystoma jeffersonianum	Jefferson's salamander	NL	VT-SC	Well-shaded deciduous forest with ponds and pools for breeding. Found within 6 mi of VYNPS.

Table 2-12. (contd)

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat
Ambystoma opacum	marbled salamander	NL	NH-E	Sandy and gravelly areas of mixed deciduous woodlands; low areas around ponds, swamps, and quiet streams during breeding season. Known to occur in Cheshire County, New Hampshire.
Hemidactylium scutatum	four-toed salamander	NL	VT-SC	Swamps, boggy streams, and wet, wooded, or open areas near ponds or quiet, mossy, or grassy/sedgy pools. Found within 6 mi of VYNPS.
Bufo fowleri	Fowler's toad	NL	VT-SC	Wooded areas, river valleys, floodplains, agricultural areas; usually in areas with deep friable soils. Breeds in shallow water of marshes and bodies of water lacking a strong current. Found within 6 mi of VYNPS.
Reptiles				
Coluber constrictor	eastern racer	NL	VT-T	Wide range of habitats including prairies, shrublands, woodlands, forests, stream sides, and semi-agricultural areas. Found within 6 mi of VYNPS.
Clemmys guttata	spotted turtle	NL	VT-E	Unpolluted, small, shallow bodies of water such as marshes, marshy pastures, bogs, fens, streams, swamps, ponds, and vernal pools surrounded by relatively undisturbed meadow or undergrowth. Found within 6 mi of VYNPS.

Table 2-12. (contd)

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat
Crotalus horridus	timber rattlesnake	NL	NH-E	Mountainous or hilly deciduous or mixed deciduous-coniferous forest, often with rocky outcroppings, steep ledges, and rock slides. Known to occur in Cheshire County, New Hampshire.
Birds				
Haliaeetus leucocephalus	bald eagle	T, PDL[(b)]	VT-E	Large open bodies of water with adjacent trees. Nests along Connecticut River less than 1 mi downstream of VYNPS site. Migrates and winters through area. Known to occur in Windham and Windsor Counties, Vermont.
Mammals				
Myotis sodalis	Indiana bat	E	VT-E	Riparian, bottomland, and upland forest habitats. Possible occurrence in Windham and Windsor County, Vermont, and Cheshire County, New Hampshire.

(a) NL = not listed, E=endangered, T = threatened, PDL = proposed for delisting, VT-E = listed as endangered in Vermont, VT-T = listed as threatened in Vermont, VT-SC = species of special concern in Vermont, NH-E = listed as endangered in New Hampshire, NH-T = listed as threatened in New Hampshire. Note that for State-listed species, mention is only made regarding occurrence in the State of listing.

(b) In a press release dated June 28, 2007, the Department of Interior (DOI) announced the bald eagle will be delisted.

Sources: DeGraff and Rudis 1986; DOI 2007; Gleason and Chronquist 1991; FWS 2002b, 2006c; LaRoche 2005; VDFW 2005a,b; CBS 2006; EPA 2006b; NatureServe 2006

Plant and the Environment

The northeastern bulrush is found in ponds, wet depressions, and shallow sinkholes within small (less than 1 ac) wetland complexes (Copeyan 1993). The single population in New Hampshire, observed in 1992, occurred on private land in northern Cheshire County in a drained beaver pond dominated by grasses and sedges. The two populations in Vermont are located in Windham County about 15 mi apart. In one of these populations, individuals occur in several small shallow ponds surrounded by emergent wetlands in an alluvial meadow of the Connecticut River. In the other site, plants occur along the edges of a beaver meadow in the zone of emergent vegetation. All sites are characterized by fluctuating water levels fed primarily by surface water runoff.

The northeastern bulrush is not known to occur on the VYNPS site or on either transmission line within the scope of license renewal.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) was Federally listed in 1967. It was listed as threatened in the conterminous U.S., but was proposed for delisting in 1999 (FWS 1999). The U.S. Department of Interior (DOI) announced on June 28, 2007, that the bald eagle was to be delisted (DOI 2007). Critical habitat has not been designated for this species. Drastic declines in the number of bald eagles was linked to reproductive failure associated with widespread use of the insecticide dichloro-diphenyl-trichloroethane (DDT). The 1972 ban of DDT for use in the United States was pivotal in the recovery of the species.

The bald eagle ranges across much of North America. The species frequents estuaries, large lakes, reservoirs, major rivers, and some coastal habitats. Fish form the bulk of its diet, but waterfowl and carrion are also eaten. Bald eagles typically nest in trees near water, especially in large trees along shorelines away from disturbance. Adults tend to use the same breeding area for years and often use the same nest.

Bald eagles can occur in the VYNPS area throughout the year. VYNPS's location on the Vernon Pool of the Connecticut River makes it ideal as a foraging and roosting area for eagles. Eagles frequently roost on the large riparian trees along the site shoreline. Several bald eagles were observed on or near the site during the NRC staff's site audit in May 2006. During the winter, open water near the discharge canal could attract foraging eagles that would otherwise leave the area.

There is also the potential for breeding of the bald eagle on or near the VYNPS site. For several years, Vermont was the only state in the conterminous United States that did not have a breeding pair of bald eagles (VDFW 2006c). However, in 2005, a bald eagle pair built a nest in a large pine along the Connecticut River just downstream of Vernon Dam less than 1 mi from VYNPS. The pair successfully hatched at least one young in this nest in April 2006 (VDFW 2006c), but by late May the eaglet had died (VDFW 2006d). Although there was evidence of raccoon predation, the cause of death was not known (VDFW 2006d).

Indiana Bat

The Indiana bat (*Myotis sodalis*) was Federally listed as endangered in 1967. No critical habitat has been designated for this species in the project area. The Indiana bat ranges across much of the eastern United States (FWS 1983). Large hibernating populations occur in Indiana, Missouri, and Kentucky. Most Indiana bats migrate seasonally between winter hibernacula and summer ranges.

Suitable habitat for the Indiana bat consists of riparian, bottomland, and upland forest habitats with trees that have crevices or exfoliating bark that can be used as roosting sites. Maternity colonies are formed mostly in riparian and floodplain areas of small- to medium-sized streams (FWS 1983). Optimum foraging habitat consists of streams lined on both sides with mature trees that overhang the water, although other habitats are sometimes used.

Although there are no known records of the Indiana bat in either Windham or Windsor Counties, Vermont, or Cheshire County, New Hampshire, there is a possibility that the species occurs within suitable habitat on or near the VYNPS site or transmission lines associated with the site. The summer range of this species includes the southern half of Vermont and the southwestern portion of New Hampshire (FWS 1983).

2.2.7 Radiological Impacts

A radiological environmental monitoring program (REMP) has been conducted around the VYNPS site since 1970. The objectives of the REMP are to provide an early indication of the appearance or accumulation of any radioactive material in the environment caused by the operation of the station, to provide assurance to regulatory agencies and the public that the station's environmental impact is known and within anticipated limits, to verify the adequacy and proper functioning of station effluent controls and monitoring systems, and to provide standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental releases of radioactive material (Entergy 2006l).

Each year, results of measurements of radiological releases are summarized in the VYNPS Annual Radioactive Effluent Release Report (e.g., Entergy 2006c). The limits for all radiological releases are specified in the ODCM (Entergy 2002c), and these limits are designed to meet Federal standards and requirements.

The REMP includes monitoring of the airborne pathway (air particulates and iodine), waterborne pathways (river water, groundwater, and river sediment), ingestion pathways (milk, silage, mixed grass, and fish), and direct radiation pathway (gamma dose on thermoluminescent dosimeter (TLD) locations) (Entergy 2006l). For trending purposes, radiological and direct radiation measurements are compared with past years. Sampling locations are chosen based on meteorological factors, preoperational planning, and results of land-use surveys. A number of locations, in areas very unlikely to be affected by plant operations, are selected as controls. The environmental monitoring reports over the last 5 years have been reviewed. The results indicate that the radiation and radioactivity in the environmental media monitored around the plant have been well within applicable regulatory limits (Entergy 2002a, 2003a, 2004a, 2005a, 2006l).

The Vermont Department of Health (VDH) has also been conducting radiological surveillance and monitoring around the VYNPS since 1971. The results are summarized in the annual State of Vermont, Vermont Yankee Nuclear Power Station Environmental Radiation Surveillance Reports (VDH 2002, 2003, 2004, 2005, 2006). The samples collected and the measurements made by VDH annually include:

- The direct gamma radiation emanations as measured by TLDs at the site boundary and various other locations around the site,
- The amount of radioactive particulates and radioactive iodine in air,
- Water from wells and waterways surrounding the plant, and
- Various wild and cultivated vegetation, river bed sediments, and soils.

The VDH reports present long-term historical trends and in some cases compare the results with background measurements. The 2005 report concludes that there are no significant adverse health effects from operation of VYNPS (VDH 2006).

In addition to monitoring radioactivity in environmental media, Entergy annually assesses doses to individuals from gaseous and liquid effluents (if any) at several locations based on effluent release data and mathematical modeling methods approved by the NRC. Calculations are performed using the plant effluent release data, onsite meteorological data, and appropriate pathways identified in the ODCM. Radiation dose results for the 5-year period of 2001 through 2005 (Entergy 2002b, 2003b, 2004b, 2005b, 2006c) were reviewed. The results for 2005, which were representative of the values for the other years, were as follows:

- The maximum annual whole body dose to an individual on the site boundary not adjacent to the Connecticut River (called the maximally exposed individual, or MEI) from all pathways including direct radiation was 13.5 mrem/yr. Over 99.9 percent of this dose was due to direct radiation because of the individual's close proximity to the plant. This dose is less than the EPA (40 CFR Part 190) dose limit of 25 mrem/yr to the whole body of any member of the public from the entire fuel cycle. It also meets NRC's dose limit in 10 CFR Part 20, which is based on the EPA's limit. It is also below the 20 mrem/yr limit imposed on VYNPS by the Vermont Department of Health (VDH 1977).

- The maximum annual dose to the thyroid, which was also the organ with the maximum dose, of the MEI from all effluents was also 13.5 mrem. Similar to the whole body dose, over 99.9 percent of the thyroid dose was due to the direct radiation. This dose is less than the EPA (40 CFR Part 190) dose limit of 75 mrem/yr to the thyroid of any member of the public from the entire fuel cycle. It also meets NRC's dose limit in 10 CFR Part 20, which is based on the EPA limit.

- The main source of direct radiation is the gamma radiation originating in the turbine building. These gamma rays spread out radially from the turbine building. Some directed toward the sky get scattered back to earth by the atoms in the air, particulate matter suspended in the air, or the clouds before they reach the MEI (by a process called skyshine). The direct radiation decreased rapidly with distance from the plant. For example, TLDs, which measure the direct radiation, registered an annual average reading of 0.0094 milliRoentgen (mR)/hr at a location 210 m away from the center of the turbine building on the site boundary in the west-southwest (WSW) direction. At 520 m away from the center of the turbine building in the same direction, the average annual TLD measurement was 0.0066 mR/hr. The average TLD measurements at control locations indicative of the background radiation in the vicinity of the plant were 0.0063 mR/hr with a standard deviation of 0.00033 mR/hr. These results indicate that direct radiation from the plant went down to essentially zero at about 310 m from the site boundary in the WSW direction. Similar reductions in direct radiation measurements were observed for other directions.

These results confirm that VYNPS has been operating in compliance with all the Federal (Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190) regulations as well as the State of Vermont regulations (VDH 1977). In March 2006, the NRC issued a license amendment that allowed Entergy to increase the thermal power of VYNPS by 20 percent (to 1912 MW(t)). In the EA and the FONSI accompanying the license amendment (NRC 2006a), it is estimated that when the power increases by 20 percent, the direct radiation component of the MEI dose at the site boundary would increase by about 26 percent and would be about 18.6 mrem per year. Considering that over 99.9 percent of the individual's dose is from direct radiation, the whole body dose to the MEI is estimated to be about 18.7 mrem/yr.

In March of 2006, Entergy started the power uprate and completed it in May 2006. In May 2006, Entergy also installed new shielding (3-in.-thick steel) on top of the high-pressure turbine to cut down on the skyshine component of the direct radiation. Entergy staff measured the exposure rate at the site boundary before the uprate, after the uprate but before the new shield was installed, and after the installation of the shield. The results indicated that the exposure rates at the site boundary were 0.001313 mR/hr before the uprate, 0.002534 mR/hr after the uprate but before the shield was installed, and 0.001866 mR/hr after the shield was installed (Entergy 2006d). On an annual basis, the exposure rates were estimated to be 11.50 mR, 22.2 mR, and 16.35 mR, respectively, for the same conditions. Although not exactly correct, the exposure rate in terms of 1 mR/hr is often considered to be equivalent to a dose rate of 1 mrem/hr. Therefore, the measured values indicate that with the newly installed shield in place, the MEI dose at the site boundary will continue to satisfy both the Federal and State regulations.

As discussed in Section 2.1.4.3, there are two areas on the VYNPS site that have been approved for disposal of slightly contaminated materials by land spreading. The Annual Radioactive Effluent Release Reports provide the estimated doses to two types of hypothetical individuals due to these disposal operations: (1) someone who is directly exposed to all the material accumulated on the disposal site during the period the licensee has active control of the disposal sites, and (2) an inadvertent intruder after the licensee relinquishes active control of the disposal sites. (The data and assumptions used and the calculations performed to estimate these doses are outlined in Appendices B, F, and I of the ODCM [Entergy 2002c], [NRC 2005], and [Entergy 2004m]). For example, Appendix J in the Radioactive Effluent Release Report for 2005 (Entergy 2006c) lists the maximum organ (including whole body) dose to the first individual from material spread in 2005 as 0.000454 mrem/yr. The maximum organ dose for the same individual from all past spreading operations, including the material spread in 2005, is given as 0.115 mrem/yr. For an inadvertent intruder, the projected dose due to material accumulated through 2005 is estimated as 0.378 mrem/yr.

In April 2006, Entergy was granted approval by the Vermont Public Service Board to construct a dry fuel storage facility onsite. Once the facility is constructed, some of the spent fuel that is currently in the spent fuel pool onsite will be moved to the dry storage facility. It is estimated that the dry storage facility will increase the annual dose received by the MEI by approximately 0.3 mrem (Entergy 2006j). All of this increase is expected to come from direct radiation. With this increase, the estimated whole body dose to the MEI would be approximately 19 mrem/yr, which would still be within the Federal and State limits.

Aside from the changes associated with the power uprate and the installation of the dry fuel storage facility, as discussed above and in Section 2.1.4, Entergy does not anticipate any significant changes to the radioactive effluent releases or exposures from VYNPS operations during the renewal period; therefore, the impacts on the environment are not expected to change.

2.2.8 Socioeconomic Factors

The NRC staff reviewed the Entergy ER (Entergy 2006a) and information obtained from county, city, and local economic development staff. The following sections describe the housing market, community infrastructure, population, and economy in the region surrounding the VYNPS site.

2.2.8.1 Housing

VYNPS employs approximately 650 workers, the majority of whom live in Windham County, Vermont (43 percent), and Cheshire County, New Hampshire (25 percent). The remainder are located in Franklin County, Massachusetts (17 percent), and a number of other counties (Table 2-13). Given the residential locations of VYNPS employees, the most significant impacts

Table 2-13. VYNPS Permanent Employee Residence Information by County and City

County and City[a]	Percent of Total
WINDHAM COUNTY	
Brattleboro	14
Vernon	14
Guilford	3
Putney	2
Newfane	2
Others	8
Total Windham County	43
CHESHIRE COUNTY	
Hinsdale	6
Keene	5
West Chesterfield	3
Spofford	2
Others	9
Total Cheshire County	25
FRANKLIN COUNTY	
Greenfield	6
Others	11
Total Franklin County	17
Other Counties	15
Grand Total	100

(a) Addresses are for both unincorporated (counties) and incorporated (cities and towns) areas.
Source: Entergy 2006a

of plant operations are likely to occur in Windham County, Cheshire County, and Franklin County. The focus of the analysis in this SEIS is on the impacts of VYNPS operations in these counties.

Entergy refuels VYNPS every 18 months. During refueling, approximately 700 to 900 additional workers are employed for a 30-day period (Entergy 2006a). The majority of these workers reside in the same communities as the permanent employees at the plant.

The number of housing units and housing vacancies in Windham County, Cheshire County, and Franklin County are shown in Table 2-14. In Windham County, the total number of housing units grew at an annual rate of 0.5 percent over the period 1990 to 2000, while the number of occupied units grew at an average annual rate of 1.2 percent over the same period. With an annual average population growth rate of 0.6 percent during this period, there was a slight decline (−1.0 percent) in the annual rate of growth in the number of vacant units during this period. In Cheshire County, housing market trends were similar to those in Windham County. Annual growth in housing in Cheshire County was 0.5 percent between 1990 and 2000, with slightly larger growth in the number of occupied housing units (0.9 percent). In Franklin County, annual growth in housing between 1990 and 2000 was 0.5 percent, with a slightly higher rate of growth in occupied housing (0.6 percent). With annual population growth in Cheshire County

Table 2-14. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990	2000	Average Annual Growth Rate 1990 to 2000
WINDHAM COUNTY			
Housing units	25,796	27,039	0.5
Occupied units	16,264	18,375	1.2
Vacant units	9,532	8664	−1.0
CHESHIRE COUNTY			
Housing units	30,350	31,876	0.5
Occupied units	25,856	28,299	0.9
Vacant units	4494	3577	−2.3
FRANKLIN COUNTY			
Housing units	30,394	31,939	0.5
Occupied units	27,640	29,466	0.6
Vacant units	2754	2473	−1.1

Source: USCB 2006a

and Franklin County at 0.5 percent and 0.2 percent, respectively, the number of vacant units fell in both counties, by −2.3 percent in Cheshire County and by −1.1 percent in Franklin County. The housing vacancy rate in 2000 was 32.0 percent in Windham County, 11.2 percent in Cheshire County, and 7.7 percent in Franklin County. The high rates in Windham County and Cheshire County are due primarily to the large number of seasonal homes in the region.

2.2.8.2 Public Services

Water Supply

Water supplied by public water systems in Windham County, Cheshire County, and Franklin County comes from both surface water and groundwater sources (Table 2-15). Currently, there are six public water suppliers within 10 mi of VYNPS, with the Brattleboro system providing 68 percent of total capacity (Entergy 2004c). Large parts of the three counties do not have access to public water systems and use groundwater and springs as their primary water source. More than 50 wells within a mile of VYNPS supply water for domestic and farm use. All the public water supply systems within 10 mi of the plant have additional capacity to meet new water demands (Entergy 2004c).

VYNPS withdraws water from the Connecticut River for plant service and fire protection at a rate of 18,400 gpm, and from wells located onsite at a maximum rate of 35 gpm (Section 2.2.2). The plant does not use groundwater from local municipal systems. Fire protection for the plant is provided by the Town of Vernon Fire Department (Town of Vernon 2006).

Table 2-15. Major County Public Water Supply Systems in 2004

Water System	Source	Maximum Capacity (million gpd)
	WINDHAM COUNTY	
Brattleboro	Surface water	3
Brattleboro	Groundwater	3.2
	CHESHIRE COUNTY	
Hinsdale	Groundwater	1
Winchester	Groundwater	0.6
	FRANKLIN COUNTY	
Northfield	Groundwater	0.2
Bernardston	Groundwater	1.1

Source: Entergy 2004c

Education

VYNPS is located in the Windham Southeast Supervisory Union School District, which is one of four school districts serving Windham County. In 2004, the district had 9 schools, with a total enrollment of 3106 students, and employed 48 teachers (Standard and Poors 2006). Expenditures in the district are currently $14,738 per student compared to $13,408 for Vermont as a whole (Public School Review 2006). The only school located in the town of Vernon is the Vernon Elementary School, which had 228 students and 10 teachers in 2004 (Public School Review 2006). Student enrollment in the district, together with expenditures per student and the number of teachers in the district, have remained stable over the 2000 to 2004 period (Standard and Poor’s 2006; Public School Review 2006).

In 2004, Windham County had an additional 20 private schools, with an enrollment of 2114 students (Private School Review 2006).

Transportation

Access to VYNPS is via State Highway 142, approximately 0.8 mi west of the plant. The highway runs north-south in the vicinity of the plant, generally following the route of the Connecticut River. Access to the plant itself is provided via two intersections on Highway 142 and Governor Hunt Road. Interstate I-91 and U.S. Highway 5 run north-south through the county, connecting Brattleboro with Greenfield to the south, while Highway 9 connects Brattleboro with Bennington to the west, and Keene to the east in New Hampshire. Highway 30 links Brattleboro with other towns to the northwest. Most VYNPS employees traveling from the northern and western parts of the county use these roads to reach the site (Entergy 2006a).

Two segments of Highway 142 for which traffic counts are available were assessed in the ER. Moderate increases in traffic have occurred between 1992 and 2002 to the north of the plant on Highway 142, with increases in commuter and commercial traffic, while traffic has been relatively stable south of the plant on Highway 142 over the same period (Entergy 2006a).

2.2.8.3 Offsite Land Use

VYNPS is located in the town of Vernon, Vermont, in Windham County. The town of Vernon occupies 19.4 mi^2. The 2000 Census reported Vernon’s population to be 2119, and the town receives approximately $1 million in property tax revenue (Entergy 2006a). Land use in the town has changed little over the last 20 to 30 years. From 1970 to 1990, approximately 425 ac of forest were converted to nonforested land, and 260 ac were developed for other land uses. The VYNPS site is currently surrounded by the Connecticut River on the east, by farm and pasture land mixed with wooded areas on the north and south, and by the town of Vernon on the west (Entergy 2004c). The nearest homes are situated along the Governor Hunt Road just to the west of the site, and the Vernon Elementary School is west of Highway 4, approximately 1500 ft from the reactor building (Entergy 2004c). The town of Vernon has no zoning ordinances, subdivision ordinances, or development review board. The town did approve the 2003 Town Plan, which outlines the community's plan for future growth and development (Entergy 2006a).

The town of Vernon derives significant revenue from VYNPS. Property taxes paid by Entergy make up approximately 40 percent of the town of Vernon's General Fund, which is utilized for police, fire, roads, and other town services. Entergy's State Electric Generation Education Tax payment covers approximately a third of the Vernon School District's budget. This funding enables the town of Vernon and Windham County to maintain lower tax rates than would otherwise be needed to fund the current level of public infrastructure and services for the county and local government (Entergy 2006a).

Windham County occupies roughly 789 mi^2, and its population increased from 41,588 to 44,284 between 1990 and 2004. The average annual population growth rate between the 2000 and 2003 censuses was 0.1 percent (Entergy 2006a). The major land uses within the county consist of woodland (56 percent), cropland (29 percent), pasture land (8 percent), and other uses (7 percent) (Entergy 2006a). Conversion of land to development is less intense in the county as compared to State-wide trends, with growth being associated with a recreational facility and resort and vacation home development. According to the 2002 USDA Census of Agriculture, 397 farms were located in the county, which is a 3 percent increase since 1997 (USDA 2006b). Land acreage associated with farms increased 21 percent during this period to over 60,000 ac. The major farm commodities in Windham County are cattle and dairy products, and the major crops are hay and silage (Entergy 2006a). The Windham Regional Commission has drafted a new regional plan to assist the towns in southeastern Vermont in collectively addressing regional land use, as well as environmental and socioeconomic issues (Windham Regional Commission 2006).

Cheshire County, New Hampshire, has a total area of 729 mi^2. In 2003, the county had a population of 75,965, with an average annual growth rate of 0.9 percent between the 2000 and 2003 censuses (Entergy 2006a). Cheshire County, located in the Monadnock region of southwestern New Hampshire, has a mix of rural villages, urban settings, and forest and agricultural land. Approximately 83 percent of the county is forested, and the acreage in farms increased from 38,216 ac to 41,651 ac between 1987 and 1997, while the acreage in cropland declined from 14,475 ac to 12,301 ac during that period (USDA 2006a; University of New Hampshire Cooperative Extension 2006). Cheshire County is one of three New Hampshire counties that are partners in the Southwest Region Planning Commission, which serves to promote sound decision making for the conservation and effective management of natural, cultural, and economic resources (Southwest Regional Planning Commission 2006). It is also a member of the Monadnock Economic Development Corporation, which strives to enhance the industrial and business base of the area to improve the standard of living, quality of life, and economic vitality of member communities (Monadnock Economic Development Corporation 2006).

Franklin County, Massachusetts, located approximately 4 mi south of the town of Vernon, has a total area of 725 mi^2. In 2003, the county had a population of 72,204, with an annual average growth rate of 0.3 percent between the 2000 and 2003 censuses (Entergy 2006a). The county exists today only as an historical geographic region, and it has no county government. The Franklin Regional Council of Governments provides regional and local planning, human services advocacy and coordination, and municipal services to the 26 towns located in the upper Connecticut River Valley in midwestern Massachusetts that make up Franklin County. The area is one of the most rural regions in Massachusetts (Franklin Regional Council of Governments 2006).

The nearest urban area within 10 mi of the site is the city of Brattleboro, Vermont (2000 population, 12,005), which is located about 5 mi upriver. The remainder of this area is rural, with approximately 75 to 80 percent of the area being wooded, and it contains several small villages and towns with populations between 1000 and 4000 (Entergy 2006a). The area between 10 mi and 25 mi of the site is predominately rural and has two urban centers with 2000 census populations of around 20,000 residents (Greenfield, Massachusetts, 18,168, and Keene, New Hampshire, 22,563) (Entergy 2004c; AEC 1972).

The site area is host to a New England Central Railroad line that is approximately 0.5 mi west of the plant at its closest approach. A former rail line right-of-way on the east side of the Connecticut River is now owned by the State of New Hampshire and has been converted for recreational use by the public. Canoeing and some sport fishing take place on Vernon Pond and adjacent river areas; users are precluded from landing on station waterfront property. The New England Electric Company has developed a series of small recreation areas along the Connecticut River. There are no public water supply intakes located on the Connecticut River downstream of VYNPS (AEC 1972; Entergy 2004c, 2006a). The town of Vernon manages the J. Maynard Miller Town Forest, and the Vermont Fish and Game Department owns several large forested areas (Town of Vernon 2003b, 2006).

2.2.8.4 Visual Aesthetics and Noise

The plant is located on a river terrace. The elevation of the site ranges from 220 ft to approximately 280 ft above mean sea level, which helps shield some of the plant structures from the public road on the west boundary where several residences are located. The plant is periodically visible from the Hinsdale, New Hampshire, side of the river, and landscaping serves to partially blend the site with the surrounding countryside (AEC 1972).

The reactor building, turbine building, stack, and meteorological towers are visible from Vermont State Highway 142, which passes by the plant, and also from New Hampshire State Highway 119, on the other side of the river. The reactor building (~305 ft) has reinforced concrete side walls, with the top 40 ft covered with a light grey metal siding. The turbine building (~90 ft) has a structural steel frame covered with a light green corrugated metal siding. The tapered, reinforced concrete stack is 318 ft high and has white strobe lights at the ~300-ft level (AEC 1972). The primary meteorological tower has a variable intensity red light at the top and steady red lights at the mid-height level (Entergy 2006f).

The 50-ft cooling towers are not visible from Highway 142, though the plume is visible from Vernon and Highway 119 in New Hampshire (AEC 1972). The aesthetic impacts associated with cooling tower operations will not change significantly. The cooling towers will continue to operate based on the flow rate and ambient temperature of the river. With the plant's uprated power level, the dimensions of the plumes generated during the summer will increase by approximately 328 ft in length, 65.6 ft to 98.4 ft in width, and up to 164 ft in height (NRC 2006a).

Three 345-kV transmission lines connect to the plant's 345-kV switchyard. Two of these lines span the Connecticut River to the New Hampshire side in tandem with a 115-kV line. The third 345-kV line extends north from the plant. The lines are visible from many vantage points. The aesthetic impacts associated with transmission are not expected to change significantly during the license renewal period.

Noise from operation of the mechanical draft cooling towers may be a source of irritation to the public during summer months and a minor irritant to nearby residences (AEC 1972). No significant increase in noise is anticipated for cooling tower operation following the extended power up-rate to approximately 120 percent of the original NRC-licensed power level (Entergy 2005c). As a condition of the approval of the uprate, the Vermont Public Service Board required replacing 21 of the 22 125-horsepower (hp) cooling tower motor/fan units with 200-hp units and replacing the 8-bladed fans with 10-bladed fans, with one of the design criteria being that the motor/fan changes could not increase the cooling tower environmental noise level by more than 1 "A-weighted" decibel level (dBA); the A-weighted decibel scale being used better approximates the range of sensitivity of the human ear to sounds of different frequencies. After a series of sound-level tests, not only did the fan modifications comply with the requirement that the cooling tower noise level shall not increase by more than 1 dBA, but sound levels were generally the same or up to 1.2 dBA quieter than the baseline measurements (Entergy 2005c; NRC 2006a).

2.2.8.5 Demography

In 2000, 153,409 people lived within 20 mi of VYNPS, for a density of 122 persons/mi^2. This density translates to Category 4 (least sparse) (Entergy 2006a), using the measure of sparseness described in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)[a]. At the same time, there were 1,513,282 persons living within 50 mi of the plant, for a density of 193 persons/mi^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.

The NRC sparseness and proximity matrix assigns a Category 4 rating (high density) for this measure as well. There are no growth control measures that would limit housing development in this area (Entergy 2006a).

Table 2-16 shows population trends for Windham County, Cheshire County, and Franklin County, the area in which the majority of VYNPS employees live. Annual average growth rates in the three counties show moderate growth during the 1990s. The annual average growth rate for each State over the period 1990 to 2000 was 0.8 percent for Vermont, 1.1 percent for New Hampshire, and 0.5 percent for Massachusetts. Growth in each county is forecasted to continue at moderate levels over the period 2003 to 2032 (Entergy 2006a).

Table 2-16. Population Growth in Windham County, Cheshire County, and Franklin County, 1990 to 2032

Year	Population	Annual Growth Percent[a]
WINDHAM COUNTY		
1990	41,588	–[b]
2000	44,216	0.6
2003	44,379	0.1
2032	48,941	0.3
CHESHIRE COUNTY		
1990	70,121	–
2000	73,825	0.5
2003	75,965	0.9
2032	96,895	0.7
FRANKLIN COUNTY		
1990	70,092	–
2000	71,535	0.2
2003	72,204	0.3
2032	77,231	0.2

(a) Annual percent growth rate is calculated over the previous decade.
(b) A dash indicates no data available.
Source: Entergy 2006a

Transient Population

The transient population in the vicinity of the VYNPS site consists primarily of tourists visiting the various recreational areas in southern Vermont and seasonal residents of resorts and vacation home developments (Entergy 2006a). An estimated 35,265 tourists per day visit the southern Vermont area (Entergy 2006n).

Migrant Farm Labor

Although approximately 1900 seasonal or migrant workers are employed during the summer and fall months in the three-county area (USDA 2006b), the majority of agricultural laborers reside in the area (Entergy 2006a). Agriculture in the area is declining in importance with the development of recreation and summer residency in the area.

2.2.8.6 Economy

Employment and Income

In 2003, total employment in Windham County was 23,083 (USCB 2006b). Service industries dominate employment in the county and account for almost 50 percent of total employment (11,345 people employed). The largest employer within 10 mi of the plant is C&S Wholesale Grocers, which has 840 employees (Table 2-17). Manufacturing also plays an important part in the local economy, with almost 21 percent of county employment (4779 people). Wholesale and retail trade employs 17.3 percent (3995 people) of the county workforce. In Cheshire County, the services sector also provides the largest share of total county employment, with almost 43 percent (13,046 people), followed by wholesale and retail trade and manufacturing, both with approximately 20 percent of the county employed workforce. Employment in Franklin County is also dominated by services (43 percent of county jobs, 13,624 people), with a similar share of total employment (21 percent) in wholesale and retail trade as Windham and Cheshire Counties. Employment in agriculture (8 percent of total county employment) and utilities (7 percent of county jobs) are relatively more important in Franklin County than in Windham County and Cheshire County.

In Windham County, personal income was $1.5 billion in 2003 (in 2005 dollars), with a per capita income of $33,079 (2005 dollars) (DOC 2006). In Cheshire County, personal income was $2.5 billion and per capita income was slightly higher at $33,485. In Franklin County, personal income was $2.3 billion and per capita income was $32,094.

Unemployment

In January 2006, unemployment in Windham County and Cheshire County was relatively low at 3.4 percent and 3.3 percent, respectively. In Franklin County it was somewhat higher, at

Table 2-17. Major Employment Facilities Within 10 mi of the VYNPS Site

Firm	Number of Employees
C&S Wholesale Grocers	840
Windham Southeast Supervisory Union (County School District)	800
Entergy Nuclear	600
United Natural Foods	487
Retreat Healthcare	430
World Learning/School for International Training	362
Brattleboro Memorial Hospital	276
Cersosimo Lumber	252
Chittenden Bank	250
Wal-Mart	220
FiberMark	200

Source: Brattleboro Area Chamber of Commerce 2006

5 percent (DOL 2006). The unemployment rate for Vermont as a whole was 4.1 percent in January 2006; the New Hampshire rate was 3.8 percent, and the Massachusetts rate was 5.3 percent.

Taxes

Property taxes are paid by VYNPS to the town of Vernon and by the Entergy corporate office facility in Brattleboro to Brattleboro Township. The State also levies an electricity generation tax on the plant, in addition to State sales, franchise use, and excise taxes on VYNPS and the Entergy corporate office facility. Revenues are used by the town of Vernon and Brattleboro Township to fund local and county emergency management programs, public safety, local public schools, local government operations, local road maintenance, and the local library system.

The plant is a significant source of tax revenue for local government in Vernon. Over the period 2003 to 2005, on average, approximately 65 percent (about $1.2 million in 2005 dollars) of total tax revenues spent in the town of Vernon came from property taxes paid to the township by VYNPS (Table 2-18). In contrast, only about 1 percent (about $0.2 million in 2005 dollars) of Brattleboro Township tax revenues, on average, over the period 2003 to 2005 came from

Table 2-18. VYNPS Contribution to Vernon Tax Revenues

Year	Total Tax Revenues (millions $2005)[a]	Taxes Paid by VYNPS (millions $2005)[b]	Percent of Total Tax Revenues
	TOWN OF VERNON		
2003	1.7	1.2	69
2004	1.8	1.1	65
2005	2	1.2	60
	BRATTLEBORO TOWNSHIP		
2003	25.8	0.2	1
2004	25.6	0.2	1
2005	22.4	0.2	1
	VERMONT		
2003	1655	6.4	>1
2004	1827	6.5	>1
2005	2243	6.2	>1

(a) Sources: Town of Vernon 2003b, 2004; Town of Brattleboro 2006; USCB 2006c
(b) Source: Entergy 2006o

Entergy. Revenues from VYNPS, from the Entergy facility in Brattleboro and from electricity generation taxes levied by the State constituted less than 1 percent of total State revenues in 2005.

Utility restructuring legislation has not been enacted in Vermont, making it difficult to predict the long-term impact of any such changes in the electricity industry in the State on VYNPS. Any changes in assessed valuation of plant property and equipment that may potentially occur could affect property tax payments to the townships and the county. However, any impacts on tax revenues as a result of restructuring would not occur as a direct result of license renewal.

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at the VYNPS site and in the surrounding area.

2.2.9.1 Cultural Background

The area in and around the VYNPS site has the potential for significant prehistoric and historic resources. The area around the Connecticut River is highly sensitive for archaeological material. Human occupation in this region roughly follows a standard chronological sequence for prehistory in the Eastern United States: Paleo-Indian Period (10000 BC to 7000 BC); Archaic Period (7000 BC to 1000 BC); Woodland Period (1000 BC to AD 1500). In general, the Paleo-Indian Period is characterized by highly mobile bands of hunters and gatherers. A typical Paleo-Indian site might consist of an isolated stone point or knife (of a style characteristic of the period) in an upland area along large river valleys or ancient lake beds. The Archaic Period represents a transition from a highly mobile existence to a more sedentary existence. It is a period of increased local resource exploitation (e.g., predominantly deer and small mammals, fish and other aquatic resources, nuts and seeds), more advanced tool development, and increased complexity in social organization. The Woodland Period is a continuation of the complexities begun during the Archaic Period with the introduction of ceramic technology. Pottery, the principal distinguishing feature between Archaic and Woodland Period sites, begins to appear in the archaeological record during this time. Generally, the Woodland people lived in small permanent or semipermanent settlements. The bow and arrow first appears during the Woodland time period.

The historic period in this region began with the arrival of the first European settlers in the mid-1500s. However, the earliest European settlement in Windham County was Fort Dummer, established in 1725 on the current site of Brattleboro, Vermont. The Native Americans living in the area were collectively known as the Abenaki. The Abenaki are divided into the eastern and western groups. Vermont was home to the western groups, which included the Sokokis, Squakheag, and the Winnipesaukees. The Fort Hill site, a Sokokis/Squakheag village located on the Connecticut River near the VYNPS, contains evidence of European influence.

European claims on the region began in 1687 when Native American groups first deeded some of the land in the Vernon area. The first permanent settler was Joseph Stebbins in 1740 (Cowie and Peterson 1991). In 1791, Vermont became the 14th State in the United States. The first railroad arrived in the area in 1847 opening the State to further development. The Vernon area had an agricultural focus, with several mills and sawmills.

Windham County has 75 sites listed on the *National Register of Historic Places* (NRHP). The nearest NRHP-listed property is the Pond Road Chapel, located 3 mi south of VYNPS. There are 17 National Historic Landmarks (NHLs) in Vermont. Two of the NHLs are located in Windham County. The Naulakha site, the residence of Rudyard Kipling, is located 15 mi north of VYNPS, and the Rockingham Meeting House is located roughly 36 mi to the north.

In addition, Vermont maintains a *State Register of Historic Places* (SRHP). The SRHP is kept by the Vermont Division for Historic Preservation. The SRHP includes archaeological sites, historic buildings, structures, and landscapes. The SRHP contains over 30,000 properties. The VYNPS has a SRHP-listed site on its property. The Governor Hunt House is an eighteenth century house once owned by Jonathan Hunt, who was elected Lieutenant Governor of Vermont in 1794. The structure, built in the early 1780s, is owned by the VYNPS and is used as a meeting facility. This is the only known historic property at VYNPS.

2.2.9.2 Historic and Archaeological Resources at the VYNPS Site

The VYNPS site occupies approximately 125 ac. No formal archaeological survey was conducted at the VYNPS site prior to initial construction (AEC 1972). There is potential for intact archaeological deposits within the undeveloped areas of the VYNPS site. The VYNPS is located on the floodplain of the Connecticut River. As a result, there is the potential for deeply buried archaeological material.

The Vermont Archaeological Society was contacted during initial planning for the power station's construction (AEC 1972). Extensive subsurface excavation is reported to have taken place prior to construction, but no intact archaeological deposits were identified. It is unclear whether the excavations were directed by the Vermont Archaeological Society. There does not appear to be any documentation of the investigations that took place prior to construction.

A considerable amount of the site was disturbed during construction. Aerial photographs from construction are the only evidence of the extent of the disturbance. Two archaeological investigations have been undertaken since the plant was constructed. These surveys examined a 34-ac area on the northern and western end of the plant property and a 10-ac area on the southeastern portion of the site. These investigations did not identify any intact subsurface cultural remains. Two shovel tests on the western portion of the property uncovered historic artifacts dating to the nineteenth century, but no subsurface features were associated with these artifacts (Hanson 1991). The southern survey established that disturbance from construction activities extends to roughly 3.5 ft below ground surface (Hartgen 2001).

The Governor Hunt House was purchased in 1968 by the Vermont Yankee Power Corporation. The house was restored to its original condition in 1990. An addition was added to the back of the house to accommodate a meeting room for the plant. The house is open for interpretive tours in the summer and by appointment.

A file search was conducted at both the New Hampshire State Historic Preservation Office (SHPO) and the Vermont SHPO to determine if any archaeological sites were in close proximity to the transmission lines associated with VYNPS. No archaeological sites were identified near the Chestnut Hill transmission lines in New Hampshire (NHDHR 2006). However, areas were identified as highly sensitive for cultural resources. The Vermont SHPO file search identified one archaeological site in the vicinity of the Coolidge transmission line; this transmission line is not owned by Entergy. The transmission line is owned by Vermont Electric Power Company, and the NRC has no regulatory authority over that company. The site consists of several stone waste flakes found on the bank of a river. The site's eligibility for listing on the *National Register of Historic Places* has not been determined. The material appears to have been found within roughly 1000 ft of the transmission line right-of-way but, given the location, it is difficult to determine the site boundary. By letter dated October 30, 2006, the NRC staff informed Vermont

Electric Power Company of the existence of the site and provided information that can be used by the company to find the documentation concerning the site at the Vermont SHPO.

Although no known sites of significance to Native Americans have been identified at the VYNPS site, government-to-government consultation with the appropriate Federally recognized Native American Tribes has been initiated (Appendix E).

2.2.10 Related Federal Project Activities and Consultations

The NRC staff reviewed the possibility that the activities of other Federal agencies might impact the renewal of the OL for the VYNPS. Any such activities could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency for the preparation of the SEISs.

Vernon Dam, located 0.75 mi downstream from the VYNPS, is licensed by the Federal Energy Regulatory Commission (FERC) as Project No. 1094, as one of a series of dams constructed on the Connecticut River for hydroelectric and flood control purposes. The Vernon Dam and Hydroelectric Station is owned and operated by TransCanada and is currently undergoing renovation (Entergy 2006a).

Federal facilities and lands located within 50 mi of the VYNPS include the Green Mountain National Forest and North Springfield Lake in Vermont, U.S. Air Force Westover facility and Fort Devens U.S. Army Military Reservation in Massachusetts, and the Wapack National Wildlife Refuge in New Hampshire (NRC 2006a). Only the Green Mountain National Forest in Vermont is closer than 25 mi. There are no Native American lands within 50 mi of the VYNPS (Entergy 2006a).

After reviewing the Federal activities in the vicinity of the VYNPS, the NRC staff determined that there are no known or reasonably foreseeable Federal project activities that would make it desirable for another Federal agency to become a cooperating agency for preparing this SEIS.

The NRC is required under Section 102(c) of the National Environmental Policy Act (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. The NRC staff has consulted with the FWS and NMFS on Federally listed and proposed threatened or endangered species and with NMFS on EFH. The consultations are described in Sections 2.2.5, 2.2.6, and 4.6. Correspondence regarding these consultations and NRC's EFH assessment are included in Appendix E.

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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 characteristics.

(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 in this Supplemental Environmental Impact Statement (SEIS) 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.

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

Table 3-1. Category 1 Issues for Refurbishment Evaluation

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

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.

The potential environmental effects of refurbishment actions would be identified, and the analysis would be summarized within this section, if such actions were planned. Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy), indicated that it has performed an integrated plant assessment evaluating structures and components pursuant to Title 10, Part 54, Section 54.21, of the *Code of Federal Regulations* (10 CFR 54.21) to identify activities that are necessary to continue operation of VYNPS 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 Environmental Report (ER) (Entergy 2006).

The integrated plant assessment that Entergy conducted under 10 CFR Part 54 did not identify the need to undertake any major refurbishment or replacement actions to maintain the functionality of important systems, structures, and components during the VYNPS license renewal period. Therefore, refurbishment is not considered in this SEIS.

Table 3-2. Category 2 Issues for Refurbishment Evaluation

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

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

3.1 References

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

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

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4.0 Environmental Impacts of Operation

Environmental issues associated with 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 characteristics.

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

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

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

Category 2 issues are those that 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 addresses the issues related to operation during the renewal term that are listed in Table B-1 of Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), Subpart A, Appendix B, and are applicable to the Vermont Yankee Nuclear Power Station (VYNPS). Section 4.1 addresses issues applicable to the VYNPS 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 potential new information that was raised during the scoping period, and Section 4.8 discusses cumulative

(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.

impacts. The results of the evaluation of environmental issues related to operation during the renewal term are summarized in Section 4.9. Category 1 and Category 2 issues that are not applicable to VYNPS because they are related to plant design features or site characteristics not found at VYNPS 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 VYNPS cooling system operation during the renewal term are listed in Table 4-1. Entergy Nuclear Vermont Yankee, LLC And Entergy Nuclear Operations, Inc. (Entergy) stated in its Environmental Report (ER) (Entergy 2006a) that it is not aware of any new and significant information associated with the renewal of the VYNPS operating license (OL). The U.S. Nuclear Regulatory Commission (NRC) staff has not identified any new and significant information during its independent review of the Entergy ER, the site visit, the scoping process, public comments on the draft SEIS, or the evaluation of other available information (e.g., potential impacts associated with the extended power uprate [EPU]) (NRC 2006a). Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

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

- <u>Altered current patterns at intake and discharge structures</u>. 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts of altered current patterns during the renewal term beyond those discussed in the GEIS.

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

Table 4-1. Category 1 Issues Applicable to the Operation of the VYNPS 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	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Temperature effects on sediment transport capacity	4.2.1.2.3
Scouring caused by discharged cooling water	4.2.1.2.3
Eutrophication	4.2.1.2.3
Discharge of chlorine or other biocides	4.2.1.2.4
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4
Discharge of other metals in wastewater	4.2.1.2.4
Water-use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY	
Accumulation of contaminants in sediments or biota	4.2.1.2.4
Entrainment of phytoplankton and zooplankton	4.2.2.1.1
Cold shock	4.2.2.1.5
Thermal plume barrier to migrating fish	4.2.2.1.6
Distribution of aquatic organisms	4.2.2.1.6
Premature emergence of aquatic insects	4.2.2.1.7
Gas supersaturation (gas bubble disease)	4.2.2.1.8
Low dissolved oxygen in the discharge	4.2.2.1.9
Losses from predation, parasitism, and disease among organisms	4.2.2.1.10
Stimulation of nuisance organisms	4.2.2.1.11
AQUATIC ECOLOGY (PLANTS WITH COOLING-TOWER-BASED HEAT DISSIPATION SYSTEMS)	
Entrainment of fish and shellfish in early life stages	4.3.3
Impingement of fish and shellfish	4.3.3
Heat shock	4.3.3
TERRESTRIAL RESOURCES	
Cooling tower impacts on crops and ornamental vegetation	4.3.4
Cooling tower impacts on native plants	4.3.5.1
HUMAN HEALTH	
Microbiological organisms (occupational health)	4.3.6
Noise	4.3.7

> 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts of temperature effects on sediment transport capacity during the renewal term beyond those discussed in the GEIS.

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

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

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts of scouring caused by discharged cooling water 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be 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.

However, the NRC staff did receive a comment during the scoping process concerning the presence of biocides in cooling water drift, providing potentially new and significant information on this issue. The NRC staff's evaluation of this information is presented in Section 4.7.

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information, including the National Pollutant Discharge Elimination System (NPDES) permit for VYNPS, and discussion with the Vermont Department of Environmental Conservation (VDEC). During the scoping process, the NRC staff received a comment concerning the potential impact on human health from the presence of biocides in the cooling tower drift. The NRC staff examined this concern to determine if it represents new and significant information. The NRC staff's evaluation is provided in Section 4.7. The NRC staff, based on the evaluation in Section 4.7, concludes that there would be no impacts of discharge of chlorine or other biocides during the renewal term beyond those discussed in the GEIS.

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

> Effects are readily controlled through the NPDES permit (in the case of VYNPS, issued by the State of Vermont), an Indirect Discharge Permit, and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information, including the NPDES permit for VYNPS, and discussion with the VDEC. Therefore, the NRC staff concludes that there would be no impacts of discharges of sanitary wastes and minor chemical spills during the renewal term beyond those discussed in the GEIS.

- <u>Discharge of other metals in wastewater</u>. 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information, including the NPDES permit for VYNPS, and discussion with the VDEC. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information, including the NPDES permit for VYNPS, and discussion with the VDEC. Therefore, the NRC staff concludes that there would be no impacts of water-use conflicts for plants with once-through cooling systems 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of available information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, the review of monitoring programs, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no problems associated with the 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. During the course of the NRC staff review, a number of comments were raised by members of the public and public interest groups on the impact of the thermal plume during license renewal from VYNPS on migratory fish species in the Connecticut River. The NRC staff examined the information provided in the comments as well as other sources to determine if it represents new and significant information. The NRC staff's evaluation is provided in Section 4.7. The NRC staff, based on the evaluation in Section 4.7, concludes that there would be no impacts of thermal plume barriers on migrating fish during the renewal term beyond those discussed in the GEIS.

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

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

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, the review of monitoring programs, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts on the distribution of aquatic organisms during the renewal term beyond those discussed in the GEIS.

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

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

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts on premature emergence of aquatic insects 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, the review of monitoring programs, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be 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. 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts from stimulation of nuisance organisms during the renewal term beyond those discussed in the GEIS.

- Entrainment of fish and shellfish in early life stages (cooling-tower-based heat dissipation). Based on information in the GEIS, the Commission found that

  > Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.

  VYNPS has the capability to operate using once-through or closed-cycle cooling or an intermediate condition called the hybrid mode. For closed-cycle cooling, the issue of entrainment is considered a Category 1 issue, not requiring a site-specific analysis but rather a determination of whether or not there is new and significant information that calls into question the conclusions of the NRC staff's GEIS. However, since VYNPS does employ once-through cooling, at least for a portion of the year, the issue of entrainment does require a site-specific analysis as a Category 2 issue. The analysis is presented in Section 4.1.2 of this document and provides a site-specific assessment of impact for the issue of entrainment for the station cooling system under closed-cycle, hybrid, and once-through modes of operation.

- Impingement of fish and shellfish (cooling-tower-based heat dissipation). Based on information in the GEIS, the Commission found that

  > The impingement of fish and shellfish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.

  VYNPS has the capability to operate using once-through or closed-cycle cooling or an intermediate condition called the hybrid mode. For closed-cycle cooling, the issue of impingement is considered a Category 1 issue, not requiring a site-specific analysis but rather a determination of whether or not there is new and significant information that calls into question the conclusions of the NRC staff's GEIS. However, since VYNPS does employ once-through cooling, at least for a portion of the year, the issue of impingement does require a site-specific analysis as a Category 2 issue. The analysis is presented in Section 4.1.3 of this document and provides a site-specific assessment of impact for the issue of impingement for the station cooling system under closed-cycle, hybrid, and once-through modes of operation.

- Heat shock (cooling-tower-based heat dissipation). Based on information in the GEIS, the Commission found that

  > Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.

VYNPS has the capability to operate using once-through or closed-cycle cooling or an intermediate condition called the hybrid mode. For closed-cycle cooling, the issue of heat shock is considered a Category 1 issue, not requiring a site-specific analysis but rather a determination of whether or not there is new and significant information that calls into question the conclusions of the NRC staff's GEIS. However, since VYNPS does employ once-through cooling, at least for a portion of the year, the issue of heat shock does require a site-specific analysis as a Category 2 issue. The analysis is presented in Section 4.1.4 of this document and provides a site-specific assessment of impact for the issue of heat shock for the station cooling system under closed-cycle, hybrid, and once-through modes of operation.

- Cooling tower impacts on crops and ornamental vegetation. Based on information in the GEIS, the Commission found that

  > Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the NRC staff's site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there are no cooling tower impacts on crops and ornamental vegetation during the renewal term beyond those discussed in the GEIS.

- Cooling tower impacts on native plants. Based on information in the GEIS, the Commission found that

  > Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the NRC staff's site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there are no cooling tower impacts on native vegetation during the renewal term beyond those discussed in the GEIS.

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

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

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the NRC staff's site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 VYNPS are discussed in the sections that follow and are listed in Table 4-2.

4.1.1 Water Use Conflicts (Make-Up from a Small River)

For power plants with cooling ponds or cooling towers using make-up water from a small river with low flow, i.e., less than 3.15×10^{12} ft^3/yr threshold value in 10 CFR 51.53(3)(ii)(A), water use conflicts are considered a Category 2 issue that requires plant-specific assessment before license renewal.

Cooling water withdrawn from the Connecticut River (at Vernon Pool) can be circulated through the VYNPS system in one of three modes of operation, including closed-cycle, open-cycle (once-through cooling), or hybrid-cycle. Category 2 applies to the VYNPS because the Connecticut River has an average daily flow of about 10,500 cubic feet per second (cfs) (3.3×10^{11} ft^3/yr), based on flows measured from 1944 to 1988 (Entergy 2006a) and about 11,101 cfs (3.5×10^{11} ft^3/yr), based on flows measured from 2000 to 2005 (Normandeau 2001, 2002, 2003, 2004b, 2005; DeWald 2006). Vernon Pool is an approximately 25-mi long, 2250-ac impoundment created by the construction of the Vernon Dam, less than a mile downstream of the plant. The dam facility, owned and operated by TransCanada, is required to maintain a

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

ISSUE-10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR Part 51.53(a)(3)(ii) Subparagraph	SEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE			
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	4.3.2.1 4.4.2.1	A	4.1.1
AQUATIC ECOLOGY			
Entrainment of fish and shellfish in early life stages	4.2.2.1.2	B	4.1.2
Impingement of fish and shellfish	4.2.2.1.3	B	4.1.3
Heat shock	4.2.2.1.4	B	4.1.4
HUMAN HEALTH			
Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	4.3.6	G	4.1.5

minimum sustained flow of 1250 cfs. The surface elevation of the pool fluctuates as much as 8 ft due to operations at upstream dams, Vernon Dam, and runoff inflow. The maximum depth of the pool near Vernon Dam is about 40 ft (Entergy 2006a).

According to the ER, 5000 gpm (11.1 cfs) of the 360,000 gpm (802.1 cfs) of water withdrawn from the Connecticut River for condenser cooling would be lost to evaporation (as an upper bound). This loss represents a reduction in flow of less than 0.10 percent of the average daily flow. It also represents a reduction in flow of 0.37 percent of the low median monthly flow (3050 cfs)[(a)], 0.73 percent of the flow under drought conditions (1523 cfs)[(b)], and 0.89 percent of the minimum sustained flow requirement for Vernon Dam (1250 cfs). These values are well below the Vermont Water Quality Standards criterion of 5 percent for Class B Water

(a) Low median monthly flow is the median monthly flow for the month having the lowest median monthly flow (Vermont Water Quality Standards, Section 1-01.B.24).

(b) Drought flow is referred to as 7Q10 in Vermont Water Quality Standards, Section 3-01.C.1.b, and is the 7-day average low flow over a 10-year return period, adjusted to nullify any effects of artificial flow regulation, that has a 10 percent chance of occurring in a given year.

Management Type 1 waters (constituting aquatic biota, wildlife, and aquatic habitat). Thus, impacts to the flow of the Connecticut River through Vernon Pond due to consumptive water use are not considered significant.

The NRC staff independently reviewed the Entergy ER, visited the site, and reviewed the VYNPS NPDES permit, and other reports and has evaluated the consumptive water use associated with VYNPS operations (due to evaporative water loss). Based on this information, the NRC staff concludes that the potential impacts of water use conflicts are SMALL and no additional mitigation is warranted.

4.1.2 Entrainment of Fish and Shellfish in Early Life Stages

For plants with once-through cooling systems, the entrainment of fish and shellfish in early life stages into cooling water systems associated with nuclear power plants is considered a Category 2 issue, which requires a site-specific assessment before license renewal. VYNPS operates in a closed-cycle mode part of the year during which time entrainment is categorized as a Category 1 issue. The hybrid-cycle mode, not discussed in the GEIS (NRC 1996), is neither defined as a Category 1 or 2 issue. Conservatively, for VYNPS, the NRC staff considered entrainment as a Category 2 issue providing a site-specific analysis of entrainment for the entire year under all three operating modes. To perform this assessment, the NRC staff reviewed the applicant's ER (Entergy 2006a) and related documents, including the Clean Water Act (CWA) Section 316 demonstrations (Aquatec 1978, 1990; Normandeau 2004a), and visited the VYNPS site. The NRC staff also reviewed the applicant's State of Vermont NPDES Permit No. VT0000264, as amended, issued on September 28, 2004, and in force until March 31, 2006 (VDEC 2004), the application for the NPDES permit renewal (Entergy 2005a), and recent entrainment sampling data.

On July 9, 2004, the EPA published a final rule in the *Federal Register* (EPA 2004) that addresses cooling water intake structures at existing power plants, such as VYNPS, where flow levels exceed a minimum threshold value of 50 million gpd. The rule is Phase II in the EPA's development of CWA 316(b) regulations that establish national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that exceed the threshold value for water withdrawals. The national requirements, which were to be implemented through the NPDES permitting process, minimize the adverse environmental impacts associated with the continued use of the intake systems. Section 316(b) of the CWA requires that the location, design, construction, and capacity of the cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts (Title 33, Section 1326, of the *United States Code* (33 USC 1326)). Entrainment of fish and shellfish into the cooling water system is a potential adverse environmental impact that can be minimized by use of the best technology available.

Under the Phase II rule, licensees would have been required to demonstrate compliance with the Phase II performance standards at the time of renewal of their NPDES permit. As part of the NPDES renewal, licensees may have been required to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigative measures to comply with this regulation. The new performance standards were designed to significantly reduce entrainment losses due to water withdrawals associated with cooling water intake structures used for power production. Any additional site-specific mitigation required as a result of the 316(b) Phase II reviews would result in less impact from entrainment during the license renewal period. On March 20, 2007, the EPA issued a memorandum informing its Regional Administrators that they should consider the Phase II rule suspended (EPA 2007a). Effective July 09, 2007, the EPA suspended the Phase II rule (NRC 2007b). As a result, all permits for Phase II facilities should include conditions under Section 316(b) of the CWA that are developed on a Best Professional Judgment basis, rather than best technology available. Best Professional Judgment is used by NPDES permit writers to develop technology-based permit conditions on a case-by-case basis using all reasonably available and relevant data. Any site-specific mitigation required under the NPDES permitting process would result in a reduction in the impacts of continued plant operations.

In April 2006, VYNPS submitted their Proposal for Information Collection (PIC) to the Vermont Agency of Natural Resources (VANR) to demonstrate compliance with the Phase II requirements. Data collection began in April 2005. The data were to be summarized and submitted to the State in the form of a Comprehensive Demonstration Plan (CDP). With the planned suspension of the Phase II regulations, the status of the CDP is undetermined. Entrainment sampling was conducted by Entergy in 2005 and 2006 as a requirement of the 2006 PIC. Although no final report or CDP has been issued by Entergy, the NRC staff reviewed the data (NRC 2007). NRC staff determined that the ichthyoplankton densities collected in 2005 and 2006 were consistent with data and conclusions from previous studies in Vermont.

The VYNPS withdraws a maximum of 518 million gpd (360,000 gpm or 802 cfs) during once-through operation to a minimum of 14.4 million gpd (10,000 gpm or 22 cfs) during closed-cycle operation. During 2004, the monthly average daily river discharge at Vernon Dam ranged from 3967 cfs in October to 23,570 cfs in April. The lowest daily discharge was 1757 cfs on July 7, while the highest daily flow was 50,618 cfs on April 2 (Normandeau 2005). The VYNPS operates in a closed- or hybrid-cycle mode during the warmer months of the year and, at times, may also operate these modes during the cooler months.

Entrained fish eggs and larvae experience thermal stress and mechanical and hydraulic forces during transport through a plant's cooling system. In a study of the Haddam Neck Plant, a nuclear plant with once-through cooling that formerly operated on the lower Connecticut River, Marcy (2004c (1976c) and references cited therein) found mechanical damage to be the main cause of entrainment mortality, while thermal shock was responsible for only about 20 percent of the mortality. While some entrainment survival occurs, 100 percent mortality is normally assumed as a conservative estimate of entrainment losses for all operational modes. The NPDES permit requires larval fish sampling to be done weekly during the spawning period (late spring through early summer) (Normandeau 2005).

The portion of Vernon Pool near VYNPS was found not to be a good fish spawning area due to daily water level fluctuations, a steep shoreline, and a silty sand substrate. Therefore, the amount of ichthyoplankton entrained in the area would be expected to be limited. Overall, densities of ichthyoplankton near the VYNPS intake were <1 fish/m^3, which were much lower than densities in littoral areas estimated by Aquatec (1990). For example, minnow densities near the VYNPS intake were <0.6 larvae/m^3, whereas densities in shallow, slow-moving nearshore areas were as high as 3000/m^3 (Aquatec 1990). Monitoring results indicate that larval fish densities are low in the VYNPS area and the impact of entrainment has been minimal (Entergy 2006a).

Table 4-3 presents some of the results of entrainment collections that have been made in the Connecticut River in the vicinity of the VYNPS intake since 1988. Entrainment collections at VYNPS are generally made from early May through early to mid July each year, as dictated by the NPDES permit. In general, the common warmwater species that are resident within Vernon Pool were predominant in entrainment collections. These included the spottail shiner (*Notropis hudsonius*), white perch (*Morone americana*), and centrarchids. No Atlantic salmon (*Salmo salar*) and only one American shad (*Alosa sapidissima*) have been collected in entrainment samples.

To interpret the impacts of entrainment on the fish community, entrainment losses must be compared to the distribution, abundance, and life cycles of the populations and species that occur near VYNPS. The ultimate impact of entrainment losses must be evaluated in terms of a system's resiliency (i.e., environmental stability, productivity, population compensation, and ecological and economic importance of the individual species) (Noguchi et al. 1985). When assessing the significance of entrainment, entrainment losses need to be weighed against the losses that occur from natural mortality of fish eggs and larvae. For example, the survival from egg to adult for the American shad is about 0.001 percent (Marcy 2004b (1976b)). Based on riverine and entrainment collections of resident and anadromous fish, which have been ongoing since before VYNPS began commercial operations (e.g., Aquatec 1978, 1990; Entergy and Normandeau 2004; Normandeau 2005), the applicant stated that no observable adverse impacts to any fish species or to the overall fish community of Vernon Pool due entrainment by VYNPS has been demonstrated (Entergy 2006a).

Based on the results of the extensive sampling program conducted by the applicant, the NRC staff has determined that the potential impacts of entrainment of fish and shellfish by VYNPS during the 20-year renewal period would be SMALL and no additional mitigation is warranted.

Table 4-3. Percentages (and Numbers) of Fish Eggs and Larvae Entrained at VYNPS

	Collection Period			
Species	**1988 and 1990-1997**	**2001**	**2003**	**2004**
Common carp (*Cyprinus carpio*)	0.3 (18)[(a)]	0.2 (3)	2.2 (27)	0.5 (5)
Spottail shiner (*Notropis hudsonius*)	0.03 (2)	57.9 (978)	71.6 (875)	25.4 (269)
Notropis spp.	49.6[(b)] (2850)	0.0 (0)	0.0 (0)	0.0 (0)
Cyprinidae	13.7[(b)] (788)	0.0 (0)	0.0 (0)	0.0 (0)
White sucker (*Catostomus commersoni*)	0.02 (1)	37.9 (640)	0.2 (2)	1.0 (11)
White perch (*Morone americana*)	20.7 (1191)	1.8 (31)	14.6 (178)	3.4 (36)
Sunfish (*Lepomis* spp.)	10.9 (628)	1.8[(c)] (31)	8.2[(c)] (100)	68.7 (726)
Largemouth bass (*Micropterus salmoides*)	0.07 (4)	0.0[(d)] (0)	0.0[(d)] (0)	0.0 (0)
Yellow perch (*Perca flavescens*)	4.2 (244)	0.1 (2)	3.2 (39)	0.5 (5)
Walleye (*Sander vitreus*)	0.14 (8)	0.1 (2)	0.1 (1)	0.2 (2)
Other species (including unidentifiable fishes)		0.1[(e)] (2)	0.0 (0)	0.3[(e)] (3)
Total	100 (5747)	100 (1690)	100 (1222)	100 (1057)

(a) The percentage and the total number collected followed by the number entrained in parentheses for each species during the collection period.
(b) Based on entrainment sample identifications done in the subsequent years and fish species known from lower Vernon Pool, most individuals identified as only *Notropis* spp. or Cyprinidae were probably spottail shiners.
(c) Listed as Centrarchidae and therefore may also include some largemouth bass.
(d) See footnote (c). Likely some largemouth bass eggs and larvae were entrained.
(e) Other species comprised almost entirely of the tessellated darter (*Etheostoma olmstedi*).
Sources: Normandeau 1999; VYNPS and Normandeau 2002; Entergy and Normandeau 2004; Normandeau 2005

However, under the provisions of the CWA 316(b) regulations, the VDEC may impose further restrictions or require modifications to the cooling system to reduce the impact of entrainment under the NPDES permitting process.

4.1.3 Impingement of Fish and Shellfish

For power plants with once-through cooling systems, the impingement of fish and shellfish on screens associated with plant cooling systems is considered a Category 2 issue, which requires a site-specific assessment before license renewal. VYNPS operates in a closed-cycle mode part of the year, during which time impingement is categorized as a Category 1 issue. The hybrid-cycle mode, not discussed in the GEIS (NRC 1996), is neither defined as a Category 1 or 2 issue. Conservatively, for VYNPS, the NRC staff considered impingement as a Category 2 issue providing a specified analysis of impingement for the entire year under all three operating modes. To perform this evaluation, the NRC staff reviewed the applicant's ER (Entergy 2006a) and related documents, including the Clean Water Act (CWA) Section 316 demonstrations (Aquatec 1978, 1990; Normandeau 2004a), and visited the VYNPS site. The NRC staff also reviewed the applicant's State of Vermont NPDES Permit No. VT0000264, as amended, issued on September 28, 2004, the application for the NPDES permit renewal (Entergy 2005a), and recent impingement sampling data.

Impacts of existing cooling water systems, including the impacts of impingement, are regulated under the provisions of the CWA as described in Section 4.1.2. Section 4.1.2 also includes a discussion of Section 316(b) requirements, which are also relevant to impingement. The staff did consider data collected by VYNPS as part of the proposed CDP that the applicant planned to submit in compliance with the Phase II regulations. As explained in Section 4.1.2, the EPA has suspended the Phase II regulations effective July 09, 2007 (EPA 2007b). Any site-specific mitigation required under the NPDES permitting process would result in a reduction in the impacts of continued plant operations.

At VYNPS, the intake velocities through the traveling screens vary from a high of 1.96 ft/s during the extreme low river water level of 212 ft MSL to 1.57 ft/s at the normal river water level of 220 ft MSL (Entergy 2006a). At these intake velocities, fishes can be impinged against the traveling screens. Impinged fishes are not returned to the river.

As part of the NPDES requirements, VYNPS is required to monitor fish impingement. Routine impingement sampling is conducted at VYNPS from April 1 through June 15 and from August 1 through October 31. Additionally, limits are established by the State of Vermont for the number of American shad and Atlantic salmon (*Salmo salar*) that can be impinged. The impingement limit for Atlantic salmon is set at 0.1 percent of the estimated smolt-equivalents (estimated number of smolts from a population that successfully emigrate from a specified area) migrating past VYNPS. If this limit is exceeded, the plant must run in a closed cycle until June 15. The American shad impingement limit is set at one impinged shad for each adult shad that passes the Vernon Dam fishway and/or is transported by State or Federal fisheries personnel upstream of Vernon Dam (Aquatec 1990). Impingement numbers below those established for the two anadromous fish species are considered by the Environmental Advisory Committee (comprised of the Vermont Department of Environmental Conservation, Vermont Department of Fish and Wildlife, New Hampshire Department of Environmental Services, New Hampshire Department of Fish and Game, Massachusetts Department of Environmental Protection, Massachusetts Division of Fish and Wildlife, and the U.S. Fish and Wildlife Service (FWS) Coordinator of the Connecticut River Anadromous Fish Program) to be impingement losses that are not adverse to the populations of these species (Entergy 2006a). To date, the NPDES limits established for Atlantic salmon and American shad have not been exceeded.

During the initial 316 demonstration (Aquatec 1978), an average of 23 fish per 24-hr period were impinged during 685 days of once-through operation. These samples were collected between 1974 and 1977, and included impingement collections made during peak winter months. No Atlantic salmon or American shad were impinged during this period. Between 1981 and 1989, about 40,000 fish were collected in 1560 impingement samples for an average of nearly 26 fish impinged per 24-hr period (Aquatec 1990). Over 80 percent were small sunfishes, rock bass, minnows, and yellow perch. During this period, 59 juvenile Atlantic salmon and only one American shad were impinged (Aquatec 1990).

The NRC staff also reviewed the impingement data collected during 2005 and 2006 as a requirement of Entergy's April 2006 PIC. Although no formal report or CDP has been issued by Entergy, the NRC staff did review the data (NRC 2007). The NRC staff determined that the impingement data collected in 2005 and 2006 were consistent with previous impingement losses at VYNPS.

Table 4-4 presents some of the results of impingement collections that have been made at VYNPS since 1988. Impingement collections at VYNPS are generally made from April 1 through June 15 and August 1 through October 31 each year, as dictated by NPDES permit stipulations. In general, the common warmwater species that are resident within Vernon Pool were predominant in impingement collections. These included sunfish, rock bass, and yellow perch. The numbers of American shad and Atlantic salmon impinged at VYNPS were lower than the yearly NPDES permit limits set for these species. For example, 25 American shad and 9 Atlantic salmon were impinged in 2001. The permit limits were set at 1666 American shad and 231 Atlantic salmon (VYNPS and Normandeau 2002). In 2003, 13 American shad and 28 Atlantic salmon were impinged, while the permit limits for the year were set at 1140 and 364, respectively (Entergy and Normandeau 2004). In 2004, 73 American shad and no Atlantic salmon were impinged. The NPDES permit impingement limits for 2004 were set at 1005 American shad and 252 Atlantic salmon (Normandeau 2005).

Table 4-4. Percentages (and Numbers) of Fish Species Impinged at VYNPS[a]

Species	Collection Period			
	1988 and 1990-1997	2001	2003	2004
Sea lamprey (*Petromyzon marinus*)	0.9 (130)[b]	34.4 (241)	0.2 (2)	0.0 (0)
American shad (*Alosa sapidissima*)	2.6 (387)	3.6 (25)	1.1 (13)	30.8 (73)
Atlantic salmon (*Salmo salar*)	1.4 (202)	1.3 (9)	2.5 (28)	0.0 (0)
Chain pickerel (*Esox niger*)	0.2 (31)	0.4 (3)	1.0 (11)	0.8 (2)
Golden shiner (*Notemigonus crysoleucas*)	1.1 (161)	2.1 (15)	0.6 (7)	0.4 (1)
Spottail shiner (*Notropis hudsonius*)	7.7 (1139)	0.3 (2)	0.8 (9)	2.1 (5)
Yellow bullhead (*Ameiurus natalis*)	1.5 (227)	0.0 (0)	3.4 (39)	0.4 (1)
Rock bass (*Ambloplites rupestris*)	10.8 (1599)	4.7 (33)	9.5 (108)	9.7 (23)
Pumpkinseed (*Lepomis gibbosus*)	5.8 (853)	1.7 (12)	14.2 (162)	2.5 (6)
Bluegill (*Lepomis macrochirus*)	19.9 (2937)	28.7 (201)	32.6 (372)	28.3 (67)
Unidentified sunfish (*Lepomis* spp.)	20.1 (2967)	0.0 (0)	0.0 (0)	0.0 (0)
Smallmouth bass (*Micropterus dolomieu*)	1.9 (279)	1.0 (7)	2.4 (27)	3.8 (9)
Largemouth bass (*Micropterus salmoides*)	0.9 (134)	0.6 (4)	5.1 (58)	1.3 (3)
Black crappie (*Pomoxis nigromaculatus*)	0.01 (1)	1.7 (12)	11.0 (126)	4.2 (10)
Yellow perch (*Perca flavescens*)	15.2 (2247)	18.3 (128)	15.0 (171)	8.4 (20)
Other species (including unidentifiable fishes)	28.3 (4184)	1.1 (8)	0.8 (9)	7.2 (17)
Totals	100 (14,778)	100 (700)	100 (1142)	100 (237)

(a) Data presented represent a portion of the impingement data collected at this facility.
(b) The percent of total number impinged followed by the total number impinged in parentheses for each species during the collection period.
Sources: Normandeau 1999, 2005; VYNPS and Normandeau 2002; Entergy and Normandeau 2004;

No observable adverse impacts to any fish species or to the overall fish community of Vernon Pool due impingement at VYNPS has been demonstrated, based on riverine and impingement collections of resident and anadromous fish, which have been ongoing since before VYNPS began commercial operations (Aquatec 1978, 1990; Entergy and Normandeau 2004; Normandeau 2005; Entergy 2006a).

Based on the results of the extensive sampling program conducted by the applicant, and the utilization of closed- or hybrid-cycle modes during much of the year, the NRC staff has determined that the potential impacts of impingement of fish and shellfish by VYNPS during the 20-year renewal period would be SMALL and no additional mitigation is warranted. However, under the provisions of the CWA 316(b) under the NPDES permitting process, the VDEC may impose further restrictions or require modifications to the cooling system to reduce the impact of impingement.

4.1.4 Heat Shock

Heat shock can be defined as acute thermal stress caused by exposure to a sudden elevation of water temperature that adversely affects the metabolism and behavior of fish and can lead to death. Heat shock is most likely to occur when an off-line unit returns to service or when a station has a discharge canal. For plants with once-through cooling systems, the impacts of heat shock are listed as a Category 2 issue and require plant-specific evaluation before license renewal. Impacts on fish and shellfish resources resulting from heat shock are a Category 2 issue because of continuing concerns about acute thermal-discharge impacts and the possible need to modify thermal discharges in the future in response to changing environmental conditions (NRC 1996). VYNPS operates in a closed-cycle mode part of the year during which time heat shock is categorized as a Category 1 issue. The hybrid-cycle mode, not discussed in the GEIS (NRC 1996), is neither defined as a Category 1 or 2 issue. Conservatively, for VYNPS, the NRC staff considered heat shock as a Category 2 issue, providing a specified analysis of heat shock for the entire year under all three operating modes.

Information considered by the NRC staff during its assessment includes (1) the type of cooling system (e.g., once-through, closed-cycle, or cooling lake) and (2) evidence of CWA Section 316(a) variance or equivalent State documentation. To perform this evaluation, the NRC staff reviewed the applicant's ER (Entergy 2006a) and related documents, including the Clean Water Act (CWA) Section 316 demonstrations (Aquatec 1978, 1990; Normandeau 2004), and visited the VYNPS site. The NRC staff also reviewed the applicant's State of Vermont NPDES Permit No. VT0000264, as amended, issued on September 28, 2004 (VDEC 2004), and the application for the NPDES permit renewal (Entergy 2005a). This included an evaluation of the environmental impact of a 1°F increase for the time period May 16 through October 14.

For coldwater species, which are generally stenothermal, the physiological effects from temperature are often the main factors controlling their distribution. Ambient temperatures of

80.6°F often exceed the lethal temperature of coldwater species (Cherry et al. 1975). When Connecticut Yankee, a nuclear power plant with once-through cooling that formerly operated on the Lower Connecticut River was operational, most fish left the discharge canal when temperatures reached about 95°F, but some would return even after a temperature drop of only 1.8°F (Marcy 2004a (1976a)). There was no indication that the fish that inhabited the discharge canal during the warmer seasons suffered any mortality due to increased water temperatures (Marcy 2004a (1976a)). Fish were able to leave the area as temperatures approached their upper limits of tolerance. However, some species such as pumpkinseed, white perch, golden shiner, white catfish (*Ameiurus catus*), and brown bullhead (*A. nebulosus*) were collected in the discharge canal at a temperature of 104°F, while the common carp and spottail shiner were collected at a maximum canal temperature of 102.6°F (Marcy 2004a (1976a)).

For the initial 316 demonstration (Aquatec 1978), brown trout (*Salmo trutta*) were held in live cages in the VYNPS discharge plume. All of the fish were able to survive 10 days of rapidly and widely fluctuating temperatures of 15°F or more within 10 minutes when ambient temperatures did not exceed 60°F, which is generally the temperature that occurs in the October 15 to May 15 period when VYNPS operates in an open cycle. American eels can survive short-term thermal shocks, as demonstrated by individuals having apparently survived elevated Connecticut Yankee discharge channel temperatures of 104°F (American Eel Plan Development Team 2000).

Near the VYNPS discharge, heated effluent during the warmer summer months is about 80 to 90°F, with a very infrequent worst-case maximum of around 100°F (Normandeau 2004). Table 4-5 summarizes thermal preferences and tolerances for several of the more common warmwater species that are resident in the VYNPS area.

The NRC staff has determined that the potential for heat shock during the renewal term is unlikely because of the design, location, and operation of VYNPS. The station discharges via a shoreline surface discharge to the Connecticut River, a relatively large body of water. Vernon Pool contains sufficient thermal refugia for fish even during the late summer or early fall when there is high ambient river water temperatures. Station operation historically has resulted in a gradual increase in cooling water discharge temperatures during power ascension, thereby avoiding a rapid and possibly lethal increase in water temperatures. Similar operating procedures are expected during the renewal term. Finally, heat shock has not been a problem historically at VYNPS. No instances of heat shock-related mortality to fish in Vernon Pool have been reported during the past years of commercial operation. Again, it is unlikely that heat shock-related mortalities would occur during the renewal term. Therefore, the NRC staff has determined that the impact related to heat shock to fish and shellfish during the renewal term would be SMALL and no additional mitigation is warranted.

Table 4-5. Thermal Preferences and Tolerances of Warmwater Species That Occur in the VYNPS Area

Species	Thermal Preference	Spawning Temperature	Upper Tolerance Limit
Common carp (*Cyprinus carpio*)	68°F	65-68°F	96°F
White sucker (*Catostomus commersoni*)	57°F	50°F	82°F
Bluegill (*Lepomis macrochirus*)	60-80°F	67°F	92.8°F
Pumpkinseed (*Lepomis gibbosus*)	60-80°F	68°F	95°F
Largemouth bass (*Micropterus salmoides*)	79-81°F	66°F	90.5°F
Smallmouth bass (*Micropterus dolomieu*)	68-0°F	62°F	90.5°F
Walleye (*Sander vitreus*)	77°F	50°F	84°F
Yellow perch (*Perca flavescens*)	63°F	45-50°F	91.4°F

Sources: AEC 1972; Marcy 2004a (1976a)

4.1.5 Microbiological Organisms (Public Health)

The effects of microbiological organisms on human health are listed as a Category 2 issue and require plant-specific evaluation before license renewal for those plants with closed-cycle cooling on a small river. The average annual flow of the Connecticut River near the VYNPS site is 3.3×10^{11} ft^3/yr (Entergy 2006a), which is less than the 3.15×10^{12} ft^3/yr threshold value specified in 10 CFR 51.53(c)(3)(ii)(G) for thermal discharge to a small river. Hence, the NRC staff considers the Connecticut River to be a small river, and the effects of its discharge on microbiological organisms must be addressed for VYNPS.

The Category 2 designation is based on the magnitude of the potential public-health impacts associated with thermal enhancement of the enteric pathogens *Salmonella* spp. and *Shigella* spp., the *Pseudomonas aeruginosa* bacterium, thermophilic fungi, *Legionella* spp. bacteria, and pathogenic strains of the free-living amoebae *Naegleria* spp. and *Acanthamoeba* spp. (NRC 1999). Thermophilic microorganisms can have optimum growth at temperatures of 122°F or more, a maximum temperature tolerance of up to 158°F, and a minimum tolerance of about

68°F (Deacon 2003). However, thermal preferences and tolerances differ among the various microorganisms and environmental conditions. *P. aeruginosa* has an optimum temperature for growth of 98.6°F and can tolerate a temperature as high as 107.6°F (Todar 2004). A water temperature range of 90 to 105°F provides ideal conditions for *Legionella* spp. bacterial growth (CDC 2005). *Salmonella* spp. can thrive at temperatures between 40 and 140°F (Kendall 2006). Populations of the pathogenic amoeba *Naegleria fowleri* can be enhanced in thermally altered water bodies at temperatures ranging from 95 to 106°F or higher, but this organism is rarely found in water cooler than 95°F, as indicated by studies reviewed and coordinated by Tyndall et al. (1989).

No public swimming areas occur in the Connecticut River between Brattleboro and Vernon, and the incidence of swimming and diving activities near VYNPS is low (Entergy 2006a). Recreational uses near the plant include fishing and boating. Entergy employees and contractors also perform sampling in the river. These activities create a potential for human exposure to microbiological organisms. The ambient temperatures of the Connecticut River near the VYNPS site vary from near freezing (approximately 32°F) in the winter to a maximum 84°F in the summer (Entergy 2006a). Between 1998 to 2002, ambient river temperatures never exceed 80°F (Normandeau 2004). Therefore, ambient river conditions are not likely to support the proliferation of pathogenic organisms of concern. As discussed in Section 4.1.4, average summer temperatures at the downstream monitoring station do not average more than 2°F above ambient. In addition, water temperatures at the downstream monitoring station are not to exceed 85°F (Entergy 2006b). Based on the small area of maximum water temperatures near the point of discharge (80 to 90°F, with an infrequent worst-case of 100°F (Normandeau 2004)), coupled with the dilution provided by the Connecticut River, thermophilic microorganisms are not expected to cause any appreciable public health risk. No reported cases of *Naegleria fowleri* or amoebic meningoencephalitis or other water-borne illnesses have been reported in the vicinity of VYNPS (Entergy 2006a).

Based on the evaluation presented above, thermophilic microbiological organisms are not likely to occur as a result of VYNPS discharges to the Connecticut River. The NRC staff concludes that impacts on public health from thermophilic microbiological organisms from continued operation of VYNPS during the license renewal period would be SMALL, and no additional mitigation is warranted.

4.2 Transmission Lines

The Final Environmental Statement (FES) for VYNPS (AEC 1972) describes two transmission lines that were built to connect VYNPS with the transmission system. The transmission lines, as well as their ownership and responsibilities for their maintenance, are described in Section 2.1.7 of this Supplemental Environmental Impact Statement (SEIS). The 2-mi-long Chestnut Hill 115-kV transmission line connects to the Vermont-New Hampshire transmission grid, while the 50-mi-long Coolidge 345-kV transmission line connects to the New England transmission grid (AEC 1972). The Chestnut Hill line has a 300-ft right-of-way, and the Coolidge line has a 200-ft right-of-way.

Vegetation control along the Coolidge and Chestnut Hill transmission lines in Vermont is accomplished through the use of hand-applied herbicides and mechanical clearing. Procedures are in place to ensure that vegetation management along rights-of-way is carried out in a manner to protect local water bodies and aquatic organisms that could be adversely impacted from herbicide application in the immediate vicinity of stream and river crossings. Herbicides that are used comply with Federal and State regulations and are applied by licensed applicators. No herbicides are used in maintaining the right-of-way of the Chestnut Hill transmission line in New Hampshire.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to VYNPS transmission lines are listed in Table 4-6. Entergy stated in its ER that it is not aware of any new and significant information associated with the renewal of the VYNPS operating license (OL) (Entergy 2006a). The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and its evaluation of other information. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS (NRC 1999). For all of those issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4-6. Category 1 Issues Applicable to the VYNPS Transmission Lines During the Renewal Term

ISSUE–10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
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
Floodplains and wetlands on power line right-of-way	4.5.7
AIR QUALITY	
Air quality effects of transmission lines	4.5.2
LAND USE	
Onsite land use	4.5.3
Power line rights-of-way	4.5.3

A brief description of the NRC 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, consultation with the U.S. Fish and Wildlife Service (FWS) and the VANR, and its evaluation of other information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, consultation with the FWS and VANR, and its evaluation of other information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and its evaluation of other information and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be no impacts of electromagnetic fields on flora and fauna during the renewal term beyond those discussed in the GEIS.

- Floodplains and wetlands on power line rights-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 wetlands. No significant impact is expected at any nuclear power plant during the license renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, consultation with the FWS and VANR, and its evaluation of other information. Therefore, the NRC staff concludes that there would be no impacts of power line rights-of-way on floodplains and wetlands 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and its evaluation of other information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and its evaluation of other information. Therefore, the NRC staff concludes that there would be no onsite land-use impacts during the renewal term beyond those discussed in the GEIS.

- Power line rights-of-way. Based on information in the GEIS, the Commission found that

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

The NRC staff has not identified any new and significant information during its independent review of the ER, or the site visit, the scoping process, public comments on the draft SEIS, and its evaluation of other information. Therefore, the NRC staff concludes that there would be no impacts of power line rights-of-way on land use 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 4-7 and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-7. Category 2 and Uncategorized Issues Applicable to the VYNPS Transmission Lines 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
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[(a)]	4.2.2

(a) Not addressed.

4.2.1 Electromagnetic Fields – Acute Effects

Based on the GEIS, the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been found to be a problem at most operating plants and generally is not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of this SEIS.

In the GEIS (NRC 1996), the NRC staff found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) (IEEE 2002) criteria, it was not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines 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.

Both transmission lines associated with VYNPS were constructed in accordance with NESC and industry guidance in effect at that time. The transmission facilities are maintained to ensure continued compliance with current standards. Since the lines were constructed, a new criterion has been added to the NESC for power lines with voltages exceeding 98 kV. This criterion states that the minimum clearance for a line must limit induced currents due to static effects to 5 milliamperes (mA).

Entergy (2006a) has reviewed the transmission lines for compliance with this criterion. Vermont Electric Power Company, Inc. (VELCO) indicated that the Coolidge line has not operated in excess of 212°F, which is within its original design specifications which assumed an eventual 345-kV line, and that the line meets the current NESC clearance standards (Entergy 2006c). Northeast Utilities indicated that the Chestnut Hill line also only operates within its design limits and meets current NESC clearance standards (Entergy 2006c). No induced shock hazard to the public should occur, since the lines are operating within original design specifications and meet current NESC clearance standards.

The NRC staff has reviewed the available information, including the applicant's evaluation and computational results. Based on this information, the NRC staff evaluated the potential impacts for electric shock resulting from operation of VYNPS and its associated transmission lines. It is the NRC staff's conclusion that the potential impacts from electric shock during the renewal period would be SMALL and no additional mitigation is warranted.

4.2.2 Electromagnetic Fields – Chronic Effects

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

The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (DOE). The report by NIEHS (1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF (extremely low frequency-electromagnetic field) exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive

> regulatory action is warranted such as continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or noncancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the NRC staff to change its position with respect to the chronic effects of electromagnetic fields. The NRC 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 VYNPS in regard to radiological impacts are listed in Table 4-8. Entergy stated in its ER (Entergy 2006a) that it is not aware of any new and significant information associated with the renewal of the VYNPS OL. The EPU that took place in early 2006 and the new dry fuel storage facility, which is being constructed onsite, have been considered by the NRC in its evaluation of the radiological impacts, and the impacts have been determined to be within the envelope established in the GEIS. The NRC staff has not identified any new and significant information during its independent review of the ER or during the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS. For these issues, the NRC staff concluded in the GEIS that the impacts are SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4-8. 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 Sections
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 NRC staff’s review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Radiation exposures to the 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts of occupational radiation exposures during the renewal term beyond those discussed in the GEIS.

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

4.4 Socioeconomic Impacts of Plant Operations During the License Renewal Period

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to socioeconomic impacts during the renewal term are listed in Table 4-9. Entergy stated in its ER (Entergy 2006a) that it is not aware of any new and significant information associated with the renewal of the VYNPS OL. The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the NRC staff's site visit, the scoping process, public comments on the draft SEIS, and its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the NRC staff concluded in the GEIS that the impacts are SMALL and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4-9. Category 1 Issues Applicable to Socioeconomics During the Renewal Term

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

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

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

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

  The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the NRC staff's site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no aesthetic impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

Table 4-10 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and environmental justice, which was not addressed in the GEIS.

Table 4-10. 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 Sections	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 NRC staff's SEIS.

4.4.1 Housing Impacts During Operations

In determining housing impacts, the applicant chose to follow Appendix C of the GEIS (NRC 1996), which presents a population characterization method that is based on two factors, "sparseness" and "proximity" (GEIS Section C.1.4 (NRC 1996)). Sparseness measures population density within 20 mi of the site, and proximity measures population density and city size within 50 mi. Each factor has categories of density and size (GEIS Table C.1), and a matrix is used to rank the population category as low, medium, or high (GEIS Figure C.1).

In 2000, there were 153,409 people living within 20 mi of VYNPS, for a density of 122 persons/mi^2. This density translates to Category 4 (least sparse), using the GEIS measure of sparseness (Entergy 2006a). At the same time, there were 1,513,282 persons living within 50 mi of the plant, for a density of 193 persons/mi^2. The NRC sparseness and proximity matrix assigns a Category 4 rating (high density) for this measure as well. There are no growth controls that would limit housing development in this area (Entergy 2006a).

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. The VYNPS site is located in a high-population area, and Windham County, Cheshire County, and Franklin County are not subject to growth-control measures that would limit housing development. Based on the NRC criteria, Entergy expects housing impacts to be SMALL during continued operations (Entergy 2006a).

SMALL impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring State-wide, and no housing construction or conversion is required to meet new demand (NRC 1996). The GEIS assumes that an additional staff of 60 permanent workers might be needed during the license renewal period to perform routine maintenance and other activities.

The housing vacancy rate in 2000 was 32.0 percent in Windham County, 11.2 percent in Cheshire County, and 7.7 percent in Franklin County. If these vacancy rates continue, small increases in the number of workers at the plant during the license renewal period would mean no new housing construction would be required.

The NRC staff reviewed the available information relative to housing impacts and Entergy's conclusions. Based on this review, the NRC staff concludes that the impact on housing during the license renewal period would be SMALL and no mitigation is 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, 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 GEIS indicates 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 both plant demand and plant-related population growth. Section 2.2.2 describes the VYNPS-permitted withdrawal rate and actual use of water.

The NRC staff has reviewed the available information, including permitted and actual water-use rates at VYNPS, water supply capacities for the major water supply systems in Windham County, Cheshire County, and Franklin County, and expected population growth. Based on this information, the NRC staff concludes that the potential impacts of VYNPS operation during the license renewal period would be SMALL, and no mitigation is 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."

Section 4.7.4 of the GEIS defines the magnitude of land-use changes as a result of plant operation during the license renewal term as follows:

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

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

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

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS 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. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use changes would be LARGE. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development.

Property taxes are paid by VYNPS to the town of Vernon and the Entergy corporate office facility in Brattleboro to Brattleboro Township. Property taxes paid by VYNPS to the town of Vernon approximate 65 percent (about $1.2 million in 2005 dollars) of total township tax revenue, which is utilized for police, fire, public works, roads, and other town services. Entergy's State Electric Generation Education Tax payment covers approximately a third of the Vernon School District's budget. In contrast, only 1 percent (about $0.2 million in 2005 dollars) of Brattleboro Township revenues, on average, over the period 2003 to 2005 came from Entergy. Revenues from VYNPS, the Entergy facility and electricity generation taxes levied by the State constitute less than 1 percent of total State revenues in 2005. These payments represent a significant, positive impact on the condition of Vernon, while a small, positive impact on the fiscal conditions of the township and State.

Because no refurbishment or new construction activities are associated with the license renewal, no additional sources of plant-related tax payments are expected that could further influence land use in the town, township, or State. The continued collection of property taxes from VYNPS will result in moderate indirect tax-driven land-use pattern changes through lower local property taxes and the current level of public infrastructure and services (Entergy 2006a). This source of revenue allows the town and local school district to keep tax rates below the levels they would otherwise have in order to fund the higher levels of public infrastructure and services and educational facilities and staffing.

Windham County's average annual population growth rate between the 2000 and 2003 censuses was 0.1 percent, while Cheshire County's rate was 0.9 percent, and Franklin County's rate was 0.3 percent (Section 2.2.8.3). These three counties are rural with growing areas of recreational development. The GEIS assumes that an additional 60 permanent workers might be needed during the license renewal period to perform routine maintenance and other activities; thus, land-use changes from VYNPS population-related growth would be negligible. The town of Vernon did approve the 2003 Town Plan, which outlines the community's plan for future growth and development (Entergy 2006a); land use has changed little over the last 20 to 30 years. All three counties are members of regional planning commissions.

No major plant refurbishment or construction activities have been identified as necessary to support the continued operation of the VYNPS beyond the end of the existing operating license term (Entergy 2006a). Because it is anticipated there will be no increase in the assessed value of VYNPS due to refurbishment-related improvements or normal maintenance, annual property taxes from VYNPS to the town of Vernon and Brattleboro Township might remain relatively constant throughout the license renewal period. Since utility restructuring legislation has not been enacted in Vermont, the long-term impact of any such changes in the electricity industry in the State on VYNPS is difficult to predict. Any changes to the VYNPS tax rates due to the restructuring would be independent of license renewal.

VYNPS will continue to be a significant source of tax revenue for the town of Vernon. However, despite having this significant income source since plant construction in the early 1970s, Vernon has not nor expects to experience large land use changes. VYNPS environs continue to remain largely rural, and annual population growth rates for the three-county region have recently averaged between 0.1 to 0.9 percent (Entergy 2006a). The criteria in the GEIS (Section C.4.1.5.2), results in the assignment of an impact level of MODERATE when tax levels are greater than 10 percent. However, the case study assumed a certain level of refurbishment. As no major refurbishment activities are planned at Vermont Yankee to support license renewal, no new sources of plant-related tax payments are expected that could significantly affect land use in the three-county region. Based on the aforementioned information derived from the applicant, the NRC staff's site visit, the scoping process, discussions with Vernon officials and regional land-use planning agency personnel, public comments on the draft SEIS, and other public sources, the NRC staff concluded that tax-related land-use impacts are likely to be SMALL and no additional mitigation is warranted.

4.4.4 Public Services: Transportation Impacts During Operations

Table B-1, 10 CFR Part 51, states: "Transportation impacts (level of service) of highway traffic generated ... during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites." All applicants are required by 10 CFR 51.53(c)(3)(ii)(J) to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license.

Given the small number of additional workers required during the renewal period, there would be no significant additional impacts to the transportation network in the vicinity of the VYNPS site. Therefore, the NRC staff concluded that transportation impacts during operation are likely to be SMALL and no mitigation is warranted.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires that Federal agencies take into account the effects of their undertakings on historic properties. The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation at 36 CFR Part 800. Renewal of an OL is an undertaking that could potentially affect historic properties. Therefore, according to the NHPA, the NRC is to make a reasonable effort to identify historic properties in the areas of potential effects. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office (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.

Entergy contacted the Vermont SHPO on September 15, 2005, regarding preparation of its application for license renewal (Entergy 2006a). The NRC contacted the Vermont SHPO and the Advisory Council on Historic Preservation on May 8, 2006, and the appropriate Federally recognized Native American Tribes in the region on May 10, 2006. These letters are available in Appendix E. The Vermont SHPO was contacted directly by the NRC to determine if there were any comments on the draft SEIS. The SHPO did not provide any comments.

A search of the Vermont SHPO files for the region around the VYNPS shows that the region is highly sensitive for archaeological remains. While no prehistoric archaeological sites have been identified on the VYNPS property, the Governor Hunt House is a historically significant property owned and managed by the plant operator. The area around the house has the potential to contain buried remains associated with the Governor Hunt House. Additionally, the VYNPS property is located on the floodplain of the Connecticut River, which has the potential to contain deeply buried archaeological deposits.

Continued operation of VYNPS would likely protect any archaeological sites present within the VYNPS site boundary by protecting those lands from development and providing secured access. However, because there is the potential for cultural resources to be present at the site, the applicant should take care during normal operations and maintenance activities related to operations not to inadvertently affect cultural resources. To avoid such adverse impacts, environmental review procedures have been put in place at VYNPS regarding undertakings that involve land disturbing activities in undisturbed surface and subsurface areas as well as modifications to historic structures (i.e., Governor Hunt House). These procedures include contacting the SHPO to establish the actions necessary to protect known or as of yet undiscovered cultural resources before an action is allowed to occur.

The archaeological site in close proximity to the Coolidge transmission line has the potential to be impacted by right-of-way maintenance activities. However, the site's location adjacent to a river makes any impacts to the site unlikely. VELCO's procedures consider minimization of erosion and bank destabilization along rivers and wetlands, which could further protect the site. These procedures would likely protect the archaeological site from impact. Similarly, the areas sensitive for archaeological remains along the Chestnut Hill line are along waterways, which are protected by current maintenance procedures, thereby minimizing the potential for impacts to previously unidentified archaeological remains.

Based on this analysis of cultural resources, the NRC staff concludes that the impact of license renewal would be SMALL and that further mitigation is not necessary. While the area is highly sensitive for cultural resources and a historic property is on the VYNPS site (i.e., Governor Hunt House), the procedures are adequate to protect cultural resources at the plant. Therefore, daily operations at the VYNPS during the license renewal period would likely have a SMALL impact on cultural resources. The potential for impacts to cultural resources along the transmission lines is considered SMALL.

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy that requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its actions on minority[a] or low-income populations. The memorandum accompanying Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act of 1969 (NEPA). The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice (CEQ 1997). Although the Executive Order is not mandatory for independent agencies, the NRC has voluntarily committed to undertake environmental justice reviews. Specific guidance is provided in NRC Office of Nuclear Reactor Regulation Office Instruction LIC-203, *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues Rev. 1* (NRC 2004a). In 2004, the Commission issued a final *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (NRC 2004b).

The scope of the review as defined in NRC guidance (NRC 2004a) includes identification of impacts on minority and low-income populations, the location and significance of any environmental impacts during operations on populations that are particularly sensitive, and information pertaining to mitigation. It also includes an evaluation of whether these impacts are likely to be disproportionately high and adverse.

The NRC staff looks for minority and low-income populations within a 50-mi radius of the site. For the NRC staff's review, a minority population exists in a census block group[b] if the percentage of each minority and aggregated minority category within the census block group

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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; Black races; or Hispanic ethnicity. "Other" races and multiracial individuals may be considered as separate minorities (NRC 2004a).

(b) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the U.S. Census Bureau (USCB) collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census data users in accordance with USCB guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts (USCB 2006).

exceeds the corresponding average minority percentage in Vermont, New Hampshire, and Massachusetts by 20 percentage points, or if the percentage of minorities within a census block group is at least 50 percent. A low-income population exists if the percentage of low-income population within a census block group exceeds the corresponding average percentage of low-income population in the three states by 20 percentage points, or if the percentage of low-income population within a census block group is at least 50 percent.

For the VYNPS review, the NRC staff examined the geographic distribution of minority and low-income populations within 50 mi of the site, employing data from the 2000 census (USCB 2006).

Figures 4-1 and 4-2 show the distribution of census block groups for the minority and low-income populations, respectively.

There are no census block groups in Vermont or New Hampshire within the 50-mi region that exceed the NRC thresholds defining minority populations. A number of block groups in Massachusetts within the 50-mi region exceeded the NRC thresholds. These are located to the south of VYNPS in Springfield and Northampton, and to the southeast of the site in Worcester, Leominster, and Fitchburg. The majority of the census block groups exceeding the thresholds defining a low-income population are located in the same communities to the south and southeast of the site containing minority populations. Additional low-income population block groups are located in Greenfield, Adams, and Pittsfield, Massachusetts, in Bennington, Vermont, and in Keene, New Hampshire.

With the locations of minority and low-income populations identified, the NRC 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. Based on NRC staff guidance (NRC 2004a), air, land, and water resources within about 50 mi of the VYNPS site were examined. Within that area, a few potential environmental impacts could affect human populations; all of these were considered SMALL for the general population.

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

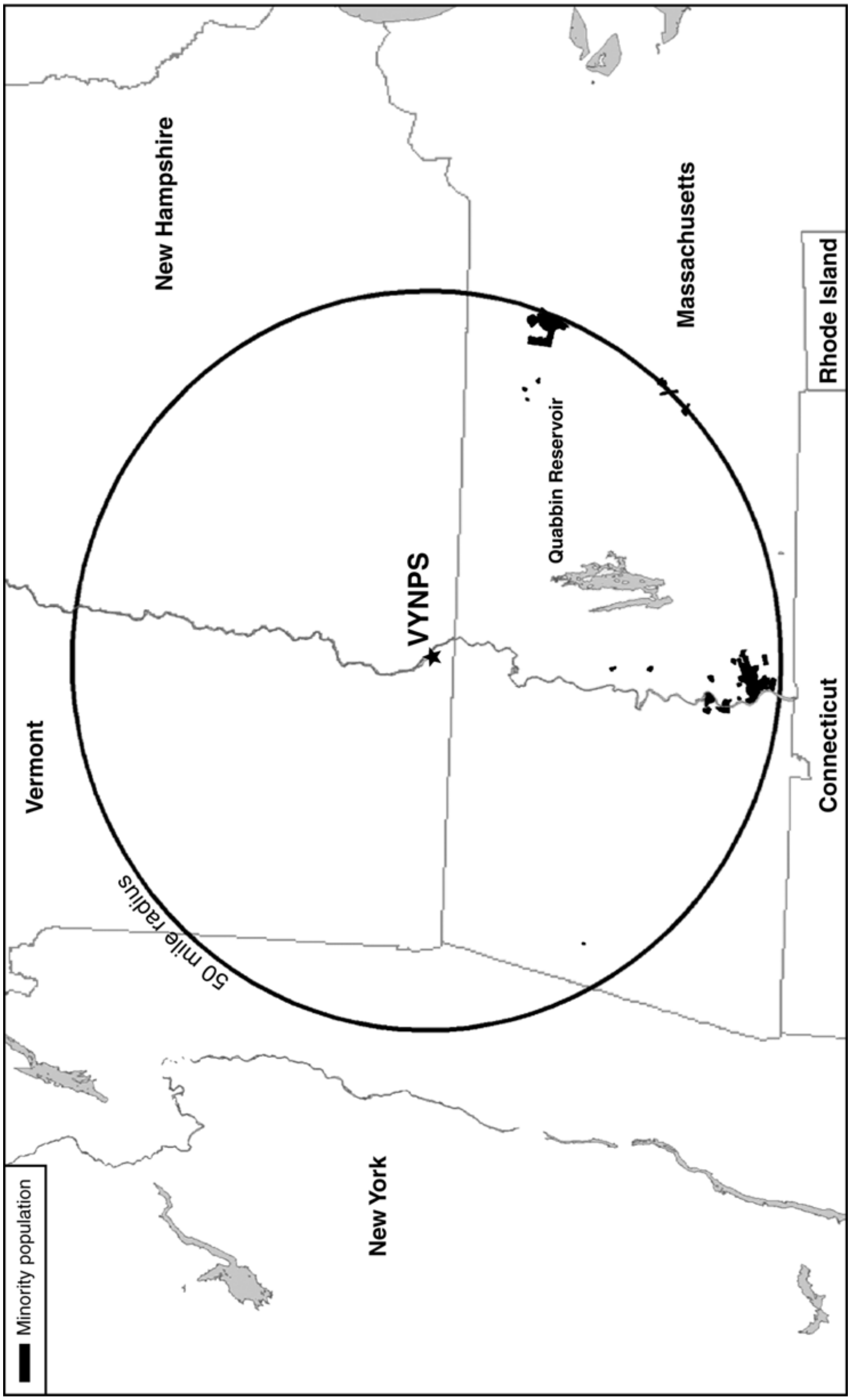

Figure 4-1. Geographic Distribution of Minority Populations (shown in shaded areas) Within 50 mi of the VYNPS Site Based on Census Block Group Data

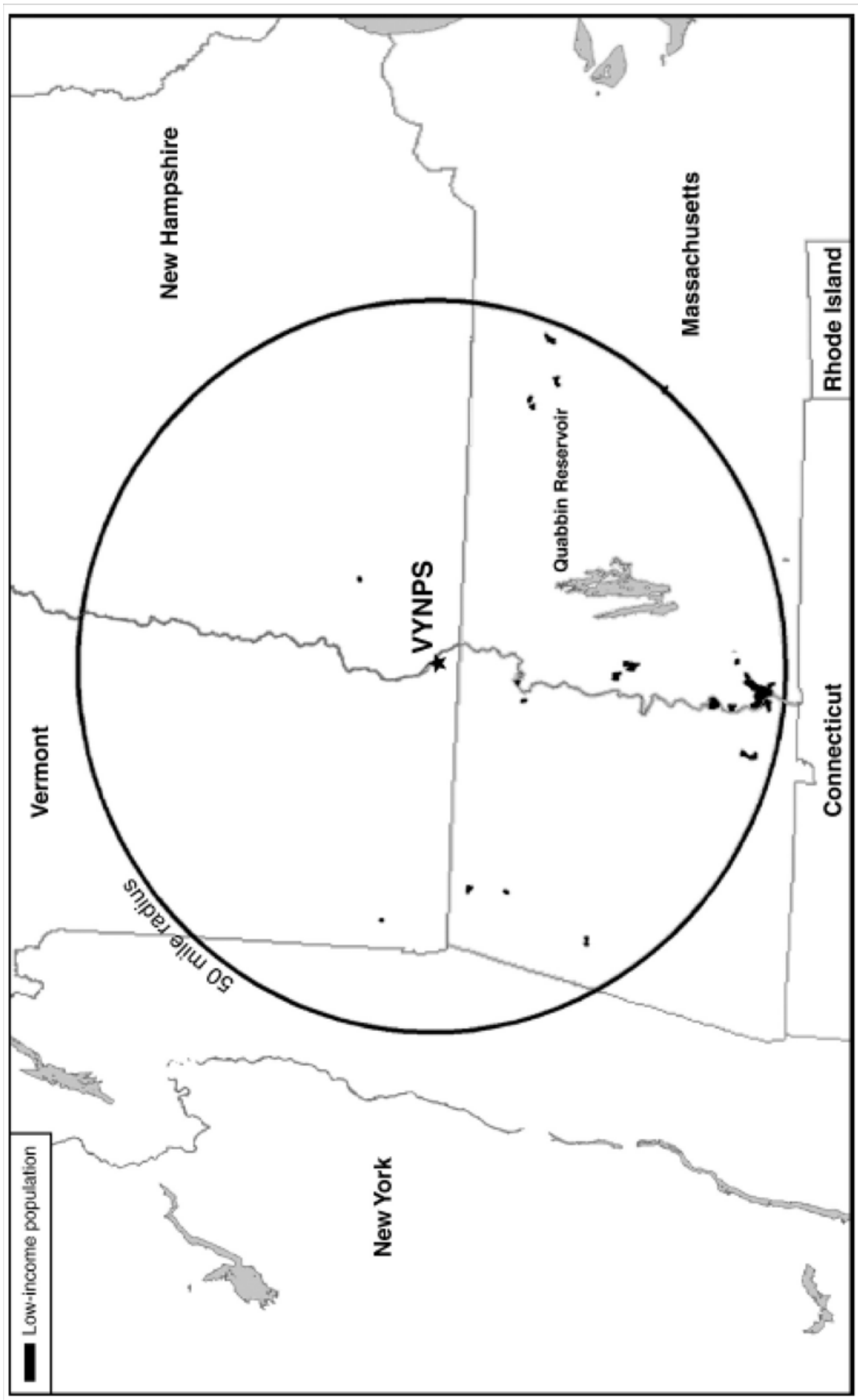

Figure 4-2. Geographic Distribution of Low-Income Populations (shown in shaded areas) Within 50 mi of the VYNPS Site Based on Census Block Group Data

4.5 Groundwater Use and Quality

The Category 1 issue in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that is applicable to VYNPS groundwater use and quality is listed in Table 4-11. Entergy stated in its ER (Entergy 2006a) that it is not aware of any new or significant information associated with the renewal of the VYNPS OL. The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS. For the issue, the NRC staff concluded in the GEIS that the impact would be SMALL and additional mitigative measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4-11. 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 Sections
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 NRC staff's review and the GEIS conclusions, as codified in 10 CFR Part 51, Table B-1, 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 groundwater-use conflicts.

As discussed in Section 2.2.2, VYNPS groundwater use is less than 100 gpm. The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no groundwater-use conflicts during the renewal term beyond those discussed in the GEIS.

The Category 2 issue related to groundwater use and quality during the renewal term is listed in Table 4-12. This issue requires a plant-specific analysis.

Table 4-12. Category 2 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	10 CFR Part 51.53(a)(3)(ii) Subparagraph	SEIS Section
GROUNDWATER USE AND QUALITY			
Groundwater-use conflicts (plants using cooling towers withdrawing make-up water from a small river)	4.8.1.3 4.4.2.1	B	4.5

4.5.1 Groundwater-Use Conflicts (Make-Up from a Small River)

The issue of groundwater-use conflicts applies to VYNPS because it withdraws water from the Connecticut River (Vernon Pool), an approximately 25-mi-long, 2250-ac impoundment created by the construction of Vernon Dam on the Connecticut River, and such withdrawals can potentially impact recharge rates to local groundwater resources. The dam facility, owned and operated by TransCanada, is required to maintain a minimum sustained inflow of 1250 cfs. The surface elevation of Vernon Pool fluctuates as much as 8 ft due to operations at upstream and downstream dams and runoff inflow.

The Connecticut River has an average daily flow of about 10,500 cfs (3.3×10^{11} ft^3/yr), based on flows measured from 1944 to 1988 (Entergy 2006a), and about 11,101 cfs (3.5×10^{11} ft^3/yr), based on flows measured from 2000 to 2005 (Normandeau 2001, 2002, 2003, 2004b, 2005; DeWald 2006). The maximum consumptive loss due to cooling tower evaporation is estimated to be 5000 gpm (11.1 cfs) (AEC 1972). This represents a reduction in flow of less than 0.10 percent of the average daily flow. It also represents a reduction in flow of 0.37 percent of the low median monthly flow (3050 cfs), 0.73 percent of the flow under drought conditions (1523 cfs), and 0.89 percent of the minimum sustained flow requirement for Vernon Dam (1250 cfs). These values are well below the Vermont Water Quality Standards criterion of 5 percent for Vermont Class B waters (Section 4.1.1). Because impacts to the flow in the Connecticut River due to consumptive use are not considered significant, the NRC staff concludes that impacts to groundwater use would also be SMALL and no additional mitigation is warranted.

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 4-13.

Table 4-13. 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 Part 51.53(c)(3)(ii) Subparagraph	SEIS Section
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
Threatened or endangered species	4.1	E	4.6

This issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they or their critical habitat would be adversely affected by continued operation of the nuclear plant during the license renewal term. The presence of threatened or endangered species or their critical habitat in the vicinity of the VYNPS site is discussed in Sections 2.2.5.2 and 2.2.6.2.

The NRC contacted FWS to determine the presence of Federally listed threatened or endangered species in the vicinity of VYNPS or associated transmission lines (NRC 2006b, 2006d). The FWS determined that the bald eagle was the only Federally listed species known to occur in the vicinity of these facilities, and that bald eagles nest less than one mile downstream of VYNPS (FWS 2006). In addition, FWS determined that no impacts to the eagles are known to occur at this site that could be attributed to VYNPS or its transmission lines, and that preparation of a biological assessment or further consultation under Section 7 of the Endangered Species Act is not required.

The NRC also contacted the U.S. National Marine Fisheries Service (NMFS) to determine the presence of Federally listed threatened and endangered species in the vicinity of VYNPS (NRC 2006c). The NMFS determined that no Federally listed or proposed threatened or endangered species or designated critical habitat for listed species under the jurisdiction of NMFS are known to exist in the project area. Therefore, the NMFS concluded that no further consultation pursuant to section 7 of the Endangered Species Act is required (NMFS 2006).

4.6.1 Aquatic Species

The FWS (2006) did not list any Federally listed or proposed threatened or endangered aquatic species under FWS jurisdiction that occur within the VYNPS area, and the proposed project would not adversely affect Federally listed species under FWS jurisdiction. However, the Federally listed (endangered) dwarf wedgemussel (*Alasmidonta heterodon*) and shortnose sturgeon (*Acipenser brevirostrum*) are reported to inhabit the Connecticut River. As discussed in Section 2.2.5, no specimens of the dwarf wedgemussel have been found in Vernon Pool between Bellows Falls Dam (river mile (RM) 174) and Vernon Dam (RM 142) in recent surveys. The closest occurrence in the Connecticut River is near Rockingham, Vermont, just north of Bellows Falls Dam, over 30 mi upstream of VYNPS (NHFGD 2005; Entergy 2006a).

The VYNPS cooling water intake and discharge are closely monitored under the NPDES program. The NPDES permit limits are reviewed on a regular basis to ensure the protection of aquatic biota. This includes the tessellated darter, slimy sculpin, and Atlantic salmon smolts that serve as hosts for the glochidia of the dwarf wedgemussel. The tessellated darter is common throughout the Connecticut River watershed (Hartel et al. 1996). The slimy sculpin is well distributed throughout the Connecticut River watershed (NHFGD 2005), although it has not been collected in river or impingement samples associated with VYNPS (Normandeau 2005). Atlantic salmon smolts are also common throughout the Connecticut River due to stocking programs. Few smolts are annually impinged at VYNPS (Normandeau 2005), and they have not been impinged at numbers above those allowed by the NPDES permit (Section 4.1.3). Therefore, potential indirect impacts to the dwarf wedgemussel due to operational effects on their host fish species would be negligible.

Known populations of the shortnose sturgeon in the Connecticut River occur downstream of the Turners Falls Dam (RM 123) in Massachusetts. This area is about 20 mi downstream of VYNPS (Entergy 2006a; NMFS 2006). As shortnose sturgeon spawning can occur over a range of water temperatures (48.2 to 64.4°F) (NHFGD 2005), the thermal discharge would have no noticeable impact to shortnose sturgeon inhabiting the Connecticut River below the Turners Fall Dam. Therefore, impacts associated with the operation of VYNPS, located 20 mi upstream, are too far removed to adversely affect this species.

There are no plans to conduct refurbishment or construction activities at VYNPS. Therefore, the NRC staff has concluded that continued operation of the plant during the license renewal term will have no effect of the dwarf wedgemussel or the shortnose sturgeon. Thus, it is the NRC staff's finding that the impacts on threatened or endangered aquatic species from an additional 20 years of operation of VYNPS would be SMALL and no additional mitigation is warranted.

4.6.2 Terrestrial Species

FWS (2006) stated that, except for the bald eagle (*Haliaeetus leucocephalus*), no other Federally listed or proposed threatened or endangered species under FWS jurisdiction are known to occur within the VYNPS area and the areas of transmission lines within the scope of license renewal, and that operations during the license renewal term would not adversely affect Federally listed species under FWS jurisdiction. They concluded that preparation of a biological assessment or further consultation under Section 7 of the Endangered Species Act (ESA) would not be required. In a press release dated June 28, 2007, the U.S. Department of Interior (DOI) announced the bald eagle will be delisted (DOI 2007).

Bald eagles can occur in the VYNPS area throughout the year, are known to use the site for foraging and roosting, and nest less than 1 mi downstream of the site near the Vernon Dam. During the winter, open water near the discharge canal could attract foraging eagles that would otherwise leave the area. This close proximity to the site increases the potential for interactions between the bald eagle and VYNPS, but adverse effects are not considered likely. The bald eagle may benefit from the maintenance of open water near the plant's discharge during the winter, as this may provide additional foraging opportunities for the species.

Transmission lines pose a potential collision hazard to migrant and resident bird species, including the bald eagle. In the GEIS, the NRC assessed the impacts of transmission lines on avian populations (NRC 1996). The NRC concluded that mortality resulting from bird collisions with transmission lines associated with an additional 20 years of operation would be of SMALL significance (see Section 4.2). This conclusion was based on (1) no indication in the existing literature that collision mortality is high enough to result in population-level impacts, and (2) the lack of known instances where nuclear power plant lines affect large numbers of individuals in local areas. Continued operation of VYNPS and operation and maintenance of the VYNPS-to-Coolidge and VYNPS-to-Chestnut Hill transmission lines during the license renewal period are not likely to adversely affect the bald eagle.

The Indiana bat is not known to occur at the VYNPS site or along associated transmission lines, but potential habitat occurs within the project area. It should be noted, however, that this species is difficult to detect without conducting specialized surveys, and such surveys of the site and vicinity have not been conducted. License renewal and continued operations of VYNPS are not likely to adversely affect the Indiana bat for several reasons. No refurbishment is considered necessary during the license renewal period at the VYNPS site (Entergy 2006a), and, therefore, significant land disturbance during that period is not considered likely. However, any activities during the renewal period that could result in land disturbance would undergo a predisturbance evaluation and consideration of impacts on threatened and endangered species. Vegetation management within the transmission line rights-of-way (ROWs) prevents the establishment of large trees within the ROWs that could be used by the Indiana bat. Only dangerous trees in the border zone of the ROWs are removed during routine vegetation management. This greatly limits the likelihood that a tree used by Indiana bats for roosting or nursery habitat would be affected. On the basis of these considerations, continued operation of VYNPS during the license renewal period would not be expected to adversely affect the Indiana bat.

The two Federally listed plant species, Jesup's milk-vetch and northeastern bulrush, are not expected to be adversely affected by VYNPS license renewal. Jesup's milk-vetch occurs only in an area along the Connecticut River approximately 50-mi upstream of the VYNPS site. The site is not affected by VYNPS operations nor by operation and maintenance of the transmission lines within the scope of license renewal. Although not known to occur within either of the transmission line corridors, the northeastern bulrush occurs in wetlands of both counties traversed by transmission lines within the scope of license renewal. ROW maintenance is not expected to adversely affect this species because herbicides are not used by maintenance crews near wetlands and any hand-clearing of vegetation would increase the openness of habitats, which should benefit this species. Surveys conducted prior to any land disturbance on the VYNPS site, as required by site environmental review procedures, would ensure that any previously undetected populations of this species could be avoided.

Continued operations and transmission line maintenance during the license renewal term are not expected to adversely affect State-listed threatened or endangered terrestrial species (Table 2-12). No refurbishment is considered necessary during the license renewal period at the VYNPS site (Entergy 2006a), and, therefore, significant land disturbance during that period is not considered likely. However, environmental review procedures in place at VYNPS ensure the consideration of impacts on threatened and endangered species of any activities that could result in land disturbance. Maintenance procedures for transmission line ROWs limits vegetation clearing to that needed to ensure line safety, and cutting and herbicide use near wetlands or stream crossings (where many of the State-listed species are found) is limited (cutting) or prohibited (herbicide). State-listed species adapted to more open habitats could benefit from transmission line maintenance practices that maintain openings.

In conclusion, it is the NRC staff's finding that the impact on threatened or endangered terrestrial species of an additional 20 years of operation of VYNPS and the VYNPS-to-Coolidge and VYNPS-to-Chestnut Hill transmission line would be SMALL and no additional mitigation is warranted.

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

Comments received from the public during the scoping period and on the draft SEIS indicated concern about the effects of biocides present in the cooling tower drift during the license renewal period. This issue is discussed in Section 4.7.1. Concerns were also expressed that thermal discharges to the Connecticut River from the VYNPS during the renewal period would adversely affect migratory fish species. This issue is discussed in Section 4.7.2.

4.7.1 Evaluation of Potential New and Significant Information Concerning Biocides in Cooling Water Drift

As discussed in Section 2.1.3, water treatment chemicals that contain Vermont-listed hazardous air contaminants (HACs) are in use in the circulating water system. Releases of Category III HACs to the atmosphere are the result of biocides (Nalco H-550 and Spectrus NX-1104) being present in "drift" from the cooling tower.[a] For all of the Category III HACs involved, the

(a) Cooling tower drift is the result of the entrainment of cooling water droplets in the air being exhausted from a wet counter-flow-designed cooling tower such as the one being operated by VYNPS.

calculated releases were substantially below the respective action levels (both expressed as lb/8-hr period): 0.002 vs. 0.025 for dodecylguanidine, 0.001 vs. 2330 for ethyl alcohol, 0.001 vs. 4120 for isopropyl alcohol, and 0.015 vs. 340 for glutaraldehyde.

VYNPS has discontinued the use of Nalco H-550 (DeWald 2006) but will continue to use Spectrus NX-1104. Entergy has requested approval for a number of additional water treatment chemicals in its application to the State for a new NPDES permit (Entergy 2005a). If approval for use is granted through the issuance of a new NPDES, and in accordance with air pollution regulations, Entergy will identify the HACs present in each of the approved chemicals and will ensure that all subsequent annual reports to the State regarding HAC releases include calculations for each HAC for which there is the potential for release to the atmosphere as drift from the cooling tower (DeWald 2006). The operating conditions of the cooling tower are not expected to change significantly, and, therefore, the drift rate can be expected to remain generally the same as was reported for calendar year 2005.

Drift from the cooling tower has the potential to contain such HACs; thus, such drift constitutes a release to the atmosphere. A member of the public at the June 07, 2006 public scoping meeting expressed concern over exposure to a specific HAC, glutaraldehyde, known to be present in one of the biocides formerly in use. The most recent data indicate that the amount of glutaraldehyde released to the atmosphere was well below the state action level. The facility has indicated that it discontinued the use of this particular biocide as of 2005 (DeWald 2005). Furthermore, the applicant has requested the removal of this biocide from its authorized list of chemicals for the most recent NPDES permit renewal application. Therefore, the potential for future releases of glutaraldehyde from the use of that biocide has been eliminated.

Beyond the concern expressed in the comment, however, the NRC staff realizes that there is a broader issue regarding the potential for release of other HACs contained in water treatment chemicals in cooling tower drift. The NRC staff determined the facility is aware of the potential for such releases and has performed the necessary calculations and made the required emission reports to the State regarding the releases of HACs from the cooling towers. Data discussed above indicate that all of the HACs present in the cooling water were released in drift at concentrations well below the state action levels. In association with its recent application for EPU, Entergy commissioned a study to determine the increased water consumption rates due to both evaporation and drift at the cooling tower when operating under EPU conditions (Entergy 2003). Using an appropriate model, the study established both the distribution and chemical concentrations of drift droplets resulting from worst case conditions (i.e., those operational conditions [for both the reactor and the cooling system] and meteorological conditions that would result in a worst case with respect to the release of drift [high heat rejection rate, low mass air flow, spring season when water deposition rates are expected to be highest]). Aspects of the study and its conclusions were also summarized in testimony provided to the New England Coalition Ninth Set of Information Requests (Yasi and Thomas 2003). The relevant findings of the study as represented in submitted testimony included the following:

- The monthly average evaporation rates and corresponding water consumption rates are small compared to average river flow, in the worst case amounting to less than 1.5% of the minimum river flow value of 1,250 cubic feet per second (cfs),

- Under EPU conditions, the drift rate is estimated at 183 gallons per minute (gpm),

- The average water deposition rate over all directions drops off rapidly with distance from the cooling tower,

- The highest predicted offsite water deposition rate over land is approximately 0.10 in. per month (compared to the lowest long-term average monthly precipitation rate (Albany, NY, meteorological station) of 2.39 in.).

- The water drift deposition rate falls to 0.04 in. per month at 500 m and below 0.01 in. per month at 900 m downwind of the cooling tower,

- The predicted change in drift rate from existing power rate to EPU (120%) is small,

- With meteorological data spanning a five-year period (i.e., encompassing all meteorological conditions expected to be encountered), modeling determined that the drift rate of the cooling tower is essentially constant.

Because cooling tower operating conditions are not expected to change in the foreseeable future, the drift rate is expected to remain essentially unchanged, and equilibrium concentrations of water treatment chemicals are expected to be low. Consequently, even though there may be changes to the water treatment chemicals used in the future, the magnitudes of releases of such chemicals in cooling tower drift can be expected to remain relatively small. Further, it is expected that cooling tower drift will fall to the ground in the immediate vicinity of the cooling tower; thus, pathways of exposures to the general public do not practically exist.

For the reasons stated above, the concerns expressed do not represent information that would be considered new and significant relative to HACs released in cooling tower drift, as the impacts resulting from their release due to continued operation of VYNPS are SMALL.

4.7.2 Evaluation of Potential New and Significant Information Concerning Thermal Discharges to the Connecticut River

The NRC staff received comments from members of the public and public interest groups during the scoping period and on the draft SEIS suggesting that thermal discharges to the Connecticut River from the VYNPS during the renewal period would adversely affect migratory fish species. In particular, concerns were raised that thermal discharges from VYNPS' cooling system would affect both the spawning migration and outmigration of juveniles and post-spawning adults for American shad and Atlantic salmon. It was suggested that upstream movement of adults of both species could be disrupted or denied by the thermal plume in the vicinity of the VYNPS. Fish could become confused by the elevated temperature at the entrance to the Vernon Dam fish ladder or water temperatures could be above the avoidance limits for the species. Conversely, during downstream movement, fish could be delayed due to avoidance of the thermal plume. Concerns were expressed that any delays in outmigration could result in physiological changes to individuals that may ultimately affect their survival during the transition from a freshwater to a marine environment. Also, it was believed that delayed outmigration could result in American shad acclimatizing to warmer water temperatures and then experiencing cooler ambient river temperatures near or at their lower tolerance limit as they resume downstream movement.

It has been suggested that thermal plumes could constitute a barrier to migrating fish if the thermal mixing zone covers all or a substantial cross sectional area of the river and/or exceeds thermal tolerance limits. Conversely, impacts from thermal plumes are considered to be of small significance if fish migrations are not blocked and populations of aquatic organisms in the vicinity of the plant are not reduced (NRC 1996). As thermal plume barriers have not been observed to be a problem at any existing nuclear power plant, the NRC staff determined that thermal plume barriers to migrating fish are classified as a Category 1 issue (NRC 1996). In the 1980s, a study, known as Project SAVE (Save Available Vermont Energy) was conducted at VYNPS to evaluate the effects of thermal discharge, impingement, and entrainment on aquatic resources (Aquatec 1990). As part of Project SAVE, migration of anadromous species was evaluated. No correlation was found between the operation of VYNPS and the size of the American shad run through the Vernon Dam fishway. Also, no large exclusionary areas to American shad were found as a result of plant operations (Aquatec 1990). As most American shad move in the lower half of the water column (Witherell and Kynard 1990), they are unlikely to be deterred by a surface discharge thermal plume at the surface (NRC 1996). As no statistical differences were observed in American shad counts at Vernon Dam before, during, and following power outages at VYNPS, it was concluded that upstream migration of shad was not affected by thermal discharges from the plant (Normandeau 2004a).

Similarly, no blockages of adult Atlantic salmon past Vernon Dam due to VYNPS operations were observed during Project SAVE (Aquatec 1990). Seventy-five percent of the adult Atlantic salmon that passed Turners Falls Dam passed the Vernon Dam fishway; while radiotelemetry studies of smolts revealed that downstream movement into and through the VYNPS thermal plume occurred without any observed delays (Aquatec 1990). Most Atlantic salmon smolt migration past VYNPS is completed by early June. Therefore, downstream migration past the VYNPS is completed before the upper limit for feeding of 72.5°F or 7-day upper limit for survival of 82°F is exceeded (Normandeau 2004a). Atlantic salmon smolts migrating past VYNPS would not be subjected to elevated temperatures for more than 12 hr, and could avoid the warmest waters by swimming around or under the plume (Normandeau 2004a).

American shad comprised 0.7 percent of electroshocking catches above Vernon Dam between 1991 and 2002; while no Atlantic salmon were collected. During these years, only two American shad larvae were collected in ichthyoplankton samples collected near the VYNPS intake (Normandeau 2004a). As discussed in Section 4.1.3, impingement of American shad and Atlantic salmon at VYNPS has always been well below annual limits stipulated in the NPDES permit. These results imply that these species do not frequent lower Vernon Pool; therefore, suggesting that the thermal plume from VYNPS does not delay movements of American shad or Atlantic salmon or function as an attraction to these species.

Upstream passage of American shad has been very successful at Vernon Dam. For example, between 1995 and 2002, counts of American shad at the Vernon Dam fishway were over 71 percent of those counted at the Turners Falls Dam fishway. In comparison, counts at Turners Falls Dam were only 3.6 percent of those at Holyoke Dam (Normandeau 2004a). This supports the finding that VYNPS operations have a minimal impact on American shad migrations, especially in comparison to passage problems at Turners Falls Dam. Similarly, most adult Atlantic salmon that pass Turners Falls Dam have been found to pass Vernon Dam, with most continuing on to be counted at Bellows Falls Dam. Section 2.2.5 provides further discussion on migratory fish species passage at these dams.

As discussed in Section 2.2.5, the decreases in American shad that have been observed in the Connecticut River since the early 1990s have not been confined to the river, but have been observed throughout the Atlantic coast. Recovery of the striped bass population has likely increased predatory pressure on American shad. This factor coupled with excessive commercial harvests within the estuaries and Atlantic Ocean are believed to be primarily responsible for decreases in this species of shad. Similarly, spawning run declines of Atlantic salmon have occurred throughout the range of the species. As discussed in Section 2.2.5, this decline is thought to be due to impacts that occur while the Atlantic salmon is in the sea.

Overall, none of the observed changes in fish community composition or distribution in over 30 years of study of the aquatic resources in lower Vernon Pool and upper Turners Falls Pool can be reasonably attributed to operations of VYNPS (Normandeau 2004a). Modeling of thermal discharges from VYNPS indicated that most of the eastern half of Vernon Pool near Vernon Dam would experience minimal elevated temperatures (Swanson et al. 2005) therefore preventing the establishment of a thermal barrier to in- or out- migration. Also, solar radiation contributes to much of the difference in river temperatures between the monitoring station upstream of VYNPS and the monitoring station downstream of Vernon Dam (Normandeau 2004a). The highest temperatures that outmigrating fish would experience would be in the immediate area of Vernon Dam near the fishways. It would only take a short time (e.g., minutes to seconds) for them to pass through this area. When the fishways are operational, temperature differentials are well within thermal tolerance limits of the migratory species. The NPDES permit for VYNPS contains operational and temperature limits to protect water quality and minimize impacts to aquatic biota. No observable adverse impacts to any fish species or to the overall fish community of Vernon Pool due to thermal discharges from VYNPS have been demonstrated since VYNPS began commercial operations (Aquatec 1978, 1990; Entergy and Normandeau 2004; Normandeau 2005; Entergy 2006a). For example, neither decreases in the growth rates of resident fish species nor delays in movement of migratory species due to the VYNPS thermal plume have been observed (Aquatec 1990; Normandeau 2004a).

For the reasons stated above, the concerns expressed do not represent information that would be considered new and significant or call into question the NRC staff's conclusions that impacts on the migration of fish from continued operation of VYNPS are SMALL.

4.8 Cumulative Impacts

The NRC staff considered potential cumulative impacts in its environmental analysis of operations of VYNPS. For the purposes of this analysis, past actions are those related to the resources at the time of the plant licensing and construction, present actions are those related to the resources at the time of current operation of the power plant, and future actions are considered to be those that are reasonably foreseeable through the end of plant operation, which would include the 20-year license renewal term. Therefore, the analysis considers potential impacts through the end of the current license term as well as the 20-year renewal license term. The geographical area over which past, present, and future actions would occur is dependent on the type of action considered and is described below for each impact area.

The impacts of the proposed action, as described in Sections 4.1 through 4.6, are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. These combined impacts are defined as "cumulative" in 40 CFR 1508.7 and include individually minor but collectively significant actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

4.8.1 Cumulative Impacts on Aquatic Resources

For the purposes of this analysis, the geographic area considered for cumulative impacts resulting from operation of the cooling system at VYNPS is primarily the portion of the Connecticut River between Turners Falls Dam (RM 123) and Vernon Pool up to Brattleboro, Vermont (RM 149), although the entire Connecticut River was also considered, especially in regard to migratory fish species. As discussed in Section 4.1, the NRC staff found no new and significant information to indicate that the conclusion regarding any of the Category 1 issues related to the cooling system at VYNPS is inconsistent with the conclusions in the GEIS (NRC

1996). Additionally, the NRC staff determined that none of the Category 2 issues related to the cooling system (i.e., entrainment, impingement, and thermal shock) would have greater than a SMALL impact on aquatic resources. The transmission line right-of-way maintenance activities in the vicinity of stream and river crossings employ procedures to minimize erosion and shoreline disturbance while encouraging vegetative cover. Therefore, impacts from the transmission lines associated with the VYNPS would have a negligible impact on aquatic resources near VYNPS.

The cumulative impacts of past actions have resulted in the existing water quality and aquatic resource conditions near VYNPS. The major changes and modifications within the Connecticut River that have resulted in the greatest impacts on aquatic resources include physical and chemical stresses and introduced species. The physical and chemical stresses include urban, industrial, and agricultural contaminants (e.g., nutrients, toxic chemicals, sediment); land-use changes (e.g., residential, agricultural, and industrial development); acid rain and channelization; and dams and associated impoundments (Center for the Environment 2004; Connecticut River Watershed Council undated; Field 2005). These stresses can affect fish, benthic macroinvertebrates, and plankton populations; cause a loss of habitat; and contaminate fish, which leads to restrictions on human consumption. Dam construction began in the 1800s and resulted in the reduction of the distribution and/or extirpation of migratory species within the Connecticut River. Upstream passage restoration began in the 1970s, and downstream passage restoration began in the 1980s (Boubee and Haro 2003). In addition to dams blocking fish movement, both migratory and resident fishes could be damaged or killed by turbine passage. For example, various estimates of mortality related to downstream dam passage for the American shad range from 1 to 10 percent to as high as 90 percent (Savoy and Crecco 2004). Other than the hydroelectric dams, no significant diversions of water pose a threat to migratory fishes (Gephard and McMenemy 2004). Thermal plumes from other power plants along the Connecticut River can affect aquatic species, particularly migratory fishes (AEC 1972).

The river water supply is adequate to meet the needs of VYNPS for cooling purposes under all flow conditions. The NRC staff, while preparing this assessment, assumed that other industrial, commercial, or public installations could be located in the general vicinity of VYNPS prior to the end of VYNPS operations. Any discharge of water by such facilities into the Connecticut River would be regulated by the VANR. They set discharge limits considering the overall or cumulative impact of all other regulated activities in the area. Compliance with the CWA and its NPDES permit minimizes the cumulative impacts that VYNPS would have on aquatic resources. Continued operation of VYNPS would require renewed discharge permits from the VANR, which would address changing requirements so that cumulative water quality objectives would be served.

The VYNPS is located within a reach of the Connecticut River, which serves as a migratory corridor that links spawning and rearing habitats for several migratory fish species, including the anadromous American shad, Atlantic salmon, blueback herring, sea lamprey, and the catadromous American eel (VANR 2005). All of these species were extirpated from some or most of the river as a result of dams. However, since the construction of fish ladders at the dams, these species have been undergoing restoration as part of the Anadromous Fish Restoration Program, which is a cooperative effort among the States of Connecticut, Massachusetts, New Hampshire, and Vermont, as well as the U.S. Bureau of Sport Fisheries and Wildlife and the U.S. Bureau of Commercial Fisheries (Entergy 2006a). The increased abundance of striped bass in the estuary and lower reaches of the Connecticut River may be partly responsible for the dramatic drop in the number of American shad and blueback herring that have occurred in the Connecticut River (and other East Coast river systems) since 1992 (Savoy and Crecco 2004).

Future contributions to cumulative impacts to aquatic resources within the Connecticut River would generally occur from those actions that currently cause impacts (e.g., human habitation, urban and industrial development, agriculture, commercial, and recreational fisheries). The potential also exists for the expansion of non-native species that already occur in the Connecticut River, and for additional non-native species to become established within the river. Among the species introduced into the Connecticut River (Connecticut River Atlantic Salmon Commission 1998), those prevalent in the area near VYNPS include the rock bass, bluegill, smallmouth bass, largemouth bass, common carp, white catfish, channel catfish, and walleye.

The dwarf wedgemussel and shortnose sturgeon are the only Federally listed aquatic species that are reported from the Connecticut River in the area being considered for cumulative impacts. As mentioned in Section 2.2.5, past actions that have adversely affected these species have included siltation, impoundments, and contaminants. The introduction or spread of the zebra mussel (*Dreissena polymorpha*) or Asiatic clam (*Corbicula fluminea*) within the Connecticut River would have the potential to adversely affect the dwarf wedgemussel and other native mussel species. As discussed in Section 4.6.1, existing populations of the dwarf wedgemussel and shortnose sturgeon are too far removed from VYNPS for plant operations to contribute to the cumulative impacts that affect these species. Additionally, entrainment, impingement, and thermal discharges have only minimal localized impact on species that would be suitable hosts for the glochidia of the dwarf wedgemussel.

Because the aquatic resources of the Connecticut River are influenced by many controlling factors, the incremental contributions of VYNPS operations cannot be quantified precisely without additional investigations. It is likely, however, that VYNPS impacts are localized and have a minimal contribution to the cumulative impact on aquatic resources in the Connecticut River. The NRC staff concludes that the cumulative impact of continued operation of the VYNPS cooling system on aquatic resources in the Connecticut River would be SMALL and no additional mitigation is warranted. However, under the provisions of the CWA 316(b) regulations, the VDEC may impose further restrictions or require modifications to the cooling system to reduce the impacts on aquatic resources from entrainment and impingement under the NPDES permitting process.

In addition to the assessment above, the NRC contacted the NMFS to determine if any species needed to be evaluated under the essential fish habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act (NRC 2006c). The NMFS indicated that the Connecticut River and tributaries are designated essential fish habitat for Atlantic salmon; therefore, the NMFS instructed the NRC to evaluate the impact of the operation of VYNPS on the essential fish habitat of the Atlantic salmon (NMFS 2006). An assessment of the essential fish habitat for the Atlantic salmon, provided to the NMFS for review, is included in Appendix E of this SEIS. By letter dated January 4, 2007, NMFS stated that it would be unable to undertake an EFH consultation for the VYNPS license renewal review (NMFS 2007).

4.8.2 Cumulative Impacts on Terrestrial Resources

This section analyzes past, present, and future actions that could result in adverse cumulative impacts on terrestrial resources, including wildlife populations, upland habitat, wetlands, floodplains, and land use. For the purposes of this analysis, the geographic area that encompasses the past, present, and foreseeable future actions that could contribute to adverse cumulative impacts on terrestrial resources includes Windham County, Vermont, and Cheshire County, New Hampshire, which contain VYNPS and its associated transmission lines. VYNPS and its associated transmission lines occupy a very small percentage of the overall land area of the two counties (0.24 and 0.02 percent, respectively).

Past land-use changes include construction of the VYNPS facility and the VYNPS-to-Coolidge and VYNPS-to-Chestnut Hill transmission lines. While some expansion of commercial and residential development has occurred in the area since the station was built in the late 1960s, the area remains fairly rural and undeveloped. Continued operations during the license renewal term are not expected to result in a change in land use, development rates, or terrestrial habitat loss in the area.

As described in Section 2.2.6, several small wetland areas that are ranked by the State as Category 3 wetlands (i.e., they are not considered significant for providing wetland functions) are present on the site. In addition, some relatively undisturbed terrestrial habitats exist on the station (e.g., mixed and deciduous woodland and riparian habitat). No impacts to these wetland or terrestrial habitats are anticipated during the license renewal term, and any activities would be reviewed for impacts prior to implementation.

Four Federally listed threatened or endangered terrestrial species are listed for the two-county project area, but there is no critical habitat designated in either county (Section 2.2.6.2). The FWS determined that the bald eagle was the only Federally listed species known to occur in the vicinity of VYNPS facilities (FWS 2006). In addition, FWS determined that no impacts to the eagles are known to occur that could be attributed to VYNPS or its transmission lines.

On the basis of these considerations, the NRC staff concludes that the incremental contribution of VYNPS operations to cumulative impacts on terrestrial resources, including terrestrial threatened or endangered species, is SMALL, and that operations of VYNPS during the license renewal term would not result in a change to current levels of cumulative impact. No additional mitigation is warranted.

4.8.3 Cumulative Human Health Impacts

The radiological dose limits for protection of the public and workers have been developed by the EPA and the NRC to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 40 CFR Part 190 and 10 CFR Part 20. For the purpose of this analysis, the area within a 50-mi radius region of interest (ROI) of the VYNPS site was included. There are no other operating nuclear fuel cycle facilities within the 50-mi ROI. The Yankee Rowe nuclear reactor, which is located about 30 mi to the west-southwest of VYNPS in Greenfield, Massachusetts, was permanently shut down on October 1, 1991. It is undergoing decommissioning. One other nuclear fuel-cycle facility, the 50-mi ROI of which intersects with the 50-mi ROI of VYNPS, is Haddam Neck nuclear power plant located approximately 90 mi south of VYNPS in East Hampton, Connecticut. This plant is also shut down and is currently undergoing decommissioning. A research and test reactor that was operated by Combustion Engineering for the U.S. Navy in Windsor, Connecticut (approximately 75 mi away from VYNPS), is also in final stages of decommissioning. Because of their distance and nonoperational status, these nuclear facilities are not expected to contribute to the cumulative impacts at or near the VYNPS.

As stated in Section 2.2.7, the owners of VYNPS have conducted a radiological environmental monitoring program (REMP) around the VYNPS site since 1970, with the results presented annually in the VYNPS Annual Radiological Environmental Operating Report (Entergy 2006d). In addition, the Vermont Department of Health, Division of Health Protection, has conducted an environmental surveillance program in the vicinity of VYNPS since 1971 (VDH 2006). Both the REMP and the State of Vermont VYNPS Surveillance Program measure radiation and radioactive materials from all sources, including VYNPS emissions, and thus consider cumulative radiological impacts. On the basis of an evaluation of results from both of these programs and considering the effects of the EPU and the dry fuel storage facility onsite, the NRC staff concluded in Sections 2.2.7 and 4.3 that impacts of radiation exposure on the public and workers (occupational) from operation of VYNPS during the renewal term would be SMALL. The NRC staff is not aware of any plans or proposals for new nuclear facilities in the vicinity of VYNPS that would potentially contribute to cumulative radiological impacts. Therefore, the NRC staff concludes that future cumulative radiological impacts would be SMALL and no additional mitigation is warranted. The NRC and States of Vermont, New Hampshire, and Massachusetts would regulate any future actions in the vicinity of the VYNPS site that could contribute to cumulative radiological human health impacts.

The NRC staff determined that the electric-field-induced currents from the VYNPS transmission lines are well below the National Electrical Safety Code (NESC) recommendations for preventing electric shock from induced currents. Therefore, the VYNPS transmission lines do not detectably affect the overall potential for electric shock from induced currents within the analysis area. With respect to chronic effects of electromagnetic fields, although the NRC staff considers the GEIS finding of "not applicable" to be appropriate in regard to VYNPS, the VYNPS transmission lines are not likely to detectably contribute to the regional exposure to extremely low frequency-electromagnetic fields (ELF-EMFs). The VYNPS transmission lines pass through a sparsely populated, rural area with very few residences or businesses close enough to the lines to have detectable ELF-EMFs. Therefore, the NRC staff has determined that the cumulative impacts of the continued operation of the VYNPS transmission lines will be SMALL and no additional mitigation is warranted.

4.8.4 Cumulative Socioeconomic Impacts

The continued operation of VYNPS is not likely to result in significant cumulative impacts for any of the socioeconomic impact measures assessed in Section 4.4 of this SEIS (public services, housing, and offsite land use). This is because operating expenditures, staffing levels, and local tax payments during renewal would be similar to those during the current license period.

When combined with the impact of other potential activities likely in the area surrounding the plant, socioeconomic impacts resulting from VYNPS license renewal would not produce an incremental change in any of the impact measures used. The NRC staff therefore determined that the impacts on employment, personal income, housing, local public services, utilities, and education occurring in the local socioeconomic environment as a result of license renewal activities, in addition to the impacts of other potential economic activity in the area, would be SMALL. The NRC staff determined that the impact on offsite land use would be SMALL because no refurbishment activities are planned at VYNPS and no new incremental changes to plant-related tax payments are expected that could influence land use by fostering considerable growth. The impacts of license renewal on transportation and environmental justice would also be SMALL. There are no reasonably foreseeable scenarios that would alter these conclusions in regard to cumulative impacts.

Although archaeological surveys at the VYNPS have failed to identify intact archaeological sites, and the potential exists for significant cultural resources to be present within the site boundaries due to its location on the Connecticut River floodplain, it does not appear likely that the proposed license renewal would adversely affect these resources. The applicant has indicated that no refurbishment or replacement activities, including additional land-disturbing activities, at the plant site (or along existing transmission corridors) are planned for the license renewal period (Entergy 2006a). Absent land-disturbing activities, continued operation of VYNPS would likely protect any cultural resources present within the VYNPS site boundary by protecting those lands from development and providing secured access. Prior to a ground-disturbing activity in an undisturbed area, it is expected the applicant would evaluate the potential for impacts on cultural resources in consultation with the SHPO and appropriate Native American Tribes, as required under Section 106 of the National Historic Policy Act; therefore, the contribution to a cumulative impact on cultural resources by continued operation of VYNPS during the license renewal period would be SMALL.

4.8.5 Cumulative Impacts on Groundwater Use and Quality

The geographic range of analysis for cumulative impacts on groundwater encompasses wells completed in the unconsolidated glacial and fluvial sediments making up the unconfined aquifer to a depth of about 30 to 70 ft and the underlying Ordovician gneiss and granitic intrusives of the Oliverian Plutonic and New Hampshire Plutonic Series (Entergy 2005b, Buckley 2006).

Groundwater in the region generally flows towards the Connecticut River, but fluctuates depending on precipitation and water level changes in the river. Well users in the vicinity rely on wells completed in the glacial deposits. Deeper wells, which go into the underlying bedrock, generally have lower yields (AEC 1972, Entergy 2004).

VYNPS draws its potable water supply from four onsite wells completed at depths greater than 350 ft (as listed in Table 2-2). Based on usage in 2002 and 2003, the maximum demand for these wells is about 8.54 gpm, well below the Category 2 threshold of 100 gpm for groundwater use. The facility does not have plans for further groundwater development, either by increased pumping or installation of additional wells. Compared to regional water withdrawal rates and projected increases, VYNPS operational uses are considered inconsequential.

As described in Section 2.2.3.2, site exceedences of groundwater standards have included petroleum compounds. However, the areal extent of contamination remains on the facility's property, and various remedial activities (e.g., free product recovery) and monitoring systems are operating under State regulation. Therefore, the contamination does not contribute to offsite regional groundwater impacts. This is also true of discharges related to the plant's sewage treatment and disposal systems.

On the basis of actual and planned pumping rates and the fact that increasing groundwater extraction would require State approval, the NRC staff concludes that the plant's contribution to cumulative impacts on groundwater resources through water usage would be minor and no additional mitigation is warranted. On the basis of groundwater quality, the NRC staff concludes that the plant's contributions to cumulative impacts on the quality of local groundwater resources also would be inconsequential. As long as remediation and monitoring continue, where necessary, under State regulatory oversight, no additional mitigation is warranted.

4.8.6 Conclusions Regarding Cumulative Impacts

The NRC staff considered the potential impacts resulting from operation of VYNPS during the license renewal term and other past, present, and future actions in the vicinity of VYNPS. The NRC staff's determination is that the potential cumulative impacts resulting from VYNPS operation during the license renewal term would be SMALL.

4.9 Summary of Impacts of Operations During the Renewal Term

Neither Entergy nor the NRC staff is aware of information that is both new and significant related to any of the applicable Category 1 issues associated with VYNPS operation during the renewal term. Consequently, the NRC 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 would not likely be sufficiently beneficial to warrant implementation.

Plant-specific environmental evaluations were conducted for 14 Category 2 issues applicable to VYNPS operation during the renewal term as well as for environmental justice and chronic effects of electromagnetic fields. For 13 issues and environmental justice, the NRC staff concludes that the potential environmental impact of renewal term operations of VYNPS would be of SMALL significance in the context of the standards set forth in the GEIS and no additional mitigation is warranted. For Federally listed threatened and endangered species, the NRC staff's conclusion is that the impact resulting from license renewal would be SMALL and that further investigation is not warranted. In addition, the NRC staff determined that a consensus has not been reached by appropriate Federal health agencies regarding chronic adverse effects from electromagnetic fields.

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. The NRC staff concluded that the impacts of continued operation of VYNPS during the license renewal period would not result in significant cumulative impacts on potentially affected resources.

4.10 References

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

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, *Parks, Forests, and Public Property, Part 800*, "Protection of Historic Properties."

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

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

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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 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 characteristics.

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

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

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

Category 2 issues are those that 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 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 U.S. Nuclear Regulatory Commission (NRC) approval to operate a nuclear power facility, an applicant for an initial operating license (OL) 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.

Design-basis accidents (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 Title 10, Part 50 and Part 100, of the *Code of Federal Regulations* (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 OL. The results of these evaluations are found in license documentation such as the applicant's Final Safety Analysis Report (FSAR), the NRC staff's Safety Evaluation Report (SER), the Final Environmental Statement (FES), and Section 5.1 of this Supplemental Environmental Impact Statement (SEIS). A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximally exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the license renewal period. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable, and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, DBAs 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 makes them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This issue, applicable to Vermont Yankee Nuclear Power Station (VYNPS), 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 Sections
POSTULATED ACCIDENTS	
Design-basis accidents	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.

Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy), stated in its Environmental Report (ER) (Entergy 2006a) that it is not aware of any new and significant information associated with the renewal of the VYNPS OL. The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to DBAs 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, regardless of offsite consequences. In the GEIS, the NRC staff assessed the impacts of severe accidents using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Severe accidents initiated by external phenomena, such as tornadoes, floods, earthquakes, fires, and sabotage, traditionally have not been discussed in quantitative terms in FESs and were not specifically considered for the VYNPS site in the GEIS. However, in the GEIS, the NRC staff did evaluate existing impact assessments performed by the NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal performed a discretionary analysis of terrorist acts in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the Commission concludes that the risk from sabotage and beyond-design-basis earthquakes at existing nuclear power plants is small and, additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (GEIS, Vol. 1, p. 5-18).

Based on information in the GEIS, the Commission found that

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

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to VYNPS, 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 NRC staff has not identified any new and significant information with regard to the consequences from severe accidents during its independent review of the Entergy ER (Entergy 2006a), or the site visit, the scoping process and public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC 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 NRC staff has reviewed severe accident mitigation alternatives (SAMAs) for VYNPS. The results of its review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives

Section 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the NRC 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 Vermont Yankee Nuclear Power Station (VYNPS); therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

This section presents a summary of the SAMA evaluation for VYNPS conducted by Entergy Nuclear Generation Company (Entergy), and described in the ER, and the NRC's review of this evaluation. The details of the review are described in the NRC staff evaluation that was prepared with contract assistance from Information Systems Laboratories, Inc. The entire evaluation for VYNPS is presented in Appendix G.

The SAMA evaluation for VYNPS was conducted with a four-step approach. In the first step Entergy quantified the level of risk associated with potential reactor accidents using the plant-specific probabilistic safety assessment (PSA) and other risk models.

In the second step Entergy examined the major risk contributors and identified possible ways (SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. Entergy initially identified 302 potential SAMAs for VYNPS. Entergy screened out 236 SAMAs from further consideration because they are not applicable at VYNPS due to design differences, have already been implemented at VYNPS, or are addressed by a similar SAMA. The remaining 66 SAMAs were subjected to further evaluation.

In the third step Entergy estimated the benefits and the costs associated with each of the remaining SAMAs. Estimates were made of how much each SAMA could reduce risk. Those estimates were developed in terms of dollars in accordance with NRC guidance for performing regulatory analyses (NRC 1997). The cost of implementing the proposed SAMAs was also estimated.

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost-beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost-benefit). Entergy found two SAMAs to be potentially cost-beneficial (Entergy 2006b). However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, four additional potentially cost-beneficial SAMAs were identified (Entergy 2006b and 2006c).

The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54. Entergy's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.2 Estimate of Risk

Entergy submitted an assessment of SAMAs for VYNPS as part of the ER (Entergy 2006a). This assessment was based on the most recent VYNPS PSA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the VYNPS Individual Plant Examination (IPE) (VYNPC 1993) and Individual Plant Examination of External Events (IPEEE) (VYNPC 1998).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 8.0×10^{-6} per year. This CDF is based on the risk assessment for internally-initiated events. Entergy did not include the contribution to risk from external events within the VYNPS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by increasing the estimated benefits for internal events by a factor of 3.33. The breakdown of CDF by initiating event is provided in Table 5-3.

As shown in Table 5-3, events initiated by loss of offsite power, internal flooding, transients without the power conversion system, and loss of an AC bus are the dominant contributors to CDF. Although not separately reported, station blackout (SBO) sequences contribute 2.3×10^{-6} per year (about 29 percent of the total internal events CDF), while anticipated transient without scram (ATWS) sequences contribute 1.5×10^{-7} per year to CDF (about 2 percent of the total internal events CDF).

Entergy estimated the dose to the population within 80 km (50 mi) of the VYNPS site to be approximately 0.151 person-Sv (15.1 person-rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-4. Containment failures within the early time frame (less than 6 hours following event initiation) dominate the population dose risk at VYNPS.

The NRC staff has reviewed Entergy's data and evaluation methods and concludes that the quality of the risk analyses is adequate to support an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDFs and offsite doses reported by Entergy.

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, Entergy searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, Entergy considered insights from the plant-specific PSA, and SAMA analyses performed for other operating plants that have submitted license renewal applications. Entergy identified 302 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training.

Table 5-3. VYNPS Core Damage Frequency

Initiating Event	CDF (Per Year)	% Contribution to CDF
Loss of offsite power	2.8×10^{-6}	35
Internal Flooding	1.4×10^{-6}	17
Transients without power conversion system	8.4×10^{-7}	11
Loss of AC Bus 3	7.9×10^{-7}	10
Loss of AC Bus 4	7.3×10^{-7}	9
Loss of DC bus 2	2.8×10^{-7}	4
Loss of DC bus 1	2.8×10^{-7}	3
Inadvertently opened relief valve	2.7×10^{-7}	3
Reactor trip	1.7×10^{-7}	2
Anticipated Transient Without Scram	1.5×10^{-7}	2
Loss of Coolant Accidents	7.3×10^{-8}	1
Stuck-open relief valve	6.5×10^{-8}	1
Total loss of service water	5.2×10^{-8}	1
Interfacing System LOCA	3.9×10^{-8}	<1
LOCA outside containment	3.4×10^{-8}	<1
Total CDF	**8.0×10^{-6}**	**100**

Table 5-4. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose (Person-Rem[1] Per Year)	% Contribution
Early Containment Failure	12.8	85
Late Containment Failure	2.1	14
Containment Bypass	0.2	1
Intermediate Containment Failure	< 0.1	< 1
Intact Containment	negligible	negligible
Total	**15.1**	**100**

[1]One person-Rem = 0.01 person-Sv

Entergy removed 236 SAMAs from further consideration because they are not applicable at VYNPS due to design differences, have already been implemented at VYNPS, or are addressed by a similar SAMA. A detailed cost-benefit analysis was performed for each of the 66 remaining SAMAs (Entergy 2006a).

The staff concludes that Entergy used a systematic and comprehensive process for identifying potential plant improvements for VYNPS, and that the set of potential plant improvements identified by Entergy is reasonably comprehensive and, therefore, acceptable.

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

Entergy evaluated the risk-reduction potential of the remaining 66 SAMAs. The majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement.

Entergy estimated the costs of implementing the 66 candidate SAMAs through the application of engineering judgement, and use of other licensees' estimates for similar improvements. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency costs associated with unforeseen implementation obstacles.

The NRC staff reviewed Entergy'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 somewhat conservative (i.e., the estimated risk reduction is similar to or somewhat higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on Entergy's risk reduction estimates.

The NRC staff reviewed the bases for the applicant's cost estimates. For certain improvements, the NRC staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The NRC staff found the cost estimates to be consistent with estimates provided in support of other plants' analyses.

The NRC staff concludes that the risk reduction and the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

5.2.5 Cost-Benefit Comparison

The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184 (NRC 1997) and was executed consistent with this guidance. NUREG/BR-0058 has recently been revised to reflect the agency's revised policy on discount rates. Revision 4 of NUREG/BR-

0058 states that two sets of estimates should be developed – one at three percent and one at seven percent (NRC 2004). Entergy provided both sets of estimates (Entergy 2006a).

Entergy identified three potentially cost-beneficial SAMAs in the baseline analysis contained in the ER (using a seven percent discount rate, and considering the combined impact of both external events and uncertainties). The potentially cost-beneficial SAMAs are:

- SAMA 47 – shield injection system electrical equipment from potential water spray. This SAMA involves installing shields in two locations to address the impacts of breaks in either of the two locations.

- SAMA 65 – modify procedures to allow operators to defeat the low reactor pressure interlock circuitry that inhibits opening the LPCI or core spray injection valves following sensor or logic failures that prevent all low pressure injection valves from opening.

- SAMA 66 – install a bypass switch to allow operators to bypass the low reactor pressure interlock circuitry that inhibits opening the LPCI or core spray injection valves following sensor or logic failures that prevent all low pressure injection valves from opening.

In response to a request for additional information (RAI), Entergy provided a revised assessment based on a modified multiplier for external events and a separate accounting of uncertainties (Entergy 2006b). The revised baseline assessment resulted in identification of only one potentially cost-beneficial SAMA (SAMA 65). When accounting for uncertainties, SAMA 66 was also potentially cost-beneficial. (SAMA 47, which was marginally cost-beneficial in Entergy's original SAMA assessment, is not cost-beneficial in the revised assessment.) However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, four additional potentially cost-beneficial SAMAs were identified (Entergy 2006b and 2006c):

- SAMA 63, control containment venting within a narrow pressure band.

- New SAMA involving operator procedure revisions to provide additional space cooling to the EDG room via the use of portable equipment.

- New SAMA involving use of a portable generator to power the battery chargers.

- New SAMA involving use a portable generator to provide power to individual 125VDC motor control centers (MCCs).

The NRC staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than the associated benefits.

5.2.6 Conclusions

The NRC staff reviewed Entergy's analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by Entergy are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited by the unavailability of an external event PSA, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process, and increasing the estimated SAMA benefits for internal events by a multiplier to account for potential benefits in external events.

Based on its review of the SAMA analysis, the NRC staff concurs with Entergy's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all or a subset of potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff considers that further evaluation of these SAMAs by Entergy is warranted. However, none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

5.3 References

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

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

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

10 CFR Part 73. *Code of Federal Regulations*, Title 10, *Energy*, Part 73, "Physical Protection of Plants and Materials."

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). 1997. *Regulatory Analysis Technical Evaluation Handbook*. NUREG/BR-0184, Washington, D.C.

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U.S. Nuclear Regulatory Commission (NRC). 2004. *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission*. NUREG/BR-0058, Rev. 4, Washington, D.C.

Vermont Yankee Nuclear Power Corporation (VYNPC). 1993. Letter from James P. Pelletier, VYNPS to U.S. Nuclear Regulatory Commission Document Control Desk. *Vermont Yankee Response to Generic Letter 88-20: Report on the Individual Plant Examination for Severe Accident Vulnerabilities - 10CFR 50-54 (f)*. (December 21, 1993).

Vermont Yankee Nuclear Power Corporation (VYNPC). 1998. Letter from Don M. Leach, VYNPS to NRC Document Control Desk. *Vermont Yankee Nuclear Power Station License No. DPR-28 (Docket No. 50-271) Submittal of the Vermont Yankee Individual Plant Examination for External Events (IPEEE) Report - Response to Generic Letter 88-20, Supplement 4.* (June 30, 1998).

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, Volumes 1 and 2 (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 characteristics.

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

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

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

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

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management during the license renewal term that are listed in Table B-1 of Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), Subpart A, Appendix B, and are applicable to the Vermont Yankee Nuclear Power Station (VYNPS). 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

(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.

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 Power Reactor." The U.S. Nuclear Regulatory Commission (NRC) staff also addresses the impacts from radon-222 and technetium-99 in the GEIS.

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 VYNPS 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 Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and 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

Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy) stated in its Environmental Report (ER) (Entergy 2006) that it is not aware of any new and significant information associated with the renewal of the VYNPS operating license (OL). The extended power uprate granted in March 2006 and the construction of the new dry fuel storage facility, which is expected to be completed in 2006, have been considered by the NRC in its evaluation of the radiological impacts and the impacts have been determined to be within the boundaries established in the GEIS. The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the NRC staff concluded in the GEIS that the impacts are SMALL except for the collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, as discussed below, and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the NRC 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

  Offsite 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be no offsite radiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

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

  The 100-year environmental dose commitment to the U.S. population from the fuel cycle, HLW and spent fuel disposal excepted, is calculated to be about 14,800 person-rem, 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 United States. 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 that will not ever be mitigated (e.g., no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits and even smaller fractions of natural background exposure to the same populations.

Nevertheless, despite all the uncertainty, some judgment 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 judgment 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 HLW and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, *Technical Bases for Yucca Mountain Standards* (NAS 1995), 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 mrem 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 mrem 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 mrem per year. The lifetime individual risk from the 100 millirem annual dose limit is about 3×10^{-3}.

Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the *Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste*, October 1980 (DOE 1980). The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1000 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 HLW repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, the U.S. Environmental Protection Agency's (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 1000 premature cancer deaths worldwide for a 100,000-metric tonne (MTHM) repository.

Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment 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 HLW disposal, this issue is considered Category 1.

On February 15, 2002, based on a recommendation by the Secretary of the 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, in Joint Resolution 87, which designated Yucca Mountain as the repository for spent nuclear waste. On July 23, 2002, the President signed Joint Resolution 87 into law; Public Law 107-200, 116 Stat. 735 (2002) designates Yucca Mountain as the repository for spent nuclear waste. This development does not represent new and significant information with respect to the offsite radiological impacts from license renewal related to disposal of spent nuclear fuel and high-level nuclear waste.

The EPA developed Yucca-Mountain-specific repository standards, which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion, issued July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated the EPA's radiation protection standards for the candidate repository, which required compliance with certain dose limits over a 10,000-year period. The Court's decision also vacated the compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63. In response to the Court's decision, the EPA issued its proposed revised standards to 40 CFR Part 197 on August 22, 2005 (EPA 2005). In order to be consistent with the EPA's revised standards, the NRC proposed revisions to 10 CFR Part 63 on September 8, 2005 (NRC 2005).

Therefore, for the HLW and spent fuel disposal component of the fuel cycle, there is some uncertainty with respect to regulatory limits for offsite releases of radioactive nuclides for the current candidate repository site. However, prior to promulgation of the affected provisions of the Commission's regulations, the NRC staff assumed that limits would be developed along the lines of the 1995 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 that would comply with such limits could and likely would be developed at some site.

Despite the current uncertainty with respect to these rules, some judgment as to the regulatory NEPA implications of offsite radiological impacts of spent fuel and HLW disposal should be made. The NRC staff concludes that these impacts are acceptable in that the impacts would not be sufficiently large to require the NEPA conclusion that the option of extended operation under 10 CFR Part 54 should be eliminated.

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, evaluation of other available information, and public comments on the draft SEIS. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 onsite 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 onsite with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be 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 the NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting HLW 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 the summary table.

VYNPS meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

There are no Category 2 issues for the uranium fuel cycle and solid waste management.

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 Management and Disposal for Yucca Mountain, Nevada.”

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Joint Resolution Approving the Site at Yucca Mountain, Nevada, for the Development of a Repository for the Disposal of High-Level Radioactive Waste and Spent Nuclear Fuel, pursuant to the Nuclear Waste Policy Act of 1982. 2002. Public Law 107-200. 116 Stat. 735.

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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, Vol. 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2005. “Implementation of a Dose Standard After 10,000 Years.” *Federal Register*, Vol. 70, No. 173, pp. 53313–53320. Washington, D.C. (September 8, 2005).

7.0 Environmental Impacts of Decommissioning

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*, NUREG-0586, Supplement 1 (NRC 2002). The U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, identifies a range of impacts for each environmental issue.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation 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 issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were 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 characteristics.

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

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

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

Category 2 issues are those that 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.

(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.

7.1 Decommissioning

Category 1 issues in Table B-1 of Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), Subpart A, Appendix B, that are applicable to Vermont Yankee Nuclear Power Station (VYNPS) decommissioning following the renewal term are listed in Table 7-1. Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy) stated in its Environmental Report (ER) (Entergy 2006) that it is aware of no new and significant information regarding the environmental impacts of VYNPS license renewal. The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures would not likely be sufficiently beneficial to be warranted.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of VYNPS 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

A brief description of the NRC 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 caused by buildup of long-lived radionuclides during the license renewal term.

  The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no radiation dose impacts associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts from 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts on air quality associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts on water quality associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts on ecological resources associated with decommissioning following the license renewal term 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 NRC staff has not identified any new and significant information during its independent review of the Entergy ER, or the site visit, the scoping process, public comments on the draft SEIS, and its evaluation of other available information. Therefore, the NRC staff concludes that there would be no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 References

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

Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy). 2006. *Applicant's Environmental Report – Operating License Renewal Stage, Vermont Yankee Nuclear Power Station*. Docket No. 50-271. Brattleboro, Vermont. (January 25, 2006). ADAMS No. ML060300086.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Vols. 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, Vol. 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Washington, D.C.

8.0 Environmental Impacts of Alternatives

This chapter examines the potential environmental impacts associated with (1) denying the renewal of the Vermont Yankee Nuclear Power Station (VYNPS) operating license (OL) (i.e., the no-action alternative); (2) replacing VYNPS electric-generation capacity using electric-generation sources other than VYNPS; (3) purchasing electric power from other sources to replace power generated by VYNPS; and (4) a combination of generation and conservation measures. In addition, other alternatives that were deemed unsuitable for replacement of power generated by VYNPS are discussed.

The environmental impacts of alternatives are 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 the footnotes to Table B-1 of Title 10, Part 51, of the *Code of Federal Regulations* (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 category of environmental justice and transportation.

8.1 No-Action Alternative

NRC regulations implementing the National Environmental Policy Act (NEPA), 10 CFR Part 51, Subpart A, Appendix A(4), specify that the no-action alternative be discussed in an NRC Environmental Impact Statement (EIS). For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the VYNPS OL, and Entergy would then cease plant operations by the end of the current OL and initiate decommissioning of the plant. Entergy eventually would be required to shut down VYNPS and to comply with NRC decommissioning

(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.

requirements in 10 CFR 50.82, whether or not the OL is renewed. If the VYNPS OL is renewed, shutdown of the unit and decommissioning activities would not be avoided, but would be postponed for up to an additional 20 years.

The environmental impacts associated with decommissioning under a license renewal or the no-action alternative would be bounded by the discussion of impacts in Chapter 7 of the license renewal GEIS (NRC 1996), Chapter 7 of this Supplemental Environmental Impact Statement (SEIS), and the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC 2002). The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those that would occur after 40 years of operation.

Impacts from the decision to permanently cease operations are not considered in NUREG-0586, Supplement 1.[a] Therefore, immediate impacts that occur between plant shutdown and the beginning of decommissioning are considered here. These impacts would occur when the unit shuts down regardless of whether the license is renewed or not and are discussed below, with the results presented in Table 8-1. Plant shutdown would result in a net reduction in power production capacity. The power not generated by VYNPS during the license renewal term would likely be replaced by (1) power purchased from other electricity providers, (2) generation alternatives other than VYNPS, (3) demand-side management (DSM) and energy conservation, or (4) some combination of these options. The environmental impacts of these options are discussed in Section 8.2.

- **Land Use**

  In Chapter 4, the NRC staff concluded that the impact of continued plant operation on land use would be SMALL. Onsite land use would not be affected immediately by the cessation of operations. Plant structures and other facilities are likely to remain in place until decommissioning. The transmission lines associated with VYNPS are expected to remain in service after the plant stops operating. As a result, maintenance of the rights-of-way will continue as before. Therefore, the NRC staff concludes that the impact on land use from plant shutdown would be SMALL.

- **Ecology**

  In Chapter 4, the NRC staff concluded that the ecological impact of continued plant operation would be SMALL. Cessation of operations would be accompanied by a reduction in cooling water flow and in the thermal plume from the plant. These changes would reduce

(a) Appendix J of NUREG-0586, Supplement 1, discusses the socioeconomic impacts of plant closure. The results of the analysis in Appendix J, however, were not incorporated into the analysis presented in the main body of the NUREG.

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

Impact Category	Impact	Comment
Land use	SMALL	Impact is expected to be SMALL because plant shutdown would not be expected to result in changes to onsite or offsite land use.
Ecology	SMALL	Impact is expected to be SMALL because aquatic impacts would be reduced from current levels, and terrestrial impacts are not expected because there would not be any changes in transmission line right-of-way maintenance practices.
Water use and quality – surface water	SMALL	Impact is expected to be SMALL because surface-water intake and discharges would be eliminated.
Water use and quality – groundwater	SMALL	Impact is expected to be SMALL because groundwater use would decrease.
Air quality	SMALL	Impact is expected to be SMALL because emissions related to plant operation and worker transportation would decrease.
Waste	SMALL	Impact is expected to be SMALL because generation of high-level waste would stop, and generation of low-level and mixed waste would decrease.
Human health	SMALL	Impact is expected to be SMALL because radiological doses to workers and members of the public, which are within regulatory limits, would be further reduced.
Socioeconomics	SMALL TO LARGE	Impacts are expected to range from SMALL to LARGE. The impact of loss of employment and tax revenues at the state level would be SMALL; the impact of loss of tax revenues at the local level would be LARGE.
Transportation	SMALL	Impact is expected to be SMALL because the decrease in employment would reduce traffic.
Aesthetics	SMALL	Impact is expected to be SMALL because plant structures would remain in place and the visibility of plumes from the cooling towers would be eliminated.
Historic and archaeological resources	SMALL	Impact is expected to be SMALL because shutdown of the plant would not result in land disturbance.
Environmental justice	SMALL	Impact is expected to be SMALL because the loss of overall employment would be small.

environmental impacts on terrestrial and aquatic species. The transmission lines associated with VYNPS are expected to remain in service after VYNPS stops operating. As a result, maintenance of the rights-of-way and subsequent impacts on the terrestrial ecosystem would continue as before. Therefore, the NRC staff concludes that the ecological impact from shutdown of the plant would be SMALL.

- **Water Use and Quality – Surface Water**

  In Chapter 4, the NRC staff concluded that the impact of continued plant operation on surface-water use and quality would be SMALL. When the plant stops operating, there would be an immediate reduction in the consumptive use of water because of the reduction in cooling water flow and in the amount of heat rejected to the Connecticut River. Therefore, the NRC staff concludes that the impact on surface-water use and quality from plant shutdown would be SMALL.

- **Water Use and Quality – Groundwater**

  In Chapter 4, the NRC staff concluded that the impact of continued plant groundwater use on groundwater availability and quality would be SMALL. When the plant stops operating, there would be a reduction in the use of water because cooling towers would no longer be required and there would be reduced potable water consumption and sanitary use as the size of the plant staff decreases. Therefore, the NRC staff concludes that the impact on groundwater use and quality from shutdown of the plant would be SMALL.

- **Air Quality**

  In Chapter 4, the NRC staff concluded that the impact of continued plant operation on air quality would be SMALL. When the plant stops operating, there would be a reduction in emissions from activities related to plant operation, such as worker transportation. Therefore, the NRC staff concludes that the impact on air quality from shutdown of the plant would be SMALL.

- **Waste**

  The impacts of radioactive waste generated by continued plant operation are discussed in Chapter 6. The impact of low-level and mixed waste from plant operation is characterized as SMALL. When VYNPS stops operating, it would stop generating high-level waste (HLW), and the generation of low-level and mixed waste associated with plant operation and maintenance would be reduced. Therefore, the NRC staff concludes that the impact of waste generated after shutdown of the plant would be SMALL.

- **Human Health**

  In Chapter 4, the NRC staff concluded that the impacts of continued plant operation on human health would be SMALL. After the cessation of operations, the amount of radioactive material released to the environment in gaseous and liquid forms would be reduced. Therefore, the NRC staff concludes that the impact of shutdown of the plant on human health would be SMALL. In Chapter 5, the NRC staff concluded that the impacts of accidents during operation would be SMALL. After shutdown, the variety of potential accidents at the plant would be reduced to a limited set associated with fuel handling and storage. Therefore, the NRC staff concludes that the impact of potential accidents following shutdown of the plant would be SMALL.

- **Socioeconomics**

  In Chapter 4, the NRC staff concluded that the socioeconomic impact of continued plant operation would be SMALL. There would be immediate socioeconomic impacts associated with the shutdown of the plant because of the reduction in the staff at the plant. There may also be an immediate reduction in property tax revenues for Windham County, and this is anticipated to be LARGE. The overall impact would depend on the state of the economy, the net change in workforce at the plant, and the changes in local government tax receipts. Appendix J of Supplement 1 to NUREG-0586 (NRC 2002) shows that the overall socioeconomic impact of plant closure plus decommissioning could be greater than SMALL. The NRC staff concludes that the socioeconomic impact of VYNPS shutdown on employment would be SMALL because of the relatively small employment loss compared with total employment in the economy of the surrounding area. Therefore, the NRC staff concludes that the socioeconomic impacts of plant shutdown would range from SMALL to LARGE. Impacts could be offset if new power-generating facilities are built at or near the current site.

- **Transportation**

  In Chapter 4, the NRC staff concluded that the impact of continued plant operation on transportation would be SMALL. Cessation of operations would be accompanied by a reduction of traffic in the vicinity of the plant. Most of the reduction would be associated with a reduction in the plant workforce, but there also would be a reduction in shipment of material to and from the plant. Therefore, the NRC staff concludes that the impact of plant closure on transportation would be SMALL.

- **Aesthetics**

  In Chapter 4, the NRC staff concluded that the aesthetic impact of continued plant operation would be SMALL. Cessation of operations would be accompanied by the elimination of visible plumes from the cooling towers. Plant structures and other facilities are likely to remain in place until decommissioning. Therefore, the NRC staff concludes that the aesthetic impact of plant closure would be SMALL.

- **Historic and Archaeological Resources**

  In Chapter 4, the NRC staff concluded that the impacts of continued plant operation on historic and archaeological resources would be SMALL. Onsite land use would not be affected immediately by the cessation of operations. Plant structures and other facilities would likely remain in place until decommissioning. The transmission line associated with the project is expected to remain in service after the plant stops operating. As a result, maintenance of the transmission line right-of-way would continue as before. Therefore, the NRC staff concludes that the impact on historic and archaeological resources from plant shutdown would be SMALL.

- **Environmental Justice**

  In Chapter 4, the NRC staff concluded that the environmental justice impact of continued operation of the plant would be SMALL. Continued operation of the plant would not have a disproportionately high and adverse impact on minority and low-income populations. Shutdown of the plant also would not have disproportionately high and adverse impacts on minority and low-income populations resulting from the loss of employment opportunities at the site or from secondary socioeconomic impacts (e.g., loss of patronage at local businesses because the loss would be very minor in the context of the regional economy). The NRC staff concludes that the environmental justice impact of plant shutdown is expected to be SMALL. Any impact would be offset if new power-generating facilities are built at or near the current site. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of this impact.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with developing alternative sources of electric power to replace the power generated by VYNPS assuming that the OL for VYNPS is not renewed. The order of presentation of alternative energy sources does not imply which alternative would be most likely to occur or to have the least environmental impacts. The following power-generation alternatives are considered in detail:

- Coal-fired plant generation at an alternate site (Section 8.2.1),

- Natural-gas-fired plant generation at the VYNPS site and at an alternate site (Section 8.2.2), and

- New nuclear power plant generation at an alternate site (Section 8.2.3).

The alternative of purchasing power from other sources to replace power generated at VYNPS is discussed in Section 8.2.4. Other power-generation alternatives and conservation alternatives considered by the NRC staff and found not to be reasonable replacements for VYNPS 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 its *Annual Energy Outlook 2007 with Projections to 2030*, the EIA projects that more than 54 percent of new electric-generating capacity between 2006 and 2030 will be coal-fired plants (EIA 2007). The proportion of electricity produced by coal-fired plants will fall slightly in the near future but will grow to 57 percent of total generation by 2030 due largely to relative fuel prices. Natural-gas-fired plants accounted for 19 percent of the total supply in 2005. By 2015, EIA predicts their contribution to grow to 22 percent and then fall to 16 percent by 2030 (EIA 2007). Renewable fuel technologies such as wind, solar, and hydropower provided 9 percent of the total electricity consumed in 2005, and this is expected to remain relatively constant through 2030 (EIA 2007). Of the renewable fuels, hydropower provided the most power at 6.6 percent in 2005 and is expected to fall to 5.3 percent in 2030 (EIA 2007). The drop in hydropower is due to the lack of new locations for development. The share of power resulting from other renewable sources of power is expected to rise from 2.3 percent in 2005 to 3.6 percent in 2030 due to technological advances and State and Federal support (EIA 2007).

Nuclear plants currently provide 19 percent of the power in the United States (EIA 2007). EIA expects new nuclear plant construction partly due to Energy Policy Act of 2005 tax incentives. By 2030, EIA expects nuclear power to supply 15 percent of the total power produced in the United States, including 12 gigawatts (GW) of new nuclear capacity by 2030 (EIA 2007).

As EIA's analysis indicates, there has been an increased interest in constructing new nuclear power facilities, also evidenced by the certification of four standard nuclear power plant designs and recent activities involving the review of other plant designs and potential sites. The NRC in response has established the Office of New Reactors (NRO) to prepare for and manage future reactor and site licensing applications (NRC 2006). Therefore, a new nuclear plant alternative for replacing power generated by VYNPS is considered in this SEIS (see Section 8.2.3).

VYNPS has a net electrical capacity of 650 MW(e) (Section 3.2.1; Entergy 2006). For the coal- and natural-gas-fired plant alternatives, the NRC staff assumed construction of a 620-MW(e) and a 608-MW(e) plant, respectively, which is consistent with Entergy's Environmental Report (ER) (Entergy 2006). This assumption will understate the environmental impacts of replacing the 650 MW(e) from VYNPS by about 5 to 6 percent. The applicant did not identify any specific alternate sites in the ER for the coal-fired or natural-gas-fired plants; however, it was assumed that a suitable location could be found in the region. For the new nuclear power plant alternative, the NRC staff assumed the same capacity as VYNPS. Given the small size of the VYNPS property, 125 ac, it was assumed that the coal-fired and nuclear power plant would have to be constructed at an alternate location (Entergy 2006). Therefore, this SEIS only evaluates construction of a natural-gas-fired plant at the VYNPS site, while it considers construction of all three power plant alternatives at an alternate site for the analysis of environmental impacts.

8.2.1 Coal-Fired Plant Generation

The coal-fired plant alternative is analyzed for a generic alternate site. Unless otherwise indicated, the assumptions and numerical values used are from the Entergy ER (Entergy 2006). The NRC staff reviewed the information in the Entergy ER and compared it with environmental impact information in the GEIS for license renewal. Although the OL renewal period is only 20 years, NRC considers the impact of operating a coal-fired plant for 40 years (as a reasonable projection of the operating life of a coal-fired plant). The NRC staff assumed that the VYNPS plant would remain in operation while the alternative coal-fired plant was constructed.

The NRC staff assumed the construction of one standard 620-MW(e) unit for a total capacity of 620 MW(e) as a potential replacement for VYNPS. The coal-fired plant would consume approximately 1.9 million tons/yr of pulverized bituminous coal with an ash content of approximately 8.2 percent (Entergy 2006). Entergy assumes a heat rate[a] of 10,200 Btu/kWh and a capacity factor[b] of 0.85 in its ER (Entergy 2006). EIA suggests that a new scrubbed coal-fired plant of similar capacity would require four years to construct (DOE/EIA 2007).

In addition to the impacts discussed below for a coal-fired plant at an alternate site, impacts would occur offsite as a result of the mining of coal and limestone. Impacts of mining operations would include an increase in fugitive dust emissions; surface-water runoff; erosion; sedimentation; changes in water quality; disturbance of vegetation and wildlife; disturbance of historic and archaeological resources; changes in land use; and impacts on employment.

The magnitude of these offsite impacts would largely be proportional to the amount of land affected by mining operations. In the GEIS, the NRC staff estimated that approximately 22,000 ac would be affected by the mining of coal and the disposal of the waste needed to support a 1000-MW(e) coal-fired plant during its operational life (NRC 1996). Proportionally

(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 the fuel burned for electric generation by the resulting 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.

less land would be affected by a 620-MW(e) plant. Partially offsetting this offsite land use would be the elimination of the need for uranium mining to supply fuel for VYNPS. In the GEIS, the NRC staff estimated that approximately 1000 ac would be affected for mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant.

8.2.1.1 Coal-Fired Plant with a Closed-Cycle Cooling System

In this section, the NRC staff evaluates the impacts of a coal-fired plant located at an alternate site that uses a closed-cycle cooling system. The impacts of a coal-fired plant using a once-through cooling system are considered in Section 8.2.1.2.

The overall impacts of the coal-fired plant alternative are discussed in the following sections and summarized in Table 8-2. The magnitude of impacts for an alternate site would depend on the characteristics of the particular site selected.

- **Land Use**

  In its ER, Entergy estimated that 1054 ac of land would be needed for construction of a coal-fired plant at an alternate site. Entergy assumed use of the closed-cycle cooling system for a coal-fired plant at an alternate site (see Table 8-2 for a discussion of the impacts of a coal-fired plant using a closed-cycle cooling system). Additional land would likely be required for construction of cooling towers.

  The GEIS estimates that approximately 1700 ac would be needed for a 1000-MW(e) coal-fired plant (NRC 1996). This estimate would be scaled down for the 620-MW(e) capacity of the proposed coal-fired plant alternative (i.e., 1054 ac) at an alternate site. Additional land might be needed for transmission lines and rail spurs, depending on the location of the alternate site relative to the nearest intertie connection and rail line.

  In the GEIS, the NRC staff estimated that approximately 22 ac of land per MW(e) would be affected for mining the coal and lime as well as disposing of the waste to support a coal-fired plant during its operational life (NRC 1996). Therefore, for the hypothetical 620 gross MW(e) plant utilized in this analysis, it would take approximately 13,640 ac of land. Partially offsetting this offsite land use would be the elimination of the need for uranium mining and processing to supply fuel for VYNPS. In the GEIS, the NRC staff estimated approximately 1 ac per MW(e) would be affected for mining and processing the uranium during the operating life of a nuclear power plant (NRC 1996). Therefore, for the hypothetical 620 gross MWe plant utilized in this analysis, it would take approximately 620 ac of land.

  Additional land would likely be needed at an alternate site for a transmission line to connect to the existing grid and for a rail spur.

Table 8-2. Summary of Environmental Impacts of a Coal-Fired Plant Using Closed-Cycle Cooling at an Alternate Site

Impact Category	Impact	Comments
Land use	MODERATE to LARGE	Impact would depend on the characteristics of the alternate site. The site uses approximately 1054 ac for plant, offices, and parking. Additional land (amount dependent on site chosen) would be needed for a rail spur and a transmission line. Additional offsite land-use impact of 13,640 ac for mining coal and limestone, as well as disposing waste.
Ecology	MODERATE to LARGE	Impact would depend on the characteristics of the land to be developed, surface-water body used for intake and discharge, and transmission line and rail spur routes. Impact on terrestrial ecology from cooling-tower drift. Some impingement and entrainment of aquatic organisms.
Water use and quality – surface water	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged and the characteristics of the surface-water body. Cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides, as well as wastewater, would be released.
Water use and quality – groundwater	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged and the characteristics of the aquifers.
Air quality	MODERATE	Impact from fugitive dust and emissions from vehicles and equipment during construction would be SMALL. Impact of operations on air quality during operations would be MODERATE with the following emissions expected: Sulfur oxides • 1238 tons/yr Nitrogen oxides • 472 tons/yr Particulates • 77 tons/yr of total suspended particulates • 18 tons/yr of PM_{10} Carbon monoxide • 472 tons/yr Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials – mainly uranium and thorium. Pollution-control standards may vary, depending on location. Impact during construction would be MODERATE. Impact during operation would be MODERATE.

Table 8-2. (contd)

Impact Category	Impact	Comments
Waste	MODERATE	Waste would be generated and removed during construction. During operation, total waste volume would be about 222,227 tons/yr of ash and scrubber sludge, requiring approximately 123.3 ac for disposal during the 40-year life of the plant. Waste disposal constraints may vary.
Human health	SMALL	Impact is uncertain, but considered SMALL in the absence of more quantitative data.
Socioeconomics	SMALL to LARGE	Construction impact would depend on location, but could be LARGE if the plant is located in a rural area. Up to 961 workers during the peak period of the 4-year construction period. Operation would result in a workforce of 155 full-time employees, which is a net loss of approximately 523 jobs, if the site is located in Windham County. Windham County's tax base would experience a loss and an additional reduction in employment if the alternate site is not located within the county. Employment impacts could be offset by other economic growth in the area.
Transportation	MODERATE to LARGE	Transportation impact associated with up to 961 construction workers would be MODERATE. Impact associated with 155 plant workers during operation would be SMALL. For rail transportation of coal and lime, the impact is considered SMALL to LARGE, depending on location. Barge delivery would have SMALL impacts.
Aesthetics	MODERATE to LARGE	Impact would depend on the characteristics of the site, but could be MODERATE. Intermittent noise from construction, commuter traffic, and waste disposal; continuous noise from cooling towers and mechanical equipment; and rail transportation of coal and lime would result in MODERATE noise impacts. The impact could range from MODERATE to LARGE. Additional impact would result from construction and operation of the new transmission line and rail spur. Depending on the location of the site chosen, this impact could be LARGE.
Historic and archaeological resources	SMALL to MODERATE	Impact would depend on the characteristics of the alternate site. A cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new plant construction.
Environmental justice	SMALL to MODERATE	Impact would depend on population distribution and makeup at the site.

The waste produced by the coal-fired plant would be disposed of at an alternate site, and would account for approximately 123.3 ac of land area over the 40-year plant life.

The NRC staff concludes that this alternative would result in MODERATE to LARGE land-use impacts at an alternate site, depending particularly on the location and length of the transmission line and rail spur.

- **Ecology**

Locating a coal-fired plant at an alternate site would result in construction and operational impacts. Approximately 1054 ac of land would be converted to industrial use. Even assuming siting at a previously disturbed area, the impacts would affect ecological resources. Impacts could include impacts on threatened and endangered species, 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 cause entrainment and impingement of fish and other aquatic organisms, and result in adverse impacts on aquatic resources. If needed, construction and maintenance of a transmission line and a rail spur also would have ecological impacts. There would be some additional impact on terrestrial ecology from drift from the cooling towers. Overall, the ecological impacts of constructing a coal-fired plant with a closed-cycle cooling system at an alternate site are considered to be MODERATE to LARGE.

- **Water Use and Quality**

Surface Water. At an alternate site, the impact on surface-water use and quality would depend on the volume of water needed for cooling 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 State of Vermont. The impacts would be SMALL to MODERATE and dependent on the receiving body of water.

Groundwater. Groundwater use is possible for a coal-fired plant at an alternate site if surface-water resources are limited. Groundwater withdrawal could require a permit and would likely be limited to supplying potable water. Impacts on groundwater use and quality of a coal-fired plant with a closed-cycle cooling system at an alternate site would be SMALL to MODERATE, depending on the volume of groundwater withdrawn and characteristics of the aquifer.

- **Air Quality**

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

A new coal-fired plant located in Vermont would likely need a Prevention of Significant Deterioration (PSD) permit and an operating permit under the Clean Air Act (CAA). A new coal-fired plant constructed elsewhere in the region would need to comply with applicable provisions of CAA depending on the attainment status of these areas. The plant would need to comply with the new-source performance standards for such plants as set forth in 40 CFR Part 60, Subpart D(a). The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), sulfur dioxide (SO_2) (40 CFR 60.43(a)), and NO_x (40 CFR 60.44(a)).

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. All of Vermont has been classified as attainment or unclassified for criteria pollutants (40 CFR 81.346).

Section 169A of the CAA 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. The EPA issued a new regional haze rule in 1999 (*Federal Register*, Volume 64, page 35714 (64 FR 35714); 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 toward 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)). If a coal-fired plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. Lye Brook Wilderness Area, located about 35 mi northwest of VYNPS, is a Class I area where visibility is an important value (40 CFR 81.431). Air quality in this area could be affected by a coal-fired plant at an alternate site if the site chosen were located upwind of the wildlife refuge.

Anticipated impacts for particular pollutants that would result from a coal-fired plant at an alternate site are as follows:

<u>Sulfur oxides</u>. A new coal-fired power plant would be subject to the requirements in Title IV of the CAA. Title IV was enacted to reduce SO_2 and NO_x emissions, 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. The 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. Regardless, SO_2 emissions would be greater for the coal-fired plant alternative than the proposed action.

Entergy estimates that by using wet limestone flue gas desulfurization to minimize SO_x emissions (95 percent removal), the total annual stack emissions would be approximately 1238 tons of SO_x (Entergy 2006).

Nitrogen oxides. 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 at 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (63 FR 49453 (EPA 1998)), limits the discharge of any gases that contain NO_x (expressed as nitrogen dioxide (NO_2)) in excess of 200 ng/J (1.6 lb/MWh) of gross energy output, based on a 30-day rolling average.

Entergy estimates that by using NO_x burners with overfire air and selective catalytic reduction (SCR) (95 percent reduction), the total annual NO_x emissions for a new coal-fired power plant would be approximately 472 tons (Entergy 2006). This level of NO_x emissions would be greater than under the proposed action.

Particulate matter. Entergy estimates that the total annual stack emissions would include 77 tons of filterable total suspended particulates and 18 tons of particulate matter (PM_{10}) (40 CFR 50.6). Entergy assumes a design that minimizes air emissions through a combination of boiler technology and post-combustion pollutant removal would be used for control (Entergy 2006). Particulate emissions would be greater under the coal-fired plant alternative than under the proposed action.

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

Carbon monoxide. Entergy estimates that the total CO emissions would be approximately 472 tons/yr (Entergy 2006). This level of emissions is greater than that under the proposed action.

Hazardous air pollutants, including mercury. In December 2000, the EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (EPA 2000a). The EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants. The EPA found that coal-fired power plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000a). The EPA concluded that mercury is the hazardous air pollutant of greatest concern. The EPA found that (1) there is a link between the burning of coal 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 2000a). Accordingly, on March 15, 2005, the EPA issued the Clean Air Mercury Rule to permanently cap and reduce mercury emissions from coal-fired power plants (EPA 2005).

Uranium and thorium. Coal contains uranium and thorium. Uranium concentrations are generally in the range of 1 to 10 ppm. Thorium concentrations are generally about 2.5 times greater than uranium concentrations (Gabbard 1993). One estimate is that in 1982, a typical coal-fired plant released about 5.2 tons of uranium and 12.8 tons of thorium (Gabbard 1993). However, based on information released by the USGS, most of the uranium, thorium, and the majority of their decay products released by a coal plant are retained in solid combustion waste. Modern power plants can recover more than 99.5 percent of these wastes (USGS 1997).

Carbon dioxide. A coal-fired plant would also have unregulated carbon dioxide (CO_2) emissions. The level of emissions from a coal-fired plant would be greater than that under the proposed action.

Summary. The GEIS analysis did not quantify operating emissions from coal-fired power plants but implied that air impacts could be substantial. The GEIS also mentioned global warming from unregulated CO_2 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. However, based on the above air quality analysis, NRC staff determined that operational impacts to air quality from a coal-fired power plant would be MODERATE.

Any construction phase impacts on air quality that might occur would be temporary. Construction activities would be expected to be conducted in accordance with applicable air quality requirements, and dust and emissions would likely be minimized through dust control measures. As such, the NRC staff believes that construction-phase impacts to air quality would remain SMALL.

Siting a coal-fired power plant at an alternate site within the same air jurisdiction could result in installing more stringent pollution control equipment to meet applicable local requirements. Therefore, the NRC staff concludes that the overall impact on air quality would be MODERATE.

- **Waste**

Waste would be generated during construction activities. During operations, coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash and scrubber sludge.[a] One 620-MW(e) coal-fired plant would generate approximately 222,227 tons of this waste annually for 40 years (Entergy 2006). The ash and scrubber sludge would be disposed of onsite, accounting for approximately 123.3 ac of land area over the 40-year plant life. Waste impacts on 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; however, with appropriate management and monitoring, the impact is expected to be SMALL to MODERATE. After closure of the waste site and revegetation, the land could be available for other uses.

In May 2000, the EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (EPA 2000b). The EPA concluded that some form of national regulation is warranted to address coal combustion waste products because (1) the composition of these wastes could be dangerous to human health and the environment under certain conditions; (2) the 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) the EPA identified gaps in State oversight of coal combustion wastes. Accordingly, the EPA announced its intention to issue regulations for disposal of coal combustion waste under Subtitle D of the Resource Conservation and Recovery Act.

For all of the preceding reasons, the impact from waste generated from burning coal at an alternate site is considered MODERATE.

Human Health

Worker risks associated with coal-fired plants result from fuel and limestone mining, from fuel and lime transportation, and from disposal of coal combustion waste. In addition, there

(a) Radionuclides (e.g., uranium and thorium) present in coal fly ash exist at levels equivalent to those in naturally occurring granitic, phosphate, and shale rocks (USGS 1997).

are public risks from inhalation of stack emissions. Emission impacts can be widespread and health risks difficult to quantify. The coal-fired plant alternative also introduces the risk of coal-pile fires and attendant inhalation risks.

In the GEIS, the NRC staff stated that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates, but it did 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 the EPA and State agencies, establish 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, the 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, the NRC staff expects that the human health impact from radiological doses and inhalation of toxins and particulates generated by burning coal would be SMALL at an alternate site.

- **Socioeconomics**

Construction of a coal-fired plant and associated facilities would take approximately 4 years. The NRC staff assumed that construction would take place while VYNPS continues operation and would be completed by the time VYNPS permanently ceases operations. Estimates presented in the GEIS indicate that the workforce would be 961 workers during the construction period for a 620-MW(e) coal-fired plant (NRC 1996). After construction, the local communities would be impacted by the loss of the construction jobs, although this loss would be possibly offset by other growth currently being projected for the area. Impacts on socioeconomics of operation of a coal-fired plant would be SMALL.

Construction of a replacement coal-fired power plant at an alternate site would impact the communities around VYNPS as they would experience the impact of the loss of jobs at VYNPS. The communities around the new site would have to absorb the impacts of a temporary workforce (approximately 961 workers at the peak of construction) and a permanent workforce of approximately 155 workers. In the GEIS, the NRC staff stated that socioeconomic impacts at a rural site would be larger than at an urban site, because more of the peak construction workforce would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis, and socioeconomic impacts could range from SMALL to LARGE.

- **Transportation**

Transportation-related impacts associated with a coal-fired plant at an alternate site would be dependent on the site location. The impacts on transportation associated with 961 commuting construction workers would likely be MODERATE. Transportation impacts related to the commuting of an estimated 155 workers during operations would likely be SMALL.

At an alternate site, coal and lime would probably be delivered by rail. At an alternate site, impacts associated with rail transportation would depend on the site location and distance to the existing rail line. Impacts associated with rail transportation at an alternate site could range from SMALL to LARGE.

- **Aesthetics**

The coal-fired plant could be as much as 200 ft tall with cooling towers, stack, and coal piles visible in daylight hours. The exhaust stack could be as much as 650 ft high. The plant and associated stack would also be visible at night because of outside lighting. Visual impacts of a new coal-fired plant could be mitigated by landscaping and color selection for buildings that is consistent with the environment. Visual impact at night could be mitigated by reduced use of lighting, provided that the lighting meets Federal Aviation Administration (FAA) requirements (FAA 2000), and appropriate use of shielding. There could be a significant impact if construction of a new transmission line and/or rail spur is needed. A coal-fired plant at an alternate site would likely have a MODERATE to LARGE aesthetic impact, depending on the site location chosen.

A coal-fired plant 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, such as cooling towers. Intermittent sources include the equipment related to coal handling, solid waste disposal, transportation related to coal and lime delivery, use of outside loudspeakers, and the commuting of plant employees. These impacts are considered to be MODERATE.

Noise impacts associated with rail delivery of coal and lime to a plant at an alternate site 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. Nevertheless, given the frequency of train transport and the many residents likely to be within hearing distance of the rail route, the impact of noise on residents in the vicinity of the facility and the rail line is considered MODERATE.

The aesthetic impact associated with the construction and operation of a new transmission line and rail spur at an alternate site could be LARGE, depending on the location of the site chosen. Overall, the NRC staff concludes that the aesthetic impact associated with locating a coal-fired plant at an alternate site could be MODERATE to LARGE.

- **Historic and Archaeological Resources**

Before construction or any ground disturbance at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on historic and archaeological 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 corridors, rail lines, or other rights-of-way). Other lands, if any, that are acquired to support the plant would also likely need an inventory of cultural resources to identify and evaluate existing historic and archaeological resources and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Historic and archaeological resources must be evaluated on a site-specific basis. The impacts can generally be effectively managed under current laws and regulations, and as such, the categorization of impacts at an alternate site could range from SMALL to MODERATE, depending on what resources are present and whether mitigation is necessary.

- **Environmental Justice**

Environmental justice impacts would depend on the site chosen and the nearby population distribution. Construction activities would offer new employment possibilities. This could affect housing availability and prices during construction, which could disproportionately affect minority and low-income populations. Closure of VYNPS would result in a decrease in employment of approximately 678 operating employees, possibly offset by general growth in the area. Following construction, it is possible that the ability of local government to maintain social services could be reduced at the same time as diminished economic conditions reduce employment prospects for minority or low-income populations. Overall, the impact is expected to be SMALL. Projected economic growth in the area and the ability of minority and low-income populations to commute to other jobs outside the area could mitigate any adverse effects.

The environmental justice impact at an alternate site would depend on the site chosen and the nearby population distribution, and could range from SMALL to MODERATE.

8.2.1.2 Coal-Fired Plant with a Once-Through Cooling System

This section discusses the environmental impacts of constructing a coal-fired generation system at an alternate site using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are the same as the impacts for a coal-fired plant using the closed-cycle system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8.3 summarizes these differences. The design and operation of the intake would need to comply with performance standards of the EPA's 316(b) regulations to minimize adverse impacts associated with water withdrawal, and heated discharges would need to comply with 316(a) regulations.

Table 8-3. Summary of Environmental Impacts of Coal-Fired Plant Generation at an Alternate Site with Once-Through Cooling System

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land use	Impacts may be less (e.g., through elimination of cooling towers) or greater (e.g., if a reservoir is required).
Ecology	Impact would depend on ecology at the site. Possible impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock. No impact on terrestrial ecology from cooling tower drift.
Water use and quality-surface water	Increased water withdrawal leading to possible water-use conflicts; thermal load higher on receiving body of water than with closed-cycle cooling; no discharge of cooling tower blowdown.
Water use and quality-groundwater	No change. Use of groundwater would likely be restricted to potable water only.
Air quality	No change
Waste	No change
Human health	No change
Socioeconomics	No change
Transportation	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and archaeological resources	No change
Environmental justice	No change

8.2.2 Natural-Gas-Fired Plant Generation

The environmental impacts of the natural-gas-fired plant alternative are examined in this section for both the VYNPS site and an alternate site. The NRC staff assumed that the plant would use a closed-cycle cooling system (Section 8.2.2.1). In Section 8.2.2.2, the NRC staff also evaluated the impacts of once-through cooling.

The existing switchyard, offices, and transmission line would be used for the gas-fired alternative at the VYNPS site. For purposes of analysis, Entergy estimates that approximately 40 mi of buried gas supply pipeline would need to be constructed to connect to the existing pipeline near Renfrew, Massachusetts (Tennessee Pipeline) (Entergy 2006).

If a new natural-gas-fired plant were built at an alternate site in Vermont to replace VYNPS, construction of a new natural gas supply pipeline and a new transmission line could be needed.

In the GEIS, the NRC staff estimated disturbance of up to 2500 ac for construction of a 60-mi transmission line to an alternate site (NRC 1996).

The NRC staff assumed that a replacement natural-gas-fired plant would use combined-cycle technology. 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.

Entergy assumed a 608 MW(e) combined-cycle plant, as the gas-fired plant alternative at VYNPS (Entergy 2006). This capacity is approximately equivalent to the VYNPS total net capacity of 650 MW(e). Entergy estimates that the plant would consume approximately 26.9 billion ft^3 of gas annually at a heat rate of 6204 Btu per kW/hr (Entergy 2006).

Unless otherwise indicated, the assumptions and numerical values used are from the Entergy ER (Entergy 2006). The NRC staff reviewed this information and compared it with environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating a natural-gas-fired plant for 40 years is considered (as a reasonable projection of the operating life of a natural-gas-fired plant).

8.2.2.1 Natural-Gas-Fired Plant with a Closed-Cycle Cooling System

The overall impacts of a natural-gas-fired plant with a closed-cycle cooling system are discussed in the following sections and summarized in Table 8-4. The extent of impacts at an alternate site would depend on the characteristics of the selected location of the plant site.

Table 8-4. Summary of Environmental Impacts of a Natural-Gas-Fired Plant Using Closed-Cycle Cooling at the VYNPS Site and at an Alternate Site

Impact Category	VYNPS Site		Alternate Site	
	Impact	Comments	Impact	Comments
Land use	SMALL to MODERATE	Impact would depend on the degree to which previously disturbed lands were utilized. Uses approximately 67 ac for plant site. Additional impact of up to approximately 364 ac for construction of 40 mi of underground gas pipeline. Additional land needed for cooling towers.	MODERATE to LARGE	Impact would depend on the characteristics of the alternate site. Uses approximately 110 ac for power block, cooling towers, offices, roads, and parking areas. Additional land would be needed for a new transmission line (amount dependent on site chosen) and for construction and/or upgrade of a gas pipeline.
Ecology	MODERATE to LARGE	Impact would depend on the characteristics of the land to be developed. Using developed areas at the current VYNPS site would reduce impacts on ecology. Impacts could occur with construction of a gas pipeline. Impact on terrestrial ecology from cooling-tower drift. Impact on aquatic ecology would be reduced from current levels because surface-water intake and thermal discharge would be reduced.	MODERATE to LARGE	Impact would depend on the characteristics of the land to be developed; the surface-water body used for intake and discharge, and transmission and pipeline routes. Impact on terrestrial ecology from cooling-tower drift. Some impingement and entrainment of aquatic organisms.
Water use and quality – surface water	SMALL	Impact on surface water would be reduced from current level. Cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides, as well as wastewater, would be released. Temporary erosion and sedimentation could occur in any streams crossed during pipeline construction.	SMALL to MODERATE	Impact would depend on volume of water withdrawn and discharged and characteristics of surface-water body. Cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides, as well as wastewater, would be released. Temporary erosion and sedimentation could occur in streams crossed during pipeline construction.

Table 8-4. (contd)

Impact Category	VYNPS Site		Alternate Site	
	Impact	Comments	Impact	Comments
Water use and quality – groundwater	SMALL	Impact would be similar to current VYNPS operations if groundwater continues to be used for potable water.	SMALL to MODERATE	Impact would depend on the location of the site, the volume of water withdrawn and discharged, and characteristics of the aquifer.
Air quality	MODERATE	Impact from fugitive dust and emissions from vehicles and equipment during construction would be SMALL. Impact of operations on air quality during operations would be MODERATE with the following emissions expected: Sulfur oxides • 47.7 tons/yr Nitrogen oxides • 153.1 tons/yr Carbon monoxide • 32.2 tons/yr PM_{10} particulates • 26.7 tons/yr Some hazardous air pollutants.	MODERATE	Same emissions as a natural-gas-fired plant at the VYNPS site, although pollution-control standards may vary depending on location. Impacts during construction would be SMALL. Impacts during operation would be MODERATE.
Waste	SMALL	Waste would be generated and removed during construction. Minimal waste from fuel consumption during operation.	SMALL	Same impact as a natural-gas-fired plant at the VYNPS site. Waste disposal constraints may vary.
Human health	SMALL	Human health risks associated with gas-fired plants may result from NO_x emissions, which are regulated. Impacts are expected to be SMALL.	SMALL	Same impact as a natural-gas-fired plant at the VYNPS site.

Table 8-4. (contd)

Impact Category	VYNPS Site		Alternate Site	
	Impact	**Comments**	**Impact**	**Comments**
Socioeconomics	MODERATE	During construction, impact would be MODERATE. Fewer than 730 additional workers during the peak of the 3-year construction period, followed by a reduction of the current VYNPS workforce from 678 to 92. Windham County would experience a reduced demand for goods and services as well as a loss in its tax base and employment, but this would be potentially offset by projected economic growth in the area. Impact during operation would be SMALL.	MODERATE	Construction impact would depend on location, but could be MODERATE if the location is in a rural area. Up to 730 additional workers during the peak of the 3-year construction period. Windham County would experience a loss in its tax base and employment if the plant is built outside of the county, but this would be potentially offset by projected economic growth in the area. Impact during operation would be SMALL.
Transportation	MODERATE	Transportation impact associated with construction workers would be MODERATE, as 678 VYNPS workers and fewer than 730 construction workers would be commuting to the site. Impact during operation would be SMALL as the number of commuters would be reduced to 92.	MODERATE	Transportation impact associated with 730 construction workers would be MODERATE. Impact during operation would be SMALL as the number of commuters would be reduced to 92.
Aesthetics	MODERATE	MODERATE aesthetic impact due to visibility of plant units, exhaust stacks, cooling towers and plumes, and gas compressors. Intermittent noise from construction and continuous noise from cooling towers and mechanical equipment would result in MODERATE impact.	MODERATE to LARGE	Impact would depend on the characteristics of the site, but would be similar to those for a natural-gas-fired plant at the VYNPS site with additional impact from the new transmission line and gas pipeline. The impact could range from MODERATE to LARGE.

Table 8-4. (contd)

Impact Category	VYNPS Site Impact	VYNPS Site Comments	Alternate Site Impact	Alternate Site Comments
Historic and archaeological resources	SMALL to MODERATE	Impact would depend on the degree to which previously disturbed lands were utilized. A cultural resource inventory would be needed to identify, evaluate, and mitigate the potential impact of new plant construction.	SMALL to MODERATE	Impact would depend on the characteristics of the alternate site. A cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new plant construction.
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; the loss of 586 operating jobs at VYNPS could reduce employment prospects for minority and low-income populations. Impact could be offset by projected economic growth and the ability of affected workers to commute to other jobs.	SMALL to MODERATE	Impact would depend on population distribution and makeup at site.

- **Land Use**

For siting a natural-gas-fired plant at VYNPS, existing facilities and infrastructure would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the NRC staff assumed that a natural-gas-fired plant would use the existing switchyard, offices, and transmission line. Much of the land that would be used has been previously disturbed. At VYNPS, the NRC staff assumed that approximately 67 ac would be needed for the plant and associated infrastructure. (However, additional land would also be needed for construction of cooling towers for a closed-cycle cooling system.) There would be an additional impact of up to approximately 364 ac for construction of a 40-mi gas pipeline, assuming a 75-ft-wide right of way. Approximately 90 ac of already developed land at the VYNPS site is available (Entergy 2006).

For construction at an alternate site, the NRC staff assumed in the GEIS that 110 ac would be needed for a 1000-MW(e) plant and associated infrastructure (NRC 1996). This estimate would be scaled down for the 608-MW(e) capacity of the gas-fired plant alternative considered here (i.e., 67 ac). The additional amount of land impacted by the construction of a new transmission line and a gas pipeline is dependent on the site location chosen. The NRC staff assumed in the GEIS that approximately 2500 ac would be impacted for construction of a 60-mi transmission line (NRC 1996).

Regardless of where a gas-fired plant is built, additional land (approximately 2190 ac) would be required for natural gas wells and collection stations (NRC 1996). Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for VYNPS. In the GEIS (NRC 1996), the NRC staff estimated that approximately 1000 ac would be affected by the mining and processing of uranium during the operating life of a 1000-MW(e) nuclear power plant.

Overall, the NRC staff concludes that land-use impact for a gas-fired plant at the VYNPS site would be SMALL to MODERATE given the availability of previously developed and disturbed land that could be used for the plant site, the use of existing transmission systems, and the proximity of an existing gas pipeline. Impacts on land use at an alternate site could be greater, depending on the site chosen and the land requirements for a new transmission line and new gas pipeline, and are characterized as MODERATE to LARGE.

- **Ecology**

At the VYNPS, there would be ecological impacts related to possible habitat loss and to cooling tower drift associated with siting of the gas-fired plant. There would also be ecological impacts associated with bringing a new underground gas pipeline to the VYNPS. Impacts due to habitat loss could be reduced through the use of previously impacted land. 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 gas pipeline and/or transmission line. Construction of the transmission line and construction and/or upgrading of the gas pipeline to serve the plant would be expected to have temporary ecological impacts. Ecological impacts on the plant site and utility easements could include impacts on threatened or endangered species, wildlife habitat loss and reduced productivity, habitat fragmentation, and a local reduction in biological diversity. The cooling makeup water intake and discharge could have aquatic resource impacts. Overall, the ecological impacts are considered MODERATE to LARGE at either location.

- **Water Use and Quality**

<u>Surface Water</u>. Each of the natural-gas-fired units would include a heat-recovery boiler, using a portion of the waste heat from the combustion turbines to generate additional electricity. The net result would be an overall reduction in the amount of waste heat rejected from the plant, with an associated reduction in the amount of cooling water required by the plant. Thus, the cooling water requirements for the natural-gas-fired combined-cycle units would be much less than those for conventional steam-electric generators, including the

existing nuclear unit. Plant discharge would consist mostly of cooling-tower blowdown, with the discharge having a higher temperature and increased concentration of dissolved solids, relative to the receiving body of water, and intermittent low concentrations of biocides (e.g., chlorine). In addition to the cooling-tower blowdown, treated process waste streams and sanitary wastewater might also be discharged. All discharges would be regulated by the Vermont Department of Environmental Conservation (VDEC). There would be consumptive use of water due to evaporation from the cooling towers. Overall, the surface-water impacts of operation under the natural-gas-fired plant alternative at the VYNPS site are considered SMALL.

A natural-gas-fired plant at an alternate site is assumed to use surface water for cooling makeup water and discharge. Intake and discharge would involve relatively small quantities of water compared with either the coal-fired plant alternative or the proposed action. The impact on 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. Discharges would be the same as those described above for a gas-fired plant at the VYNPS site. Intake from and discharge to any surface body of water would be regulated by the VDEC. The impact would be SMALL to MODERATE.

Water-quality impacts from sedimentation during construction were characterized in the GEIS as SMALL (NRC 1996). The NRC staff also noted in the GEIS that operational water-quality impacts would be similar to, or less than, those from other generating technologies.

<u>Groundwater</u>. Any groundwater withdrawal would require a permit from the local permitting authority. VYNPS currently uses groundwater for potable water, and this practice would likely continue under the gas-fired plant alternative. Impacts on groundwater use and quality would be considered SMALL. Impacts on groundwater at an alternate site would depend on the volume of water needed and characteristics of the groundwater source. Groundwater withdrawal could require a permit and would likely be limited to potable water. The NRC staff concludes that impacts at an alternate site would be SMALL to MODERATE, depending on site-specific conditions.

- **Air Quality**

Natural gas is a relatively clean-burning fuel. The gas-fired plant alternative would release similar types of emissions, but in lesser quantities than the coal-fired plant alternative.

A new gas-fired plant located in Vermont would likely need a PSD permit and an operating permit under the CAA. A new combined-cycle natural gas power plant would also be subject to the new-source performance standards for such units at 40 CFR Part 60, Subparts D(a) and GG. These regulations establish emission limits for particulates, opacity, SO_2, and NO_x.

The 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 attainment or unclassified under the CAA. All of Vermont has been classified as attainment or is unclassified for criteria pollutants (40 CFR 81.346).

Section 169A of the CAA 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. The EPA issued a new regional haze rule in 1999 (64 FR 35714; 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 toward 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)). If a natural-gas-fired plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. Lye Brook Wilderness Area, located about 35 mi northwest of VYNPS, is a Class I area where visibility is an important value (40 CFR 81.431). Air quality in this area could be affected by a gas-fired plant at the VYNPS site or at an alternate site if the site chosen were located upwind of the wildlife refuge.

Entergy projects the following emissions for the natural-gas-fired plant alternative (Entergy 2006):

- Sulfur oxides – 47.7 tons/yr
- Nitrogen oxides – 153.1 tons/yr
- Carbon monoxide – 32.2 tons/yr
- PM_{10} particulates – 26.7 tons/yr

A natural-gas-fired plant would also have unregulated CO_2 emissions but at lower levels than the coal-fired alternative.

In December 2000, the EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (EPA 2000a). The EPA found that natural-gas-fired power plants emit arsenic, formaldehyde, and nickel. Unlike coal- and oil-fired plants, the 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 (EPA 2000a).

Construction activities would result in temporary fugitive dust. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process.

Any impacts on air quality that might occur would be temporary. Construction activities are expected to be conducted in accordance with applicable air quality requirements, and dust and emissions would likely be minimized by using standard emission control measures.

Air emissions would likely be the same at VYNPS or at an alternate site. The overall air quality impact for a new natural-gas-fired plant sited at VYNPS or at an alternate site is considered MODERATE.

- **Waste**

There would be spent selective catalytic reduction (SCR) catalyst from NO_x emissions control and small amounts of solid waste products (i.e., ash) from burning natural gas fuel. In the GEIS, the NRC staff concluded that waste generation from gas-fired technology would be minimal (NRC 1996). Natural gas combustion results in very few by-products because of the clean nature of the fuel. 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 associated with the natural-gas-fired plant alternative would be SMALL for a plant sited at VYNPS or at an alternate site.

- **Human Health**

In Table 8-2 of the GEIS, the NRC staff identified cancer and emphysema as potential health risks from gas-fired plants (NRC 1996). The risks may be attributable to NO_x emissions that contribute to ozone formation, which in turn contributes to health risks. Nitrogen oxide emissions from any gas-fired plant would be regulated. For a plant sited in Vermont, NO_x emissions would be regulated by the VDEC. Overall, the impact on human health of the natural-gas-fired plant alternative sited at VYNPS or at an alternate site is considered SMALL.

- **Socioeconomics**

Construction of a natural-gas-fired plant would take approximately 3 years. Peak employment would be less than approximately 730 workers. The NRC staff assumed that construction would take place while VYNPS continues operation and would be completed by the time it permanently ceases operations. During construction, the communities surrounding the VYNPS site would experience demands on housing and public services that could have MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from other parts of Windham County or from other nearby counties. After construction, the communities would be impacted by the loss of jobs. The current VYNPS workforce (approximately 678 workers) would decline through a decommissioning period to a minimal maintenance size. The gas-fired plant would introduce a replacement tax base at VYNPS or at an alternate site and approximately 92 new permanent jobs. This would represent a net loss of 586 jobs at the VYNPS site.

In the GEIS (NRC 1996), the NRC staff concluded that socioeconomic impacts from constructing a natural-gas-fired plant would not be very noticeable and that the small operational workforce would have the lowest socioeconomic impacts of any nonrenewable technology. Compared with the coal-fired and nuclear plant alternatives, the smaller size of the construction workforce, the shorter construction time frame, and the smaller size of the operations workforce would mitigate socioeconomic impacts. The loss of 586 permanent jobs (up to 678 jobs if an alternate site is not located in Windham County) may be partially tempered by the projected economic growth of the area. For these reasons, socioeconomic impacts associated with construction and operation of a natural-gas-fired power plant would be MODERATE and SMALL, respectively, for siting at VYNPS or at an alternate site.

- **Transportation**

Transportation impacts associated with construction and operating personnel commuting to a natural-gas-fired plant would depend on the population density and transportation infrastructure in the vicinity of the site. The impacts can be classified as MODERATE for construction and SMALL for operation at VYNPS or at an alternate site.

- **Aesthetics**

For a natural-gas-fired plant, the turbine buildings (approximately 100 ft tall) and exhaust stacks (approximately 125 ft tall), and cooling towers and plumes would be visible during daylight hours from offsite. The gas pipeline compressors also would be visible. Noise and light from the plant would be detectable offsite. Intermittent noise from construction and continuous noise from cooling towers and mechanical equipment would result in MODERATE impact. Overall, the aesthetic impacts associated with construction and operation of a natural-gas-fired plant at the VYNPS site are categorized as MODERATE.

At an alternate site, the buildings, cooling towers, cooling-tower plumes, and the associated transmission line and gas pipeline compressors would be visible offsite. There would also be a visual impact from a new transmission line. Aesthetic impacts would be mitigated if the plant were located in an industrial area adjacent to other power plants. Noise impacts would be similar to those described for the VYNPS site. Overall, the aesthetic impacts associated with an alternate site are categorized as MODERATE to LARGE and would depend on the characteristics of the area to be developed. Depending on the site chosen, the greatest contributor to aesthetic impact would be the new transmission line.

- **Historic and Archaeological Resources**

  Before construction or any ground disturbance at VYNPS 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 historic and archaeological 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 and pipeline corridors, or other rights-of-way). Other lands, if any, that are acquired to support the plant would also likely need an inventory of cultural resources to identify and evaluate existing historic and archaeological resources and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

  Historic and archaeological resources must be evaluated on a site-specific basis. The impacts can generally be effectively managed under current laws and regulations, and as such, the categorization of impacts ranges from SMALL to MODERATE, depending on what resources are present and whether mitigation is necessary.

- **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 new natural-gas-fired plant were built at the VYNPS site. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect minority and low-income populations. Closure of VYNPS would result in a decrease in employment of approximately 678 operating employees, partially offset by the 92 workers required for operation of the new plant, and possibly by general growth in the area. Following construction, it is possible that the ability of local government to maintain social services could be reduced at the same time as diminished economic conditions reduce employment prospects for minority or low-income populations. Overall, environmental justice impacts are expected to be SMALL. Projected economic growth in the area and the ability of minority and low-income populations to commute to other jobs outside the area could mitigate any adverse effects.

  Environmental justice impacts at an alternate site would depend upon the site chosen and the nearby population distribution; therefore, impacts could range from SMALL to MODERATE.

8.2.2.2 Natural-Gas-Fired Plant with a Once-Through Cooling System

This section discusses the environmental impacts of constructing a natural gas-fired generation system at an alternate site using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are the same as the impacts for a natural-gas-fired plant using the closed-cycle system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-5 summarizes the incremental differences. The design and operation of the intake would need to comply with performance standards of the EPA's 316(b) regulations to minimize adverse impacts associated with water withdrawal, and heated discharges would need to comply with 316(a) regulations.

Table 8-5. Summary of Environmental Impacts of Natural Gas-Fired Generation at an Alternate Site with Once-Through Cooling

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land use	Impacts may be less (e.g., through elimination of cooling towers) or greater (e.g., if a reservoir is required).
Ecology	Impact would depend on the ecology at the site. Potential impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock. No impact on terrestrial ecology from cooling tower drift.
Water use and quality – surface water	Increased water withdrawal leading to possible water-use conflicts, thermal load higher on receiving body of water than with closed-cycle cooling; no discharge of cooling tower blowdown.
Water use and quality – groundwater	No change. Use of groundwater would likely be restricted to potable water only.
Air quality	No change
Waste	No change
Human health	No change
Socioeconomics	No change
Transportation	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and archaeological resources	No change
Environmental justice	No change

8.2.3 Nuclear Power Plant Generation

Since 1997, the NRC has certified four new standard designs for nuclear power plants under 10 CFR Part 52, Subpart B. These designs are the 1300-MW(e) U.S. Advanced Boiling Water Reactor (10 CFR Part 52, Appendix A), the 1300-MW(e) System 80+ Design (10 CFR Part 52, Appendix B), the 600-MW(e) AP600 Design (10 CFR Part 52, Appendix C), and the 1117- to 1154-MW(e) AP1000 design (10 CFR Part 52, Appendix D). All 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 the 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 more attractive from a cost standpoint. In addition, System Energy Resources, Inc.; Exelon Generation Company, LLC; Dominion Nuclear North Anna, LLC; and Southern Nuclear Operating Company have recently submitted applications for early site permits for new advanced nuclear power plants under the procedures in 10 CFR Part 52, Subpart A (SERI 2003; Exelon 2003; Dominion 2003; SNOC 2006). Consequently, construction of a new nuclear power plant at the an alternate site is considered in this section. The NRC 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 an alternate site. In the GEIS, the NRC estimated that for a 1000-MW(e) reactor, 500 to 1000 ac would be required for construction (NRC 1996). The impacts shown in Table S-3 were adjusted to reflect the replacement of 650 MW(e) generated by VYNPS. 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 the 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 new nuclear power plant. Additional environmental impact information for a new nuclear power plant using closed-cycle cooling is presented in Section 8.2.3.1, and using once-through cooling is presented in Section 8.2.3.2.

8.2.3.1 New Nuclear Plant with a Closed-Cycle Cooling System

The overall impacts of a new nuclear plant are discussed in the following sections and are summarized in Table 8-6. The extent of impacts at an alternate site would depend on the location of the site that is selected.

In addition to the impacts discussed below, impacts would occur offsite as a result of uranium mining. Impacts of mining would include an increase in fugitive dust emissions, surface-water runoff, erosion, sedimentation, changes in water quality, disturbance of vegetation and wildlife, disturbance of historic and archaeological resources, changes in land use, and impacts on employment.

The magnitude of these offsite impacts would be largely proportional to the amount of land affected by mining. However, there would be no net change in land needed for uranium mining because land needed for the new nuclear plant would offset land needed to supply uranium for fuel at VYNPS.

Table 8-6. Summary of Environmental Impacts of a New Nuclear Power Plant Using Closed-Cycle Cooling at an Alternate Site

Impact Category	Impact	Comments
Land use	MODERATE to LARGE	Impact would depend on the characteristics of the alternate site. Impact would depend on the degree to which previously disturbed lands were utilized. Requires approximately 325 to 650 ac for the plant. Additional offsite land use impacts from uranium mining plus additional land for a transmission line.
Ecology	MODERATE to LARGE	Impact would depend on the characteristics of the land to be developed, surface-water body used for intake and discharge, and transmission line route. Impact on terrestrial ecology from cooling-tower drift. Some impingement and entrainment of aquatic organisms.
Water use and quality – surface water	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged and the characteristics of the surface-water body. Cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides, as well as wastewater, would be released.
Water use and quality – groundwater	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged and the characteristics of the aquifer.
Air quality	SMALL	Impact from fugitive dust and emissions from vehicles and equipment during construction would be SMALL. Emissions from diesel generators and possibly other sources during operation would be similar to current VYNPS operation, and their impact on air quality would be SMALL.
Waste	SMALL	Waste would be generated and removed during construction. Waste impacts for an operating nuclear power plant are presented in 10 CFR Part 51, Appendix B, Table B-1.
Human health	SMALL	Human health impacts for an operating nuclear power plant are presented in 10 CFR Part 51, Appendix B, Table B-1.
Socioeconomics	MODERATE to LARGE	Construction impact would depend on location, but could be LARGE at a rural location. Windham County would experience a loss in its tax base and employment if the chosen site is located outside of the county, but possibly offset by economic growth in the area.
Transportation	MODERATE to LARGE	Impact would depend on the location of the site. Transportation impacts of up to 2500 construction workers could be MODERATE to LARGE. Transportation impacts of 678 commuting personnel could be SMALL to MODERATE.

Table 8-6. (contd)

Impact Category	Impact	Comments
Aesthetics	MODERATE to LARGE	Impact would depend on the characteristics of the site. Aesthetic impact due to the addition of cooling towers and other structures including the visual impacts of a new transmission line would be MODERATE to LARGE. Intermittent noise from construction and commuter traffic and continuous noise from cooling towers and mechanical equipment could result in impacts ranging from SMALL to MODERATE depending on the location of the site.
Historic and archaeological resources	SMALL to MODERATE	Impact would depend on the characteristics of the alternative site. A cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new construction.
Environmental justice	SMALL to LARGE	Impacts would vary, depending on population distribution and makeup at the site.

- **Land Use**

  Land-use impacts at an alternate site would alter approximately 325 to 650 ac of land (NRC 1996) except for the land needed for a transmission line to connect to the grid. The amount of land needed for the transmission line would depend upon the location of the alternate site. 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, siting a new nuclear plant at an alternate site would result in MODERATE to LARGE land-use impacts.

- **Ecology**

  At an alternate site, there would be construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts would affect ecological resources. Impacts could include impacts on threatened and endangered species, 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. Impacts on terrestrial ecology could result from cooling-tower drift. Construction and maintenance of a transmission line, if needed, would have ecological impacts. Overall, the ecological impacts at an alternate site would be MODERATE to LARGE and would depend on the ecological conditions at the site and the amount of land to be developed.

- **Water Use and Quality**

  Surface Water. 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 VDEC. The impacts would be SMALL to MODERATE, and their magnitude would depend on the characteristics of the surface-water body used as the source of cooling water.

  Groundwater. The NRC staff assumed that a new nuclear power plant located at an alternate site would use groundwater for reactor makeup water and potable water. Use of groundwater for a nuclear power plant sited at an alternate site would require a permit from the local permitting authority.

  Overall, impacts from a plant similar to VYNPS at an alternate site are considered to be SMALL to MODERATE, depending on the volume of groundwater used and characteristics of the aquifer.

- **Air Quality**

  Construction of a new nuclear plant sited at an alternate site would result in fugitive dust emissions during the 5-year construction period. Exhaust emissions would also be produced by vehicles and motorized equipment used during the construction process. In the draft SEIS, the NRC staff determined that impacts to air quality during the construction process would be MODERATE. In response to comments on the draft SEIS, NRC staff reevaluated its earlier analysis and now concludes that the construction-stage impacts on air quality from a new nuclear plant would be SMALL for several reasons. Primarily, any impacts to air quality would be temporary. In addition, construction activities are expected to be conducted in accordance with applicable air quality requirements, and dust and emissions would likely be minimized by using standard emission control measures. An operating nuclear plant would have minor air emissions associated with diesel generators and other minor intermittent sources and would have impacts similar to the current impacts associated with operation of VYNPS (i.e., SMALL).

- **Waste**

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

- **Human Health**

  Human health impacts for an operating nuclear power plant are presented 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 an alternate site would not alter human health impacts. Therefore, the impacts would be SMALL.

- **Socioeconomics**

  If a new nuclear power plant were constructed at an alternate site, the communities around the new site would have to absorb the impacts of a large, temporary workforce (up to 2500 workers at the peak of construction) and a permanent workforce of approximately 678 workers. In the GEIS (NRC 1996), the NRC staff indicated that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction workforce would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis, and impacts could range from MODERATE to LARGE, depending on the socioeconomic characteristics of the area around the site.

- **Transportation**

  Transportation-related impacts associated with commuting construction 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, and would depend on the characteristics of the transportation system and population in the vicinity of the site.

- **Aesthetics**

  At an alternate site, there would be an aesthetic impact from the buildings, cooling towers, and the plume associated with the cooling towers. There could also be a significant aesthetic impact associated with construction of a new transmission line. The length of the transmission line would depend upon the location of the plant. Noise and light from the plant would be detectable offsite. The impact of noise and light would be less if the plant were located in an industrial area adjacent to other power plants. Overall, the aesthetic impacts associated with locating a new nuclear plant at an alternate site can be categorized as MODERATE to LARGE. Depending on the location chosen, the greatest contributor to this categorization could be the aesthetic impact of the new transmission line. Intermittent noise from construction and commuting traffic and continuous noise from cooling towers and mechanical equipment could result in impacts ranging from SMALL to MODERATE depending on the location of the site.

- **Historic and Archaeological Resources**

  Before construction or any ground disturbance at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on historic and archaeological 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 and pipeline corridors, or other rights-of-way). Other lands, if any, that are acquired to support the plant would also likely need an inventory of cultural resources to identify and evaluate existing historic and archaeological resources and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

  Historic and archaeological resources must be evaluated on a site-specific basis. The impacts can generally be effectively managed under current laws and regulations, and as such, the categorization of impacts ranges from SMALL to MODERATE at an alternate site, depending on what resources are present and whether mitigation is necessary.

- **Environmental Justice**

  The environmental justice impact at an alternate site would depend upon the site chosen and the nearby population distribution. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect the minority and low-income populations. After completion of construction, it is possible that the ability of the local government to maintain social services could be reduced at the same time as diminished economic conditions reduce employment prospects for the minority and low-income populations. Overall, impacts could range from SMALL to LARGE.

8.2.3.2 New Nuclear Plant with a Once-Through Cooling System

This section discusses the environmental impacts of constructing and operating a new nuclear power plant using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are similar to the impacts for a nuclear power plant using a closed-cycle system. However, there are minor differences between the closed-cycle and once-through cooling systems. Table 8-7 summarizes these differences. The design and operation of the intake would need to comply with performance standards of the EPA's 316(b) regulations to minimize adverse impacts associated with water withdrawal, and heated discharges would need to comply with 316(a) regulations.

8.2.4 Purchased Electrical Power

If available, purchased power from other sources could potentially obviate the need to renew the VYNPS OL. A description of the current energy trading system in Vermont is provided in the

Table 8-7. Summary of Environmental Impacts of a New Nuclear Power Plant Using Once-Through Cooling

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land use	Impact may be less (e.g., through elimination of cooling towers) or greater (e.g., if a reservoir is required).
Ecology	Impact would depend on the ecological conditions in areas to be developed. Possible impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock. No impact on terrestrial ecology from cooling-tower drift.
Water use and quality – surface water	Greater water withdrawal rates leading to possible water-use conflicts, thermal load higher on receiving body of water than with closed-cycle cooling; no discharge of cooling-tower blowdown.
Water use and quality – groundwater	No change
Air quality	No change
Waste	No change
Human health	No change
Socioeconomics	No change
Transportation	No change
Aesthetics	Less aesthetic impact because cooling towers are not used.
Historic and archaeological resources	No change
Environmental justice	No change

Vermont Electric Plan (State of Vermont 2005). It is unlikely, however, that sufficient baseload, firm power supply would be available to replace VYNPS capacity.

Imported power from Canada or Mexico is unlikely to be available for replacement of VYNPS capacity. In Canada, 60 percent of the country's electrical generation capacity is derived from renewable energy sources, principally hydropower (EIA 2004b). Canada plans to expand hydroelectric capacity, including large-scale projects (EIA 2004b). Canada's nuclear generation is projected to increase from 10,000 MW in 2001 to 15,200 MW in 2020 before reaching a forecasted decline to 12,400 MW in 2025 (EIA 2004b). The EIA projected that total gross

U.S. imports of electricity from Canada and Mexico will gradually increase from 38.4 billion kWh in 2001 to 47.2 billion kWh in 2010 and then gradually decrease to 15.2 billion kWh in 2025 (EIA 2004a). Consequently, it is unlikely that electricity imported from Canada or Mexico would be able to replace VYNPS capacity.

If power to replace VYNPS capacity were to be purchased from sources within the United States or a foreign country, the power-generation technology would likely be one of those described in this SEIS and in the GEIS (probably coal, natural gas, nuclear, or hydropower). 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 the VYNPS OL. 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 power-generation technologies considered by the NRC are discussed in the following paragraphs.

8.2.5.1 Oil-Fired Plant Generation

The EIA projects that oil-fired plants will account for very little of the new generation capacity in the United States between 2005 and 2025 because of higher fuel costs and lower efficiencies (EIA 2004a). Electricity produced through oil-fired generation is more expensive than electricity produced from coal-fired generation and is likely to be more expensive than electricity produced by nuclear power. In addition, 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. For these reasons, oil-fired generation is not considered an economically feasible alternative to VYNPS license renewal.

Construction and operation of an oil-fired plant would have environmental impacts. For example, in Section 8.3.11 of the GEIS, the NRC staff estimated that construction of a 1000-MW(e) oil-fired plant would require about 120 ac of land for the facility and additional land for an oil pipeline (NRC 1996). In addition, operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those of a coal-fired plant.

8.2.5.2 Wind Power

Wind power, by itself, is not suitable for large baseload capacity. As discussed in Section 8.3.1 of the GEIS, wind is not constant, and average annual capacity factors for wind plants are relatively low (on the order of 30 percent) (NRC 1996). Wind power, only in conjunction with energy storage mechanisms or other sources of electrical generation, might serve as a means of providing baseload power. However, current energy storage technologies are too expensive for wind power to serve as a large baseload generator by itself.

Southeastern Vermont and surrounding areas of Massachusetts and New Hampshire generally have poor wind power potential. However, crests along the Green Mountains located roughly 25 mi west of VYNPS have excellent wind potential, as do crests in the Massachusetts Berkshire Mountains and New Hampshire White Mountains. The annual wind power estimates for this area range from a rating of Class 1 and some Class 2, increasing to Classes 5 and 6 along the mountain crests (DOE 2006a). Areas designated Class 3 or greater are suitable for most wind energy applications (DOE 2004). Most of this region is below the Class 3 rating. Land-use conflicts, such as urban development, farmland, and environmentally sensitive areas, also minimize the amount of land suitable for wind energy applications (PNNL 1986).

DOE's National Renewable Energy Laboratory (NREL) estimates that the footprint of a 1.5-MW wind turbine is between 0.25 and 0.5 ac. In addition, a spacing interval of 5 to 10 turbine rotor diameters between wind turbines is typically maintained to prevent interferences between turbines (NREL 2006). Five turbine rotor diameters would be suitable for optimal wind conditions, increasing to 10 depending on the amount of wind turbulence and other potential topographic disturbances. Land disturbance during construction to install the turbine is estimated to be between 1 to 3 ac per turbine related to grading the site for installation, laydown areas for equipment and materials, and staging areas for construction equipment used to hoist the turbines and their towers into place. The area surrounding the turbine is then reclaimed after construction is completed. These estimates do not include land used for substations, control buildings, access roads, and other related facilities. Assuming that a common commercially available land-based turbine is used (1.5 MW), 453 turbines in a linear array are estimated to be needed in land areas with a wind class of Class 3 or greater to produce 680 MW(e), using the NREL's Wind Farm Area Calculator (NREL 2006). Assuming a rotor diameter of roughly 200 ft for a 1.5-MW turbine, the total acreage for a wind farm with 453 turbines in a linear array in optimal wind conditions could require more than 2,075 ac; 226.5 ac would be dedicated to the turbine footprint (assuming approximately 0.5 ac per turbine base), and the remaining land between turbines could be available for other uses, such as grazing or agricultural land. These numbers do not take into account the low annual capacity factor of approximately 30 percent that is associated with wind energy.

Consequently, the current VYNPS site is too small to support a baseload level of wind generation capacity. Although impacts would depend on the site chosen, common issues of concern include visual impacts, noise, potential interferences with aircraft operations, and bird and bat collisions.

8.2.5.3 Solar Power

Solar technologies including photovoltaic cells and solar thermal systems use the sun's energy to produce electricity. In the GEIS, the NRC staff noted that by its nature, solar power is intermittent. Therefore, solar power by itself is not suitable for baseload capacity and is not a feasible alternative to license renewal of VYNPS. 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. Solar power, in conjunction with energy storage mechanisms, might serve as a means of providing baseload power. However, current energy storage technologies are too expensive to permit solar power to serve as a large baseload generator.

Therefore, solar power technologies (photovoltaic and thermal) cannot currently compete with conventional fossil-fueled technologies in grid-connected applications because of high costs per kilowatt of capacity (NRC 1996).

Natural resources (e.g., wildlife habitat, land use, and aesthetics) can incur substantial impacts from construction of solar-generating facilities. As stated in the GEIS, land requirements are high – 35,000 ac per 1000 MW(e) for photovoltaic and approximately 14,000 ac per 1000 MW(e) for solar thermal systems. Neither type of solar electric system would fit at the VYNPS site, and both would have LARGE environmental impacts at an alternate site.

In this region, a flat-plate solar collector receives approximately 3.5 to 4.0 kWh of solar radiation per square meter per day (DOE 2006b). 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 VYNPS OL. Some solar power may be substituted for electric power in rooftop and building applications. Implementation of non-rooftop solar generation on a scale large enough to replace VYNPS would likely result in LARGE environmental impacts.

8.2.5.4 Hydropower

There are few remaining sites in the Vermont market region that would be environmentally suitable for a hydroelectric facility. These remaining sites lack the ability to replace the production capability of VYNPS (INEEL 1998). In Section 8.3.4 of the GEIS, the NRC staff points out that 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.

The NRC staff estimated in the GEIS that land requirements for hydroelectric power are approximately 1 million ac per 1000 MW(e). Replacement of VYNPS generating capacity would require flooding less than this amount of land. Because of the small supply of suitable sites in the region and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to replace VYNPS, the NRC staff concludes that hydropower is not a feasible alternative to VYNPS OL renewal on its own. Any attempts to site hydroelectric facilities large enough to replace VYNPS 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. Geothermal technology is limited by the geographical availability of the resource and immature status of the technology (NRC 1996). As illustrated in Figure 8.4 in the GEIS, geothermal electric-generating 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 location in Vermont for geothermal capacity to serve as an alternative to VYNPS (DOE 2006b). The NRC staff concludes that geothermal energy is not a feasible alternative to renewal of the VYNPS OL.

8.2.5.6 Wood Waste

The use of wood waste to generate electricity is largely limited to those states with significant wood resources, such as California, Maine, Georgia, Minnesota, Oregon, Washington, and Michigan. Electric power is generated in these states by the pulp, paper, and paperboard industries that consume wood and wood waste for energy; these industries benefit from the use of waste materials that could otherwise represent a disposal problem.

DOE estimates that Vermont, Massachusetts, and New Hampshire have resources for wood fuels consisting of urban, mill, and forest residues; approximately 3,750,000 dry tons/yr are available in these three States (Walsh et al. 2000) at $50 per dry ton delivered. As the National Renewable Energy Laboratory (NREL) has estimated that 1100 kWh of electricity can be produced by 1 dry ton of wood residue, approximately 4.12 terawatt hours (TWh) of electricity can be generated annually from wood residue in this region (NREL 2004). This is less than the net electricity produced by VYNPS.

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. Like coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

While wood resources are available in the region, wood energy is not considered a reasonable alternative to renewal of the VYNPS OL because of low fuel availability and high delivered fuel costs.

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 2004). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (EIA 2001). Mass-burning technologies are most commonly used in the United States. This group of technologies processes raw municipal solid waste “as is,” with little or no sizing, shredding, or separation before combustion.

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 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 (EIA 2001). The EIA projects an increase in electricity generation from municipal solid waste and landfill gas by 7 billion kWh to 29 billion kWh in 2025; however, no new capacity is expected (EIA 2005).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of unfavorable economics, particularly with electricity prices stable in real terms. U.S. electricity prices in 2005 dollars are expected to decline by 7 percent by 2015 and increase slightly by 2030 to roughly 2006 levels (EIA 2007). Prices are expected to increase by 0.3 percent per year from 2011 until 2025, following the trend of the generation component of electricity price (EIA 2004a).

Municipal solid waste combustion generates 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 or scrubbers (EIA 2001).

Currently, there are approximately 89 waste-to-energy plants operating in the United States. These plants generate approximately 2700 MW(e), or an average of approximately 30 MW(e) per plant (Integrated Waste Services Association 2007), a much smaller capacity than that needed to replace the 650 MW(e) of VYNPS.

The initial capital costs for municipal solid waste plants are greater than for comparable steam-turbine technology at wood-waste facilities. This is because of the need for specialized waste-separation and waste-handling equipment for municipal solid waste (NRC 1996). Furthermore, estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant should be approximately the same as that for a coal-fired plant. In addition, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal). Some of these impacts would be MODERATE, but still larger than the environmental effects of license renewal of VYNPS; therefore, municipal solid waste would not be a feasible alternative to renewal of the VYNPS OL, particularly at the scale required.

8.2.5.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid waste fuels, there are several other concepts for power generation, including burning crops, converting crops to a liquid fuel such as ethanol, and converting crops or wood waste to gaseous fuel. In the GEIS, the NRC staff points out that none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as VYNPS. For these reasons, such fuels do not offer a feasible alternative to renewal of the VYNPS OL.

8.2.5.9 Fuel Cells

Fuel cells work without combustion and its environmental impacts. 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 CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

Phosphoric acid fuel cells are generally considered first-generation technology. These fuel cells are commercially available at a cost of approximately $4000 to $4500/kW of installed capacity (DOE 2006c). 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.

Due to cost issues, the DOE formed the Solid State Energy Conversion Alliance (SECA), with the goal of producing new fuel cell technologies at a cost of $400/kW or lower by 2010 (DOE 2006d). Fuel cells have the potential to become economically competitive if SECA can reach its goal. For comparison, the installed capacity cost for a natural-gas-fired, combined-cycle plant is about $500 to $600/kW (Northwest Power Planning Council 2000). At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Consequently, fuel cells are not a feasible alternative to renewal of the VYNPS OL.

8.2.5.10 Delayed Retirement

Existing generating units slated for retirement would likely require major refurbishment to upgrade or replace plant components to meet current environmental regulations, such as those regarding air emissions. For this reason, delayed retirement of other Entergy generating units would not be a feasible alternative to renewal of the VYNPS OL. Entergy concluded in its ER (Entergy 2006) that closing the VYNPS would not remove the need for the 650 MW(e) produced by the plant. The environmental impacts of delayed retirement of non-nuclear generating sources would be similar to the impacts from the operation of coal-fired and natural-gas-fired plants. The NRC staff agrees that delayed retirement is not a feasible alternative to renewal of the VYNPS OL.

8.2.5.11 Utility-Sponsored Conservation

Market conditions that initially favored utility-sponsored conservation programs (i.e., demand-side management (DSM)), including educational programs, energy efficiency programs, and load management programs, have changed significantly. The potential for new or expanded DSM programs has decreased in recent years due to mandated energy efficiency standards and years of customer education programs. Vermont, Massachusetts, and New Hampshire each offer electric energy efficiency programs (NCSC 2007). In Vermont, these programs are administered by Efficiency Vermont, a group funded by an energy efficiency charge on state energy bills. Programs include promoting the use of energy-efficient appliances, providing information to homeowners and businesses on energy-efficient technologies, and information on energy-efficient building materials (Efficiency Vermont 2006). Although this program has resulted in some demand reductions, and the environmental impacts of implementing a DSM program would be SMALL, implementation of a similar program in this region would not be able to realistically replace the 650 MW(e) of net generating capacity of VYNPS. Therefore, the conservation alternative by itself is not considered a reasonable alternative to renewing the VYNPS OL.

8.2.6 Combination of Alternatives

Even though individual alternatives to VYNPS might not be sufficient on their own to replace VYNPS capacity because of the small size of the resource or lack of cost-effective opportunities, it is conceivable that a combination of alternatives might be cost-effective. As discussed previously, VYNPS has a combined net electrical capacity of 650 MW(e). For the coal- and natural-gas-fired plant alternatives, the use of standard-sized units as potential replacements for VYNPS were assumed for purposes of the analyses.

There are many possible combinations of alternatives. Table 8-8 presents the environmental impacts of one assumed combination of alternatives consisting of 530 MW(e) of combined-cycle natural-gas-fired plant generation using closed-cycle cooling, a DSM reduction in peak electric demand of 40 MW(e), and 80 MW in purchased power. The NRC staff considered a natural-gas-fired plant over a coal-fired plant because a comparison of the impacts indicates that a coal-fired plant would have greater impacts than a similar-sized gas-fired plant (see Tables 8-2 and 8-4). Also, the footprint of the natural-gas-fired plant is smaller and could be accommodated within previously disturbed portions of the VYNPS site. The impacts are based on the assumptions for constructing and operating a natural-gas-fired plant, as discussed in Section 8.2.2, adjusted for the reduced capacity. Energy reduction savings associated with DSM would result in no addition to the environmental impacts listed in Table 8-8 for a natural-gas-fired plant.

Operation of a new natural-gas-fired plant would result in increased emissions (compared with the proposed action) and other environmental impacts. Environmental impacts related to the number of acres of land disturbed and air emissions are scaled based on the reduced amount of electricity produced. However, the number of workers was not likewise scaled. Conservatively, the number of workers for a 608-MW(e) plant, as used in Table 8-4, is also used here for a 530-MW(e) natural-gas-fired-plant. The environmental impacts of power generation associated with power purchased from other generators would still occur, but would be located elsewhere in the region, nation, or another country (Canada) as discussed in Section 8.1.4. The environmental impacts associated with purchased power are not shown in Table 8-8.

The NRC staff also evaluated a combination of alternatives that employs only renewable energy alternatives. The combination evaluated includes 200 MW wind power, 200 MW solar power, 40 MW DSM reduction in peak electric demand, and 210 MW purchased renewable energy (assumed to be hydroelectric power purchased from Canada). The wind power capacity evaluated would require a minimum of 134 1.5-MW turbines on land (occupying an estimated 600 ac). The solar power capacity evaluated would require a minimum of 2800 ac for solar thermal energy or 7000 ac for photovoltaic energy. It should be noted that the acreage estimate for wind power is a conservative estimate, and significant additional acreage (up to approximately 1400 ac) could be required to provide 200 MW because the capacity factor of wind is estimated to be on the order of 30 percent; the 25 percent capacity factor of solar has been factored into the above estimate of area, which was determined based on information provided in the GEIS (NRC 1996). Thus, for the all-renewable-energy combination of alternatives, a minimum of 8400 ac would be needed for a land-based system. These estimates do not include installation of new transmission capacity, which would be needed.

Table 8-8. Summary of Environmental Impacts of Combination of Alternatives at the VYNPS Site and at an Alternate Site

Impact Category	VYNPS Site		Alternate Site	
	Impact	**Comments**	**Impact**	**Comments**
Land use	SMALL to MODERATE	Impact would depend on the degree to which previously disturbed lands were utilized. Uses 32 ac for plant site. Additional impact of up to approximately 364 ac for construction of a 40-mi underground gas pipeline.	MODERATE to LARGE	Impact would depend on the characteristics of the alternate site. Uses 58 ac for power block, offices, cooling towers, roads, and parking areas. Additional land needed for a new transmission line (amount dependent on site chosen) and for construction and/or upgrade of a gas pipeline.
Ecology	SMALL to MODERATE	Impact would depend on the characteristics of land to be developed. Uses developed areas at current VYNPS site, thereby reducing impacts on ecology. Impacts could occur with construction of a gas pipeline. Impacts on terrestrial ecology from cooling-tower drift are expected. Impact on aquatic ecology would be reduced from current levels because surface-water intake and thermal discharge would be reduced.	MODERATE to LARGE	Impact would depend on the characteristics of the land to be developed, surface-water body used for intake and discharge, and transmission and pipeline routes.
Water use and quality – surface water	SMALL	Impact would be reduced from current level. Cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides, as well as wastewater, would be released. Temporary erosion and sedimentation could occur in streams crossed during pipeline construction.	SMALL to MODERATE	Impact would depend on volume of water withdrawn and discharged and characteristics of surface-water body. Cooling-tower blowdown containing increased dissolved solids and intermittent low concentrations of biocides, as well as wastewater, would be released. Temporary erosion and sedimentation could occur in streams crossed during pipeline construction.

Table 8-8. (contd)

Impact Category	VYNPS Site		Alternate Site	
	Impact	Comments	Impact	Comments
Water use and quality – groundwater	SMALL	Impact would be similar to current VYNPS operations if groundwater continues to be used for potable water.	SMALL to MODERATE	Impact would depend on the location of the site, volume of water withdrawn and discharged, and the characteristics of the aquifer.
Air quality	MODERATE	Impact from fugitive dust and emissions from vehicles and equipment during construction would be SMALL. Impact of operations on air quality would be MODERATE with the following emissions expected: Sulfur oxides • 37 tons/yr Nitrogen oxides • 119 tons/yr Carbon monoxide • 172 tons/yr PM_{10} particulates • 22 tons/yr Some hazardous air pollutants.	MODERATE	Same emissions as a natural-gas-fired plant at the VYNPS site, although pollution control standards may vary depending on location.
Waste	SMALL	Minimal waste product from fuel consumption. Waste would be generated and removed during construction.	SMALL	Same impact as a natural-gas-fired plant at the VYNPS site. Waste disposal constraints may vary.
Human health	SMALL	Human health risks associated with natural-gas-fired plants may be attributable to NO_x emissions, which are regulated. Impacts considered SMALL.	SMALL	Same impacts as a natural-gas-fired plant at the VYNPS site.

Table 8-8. (contd)

Impact Category	VYNPS Site		Alternate Site	
	Impact	**Comments**	**Impact**	**Comments**
Socioeconomics	MODERATE	During construction, impact would be MODERATE. Up to 636 additional workers during the peak of the 3-year construction period, followed by a reduction in the current VYNPS workforce from 678 to 80. Windham County would experience reduced demand for goods and services as well as a loss in its tax base and employment, but this would be potentially offset by projected economic growth in the area. Impact during operation would be SMALL.	MODERATE	Construction impact would depend on location, but could be MODERATE if the location is in a rural area. 636 additional workers during the peak of the 3-year construction period. Windham County would experience a loss in its tax base and employment if a plant were constructed outside of the county, but this would be potentially offset by projected economic growth in the area. Impact during operation would be SMALL.
Transportation	MODERATE	Transportation impact associated with construction workers would be MODERATE as 678 VYNPS workers and up to 636 construction workers would be commuting to the site. Impact during operation would be SMALL as the number of commuters would be reduced to 80.	MODERATE	Transportation impact associated with 636 construction workers commuting to the site would be MODERATE. Impacts during operation associated with 80 plant workers commuting to the site would be SMALL.
Aesthetics	MODERATE	MODERATE aesthetic impact due to visibility of plant units, exhaust stacks, cooling towers, plumes, and gas compressors. Intermittent noise from construction and continuous noise from cooling towers and mechanical equipment would result in MODERATE impacts.	MODERATE to LARGE	Impact would depend on the characteristics of the site, but would be similar to those for a natural-gas-fired plant at the VYNPS site, with additional impact from the new transmission line and gas pipeline.

Table 8-8. (contd)

Impact Category	VYNPS Site		Alternate Site	
	Impact	Comments	Impact	Comments
Historic and archaeological resources	SMALL to MODERATE	Impact would depend on the degree to which previously disturbed lands were utilized. A cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new construction on cultural resources in undeveloped areas.	SMALL to MODERATE	Impact would depend on the characteristics of the alternate site. A cultural resource inventory would be needed to identify, evaluate, and mitigate potential impacts of new construction.
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 could occur during construction; loss of 554 operating jobs at VYNPS could reduce employment prospects for minority and low-income populations. Impact could be offset by projected economic growth and the ability of affected workers to commute to other jobs.	SMALL to MODERATE	Impact would depend on population distribution and makeup at the site. Some impact on housing could occur during construction.

The impacts of this combination of alternatives would approach a rating of LARGE during construction (wind turbine installation and construction of a solar power plant). Less land disturbance would result if rooftops are used throughout the local communities for solar applications. Depending on site locations, installation of wind turbines, solar panels, and associated facilities including transmission systems would have potentially LARGE impacts associated with land disturbance. Land disturbance would result in impacts to land use, terrestrial ecology, aquatic ecology, and archaeological sites. Construction impacts on air quality, water quality, and noise could be MODERATE depending on location and construction practices. Wind and solar technologies would require systems to store electricity for periods of peak demand to compensate for periods of intermittency. Local impacts during operation likely would be SMALL for wind, solar, DSM, and purchased power in most environmental areas. Impacts would depend on the site chosen, but common concerns regarding wind power that could cause MODERATE impacts include visual impacts, potential interferences with radar and aircraft, and bird and bat collisions.

The impacts of this combination of alternatives would approach a rating of LARGE during construction (wind turbine installation and construction of a solar power plant). Less land disturbance would result if rooftops are used throughout the local communities for solar applications. Depending on site locations, installation of wind turbines, solar panels, and associated facilities including transmission systems would have potentially LARGE impacts associated with land disturbance. Land disturbance would result in impacts to land use, terrestrial ecology, aquatic ecology, and archaeological sites. Construction impacts on air quality, water quality, and noise could be MODERATE depending on location and construction practices. Wind and solar technologies would require systems to store electricity for periods of peak demand to compensate for periods of intermittency. Local impacts during operation likely would be SMALL for wind, solar, DSM, and purchased power in most environmental areas. Impacts would depend on the site chosen, but common concerns regarding wind power that could cause MODERATE impacts include visual impacts, potential interferences with radar and aircraft, and bird and bat collisions.

The NRC 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 the proposed action.

8.3 Summary of Alternatives Considered

The environmental impacts of the proposed action, renewal of the VYNPS OL, would be SMALL for all impact categories, except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal. Collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal were not assigned a single significance level but were determined by the Commission to be Category 1 issues nonetheless. Alternatives to the proposed action that were evaluated include license renewal with implementation of the 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 a combination of alternatives (discussed in Section 8.2.6).

The no-action alternative would require the replacement of electrical-generating capacity by (1) DSM and energy conservation, (2) power purchased from other electricity providers, (3) power-generation alternatives other than VYNPS, or (4) some combination of these options. For each of the new-generation alternatives (coal, natural gas, and nuclear), the environmental impacts would be greater 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 VYNPS. 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 VYNPS OL.

The NRC 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

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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 January 25, 2006, Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license (OL) for Vermont Yankee Nuclear Power Station (VYNPS) for an additional 20-year period (Entergy 2006a). If the OL is renewed, State regulatory agencies and Entergy will ultimately decide whether the plant will continue to operate based on factors such as the need for power, or other matters within the State's jurisdiction or the purview of the owners. If the OL is not renewed, then the plant must be shut down at or before the expiration of the current OL, which expires on March 21, 2012.

Section 102 of the National Environmental Policy Act (NEPA) 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 Title 10, Part 51, of the *Code of Federal Regulations* (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 Entergy 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 (NRC 2006a) on April 21, 2006. The NRC staff visited the VYNPS site in May 2006, conducted an open house on June 6, 2006, at which comments were accepted, and held public scoping meetings on June 7, 2006, in Brattleboro, Vermont (NRC 2006b). The NRC staff reviewed the Entergy Environmental Report (ER) (Entergy 2006b) and compared it with 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 NRC staff also considered the public comments received during the scoping process for preparation of this Supplemental Environmental Impact Statement (SEIS) for VYNPS. Comments received during the scoping period were summarized in the VYNPS scoping report (NRC 2006b). The public comments received during the scoping period that were considered to be within the scope of the environmental review are provided in Appendix A, Part 1, of this SEIS.

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

The NRC staff held two public meetings in Brattleboro, Vermont, on January 31, 2007, to describe the preliminary results of the NRC environmental review and to answer questions to provide members of the public with information to assist them in formulating their comments on the draft SEIS.

On February 27, 2007, members of the NRC staff met with members of the Vermont State Legislature in Montpelier, Vermont, to present the findings of the draft SEIS. No formal comments were received from the legislators at this meeting because no transcript was recorded. The NRC did, however, receive written comments for formal consideration from some of the legislators and members of the public who observed the meeting.

The comment period for the draft SEIS ended March 7, 2007. All of the comments received on the draft SEIS were considered by the NRC staff in developing the final SEIS and are presented in Appendix A, Part II, of this SEIS.

This SEIS includes the NRC staff's analysis that considers and weighs the environmental effects of the proposed action, including cumulative impacts, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse effects. This SEIS also includes the NRC 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 evaluation criterion for the NRC staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

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

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current 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 the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

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

(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."

(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 (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 NRC staff relied on conclusions as amplified by supporting information in the GEIS for issues designated Category 1 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B. The NRC staff also determined that information provided during the public comment period did not identify any new issue that requires site-specific assessment.

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 NRC staff's consideration of all 92 environmental issues identified in the GEIS. The NRC 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 OL for VYNPS) and alternative methods of power generation. These alternatives were evaluated assuming that the replacement power generation plant is located at either the VYNPS site or at some other unspecified location.

9.1 Environmental Impacts of the Proposed Action – License Renewal

Entergy and the NRC staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither Entergy nor the NRC 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 the scoping process, public comments on the draft SEIS, Entergy, nor the NRC staff has identified any new issue applicable to VYNPS that has a significant environmental impact. Therefore, the NRC staff relies upon the conclusions of the GEIS for all Category 1 issues that are applicable to VYNPS.

Entergy's license renewal application presents an analysis of the Category 2 issues that are applicable to VYNPS. The NRC staff has reviewed the Entergy analysis for each issue and has conducted an independent review of each issue plus environmental justice and chronic effects from electromagnetic fields. Three Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at VYNPS. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. Entergy (Entergy 2006b) 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 VYNPS 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 Operation of VYNPS (AEC 1972).

Fourteen 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 14 Category 2 issues and environmental justice, the NRC staff concludes that the potential environmental impacts would be of SMALL significance in the context of the standards set forth in the GEIS. In addition, the NRC 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 NRC staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for VYNPS and the plant improvements already made, the NRC staff concludes several candidate SAMAs are potentially cost-beneficial. However, none of these SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54.

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 is warranted. However, under the provisions of the Clean Water Act 316(b) regulations, the Vermont Department of Environmental Conservation (VDEC) may impose further restrictions or require modifications to the cooling system to reduce the impacts on aquatic resources from entrainment and impingement under the National Pollutant Discharge Elimination System (NPDES) permitting process. Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. For purposes of this analysis, where VYNPS license renewal impacts are deemed to be SMALL, the NRC staff concluded that these impacts would not result in significant cumulative impacts on potentially affected resources.

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 for 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. However, under the provisions of the Clean Water Act 316(b) Phase II regulations, the VDEC may impose further restrictions or require modifications to the cooling system to reduce the impacts on aquatic resources from entrainment and impingement. The adverse impacts of likely alternatives if VYNPS ceases operation at or before the expiration of the current OL would not be smaller than those associated with continued operation of this unit, 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 VYNPS during the current license period was made when the plant was built. The resource commitments 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 storage space. VYNPS replaces a portion of the fuel assemblies in its unit during every refueling outage, which occurs on an 18-month cycle.

The likely power-generation alternatives if VYNPS ceases operation on or before the expiration of the current OL 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 VYNPS site was set when the plant was approved and construction began. That balance is now well-established. Renewal of the OL for VYNPS and continued operation of the plant would not alter the existing balance, but may postpone the availability of the site for other uses. Denial of the application to renew the OL would lead to shutdown of the plant and would alter the balance in a manner that depends on subsequent uses of the site. For example, the environmental consequences of turning the VYNPS 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 OL for VYNPS. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. As noted in Chapter 3, no refurbishment and no refurbishment impacts are expected at VYNPS. Chapters 4 through 7 discuss environmental issues associated with renewal of the OL. 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 OL), the no-action alternative (denial of the application), alternatives involving nuclear, coal-, or gas-fired power generation at the VYNPS site and at an unspecified alternate site, and a combination of alternatives are compared in Table 9-1. Closed-cycle cooling systems are assumed for all power-generation alternatives.

Substitution of once-through cooling for the closed-cycle cooling system in the evaluation of the nuclear and gas- and coal-fired generation alternatives would result in somewhat greater environmental impacts in some impact categories.

Table 9-1 shows that the significance of the environmental effects of the proposed action would be 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, especially during construction.

Table 9-1. Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Power Generation Using Closed-Cycle Cooling

Impact Category	Proposed Action	No-Action Alternative (Denial of Renewal)	Coal-Fired Generation	Natural-Gas-Fired Generation		New Nuclear Generation	Combination of Alternatives	
			Alternate Site	VYNPS Site	Alternate Site	Alternate Site	VYNPS Site	Alternate Site
Land use	SMALL	SMALL	MODERATE to LARGE	SMALL to MODERATE	MODERATE to LARGE	MODERATE to LARGE	SMALL to MODERATE	MODERATE to LARGE
Ecology	SMALL	SMALL	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	SMALL to MODERATE	MODERATE to LARGE
Water use and quality – surface water	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL to MODERATE
Water use and quality – groundwater	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL to MODERATE
Air quality	SMALL	SMALL	MODERATE	MODERATE	MODERATE	SMALL	MODERATE	MODERATE
Waste	SMALL	SMALL	MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL
Human health	SMALL[(a)]	SMALL	SMALL	SMALL	SMALL	SMALL[(a)]	SMALL	SMALL
Socioeconomics	SMALL	SMALL to LARGE	SMALL to LARGE	MODERATE	MODERATE	MODERATE to LARGE	MODERATE	MODERATE
Transportation	SMALL	SMALL	MODERATE to LARGE	MODERATE	MODERATE	MODERATE to LARGE	MODERATE	MODERATE
Aesthetics	SMALL	SMALL	MODERATE to LARGE	MODERATE	MODERATE to LARGE	MODERATE to LARGE	MODERATE	MODERATE to LARGE
Historic and archaeological resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Environmental justice	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to LARGE	SMALL	SMALL to MODERATE

(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.

9.3 NRC Staff Conclusions and Recommendations

Based on (1) the analysis and findings in the GEIS (NRC 1996, 1999), (2) the Entergy ER (Entergy 2006b), (3) consultation with Federal, State, and local agencies, (4) the NRC staff's own independent review, and (5) the NRC staff's consideration of public comments received, the recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for VYNPS are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

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."

Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy). 2006a. *License Renewal Application, Vermont Yankee Nuclear Power Station, Facility Operating License No. DPR-28*. Docket No. 50-271. Brattleboro, Vermont. ADAMS No. ML060300085.

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NRC FORM 335 (9-2004) NRCMD 3.7 U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET** *(See instructions on the reverse)*	1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) NUREG-1437, Supplement 30 Volume 1, Main Report
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8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

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

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Same as Block 8

10. SUPPLEMENTARY NOTES

Docket No. 50-271

11. ABSTRACT *(200 words or less)*

This final supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted to the NRC by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy) to renew the operating license for Vermont Yankee Nuclear Power Station (VYNPS) for an additional 20 years under 10 CFR Part 54. This SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's recommendation regarding the proposed action.

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

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*	13. AVAILABILITY STATEMENT
VYNPS, Vermont Yankee, Vermont Yankee Nuclear Power Station SEIS, Supplemental EIS Supplement to the Generic Environmental Impact Statement GEIS NEPA Environmental Environmental Impact Statement License Renewal	unlimited 14. SECURITY CLASSIFICATION *(This Page)* unclassified *(This Report)* unclassified 15. NUMBER OF PAGES 16. PRICE