U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437
Supplement 46

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 46

Regarding Seabrook Station

Draft Report for Comment

Office of Nuclear Reactor Regulation

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Office of Nuclear Reactor Regulation

Proposed Action	Issuance of renewed operating license NPF-86 for Seabrook Station in the city of Seabrook, Rockingham County, NH
Type of Statement	Draft Supplemental Environmental Impact Statement
Agency Contact	Michael Wentzel U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Mail Stop O-11F1 Washington, D.C. 20555-0001 Phone: 301-415-6459 E-mail: michael.wentzel@nrc.gov
Comments	Any interested party may submit comments on this supplemental environmental impact statement (SEIS). Please specify NUREG-1437, Supplement 46, draft, in your comments. Comments must be received by October 26, 2011. Comments received after the expiration of the comment period will be considered if it is practical to do so, but assurance of consideration of late comments will not be given. Comments may be submitted electronically by searching for docket ID NRC-2010-0206 at the Federal rulemaking website, http://www.regulations.gov. Comments may also be mailed to the following address: Chief, Rules, Announcements, and Directives Branch Division of Administrative Services Office of Administration Mail Stop: TWB-05-B01M U.S. Nuclear Regulatory Commission Washington, DC 20555-0001 Please be aware that any comments that you submit to the U.S. Nuclear Regulatory Commission (NRC) will be considered a public record and entered into the Agencywide Documents Access and Management System (ADAMS). Do not provide information you would not want to be publicly available.

ABSTRACT

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by NextEra Energy Seabrook, LLC (NextEra) to renew the operating license for Seabrook Station (Seabrook) for an additional 20 years.

This draft SEIS includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from new natural-gas-fired combined-cycle generation; new nuclear generation; a combination alternative that includes some natural-gas-fired capacity, and a wind-power component; and the no-action alternative of not renewing the license.

The NRC's preliminary recommendation is that the adverse environmental impacts of license renewal for Seabrook are not great enough to deny the option of license renewal for energy-planning decision makers. This recommendation is based on the following:

- analysis and findings in the generic environmental impact statement (GEIS)
- the Environmental Report (ER) submitted by NextEra
- consultation with Federal, State, and local agencies
- NRC staff's own independent review
- NRC staff's consideration of public comments received during the scoping process

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EXECUTIVE SUMMARY

Background

By letter dated May 25, 2010, NextEra Energy Seabrook, LLC (NextEra) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to issue a renewed operating license for Seabrook Station (Seabrook) for an additional 20-year period.

Pursuant to Title 10, Part 51.20(b)(2) of the *Code of Federal Regulations* (10 CFR 51.20(b)(2)), the renewal of a power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c) states that the NRC shall prepare an EIS, which is a supplement to the Commission's NUREG-1437, *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants*.

Upon acceptance of NextEra's application, the NRC staff began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent to prepare a supplemental EIS (SEIS) and conduct scoping. In preparation of this SEIS for Seabrook, the NRC staff performed the following:

- conducted public scoping meetings on August 19, 2010, in Hampton, NH
- conducted a site audit at the plant in October 2010
- reviewed NextEra's environmental report (ER) and compared it to the GEIS
- consulted with other agencies
- conducted a review of the issues following the guidance set forth in NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal"
- considered public comments received during the scoping process

Proposed Action

NextEra initiated the proposed Federal action—issuing a renewed power reactor operating license—by submitting an application for license renewal of Seabrook, for which the existing license (NPF-86) will expire on March 15, 2030. The NRC's Federal action is the decision whether or not to renew the license for an additional 20 years.

Purpose and Need for Action

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for baseload power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning decision makers, such as State, utility, and, where authorized, Federal agencies (other than NRC). This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review required by the Atomic Energy Act or findings in the National Environmental Policy Act (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 whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, the appropriate energy-planning decision makers, along with NextEra, will ultimately decide if the plant will continue to operate based on factors such as the need for power. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, March 15, 2030.

Environmental Impacts of License Renewal

The SEIS evaluates the potential environmental impacts of the proposed action. The environmental impacts from the proposed action are designated as SMALL, MODERATE, or LARGE. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- The environmental impacts associated with the issue are 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 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.
- Mitigation of adverse impacts associated with the issue is 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.

> **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 Category 1 issues, no additional site-specific analysis is required in this draft SEIS unless new and significant information is identified. Chapter 4 of this report presents the process for identifying new and significant information. Site-specific issues (Category 2) are those that do not meet one or more of the criterion for Category 1 issues; therefore, an additional site-specific review for these non-generic issues is required, and the results are documented in the SEIS. The NRC staff has reviewed NextEra's established process for identifying and evaluating the significance of any new and significant information on the environmental impacts of license renewal of Seabrook. Neither NextEra nor NRC identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. This conclusion is supported by NRC's review of the applicant's ER, other documentation relevant to the applicant's activities, the public scoping process and substantive comments raised, consultations with Federal and state agencies, and the findings from the environmental site audit conducted by NRC staff. Further, the NRC staff did not identify any new issues applicable to Seabrook that have a significant environmental impact. The NRC staff, therefore, relies upon the conclusions of the GEIS for all Category 1 issues applicable to Seabrook.

Table ES-1 summarizes the Category 2 issues applicable to Seabrook, as well as the NRC staff's findings related to those issues. If the NRC staff determined that there were no Category 2 issues applicable for a particular resource area, the findings of the GEIS, as documented in Appendix B to Subpart A of 10 CFR Part 51, stand.

Table ES-1. Summary of NRC conclusions relating to site-specific impact of license renewal

Resource Area	Relevant Category 2 Issues	Impacts
Land Use	None	SMALL
Air Quality	None	SMALL

Resource Area	Relevant Category 2 Issues	Impacts
Surface Water Resources	None	SMALL
Groundwater Resources	None	SMALL
Aquatic Resources	Impingement Entrainment Heat shock	SMALL to LARGE
Terrestrial Resources	None	SMALL
Protected Species and Habitats	Threatened or endangered species	SMALL to LARGE
Human Health	Electromagnetic fields—acute effects (electric shock)	SMALL
Socioeconomics	Housing Impacts Public services (public utilities) Offsite land use Public services (public transportation) Historic and archaeological resources	SMALL

With respect to environmental justice, the NRC staff has determined that there would be no disproportionately high and adverse impacts to these populations from the continued operation of Seabrook during the license renewal period. Additionally, the NRC staff has determined that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

NextEra reported in its ER that it is aware of one potentially new issue related to its license renewal application—elevated concentrations of tritium were documented on the Seabrook site due to a previous leak from the cask loading area/transfer canal adjacent to the spent fuel pool. Overall groundwater monitoring suggests that offsite migration of tritium is not occurring, because NextEra detected no tritium in marsh sentinel wells. As discussed in Section 4.10 of this SEIS, the NRC staff agrees with NextEra's position that there are no significant impacts associated with tritium in the groundwater at Seabrook.

Severe Accident Mitigation Alternatives

Since NextEra had not previously considered alternatives to reduce the likelihood or potential consequences of a variety of highly uncommon, but potentially serious, accidents at Seabrook, NRC regulation 10 CFR 51.53(c)(3)(ii)(L) requires that NextEra evaluate Severe Accident Mitigation Alternatives (SAMAs) in the course of the license renewal review. SAMAs are potential ways to reduce the risk or potential impacts of uncommon, but potentially severe, accidents, and may include changes to plant components, systems, procedures, and training.

The NRC staff reviewed the ER's evaluation of potential SAMAs. As stated by the applicant, the four potentially cost-beneficial SAMAs are not aging-related. The staff reviewed the identified potentially cost-beneficial SAMAs and agrees that the mitigative alternatives do not involve aging management of passive, long-lived systems, structures, or components during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

Alternatives

The NRC staff considered the environmental impacts associated with alternatives to license renewal. These alternatives include other methods of power generation and not renewing the Seabrook operating license (the no-action alternative). Replacement power options considered were new natural-gas-fired combined-cycle generation; new nuclear generation; and a combination alternative that includes a some natural-gas-fired capacity and a wind-power component. The NRC staff initially considered a number of additional alternatives for analysis as alternatives to license renewal of Seabrook; these were later dismissed due to technical, resource availability, or commercial limitations that currently exist and that the NRC staff believes are likely to continue to exist when the existing Seabrook license expires. The no-action alternative by the NRC staff, and the effects it would have, were also considered.

Where possible, the NRC staff evaluated potential environmental impacts for these alternatives located both at the Seabrook site and at some other unspecified alternate location. Energy conservation and energy efficiency; solar power; wood waste; hydroelectric power; ocean wave and current energy; geothermal power; municipal solid waste; biomass; oil-fired power; fuel cells; new coal-fired generation; purchased power; and wind power were also considered. The NRC staff evaluated each alternative using the same impact areas that were used in evaluating impacts from license renewal.

Recommendation

The NRC's preliminary recommendation is that the adverse environmental impacts of license renewal for Seabrook are not great enough to deny the option of license renewal for energy-planning decision makers. This recommendation is based on the following:

- analysis and findings in the GEIS
- the ER submitted by NextEra
- consultation with Federal, State, and local agencies
- NRC staff's own independent review
- consideration of public comments received during the scoping process

ABBREVIATIONS AND ACRONYMS

AADT	average annual daily traffic
ac	acre
AC	alternating current
ACC	averted cleanup and contamination costs
ACHP	Advisory Council on Historic Preservation
ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Authority
AEC	Atomic Energy Commission
ALARA	as low as is reasonably achievable
ANL	Argonne National Laboratory
ANOSIM	analysis of similarities
ANOVA	analysis of variance
AOC	averted offsite property damage cost
AOE	averted offsite occupational exposure
AOSC	averted onsite costs
AOV	air-operated valve
APE	averted public exposure
ARD	Air Resources Division
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
AWEA	The American Wind Energy Association
BAU	business as usual
Btu	British thermal unit
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CAR	Code of Administrative Rules
CCR	coal combustion residue
CCS	carbon capture and storage
CDF	core damage frequency
CDM	clean development mechanism
CEI	compliance evaluation inspection
CEQ	Council on Environmental Quality
C_{eq}	carbon equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CET	containment event tree
CEVA	containment enclosure ventilation area

CFR	U.S. Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CIV	containment isolation valve
CL	confidence limit
CLB	current licensing basis
cm	centimeter
CMR	Code of Massachusetts Regulations
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COE	cost of enhancement
CPUE	catch per unit effort
CR	control rod
CRI	control rod insertion
CS	cooling system
CSC	Coastal Services Center
CSP	concentrating solar power
CV	coefficient of variation
CWA	Clean Water Act
DBA	design-basis accident
dBa	decibel
DC	direct current
DFW	Division of Fisheries and Wildlife
DG	diesel generator
DOE	U.S. Department of Energy
DR	demand response
DSM	demand side management
ECCS	emergency core cooling system
EDG	emergency diesel generator
EERE	Office of Energy Efficiency and Renewable Energy
EFH	essential fish habitat
EIA	Energy Information Administration
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
EMS	emergency management system
ENHA	Essex National Heritage Area
EO	Executive Order
EOP	emergency operating procedure

EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPR	U.S. Evolutionary Power Reactor
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	environmental report
ESA	Endangered Species Act
ETE	evacuation time estiamte
F&O	facts and observations
FERC	Federal Energy Regulatory Commission
FIVE	fire-induced vulnerability evaluation
FLM	Federal Land Manager
FPL	Florida Power and Light
FPLE	Florida Power and Light Energy Seabrook, LLC
FPL-NED	Florida Power and Light-New England Division
FR	Federal Register
ft	feet
g	gram
gal.	gallon
GEIS	generic environmental impact statement
GHG	greenhouse gas
GL	Generic Letter
gpm	gallons per minute
GWh	gigawatt hour
GWP	global warming potential
ha	hectare
HAP	hazardous air pollutant
HCLPF	high confidence low probability of failure
HELB	high-energy line break
HPI	high-pressure injection
HRA	human reliability analysis
HVAC	heating, ventilation, and air conditioning
IES	Institute of Educational Services
IGCC	integrated gasification combined cycle
in.	inch
IPCC	Intergovernmental Panel on Climate Change
IPE	individual plant examination

IPEEE	individual plant examination of external events
ISLOCA	interfacing system loss-of-coolant accident
ISO	independent system operator
ISO-NE	New England's Independent System Operator
kg	kilogram
KLD	KLD Associates
km	kilometer
km^2	square kilometer
kV	kilovolt
kWh	kilowatt hour
L	liter
lb	pound
LERF	large early release frequency
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LRA	license renewal application
m	meter
m^3	cubic meter
mA	milliampere
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
MD	motor-driven
MDFG	Massachusetts Department of Fish and Game
MDFW	Massachusetts Division of Fisheries and Wildlife
MDS	multi-dimensional scaling
MELCOR	Methods for Estimation of Leakages and Consequences of Releases
mgd	million gallons per day
mGy	million gallons per year
MHC	Massachusetts Historical Commission
mi	mile
mi^2	square mile
mm	millimeter
MMI	modified Mercalli intensity
MMPA	Marine Mammal Protection Act
MMS	minerals management services
MMT	million metric tons
MOV	motor-operated valve
MPCS	main plant computer system

mph	miles per hour
mrad	milliradian
mrem	millirem
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	mean sea level
mSv	millisievert
MSW	municipal solid waste
MT	metric ton
MTHM	metric tonne of heavy metal
MTU	metric ton of uranium
MW	megawatt
MWd	megawatt day
MWe	megawatt-electric
MWh	megawatt hour
MWt	megawatt-thermal
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAESC	North Atlantic Energy Service Corporation
NAI	Normandeau Associates, Inc.
NAS	National Academy of Sciences
NCDC	National Climate Data Center
NCES	National Center for Education Statistics
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NESN	New England Seismic Network
NETL	National Energy Technology Laboratory
NextEra	NextEra Energy Seabrook, LLC
NF_3	nitrogen trifluoride
NGCC	natural-gas-fired combined-cycle
NHDES	New Hampshire Department of Environmental Services
NHDHR	New Hampshire Division of Historical Resources
NHDOT	New Hampshire Department of Transportation
NHDRED	New Hampshire Department of Resources and Economic Development
NHELMIB	New Hampshire Economic and Labor Market Information Bureau
NHFGD	New Hampshire Fish and Game Department
NHNHB	New Hampshire Natural Heritage Bureau
NHOEP	New Hampshire Office of Energy and Planning
NHSCO	New Hampshire State Climate Office

NHY	New Hampshire Yankee
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRCS	National Resources Conservation Service
NREL	National Renewal Energy Laboratory
NRHP	National Register of Historic Places
NRR	Office of Nuclear Reactor Regulation
NSR	new source review
NU	Northeast Utilities Service Company
NWF	National Wildlife Federation
NYDEC	New York Department of Environmental Conservation
O_3	ozone
OCS	outer continental shelf
ODCM	Offsite Dose Calculation Manual
PAB	primary auxiliary building
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PCCW	primary component cooling water
pCi/L	picocuries per liter
PGA	peak ground acceleration
PM	particulate matter
PM_{10}	particulate matter with aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with aerodynamic diameter of 2.5 microns or less
PNNL	Pacific Northwest National Laboratory
PORV	power-operated relief valve
POST	Parliamentary Office of Science and Technology
PRA	probabilistic risk assessment
PSD	Prevention of Significant Deterioration
psia	per square inch absolute
PSNH	Public Service Company of New Hampshire
PV	photovoltaic
RAI	request for additional information

RCRA	Resource Conservation and Recovery Act of 1976
RCS	reactor cooling system
REMP	Radiological Environmental Monitoring Program
RGGI	Regional Greenhouse Gas Initiative
RHR	residual heat removal
ROI	region of influence
ROW	right-of-way
RPC	replacement power costs
RRW	risk reduction worth
RSA	revised statutes annotated
RSCS	Radiation Safety and Control Services, Inc.
RSP	remote shutdown panel
RWST	reactor water storage tank
SAAQS	State Ambient Air Quality Standards
SAMA	severe accident mitigation alternative
SAMG	severe accident mitigation guideline
SAR	safety analysis report
SBO	station blackout
SCR	selective catalytic reduction
Seabrook	Seabrook Station
SEIS	supplemental environmental impact statement
SEPS	supplemental electrical power system
SER	safety evaluation report
SF_6	sulfur hexafluoride
SHPO	State Historic Preservation Officer
SI	safety injection
SO_2	sulfur dioxide
SO_x	sulfur oxide
SQG	small quantity generator
SR	State Route
SRP	standard review plan
STG	steam turbine generator
SUFP	start up feed pump
Sv	sievert
SW	service water
SWGR	switchgear
SWPPP	Stormwater Pollution Prevention Plan
SWS	service water system
TDAFW	turbine-driven auxiliary feedwater

TE	temperature element
TIBL	thermal internal boundary layer
US	U.S. Route
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Research Program
USGS	U.S. Geological Survey
VOC	volatile organic compound
WEC	wave energy conversion
WOE	weight-of-evidence
WOG	Westinghouse Owner's Group
YOY	young-of-the-year

1.0 PURPOSE AND NEED FOR ACTION

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 51)—which implement the National Environmental Policy Act (NEPA)—issuance of a new nuclear power plant operating license requires the preparation of an environmental impact statement (EIS).

The Atomic Energy Act of 1954 originally specified that licenses for commercial power reactors be granted for up to 40 years with an option to renew. The 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility.

The decision to seek a license renewal rests entirely with nuclear power facility owners and, typically, is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC makes the decision to grant or deny license renewal based on whether the applicant has demonstrated that the environmental and safety requirements in the agency's regulations can be met during the period of extended operation.

1.1 Proposed Federal Action

NextEra Energy Seabrook, LLC (NextEra) initiated the proposed Federal action by submitting an application for license renewal Seabrook Station (Seabrook), for which the existing license, NPF-86, expires on March 15, 2030. The NRC's Federal action is the decision whether to renew the license for an additional 20 years.

1.2 Purpose and Need for the Proposed Federal Action

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for baseload power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning decision makers, such as State, utility, and, where authorized, Federal agencies (other than NRC). This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review required by the Atomic Energy Act or findings in the National Environmental Policy Act (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 whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, the appropriate energy-planing decision makers, along with NextEra, will ultimately decide if the plant will continue to operate based on factors such as the need for power. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, March 15, 2030.

1.3 Major Environmental Review Milestones

NextEra submitted an Environmental Report (ER) (NextEra, 2010a) as part of its license renewal application (NextEra, 2010) in May 2010. After reviewing the application and the ER for sufficiency, the NRC staff published a Notice of Acceptance and Opportunity for Hearing in the *Federal Register* (75 FR 42462) on July 21, 2010. The NRC published another notice in the

Federal Register, also on July 21, 2010, on its intent to conduct scoping, thereby beginning the 60-day scoping period.

The agency held two public scoping meetings on August 19, 2010, in Hampton, NH. The NRC report entitled, "Environmental Impact Statement Scoping Process Summary Report for Seabrook Station," dated March 2011, presents the comments received during the scoping process (NRC, 2011). Appendix A to this draft Supplemental Environmental Impact Statement (SEIS) presents the comments considered to be within the scope of the environmental license renewal review and the associated NRC responses.

In order to independently verify information provided in the ER, the NRC staff conducted a site audit at Seabrook in October 2010. During the site audit, NRC staff met with plant personnel; reviewed specific documentation; toured the facility; and met with interested Federal, State, and local agencies.

Figure 1.3-1 shows the major milestones in the public review of the SEIS. Upon completion of the scoping period and site audit, the NRC staff compiled its finding in this document, the draft SEIS. This document is made available for public comment for 75 days. During this time, the NRC staff will host public meetings and collect public comments. Based on the information gathered, the NRC staff will amend the draft SEIS findings as necessary and then publish the final SEIS.

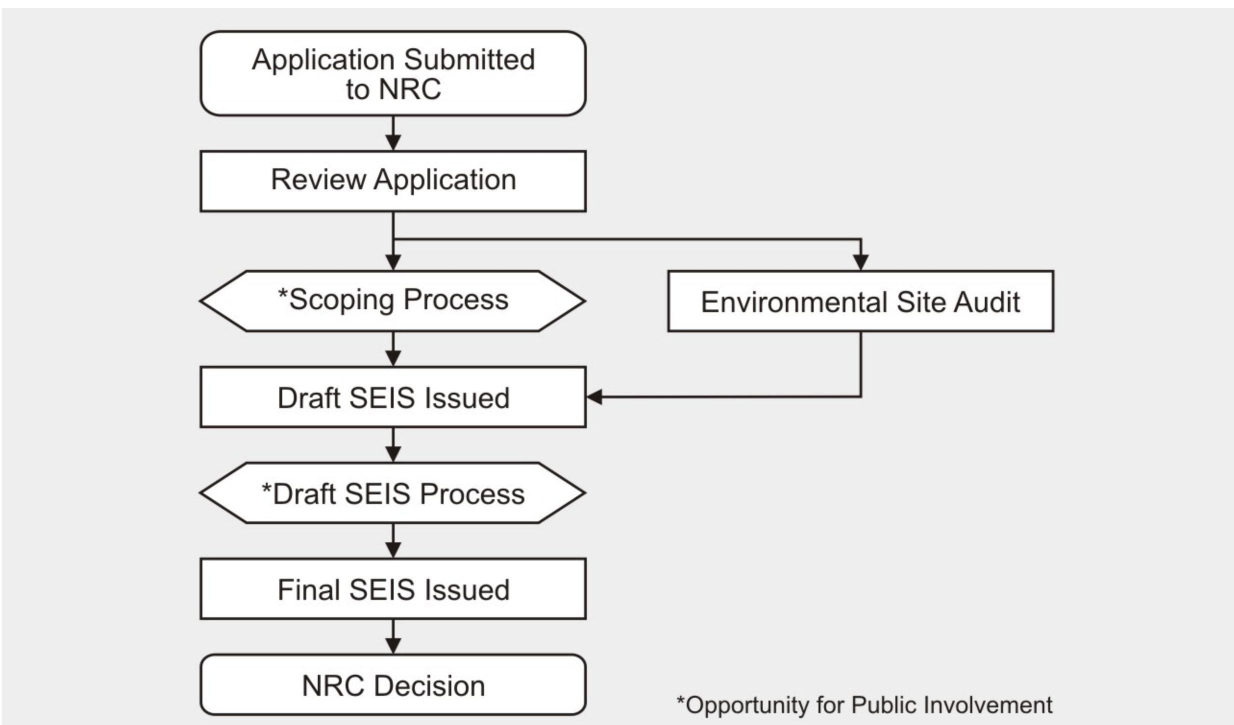


Figure 1.3-1. Environmental review process

The process provides opportunities for public involvement.

The NRC has established a license renewal process that can be completed in a reasonable period of time with clear requirements to assure safe plant operation for up to an additional 20 years of plant life. The safety review is conducted simultaneously with the environmental review. The NRC staff documents the findings of the safety review in a safety evaluation report

(SER). The NRC considers the findings in both the SEIS and the SER in its decision to either grant or deny the issuance of a renewed license.

1.4 Generic Environmental Impact Statement

The NRC performed a generic assessment of the environmental impacts associated with license renewal to improve the efficiency of the license renewal process. The *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS), NUREG-1437, documents the results of the NRC staff's systematic approach to evaluate the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years (NRC, 1996; NRC, 1999). NRC staff analyzed in detail and resolved those environmental issues that could be resolved generically in the GEIS.

The GEIS establishes 92 separate issues for the NRC staff to independently verify. Of these issues, the NRC staff determined that 69 are generic to all plants (Category 1) while 21 issues do not lend themselves to generic consideration (Category 2). Two other issues remained uncategorized; environmental justice and chronic effects of electromagnetic fields must be evaluated on a site-specific basis. A list of all 92 issues can be found in Appendix B.

For each potential environmental issue, the GEIS does the following:

- describes the activity that affects the environment
- identifies the population or resource that is affected
- assesses the nature and magnitude of the impact on the affected population or resource
- characterizes the significance of the effect for both beneficial and adverse effects
- determines if the results of the analysis apply to all plants
- considers if 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 "significant." The NRC established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE—as defined below.

> **Significance** indicates the importance of likely environmental impacts and is determined by considering two variables: **context** and **intensity**.
>
> **Context** is the geographic, biophysical, and social context in which the effects will occur.
>
> **Intensity** refers to the severity of the impact, in whatever context it occurs.

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 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 (Figure 1.4-1). Issues are assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet the following criteria:

- 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 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).
- 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.

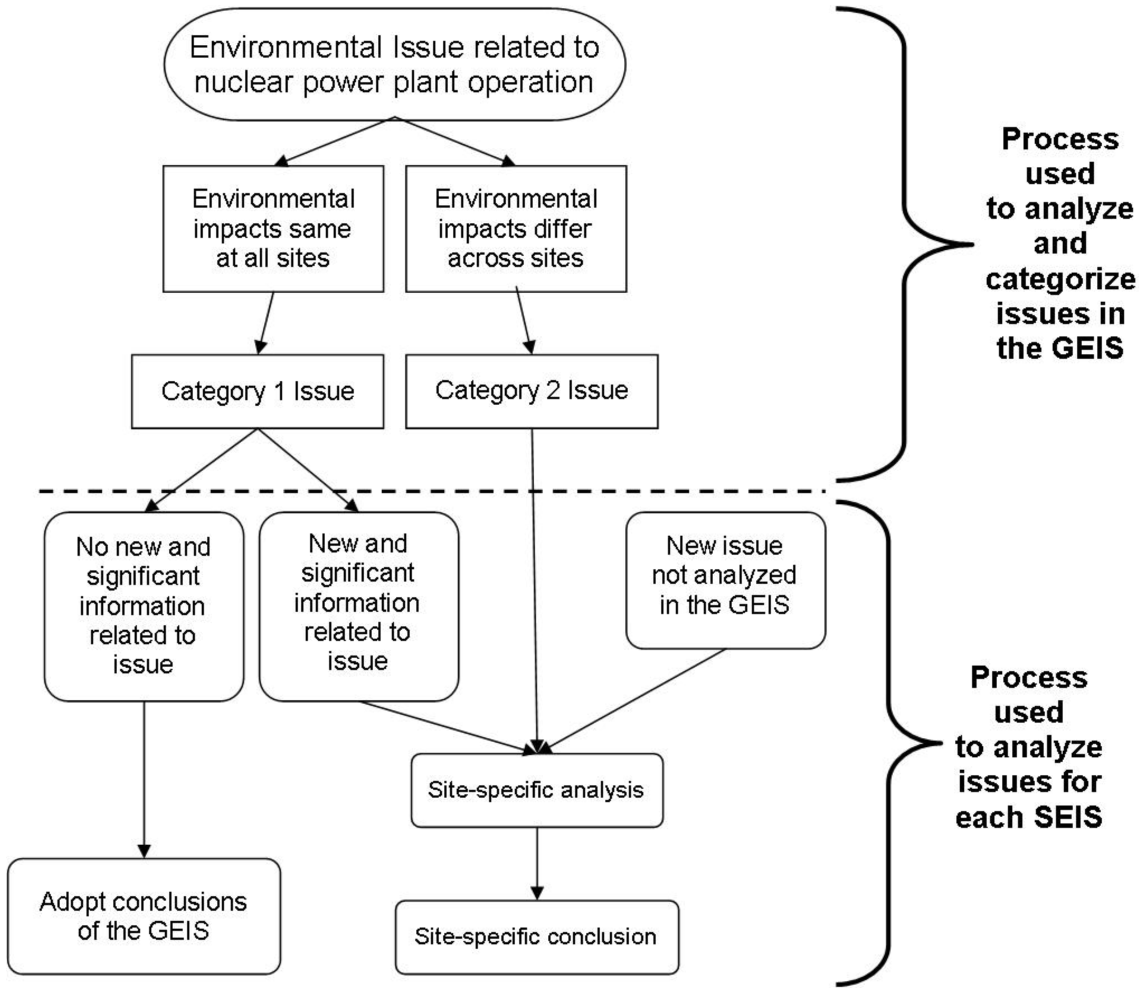


Figure 1.4-1. Environmental issues evaluated during license renewal

In the GEIS, 92 issues were evaluated.
A site-specific analysis is required for 23 of those 92 issues.

For generic issues (Category 1), no additional site-specific analysis is required in the SEIS unless new and significant information is identified. Chapter 4 of this report presents the process for identifying new and significant information. Site-specific issues (Category 2) are those that do not meet one or more of the criteria of Category 1 issues; therefore, additional site-specific review for these issues in required. The SEIS presents the results of those site-specific reviews.

1.5 Supplemental Environmental Impact Statement

This SEIS presents an analysis that considers the environmental effects of the continued operation of Seabrook, alternatives to license renewal, and mitigation measures for minimizing adverse environmental impacts. Chapter 8 contains analysis and comparison of the potential environmental impacts from alternatives, and Chapter 9 presents the preliminary recommendation to the Commission as to whether or not the environmental impacts of license renewal are so great to deny the option of license renewal for energy-planning decision makers. The final recommendation will be made after consideration of comments received on the draft SEIS.

In the preparation of this SEIS for Seabrook, the NRC staff conducted the following activities:

- reviewed the information provided in the NextEra ER
- consulted with other Federal, State, and local agencies
- conducted an independent review of the issues during the site audit
- considered the public comments received during the scoping process

New information can be identified from many sources, including the applicant, the NRC, other agencies, or public comments. If a new issue is revealed, it is first analyzed to determine if it is within the scope of the license renewal evaluation. If it is not addressed in the GEIS, the NRC staff determines its significance and documents its analysis in the SEIS.

> **New and significant information** either identifies a significant environmental issue that was not covered in the GEIS or was not considered in the analysis in the GEIS and leads to an impact finding that is different from the finding presented in the GEIS.

1.6 Cooperating Agencies

During the scoping process, no Federal, State, or local agencies were identified as cooperating agencies in the preparation of this SEIS.

1.7 Consultations

The Endangered Species Act of 1973, as amended; the Magnuson-Stevens Fisheries Conservation and Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 require that Federal agencies consult with applicable State and Federal agencies and groups before taking action that may affect endangered species, fisheries, or historic and archaeological resources, respectively. Below are the agencies and groups with whom the NRC consulted; Appendix D to this report includes copies of consultation documents.

- Advisory Council on Historic Preservation (ACHP)
- Massachusetts Historical Commission
- National Marine Fisheries Service (NMFS), Northeast Regional Office, Gloucester, MA
- New Hampshire Department of Environmental Sciences (NHDES)
- New Hampshire Division of Historical Resources (NHDHR)
- New Hampshire Natural Heritage Bureau (NHNHB)
- U.S. Fish and Wildlife Service (USFWS), Northeast Regional Office, Hadley, MA

1.8 Correspondence

During the course of the environmental review, the NRC staff contacted the following Federal, State, regional, local, and tribal agencies. Appendix E to this report contains a chronological list of all documents sent and received during the environmental review.

- Abenaki Nation of Missisquoi
- Abenaki Nation of New Hampshire
- ACHP
- Bureau of Indian Affairs, Eastern Regional Office, Nashville, TN
- Cowasuck Band of Pennacook-Abenaki People
- Massachusetts Division of Fisheries and Wildlife
- Massachusetts Historical Commission
- NMFS, Northeast Regional Office, Gloucester, MA
- NHDES
- NHDHR
- New Hampshire Natural Heritage Bureau
- USFWS, Northeast Regional Office, Hadley, MA
- Wampanoag Tribe of Gay Head-Aquinnah

A list of persons who received a copy of this draft SEIS is provided in Table 1.8-1.

Table 1.8-1. List of persons who received a copy of the Draft SEIS

Jeffrey Andrews NHDES	Robert Backus	Paul Blanch
Doug Bogen	Gilbert Brown	Thomas Burack Commissioner, NHDES
Ed Carly NextEra	Joe Casey	Chair Rockingham County Board of Commissioners
Chairman Town of Seabrook Board of Selectmen	Richard Cliche NextEra	Melissa Coppola Environmental Information Specialist, New Hampshire Natural Heritage Bureau
Patricia DeTuillo Amesbury Public Library	EIS Filing Section U.S. Environmental Protection Agency (EPA)	EIS Review Coordinator EPA, Region 1
Joseph Fahey	Kevin Fleming	Paul Freeman Site Vice President, NextEra
Sandra Gavutis Executive Director, C-10 Research & Education Foundation	Debbie Grinnell	Doug Grout Chief of Marine Fisheries, New Hampshire Fish & Game Department
Janet Guen	Paul Gunter	William Harris
Emily Holt Massachusetts Division of Fisheries & Wildlife	Joyce Kemp	Patricia Kurkul Regional Administrator, NOAA Fisheries Service
Mary Lampert	Robert McDowell	Scott Medford

Marvin Moriarty Regional Officer, USFWS	Elizabeth Muzzey State Historic Preservation Officer (SHPO), NHDHR	Reid Nelson Director, ACHP
Tim Noonis	NRC Regional Administrator NRC, Region I	NRC Senior Resident NRC, Region I
Dennis O'Dowd Administrator, New Hampshire Department of Health & Human Services	Michael O'Keefe NextEra	Andrew Port
Russell Prescott New Hampshire State Senator, District 23	Robin Read New Hampshire State Representative, District 16	Ann Robinson Seabrook Library
Peter C.L. Roth Senior Assistant Attorney General, New Hampshire Department of Justice	Michael Schidlovsky	Brona Simon SHPO, Massachusetts Historical Commission
Peter Somssich	Dennis Wagner	David Webster Branch Chief EPA, Region 1
Christian Williams NHDES	Cathy Wolff	

1.9 Status of Compliance

NextEra is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. Appendix H to the GEIS describes some of the major Federal statutes. Table 1.9-1 lists the permits and licenses issued by Federal, State, and local authorities for activities at Seabrook.

Table 1.9-1. Licenses and permits

Existing environmental authorizations for Seabrook operations.

Permit	Number	Dates	Responsible agency
Operating License	NPF-86	Issued: 3/15/1990 Expires: 3/15/2030	Operating License
National Pollutant Discharge Elimination System (NPDES) Permit	NH0020338	Issued: 4/1/2002 Expired: 4/1/2007 Renewal application submitted: 9/25/2006	EPA
NPDES Storm Water Multi-Sector General Permit for Industrial Activities	Notice of Intent Number NHR05A729	Issued: 9/29/2008 Expires: 9/29/2013	EPA
Hazardous Materials Certificate of Registration	061109 003 013RT	Issued: 6/15/2009 Expires: 6/30/2012	U.S. Department of Transportation
Permit to Discharge	SEA1003	Issued: 5/21/2010 Expires: 5/20/2013	Town of Seabrook
Certificate of Compliance	021207930308A	Issued: 3/20/2008 Expires:12/11/2010 Renewal application submitted: 8/7/2010	NHDES, Waste Management Division

Permit	Number	Dates	Responsible agency
Title V General Permit	GSP-EG-225	Issued: 7/2/2008 Expires: 4/30/2013	NHDES, Air Resources Division
Title V Operating Permit	TP-OV-04-017	Issued: 6/5/2006 Expires: 6/30/2011 Renewal application submitted: 12/22/2010	NHDES, Air Resources Division
Hazardous Waste Limited Permit	DES-HW-LP-02-09	Issued: 10/9/2008 Expires: 10/9/2013	NHDES, Waste Management Division
Aboveground Storage Tank Registration	Facility ID#930908A	Issued: 12/24/2007 Expires: N/A	NHDES, Waste Management Division
Permit to Display Finfish and Invertebrates	MFD 0801	Issued: 1/1/2011 Expires: 12/31/2011	New Hampshire Fish & Game Department
Registration to Transport Radioactive Material	FP-S-103110	Issued: 9/27/2010 Expires: 10/31/2012	Virginia Department of Emergency Management
License to Deliver Radioactive Material	T-NH001-L10	Issued: 1/1/2011 Expires:12/31/2011	Tennessee Department of Environment & Conservation
Permit to Deliver Radioactive Material	0111000045	Issued: 4/21/2011 Expires: 4/30/2012	Utah Department of Environmental Quality

1.10 References

NextEra Energy Seabrook, LLC (NextEra), 2010, "License Renewal Application, Seabrook Station," May 25, 2010, Agencywide Documents Access and Management System (ADAMS) Accession No. ML101590099.

NextEra, 2010a, "License Renewal Application, Seabrook Station," Appendix E, "Applicant's Environmental Report, Operating License Renewal Stage," May 25, 2010, ADAMS Accession Nos. ML101590092 and ML101590089.

NextEra, 2011, Letter from P. Freeman, Site Vice President, NextEra, to NRC Document Control Desk, "Subject: Seabrook Station Environmental Permit Renewals," February 18, 2011, ADAMS Accession No. ML110550161.

U.S. Nuclear Regulatory Commission (NRC), 1996, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, Volumes 1 and 2, May 31, 1996, ADAMS Accession Nos. ML040690705 and ML040690738.

NRC, 1999, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, Volume 1, Addendum 1, Section 6.3, "Transportation," Table 9.1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report," August 31, 1999, ADAMS Accession No. ML040690720.

NRC, 2010, "NextEra Energy Seabrook; Notice of Intent to Prepare an Environmental Impact Statement and Conduct the Scoping Process for Seabrook Station, Unit 1," *Federal Register*, Vol. 75, No. 138, pp. 42168–42170, July 20, 2010.

NRC, 2011, "Issuance of Environmental Scoping Summary Report Associated with the Staff's Review of the Application by NextEra Energy Seabrook, LLC for Renewal of the Operating License for Seabrook Station (TAC Number ME3959)," March 1, 2011, ADAMS Accession No. ML110100113.

2.0 AFFECTED ENVIRONMENT

Seabrook Station (Seabrook) is located in the Town of Seabrook, Rockingham County, NH, 2 miles (mi) (3.2 kilometers (km)) west of the Atlantic Ocean. Seabrook is approximately 2 mi (3.2 km) north of the Massachusetts state line, 15 mi (24 km) south of the Maine state line, and 10 mi (16 km) south of Portsmouth, NH. There are two metropolitan areas within 50 mi (80 km) of the site: Manchester, NH (31 mi (50 km) west-northwest) and Boston, MA (41 mi (66 km) south-southwest). Figure 2.1-1 and Figure 2.1-2 present the 6-mi (10-km) and 50-mi (80-km) vicinity maps, respectively.

Because existing conditions are partially the result of past construction and operation at the plant, the impacts of these past and ongoing actions, and how they have shaped the environment, are presented in this chapter. Section 2.1 describes the facility and its operation; Section 2.2 discusses the affected environment; and Section 2.3 describes related Federal and State activities near the site.

2.1 <u>Facility Description</u>

The Seabrook site spans 889 acres (ac) (360 hectare (ha)) on a peninsula bordered on the north by Browns River, Hunts Island Creek on the south, and estuarine marshlands on the east. Seabrook is divided into two lots. Lot 1 is owned by the joint owners of Seabrook and encompasses approximately 109 ac (44 ha). This is where most of the operating facility is located and is mostly developed. Site structures include the Unit 1 containment building, primary auxiliary building (PAB), fuel storage building, waste processing building, control and diesel generator building, turbine building, administration and service building, ocean intake and discharge structures, circulating water pump house, and service water pump house (NextEra, 2010a). The original construction plans called for two identical units at Seabrook; however, construction on Unit 2 was halted prior to completion. The remaining Unit 2 buildings are now used primarily for storage.

Lot 2 is owned by NextEra Energy Seabrook, LLC (NextEra) and is approximately 780 ac (316 ha) and is also the exclusion area. Lot 2 is mainly an open tidal marsh area with fabricated linear drainage ditches and tidal creeks. This area is made available for wildlife resources (NextEra, 2010a). Figure 2.1-3 provides a general layout of Seabrook.

2.1.1 Reactor and Containment Systems

Seabrook Unit 1 is a nuclear-powered steam electric generating facility that began commercial operation on August 19, 1990. Though NextEra initially planned for two units at Seabrook, NextEra cancelled construction of Unit 2 in 1984. NextEra has no plans to complete Unit 2 in the future. Seabrook Unit 1 is powered by a Westinghouse pressurized water reactor (PWR). Westinghouse Electric Company supplied the nuclear steam supply system, and General Electric Company supplied the turbine generator. The nuclear steam supply system at Seabrook is a four-loop PWR. The reactor core heats up water, which is then pumped to four U-tube heat exchangers—known as steam generators—where the heat boils the water on the shell-side into steam. After drying, the steam travels to the turbines. The steam yields its energy to turn the turbines, which connect to the electrical generator.

Figure 2.1-1. Location of Seabrook, 6-mi (10-km) region

Source: (NextEra, 2010a)

Figure 2.1-2. Location of Seabrook, 50-mi (80-km) region

Source: (NextEra, 2010a)

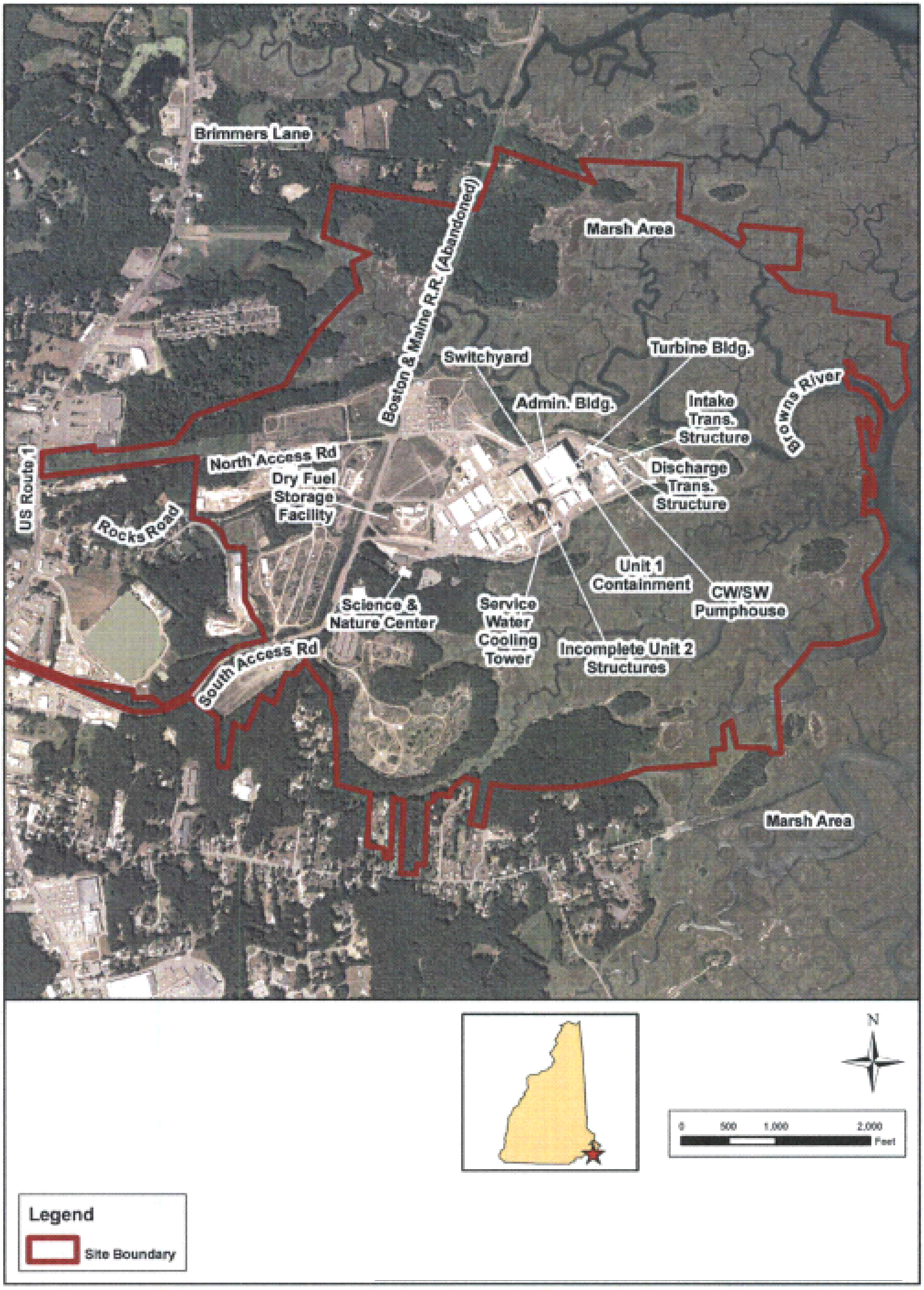


Figure 2.1-3. Seabrook site boundary and facility layout

Source: (NextEra, 2010a)

The reactor, steam generators, and related systems are enclosed in a containment building that is designed to prevent uncontrolled emissions of radioactivity to the environment. The containment building is a reinforced concrete cylinder with a slab base and hemispherical dome. A carbon steel liner attached to the inside face of the concrete shell ensures a high degree of leak tightness. In addition, the 3.6-foot (ft) (1.1-meter (m)) thick concrete walls serve as a radiation shield for both normal and accident conditions (NextEra, 2010a).

Seabrook fuel for the reactor core consists of low-enriched (less than 5 percent by weight) uranium-235. Fuel design is such that individual rod average burnup (burnup averaged over the length of the fuel rod) will not exceed 62,000 megawatt days (MWd) per metric ton uranium (MTU). Unit 1 originally produced a reactor core power of 3,411 megawatts-thermal (MWt). The reactor core power was increased in 2005 to 3,587 MWt and then again in 2006 to the plant's current output of 3,648 MWt. The original design net electrical capacity was 1,198 megawatts-electric (MWe), which was increased to 1,221 MWe in 2005 and then to 1,245 MWe in 2006 (NextEra, 2010a).

2.1.2 Radioactive Waste Management

The radioactive waste systems collect, treat, and dispose of radioactive and potentially radioactive wastes that are byproducts of Seabrook operations. The byproducts are activation products resulting from the irradiation of reactor water and impurities within the reactor water (principally metallic corrosion products) and fission products, resulting from defective fuel cladding or uranium contamination within the reactor coolant system. Operating procedures for the radioactive waste system ensure that radioactive wastes are safely processed and discharged from Seabrook. The systems are designed and operated to assure that the quantities of radioactive materials released from Seabrook are as low as is reasonably achievable (ALARA) and within the dose standards set forth in Title 10, Part 20 of the *Code of Federal Regulations* (10 CFR Part 20), "Standards for Protection against Radiation," and 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." The Seabrook Offsite Dose Calculation Manual (ODCM) contains the methods and parameters used to calculate offsite doses resulting from radioactive effluents. These methods are used to ensure that radioactive material discharged from Seabrook meets regulatory dose standards.

Radioactive wastes resulting from Seabrook operations are classified as liquid, gaseous, and solid. Radioactive wastes generated by Seabrook operations are collected and processed to meet applicable requirements. The design and operational objectives of the radioactive waste management systems are to limit the release of radioactive effluents from Seabrook during normal operation and anticipated operational occurrences (NextEra, 2010a).

Reactor fuel that has exhausted a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages, typically every 18 months. Spent nuclear fuel from the reactor is stored onsite in a spent fuel pool and a dry fuel storage facility. The dry fuel storage facility is licensed in accordance with 10 CFR Part 72 (NextEra, 2010a).

Storage of radioactive materials is regulated by the U.S. Nuclear Regulatory Commission (NRC) under the Atomic Energy Act of 1954, as amended, and storage of hazardous wastes is regulated by the U.S. Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act of 1976 (RCRA).

Systems used at Seabrook to process liquid, gaseous, and solid radioactive wastes are described in the following sections.

2.1.2.1 Radioactive Liquid Waste System

The Seabrook liquid waste system collects, segregates, stores, and disposes of radioactive liquid waste. This system is designed to reduce radioactive materials in liquid effluents to levels that are ALARA and reduce the volume of waste through recycling. The system collects and transports non-corrosive, radioactive, or potentially radioactive liquid wastes from equipment and floor drains to be processed using a combination of filtration and demineralization (NextEra, 2010a).

All liquid radwaste process systems end in either a sample or distillate tank. Liquid wastes are processed on a batch basis so that each treated batch can be sampled. Depending on the sample results, the waste is either reprocessed or returned to the condensate storage tanks for reuse in Seabrook. Once the liquid waste is processed, it is evaluated to meet discharge limit requirements and then released to the Atlantic Ocean via the station's discharge transition structure. Radioactive effluent releases require positive operator action, are continuously monitored, and can be automatically terminated in the event of a high radiation alarm or a power failure.

Any solid wastes generated as a byproduct of the liquid waste processing system are packaged for offsite shipment. Evaporators that were installed for use in the liquid waste processing system but then never used are being evaluating for long-term lay-up or abandonment (NextEra, 2010a).

2.1.2.2 Radioactive Gaseous Waste System

Gaseous waste management systems process and control the release of gaseous radioactive effluents to the atmosphere. The purpose of the radioactive gaseous waste system is to collect and process radioactive and potentially radioactive waste gas. This system also limits the release of gaseous activity so that personnel exposure and activity releases, in restricted and unrestricted areas, are ALARA. The radioactive gaseous waste system is used to reduce radioactive materials in gaseous effluents before discharge to meet the dose limits in 10 CFR Part 20 and the dose design objectives in Appendix I to 10 CFR Part 50. Offgases from the main condenser are the major source of gaseous radioactive waste. Other radioactive gas sources collected by the system include leakage from steam piping and equipment in the reactor building, turbine generator building, and radwaste building.

Before release into the environment through the PAB normal ventilation cleanup exhaust unit, the gas is passed through charcoal and particulate filtration media. Seabrook discharges gaseous waste in accordance with the procedures and methods described in the ODCM so that exposure to persons offsite are ALARA and do not exceed limits specified in 10 CFR Part 20 and Appendix I to 10 CFR Part 50.

2.1.2.3 Radioactive Solid Waste Processing Systems

Seabrook's solid waste management system is designed to safely collect, process, package, store, and prepare radioactive wet and dry solid waste materials generated by plant operations for shipment to an offsite waste processor for disposal at a licensed burial facility. The system is designed to process waste while maintaining occupational exposure at ALARA. To ensure compliance with applicable regulations in 10 CFR Parts 20, 61, and 71, characterization, classification, processing, waste storage, handling, and transportation of solid wastes are controlled by the Process Control Program.

Due to differences in radioactivity or contamination levels of the many wastes, various methods are employed for processing and packaging. The disposition of a particular item of waste is determined by its radiation level, type, presence of hazardous material, and the availability of disposal space. The wet solid wastes system transfers resins from sluice tanks to liners to then be packaged for offsite shipment. Solid dry active wastes—such as contaminated paper, plastic, wood, metals, and spent resin—may be processed by compaction in either boxes or cargo containers. During compaction, the airflow in the vicinity of the compactor is directed by the compactor exhaust fan through a high-efficiency particulate filter before it is discharged. Large or highly radioactive components and equipment, that have been contaminated during reactor operation and that are not amenable to compaction, are handled either by qualified plant personnel or by outside contractors specializing in radioactive materials handling, and the components and equipment are packaged in shipping containers for transportation offsite. Solid radioactive wastes are packaged and shipped from Seabrook in containers that meet the requirements established by the U.S. Department of Transportation and by the NRC.

Seabrook also generates small quantities of low-level mixed waste—waste that exhibits hazardous characteristics and contains low levels of radioactivity. The plant generates approximately 1 gallon (gal) per year of mixed waste as a byproduct of oil and grease analyses. Seabrook is classified as a Federal Small Quantity Generator (SQG) of Hazardous Waste and is not permitted for mixed waste storage; the mixed waste is collected and sent to a licensed facility for processing and disposal within 90 days. Some unique plant maintenance events, such as steam generator cleaning, can generate a larger amount of mixed waste. During the 2009 refueling outage, for example, 40 tons of mixed waste was generated during chemical cleaning of the steam generators, a process that may be performed in future outages. Any additional mixed waste resulting from this process will be collected and sent to a licensed processor within 90 days.

Class A waste is collected, sorted, packaged, and shipped offsite to the Clive, Utah disposal facility—a licensed radioactive waste landfill—for further processing. Seabrook currently ships Class B and C waste to Studsvik, a waste processing facility in Erwin, TN. Studsvik processes this waste and then, through a State of Tennessee-licensed attribution model, is allowed to take title of Seabrook's wastes. After processing and taking title of the wastes, Studsvik then sends the material to Waste Control Specialists in Andrews County, TX for long-term storage and disposal. Seabrook has an existing contract with Studsvik to process its Class B and C waste in this manner; however, should this contract expire, Seabrook would potentially need to store its Class B and C waste onsite.

Onsite, NextEra estimates that it has sufficient capacity to store Class B and C waste in its waste processing building for approximately 7 years. If NextEra were unable to find a replacement processing and disposal facility for Studsvik, 7 years of onsite storage capacity would provide a sufficient buffer, allowing enough time to design, site, and install a Class B and C waste storage facility onsite. If such a facility were required in the future, it would need to meet any relevant State and Federal licensing requirements, and the potential environmental impacts of the construction and operation of the facility would be evaluated at that time.

NextEra currently has contracts in place for processing and disposal of its Class A, B, and C wastes—and because it has a sufficient amount of storage onsite—Seabrook would be able to safely handle and store its radioactive waste during the term of license renewal.

2.1.3 Nonradiological Waste Management

Seabrook generates nonradioactive wastes as part of routine plant maintenance, cleaning activities, and plant operations. RCRA waste regulations governing the disposal of solid and hazardous waste are contained in 40 CFR Parts 239—299. In addition, 40 CFR Parts 239—259 contain regulations for solid (nonhazardous) waste, and 40 CFR Parts 260—279 contain regulations for hazardous waste. RCRA Subtitle C establishes a system for controlling hazardous waste from "cradle to grave," and RCRA Subtitle D encourages States to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills. New Hampshire State RCRA regulations are administered by the New Hampshire Department of Environmental Services (NHDES) and address the identification, generation, minimization, transportation, and final treatment, storage, or disposal of hazardous and nonhazardous waste.

2.1.3.1 Nonradioactive Waste Streams

Seabrook generates solid waste, defined by the RCRA, as part of routine plant maintenance, cleaning activities, and plant operations. New Hampshire is part of EPA Region 1 and its Solid Waste Program. In 1991, the EPA authorized NHDES to administer portions of the RCRA Program in the State of New Hampshire that are incorporated into Env-Wm 100-1100 of the New Hampshire Code of Administrative Rules.

The EPA classifies certain nonradioactive wastes as hazardous based on characteristics including ignitability, corrosivity, reactivity, or toxicity (hazardous wastes are listed in 40 CFR Part 261). State-level regulators may add wastes to the EPA's list of hazardous wastes. RCRA supplies standards for the treatment, storage, and disposal of hazardous waste for hazardous waste generators (regulations are available in 40 CFR Part 262).

The EPA recognizes the following main types of the hazardous waste generators (40 CFR 260.10) based on the quantity of the hazardous waste produced:

- large quantity generators that generate 2,200 pounds (lb) (1,000 kilograms (kg)) per month or more of hazardous waste, more than 2.2 lb (1 kg) per month of acutely hazardous waste, or more than 220 lb (100 kg) per month of acute spill residue or soil
- SQGs that generate more than 220 lb (100 kg) but less than 2,200 lb (1,000 kg) of hazardous waste per month
- conditionally-exempt small quantity generators that generate 220 lb (100 kg) or less per month of hazardous waste, 2.2 lb (1 kg) or less per month of acutely hazardous waste, or less than 220 lb (100 kg) per month of acute spill residue or soil.

The State of New Hampshire has incorporated the EPA's regulations regarding hazardous wastes and recognizes Seabrook as an SQG of hazardous wastes under New Hampshire Code of Administrative Rules Env-Wm 1403. Seabrook hazardous wastes include waste paint, waste solvents, expired laboratory chemicals, and microfilm processing waste (NextEra, 2010a).

The EPA classifies several hazardous wastes as universal wastes; these include batteries, pesticides, mercury-containing items, and fluorescent lamps. NHDES has incorporated the EPA's regulations (40 CFR Part 273) regarding universal wastes in New Hampshire Code of Administrative Rules Env-Hw 1101. Universal wastes produced by Seabrook are disposed of or recycled in accordance with NHDES regulations.

Conditions and limitations for wastewater discharge by Seabrook are specified in National Pollution Discharge Elimination System (NPDES) Permit No. NH0020338. Radioactive liquid waste is addressed in Section 2.1.2 of this supplemental environmental impact statement (SEIS). Section 2.2.4 gives more information about Seabrook NPDES permit and permitted discharges.

The Emergency Planning and Community Right-to-Know Act (EPCRA) requires applicable facilities to supply information about hazardous and toxic chemicals to local emergency planning authorities and the EPA (42 USC 11001). On October 17, 2008, the EPA finalized several changes to the Emergency Planning (Section 302), Emergency Release Notification (Section 304), and Hazardous Chemical Reporting (Sections 311 and 312) regulations that were proposed on June 8, 1998 (63 FR 31268). Seabrook is subject to Federal EPCRA reporting requirements; thus, Seabrook submits an annual Section 312 (Tier II) report on hazardous substances to local emergency response agencies.

2.1.3.2 Pollution Prevention and Waste Minimization

Currently, Seabrook has waste minimization measures in place, as verified during the Seabrook site visit conducted by NRC in October 2010. In support of nonradiological waste-minimization efforts, the EPA's Office of Prevention and Toxics has established a clearinghouse that supplies information about waste management and technical and operational approaches to pollution prevention (EPA, 2010f). The EPA clearinghouse can be used as a source for additional opportunities for waste minimization and pollution prevention at Seabrook, as appropriate.

The EPA also encourages the use of environmental management systems (EMSs) for organizations to assess and manage the environmental impacts associated with their activities, products, and services in an efficient and cost-effective manner. The EPA defines an EMS as "a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency." EMSs help organizations fully integrate a wide range of environmental initiatives, establish environmental goals, and create a continuous monitoring process to help meet those goals. The EPA Office of Solid Waste especially advocates the use of EMSs at RCRA-regulated facilities to improve environmental performance, compliance, and pollution prevention (EPA, 2010g).

2.1.4 Plant Operation and Maintenance

Maintenance activities conducted at Seabrook include inspection, testing, and surveillance to maintain the current licensing basis (CLB) of the facility and to ensure compliance with environmental and safety requirements. Various programs and activities currently exist at Seabrook to maintain, inspect, test, and monitor the performance of facility equipment. These maintenance activities include inspection requirements for reactor vessel materials, boiler and pressure vessel inservice inspection and testing, the Maintenance Structures Monitoring Program, and maintenance of water chemistry.

Additional programs include those carried out to meet technical specification surveillance requirements, those implemented in response to the NRC generic communications, and various periodic maintenance, testing, and inspection procedures (NextEra, 2010a). Certain program activities are carried out during the operation of the unit, while others are carried out during scheduled refueling outages. Nuclear power plants must periodically discontinue the production of electricity for refueling, periodic inservice inspection, and scheduled maintenance. Seabrook refuels on an 18-month interval (NextEra, 2010a).

2.1.5 Power Transmission System

Three 345-kV transmission lines connect Seabrook to the regional electric grid. Two of these lines are wholly owned and operated by Public Service Company of New Hampshire (PSNH), and one of the lines is owned and operated by PSNH (in New Hampshire) and National Grid (in Massachusetts). Unless otherwise noted, the discussion of the power transmission system is adapted from the Environmental Report (ER) (NextEra, 2010a) or information gathered at NRC's environmental site audit.

The transmission lines cross through Hillsborough and Rockingham Counties, NH, and Essex and Middlesex Counties, MA. In total, the transmission lines associated with the operation of Seabrook span 83 mi (134 km) and comprise approximately 1,759 ac (712 ha) of transmission line rights-of-way (ROWs).

Transmission lines considered in-scope for license renewal are those constructed specifically to connect the facility to the transmission system (10 CFR 51.53(c)(3)(ii)(H)); therefore, the Scobie Pond Line, the Tewksbury Line, and the Newington Line are considered in-scope for this SEIS and are discussed below in detail. All three of these transmission lines will remain a permanent part of the transmission system and will be maintained by PSNH and National Grid, regardless of Seabrook's continued operation.

Figure 2.1-4 is a map of the Seabrook transmission system. Table 2.1-1 summarizes the transmission lines. The three transmission lines are as follows:

Scobie Pond Line: This line extends westward for 5 mi (8 km) in a 245- to 255-ft (75- to 78-m)-wide ROW that it shares with the Tewksbury Line. The line then splits off and extends westward an additional 25 mi (40 km) in a 170-ft (52-m)-wide ROW to the Scobie Pond Station in Derry, NH. This line spans Rockingham and Hillsborough Counties, NH, and it is owned and operated by PSNH.

Tewksbury Line: This line extends westward for 5 mi (8 km) in a 245- to 255-ft (75- to 78-m)-wide ROW that it shares with the Scobie Pond Line. The line then splits off and extends southwestward an additional 35 mi (56 km) in a 170-ft (52-m)-wide ROW to the Tewksbury Station in Tewksbury, MA. This line spans Rockingham County, NH, and Essex and Middlesex Counties, MA. PSNH owns and operates the New Hampshire portion of the line, and National Grid owns and operates the Massachusetts portion of the line.

Newington Line: This line extends northward for 18 mi (29 km) in a 170-ft (52-m)-wide ROW to the Newington Generating Station in Newington, NH. This line is contained within Rockingham County, NH, and it is owned and operated by PSNH.

In order to ensure power system reliability and to comply with applicable Federal and State regulations, PSNH and National Grid maintain transmission line ROWs to prevent physical interference that could result in short-circuiting. This maintenance generally consists of removing or cutting tall-growing vegetation under the lines and removing or trimming of any trees near the edge of the ROWs that could fall on the lines.

Both PSNH and National Grid are required by law to comply with the North American Electric Reliability Corporation (NERC)'s FAC-003-1, Transmission Vegetative Maintenance Program (NERC, 2006) and the Northeast Power Coordinating Council's Associated Vegetative Management Program compliance requirements. FAC-003-1 reliability standards require transmission owner to maintain a formal transmission Vegetation Management Program that includes an annual plan specifying each year's work, to maintain appropriate clearances between lines and any vegetation, and to report any vegetation-related outages to the appropriate Regional Reliability Organization. According to NERC's public listing of enforcement actions, neither PSNH nor National Grid have had a compliance violation associated with vegetative maintenance between June 2008[1] through the time that this draft SEIS was published (NERC, 2010).

Generally, vegetative maintenance practices target low-growing, early successional habitat and associated plant species to minimize the intensity of maintenance over time. Specific practices vary between PSNH and National Grid and are discussed in more detail below.

[1] NERC does not have a list of enforcement actions prior to June 2008 available on their public website.

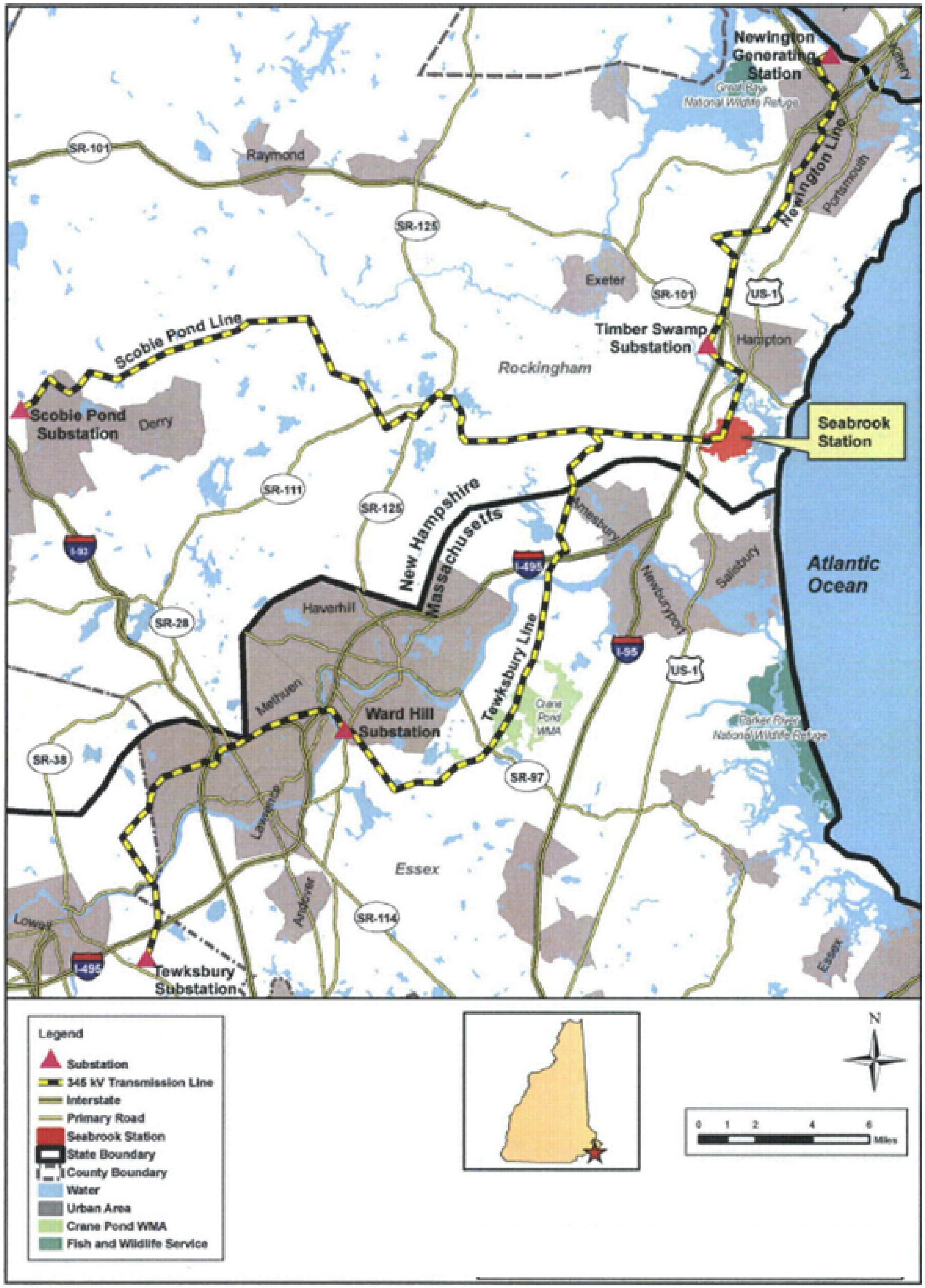


Figure 2.1-4. Seabrook transmission line map

Source: (NextEra, 2010a)

Table 2.1-1. Seabrook transmission lines

Line	Owner	kV	Approximate distance, mi (km)	ROW width,[a] ft (m)	ROW area, ac (ha)
Scobie Pond	PSNH	345	30 (48)	170 (52)	667 (270)[b]
Tewksbury	PSNH	345	40 (64)	170 (52)	873 (353)[b]
Newington	PSNH & National Grid	345	18 (29)	170 (52)	371 (150)

[a]Value given represents the typical width or typical width range along line, though ROW width may vary at intervals along the length of the line.

[b]Values given for ROW area are not mutually exclusive because the Scobie Pond and Tewksbury Lines share a 5-mi (8-km)-long stretch of ROW.

Source: (NextEra, 2010a)

Vegetative Maintenance in New Hampshire

The Scobie Pond and Tewksbury Lines, as well as the New Hampshire portion of the Newington Line, are maintained by PSNH, a subsidiary of Northeast Utilities Service Company (NU).

To identify areas requiring maintenance, PSNH conducts aerial inspections twice per year and follows up by conducting ground inspections in those areas that are targeted for maintenance work. PSNH maintains ROWs on a 4- to 7-year cycle and targets about 15–25 percent of the total acreage to be maintained in a given year (PSNH, 2010). PSNH only selectively hand cuts or mechanically mows vegetation; PSNH does not spray any herbicides within ROWs in the State of New Hampshire. PSNH may spray herbicides selectively in switchyards or other non-ROW areas only. NU standards also prohibit the use of mechanized vehicles within designated wetlands and wet areas.

Generally, PSNH's vegetative maintenance practices encourage the growth of low-growing native shrub and tree species such as bayberry (*Myrica* spp.), dogwood (*Cornus* spp.), elderberry (*Sambucus* spp.), hazelnut (*Corylus* spp.), honeysuckle (*Lonicera* spp.), meadowsweet (*Filipendula ulmaria*), mountain-laurel (*Kalmia latifolia*), juniper (*Juniperus* spp.), spicebush (*Lindera* spp.), and winterberry (*Ilex verticillata*) within the conductor zone. Species such as alder (*Alnus* spp.), hornbeam (*Carpinus* spp.), dogwood, sumac (*Rhus* spp.), willows (*Salix* spp.), and witch-hazel (*Hamamelis*) are encouraged in the border zone along the edges of the ROWs. Additionally, PSNH workers are trained to recognize Federally or State-protected plant species that may occur in the ROWs in order to avoid impacts to these species.

PSNH specifically targets the following invasive species for removal when conducting maintenance: multiflora rose (*Rosa multiflora*), common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), autumn olive (*Elaeagnus umbellate*), Russian olive (*Elaeagnus angustifolia*), Japanese barberry (*Berberis thunbergii*), and common barberry (*Berberis vulgaris*). PSNH has machine cleaning protocol for workers to follow in areas that contain invasive species to reduce the likelihood that vegetative maintenance activities would facilitate the spread of any invasive species.

Within wetlands, PSNH follows the New Hampshire Department of Resources and Economic Development (NHDRED)'s *Best Management Practices Manual for Utility Maintenance In and Adjacent to Wetlands and Waterbodies in New Hampshire* (NHDRED, 2010). This document directs utility companies to avoid wetlands when at all possible, minimize the disturbed area, preserve low-growing native vegetation, and limit work within wetland areas to the winter months when the ground is frozen and dry. The document also describes what types of equipment create the lowest impact on vegetation and wetland habitat, equipment maintenance strategies that can reduce the risk of oil or other chemical spills and reduce the spread of invasive species, and ways to minimize impacts on streams and near stream crossings.

Additionally, PSNH voluntarily follows the American National Standards Institute (ANSI) guideline document, *A300 Standards for Tree Care Operations*, which contains requirements and recommendations for tree care practices including pruning, lightning protection, and integrated vegetation management.

Vegetative Maintenance in Massachusetts

The Massachusetts portion of the Newington line is maintained by National Grid.

National Grid conducts vegetative maintenance on a 3- to 5-year cycle, following a yearly operation plan that is approved by the Massachusetts Department of Fish and Game (MDFG)'s Division of Fisheries and Wildlife to ensure that practices are not adversely affecting sensitive species or wetlands. Vegetation is generally targeted for maintenance when it reaches 6–10 ft (3 m) in height or when growth becomes moderate to high in density. National Grid follows an integrated vegetation management approach, which combines hand cutting, mechanical mowing, and selective herbicide application to encourage the long-term establishment of early successional habitat—characterized by low-growing species—over time. Ideal and encouraged habitats include wetlands, vernal pools, heaths, barrens, scrub land, fields, and meadows. Additionally, National Grid workers are regularly briefed on how to recognize Federally or State-protected plant species that may occur in the ROWs in order to avoid impacts to these species.

National Grid specifically targets the following invasive species for removal when conducting maintenance: multiflora rose, Japanese knotweed (*Fallopia japonica*), oriental bittersweet (*Celastrus orbiculatus*), glossy buckthorn, and others that are specified on the U.S. Department of Agriculture's (USDA's) (USDA, 2010) list of Massachusetts invasive and noxious weeds.

National Grid does not spray herbicides during moderate to heavy rain, deep snowfall, or within 10 ft (3 m) of wetlands, waterways, or certified vernal pools per Title 333, Part 11 of the *Code of Massachusetts Regulations* (333 CMR 11). National Grid also restricts herbicide to limited use within 100 ft (30.5 m) of wetlands, agricultural areas, and certified vernal pools and limits application in these areas to once per 12 months. Within State-designated Priority Habitat for sensitive species, herbicide treatment is prohibited without prior written approval within the Commonwealth of Massachusetts, per 321 CMR 10.14(12). Additionally, land owners may request that their land be a "no spray zone" if they maintain the land with compatible (low-growing) vegetation that will not interfere with any transmission lines or structures.

2.1.6 Cooling and Auxiliary Water Systems

Seabrook uses a once-through cooling system that withdraws water from the Gulf of Maine and discharges to the Gulf of Maine through a system of tunnels that have been drilled through ocean bedrock. Unless otherwise cited, the NRC staff drew information about Seabrook's cooling and auxiliary water systems from the NPDES Permit (EPA, 2002) and the applicant's ER (NextEra, 2010a).

Water withdrawn from the Gulf of Maine enters an intake tunnel—located at a depth of 60 ft (18.3 m)—and then travels through one of three concrete intake shafts. Each intake shaft extends upward from the intake tunnel above the bedrock. A velocity cap, which sits on top of each intake shaft (Figure 2.1-5), regulates flow and minimizes fish entrapment. The NPDES permit limits the intake velocity to 1.0 ft per second (0.3 m per second) (EPA, 2002). In 1999, NextEra modified the intake shafts with additional vertical bars to help prevent seal entrapment (NMFS, 2002).

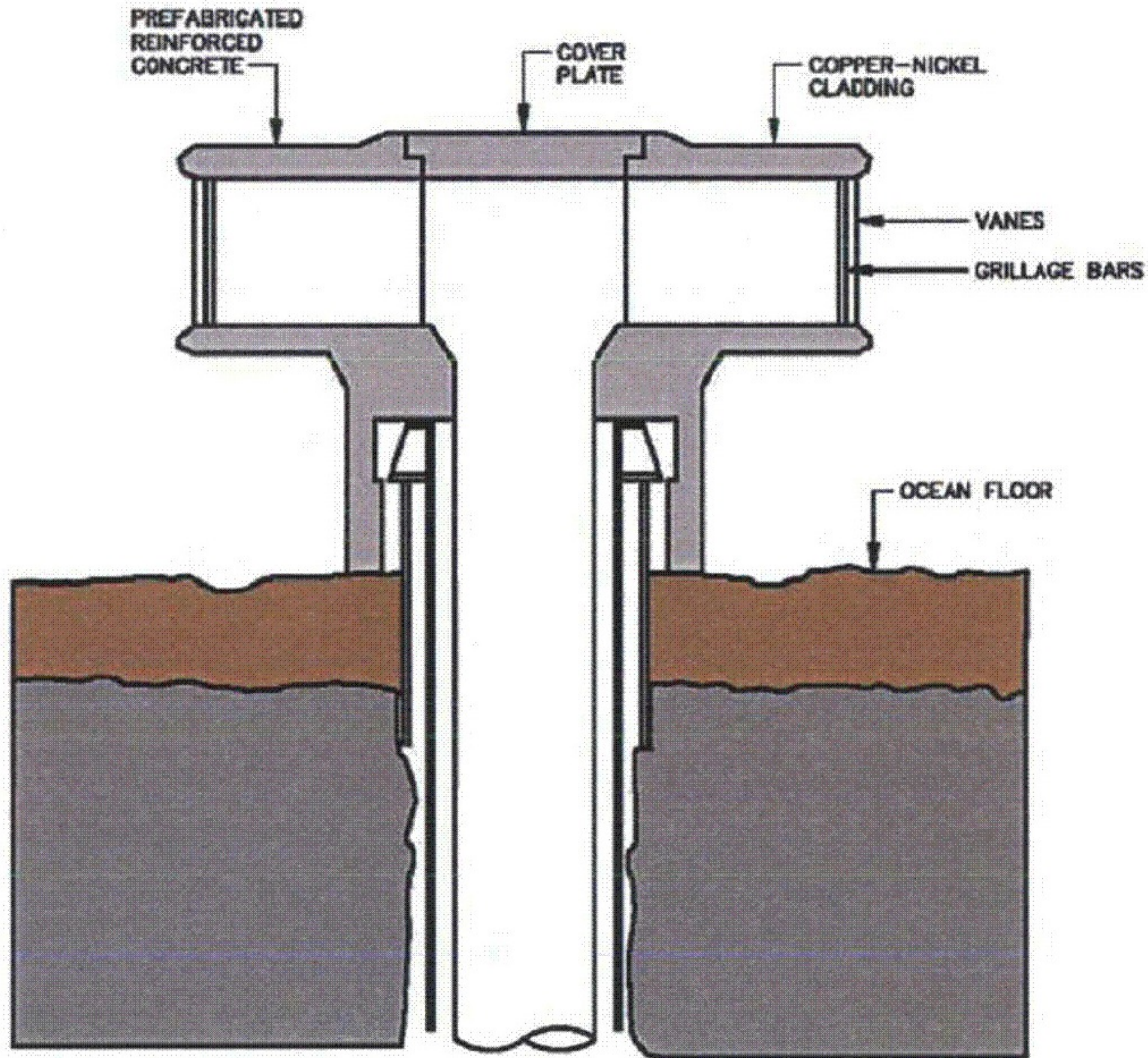


Figure 2.1-5. Intake shafts and caps at Seabrook

Source: (ARCADIS et al., 2008)

From the intake shafts, water flows through a 17,000-ft (5,182-m) intake tunnel that was drilled through the ocean bedrock. The beginning of the intake tunnel is 7,000 ft (2,134 m) from the Hampton Beach shoreline. The tunnel descends at a 0.5-percent grade from the bottom of the intake shaft, which is 160 ft (49 m) below the Gulf of Maine, to 240 ft (73 m) below mean sea level (MSL) at Seabrook (Figure 2.1-6). The 19-ft (5.8-m) diameter tunnel is concrete-lined.

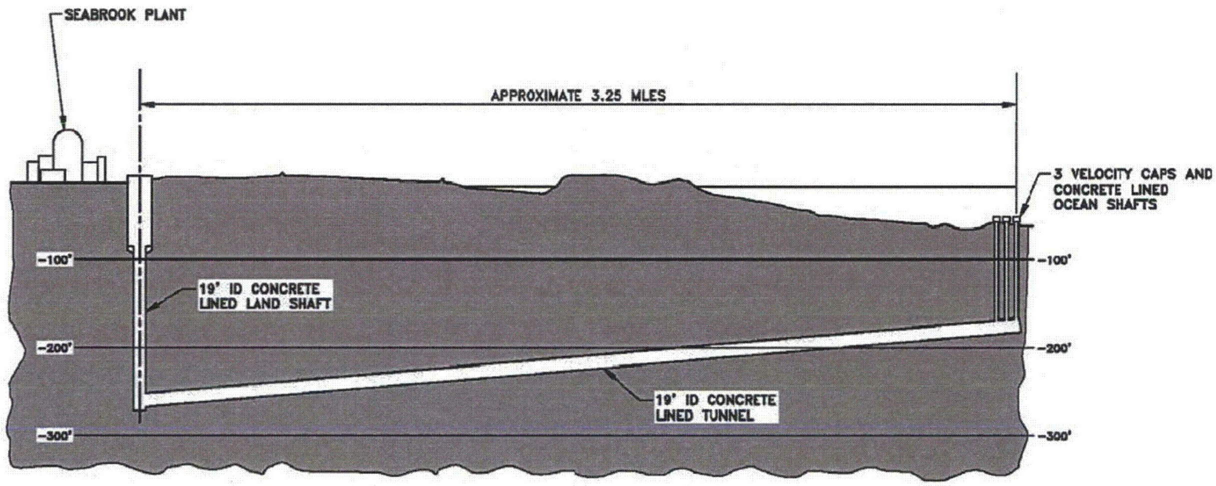


Figure 2.1-6. Profile of intake tunnel and shafts at Seabrook

Source: (ARCADIS et al., 2008)

An intake transition structure, which includes three circulating water pumps that transport the water, is located beneath Seabrook (Figure 2.1-7). Butterfly valves, 11 ft (3.3 m) in diameter, direct the water flow from the transition structure to the circulating water pump house. The water then passes through three traveling screens with a 3/8-inch (0.95-centimeters (cm)) square mesh (NextEra, 2010f). The traveling screens remove fish, invertebrates, seaweed, and other debris before the water is pumped to the main condensers and the service water system. The ocean debris is disposed as waste; therefore, none is discharged to the Gulf of Maine. The water passes to the condensers to remove heat that is rejected by the turbine cycle and auxiliary system. During normal operations, the circulating water system provides a continuous flow of approximately 390,000 gallons per minute (gpm) (869 cubic feet per second (cfs) or 24.6 cubic meters (m^3) per second (m^3/s)) to the main condenser and 21,000 gpm (47 cfs or 1.3 m^3/s) to the service water system.

Water that has passed through Seabrook discharges to the Gulf of Maine through a 16,500-ft (5,029-m) long discharge tunnel, which has the same diameter, lining, depth, and percent grade as the intake tunnel. The end of the discharge tunnel is 5,000 ft (1,524 m) from the Seabrook Beach shoreline. The effluent discharges via 11 concrete shafts that are 70 ft (21.3 m) deep and approximately 100 ft (30.5 m) apart from one another. To increase the discharge velocity and more quickly diffuse the heated effluent, a double-nozzle fixture is attached to the top of each shaft. The NPDES permit limits this discharge flow to 720 million gallons per day (mgd) (2.7 million m^3/day), and the monthly mean temperature rise may not exceed 5 degrees Fahrenheit at the surface of the receiving water (EPA, 2002).

Barnacles, mussels, and other subtidal fouling organisms can attach to concrete structures and potentially limit water flow through the tunnels. To minimize biofouling within the intake and discharge tunnels, NextEra uses a combination of physical scrubbing and a chlorination system (NextEra, 2010f). Divers physically scrub the intake structures biannually to remove biofouling organisms—such as barnacles, mussels, or other organisms—that attach to hard surfaces to grow. During outages, the inside of the intake structures are physically scrubbed to the point that chlorine is injected into the tunnels, approximately 6 ft (1.8 m) into the intake shaft. In addition, NextEra inspects the discharge diffusers during outages. The circulating water pump house, pipes, and condensers are dewatered, inspected, and cleaned as needed (FPLE, 2008).

NextEra injects chlorine and other water treatment chemicals in accordance with NPDES permit limits (EPA, 2002).

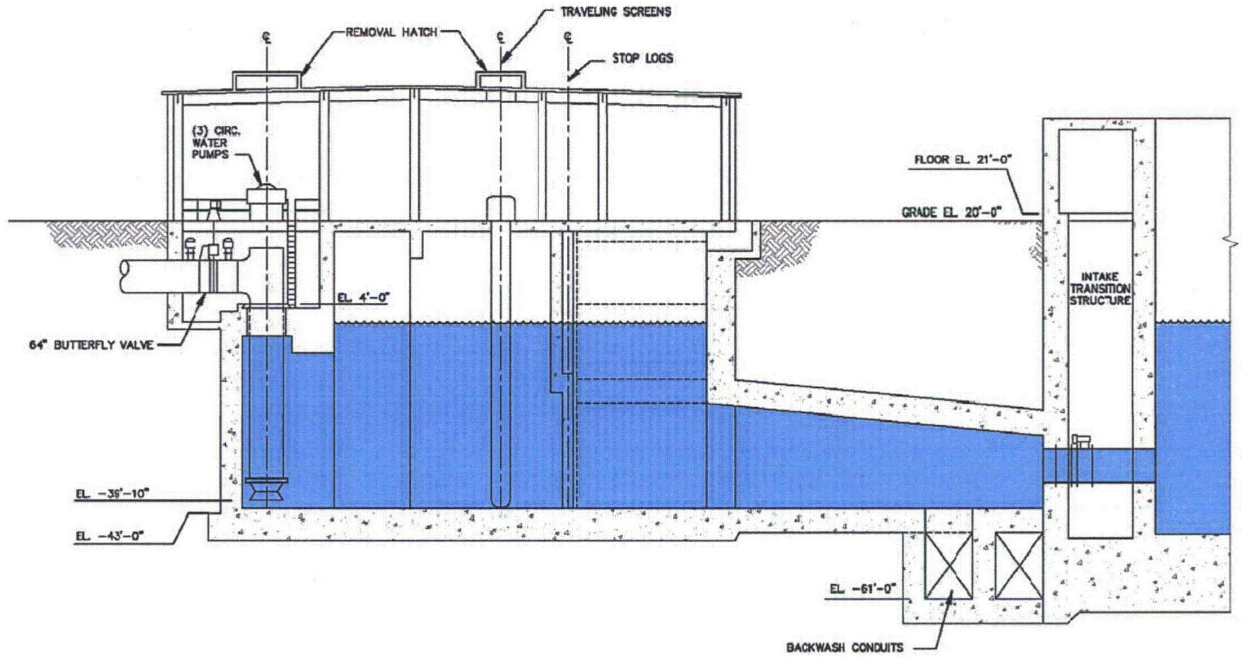


Figure 2.1-7. Circulating water pumphouse at Seabrook

Source: (ARCADIS et al., 2008)

As described above, the Gulf of Maine provides water for both the circulating water system and the service water system. Water flows from the intake structures to the service water pump house, which is separated from the circulating water system portion of the building by a seismic-reinforced concrete wall. In the event that the regular supply of cooling water from the service water pump house is unavailable, NextEra would use a standby mechanical draft evaporative cooling tower (service water tower) and 7-day makeup basin (Figure 2.1-3). This cooling tower basin has a capacity of 4.0 million gal (15,140 m^3) and is fed from the Gulf of Maine via the service water system. If ocean water is unavailable, or additional water is required, NextEra would access emergency makeup water from the domestic water supply system or from the Browns River via a portable pump (FPLE, 2008; NextEra, 2010a).

2.1.7 Facility Water Use and Quality

Seabrook relies on the Atlantic Ocean as its source of water for its circulating (cooling) and service water systems. Ocean water reaches the plant via a tunnel system that is approximately 3 mi (5 km) long. Groundwater at the site is not used as a resource, but fresh (potable) water for the plant is acquired from an offsite municipal system that uses groundwater. The following sections describe water use and relevant quality issues at Seabrook.

2.1.7.1 Surface Water Use

As discussed in Section 2.1.6, three concrete intake structures are positioned about 60 ft (18 m) below mean lower low water about 7,000 ft (2,100 m) offshore from Hampton Beach. Water flows through a tunnel approximately 3 mi (5 km) long to Seabrook and is returned to the ocean via a separate tunnel. The flow rate of ocean water for the once-through cooling system is approximately 390,000 gpm (869 cfs or 24.6 m^3/s) to the main condenser and 21,000 gpm (47 cfs or 1.3 m^3/s) to the service water system (NextEra, 2010a).

Ocean water may also be used at the station's standby emergency mechanical draft cooling tower (service water tower) and 7-day makeup water reservoir. If ocean water is unavailable to the system, emergency makeup water for the tower could be taken from the municipal water supply system or from a portable pump in the Browns River (FPLE, 2008).

2.1.7.2 Groundwater Use

Onsite groundwater is not currently used as a source of water for Seabrook. Potable water for Seabrook is currently obtained from the Town of Seabrook Water Department, which operates a system of ten municipal supply wells (NextEra, 2010a). Potable water is used by Seabrook for drinking and sanitary purposes and as makeup water to the fire water storage tanks, cooling tower, and the water treatment system (WTS). The WTS is designed to process fresh water into demineralized and deoxygenated makeup water for secondary plant systems (FPLE, 2008). Seabrook's annual average potable water use is approximately 42 million gal (159,000 cubic meters (m^3)) or about 80 gpm (300 liters per minute (L/min)) (NextEra, 2010a).

A total of 15 wells were originally installed in the bedrock aquifer to supply fresh water to the station. These were installed in two well fields located about 2,000 ft (610 m) west and 3,000 ft (910 m) north of the site. Only seven of the wells were ultimately developed and were operated to provide approximately 200 gpm (760 L/min) of water for the plant. This water was in addition to about 35 gpm (130 L/min) of water obtained from the Town of Seabrook municipal system. Since 1986, Seabrook has relied solely on the municipal system for its fresh water needs (NextEra, 2010a). During the site audit, NextEra confirmed that onsite groundwater was never used for drinking and that plans were being developed to properly abandon the seven existing supply wells and several other wells no longer used for monitoring, site characterization, or other purposes.

Groundwater is pumped onsite for dewatering and tritium plume control. Approximately 32,000 gallons per day (gpd) (120 m^3) of groundwater is pumped from the subsurface of the Unit 2 containment building to control groundwater inflow (RSCS, 2009). As discussed in Section 2.2.5, groundwater is also extracted at much lower rates from five dewatering points in order to contain relatively high tritium levels at Unit 1.

2.2 <u>Surrounding Environment</u>

Seabrook is located on 889 ac (360 ha) 2 mi (3.2 km) west of the Atlantic Ocean. The site is located about 2 mi (3.5 km) inland, in a marshland area located between Brown's River to the north and Hunt's Island Creek to the south, on an area of second-growth native forest.

Haverhill, MA, is the nearest population center and is located approximately 15 mi (24 km) southwest of the site. There are two metropolitan centers within 50 mi (80 km) of the site; Manchester, NH, located 31 mi (50 km) northwest, and Boston, MA, 41 mi (66 km) south.

2.2.1 Land Use

Broad open areas of low tidal marsh border Seabrook to the north, south, and east. Numerous tidal creeks and artificial linear drainage ditches divide the tidal marsh. The marsh is interrupted by wooded islands and peninsulas, which rise to elevations of 20–30 ft (6–9 m) above MSL. Seabrook is located on a peninsula, approximately 20 ft (6 m) in elevation, rising 16 ft (4.9m) above the surrounding Hampton Flats Salt Marsh (AEC, 1974; FPLE, 2008). The Hampton Harbor Estuary, a shallow lagoon behind the barrier beaches of Hampton Harbor, Seabrook

Beach, and Hampton Beach, borders the western edge of Seabrook approximately 1.7 mi (2.7 km) away. Approximately 10 percent of the surrounding marsh area is open water accessible only to small boats, with channel depths limited to 3–4 ft (0.9–1.2 m) at low tide (FPLE, 2008; NRC, 1982).

Seabrook is divided into two parcels: lot 1 and lot 2. Lot 1 consists of approximately 109 ac (44 ha) of developed land containing the reactor building and associated facilities, including the north and south access roads, which are owned by the Seabrook joint owners. Lot 2 is owned by NextEra and consists of approximately 780 ac (316 ha) of largely undeveloped land with a few power plant facilities. During construction, approximately 194 ac (79 ha) were cleared (NRC, 1982). By 2014, NextEra plans to have returned approximately 32 ac (13 ha), which are currently occupied by excavation spoil, to its natural state.

Major structures onsite include the Unit 1 containment and auxiliary building; fuel storage, waste processing, diesel generator, and turbine buildings; administration services building; and a cooling tower. There are also various structures that NextEra built for Unit 2, which are now used for storage. A dry spent fuel storage site is located west of Unit 2 and consists of a large concrete pad and horizontal storage modules (FPLE, 2008).

The Town of Seabrook has designated the Seabrook site as Zone 3 (Industrial Use District). The East Coast Greenway, a non-motorized, shared-use trail system, makes use of former railway ROW, a section of which would run through the Seabrook property along the State-owned Hampton Branch Railroad Corridor. The railway roadbed is fenced off at the site's property lines to restrict public access (FPLE, 2009). The Owascoag Nature Trail, a 1-mi (1.6-km) interpretive environmental education boardwalk and trail walk, offers a view of marsh and woodland habitats (FPLE, 2008; FPLE, 2009).

Public access is restricted and controlled by signs at the north and south access roads, and by fencing. Public activities occurring on, or near, Seabrook include infrequent boat traffic along the Brown's River and Hunt's Island Creek and visits to the Seabrook Science and Nature Center, which is open to the general public and located about 1,500 ft (457 m) southwest of the plant. From 2007–2010, annual attendance at the Science and Nature Center ranged between 3,380–4,486 students and walk-in visitors (NextEra, 2010f).

2.2.2 Air Quality and Meteorology

The terrain of New Hampshire ranges from hilly to mountainous, except at low elevations along the coastal plains in the southeast (NCDC, 2010). The climate of New Hampshire is primarily affected by three air masses: (1) cold, dry air from subarctic North America; (2) warm, moist air from the subtropical waters to the east—the Gulf Stream; and (3) cool, damp air from the North Atlantic. The air masses, having largely different characteristics, alternate and interact with storm systems that pass frequently, resulting in abrupt changes in temperature, moisture, sunshine, and wind patterns. Accordingly, the climate of New Hampshire is highly variable. The regional climate in New Hampshire is modified by the varying distances from relatively mild ocean waters, elevations, and types of terrain (FPLE, 2008; NextEra, 2010a).

The topography of the site is relatively flat and has no special influence on climate. Due to its proximity to the Atlantic Ocean, the site location experiences milder climate, smaller diurnal and seasonal temperature ranges, more precipitation, and less snow than at a location further inland of comparable latitude. New Hampshire lies in the prevailing westerlies, with winds from the northwest in winter and from the southwest in summer. Thus, the climate of the site is continental in character but moderated by the maritime influence of the Atlantic Ocean (FPLE, 2008).

From 1944–2008, annual average temperature at Portsmouth, located about 12 mi (19 km) north-northeast of Seabrook, was 47.5 degrees Fahrenheit (8.6 degrees Celsius). January is the coldest month with an average minimum temperature of 14.8 degrees Fahrenheit (-9.6 degrees Celsius). July is the warmest month with an average maximum temperature of 81 degrees Fahrenheit (27.2 degrees Celsius) (NHSCO, 2010). Extreme temperatures at Seabrook are moderated by the marine influences from the Atlantic Ocean. In particular, onshore sea breezes from the relatively cool ocean make the site cooler than more inland areas (NextEra, 2010a).

Precipitation around Seabrook is distributed consistently throughout the year, with monthly precipitation ranging between 3–5 inches (in) (7.6–12.7 cm) (NHSCO, 2010). At Portsmouth, precipitation tends to be the highest in fall and lowest in summer. In New Hampshire, lower-pressure, or frontal, storm systems are the principal year-round moisture sources, except in summer when this activity tends to diminish and thunderstorm activity increases (NCDC, 2010). On average, one in three days has measurable precipitation (0.01 in (0.025 cm) or higher) near Seabrook (FPLE, 2008). From 1944–2008, annual precipitation at Portsmouth averaged about 50 in (127 cm) (NHSCO, 2010). Snow falls as early as October and continues as late as April. The annual average snowfall at Portsmouth is about 69 in (175 cm).

Severe weather events—such as floods, hail, high winds, thunderstorm winds, snow and ice storms, hurricanes, and tornadoes—have been reported in Rockingham County (NCDC, 2010a). Since 1995, 46 floods were reported in Rockingham County. Flooding has occurred most often in the spring due to a combination of rain and melting snow. In addition, tropical storms and their remnants can sometimes cause significant flooding. In Rockingham County, a total of 106 hailstorms have been reported since 1963, and they mostly occurred during the summer months. Hail measuring up to 2 in (5 cm) in diameter was reported in 2006. Since 1994, 29 high-wind events were reported in Rockingham County. A gust of 154 mph (69 meters (m) per second (m/s)) was recorded in July 1996, which caused falling trees and power outages throughout New Hampshire. Across the state, thunderstorms occur on 15–30 days per year and mostly from mid-spring to early fall (NCDC, 2010). The most severe are accompanied by hail. In Rockingham County, thunderstorm wind events up to a maximum wind speed of 112 mph (50 m/s) occurred mostly during the summer months. One-hundered sixteen winter storm events—comprising heavy snow, freezing rain, and ice—were reported in Rockingham County since 1993. In particular, a few widespread and prolonged ice storms produced perilous travel and caused damage to trees and utility lines and poles (NCDC, 2010a).

Historically, most of the tropical cyclones that have passed through New England had weakened from their peak due to cold waters and fast-moving winds. The hurricanes that do make landfall are normally weak, with Category 3 (i.e., sustained winds of 111–130 mph (50−58 m/s)) being rare. Hurricane Donna in 1960 and Hurricane Floyd in 1999 attained Category 5 (sustained winds in excess of 155 mph (69 m/s)) at their peak but then were downgraded to a Category 2 hurricane and a tropical storm, respectively, around New Hampshire. Since 1851, 48 tropical storms have passed within 100 mi (161 km) of Seabrook, 10 of which were classified as hurricanes (CSC, 2010). These storms occurred most frequently from August–October. A Category 3 hurricane in 1869 is believed to be the most powerful hurricane within about 100 mi (160 km) of Seabrook. This hurricane was not named, and no detailed records are available. Hurricanes encompass a large area and cause both loss of life and property damage not only from high winds, but also from storm surges, coastal flooding, and heavy rainfall.

Tornadoes in Rockingham County occur less frequently and are less destructive than those in the central U.S. From 1950–2010, 10 tornadoes were reported in Rockingham County, mostly occurring in summer months (NCDC, 2010a). However, most of the tornadoes were relatively weak (i.e., two each were F0 or F1 (weak), five were F2 (strong), and one was F3 (severe) on the Fujita tornado scale). These tornadoes caused some property damage, one death, and 57 injuries. Most tornadoes in Rockingham County were reported far from the site, except one F2 tornado which hit Hampton Falls in 2006, about 1.3 mi (2.1 km) north of the station.

Historically, two weather-related interruptions of Seabrook operations have occurred according to NextEra: loss of queue (i.e., loss of priority for providing power to the grid) on December 13, 1992, and loss of offsite power due to a blizzard on March 5, 2001.

Implications of global climate change—including implications for severe weather and storm intensity—are important to coastal communities and to critical infrastructure such as Seabrook. Based on findings to date, published by the Intergovernmental Panel on Climate Change (IPCC), potential impacts from warming of the climate system include expansion of sea water volume; decreases in mountain glaciers and snow cover resulting in sea level rise; changes in arctic temperatures and ice; changes in precipitation, ocean salinity, and wind patterns; and changes in extreme weather (Solomon et al., 2007). Based on analysis by the U.S. Global Change Research Program for the Northeastern United States, temperatures in the northeast are projected to rise an additional 2.5–4 degrees Fahrenheit (1.4–2.2 degrees Celsius) in winter and 1.5–3.5 degrees Fahrenheit (0.8–1.9 degrees Celsius) in the summer. This would be a 2 degree Fahrenheit (1.1 degree Celsius) increase in annual average temperature since 1970. Sea level is expected to continue to rise. While there is great uncertainty, scientists have predicted that sea levels are expected to rise between 3–4 ft (0.9–1.2 m) by the end of this century, while a renewed license for Seabrook would expire in 2050. Changes in sea level, at any one coastal location, depend not only on the increase in the global average sea level but on various regional geomorphic, meteorological, and hydrological factors (USGCRP, 2009). At Seabrook, all critical structures are located at a finished grade elevation of 20 ft (6.1 m) above MSL (FPLE, 2008).

2.2.2.1 Ambient Air Quality

The Air Resources Division (ARD) of NHDES is the regulatory agency whose primary responsibility is to achieve and maintain air quality that is protective of public health and the natural environment (NHDES, 2011). In doing so, ARD administers several programs to include a Statewide Permitting Program, a Compliance Program, an Air Toxics Control Program, an Atmospheric Science and Analysis Program, an Energy/Climate Change Program, a Mobile Sources Program, and an Environmental Health Program. These programs are designed to address many complex air quality issues through such tools as local, regional, and national collaborations, data gathering, analysis, and control efforts. ARD implements regulations through permit issuances to regulate air emissions from existing and new stationary sources.

A facility that has the potential to emit 100 tons (90.7 metric tons) or more per year of one or more of the criteria pollutants, or 10 tons (9.07 metric tons) or more per year of any of the listed hazardous air pollutants (HAPs), or 25 tons (22.7 metric tons) or more per year of an aggregate total of HAPs is defined as a “major” source. Major sources are subject to Title V of the Clean Air Act (CAA) (42 U.S.C. 7401 et seq.), which standardizes air quality permits and the permitting process across the U.S. Permit stipulations include regulating source-specific emission limits, monitoring, operational requirements, recordkeeping, and reporting. Currently, Seabrook has a Title V Operating Permit (permit number: TV-OP-017) issued by the NHDES (NHDES, 2006). Under the Title V permit, Seabrook is authorized to operate two auxiliary boilers, four large diesel-powered emergency generating units, some small emergency generating units, and a diesel-engine-driven air compressor. In addition, the plant has several small diesel-powered pumps and motors that are operated infrequently and various small (permit-exempt) space heating units at the facility. Also, for the Seabrook Emergency Operations Facility (EOF) in

Newington, NHDES issued a general state permit for emergency diesel generators (permit number: GSP-EG-225) (NHDES, 2008).

Air emission sources at Seabrook emit criteria pollutants, volatile organic compounds (VOCs), and HAPs into the atmosphere. Emissions inventory data reported to the NHDES for calendar years 2005–2009 are presented in Table 2.2-1, which includes emissions from permitted sources specified in the permit. During the period 2005–2009, emissions of criteria pollutants, VOCs, and HAPs varied from year to year, but all reported annual emissions were well below the emission thresholds for a major source.

Table 2.2-1. Annual emissions inventory summaries for permitted sources at Seabrook, 2005–2009

	Annual emissions (tons/yr)[a]						
Year	**CO**	**NO_x**	**PM_{10}**	**SO_x**	**VOCs**	**HAPs**	**CO_2e [b][c]**
2005	6.29	24.65	0.59	9.71	0.59	0.04	7,893 (7,159)[d]
2006	3.48	13.90	0.36	8.38	0.31	0.03	21,933[e] (19,894)
2007	2.94	11.20	0.24	1.19	0.29	0.01	47,778 (43,336)
2008	4.07	16.23	0.42	9.66	0.36	0.04	21,568 (19,563)
2009	3.22	12.85	0.34	6.82	0.32	0.03	21,515 (19,515)

[a] CO = carbon monoxide; CO_2e = carbon dioxide equivalent; HAPs = hazardous air pollutants; NO_x = nitrogen oxides; PM_{10} = particulate matter ≤10 μm; SO_x = sulfur oxides; and VOCs = volatile organic compounds

[b] Total emissions at Seabrook, including permitted emissions and sulfur hexafluoride (SF_6) from the 345-kV Seabrook Transmission Substation

[c] CO_2 emissions for permitted sources were estimated by NRC staff using annual diesel consumption data from the applicant and the emission factors in EPA's AP-42 (EPA, 2011): *Section 1.3 Fuel Oil Combustion* for auxiliary boilers; *Section 3.3 Gasoline And Diesel Industrial Engines* for small diesel engines (<600 horsepower); and *Section 3.4 Large Stationary Diesel And All Stationary Dual-fuel Engines* for large diesel engines (>600 horsepower).

[d] Values in parentheses are in metric tons (tonnes) carbon dioxide equivalent.

[e] FPL-NED did not use the methodology prescribed by the SF_6 Memorandum of Understanding between EPA and FPL-NED, effective February 3, 2005. Thus, SF_6 annual emissions during the year 2006 were not reported to the EPA. For comparison with emissions for other years, SF_6 emissions originally estimated by FPL-NED were presented.

Source: (EPA, 2011; FPLE, 2006; FPLE, 2007; FPLE, 2008b; FPLE, 2008c; FPLE, 2009a; FPL-NED, 2006; FPL-NED, 2007; FPL-NED, 2008; FPL-NED, 2009; FPL-NED, 2010; NextEra, 2009b; NextEra, 2010b; NextEra, 2010c)

Since the issuance of the permit, Seabrook has not received a notice of violation associated with site operations. However, NHDES issued a letter of deficiency to Seabrook in April 2010, following a full site compliance evaluation for its failure to conduct an air toxics compliance determination per the state toxics rule (NHDES, 2010a). In order to return to compliance, NextEra subsequently conducted and submitted to NHDES a dispersion modeling analysis for air toxics that demonstrated that air toxic emission levels are below *de minimis* levels and ambient air limits (NextEra, 2010e).

Due to its stability and dielectric property, sulfur hexafluoride (SF_6) is widely used in the electrical industry and is contained in the switchyard breakers and bust ducts at the 345-kV Seabrook transmission substation. SF_6 is considered the most potent of greenhouse gases, with a global warming potential (GWP) of 23,900 times that of CO_2 over a 100-year time horizon (Solomon et al., 2007). In addition, SF_6 has an extremely long atmospheric lifetime of about 3,200 years, resulting in irreversible accumulation in the atmosphere once emitted. SF_6 is inadvertently released into the atmosphere during various stages of the equipment's lifecycle (e.g., leaks due to equipment age, leaks through valve fittings and joints). These emissions are regulated under New Hampshire Air Toxic Rules and subject to emission inventory reporting requirements under the plant's Title V Permit. SF_6 emissions are not subject to Federal regulations, but Seabrook, through FPL-New England Division (FPL-NED), is participating in a voluntary program with the EPA, the so-called SF_6 Emissions Reduction Partnership, to reduce greenhouse gas emissions from its operations via cost-effective technologies and practices (EPA, 1999).

Annual CO_2 emissions were estimated by NRC staff for all permitted combustions sources at Seabrook for the period of 2005–2009. These estimates were based on annual diesel consumption data from the applicant and EPA's AP-42 emission factors (EPA, 2011). Estimated annual CO_2 emissions from all permitted combustion sources were added to SF_6 emissions from the 345-kV transmission substation to arrive at the total greenhouse gas emissions from Seabrook. As shown in Table 2.2-1, annual emissions for greenhouse gases were presented in terms of carbon dioxide equivalent (CO_2e). CO_2e is a measure used to compare the emissions from various greenhouse gases on the basis of their GWP, defined as the cumulative radiative forcing effects of a gas over a specified time horizon resulting from the emission of a unit mass of gas relative to a reference gas, CO_2. The CO_2e for a gas is derived by multiplying the mass of the gas by the associated GWP. For example, the GWP for SF_6 is estimated to be 23,900; thus, 1 ton of SF_6 emission is equivalent to 23,900 tons of CO_2 emission. Total greenhouse gas emissions from Seabrook are below the EPA's mandatory reporting threshold of 25,000 metric tons CO_2 equivalent per year (74 FR 56264; October 30, 2009), except in 2007 when SF_6 emissions exceeded the threshold due, in large part, to two equipment failures.

Under the CAA, the EPA has set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment (40 CFR Part 50). NAAQS are established for criteria pollutants—carbon monoxide (CO); lead (Pb); nitrogen dioxide (NO_2); particulate matter with an aerodynamic diameter of 10 microns or less and 2.5 microns or less (PM_{10} and $PM_{2.5}$, respectively); ozone (O_3); and sulfur dioxide (SO_2)—as shown in Table 2.2-2. The CAA established two types of NAAQS: primary standards to protect public health including sensitive populations (e.g., the young, the elderly, those with respiratory disease) and secondary standards to protect public welfare, including protection against degraded visibility and damage to animals, crops, vegetation, and buildings. Some states established State Ambient Air Quality Standards (SAAQS), which can adopt the Federal standards or be more stringent than the NAAQS. The State of New Hampshire has its own SAAQS (NHDES, 2010), which are also presented in Table 2.2-2. If both an SAAQS and an NAAQS exist for the same pollutant and averaging time, the more stringent standard applies.

Table 2.2-2. National ambient air quality standards and New Hampshire State ambient air quality standards

		NAAQS		
Pollutant[(a)]	**Averaging Time**	**Value**	**Type[(b)]**	**SAAQS**
CO	1-hour	35 ppm (40 mg/m^3)	P	35 ppm (40 mg/m^3)
	8-hour	9 ppm (10 mg/m^3)	P	9 ppm (10 mg/m^3)

Pollutant[a]	Averaging Time	NAAQS		SAAQS
		Value	Type[b]	
Pb	Quarterly average	1.5 $\mu g/m^3$	P, S	1.5 $\mu g/m^3$
	Rolling 3-month average	0.15 $\mu g/m^3$	P, S	-[c]
NO_2	1-hour	100 ppb	P	-
	Annual (arithmetic average)	53 ppb	P, S	0.053 ppm (100 $\mu g/m^3$)
PM_{10}	24-hour	150 $\mu g/m^3$	P, S	150 $\mu g/m^3$
	Annual (arithmetic average)	-	-	50 $\mu g/m^3$
$PM_{2.5}$	24-hour	35 $\mu g/m^3$	P, S	65 $\mu g/m^3$
	Annual (arithmetic average)	15.0 $\mu g/m^3$	P, S	15 $\mu g/m^3$
O_3	1-hour	0.12 ppm[d]	P, S	0.12 ppm (235 $\mu g/m^3$)
	8-hour	0.08 ppm (1997 standard)	P, S	0.08 ppm
	8-hour	0.075 ppm (2008 standard)	P, S	-
SO_2	1-hour	75 ppm	P	-
	3-hour	0.5 ppm	S	0.5 ppm
	24-hour	0.14 ppm	P	0.14 ppm
	Annual (arithmetic average)	0.03 ppm	P	0.03 ppm

[a] CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter $\leq$2.5 μm; PM_{10} = particulate matter $\leq$10 μm; and SO_2 = sulfur dioxide

[b] P = primary standards, which set limits to protect public health; S = secondary standards, which set limits to protect public welfare including protection against degraded visibility, damage to animals, crops, vegetation, and buildings.

[c] A hyphen denotes that no standard exists.

[d] EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard (“anti-backsliding”).

Source: (EPA, 2010c; NHDES, 2010)

Areas considered to have air quality as good as, or better than, NAAQS are designated by EPA as “attainment areas.” Areas where air quality is worse than NAAQS are designated as “nonattainment areas.” Areas that previously were nonattainment areas but where air quality has since improved to meet the NAAQS are redesignated “maintenance areas” and are subject to an air quality maintenance plan. Rockingham County, which encompasses Seabrook, is located in the Merrimack Valley-Southern New Hampshire Interstate Air Quality Control Region (40 CFR 81.81), including southern counties in New Hampshire and northeastern counties in Massachusetts. Within New Hampshire, portions of Hillsborough, Merrimack, Rockingham, and Strafford Counties are designated as moderate nonattainment areas with EPA’s NAAQS for 8-hour ozone (40 CFR 81.330). Thus, the Town of Seabrook, encompassing Seabrook, is located in a nonattainment area for 8-hour ozone. In addition to local emissions, many of the ozone exceedances in New Hampshire are associated with the transport of ozone and its precursors from the upwind regions along prevailing winds. Cities of Manchester and Nashua in Hillsborough County are designated as a maintenance area for CO. With these exceptions, all counties in New Hampshire are designated as unclassifiable and attainment areas for all criteria pollutants.

In recent years, three revisions to NAAQS have been promulgated. Effective January 12, 2009, the EPA revised the Pb standard from a calendar-quarter average of 1.5 $\mu g/m^3$ to a rolling 3-month average of 0.15 $\mu g/m^3$ (73 FR 66964; November 12, 2008). Effective April 12, 2010, EPA established a new 1-hour primary NAAQS for NO_2 at 100 ppb (75 FR 6474; February 9, 2010), while, effective August 23, 2010, the EPA established a new 1-hour primary NAAQS for SO_2 at 75 ppb (75 FR 35520; June 22, 2010). Nevertheless, the attainment status for Rockingham County will not immediately change because it typically takes several years to establish a monitoring plan based on new standards.

Through operation of a network of air monitoring stations, NHDES has determined that the area is in compliance with the SAAQs. Air monitoring stations around the Seabrook include the following (EPA, 2010c):

- Pierce Island in Portsmouth, located about 13 mi (21 km) north-northeast of Seabrook, where NO_2, PM_{10}, $PM_{2.5}$, O_3, and SO_2 are monitored
- Seacoast Science Center in Rye, located about 12 mi (19 km) northeast of Seabrook, where ozone is monitored

Nearby stations for CO are Manchester and Nashua in Hillsborough County. No measurements for Pb are available for New Hampshire.

In addition to capping increases in criteria pollutant concentrations below the levels set by the NAAQS, the Prevention of Significant Deterioration (PSD) Regulations (40 CFR 52.21) mandate stringent control technology requirements for new and modified major sources. As a matter of policy, EPA recommends that the permitting authority notify the Federal Land Managers (FLMs) when a proposed PSD source would locate within 62 mi (100 km) of a Class I area. If the source's emissions are considerably large, EPA recommends that sources beyond 62 mi (100 km) be brought to the attention of the FLMs. The FLMs then become responsible for demonstrating that the source's emissions could have an adverse effect on air quality-related values (AQRVs), such as scenic, cultural, biological, and recreational resources. There are two Class I areas in New Hampshire: Presidential Range-Dry River Wilderness Area and Great Gulf Wilderness Area, about 85 mi (137 km) north-northwest and about 97 mi (156 km) north-northwest, respectively, of the station (40 CFR 81.419). The next nearest one is Lye Brook Wilderness Area in Vermont (40 CFR 81.431), which is located about 108 mi (174 km) west of the Seabrook. All these Class I areas are managed by the U.S. Forest Service. None of these Class I areas are situated within the aforementioned 62-mi (100 km) range. Considering the locations and elevations of these Class I areas, prevailing westerly wind directions, distances from Seabrook, and minor nature of air emissions from Seabrook, there is little likelihood that activities at Seabrook would adversely impact air quality and AQRVs in any of these Class I areas.

The onsite meteorological monitoring system currently in operation will continue to serve in that capacity for the period of extended Seabrook operations with no major changes or upgrades anticipated. The current system consists of two independent subsystems that collect meteorological data and process the information into useable data. The primary meteorological tower is located about 1,700 ft (518 m) northwest of the Unit 1 Containment Structure (NextEra, 2010c). The primary tower has instruments at 3 levels (43 ft (13 m), 150 ft (46 m), and 209 ft

(64 m)); the base of the tower is 10 ft (3 m) above MSL. Wind speed and wind direction are collected at 43-ft (13-m) and 209-ft (64-m) levels. Temperature is collected at the 43-ft (13-m) level, while solar radiation is collected at the 10-ft (3-m) level. Temperature differences are measured between 150- and 43-ft levels and between the 209- and 43-ft levels to compute the atmospheric stability. Precipitation data from a rain gauge are also collected near the base of the tower.

The signal translators convert sensor information from the tower and output at strip chart recorders in the instrument shelter; outputs are also monitored by the main plant computer system (MPCS), which samples once every 5 seconds. The most recent instantaneous data are available for on-demand display on MPCS terminals at the control room (CR) and other locations for emergency response and meteorological-related functions. In addition, every fourth 15-minute data values are archived for long-term storage by the MPCS, and the previous 24 hours of archived data values can also be displayed on-demand at the CR, the technical support center (TSC), and the EOF.

The backup meteorological tower is located about 200 ft (61 m) southeast of the primary meteorological tower. The backup meteorological tower collects wind speed and wind direction at the 37-ft (11-m) level. Signals from the backup tower are routed to a data acquisition system (DAS) located in a nearby instrument shelter. The DAS samples wind speed and wind direction every 3 seconds and transmits the data to the computer at the CR. These data are available for on-demand display on a video terminal at the CR.

2.2.3 Geologic Environment

This section describes the current geologic environment of the Seabrook site and vicinity including landforms, geology, soils, and seismic conditions.

<u>Physiography and Geology</u>. Seabrook is situated in the Seaboard Lowland section of the New England physiographic province. The topography is characterized by broad open areas of level tidal marshes, which are dissected by numerous meandering tidal creeks and linear, man-made drainage ditches, interrupted locally by wooded “islands” or peninsulas, which rise to elevations of 20–30 ft (6−9 m) above MSL. The plant is sited on one such peninsula, which is underlain by quartz diorite and includes quartzitic bedrock of generally Middle Paleozoic Age (i.e., about 400–300 million years before present). On the site, this bedrock forms a partially buried ridge trending in an approximately easterly direction. All safety-related site structures are founded on sound bedrock, on concrete fill extending to sound bedrock, or on controlled backfill extending to sound bedrock. A large portion of the site, including Unit 1, is founded on Newburyport quartz diorite, characterized as a hard, durable crystalline igneous rock consisting of medium to coarse-grained quartz diorite with inclusions of dark gray, fine-grained diorite. The bedrock is intruded by northeasterly-trending diabase dikes at widely-spaced intervals. Faults in the bedrock, that were identified and mapped during plant construction, were found to be discontinuous in nature and to die out at one or both ends within the excavated area or were transected by younger mafic dikes. Detailed observations of the bedrock surface and overlying stratified soils have revealed no evidence of post-glacial fault offsets (FPLE, 2008).

Prior to plant construction, the bedrock underlying the plant site was generally overlain by a thin veneer of glacial and post-glacial sediments comprised of Late Pleistocene (Wisconsinan) glacial till and locally overlain by post-glacial sandy outwash deposits and marine clay. Recent swamp, marsh, dune, and alluvial deposits are the youngest geological materials in the area. As indicated above, all surficial materials have been removed in the area of all major plant facilities to base these structures on competent bedrock or concrete backfill. To the south and north of the plant, the depth to bedrock increases under the tidal marshes where it is as much as 70 ft (21 m) or more below MSL, as verified by NRC staff review of geologic cross sections for the plant and vicinity. A sequence of marine and recent marsh deposits normally rests on the till along or just north of the Browns River, near the northern site boundary, and also in adjoining areas to the south (FPLE, 2008).

Soils. Soil unit mapping by the National Resources Conservation Service (NRCS) identifies the majority of the Seabrook site as Udorthents, smoothed. In general, the Udorthents classification is used to identify disturbed land with soil materials that are excessively well-drained and heterogeneous in nature. This is consistent with the developed and engineered nature of the main Seabrook site. Small areas and strips—corresponding to relatively undisturbed wooded areas along the northern strip and southern border of the plant complex encompassing the Seabrook Science and Nature Center—include soils mapped as Unadilla very fine sandy loam, 3–8 percent slopes, and Chatfield-Hollis-Canton complex, 3–8 percent slopes, very stony. These soils are derived from glacial till and other glacial materials. Chatfield-Hollis-Canton complex corresponds to inclusions of very thin soils derived from till and underlain by hard bedrock at a depths of less than 35 in (89 cm). A small inclusion of soils mapped as Deerfield fine sandy loam, 0–3 percent slopes, occurs to the west of the main plant complex along Rocks Road. These moderately well-drained soils derive from sandy outwash deposits. Marsh areas to the north, south, and east of the plant complex consist of soils mapped as Ipswich mucky peat (NRCS, 2011).

Seismology. The historical seismicity of the tectonic province encompassing Seabrook is characterized by broad areas of little to no historical earthquake activity, interrupted locally by clusters of small to moderate events located in eastern-most Maine, south-central Maine, south-coastal Maine, and near Portsmouth in southeastern New Hampshire (FPLE, 2008). A total of 66 small earthquakes (most ranging in magnitude from 2.5–3) have been recorded within a radius of 62 mi (100 km) of Seabrook. The largest was a magnitude 4.7 event in 1982, centered 56 mi (90 km) northwest of the site to the north of Concord, NH. The closest was a magnitude 2.3 event that was epicentered approximately 1.9 mi (3 km) southeast of the station (USGS, 2011).

However, larger earthquakes have occurred. Most notably, the earthquakes of 1755 and 1727, the largest historic events recorded in New England, were centered offshore of Cape Ann, MA, about 14 and 30 mi (23 and 48 km), respectively, to the southeast of the station. The larger, November 18, 1755, event produced modified Mercalli intensity (MMI) VIII shaking at its epicenter (FPLE, 2008). Its estimated magnitude was 6.0 (NESN, 2011). Ground motion in this range could cause considerable damage to ordinary substantial buildings with only slight damage to specially designed structures (USGS, 2011a). An epicenter intensity MMI VIII event was, therefore, established as the maximum earthquake for Seabrook. Nonetheless, as detailed in the updated final safety analysis report, it is inconceivable that an MMI VIII earthquake could occur on the crystalline bedrock at this site, as a nearby earthquake occurring on the adjacent tidal marsh and beach materials would be attenuated to MMI VI or less on the site bedrock. Still, the 1755 Cape Ann earthquake was used to establish the safe shutdown earthquake (SSE) for Seabrook. The horizontal peak ground acceleration (PGA) associated with this maximum earthquake potential is 0.25g (i.e., force of acceleration relative to that of Earth's gravity, "g") (FPLE, 2008).

For the purposes of comparing the SSE with a more contemporary measure of predicted earthquake ground motion, the NRC staff reviewed current PGA data from the U.S. Geological Survey (USGS) National Seismic Hazard Mapping Project. The PGA value cited is based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual frequency (chance) of occurrence of about 1 in 2,500 or 4×10^{-4} per year. For Seabrook, the calculated PGA is approximately 0.155g (USGS, 2011b).

Under the right conditions, very large undersea earthquakes may cause tsunamis or seismic sea waves. As the only major subduction zones that are more prone to produce large tsunamis are along the Caribbean Sea (FPLE, 2008; USGS, 2011b), tsunami activity is extremely rare on the U.S. Atlantic coastline compared to the Pacific. Although the possibility of tsunami impacts along the Gulf of Maine does exist from earthquakes and submarine landslides that occur in the Atlantic Ocean, the chances of a catastrophic event are minimal. The closest tectonic boundary to the Gulf of Maine area is the Mid-Atlantic Ridge, which is a seafloor-spreading center where most of the motion does not involve vertical movement necessary to produce large tsunamis (MGS, 2011). The only significant tsunami recorded on the northeastern U.S. coast resulted from the Grand Banks earthquake of 1929 (FPLE, 2008; MGS, 2011). The 7.2 magnitude earthquake on the south coast of Newfoundland triggered an underwater landslide and resulting tsunami. The tsunami was comprised of three waves ranging from 7–23 ft (2–7 m) in height, and it struck the coast of Newfoundland about 2.5 hours after the earthquake. Runup heights (the height of water onshore as measured from sea level) on Newfoundland's Burin Peninsula ranged from 28–89 ft (8.5–27 m) at the heads of some long, narrow bays (MGS, 2011). However, the southward propagation of the tsunami was insignificant and was only observable on tidal gauges down the U.S. East Coast (FPLE, 2008; NWS, 2011). In addition, there are no historical reports for this tsunami having affected the Gulf of Maine (MGS, 2011). For Seabrook, design analyses indicated that the maximum suspected tsunami would result in only minor wave action, which would be insignificant compared to the maximum expected hurricane storm wave effects (FPLE, 2008).

2.2.4 Surface Water Resources

Seabrook is located nearly 2 mi (3 km) from the Atlantic Ocean on the western shore of Hampton Harbor. The station site is situated on an upland with tidal marshland to the east and bounded on the north by tidally-influenced Browns River and its tributaries and on the south by Hunts Island Creek (see Figure 2.1-3). All site surface drainage flows toward these two tidal streams. Between the marsh area and the ocean is the shoreline community of Hampton Beach. The Atlantic Ocean's western Gulf of Maine is the source of cooling water for Seabrook (FPLE, 2008; NextEra, 2010a).

Seabrook’s discharge to surface water is permitted under its NPDES permit (EPA, 2002), which was issued April 1, 2002. The permit allows chlorine or the commercial product EVAC, or both, to be used to control biofouling. Chlorine Minimization Reports are to be submitted annually to the EPA to document the amount of chlorine used. The permit allows discharge at outfall 001 of 720 mgd (2.7 million m^3/day) on both an average monthly and maximum daily basis. This outfall collects all site discharges, including once-through cooling water discharge, stormwater, dewatering system discharge, groundwater containment system discharge, and internal outfalls, and it conveys the combined water via tunnel to the discharge structure in the Atlantic Ocean. The discharge of radioactive effluents is allowed in accordance with NRC regulations (10 CFR Part 20 and the Seabrook Operating License, Appendix A, Technical Specifications).

The permit also has limits for outfall 001 on temperature rise, total residual oxidants, pH, whole effluent toxicity, and the molluscide EVAC. EVAC may be applied twice per year during an application of less than 48 hours. The internal outfalls include various discharges, such as blowdown from the standby cooling tower, drains, sumps, and oil and water separators. Monitoring parameters at these outfalls include flow, oil and grease, total suspended solids, metals, pH, and total residual oxidants. NRC staff performed an informal walkover survey of these systems during the environmental site audit.

The 5-year permit expired in 2007. An NPDES permit renewal application was submitted to EPA in 2006. The EPA noted that the application was timely and complete; therefore, plant operations may continue under the current permit—which remains valid—until a new permit is issued (EPA, 2007). NextEra stated during the site audit that the current expired permit remains valid for chemical usage.

A recent NPDES compliance evaluation inspection (CEI) (NHDES, 2010b) noted occasional errors in submitted monthly discharge monitoring reports (DMRs) and indicated that corrected DMRs had been submitted. The recent errors were subsequently corrected by Seabrook to the satisfaction of the State (NHDES, 2010c).

An EPA online database indicated that Seabrook has had no Clean Water Act formal enforcement actions in the prior 5 years (EPA, 2010d). The database indicated, during a 12-quarter period from 2007–2010, 3 limit violations of pH at outfall 001, 1 limit violation of pH at internal outfall 026 (metal cleaning wastes), and 1 total suspended solids limit violation at internal outfall 025 (steam generator blowdown or other processes or both).

The plant's Stormwater Pollution Prevention Plan (SWPPP) identifies potential sources of pollution and lists three past spills or leaks (NextEra, 2009). These incidents took place in 2000–2001 and involved leaks of lubricating oil, fuel oil, and gasoline and diesel fuel lines. Spill response or remediation took place in each case. NextEra reported during the site audit that, since the completion of the SWPPP, they have had no reportable spills.

No dredging takes place at intake or discharge structures, as noted by NextEra during the site audit. NextEra also described that divers are used to clean the station's ocean intakes twice per year, and they have not observed ocean sediment building up near the structures.

Sanitary wastewater is discharged to the municipal wastewater treatment system. Seabrook is authorized by the Town of Seabrook to discharge 2,263 gpd (8,570 L/day) of process wastewater or 23,533 gpd (89,080 L/day) of combined process and sanitary wastewater (NextEra, 2010a).

2.2.5 Groundwater Resources

Groundwater in the Seabrook vicinity is present in unconsolidated glacial and recent deposits and in fractured bedrock. In the glacial drift, thick, coarse-grained deposits of sand and gravel are the main aquifers; they are used as the source of municipal water supplies in Seabrook and other towns. Other unconsolidated materials, such as glacial till and marine clay deposits, have low permeability and restrict groundwater movement. The tidal marshes contain brackish groundwater and have low permeability. In general, groundwater occurs under water table conditions except in places where it is confined by marine sediments. Groundwater recharge is principally via infiltrating precipitation, but recharge is greatly retarded in areas where the soil is composed of marine clays. The regional water table approximates the surface topography and frequently occurs within 10 ft (3 m) of the ground surface. Groundwater movement is limited to drainage areas where streams intersect the water table and in areas where streams are tributary to tidewater. Because these drainages are relatively small, groundwater flow paths from points of recharge to discharge generally do not exceed 1 mi (1.6 km). As such, prior to development of the plant site, natural groundwater flow from site upland areas was toward the tidal marshes (FPLE, 2008). This general pattern continues, as is shown in current site water level maps for the shallow glacial and bedrock aquifers (RSCS, 2009), though the shallow system has a localized cone of depression due to dewatering at the Unit 2 containment building.

The nearest groundwater supply wells include several private wells located at least 3,000 ft (910 m) north of the site (NextEra, 2010a). The nearest municipal well system is that of the Town of Seabrook, with wells located at least 2 mi (3.2 km) from the site, drawing from glacial-drift aquifers (FPLE, 2008). There are no designated sole source aquifers in the vicinity of Seabrook; the closest is over 50 mi (80 km) away (EPA, 2010e).

In September 1999, groundwater with elevated tritium activity concentrations was detected in the annular space around the Unit 1 containment structure. A leak of 0.1 gpd (0.38 liters per day (L/day)) was determined to be present from the cask loading area and transfer canal adjacent to the spent fuel pool. After the drain collection lines were cleaned, leakage increased over 2 years to about 30–40 gpd (110–150 L/day) (NextEra, 2010a; RSCS, 2009). The spent fuel pool leakage contaminated the surrounding concrete of the structure and resulted in diffusion of tritium into groundwater around the FSB. This leak was not directly to groundwater but to the interstitial space between the stainless steel fuel pool liner and the concrete building foundation. As part of mitigation efforts, the interstitial space was drained, and the leak in the stainless steel liner was repaired (RSCS, 2009). Additionally, to control tritium, a dewatering system was installed in 2000–2001 in the PAB and containment area of Unit 1 (NextEra, 2010a). Five dewatering points now withdraw approximately 3,000 gpd (11,400 L/day) of groundwater (NextEra, 2010a; RSCS, 2009), though variation is observed, especially seasonally. The dewatering points, along with estimated withdrawal rates, according to NextEra staff interviewed during the site audit, include the following:

- 1,000 gpd (3,800 L/day) from the containment enclosure ventilation area (CEVA)
- 150 gpd (560 L/day) from the PAB adjacent to the spent fuel pool
- 200 gpd (760 L/day) from the residual heat removal (RHR) B-equipment vault
- a small volume from the B electrical tunnel and the emergency feedwater (EFW) pump house I

The depths of these dewatering wells and dewatering points range from -16 to -61 ft (-4.8 to -18 m) MSL (RSCS, 2009). As discussed in Section 2.2.4, disposal of groundwater from the tritium dewatering points and the Unit 2 dewatering system is allowed at outfall 001.

Monitoring of the dewatering system has taken place since 2000, and NRC staff reviewed data from 2000–2009, as presented in the 2009 Site Conceptual Ground Water Model for Seabrook Station (RSCS, 2009). The results indicate tritium concentrations over 3,500,000 picocuries per liter (pCi/L) in the CEVA, approaching 19,000 pCi/L in the PAB, up to nearly 3,000 pCi/L in the RHR and B electrical tunnel, and over 7,000 pCi/L in the EFW. Since 2005, the CEVA readings have been below 50,000 pCi/L, and the PAB levels have been below 5,000 pCi/L. This is attributed to a non-metallic liner that was added to the canal as part of repairs in 2004 (RSCS, 2009). The CEVA readings continue to exceed the EPA standard of 20,000 pCi/L.

During the site audit, NRC staff inspected the interior piping of the dewatering system, a sampling port, and a connection to the containment building roof drainpipe. A demineralizer system prevents scaling in the narrow pipes. Monitoring of the dewatering system, which receives both storm water and the dewatering system discharge, takes place at the storm drain rad monitor (housed in the auxiliary boiler room of the PAB). Tritium measurements, from approximately weekly sampling from December 2008–November 2010, were generally less than the detection limit of approximately 6×10^{-7} μCi/ml (or 600 pCi/L) (NextEra, 2010f). Several samples had measurable amounts of tritium. The highest value was 1.58×10^{-5} μCi/ml (or 15,800 pCi/L), which is below the EPA standard of 20,000 pCi/L. Other detections were an order of magnitude lower. This monitoring is conducted by NextEra, independent of any regulatory requirements.

In response to the tritium detections, NextEra also instituted a groundwater monitoring network consisting of 22 wells. In 2004, 15 wells were installed, and 4 more were installed in

2007−2008. These are arranged as single shallow wells up to 10 ft (3 m) deep or as pairs of single and deep wells, with the deep wells ranging up to 174 ft (53 m) deep (RSCS, 2009). The wells are located within the nuclear protected area and around its periphery. Most of the monitoring wells are flush-mounted. At the site audit, NRC staff observed rainwater ponding atop some flush-mounted well covers but not entering the wells. In 2009, 3 temporary wells (TW-1, TW-2, and TW-3), up to 10 ft (3 m) deep, were installed in the marsh along the south seawall, outside the sheet piling, and south of the PAB.

Results of groundwater sampling, generally conducted on a quarterly basis from September 2004–March 2009, are presented in RSCS (2009a). The data indicate tritium concentrations in a shallow aquifer well (SW-1) near the Unit 1 containment ranging from less than 601–2,930 pCi/L, with no apparent trend. Detections were observed in 2 other shallow wells in November 2004, ranging up to 1,570 pCi/L (in SD-2) and in one bedrock well (in BD-3) with a concentration of 880 pCi/L. Levels have been below the detection limit of approximately 600 pCi/L ever since. The other shallow wells and bedrock wells have consistently had results below the detection limit. Additional data from June–August 2009 indicate tritium at two wells that previously had levels below the detection limit. These 2 wells (SD-1 and BD-2) are located approximately 75 ft (23 m) southwest of SW-1. Shallow well SD-1 had results from 14 samples during this period with concentrations ranging from 969–2,360 pCi/L, with no apparent trend. The adjacent bedrock well (BD-2) had results from 13 samples with concentrations ranging from greater than 568–1,880 pCi/L. Data from this well indicate a decreasing trend to levels below the detection limit of about 600 pCi/L but with a final measurement of 1,104 pCi/L in late August 2009 (RSCS, 2009a). The tritium detections at these wells are attributed to heavy rainfall and a high water table during the data collection period as well as issues concerning well construction (RSCS, 2009a).

At the three temporary wells installed in the marsh south of the PAB and downgradient of the tritium leak source, four quarters of sampling data during 2009–2010 yielded tritium results below the detection limit of approximately 600 pCi/L (NextEra, 2010f).

Water level maps for both the shallow aquifer and bedrock aquifer indicate hydraulic containment of most of the site groundwater, including the five tritium dewatering points, by the Unit 2 dewatering system (NextEra, 2010f; RCSC, 2009a). Further, overall groundwater monitoring suggests that offsite migration of tritium above the standard of 20,000 pCi/L is not occurring, although the onsite tritium activity exceeds the standard as measured at the CEVA monitoring point.

Groundwater monitoring of two wells at the vehicle maintenance building has continued since 2001 for methyl tert-butyl ether (MTBE) due to a prior release of gasoline. Haley and Aldrich (2009) summarized the decrease in MTBE from as much as 27,000 µg/L in 2001 to 25 µg/L in November 2009. Monitoring may cease when data from 2 consecutive years are below the State standard of 13 µg/L.

2.2.6 Aquatic Resources

2.2.6.1 Description of the Gulf of Maine and Hampton-Seabrook Estuary

Gulf of Maine

The Gulf of Maine is a semi-enclosed sea bounded in the south by Cape Cod, MA, and in the north by Nova Scotia, Canada. This large area extends approximately 20 mi (320 km) into the Atlantic Ocean and includes Jeffrey's Ledge, Bay of Fundy, and Georges Bank. The Gulf of Maine is located within the Acadian biogeographic province. The unique geology, topography, and oceanographic conditions within the Gulf of Maine support large phytoplankton and zooplankton populations that form the trophic basis of many commercial fisheries and their prey. Marine mammals, such as whales, seals, and porpoises, also inhabit the Gulf of Maine due in part to the abundance of fish and other prey (Thompson, 2010). Approximately 3,317 known species inhabit the Gulf of Maine (Valigra, 2006).

Habitat within the Gulf of Maine is generally more complex and diverse than in more southern temperate coastal areas due to the geologically diverse coastal and ocean basin. This complex geology includes deep basins, shallow banks, and various channels as well as smaller-scale geological features, such as canyons, pinnacles, and shoals. In the southwestern portion of the Gulf of Maine, a thick layer of sediments and glacial deposits cover a relatively flat ocean floor that gradually slopes deeper with distance from shore (Thompson, 2010).

Currents within the Gulf of Maine generally move in a counter-clockwise, or cyclonic, direction. Along the coast, water flows south around Nova Scotia, into the Bay of Fundy, and then continues in a southerly direction along the coast, which is known as the Maine coastal current. The Maine coastal current is strongly influenced by the large discharge of fresh spring melt water off the Canadian and U.S. coasts. Large-scale oceanographic circulations transport water from as far as Cape Hatteras in North Carolina and the Labrador Sea in Canada. Thus, local conditions, as well as ocean waters from as far as 1,000 mi (1,609 km) away, influence the water properties and dynamics within the Gulf of Maine.

Common Habitats and Taxa in the Gulf of Maine

<u>Rocky Intertidal and Subtidal Habitats</u>. Rocky subtidal habitats are one of the most productive habitats in the Gulf of Maine (Mann, 1973; Ojeda and Dearborn, 1989). Rocky subtidal is the prominent habitat type near the Seabrook intake and discharge structures (NAI, 2010). Algae, mussels, and oysters attach to the bedrock on the seafloor and form the basis of a complex, multi-dimensional habitat for other fish and invertebrates to use for feeding and hiding from predators (Witman and Dayton, 2001; Thompson, 2010). Spawning fish, such as herring (*Clupea* spp.) and capelin (*Mallotus villosus*), shield eggs from currents and predators within rock crevices or sessile organisms attached to the bedrock (Thompson, 2010). In the subtidal, predatory fish—such as pollock (*Pollachius virens*), cunner (*Tautogolabrus adspersus*), and sculpin (*Myoxocephalus octodecimspinosus*)—and predatory invertebrates—such as the American lobster (*Homarus americanus*), Jonah crabs (*Cancer borealis*), and Atlantic rock crabs (*Cancer irroratus*)—forage in rocky habitats (Ojeda and Deaborn, 1991). Ojeda and Dearborn (1991) determined that the most common prey items included Jonah and rock crabs, blue mussels (*Mytilus edulis*), juvenile green sea urchins (*Strongylocentrotus droebachiensis*), and Atlantic herring (*Clupea harengus*). In the rocky intertidal, mussels, crabs, sea urchins, and other marine organisms can be important prey items for mammals and seabirds (Carlton and Hodder, 2003; Ellis et al., 2005)

Species often compete for space within rocky subtidal and intertidal habitats. The area where species eventually settle is often a trade-off between accommodating physiological stress and avoiding predation or competition with other species. For example, lower depths may provide a more ideal habitat in terms of physical requirements (temperature, pressure, salinity, avoiding desiccation, etc.), but shallower areas may provide a refuge from predation. As a result, many organisms that use rocky subtidal and intertidal habitats are restricted to a depth zone that balances physiological and biological pressures (Witman, 1987).

The species distribution of common seaweeds displays vertical zonation, whereby certain species are most common at a specific depth. In the splash zone of the intertidal, which is one of the harshest environmental conditions due to desiccation and physical scouring by waves, cyanobacteria are most common. With increasing depth, green algae, brown algae, and then red algae become most common (Stephenson and Stephenson, 1972; Witman and Dayton, 2001). Common brown algae species in the shallow subtidal (13–26 ft (4–8 m) below MLLW) include sea belt (*Saccharina latissima*) and *Laminaria digitata*, whereas *Agarum clathratum*, *Laminaria* spp., and *Alaria esculenta* are more common in deeper areas (NAI, 2010; Ojeda and Dearborn, 1989; Witman, 1987). Common red algae taxa in shallow subtidal areas near Seabrook include Irish moss (*Chondrus crispus*), *Ceramium virgatum*, *Phyllophora* spp., and *Coccotylus* spp. (NAI, 2010). *Phyllophora* spp., *Coccoatylus* spp., *Phycodrys ruben*, and *Euthora cristata* become more common with increasing depth (NAI, 2010). An estimated 271 species of macroalgae, or algae large enough to been seen with the naked eye, grow in the Gulf of Maine (Thompson, 2010).

Invertebrates also display distinct vertical zonation along rocky habitats in the Gulf of Maine. In the intertidal, barnacles (*Semibalanus balanoides*) often dominate in the splash zone and blue mussels dominate lower areas (Menge and Branch, 2001). Predation by whelks (*Nucella lapillus*), sea stars (*Asterias* spp.), and green crabs (*Carcinus maenus*) limit the population of blue mussels in lower depths (Lubchenco and Menge, 1978). In the shallow subtidal, the infralittoral zone is the area dominated by macroalgae, which generally ends when there is insufficient light for photosynthesis. Below the infralittoral zone is the circalittoral zone, which is defined as the area dominated by sessile and mobile invertebrates below the infralittoral zone (Witman and Dayton, 2001). With increasing depth, the general zonation of invertebrates includes sponges, sea anemones, soft corals, mussels (blue mussels and northern horsemussel (*Modiolus modiolus*)), sea stars, and sea urchins (Witman and Dayton, 2001). Approximately 1,410 species of invertebrates live in the Gulf of Maine (Thompson, 2010).

Demersal fish are those that live on, or near, the bottom of the sea floor. Common demersal fish include Gadids—such as cods, burbot, hake, pollock, and rocklings—and flatfish—such as flounders, halibut, plaice, and sole (NAI, 2010; Thompson, 2010). Near Seabrook, the most common species include winter flounder (*Pleuronectes americanus*), hake (*Urophycis* spp.), yellowtail flounder (*Pleuronectes ferruginea*), longhorn sculpin, Atlantic cod (*Gadus morhua*), *Raja* spp., windowpane (*Scopthalmus aquosus*), rainbow smelt (*Osmerus mordax*), ocean pout (*Macrozoarces americanus*), whiting or silver hake (*Merluccius bilinearis*), and pollock (NAI, 2010).

<u>Kelp Beds</u>. Kelp seaweeds, brown seaweeds with long blades, attach to hard substrates and can form the basis of undersea "forests," commonly referred to as kelp beds. The long blades of kelp species—such as *A. clathratum*, *L. digitata*, and sea belt—provide the canopy layer of the undersea forest, while shorter foliose and filamentous algae, such as Irish moss, grow in between or at the bottom of kelp similar to the understory layer in a terrestrial forest (NAI, 2010; Thompson, 2010). The multiple layers of seaweeds provide additional habitat complexity for other fish and invertebrates to find refuge from predators and harsh environmental conditions, such as strong currents or ultraviolet light (Thompson, 2010). Lobsters often molt, or shed their exoskeleton to grow, while hiding in kelp beds (Harvey et al., 1995 in Thompson, 2010). Due to the ecological services provided by kelp, these organisms play a large role in the productivity and species diversity within kelp forests. Biologists refer to such species as "habitat formers."

<u>Sandy Bottom and Mud Flats</u>. Soft sediments, such as sand or mud, covering the ocean floor are a common habitat within the Gulf of Maine. A wide variety of organisms inhabit sandy or muddy bottom areas by living within (infauna) or on top of (epifauna) the sand or mud. The most common organisms includes polychaete worms, isopods and amphipods, larger crustaceans (e.g., crabs and shrimp), echinoderms (e.g., sea stars and sea urchins), and mollusks (e.g., surf clams (*Spisula solidissima*), soft shell clams (*Mya arenaria)*, truncate softshell clam (*Mya truncate*), and sea scallops (*Placopecten magellanicus*)) (Lenihan and Micheli, 2001; NAI, 2010). Species distribution is often a combination of several factors such as the size and chemical properties of the sandy substrate, exposure to waves or tidal action,

recruitment patterns, availability of organic matter for food, and biological interactions with other species, such as predation, competition, parasitism, and positive interactions (Lenihan and Micheli, 2001).

Pelagic Habitats. The water column is an important habitat for plankton, fish, marine mammals, turtles, and other pelagic organisms. Different water masses at various depths provide unique habitats with varying temperatures, salinities, flow, and pressure.

Phytoplankton—microscopic floating photosynthetic organisms—are pelagic organisms that form the basis of the Gulf of Maine food chain. Phytoplankton play key ecosystem roles in the distribution, transfer, and recycling of nutrients and minerals. Zooplankton are small animals that float, drift, or weakly swim in the water column of any body of water. Zooplankton include, among other forms, fish eggs and larvae with limited swimming ability, larvae of benthic invertebrates, medusoid forms of hydrozoans, copepods, shrimp, and krill (Euphausiids). Plankton are often categorized by how and where they inhabit the water column, including holoplankton (plankton that spend their entire lifecycle within the water column), meroplankton (plankton that spend a portion of their lifecycle in the water column), and hyperbenthos (benthic species that primarily reside on the seafloor but migrate into the water column on a regular basis).

Approximately 652 species of fish live in, or migrate through, the Gulf of Maine, although only 13 percent (87 species) live their entire lives within Gulf of Maine (Thompson, 2010). Pelagic fish are those that live within the water column but not at the bottom of the water column. Overholtz and Link (2006) determined that Atlantic herring is a keystone species in the Gulf of Maine due to its importance as a prey item for marine mammals, fish, and seabirds (Overholtz and Link, 2006). Common shark species include spiny dogfish (*Squalus acanthias*), which has become an important fish predator in the past few decades due to the decline in Atlantic cod, and other commercial-sought predatory fish. Other relatively common species in the vicinity of Seabrook include Atlantic mackerel (*Scomber scombrus*), blueback herring (*Alosa aestivalis*), pollock, silver hake, alewife (*Pomolobus pseudoharengus*), and rainbow smelt (*Osmerus mordax*) (NAI, 2010).

Connectedness of Habitats. Each habitat type within the Gulf of Maine is highly connected to other habitats due to various biological, physical, and oceanographic processes. Most species inhabit multiple habitat types throughout their life cycle. For example, the movement of water connects biological communities by transporting food, nutrients, larvae, sediment, and pollutants. Movement of water may be vertical, such as upwelling, or horizontal, as in the currents described above. Upwelling occurs in areas where the underwater topography and currents force cold, nutrient-rich currents to rise towards the sea surface. The influx of nutrients support the growth of phytoplankton, which, in turn, attracts dense aggregations of smaller pelagic fish, such as Atlantic herring and mackerel, and their predators, such as larger fish, mammals, and birds. Since the various physical and chemical characteristics within the water column—such as temperature, light, salinity, density, and nutrients—change with depth and distance from shore, aquatic organisms often migrate to find ideal conditions, such as food, refuge from predators, or less physiological stress. For example, several benthic organisms, such as lobsters, live and grow in the water column during early life stages to avoid benthic predators. As juveniles and adults, lobsters inhabit rocky or soft-bottom habitats in order to find prey.

Hampton-Seabrook Estuary

The Seabrook site is located within the Hampton-Seabrook Estuary, which is part of the Hampton-Seabrook watershed that provides freshwater inputs to the Gulf of Maine. The estuarine currents are tidally dominated, meaning that that the ocean tides play a dominant role in the circulation and transport of sediments within the estuary. Freshwater inputs to the watershed primarily come from the following bodies of water: Tide Mill Creek, Taylor River, Hampton Falls River, Brown's River, Cain's Brook, Blackwater River, and Little Rivers.

The Hampton-Seabrook Estuary is a highly productive ecosystem that provides a variety of ecological services and functions (NMFS, 2010a; NHNHB, 2009). Several recreational fisheries exist within the Hampton-Seabrook Harbor, including the most productive soft-shell clam beds in New Hampshire (Eberhardt and Burdick, 2009). A recreational and commercial fishery for the American lobster also exists within the estuary.

The streams, rivers, and estuaries within this watershed are a primary migration route for many anadromous fish, which are fish that migrate between freshwater and the Gulf of Maine throughout their life cycle. The Hampton-Seabrook Estuary is also an important habitat for several species of juvenile fish that inhabit the Gulf of Maine as adults (Fairchild et al., 2008; NHFGD, 2010a). Therefore, many of the species that could be entrained or impinged at the Seabrook intake structures may also inhabit the Hampton-Seabrook Estuary and associated rivers and tributaries.

Common Habitats and Taxa in Hampton-Seabrook Estuary

Several important habitats occur within the Hampton-Seabrook Estuary. Salt marshes, seagrass, and shellfish beds are the main biogenic habitats, or areas where a single type of organism forms the basis of the habitat. The predominant biogenic habitat within the estuary is salt marsh, which cover approximately 4,000 ac (1,618 ha) (Eberhardt and Burdick, 2009). In fact, the Hampton-Seabrook Estuary is home to the majority of the estimated 6,200 ac (2,509 ha) of salt marsh in New Hampshire (NHNHB, 2009). In the Gulf of Maine coastal region, NHDES (2004a) considers salt marshes the most biologically productive ecosystems. For example, vegetation within the salt marsh provides food for birds, insects, snails and crustaceans and refuge for crabs, shrimp, other shellfish, and juvenile fish to hide from predators. Dead vegetation, which is broken down into detritus, plays an important role in the food web since it is eaten by crabs and shellfish. In addition, waves or other currents often carry the detritus to offshore habitats or other near shore habitats, further promoting the ecological productivity within the vicinity. Salt marshes provide several other ecosystem functions. For example, the roots and stems of marsh plants help trap waterborne sediments that may harbor contaminants. Salt marsh plants also absorb atmospheric carbon dioxide, which is a greenhouse gas, and excess nutrients from fertilizers and sewage discharges, which can lead to eutrophication and oxygen depletion (Thompson, 2010).

Shellfish beds, such as blue mussel (*Mytilus edulis*) and soft-shell clam (*Mya arenaria*) beds, provide habitat for other aquatic organisms and help filter the water within the estuary. Small organisms attach to mussel shells, and mobile organisms can hide within crevices (Thompson, 2010). Both blue mussels and soft-shell clams are filter feeders, meaning that water flows through their gills or other filtering structures as they strain organic matter and food particles, such as plankton and detritus. While filtering water for food, these organisms also help clean the water, recycle nutrients, detoxify pollutants, and provide an essential transfer of energy from plankton to larger species (Gili and Coma, 1998; Lenihan and Micheli, 2001). For example, mussels and clams are prey for fish, larger invertebrates, and marine mammals and, in shallower areas, birds and terrestrial mammals that forage in aquatic environments (Lenihan and Micheli, 2001). In Hampton-Seabrook Estuary, green crabs (*Carcinus maenas*) are an important predator of soft shell clams (Glude, 1955; Ropes, 1969).

Eelgrass beds (*Zostera marina*) also provide important habitat for other aquatic organisms and are often referred to as underground meadows (NHDES, 2004b). Eelgrass provides food, a structurally-complex habitat, areas to hide from predators, and spawning grounds for many species. Commercially and ecologically important species that inhabit seagrass beds include blue mussels, lobster, winter flounder, Atlantic silverside (*Menidia menidia*), Atlantic cod, and other fish and invertebrates (Thompson, 2010). In addition, eelgrass increases dissolved oxygen in the estuary as a byproduct of photosynthesis and helps control erosion by slowing currents and stabilizing the sandy bottom (Thompson, 2010). Eelgrass is sensitive to changes in water quality, especially sedimentation and turbidity, since sufficient light must reach its leaves to complete photosynthesis.

Soft sediments, such as sand or mud, are a common habitat within the Hampton-Seabrook Estuary. When exposed during low tides, these areas are often called mudflats (NHDES, 2004c). A wide variety of organisms inhabit mud or sandy bottom areas by living within (infauna) or on top of (epifauna) the substrate. The most common organisms include polychaete worms, crustaceans (e.g., isopods, amphipods, green crabs, shrimps), and mollusks (e.g., soft shell clams) (Lenihan and Micheli, 2001). Although similar types of organisms may inhabit soft sediment habitats in the Gulf of Maine and Hampton-Seabrook Estuary, the species may differ due to shallower depth and lower salinity in the estuary. In addition, some species that inhabit sandy habitats in Gulf of Maine may inhabit sandy habitats in Hampton-Seabrook Estuary during earlier life stages. In the Hampton-Seabrook Estuary, sandy-bottom habitats are important substrates for eelgrass, blue mussels, and soft-shell clams, all of which help form biogenic habitats as described above.

The pelagic, or open water, environment is an important habitat for several species of fish. Several juvenile fish species use the Hampton-Seabrook Estuary as a refuge from predators and to consume prey (Fairchild et al., 2008; NHFGD, 2010a). Common fish species within Hampton-Seabrook Estuary include Atlantic silverside, winter flounder, killifish, ninespine stickleback, rainbow smelt, American sandlance, and pollock (NAI, 2010; NHFGD, 2010a).

Several anadromous fish—such as alewife, blueback herring, American shad, and rainbow smelt—migrate through Hampton-Seabrook Estuary in order to reach freshwater rivers for spawning (Eberhardt and Burdick, 2009). Each species has particular habitat requirements (e.g., dissolved oxygen, temperature, salinity, etc.) for spawning, feeding, and growing. As described further in Section 2.1.3.2, alewife, blueback herring, and rainbow smelt experienced precipitous population declines in the past few decades due to human-induced impacts, and the National Oceanographic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) currently classifies these fish as "species of concern" (NMFS, 2010a). A species is designated as a species of concern if NMFS has some concerns regarding the species' status and threats, but there is insufficient information to indicate a need to list the species under the Endangered Species Act (ESA) (NMFS, 2011f).

2.2.6.2 Environmental History of the Gulf of Maine and Hampton-Seabrook Estuary

The below sections provide a brief environmental history of the Gulf of Maine and the Hampton-Seabrook Estuary. The discussion concentrates on the major industries and actions that have influenced the current populations of aquatic organisms in the Gulf of Maine and Hampton-Seabrook Estuary.

Gulf of Maine

Pre-1900s: Whaling and Cod Industries

In the past 500 years, this Gulf of Maine region experienced increased settlement and exploitation of resources. Whaling was a major industry in colonial New England. Initially, early settlers concentrated efforts on whales relatively close to shore using small boats. Eventually, settlers built vessels to pursue the more profitable offshore sperm whales (Allen, 1928). Sperm whales were pursued for their blubber, which was used to make oil, and bones, which were used to make candles, corsets, and other products. Demand for whale oil declined in the mid 1800s, with the discovery of oil underground. From 1800–1987, whalers harvested approximately 436,000–1 million sperm whales (NMFS, 2011). Presently, all whales in U.S. waters are protected under the Marine Mammal Protection Act (MMPA) due to low populations.

In the 1700s, the Atlantic cod fishery was another large industry in New England. Cod was salted, and it became a prime export of the region (Thompson, 2010). The cod fishery continued to grow as the shipping industry boomed in New England, providing an efficient means to trade with Europe. The Atlantic cod fishery continued throughout the 21st century, resulting in a precipitous decline in the species, as discussed in more detail below

1900s–2000s: Direct and Indirect Impacts from Fishing

During the 20th century, one of the major human influences on aquatic organisms in the Gulf of Maine was from the direct and indirect effects of commercial fishing. Highly productive habitats in the Gulf of Maine support large populations of commercially sought fish, such as Atlantic cod, haddock (*Melanogrammus aeglefinus*), yellowtail flounder, halibut, other gadids (cod family), and flatfish. From the 1960s through the mid 1970s, many Gulf of Maine fisheries experienced an intense increase in fishing pressure, in part due to the arrival of distant water fishing fleets. As fish landings of commercially sought species increased, the stock biomass subsequently declined precipitously throughout the 1970s and 1980s (Sosebee et al., 2006). Despite fisheries management regulations that limited fishing pressure on several overfished fisheries, stock biomass for many fisheries remained low during the 1990s. Currently, some monitoring studies suggest the recovery of certain groundfish (commercially sought demersal fish), but the biomass of several overfished species are still below 1960’s levels (Sosebee et al., 2006).

In addition to the direct impacts from harvesting commercially sought fish, commercial fishing has indirectly influenced the abundance of non-targeted species due to increases or decreases in predation pressure or other trophic interactions. In the Gulf of Maine, the decline in fish predators resulted in a shift in community dynamics that propagated throughout the food chain, as explained below and illustrated in Figure 2.2-1. When the populations of commercially fish significantly declined, there was insufficient density of key fish predators to limit prey populations. Steneck et al. (2004) refer to this concept as “trophic-level dysfunction.”

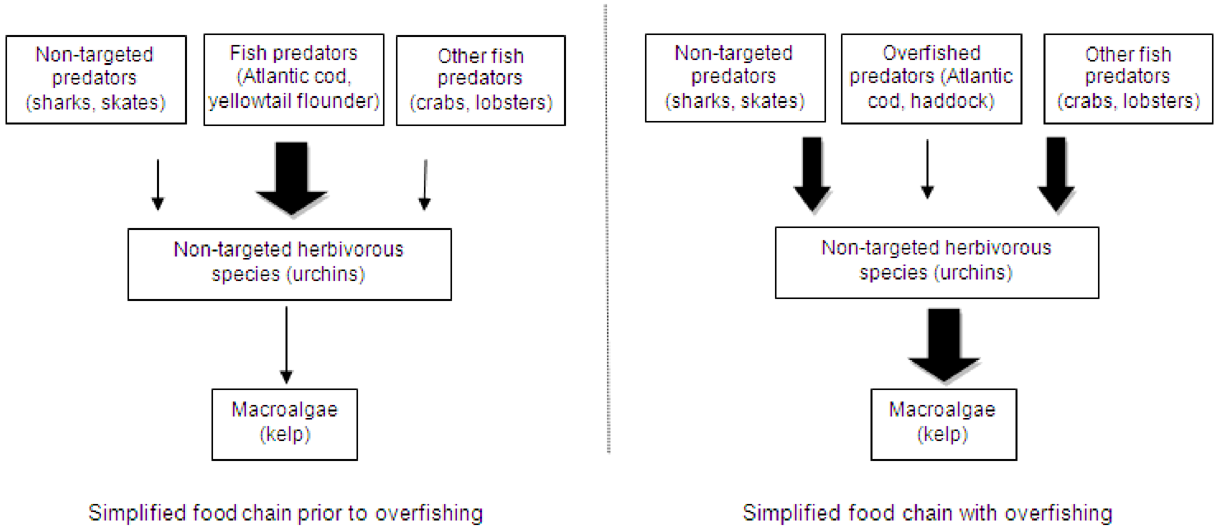
In the 1970s–1990s, the decrease in predation led to the increase in sea urchins and fish that graze on kelp (Steneck et al., 1994). Grazing pressure from urchins and herbivorous fish dramatically increased and overgrazed kelp forests, which transformed highly productive kelp forests into less productive urchin barrens, or areas dominated by crustose coralline algae (Pringle, 1986). Since the crustose coralline algae is relatively flat, this habitat has minimal structural complexity. Kelp forests have recovered in some areas since the 1980s, when a fishery for urchins intensified.

By the mid-1990s, fewer fish predators resulted in less competition with other piscivores (species that eat fish), such as sharks (e.g., spiny dogfish), skates, and predatory crustaceans (e.g., lobsters and *Cancer* crabs) (Link and Garrison, 2002; Zhang and Chen, 2007). Lower competition resulted in an increase in population for non-commercially sought piscivores. Currently, these taxa are the main predators in the Gulf of Maine.

Hampton-Seabrook Estuary

Pre-1990s: Salt Marsh Hay Harvesting and Dams

Native Americans inhabited the area surrounding the Hampton-Seabrook Estuary at least 4,000 years ago (Eberhardt and Burdick, 2009). Native Americans used the estuary as a source of food and harvested fish and shellfish. By the 1700s, colonial settlements also established near the Hampton-Seabrook Estuary. In addition to harvesting food resources for settlers, the colonial population also used salt marsh hay (*Spartina patens*) as feed for livestock (Eberhardt and Burdick, 2009). In an attempt to increase the quality and abundance of highly valued salt marsh hay, settlers dug several ditches throughout the marsh. These ditches changed the water flow patterns within the estuary and caused habitat fragmentation in areas where aquatic life could no longer pass through due to the discontinuation of sufficient water.



The simplified food chain on the left reflects the general groups of predators and herbivores within the Gulf of Maine, prior to intense commercial pressure in the 1960s. The simplified food chain on the right reflects the shift in dominance as the abundance of fish predator species, such as Atlantic cod and haddock, precipitously declined. With the removal of key fish predators, competition with other predators (sharks, skates, crabs, and lobsters) declined and predation pressure on non-targeted herbivorous fish (urchins) declined, resulting in an increase in abundance for these species. Populations of non-targeted herbivorous fish and invertebrates increased and created intense grazing pressure on kelp resulting in the precipitous decline of kelp forest, an important subtidal habitat for fish, invertebrates, and other algae.

Figure 2.2-1. Simplified Gulf of Maine food chain prior to overfishing and with the effects of overfishing

Settlers also built dams along the Taylor River and other nearby rivers in the beginning of the 17th century. Dams harvested energy from the rivers to power sawmills, windmills, grist, and fulling mills (Eberhardt and Burdick, 2009). Dams blocked the migration routes of anadromous fish that use freshwater to spawn and marine habitats as adults.

1900s–2000s: Tourism, Dams, and Urbanization

With the rise of the industrial revolution, the number and size of farms declined while urban areas expanded (Thompson, 2010). In the Gulf of Maine region, urban areas concentrated along the coast. In addition, upland farming became more efficient than harvesting hay in estuaries (Eberhardt and Brudick, 2009). By the 1930s, the combination of increased coastal population growth and upland farming influenced the growth of Hampton Beach as a popular vacation area (Eberhardt and Burdick, 2009). In attempts to control the mosquito population for tourists, developers dug additional ditches in marsh areas. However, these efforts had the opposite of the intended effects since they removed fish habitat and lowered fish populations that consume mosquitoes. In addition, these ditches restricted movement for aquatic species and reduced water flow within the estuary. The remnants of these ditches can still be seen today.

In response to the tourism boom in the 1930s, developers built jetties, bridges, roads, residences, and commercial areas along the shoreline and within sand dunes and marshes. These permanent structures decreased the dynamic nature of the estuary, whereby barrier islands, sand bars, and sand dunes would move depending on water currents and wind. As a result, a narrow inlet connecting the estuary with the Gulf of Maine filled with sediment (Eberhardt and Burdick, 2009). To this day, the Army Corps of Engineers continually dredges this inlet to allow boat and ship traffic in and out of the estuary (Hampton, 2001). Filled wetlands also permanently removed valuable habitat, fragmented available habitat for organisms to travel through, and decreased water quality due to restricted water flow.

In the last quarter of the 20th century, historical and more recent dams along the rivers connected to the Hampton-Seabrook Estuary continued to block the migration path of several anadromous fish and resulted in precipitous declines in populations (Eberhardt and Burdick, 2009). For example, the number of river herring (i.e., alewife and blueback herring) using a fish ladder at the Taylor River Dam was approximately 450,000 in 1976 but only 147 in 2006 (Ebernhardt and Burdick, 2009). Furthermore, dams can create areas with low-dissolved oxygen. Anadromous fish are especially sensitive to changes in water quality since they require specific physical conditions during various parts of their life cycle and because of the physiological stress of migrating through water with different salinity and temperature as they move from the ocean to freshwater rivers to spawn (Eberhardt and Burdick, 2009).

At the beginning of the 21st century, moderate commercial and residential development surrounded the Hampton-Seabrook Estuary (NHNHB, 2009). Run-off from developed and agricultural areas has increased the concentration of nutrients, bacteria, and other pollutants to the estuary. Increased nitrification can lead to algal blooms, where the populations of algae or other plankton increase exponentially. Plankton populations can become so dense that sunlight does not reach the bottom of the estuary, making it difficult or impossible for eelgrass and other aquatic plants to photosynthesize. In addition, algal blooms can deplete available oxygen in the water and release harmful toxins. Sections of the Hampton-Seabrook Estuary are listed on New Hampshire's 303(d) list as being impaired due to high concentrations of bacteria (NHDES, 2004). NHDES (2004) also lists the estuary as impaired for fish and shellfish consumption due to polychlorinated biphenyl, dioxin, and mercury concentrations in fish tissue and lobster tomalley.

2.2.6.3 Monitoring of Aquatic Resources Located Near Seabrook Station

The Seabrook cooling water comes from an intake structure located 60 ft (18.3 m) below mean lower low water in the Gulf of Maine (see Section 2.1.6). The seafloor in this area is relatively flat, with bedrock covered by sand, algae, or sessile invertebrates (NAI, 2010). The immediate vicinity surrounding Seabrook is the Hampton-Seabrook Estuary. No intake or discharge structures are located in the estuary. From construction until 1994, Seabrook discharged to an onsite settling basin into the Browns River.

Below is summary of the community structure and population trends for phytoplankton, zooplankton, fish, invertebrates, and macroalgae located within the vicinity of the intake and discharge structures or the Hampton-Seabrook Estuary. Protected species, including marine mammals, turtles, fish and invertebrates, are discussed in Section 2.2.8.1.

Monitoring Overview

NextEra created a monitoring plan to survey the aquatic communities in the Gulf of Maine and the Hampton-Seabrook Estuary prior to, and during, operations to help determine if operation of the nuclear plant has had an effect on aquatic communities. Since the mid-1970s, NextEra has monitored plankton, multiple life stages of fish and invertebrates, and macroalgae. NextEra sampled areas near the intake and discharge structures, referred to as the nearfield sampling sites, and areas approximately 3–4 nautical mi (5–8 km) from the intake and discharge structures, referred to as the farfield sampling sites. Sampling sites within the Hampton-Seabrook Estuary include a nearfield site, near the area previously used to discharge sewage, and 2 farfield sites in 0–10 ft (0–3 m) of water. Figure 2.2-2 shows the location of all sampling sites.

Normandeau Associates, Inc., (NAI) (2010) used a before-after control-impact (BACI) design to test for potential impacts from operation of Seabrook. This monitoring design examined the statistical significance of differences in community structure between the pre-operation and operational period at the nearfield and farfield sites. Working with Normandeau Associates and Public Service of New Hampshire (PSNH) staff, NextEra selected farfield sampling sites that would likely be outside the influence of Seabrook operations (NextEra, 2010f). The farfield sampling stations were between 3–4 nautical mi (5–8 km) north of the intake and discharge structures. NextEra selected a northern farfield location since the primary currents run north to south. NextEra selected specific sampling sites based on similarities with the nearfield sites regarding depth, substrate type, algal composition, wave energy, and other relevant factors (NextEra, 2010f).

Below, NRC summarized NextEra’s aquatic monitoring of phytoplankton, zooplankton, fish, invertebrates, and macroalgae. NRC staff also summarized monitoring studies from research or sampling programs not funded by NextEra in order to provide a comparison with the trends found by NextEra, as well as trends in other nearby coastal habitats. Some species are highlighted below due to their ecological role, dominance in the community, or commercial or recreational importance. Section 2.2.8.1 and Appendix D-1 provide more detailed information on threatened and endangered species, and essential fish habitat (EFH). Changes in community structure or abundance prior to, and during, operations are described in Section 4.5.

Phytoplankton

NextEra monitored phytoplankton at two nearfield sites (P2 and P5) and one farfield site (P7) (Figure 2.2-2). NextEra collected samples less than 3.3 ft (1 m) from the ocean surface once a month from December–February and twice a month the rest of the year (NAI, 1998).

The total abundance of phytoplankton peaked during late spring-early summer and the again during early fall. The exact timing of these peaks varied annually (NAI, 1998). Diatoms (Bacillariophyceae) generally dominated the phytoplankton community assemblage. During certain collection periods, diatoms comprised more than 90 percent of the phytoplankton community. During most years, the most common diatom taxon was *Skeletonema costatum*, which accounted for 71–81 percent of all diatoms by number of cells and 20–35 percent of all phytoplankton (NAI, 1998).

In early spring, the yellow-green alga *Phaeocystis pouchetii*, which may be toxic to some fish larvae, dominated the phytoplankton community, which was the only time when diatoms were not the most common type of plankton. During a few years, this yellow-green alga was the most common taxon (NAI, 1998).

Monthly arithmetic mean total chlorophyll *a* concentrations at the nearfield site (P2) peaked in early spring and again in the fall. Although chlorophyll *a* can be used as an indicator of total phytoplankton biomass, NAI (1998) did not find a consistent relationship between chlorophyll *a* concentrations and phytoplankton abundance in number of cells. NAI (1998) hypothesized that the difference was likely due to the various dominant taxa that had different proportions of cell size and chlorophyll *a* content.

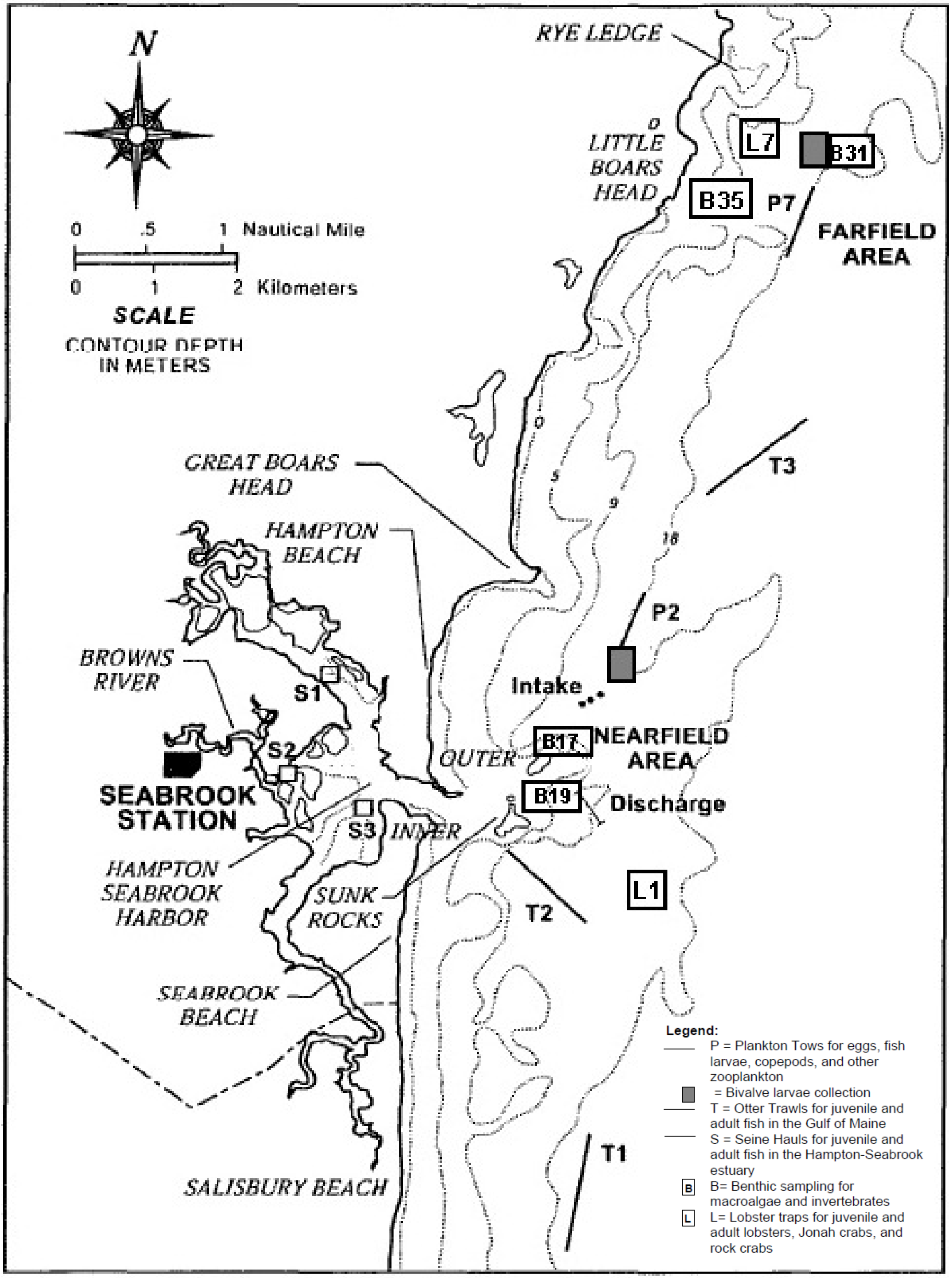


Figure 2.2-2. Sampling stations for Seabrook aquatic monitoring

Zooplankton

NextEra monitored zooplankton at two nearfield sites (P2 and P5) and one farfield site (P7) (Figure 2.2-2). NextEra conducted 1–2 duplicate oblique tows using paired 3.3-ft (1-m) diameter, 0.02-in (0.505-mm) mesh nets for fish eggs and larvae and other zooplankton and one 1.6-ft (0.5-m) diameter, 0.003-in (0.076-mm) mesh plankton net for bivalve eggs and larvae (NAI, 2010). NextEra collected two to four samples per sampling period, which varied from one to four times per month (NAI, 2010).

Throughout 23 years of monitoring studies, NAI (2010) collected approximately 27 species of fish eggs and 62 species of fish larvae near Seabrook. The most common taxa of eggs were Atlantic mackerel, followed by cunner, yellowtail flounder, hakes (primarily red and white hake), fourbeard rockling (*Enchelyopus cimbrius*), Atlantic cod, haddock, windowpane, and silver hake. The most common species of larvae were cunner, followed by American sand lance, Atlantic mackerel, fourbeard rockling, Atlantic herring, rock gunnels, winter flounder, silver hake, radiated shanny (*Ulvaria subbifurcata*), and witch flounder (*Glyptocephalus cynoglossus*).

NAI (2010) reported variations in the community structure and density of bivalve larvae over time. From the 1980s–1996, blue mussels and the rock borer *Hiatella* sp. dominated community assemblages of bivalves. However, from 1996–2002, the abundance of the prickly jingle (*Heteranomia squamula*) and blue mussels increased exponentially. As a result, prickly jingle and, to a lesser extent, blue mussels dominated monitoring samples collected by NAI from 1996–2002. The abundance of bivalve larvae for most species increased from 1996–2002. Bivalve larvae densities from 2003–2009 were similar to pre-1996 levels, although prickly jingle continue to dominate (NAI, 2010). Other common species of bivalve larvae observed within the vicinity of Seabrook include northern horsemussel, surf clam, soft shell clams, truncate softshell clam, and sea scallops.

Holoplankton near Seabrook is generally dominated by copepods, an important prey species for many fish, whales, and other aquatic life. The most abundant holoplankton species vacillated between *Calanus finmarchicus* and *Centropages typicus*, two species of copepods (NAI, 2010). When *C. typicus* dominated the holoplankton assemblage, *Metridia* sp. copepods and Appendicularia, free swimming tunicates, were more common in NAI (2010) monitoring collections. Pershing et al. (2005) reported similar fluctuations in the abundance of *Calanus finmarchicus* and *Centropages typicus* throughout the Gulf of Maine.

Meroplankton assemblages collected near Seabrook included the larvae or planktonic stages of invertebrates that inhabit the seafloor as adults. The most common species in this assemblage included the larvae of several common shallow and deep water coastal species, such as a shrimp (*Eualus pusiolus*), sand shrimp (*Crangon septemspinosa*), and cancer crabs (*Cancer* spp.), while larvae of estuarine shrimp species—such as *Hippolyte* sp. and *Palaemonetes* sp.—were relatively rare. Adult populations of such species are relatively wide-spread throughout the Gulf of Maine. The density of meroplankton assemblages were highest from 1983–2000. Other than relatively small shifts in the community assemblage and species dominance, NAI (2010) reported relatively stable abundances and community structure for meroplankton over time.

Hyperbenthos assemblages collected near Seabrook included a variety of organisms that primarily reside near the seafloor as adults. The most common taxa included the mysid shrimp (*Neomysis americana*), a cumacean hooded shrimp (*Diastylis* sp.), the amphipod *Pontogeneia inermi*, Harpacticoida copepods, and Syllidae polychaete worms. As further explained in Section 4.5, the density of hyperbenthos was generally an order of magnitude larger at the nearfield site compared to the farfield site. NAI (2010) did not observe significant changes over time.

Juvenile and Adult Fish

NextEra conducted monitoring of juvenile and adult fish by trawling for demersal fish (fish that live on or near the seafloor) in the Gulf of Maine, pulling gill nets to monitor pelagic fish (fish that live in the water column) in the Gulf of Maine, and pulling seine nets in the Hampton-Seabrook Estuary to monitor estuarine, and primarily juvenile, fish.

Demersal Fish Sampling. To monitor populations of demersal fish in the Gulf of Maine in the vicinity of Seabrook, NextEra trawled 4 replicate tows along the seafloor for 10 minutes at 3 sampling sites. NextEra used a 32.2-ft (9.8-m) shrimp otter trawl with a 1.5-in (3.8-cm) nylon stretch mesh body, a 1.3-in (3.2-cm) stretch mesh trawl bag, and a 0.5-in (1.3-cm) stretch mesh codend liner (NAI, 2010). NextEra trawled at a nearfield site (T2), which is near the intake and discharge structures, and at two farfield sites (T1 and T3) (Figure 2.2-2). NAI (2010) reported fish abundance by the geometric mean catch per 10-minute tow, which is referred to as the catch per unit effort (CPUE). The most abundant species at all three sampling stations in 2009 were winter flounder (4.8 CPUE), hake (3.2 CPUE), and longhorn sculpin (2.8 CPUE) (NAI, 2010). NextEra monitoring data indicate large changes in species abundance and composition over time. The most abundant species, during monitoring studies in the 1970s and 1980s, were yellowtail flounder (9.4 CPUE), longhorn sculpin (3.0 CPUE), and winter flounder (2.9 CPUE). Other relatively common demersal species observed during monitoring studies include Atlantic cod, *Raja* spp., windowpane, rainbow smelt, ocean pout, silver hake, and pollock.

NAI (2010) compared the CPUE for all species during the 1970s and 1980s, and during more recent years, by using an analysis of variance (ANOVA) procedure. At two (T1 and T2) of the three sampling stations, the abundance of fish was significantly higher in the 1970s through the 1980s when compared to more recent years (NAI, 2010). The combined abundance for all fish species peaked in 1980 and then decreased until 1992. From 1992–2009, NAI (2010) reported a slight increase in the combined abundance for all fish species, but abundances were lower than the peak levels observed in 1980. In 2009, the combined abundance for all fish species was similar to that found in the mid-1980s at the farfield stations but below preoperational levels at the nearfield station (NAI, 2010). Sosebee et al. (2006) analyzed trawl survey data from over 40 years to determine trends for 7 species assemblages in the Gulf of Maine. Two of those assemblages, principal groundfish and flounders, included several of the dominate species collected in NextEra's monitoring data, including yellowtail flounder, winter flounder, hake (red, white, and spotted), Atlantic cod, windowpane, and silver hake. Sosebee et al. (2006) reported similar trends for principal groundfish and flounders as the farfield stations from NextEra's monitoring, whereby flounder and principal groundfish biomass peaked in the late 1970s–early 1980s, were at record lows during the late 1980s through mid-1990s, and peaked again in 2000. In the past few years, some flounders and principal groundfish have begun to recover, but populations of many species continue to decline. Sosebee et al. (2006) associates the peak in the early 1980s with increasing international and national management efforts and subsequent reduced fishing effort. Record-high fishing intensity occurred in the late 1980s and early 1990s when fish abundances were at very low levels.

Pelagic Fish Sampling. NextEra monitored pelagic fish populations near the intake structures from 1976–1997 using gill nets at a nearfield site (G2), located near the discharge structures, and at 2 farfield sites (G1 and G3), located approximately three-fourths of a nautical mi (2 km) north of the intake and 1 nautical mi (2.5 km) south of the discharge structure. NextEra set one 100 ft (30.5 m) by 12 ft (3.7 m) net at each station. Net arrays included 4 panels with stretch mesh dimensions of 1 in (2.5 cm), 2 in (5.1 cm), 4 in (10.2 cm), and 6 in (15.2 cm). Net arrays included surface and near-bottom nets. NextEra set the nets for 2 consecutive 24-hour periods twice each month from 1976–June 1986 and once a month from July 1986–1997 (NAI, 1998).

In 1997, EPA directed NextEra to end gill net monitoring after NextEra found a dead harbor porpoise in the farfield gill net (NextEra, 2010f).

The geometric mean CPUE for all pelagic fish species peaked in 1977 and declined through 1996 (NAI, 1998). Sosebee et al. (2006) reported a different trend for principal pelagic species, which included Atlantic herring and Atlantic mackerel, two of the dominant fish in NAI monitoring surveys. Sosebee et al. (2006) reported record low biomass for principal pelagic species from 1975–1979, an increase in biomass from the mid-1980s through the 1990s, and slightly declining biomass since 2000. NAI (1998) reported a change in the community composition, or the relative abundance of the most dominant species in the 1970s and 1980s compared to monitoring during more recent years. In the 1970s and 1980s, the most abundant species were Atlantic herring (1.1 CPUE), blueback herring (0.3 CPUE), silver hake (0.3 CPUE), pollock (0.3 CPUE), and Atlantic mackerel (0.2 CPUE). During the 1990s and 2000s, the most common fish species collected were Atlantic herring (0.3 CPUE), Atlantic mackerel (0.3 CPUE), pollock (0.2 CPUE), and blueback herring (0.2 CPUE) (NAI, 1998). Other relatively common species include spiny dogfish, alewife, rainbow smelt, and Atlantic cod.

Estuarine Fish Sampling. To monitor populations of estuarine fish in the Hampton-Seabrook Estuary, NextEra pulled seine nets once a month from April–November at three sampling sites, starting in 1975. Sampling generally focused on juvenile fish, and NextEra used a 100 ft (30.5 m) by 7.8 ft (2.4 m) bag seine with a 14.1 ft (4.3 m) by 7.8 ft (2.4 m) nylon bag with 0.55-in (1.4-cm) stretch mesh, and 43 ft (13.1 m) by 7.8 ft (2.4 m) wings with 1-in (2.5-cm) stretch mesh. NextEra pulled two replicate hauls per sampling period. The nearfield site (S2) is located approximately 200 m upstream from the mouth of the Browns River, where discharge from an onsite settling pond was released until April 1994. The farfield stations, S1 and S3, were located approximately 300 m upriver from Hampton Beach Marina and approximately 300 m from Hampton Harbor Bridge in the Seabrook Harbor, respectively (Figure 2.2-2). NAI (2010) reported fish abundance by catch per seine haul or geometric mean CPUE.

The geometric mean CPUE for all species of fish was significantly higher in the 1970s through the early 1990s when compared to more recent years (NAI, 2010). Fish abundances peaked in 1980 and have been decreasing or steady ever since (NAI, 2010). NAI (2010) observed peaks at some sampling stations during various years from 1990–2009. Atlantic silverside has been the most abundant species in monitoring samples since the 1970s (NAI, 2010). New Hampshire Fish and Game Department (NHFGD) (2010a), Marine Fisheries Department, conducted seine hauls in the Hampton-Seabrook Estuary, Great Bay, Piscataqua River, and Little Harbor from 1997–2009. Similar to NAI's findings, NHFGD (2010a) observed relatively steady fish abundance, with peaks during various years. NHFGD (2010a) also observed the Atlantic silverside as the most abundant fish species during each year of sampling.

Invertebrates

Beginning in 1978, NextEra sampled two nearfield stations (B17 and B19) and one farfield station (B31) for epifaunal macroinvertebrates in the rocky subtidal (see Figure 2.2-2). In 1982, NextEra added an additional farfield station (B35). NextEra considered B17 and B35, located at 16.4 ft (5 m) and 19.7 ft (6 m) depth, respectively, to be representative of the shallow subtidal. NextEra considered B19 and B31, located at 39.4 ft (12 m) and 29.5 ft (9 m) depth, respectively, to be representative of the mid-depth subtidal. NextEra gathered samples of sessile invertebrates 3 times a year, in May, August, and November, by scraping off all organisms from 5 randomly selected 0.67 ft^2 (0.0625 m^2) areas on rock surfaces (NAI, 2010). NextEra also visually assessed the percent cover and abundance of larger invertebrates not adequately represented in the previously described sampling method. NextEra visually assessed 6 randomly placed replicate 3.3 ft (1 m) by 23 ft (7 m) band-transects at each sampling site in

April, July, and October. To evaluate recruitment and settlement patterns of sessile benthic invertebrates, NextEra placed 24-in (60-cm) by 24-in (60-cm) panels 1.6 ft (0.5 m) off the seafloor at the mid-depth stations (B19 and B31). Panels remained submerged for 4 months. NextEra deployed panels three times throughout each year, beginning in 1982.

NAI (2010) collected a total of 339 noncolonial invertebrate taxa since 1978, including sessile and mobile molluscs, crustaceans, echinoderms, and annelids. At the shallow subtidal sampling sites, the herbivorous snail, *Lacuna vincta*, was the most abundant biological group prior to 1995, followed by mytillid spat (the larval stage of mussels) and the isopod *Idotea phosphorea*. After 1995, *L. vincta* was still the most common species, but *I. phosphorea* was more common than mytillid spat. At the mid-depth sampling sites, mytillid spat was the most common biological group. Other relatively common taxa include *Anomia* sp. bivalves, skeleton shrimp (*Caprella septentrionalis*), the rock borer, *L. vincta*, and sea stars (Asteriidae).

NAI (2010) collected benthic sessile organisms on settling plates, as described above. The barnacles *Balanus* spp., which were primarily juvenile *Balanus crenatus* but may include some *Balanus balanus*, was the most common species on the settling plates. NAI (2010) observed the greatest recruitment in April. The second most abundant taxon was rock borer, a bivalve.

The following provides monitoring information for Jonah crab and rock crabs, which are important components of the rocky subtidal food web, and for lobsters and soft shell clams, both of which are commercially and recreationally harvested in the vicinity of Seabrook.

<u>Crabs</u>. NextEra monitored crab larvae at two sampling locations: P2, near the intake structure, and P7, which they considered the farfield site (Figure 2.2-2). NextEra conducted two replicate (two paired-sequential) oblique tows twice a month throughout the year. Nets were 3.3 ft (1 m) in diameter and lined with 0.02-in (0.505-mm) mesh nets. NextEra also monitored juvenile and adult crabs by setting fifteen 1-in (25.4-mm) mesh experimental lobster traps without escape vents at a nearfield site near the discharge structure (L1) and at a farfield site (L7) (Figure 2.2-2). NextEra checked traps at 2-day intervals approximately 3 times per week from June–November. Monitoring began in 1975 at L1, 1978 at P2, and 1982 at P7 and L7.

The geometric mean density of crab larvae ranged from 0.2–65 (NAI, 2010). The monthly mean CPUE for juvenile and adult Jonah crabs generally ranged from 4–23 and from 0–5 for rock crabs.

<u>Lobsters</u>. Lobsters (*Homarus americanus*) in the vicinity of Seabrook help support a substantial commercial and recreational fishery (Hampton, 2001). NextEra monitored lobster larvae at three sampling locations: P2, near the intake structure; P5, near the discharge structure; and P7, which was considered the farfield site (Figure 2.2-2). NextEra conducted 2,624-ft (800-m) long tows once a week from May–October using a 0.4-in (1-mm) mesh net that was 3.3 ft (1 m) deep by 6.6 ft (2 m) wide by 14.8 ft (4.5 m) long. NextEra also monitored juvenile and adult lobsters by setting 15.1-in (25.4-mm) mesh experimental lobster traps without escape vents at a nearfield site near the discharge structure (L1) and at a farfield site (L7) (Figure 2.2-2). NextEra checked traps at 2-day intervals approximately three times per week from June–November. Monitoring began in 1975 at L1, 1978 at P2, 1982 at P7 and L7, and 1988 at P5.

The geometric mean density of lobster larvae increased from the 1970s–2000s. The annual mean CPUE for juvenile and adult lobsters generally increased from about 35 to 150 from the 1970s–2000s. Changes in lobster abundance prior to, and during, operations are described in Section 4.5.

<u>Soft Shell Clams</u>. NextEra monitored clam larvae at three sampling locations: P1, in the Hampton-Seabrook Estuary; P2, near the intake structure; and P7, which was considered the farfield site (Figure 2.2-2). NextEra conducted plankton-tows once a week from mid-April–

October. Nets were 1.6 ft (0.5 m) diameter with a mesh of 0.003-in (0.076-mm). NextEra also monitored juvenile and adult clams at five of the largest clam flats in the Hampton-Seabrook Estuary and sites throughout Plum Island Sound (NAI, 2010). NextEra classified clams as follows: young-of-the year (YOY), 0.04-0.99 in (1-25 mm); seed clams, 0.04-0.47 in (1-12 mm); yearlings, 1-2 in (26-50 mm); and adults, greater than 2 in (50 mm) (generally at least 2 years of age (Brousseau, 1978)).

Larval density remained relatively constant from 1978–1995 and then peaked from 1996–2002. Annual mean log 10 (x+1) density (no./m^2) of YOY ranged annually from 0–3.5. The abundance of yearling clams peaked from 1978–1984, and there was a smaller peak from 1992–1997. The abundance of adult clams peaked from 1979–1986, and there were additional peaks from 1989–2001 and from 2005–2009.

Macroalgae

Beginning in 1978, NextEra sampled two nearfield stations (B17 and B19) and one farfield station (B31) for macroalgae in the rocky subtidal (see Figure 2.2-2). In 1982, NextEra added an additional farfield station (B35). NextEra considered B17 and B35, located at 16.4 ft (5 m) and 19.7 ft (6 m) depth, respectively, to be representative of the shallow subtidal. NextEra considered B19 and B31, located at 39.4 ft (12 m) and 29.5 ft (9 m) depth, respectively, to be representative of the mid-depth subtidal. NextEra gathered samples of macroalgae 3 times a year, in May, August, and November, by scraping off all algae on 5 randomly selected 0.67 ft^2 (0.0625 m^2) areas on rock surfaces (NAI, 2010). NextEra also visually assessed the percent cover and abundance of larger algae not adequately represented in the previously described collection method. NextEra visually assessed 6 randomly placed replicate 3.3 ft (1 m) by 23 ft (7 m) band-transects at each sampling site in April, July, and October.

NAI (2010) observed a total of 160 taxa of macroalgae in the vicinity of Seabrook since 1978. The mean annual number of algal taxa at each sampling site fluctuated between 6–18 per 0.67 ft^2 (0.0625 m^2) (NAI, 2010). Annual mean biomass fluctuated between 500–1200 g/m^2 at the shallow subtidal sampling sites and between 100–600 g/m^2 at the mid-depth subtidal sampling sites (NAI, 2010). The most common red algae species in the shallow subtidal was Irish moss, *Ceramium virgatum*, and the genera *Phyllophora* and *Coccotylus*. The most common red algae taxa in the mid-depth subtidal was *Phyllophora*, *Coccotylus*, *Phycodrys ruben*, and *Euthora cristata*. The most common brown algae, or kelp species, in the shallow subtidal was sea belt followed by *L. digitata*. The most common kelp species in the mid-depth subtidal was *A. clathratum*, followed by *L. digitata*, sea belt, and *A. esculenta*.

Transmission Lines

Three 345-kV transmission lines connect Seabrook to the regional electric grid. The transmission corridors are within the vicinity of a variety of aquatic habitats, including intertidal flats, salt marsh, wetlands, bogs, floodplains, rivers, streams, and ponds (NextEra, 2010a; NHNHB, 2010b). The Tewksbury Line crosses the Merrimac River in Massachusetts three times (NextEra, 2010a). As described in 2.1.3, within wetlands, PSNH follows the NHDRED's *Best Management Practices Manual for Utility Maintenance In and Adjacent to Wetlands and Waterbodies in New Hampshire* (NHDRED, 2010). Special status species that may occur along transmission lines are discussed in Section 2.2.8, and potential impacts to these species are discussed in Section 4.7.1.

2.2.7 Terrestrial Resources

2.2.7.1 Seabrook Site and Surrounding Vicinity

Seabrook lies in the Gulf of Maine Coastal Lowland subsection of the Lower New England Ecoregion. This ecoregion is characterized by delta plains, broad plateaus, gentle slopes, and coastal areas and has an elevation range of sea level to 1,500 ft (450 m) (McNab and Avers, 1994). The Gulf of Maine Coastal Lowland subsection is comprised of a narrow region along the coast with low topographic relief, a moderate climate, and tidal marshes, dunes, beaches, and rocky coastline (Sperduto, 2005). Vegetation is characterized by temperate deciduous forest, and pine-oak and white cedar swamp tend to be the dominant forest types (Bailey, 1995).

The Seabrook site is composed of two lots totaling 889 ac (360 ha). Lot 1 is 109 ac (44 ha) and contains the operating facility, associated buildings, parking lots, and roads, and Lot 2 is 780 ac (320 ha) and is mostly composed of undeveloped natural areas (NextEra, 2010a). Over 58 ac (23 ha) on the Seabrook site—split into 11 parcels—are legally preserved through conservation easements with the Society for Protection of New Hampshire Forests, the Audubon Society of New Hampshire, or the NHFGD. The land in easement is composed primarily of salt marsh or other unspecified marsh type. The Seabrook site also contains the Owascoag Nature Trail, a nearly 1-mi (0.6-km) trail that surrounds the Seabrook Science and Nature Center, both of which are located adjacent to the developed portion of the site. New Hampshire Nature Conservancy ecologists have identified four State-listed threatened plant species—salt marsh gerardia (*Agalinis maritime*), Missouri rock-cress (*Boechera missouriensis*), hackberry (*Celtis occidentalis*), and the American plum tree (*Prunus americana*)—and one State-listed critically imperiled plant species—the orange horse-gentian (*Triosteum aurantiacum*)—within the area surrounding the trail (FPL, 2010). These species, as well as other Federally and State-protected species are discussed in more detail in Section 2.2.8 of this SEIS.

The site, as a whole, is situated on an area of second-growth native forest bordering the Hampton-Seabrook Estuary. Tidal salt marsh surrounds the site to the northeast, east, and southeast. The upland portions of the site are dominated by hardwood-red cedar, oak-hickory, and hardwood-conifer stands, and the marsh areas are dominated by bands of switch grass (*Panicum virgatum*) and black-grass (*Juncus gerardi*), common reed (*Phragmites australis*) monostands, and smooth cordgrass (*Spartina alternaflora*) monostands (NextEra, 2010a).

The majority of the marsh areas and some forested areas on and around the Seabrook site are designated as the Hampton Marsh Core Conservation Area in the *Land Conservation Plan for New Hampshire's Coastal Watersheds* (Zankel et al., 2006). The Hampton Marsh Core Conservation Area is composed of 7,490 ac (3,031 ha) and contains a contiguous 3,310.8-ac (1,339.8-ha) area of tidal marsh habitat and a 920-ac (372-ha) block of unfragmented forest habitat. In the conservation plan, Zankel et al. (2006) assessed the quality of New Hampshire's unfragmented forest blocks by considering two major factors: (1) their ability to absorb infrequent, devastating natural disasters including fire and hurricanes, and (2) their ability to support a variety of interior species at population levels that ensure long term viability. Zankel et al. (2006) consider the 920-ac (372-ha) unfragmented forest block within the Hampton Marsh Core Conservation Area to be of a locally significant size and to have the capability to provide habitat for some interior forest species with smaller ranges but to likely not be able to absorb large-scale natural disturbance (Zankel et al., 2006). The Hampton Marsh Core Conservation Area also contains 12 exemplary natural communities and system types, of which 3 types are located on the Seabrook site: brackish marsh, high salt marsh, and low salt marsh (NHNHB, 2010; Zankel et al., 2006).

In addition to the exemplary communities discussed above, the Seabrook site contains the following habitats: Appalachian pine-oak forest, grasslands, hemlock-hardwood-pine forest, rocky ridge or talus slope, wet meadow and shrub wetland, brackish marsh, and intertidal flats (NHNHB, 2010; Sperduto, 2005). Detailed descriptions of these habitats can be found in the New Hampshire Natural Heritage Bureau's (NHNHB's) report, *Natural Communities of New Hampshire* (Sperduto, 2005).

Forested areas provide habitat to a variety of native wildlife, including white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), eastern cottontails (*Sylvilagus floridanus*), painted turtles (*Chrysemys picta*), garter snakes (*Thamnophis* spp.), ribbon snakes (*T. sauritus*), wood frogs (*Rana sylvatica*), American toads (*Bufo americanus*), and various species of squirrels, voles, shrews, and foxes. Common bird species in forested and developed areas include blue jays (*Cyanocitta cristata*), black-capped chickadees (*Poecile atricapillus*), robins (*Turdus migratorius*), black-and-white warblers (*Mniotilta varia*), whip-poor-wills (*Caprimulgus vociferus*), purple finches (*Carpodacus purpureus*), and numerous hawk species (NextEra, 2010a; NHFGD, 2005a; NHFGD, 2008).

In 2003, the New Hampshire Audubon Society recognized the Hampton-Seabrook Estuary as an Important Bird Area by the New Hampshire Audubon due to the extensive area of unfragmented marsh habitat that it provides to migratory shorebirds and birds that breed in salt marshes. During a 2006–2007 bird survey (McKinley and Hunt, 2008), the New Hampshire Audubon recorded observations of bird use of the estuary from July–November 2006 and May–September 2007 over multiple locations through the estuary. During the survey, 23 species of migratory shorebirds were recorded, and an estimated 3000–3500 individual birds used the estuary between late July and late September, the peak migration period for this area. The semipalmated plover (*Charadrius semipalmatus*) and semipalmated sandpiper (*Calidris pusilla*) were the most abundant species and accounted for approximately one-third of the total individuals. Black-bellied plovers (*Pluvialis squatarola*), greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*T. flavipes*), least sandpipers (*C. minutilla*), and short-billed dowitcher (*Limnodromus griseus*) were considered common, but not as abundant as the semipalmated plover or semipalmated sandpiper. The saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*) was the most common saltmarsh breeding bird identified during the survey, but this species does not regularly inhabit any of the marsh areas adjacent to the Seabrook site. The North Flats survey site, which is adjacent and to the east of the Seabrook site, contains large exposed flats, mussel flats, and peat banks with Spartina species. It is used as a roost site by black-bellied plovers, dunlins (*Calidris alpina*), and short-billed dowitchers and a foraging area by whimbrels (*Numenius phaeopus*), short-billed dowitchers, and willets (*T. semipalmata*) (McKinley and Hunt, 2008).

2.2.7.2 Transmission Line ROWs

The three in-scope transmission lines that connect Seabrook to the regional electric grid traverse a variety of habitats including forest, shrubland, marsh, residential land, agricultural land, and other developed areas. Section 2.1.5 discusses vegetative maintenance practices along the ROWs.

Within the Town of Kingston, NH, the Scobie Pond Line runs outward to the west of the site, crosses near a swamp white oak (*Quercus bicolor*) floodplain forest that is considered to be of excellent quality and is dominated by swamp white oak, red maple (*Acer rubrum*), and shagbark hickory (*Carya ovata*) (NHNHB, 2010b). The line also runs near an Atlantic white cedar (*Chamaecyparis thyoides*)-yellow birch (*Betula alleghaniensis*)-pepperbush (*Clethra* spp.) swamp that is considered to be of good quality and have a healthy population of Atlantic white cedar, black spruce (*Picea mariana*), hemlock (*Tsuga* spp.), and larch (*Larix* spp.), and an excellent variety of bog plants by the NHNHB (NHNHB, 2010b). This swamp was designated as an exemplary natural community by the Nature Conservancy (NextEra, 2010a). The Tewksbury Line, which runs outward southwest of the site and into Massachusetts, crosses portions of the Crane Pond Wildlife Management Area, a 2,123-ac (859-ha) parcel of land that is managed by the Massachusetts Division of Fisheries and Wildlife (MDFW) containing Crane Pond and Little Crane Pond as well as low-lying rolling pine and mixed hardwood forest (ENHA, 2010). Crane Pond hosts some spring-migrating waterfowl, including woodcock (*Scolopax* spp.), ruffed grouse (*Bonasa umbellus*), and wild turkey (*Meleagris gallopavo*), as well as a variety of nesting songbirds in the wetland and uplands areas (ENHA, 2010).

2.2.8 Protected Species and Habitats

As delegated by the ESA (16 USC 1531), the NMFS and the U.S. Fish and Wildlife Service (USFWS) are responsible for listing aquatic and terrestrial species as threatened and endangered at the Federal level. The State may list additional species that are regionally threatened or endangered. For the purposes of this SEIS, all Federally and State-listed species that occur, or potentially occur, in the vicinity of the Seabrook site are included in Table 2.2-3 and Table 2.2-6. Those species protected under the Marine Mammal Protection Act (MMPA) and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) are discussed in Section 2.2.8.1.

2.2.8.1 Protected Aquatic Species

This section provides information on aquatic species that are protected by Federal and State laws. Protected marine species include those that are Federally protected under the MMPA, the ESA, and the MSA as well as those managed by the USFWS or the NMFS, or both. Also included are aquatic species listed as endangered, threatened, or species of special concern by the State of New Hampshire or the State of Massachusetts. In the Gulf of Maine in the vicinity of Seabrook or along transmission lines, 14 Federally or State-listed marine species could occur, including 7 fish, 1 mussel, 3 sea turtles, and 3 whales (NMFS, 2010a; NextEra, 2010a). These listed aquatic species appear in Table 2.2-3.

Table 2.2-3. Listed aquatic species

The species below are Federally listed, New Hampshire-listed, or Massachusetts-listed as proposed, threatened, endangered, or species of special concern. These species have been recorded as occurring within the counties associated with Seabrook and its transmission line ROWs.

Scientific name	Common name	Federal status[a]	NH[b]	MA[b]	County(ies) of occurrence at site or along transmission lines or Gulf of Maine or both	Habitat
					Fish	
Acipenser brevirostrum	Shortnose sturgeon	E	E	E	Gulf of Maine; Merrimac & West Newbury, MA	Adults spawn in fast-flowing, rocky rivers; Migrate through rivers and estuaries to Gulf of Maine
Acipenser oxyrinchus oxyrinchus	Atlantic sturgeon	P		E	Gulf of Maine	Adults spawn in fast-flowing, rocky rivers; Migrate through rivers and estuaries to Gulf of Maine

Scientific name	Common name	Federal status[a]	NH[b]	MA[b]	County(ies) of occurrence at site or along transmission lines or Gulf of Maine or both	Habitat
Enneacanthus obesus [7,8,9]	Banded sunfish	--	SC		Hillsborough & Rockingham, NH	Vegetated areas of ponds, lakes, and the backwaters of lowland streams
Esox americanus americanus	Redfin pickerel	--	SC		Hillsborough & Rockingham, NH	Densely vegetated slow-moving, acidic, tea-colored streams
Pomolobus aestivalis	Blueback Herring	SC	SC		Hampton-Seabrook Watershed and Gulf of Maine	Spawn in fast and slow moving streams; Migrate from freshwater through estuaries to Gulf of Maine
Osmerus mordax	Rainbow smelt	SC	SC		Hampton-Seabrook Watershed & Gulf of Maine	Spawn in rivers with gravel substrate and fast currents; Migrate from freshwater to estuaries and the Gulf of Maine
Alosa pseudoharengus	Alewife	SC	SC		Hampton-Seabrook Watershed & Gulf of Maine	Spawn in riverine oxbows, ponds, and mid-river sites; Migrate from freshwater through estuaries to Gulf of Maine
			Mussels			
Ligumia nasuta	Eastern pond mussel	--	SC	SC	Hillsborough & Rockingham, NH; Amesbury, MA	Ponds, lakes, and the low velocity segments of streams and rivers; Occur in Great Pond, NH
			Turtles			
Caretta caretta	Loggerhead sea turtle	T		T	Gulf of Maine	Seasonally present off the coast of New Hampshire
Dermochelys coriacea	Leatherback sea turtle	E		E	Gulf of Maine	Seasonally present off the coast of New Hampshire
Lepidochelys kempi	Kemp's ridley turtle	E		E	Gulf of Maine	Seasonally present off the coast of New Hampshire
			Whales			
Balaenoptera physalus	Fin whales	E		E	Gulf of Maine	Deep waters off the coast of New Hampshire
Eubalaena glacialis	Northern right whale	E		E	Gulf of Maine	Deep waters off the coast of New Hampshire
Megaptera novaeangliae	Humpback whale	E		E	Gulf of Maine	Deep waters off the coast of New Hampshire

[a] P = Proposed for Federal listing as a Federally Threatened species in the Gulf of Maine; E = Federally Endangered; T = Federally Threatened

[b] E = Endangered; T = Threatened; SC = Special concern

Source: (MDFW, 2009a; MFGD, 2010; NextEra, 2010a; NMFS, 1998; NMFS, 2010; NMFS, 2010a; NHFGD, 2005; NHFGD, 2009; NHNHB, 2009; NHNHB, 2010; NHNHB, 2010b)

Marine Mammals

The Gulf of Maine Program of the Census of Marine Life documented 32 marine mammal species within the Gulf of Maine (Valigra, 2006). The two major groups of marine mammals that occur within the Gulf of Maine include cetaceans (whales, dolphins, and porpoises) and pinnipeds (seals). All marine mammals are protected under the MMPA of 1972, as amended. The MMPA prohibits the direct or indirect taking of marine mammals, except under certain circumstances including non-fishery commercial activities. Several of these marine mammal species are Federally listed whales, which are additionally protected under the ESA of 1976, as amended.

Northern right whales (*Eubalaena glacialis*), humpback whales (*Megatera novaeangliae*), and fin whales (*Balaenoptera physalus*) are Federally endangered species that inhabit waters off the coast of New Hampshire (NMFS, 2010a). The Gulf of Maine is an important feeding ground for whales. Primary prey for right whales includes zooplankton, such as copepods, euphausiids (krill), and cyprids (NMFS, 2011b). Humpbacks whale can consume up to 3,000 lb (1360 kg) of food per day while eating tiny crustaceans (mostly krill), plankton, and small fish (NMFS, 2011c). Fin whales also consume krill, as well as small schooling fish (e.g., herring, capelin, and sand lance) and squid (NMFS, 2011d). These whale species are not likely to occur in the vicinity of the Seabrook facility or the facility's intake or discharge structures since these whale species generally inhabit deeper waters (NMFS, 2010a).

Among the non-Federally listed whale species that occur within the Gulf of Maine are the beluga whale (*Delphinapterus leucas*), killer whale (*Orcinus orca*), minke whale (*Balaenoptera acutorostrata*), and long-finned pilot whale (*Globicephala melaena*) (Provincetown Center for Coastal Studies, 2011; Thompson, 2010). Of these four species, only the long-finned pilot whale and the minke whale are regularly observed in the Gulf of Maine (Provincetown Center for Coastal Studies, 2011). Minke whales and the long-finned pilot whale generally inhabit deeper waters than the location of the Seabrook intake and discharge structures (NMFS, 2009; Provincetown Center for Coastal Studies, 2011). There are no known occurrences of Seabrook operations affecting whales.

Non-Federally listed dolphin and porpoise species that may occur in this area include the whitebeaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*L. acutus*), common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*), striped dolphin (*Stenella coeruleoalba*), and the harbor porpoise (*Phocoena phocoena*) (Provincetown Center for Coastal Studies, 2011; Thompson, 2010). Of these seven species, only the Atlantic white-sided dolphin and the harbor porpoise are regularly observed in the Gulf of Maine (Provincetown Center for Coastal Studies, 2011; Thompson, 2010). There are no known occurrences of Seabrook operations affecting dolphins or porpoises.

Four species of seals are regularly observed in the Gulf of Maine. These include harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), harp seals (*P. groenlandica*), and hooded seals (*Cystophora cristata*) (GOMA, 2011; Provincetown Center for Coastal Studies, 2011). All four species of seals inhabit the Gulf of Maine during the winter. During warmer months, seals migrate south although some harbor seals and grey seals may remain in the Gulf of Maine year round. Seals use ocean habitats for feeding and rocky shores or outcrops, reefs, beaches and glacial ice for hauling out to rest, thermal regulation, social interaction, avoiding predators, giving birth, and rearing pups (NFMS, 2011f). Seal prey consistent primarily of fish, shellfish, and crustaceans (NFMS, 2011f). Seals occur within the vicinity of the Seabrook intake and discharge structures (NextEra, 2010a).

Turtles

Three species of sea turtles—loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) and leatherback (*Dermochelys coriacea*)—regularly occur in the Gulf of Maine (Thompson, 2010). Under ESA, the leatherback and Kemp's ridley sea turtles are listed as endangered species, and the loggerhead sea turtle is listed as threatened.

Sea turtles reside most of their life within the ocean, although they will migrate long distances to breed on sandy beaches (NMFS, 2011). Sea turtles seasonally migrate to Gulf of Maine in order to find prey. Primary feeding habitats include northerly areas on, or along, the continental shelf (Shoop, 1987 in Thompson, 2010). Leatherback turtles and loggerhead turtles would be most likely to be seasonally present off the coast of New Hampshire and occasionally within the vicinity of the Seabrook, including the intake and discharge structures (NMFS, 2010a). It is less likely for Kemp's ridley sea turtle to be present in the vicinity of Seabrook (NMFS, 2010a).

NextEra has not documented any known occurrences of Seabrook operations affecting turtles. In addition, the installment of additional vertical bars on the intake structure as part of the seal deterrent barrier should also help prevent any future incidental takes (NextEra, 2010a).

Fish, Squids, and Mollusks

Endangered, Threatened, or Species of Concern

NMFS (2010) proposed listing the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) as threatened in the Gulf of Maine. Shortnose sturgeon (*Acipenser brevirostrum*) is listed as endangered (NMFS, 1998). NMFS considers blueblack herring, alewife, and rainbow smelt species of concern due to the declines in population (NMFS, 2010a). A species is designated as a species of concern by NMFS if NMFS has some concerns regarding the species' status and threats, but has insufficient information to indicate a need to list the species under the ESA (NMFS, 2011f). This status level does not carry any procedural or substantive protections under the ESA (NMFS, 2011f).

Along the transmission lines, the banded sunfish (*Enneacanthus obesus*) and redfin pickerel (*Esox americanus americanus*), two species of fish listed as species of special concern by the State of New Hampshire, may occur in Rockingham and Hillsborough Counties, NH (NHNHB, 2009; NHNHB, 2010; NHNHB, 2010b). The eastern pond mussel (*Ligumia nasuta*), which is listed as a species of special concern by the States of New Hampshire and Massachusetts, may occur in the vicinity of the transmission lines in Hillsborough and Rockingham Counties, NH, and Amesbury County, MA (MDFW, 2009; MFGD, 2010; NHNHB, 2010b; NHNHB, 2010). In addition, the shortnose sturgeon, which is listed as endangered by the State of New Hampshire and the State of Massachusetts, may occur in the vicinity of the transmission lines in Merrimac and West Newbury Counties, MA (MDFW, 2009; MFGD, 2010).

Below is a brief description of these listed species.

<u>Atlantic Sturgeon</u>. NMFS (2010) proposed listing distinct population segments of Atlantic sturgeon in the Gulf of Maine as a threatened species. The Atlantic sturgeon is a very large anadromous fish that averages 6–9 ft (1.8–2.7 m) in length, but can exceed a length of 13 ft (4 m) and a weight of 800 lb (363 kg). This species is long-lived, and its lifespan can reach 60 years (NMFS, 2010). Spawning generally occurs in rocky, fast flowing rivers in July in Maine (NHFGD, 2005). Spawning occurs every 1–5 years for males and every 2–5 years for females (NMFS, 2010). Eggs are deposited on hard bottom substrate and are highly adhesive, generally attaching to stones or vegetation (NHFGD, 2005). Larvae are also demersal and develop into juveniles while migrating downstream into more brackish waters (NMFS, 2010). Juveniles will spend up to 4 years in riverine or tidal habitats (NHFGD, 2005). NMFS (2010)

does not believe that any rivers in New Hampshire or Massachusetts support spawning populations of Atlantic sturgeon.

Atlantic sturgeon are omnivorous benthic feeders, meaning that they consume a wide range of plants and animals that live on the ocean floor. While searching for food in soft sediment habitats, they filter mud along with their food. Adult diets include mollusks, gastropods, amphipods, isopods, and fish (NMFS, 2010).

Historically, Atlantic sturgeon likely inhabited the Connecticut, Merrimack, and Coastal watersheds (NHFGD, 2005). More recently, NHFGD (2005) reported only two Atlantic sturgeon upstream of the Great Bay Estuary System since 1981. Population decline has been attributed to over-harvesting, habitat degradation, and barriers (e.g., dams) along waterbodies connecting spawning grounds with ocean habitats (Smith, 1995).

Atlantic sturgeon currently occur in coastal waters off the coast of New Hampshire and are likely to occur within the vicinity of Seabrook (NMFS, 2010a). Seabrook captured a single Atlantic Sturgeon during site gill-net monitoring from 1976–1997 (NextEra, 2010a). Seabrook did not report impingement or entrainment of any Atlantic sturgeon since operations began in 1990 (NAI, 2010; NextEra, 2010a).

<u>Shortnose Sturgeon</u>. The shortnose sturgeon is Federally listed as endangered throughout its range and was placed on the endangered species list in 1967 (NMFS, 1998). Critical habitat has not been designated for this species. The shortnose sturgeon is often confused with the Atlantic sturgeon, but the two species can be distinguished by comparing the width of the mouths—the shortnose sturgeon has a much wider mouth than the Atlantic sturgeon. The shortnose sturgeon is much smaller than the Atlantic sturgeon, rarely exceeding 3 ft (0.9 m) in length.

The shortnose sturgeon is amphidromous, meaning that the fish spawns in freshwater, and spend time in both marine and freshwater habitats during its lifespan. Spawning occurs in fast-flowing, rocky rivers in April and May.

The shortnose sturgeon has not been observed in New Hampshire since 1971 (NHFGD, 2005). Seabrook has not captured any shortnose sturgeon within monitoring, entrainment, or impingement studies since studies began in 1975 (NextEra, 2010a).

<u>Rainbow Smelt</u>. Rainbow smelt is listed as a species of special concern by NMFS due to declining populations (NMFS, 2010a). Adult rainbow smelt generally migrate from marine waters to estuaries during late fall and winter and then migrate to freshwater streams to spawn in March or April, soon after the breakup of ice. Preferred spawning grounds include rivers with gravel substrate and fast flows (Scarola, 1987 in NHFGD, 2005). Rainbow smelt usually travel less far into rivers than other diadromous fish. Freshwater and tidal currents carry larvae from freshwater to marine waters, such as the Gulf of Maine, from April–June (Collette and Klein-MacPhee, 2002; Ganger, 1999). Adults return to estuaries or salt water after spawning (Collette and Klein-MacPhee, 2002; NHFGD, 2005). Dams have severely limited movement of rainbow smelt to and from spawning grounds (NHFGD, 2005). Rainbow smelt occur within the Hampton-Seabrook Estuary and within the vicinity of the Seabrook intake and discharge structures (NAI, 2010).

<u>Blueback Herring</u>. Blueback herring are listed as a species of special concern by NMFS due to declining populations (NMFS, 2010a). Blueback herring also spawn in freshwater during the spring and migrate to estuaries or marine waters during the summer and cooler months. Juveniles often migrate from fresh to brackish water later than adults do and as late as October or early November (NHFGD, 2005). Dams have severely limited movement of blueback herring to and from spawning grounds. Herring are an important component of freshwater, estuarine,

and marine food webs since they are prey for many predatory fish, and they help transport nutrients to freshwater systems (NHFGD, 2005). Blueback herring occur within the Hampton-Seabrook Estuary and within the vicinity of the Seabrook intake and discharge structures (NAI, 2010).

Alewife. Alewife is listed as a species of special concern by NMFS due to declining populations (NMFS, 2010a). Alewife have similar habitat requirements as blueback herring, although alewife begin their spring migration to freshwater earlier than bluebacks, and alewife spawn earlier (Collette and Klein-MacPhee, 2002). Dams have severely limited movement of alewife to and from spawning grounds. Alewife is an important component of freshwater, estuarine, and marine food webs since they are prey for many predatory fish, and they help transport nutrients to freshwater systems (NHFGD, 2005). Alewife occur within the Hampton-Seabrook Estuary and within the vicinity of the Seabrook intake and discharge structures (NAI, 2010).

Banded Sunfish. Preferred habitat for the banded sunfish includes vegetated areas of ponds, lakes, and the backwaters of lowland streams (Scarola, 1987 in NHFGD, 2005). In New Hampshire, banded sunfish are most often found in coastal watersheds (NHFGD, 2005). This species is highly tolerant of acidic water and can survive in waters with pH levels as low as 4.0 (Gonzales and Dunson, 1989). Populations tend to be locally abundant, but wide-spread distribution of the species is limited (NHFGD, 2005).

Redfin Pickerel. Redfin pickerel primarily inhabit densely vegetated, slow-moving, acidic, tea-colored streams. Steiner (2004) also observed this species in brackish waters and swampy areas with low dissolved oxygen. Spawning habitat includes shallow flood margins of stream habitats with thick vegetation (NHFGD, 2005). Spawning mainly occurs in the early spring, and may also occur in fall (Scarola, 1987 in NHFGD, 2005). Within New Hampshire, redfin pickerel exclusively inhabit the coastal and lower Merrimack watersheds (NHFGD, 2005).

Eastern Pond Mussel. Eastern pond mussels grow in soft sediments at the bottom of ponds, lakes, and the low velocity segments of streams and rivers (NHFGD, 2005). Eastern pond mussels grow in Great Pond, Kingston, which is in the vicinity of the Scobie Pond Transmission Line (NextEra, 2010a; NHNHB, 2010b). In New Hampshire, this mussel is found in three other ponds in the southeast part of the State (NHFGD, 2005). The introduction of zebra mussel (*Dreissena polymorpha*) is the primary threat to this species (NHFGD, 2005).

Eastern pond mussels spawn in summer, and larvae attach and encyst on host species, usually fish. Host fish species are unknown (NHFGD, 2005).

Species with Essential Fish Habitat in the Vicinity of Seabrook

The MSA, as amended in 1996, focuses on the importance of habitat protection for healthy fisheries. The MSA amendments, known as the Sustainable Fisheries Act, require eight regional fishery management councils to describe and identify EFH in their regions, to identify actions to conserve and enhance their EFH, and to minimize the adverse effects of fishing on EFH. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (16 U.S.C. 1802(10); 50 CFR 600.10).

NMFS (2011g) has designated the Gulf of Maine, within the vicinity of Seabrook, as EFH for 23 species. In compliance with Section 305(b)(2) of MSA, NRC has completed an EFH assessment, which can be found in Appendix D of this SEIS. A summary of the species discussed in the EFH assessment is provided below.

In their *Guide to Essential Fish Habitat Designations in the Northeastern United States*, NMFS (2011g) identifies EFH by 10 minute squares of latitude and longitude as well as by major estuary, bay, or river for estuarine waters outside of the 10 minute square grid. The waters in the vicinity of Seabrook are within the "Gulf of Maine" EFH Designation that extends from Salisbury, MA, north to Rye, NH, and includes Hampton Harbor, Hampton Beach, and Seabrook Beach. The 23 species with designated EFH in this area appear in Table 2.2-4.

Table 2.2-4. Species of fish, squids, and mollusks with designated EFH within the vicinity of Seabrook

Species	Eggs	Larvae	Juveniles	Adults
American plaice (*Hippoglossoides platessoides*)			x	x
Atlantic butterfish (*Peprilus triacanthus*)	x	x	x	x
Atlantic cod (*Gadus morhua*)	x	x	x	x
Atlantic halibut (*Hippoglossus hippoglossus*)	x	x	x	x
Atlantic herring (*Clupea harengus*)			x	x
Atlantic mackerel (*Scomber scombrus*)	x	x	x	x
Atlantic sea scallop (*Placopecten magellanicus*)	x	x	x	x
Bluefin tuna (*Thunnus thynnus*)				x
Haddock (*Melanogrammus aeglefinus*)			x	
Long-finned squid (*Loligo pealei*)			x	x
Monkfish (*Lophius americanus*)	x	x	x	x
Ocean pout (*Macrozoarces americanus*)	x	x	x	x
Pollock (*Pollachius virens*)			x	
Redfish (*Sebastes fasciatus*)		x	x	x
Red hake (*Urophycis chuss*)	x	x	x	x
Short-finned squid (*Illex illecebrosus*)			x	x
Scup (*Stenotomus chrysops*)			x	x
Summer flounder (*Paralicthys dentatus*)				x
Surf clam (*Spisula solidissima*)			x	x
Whiting & silver hake (*Merluccius bilinearis*)	x	x	x	x
Windowpane flounder (*Scopthalmus aquosus*)			x	x
Winter flounder (*Pleuronectes americanus*)	x	x	x	x
Yellowtail flounder (*Pleuronectes ferruginea*)			x	x

As described in Section 2.2.6, Seabrook has monitored fish and shellfish eggs, larvae, juveniles, and adults since the mid-1970s. In addition, Seabrook regularly records annual estimates of entrainment and impingement, as described in Section 4.5.

Table 2.2-5 presents a summary of the occurrence of EFH species within Seabrook monitoring, entrainment, and impingement studies.

Table 2.2-5. Commonality of EFH species in Seabrook monitoring, entrainment, and impingement studies

Species	Eggs		Larvae		Juveniles & Adults			
	Plankton monitoring	Entrainment	Plankton monitoring	Entrainment	Trawl monitoring	Gill Net monitoring	Seine monitoring	Impingement
American plaice	Common[b]	Occasional[c]	Common	Occasional	Occasional			Rare[d]
Atlantic butterfish	Occasional	Rare	Occasional	Rare	Rare	Occasional	Rare	Rare
Atlantic cod [a]	Common	Common	Common	Rare	Common	Occasional	Rare	Rare
Atlantic halibut					Rare			
Atlantic herring			Common	Occasional	Occasional	Abundant[e]	Occasional	Common
Atlantic mackerel	Abundant	Abundant	Abundant	Rare	Rare	Common	Rare	Rare
Atlantic sea scallop				Rare				
Bluefin tuna								
Haddock [a]	Common	Rare	Occasional	Rare	Common	Rare		Rare
Monkfish & Goosefish	Rare	Rare	Occasional	Rare	Occasional	Rare		Rare
Ocean pout			Occasional	Rare	Common	Rare		Rare
Pollock	Common	Rare	Common	Rare	Common	Common	Occasional	Common
Redfish [a]			Occasional					
Red hake [a]	Common	Common	Common	Occasional	Abundant	Occasional	Common	Common
Scup			Rare		Occasional	Rare		Rare
Summer flounder			Rare	Rare	Rare			Rare
Surf clam				Rare				
Whiting & silver hake	Common	Abundant	Common	Occasional	Common	Common	Rare	Rare
Windowpane flounder	Common	Occasional	Common	Rare	Common	Rare	Occasional	Common
Winter flounder		Rare	Common	Occasional	Common	Occasional	Common	Common

Species	Eggs		Larvae		Juveniles & Adults			
	Plankton monitoring	Entrainment	Plankton monitoring	Entrainment	Trawl monitoring	Gill Net monitoring	Seine monitoring	Impingement
Yellowtail flounder [(a)]	Abundant	Occasional	Common	Rare	Abundant	Rare	Rare	Common

[(a)] During monitoring surveys, NAI (2010) combined certain groups of species if eggs were morphologically similar and spawning periods overlapped during the sampling period. In such cases, the estimate for the entire group of species is recorded in the table above. Groups of species include Atlantic cod/Haddock/witch flounder, cunner/yellowtail founder, redhake/white hake/spotted hake, and golden redfish/deepwater redfish/and Acadian redfish. For egg entrainment estimates of these groups of species, NextEra (2010f) estimated single species entrainment rates by applying the ratio of larval species to the egg species groups.

[(b)] Common: Occurring in >10% of samples, but <10% of total catch; 5-10% of entrainment samples averaged over all years

[(c)] Occasional: Occurring in <10%–1% of samples; 1–5% of entrainment samples averaged over all years

[(d)] Rare: Occurring in <1% of samples; <1% of entrainment samples averaged over all years

[(e)] Abundant: >10% of total catch or entrainment over all years

Source: (NAI, 2010; NextEra, 2010f)

The NRC staff's EFH assessment can be found in Appendix D of this SEIS.

2.2.8.2 Protected Terrestrial Species

2.2.8.2.1 Federally Listed Species

Two Federally listed species—the piping plover (*Charadrius melodus*) and the roseate tern (*Sterna dougallii*)—potentially occur on or in the vicinity of the Seabrook site or its associated transmission line ROWs (USFWS, 2010a).

Piping Plover. The piping plover is Federally listed as threatened and State-listed as endangered in both New Hampshire and Massachusetts. The species occurs in Rockingham County, NH, and Essex County, MA. Piping plovers are small and stocky shorebirds with a sand-colored upper body, white underside, and orange legs. Piping plovers prefer flat, sandy beaches with scarce to no vegetation. Females generally lay four eggs per year, and both parents care for chicks (USFWS, 2001). Because piping plovers nest on beaches, nest abandonment due to human presence or disturbance—as well as predation from fox, cats, and other birds—poses a major threat to the piping plover. Habitat loss due to increased commercial and residential development along coastlines has also decreased the species' available habitat (USFWS, 2001). A 5-Year Review of the Recovery Plan published in 2009 (USFWS, 2009) also cited oil spills, wind turbine generators, and climate change as three additional threats to the species since its 1986 listing (USFWS, 2009).

Although the piping plover is a migratory bird, it is listed under the ESA as three distinct population segments—the Great Lakes population, the North Great Plains, and the Atlantic Coast Population—all of which were listed under the ESA in 1986. A Recovery Plan for the Atlantic Coast Population was published in 1996 (USFWS, 1996), and a 5-Year Review of the Recovery Plan was published in 2009 (USFWS, 2009). No critical habitat has been designated for the Atlantic Coast Population. Abundance of the Atlantic Coast Population has increased drastically since the species' listing. In 2009, three of the four New England population units had reached their minimum target population size for at least 1 year (USFWS, 2009).

Piping plovers are known to nest in the Town of Seabrook and inhabit the nearby coastal beaches (FWA, 2010a; NHFGD, 2008a); however, no suitable nesting or foraging habitat for the species exists on the Seabrook site or along its associated transmission line ROWs (NextEra, 2010a). In a letter to NRC, the USFWS concluded that the piping plover is unlikely to be present on or in the immediate vicinity of the Seabrook site (USFWS, 2010a).

Roseate Tern. The roseate tern is a Federally and State-listed as endangered in both New Hampshire and Massachusetts. The species occurs in Rockingham County, NH, and Essex County, MA. The roseate tern is a medium-sized coastal bird that grows to 14–16 in. (35–40 cm) in length and has a pronounced forked tail (USFWS, 1998). It has a light gray back, white underbelly, black on its head, and long white tail feathers. Both males and females have black bills that turn reddish-orange during breeding season (USFWS, 1998). The species breeds on small islands along the Northeastern coast from New York to Maine and up into Canada, and it nests in colonies mixed with common terns along the coastlines. Roseate terns feed on small schooling marine fish such as bluefish (*Pomatomus saltatrix*), American sand lance (*Ammodytes americanus*), Atlantic herring (*Clupea harengus*), and mackerel (*Scomber scombrus*) (USFWS, 1998).

The roseate terns' population was initially depleted in the late 1800s when the species was harvested for feathers (USFWS, 1998). The species recovered significantly after the promulgation of the Migratory Bird Treaty Act of 1918 (USFWS, 1998). Since the 1930s and continuing today, human population growth and development along coastlines threaten the species' continued existence. The roseate tern population has declined an estimated 75 percent since the 1930s (NYDEC, 2010).

The roseate tern is known to occur along the Atlantic coast beaches to the east of the Seabrook site, but, according to the USFWS (2010a), the species is unlikely to occur on or in the immediate vicinity of the Seabrook site.

2.2.8.2.2 New Hampshire-Listed Species

To gather information on New Hampshire-listed species, the NRC contacted the NHNHB (NRC, 2010b). In NHNHB's response to the NRC, the NHNHB noted that four State-listed plant species—salt-marsh gerardia (*Agalinis maritime*), dwarf glasswort (*Salicornia bigelovii*), orange horse-gentian (*Triosteum aurantiacum*), and Missouri rock cress (*Boechera missouriensis*)—and one State-listed bird—the willet (*Tringa semipalmata*)—have been recorded as occurring on the Seabrook site (NHNHB, 2010a). Additionally, the New Hampshire Nature Conservancy had previously identified the hackberry (*Celtis occidentalis*) and American plum tree (*Prunus americana*) as occurring along or near the Seabrook Science and Nature Center and Owascoag Nature Trail (NextEra, 2010a).

Within the Hampton Marsh Core Conservation Area (described in Section 2.2.7), which includes the Seabrook site and the surrounding 7,490 ac (3,031 ha), some State-listed species are known to occur or are likely to occur, according to Zankel et al. (2006). Plant species (excluding those mentioned above) include: sea-beach needle grass (*Aristida tuberculosa*), yellow thistle (*Cirsium horridulum*), Gray's umbrella sedge (*Cyperus grayi*), small spike-rush (*Eleocharis parvula*), salt-loving spike rush (*Eleocharis uniglumis*), hairy husondia (*Hudsonia tomentosa*), and slender blue flag (*Iris prismatica*). State-listed wildlife species that are known to occur or are likely to occur within the Hampton Marsh Core Conservation Area (excluding those mentioned above) include horned lark (*Eremophila alpestris*), osprey (*Pandion haliaetus*), and common tern (*Sterna hirundo*) (Zankel et al., 2006).

No State-listed plant species occur in areas on the Seabrook site that are regularly maintained or that would be disturbed in any way during the proposed license renewal term. Therefore, State-listed plants are not discussed in any further detail in this section. A short description of State-listed wildlife species that are known to occur in the vicinity of the Seabrook site is included below.

Along the in-scope transmission lines within New Hampshire, the NHNHB noted that the following species have been recorded as occurring along, or near, the transmission line ROWs (NHNHB, 2010b):

- four plant species—tall wormwood (*Artemisia campestris ssp. caudata*), robust knotweed (*Persicaria robustior*), northern blazing star (*Liatris scariosa var. novaeangliae*), and dwarf huckleberry (*Gaylussacia dumosa*),
- two reptiles—Blanding's turtle (*Emydoidea blandingii*) and spotted turtle (*Clemmys guttata), and*
- one bird—the vesper sparrow (*Pooecetes gramineus).*

Because PSNH does not use herbicides within New Hampshire ROWs or any mechanized vehicles within designated wetlands and wet areas, and because PSNH workers are trained to recognized Federally or State-protected species (see Section 2.1.5), species within the New Hampshire ROWs are not expected to be impacted during the proposed license renewal term (See Section 4.7.2). Therefore, they are not discussed in any further detail in this section.

The species mentioned in this section as well as additional species that have the potential to occur within the Seabrook site or along the in-scope portions of the New Hampshire transmission line ROWs, along with their State and Federal status, range of occurrence, and habitat, are listed in Table 2.2-6.

Table 2.2-6. Listed terrestrial species

The species below are Federally listed, New Hampshire-listed, or Massachusetts-listed, as threatened, endangered, or candidate species. These species have been recorded as occurring within the counties associated with Seabrook site and its transmission line ROWs. Federally listed species are in bold.

Scientific name	Common name	Federal Status[(a)]	NH[(b)]	MA[(b)]	County(ies) of occurrence	Habitat
			Amphibians			
Ambrystoma laterale	blue-spotted salamander	--	SC	SC	Hillsborough; Rockingham; Essex; Middlesex	moist, deciduous hardwood forests; swampy woodlands
			Birds			
Catoptrophorus semipalmatus	willet	--	SC	--	Rockingham	coastal beaches; marshes; lakeshores; mudflats; wet prairies
Charadrius melodus	**piping plover**	**T**	**E**	**T**	**Essex; Hillsborough; Middlesex; Rockingham**	**sandy, sparsely vegetated coastlines**
Eremophila alpestris	horned lark	--	SC	--	Rockingham	open, sparsely vegetated areas with no grass or short grass
Falco peregrinus	peregrine falcon	--	T	E	Essex; Hillsborough;	grasslands; meadowlands

Scientific name	Common name	Federal Status[(a)]	NH[(b)]	MA[(b)]	County(ies) of occurrence	Habitat
anatum					Rockingham	
Haliaeetus leucocephalus	bald eagle	D	T	E	Essex; Rockingham	forested areas near open water
Pandion haliaetus	osprey	--	SC	E	Hillsborough; Rockingham	near lakes, rivers, marshes, and other bodies of water
Pooecetes gramineus	vesper sparrow	--	--	T	Rockingham	open habitats including prairie and sage brush steppe; abandoned fields; pastures; meadows
Sterna dougallii	**roseate tern**	**E**	**E**	**E**	**Essex; Rockingham**	**open, sandy beaches with minimal human activity**
Sterna hirundo	common tern	--	T	SC	Essex; Rockingham	sandy beaches; sparsely vegetated shorelines; back bays; marshes
Vermivora chrysoptera	golden-winged warbler	--	--	E	Essex	deciduous forests with thick undergrowth
			Insects			
Enallagma laterale	New England bluet	--	SC	SC	Essex	coastal plain ponds; swampy open water
Gomphus vastus	cobra clubtail	--	SC	SC	Essex	large, sandy-bottomed rivers and lakes
Neurocordulia obsolete	umber shadowdragon	--	SC	SC	Essex; Hillsborough; Middlesex; Rockingham	sparsely vegetated lakes and rivers; artificially created reservoirs and dams
Somatochlora Georgiana	coppery emerald	--	--	E	Essex	forest clearings; small, sluggish streams
Stylurus spiniceps	arrow clubtail	--	--	T	Essex	medium to large, fast-flowing, sandy-bottomed rivers and surrounding riparian areas
			Mammals			
NONE						
			Plants			
Agalinis maritime	salt-marsh gerardia	--	E	--	Rockingham	salt marshes
Anemone cylindrical	long-fruited anemone	--	E	--	Rockingham	dry, open woods; prairies
Aristida tuberculosa	sea-beach needle grass	--	E	T	Essex; Rockingham	sandy fields; roadsides
Artemisia campestris ssp. *caudate*	tall wormwood	--	T	--	Rockingham	sparsely vegetated sandy soils
Artemisia campestris ssp.	prolific knotweed	--	E	--	Rockingham	dry prairies; wooded areas

Scientific name	Common name	Federal Status[(a)]	NH[(b)]	MA[(b)]	County(ies) of occurrence	Habitat
prolificum						
Boechera missouriensis	Missouri rock cress	--	T	T	Essex; Rockingham	bluffs; rocky woods
Celtis occidentalis	hackberry	--	T	--	Rockingham	limestone outcrops in river valleys and uplands
Cirsium horridulum	yellow thistle	--	E	--	Rockingham	pinelands; prairie; well-drained sandy soils
Cyperus grayi	Gray's umbrella sedge	--	E	--	Rockingham	maritime shrublands
Eleocharis parvula	small spike-rush	--	T	--	Rockingham	brackish and saltwater marshes
Eleocharis uniglumis	salt-loving spike-rush	--	T	--	Rockingham	upland marshes
Gaylussacia dumosa	dwarf huckleberry	--	T	--	Hillsborough; Rockingham	sandy soils; pine savannahs
Hudsonia tomentosa	hairy hudsonia	--	T	--	Rockingham	coastal sand dunes
Iris prismatica	slender blue flag	--	T	--	Rockingham	brackish to freshwater marshes; sandy shores; meadows along coasts
Liatris scariosa var. *novaeangliae*	northern blazing star	--	E	--	Rockingham	dry grasslands; barrens; forest openings
Persicaria robustior	robust knotweed	--	E		Rockingham	wet soils along coastal plains; pond or stream margins
Polygonum erectum	erect knotweed	--	E	--	Rockingham	disturbed areas; salt marshes
Polygonum ramosissimum ssp. *Prolificum*	prolific knotweed	--	E	--	Rockingham	disturbed areas; roadsides
Prunus Americana	American plum	--	E	--	Rockingham	woodland edges; stream banks; upland pastures
Pluchea odorata var. *succulent*	salt marsh fleabane	--	E	--	Rockingham	coast salt marshes
Salicornia ambigua	perennial glasswort	--	E	--	Rockingham	coastal salt marshes
Salicornia bigelovii	dwarf glasswort	--	E	--	Rockingham	coastal salt marshes
Sparganium eurycarpum	large bur-reed	--	T	--	Hillsborough	coastal plain marshes
Sporobolus cryptandrus	sand dropseed	--	E	--	Rockingham	prairie; disturbed areas; roadsides
Triosteum aurantiacum	orange horse-gentian	--	E	--	Rockingham	deciduous forest

Scientific name	Common name	Federal Status[(a)]	NH[(b)]	MA[(b)]	County(ies) of occurrence	Habitat
			Reptiles			
Clemmys guttata	spotted turtle	--	T	--	Hillsborough; Rockingham	shallow wetlands; woodlands near clean, slow-moving streams and rivers
Emydoidea blandingii	Blanding's turtle	--	E	T	Essex; Hillsborough; Middlesex; Rockingham	areas near shallow backwater pools, marshes, ponds, and streams
Glyptemys insculpta	wood turtle	--	SC	SC	Essex; Hillsborough; Middlesex; Rockingham	forested areas and grasslands near shallow, clear, sandy-bottomed streams

[(a)] C = Candidate for Federal listing; D = Delisted; E = Federally Endangered; T = Federally Threatened

[(b)] E = Endangered; T = Threatened; SC = Special concern

Source: (MDFW, 2009; MDFW, 2009a; MFGD, 2010; NextEra, 2010a; NHNHB, 2009; NHNHB, 2010; USFWS, 2009a; USFWS, 2010; NHNHB, 2010a; NHNHB, 2010b; USFWS, 2010a; Zankel et al., 2006)

Willet. The willet breeds in salt marshes and grass-dominated tidal wetlands in transitional zones between ocean and upland along the Atlantic and Gulf coasts (NHFGD, 2005e). Within the Hampton-Seabrook Estuary, willets are most commonly found in the northeast portion of the estuary and the southern edge of the estuary near the mouth of the Blackwater River (McKinley and Hunt, 2008). During a 2006–2007 survey by the New Hampshire Audubon, no willets were observed in the central portion of the estuary near the Seabrook site (McKinley and Hunt, 2008). However, the NHNHB noted that willets are known to occur in the vicinity of the Seabrook site in its letter to NRC dated September 7, 2010 (NHNHB, 2010a). The species primarily feeds on crustaceans, mollusks, polycheates, and insects near marsh edges, mud flats, and mussel beds (NHFGD, 2005e). Therefore, the mussel beds and mud flats within the marsh that borders the Seabrook site may provide some marginal foraging habitat for the species.

Horned Lark. The horned lark inhabits sparsely vegetated areas including beaches, agricultural fields, residential, and developed areas (NHFGD, 2005c). The species is a year-round resident of North America, and within New Hampshire, has been recorded throughout the state, including near the Hampton Harbor Inlet and in Hampton Beach State Park (NHFGD, 2005c). The NHNHB noted that adult individuals have been observed along the Atlantic coast in the town of Seabrook (NHNHB, 2010a). Because the species' habitat requirements and the known occurrences of horned larks in the town of Seabrook, the horned lark may use the Seabrook site as habitat.

Osprey. The osprey is a migratory bird of prey that is found worldwide. Those that breed along the North American east coast return from wintering grounds in Florida, Cuba, and South America, beginning in early spring (NHFGD, 2005d). Within New Hampshire, the species is known to nest in the White Mountains, along the Androcscoggin, Merrimack, and Connecticut Rivers, and in the Great Bay area (NHFGD, 2010). In a letter to NRC dated September 7, 2010, the NHNHB noted that two osprey nests exist to the northeast and southeast of the site along the Hampton-Seabrook Estuary (NHNHB, 2010a). Because of the proximity of the nests, ospreys are likely to pass through the Seabrook site.

Common Tern. Historically, the common tern bred on several islands with the Isles of Shoals off the coast of New Hampshire and Maine. Human disturbance and predator pressure caused the common tern to search for breeding sites on the mainland starting in the mid-1900s, and, until population restoration efforts began in 1997, the Hampton-Seabrook Estuary served as a major breeding area (NHFGD, 2005b). During a 2006–2007 survey by the New Hampshire Audubon, 10–15 pairs of common terns were found to nest within the northeast and southern portions of the Hampton-Seabrook Estuary, but the survey did not record any evidence of the species breeding on the mainland (McKinley and Hunt, 2008). The NHNHB also noted that the species is known to occur in the vicinity of the Seabrook site and along the in-scope transmission line ROWs in its letters to NRC dated September 7, 2010 (NHNHB, 2010a), and September 13, 2010 (NHNHB, 2010b). The Seabrook site may provide some marginal foraging and breeding habitat, but is unlikely to regularly support the common tern. The species is more likely to occur to the east of the site near to the Atlantic coastline where it would have access to open, bare ground, or beach.

2.2.8.2.3 Massachusetts-Listed Species

To gather information on Massachusetts-listed species, the NRC contacted the MDFG to request information on State-protected species that may occur in the area (NRC, 2010a). In the MDFG's response to the NRC, the MDFG confirmed that the information contained in their previous letter to NextEra remains current for the proposed license renewal (MDFG, 2010). In their previous letter to NextEra, dated June 15, 2009 (MDFW, 2009), the MDFG noted the occurrence of priority habitat or estimated habitat for the bald eagle (*Haliaeetus leucocephalus*), Banding's turtle, wood turtle (*Glyptemys insculpta*), blue-spotted salamander (*Ambrystoma laterale*), and five species of dragonflies along the Massachusetts portion of the in-scope transmission line ROWs.

The NRC expects no impacts to species with Massachusetts ROWs during the proposed license renewal term because:

- National Grid is prohibited from using herbicides within State-designated Priority Habitat without prior written approval within the Commonwealth of Massachusetts per 321 CMR 10.14(12),
- MDFG approves National Grid's yearly operation plan to ensure that vegetative maintenance practices are not adversely affecting sensitive species or wetlands, and
- National Grid workers are trained to recognize and avoid impacts to Federally or State-listed species (See Section 2.1.5).

Therefore, those species are not discussed in any further detail in this section.

The species mentioned in this section, as well as additional species that have the potential to occur within the Seabrook site or along the in-scope portions of the Massachusetts transmission line ROWs, along with their State and Federal status, range of occurrence, and habitat, are listed in Table 2.2-6.

2.2.9 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at Seabrook. Seabrook, and the communities that support it, can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required to operate the nuclear power plant. Plant operations, in turn, provide wages and benefits for people as well as dollar expenditures for goods and services. The measure of a communities' ability to support Seabrook operations depends on the ability of the community to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomic region of influence (ROI) is defined by the area where Seabrook employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The Seabrook ROI consists of a two-county area (Rockingham and Strafford counties), where approximately 67 percent of Seabrook employees reside (NextEra, 2010a).

Seabrook employs a permanent workforce of approximately 1,093 employees (NextEra, 2010a). Approximately 67 percent live in Rockingham County and Strafford County (Table 2.2-7). Most of the remaining 33 percent of the workforce are divided among 8 counties in Maine, Massachusetts, and New Hampshire, with numbers ranging from 10–102 employees per county, with 4 percent living in other locations. Given the residential locations of Seabrook employees, the most significant impacts of plant operations are likely to occur in Rockingham County and Strafford County. Therefore, the focus of the socioeconomic impact analysis in this SEIS is on the impacts of continued Seabrook operations on these two counties.

Table 2.2-7. Seabrook—employee residence by county

County	Number of employees	Percentage of total
Rockingham, NH	516	47
Strafford, NH	219	20
York, ME	102	9
Essex, MA	85	8
Hillsborough, NH	39	4
Middlesex, MA	27	2
Merrimack, NH	26	2
Cumberland, ME	12	1
Belknap, NH	11	1
Kennebec, ME	10	1
Other locations	46	4
Total	**1,093**	**100**

Source: (NextEra, 2010a)

Refueling outages at Seabrook normally occur at 18-month intervals. During refueling outages, site employment increases by as many as 800 temporary workers for approximately 30 days (NextEra, 2010a). Most of these workers are assumed to be similarly distributed across the same geographic areas as Seabrook employees. The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding Seabrook.

2.2.9.1 Housing

Table 2.2-8 lists the total number of occupied and vacant housing units, vacancy rates, and median value in the two-county ROI. According to the 2000 Census, there were approximately 158,600 housing units in the ROI, of which approximately 147,100 were occupied. The median value of owner-occupied housing units in Rockingham and Strafford counties in 2000 were $164,900 and $121,000, respectively. The vacancy rate was lower in Strafford County (6.5 percent) than in Rockingham County 7.5 percent (USCB, 2011).

Table 2.2-8. Housing in Rockingham County and Strafford County in New Hampshire

	Rockingham	Strafford	ROI
	2000		
Total	113,023	45,539	158,562
Occupied housing units	104,529	42,581	147,110
Vacant units	8,494	2,958	11,452
Vacancy rate (percent)	7.5	6.5	7.2
Median value (dollars)	164,900	121,000	142,950
	2009 estimates		
Total	124,904	50,918	175,822
Occupied housing units	113,957	48,355	162,312
Vacant units	10,947	2,563	13,510
Vacancy rate (percent)	8.8	5.0	7.7
Median value (dollars)	294,500	228,500	261,500

Source: (USCB, 2011)

The number of housing units grew in both counties from 2000–2009. In Rockingham County, the number of housing units grew by approximately 12,000 units (approximately 10 percent) to total of 124,904 housing units. In Strafford County, the total number of housing units increased by an estimated 11.8 percent over the same period to a total of 50,918 housing units(USCB, 2011).

2.2.9.2 Public Services

This section presents information regarding public services including water supply, education, and transportation.

Water Supply. There are six major public water suppliers In Rockingham County. The Portsmouth Water Works serves a population of 33,000 with the largest capacity and daily demand served, and smaller systems supply other municipalities in the county (Table 2.2-9). There are four major public water suppliers In Strafford County—the City of Rochester Water Department has the largest capacity, while the City of Dover Water Department serves a population of 28,000 (Table 2.2-9).

Table 2.2-9. Rockingham County and Strafford County public water supply systems (in mgd)

Water supplier	Primary water source [(a)]	Average daily demand (mgd)	System capacity (mgd)	Population served
		Rockingham County		
Aquarion Water/NH	GW	1.5	5.0	23,000
Derry Water Department	SW	1.5	3.0	15,000
Exeter Water	SW	1.1	2.0	11,000

Water supplier	Primary water source [(a)]	Average daily demand (mgd)	System capacity (mgd)	Population served
Department				
Portsmouth Water Works	SW	4.0	8.0	33,000
Salem Water Department	SW	0.6	2.5	18,000
Seabrook Water Department	GW	0.9	2.5	14,000
Strafford County				
Dover Water Department	GW	2.5-3.0	4.2	28,000
Rochester Water Department	SW	2.0-2.6	4.6	20,000
Somersworth Water Works	SW	2.0-3.0	3.0	12,000
UNH/Durham Water System	SW	1.0	2.1	16,000

[(a)] Ground water = GW; Surface Water = SW.

Source: (EPA, 2010b; Tetra Tech, 2009)

Seabrook obtains water from the Town of Seabrook Water Department, which provided an average of 0.1 mgd to the plant from 2003–2008 (NextEra, 2010a). The town's maximum permitted capacity is currently 2.5 mgd, while average daily use is 0.9 mgd, including the amount consumed by Seabrook. Demand for water in the Town of Seabrook is projected to increase from 2010–2020, with additional groundwater wells, surface water sources, and inter-municipal distribution systems all expected to meet water demand (Town of Seabrook, 2010).

Education

Primary Education

There are 36 school districts in Rockingham County with 82 schools and an enrollment of 43,852 students from 2008–2009. In Strafford County, there are 8 school districts with 30 schools and 14,917 students (NCES, 2010). In the Seabrook School District, there is 1 elementary school, which had 462 students from 2008–2009, and 1 middle school, which had 360 students. High school students residing in Seabrook attend Winnacunnet High School, located in Hampton, which had 1,273 students from 2008–2009.

Secondary Education

Within 50 mi (80.5 km) of Seabrook, there are sixty-eight 4-year institutes, the two nearest being Zion Bible College and the University of New Hampshire-Main Campus. Zion Bible College is a privately-owned college located in Haverhill, MA, approximately 15 mi (24.1 km) southwest of Seabrook. Fall 2009 enrollment totaled 260 undergraduate students and 45 full-time Faculty. The University of New Hampshire-Main Campus is located approximately 20 mi (32.2 km) north of Seabrook in Durham, NH. Total enrollment in fall of 2009 was 15,253 students, with 3,072 full-time Faculty (IES, 2010).

Transportation. U.S. Route (US) 1, located one mi (1.6 km) west of Seabrook, is a two-lane highway providing north-south access to local communities between Newburyport and Portsmouth. Interstate 95, the New Hampshire Turnpike, passes 1.6 mi (2 km) west of Seabrook, which also runs in a north-south direction. Four routes traverse the area in an east-west direction. Closest to Seabrook is State Route (SR) 107 that intersects with Interstate 95 to the southwest. SR 84 and SR 87 intersect with US 1 to the northwest of Seabrook. SR 101, the Exeter-Hampton Expressway, also intersects with US 1 in Hampton, to the north of Seabrook. Route US 1A, located 1.7 mi east of the site, provides access to coastal communities.

Table 2.2-10 lists commuting routes to Seabrook and average annual daily traffic (AADT) volume values. The AADT values represent traffic volumes for a 24-hour period factored by both day of week and month of year.

Table 2.2-10. Major commuting routes in the vicinity of Seabrook, 2009 average annual daily traffic count

Roadway & location	Average annual daily traffic (AADT)[(a)]
Interstate 95 (between Exit 1 & Exit 2)	74,600
US 1 (at East Side Road)	21,000
US 1A (Ocean Boulevard, at Seabrook)	8,900
SR 84 (Kensington Road, west of US 1)	3,400
SR 88 (Exeter Road, west of US 1)	3,600
SR 101 (in Hampton, at Interstate 95)	223,000
SR 107 (New Zealand Road, west of US 1)	24,000[(b)]

[(a)] All AADTs represent traffic volume during the average 24-hour day during 2009

[(b)] 2007 AADT data

Source: (NHDOT, 2010)

2.2.9.3 Offsite Land Use

This section focuses on Rockingham County and Strafford County, NH, where 67 percent of the Seabrook workforce currently live. In addition, Seabrook pays property taxes to numerous communities in Rockingham County.

The town of Seabrook has a total area of 9.6 square mi (mi^2) (24.9 square km (km^2)) of which 8.9 mi^2 (23.1 km^2) is land. Although wetlands, open areas and forested areas comprise almost half of the total area in the town, the amount of developed land has increased from 2.7 mi^2 (7.0 km^2) (28 percent) in 1974 to 3.7 mi^2 (9.6 km^2) (40 percent) in 2000, primarily at the expense of forested land and open space (Town of Seabrook, 2010).

The Town of Seabrook currently has no formal growth control measures (Town of Seabrook, 2010). The Master Plan indicates major concerns for the future to include the compatibility of land uses, natural resource protection, cultural resource protection, affordable housing, pollution prevention, sewage disposal, conservation of agricultural land, open space, forest land, and transportation management. Renovating of the municipal water system enabled the expansion of residential, commercial, and industrial development (FPLE, 2009).

Although large tracts of available land are suitable for industrial development in the vicinity of the Seabrook, local planners intend to gradually phase out most of the industrial development east of Interstate 95 (FPLE, 2009). The Town of Seabrook Transfer Station and Recycling Center and Hannah Foods, located immediately west of the Seabrook, use the South Access Road and the North Access Road, respectively.

Rockingham County has a total area of 727.8 mi^2 (1885.0 km^2), of which approximately 8 percent is water and wetlands. From 1974–1998, developed land within the county almost doubled, increasing from 83.1 mi^2 (215.2 km^2) (11.4 percent of the total) to 153.8 mi^2 (398.3 km^2) (21.1 percent). In 1998, forested land was the most important land use (64 percent), followed by residential (16 percent) (FPLE, 2009). Stafford County has a total area of 384 mi^2 (994.6 km^2), of which 96 percent is land. From 1974–1998, developed land within the county increased from 33.5 mi^2 (86.8 km^2) to 52.5 mi^2 (136.0 km^2) (FPLE, 2009).

2.2.9.4 Visual Aesthetics and Noise

Seabrook is located on a promontory of land, approximately 20 ft (6 m) in elevation, rising above the surrounding Hampton Flats salt marsh, whose elevation is approximately 4 ft (1 meter) (AEC, 1974; FPLE, 2008). Visually, the site is dominated by the 199-ft (61-m) containment structure and the 103-ft (31-m) high and 325-ft (99-m) long turbine and heater bay building north of the containment building. Other structures include the smaller 88-ft (27-m) high and 145-ft (44-m) long grey PAB to the south and a 220-ft (67-m) meteorological tower to the east.

Seabrook is visible from US 1A, which passes 1.7 mi (2.7 km) from the site and from Hampton Harbor to the east. During the winter season, Seabrook is visible from elevated locations, such as Powwow Hill, located approximately 2 mi (3.2 km) southwest in Amesbury, MA. Conservatively-colored metal siding was chosen to blend the structures with their natural surroundings. Trees and shrubs surrounding the plant site also screen the many of the lower Seabrook support buildings from major viewing locations and serve to break up the features of the larger structures.

Noise emanating from the single-unit Seabrook is difficult to detect offsite. Given the industrial nature of the site, noise emissions from the site would only be an intermittent minor nuisance in the vicinity (EPA, 1974). However, noise levels may sometimes exceed the 55 decibel (dBa) level that the EPA uses as a threshold to protect against excess noise during outdoor activities (EPA, 1974). Once a year, the offsite outdoor emergency warning sirens are sounded as a test following a public awareness campaign. To date, no complaints have been received at Seabrook concerning noise from operations heard offsite.

2.2.9.5 Demography

According to the 2000 Census, an estimated 448,637 people lived within 20 mi (32 km) of Seabrook, which equates to a population density of 535 persons per mi^2 (NextEra, 2010a). This translates to a Category 4, "least sparse" population density, using the generic environmental impact statement (GEIS) measure of sparseness (greater than or equal to 120 persons per mi^2 within 20 mi). An estimated 4,157,215 people live within 50 mi (80 km) of Seabrook, with a population density of 887 persons per mi^2 (NextEra 2010a). This translates to a Category 4 "in close proximity" population using the GEIS measure of proximity (greater than or equal to190 persons per mi^2 within 50 mi). Therefore, Seabrook is located in a high population area based on the GEIS sparseness and proximity matrix.

Table 2.2-11 shows population projections and growth rates from 1970–2030 in Rockingham and Strafford counties in New Hampshire. The growth rate in Rockingham County showed an increase of 12.8 percent from 1990–2000. Strafford County population also shows an increase between 1990–2000 (7.7 percent). Both county populations are expected to continue to increase in the next decades and through 2030, although at lower rates of growth.

Table 2.2-11. Population and percent growth in Rockingham County and Strafford County, from 1970–2000 and projected for 2010–2050

	Rockingham		Strafford	
Year	**Population**	**Percent growth [(a)]**	**Population**	**Percent growth [(a)]**
1970	138,951	-----	70,431	-----
1980	190,345	37.0	85,408	21.3
1990	245,845	29.1	104,233	22.0
2000	277,359	12.8	112,233	7.7
2009	***299,276***	***7.9***	***123,589***	***10.1***
2010	300,502	8.3	124,095	10.6
2020	317,673	3.1	128,733	3.7
2030	339,448	3.4	137,863	7.1
2040	358,154	5.5	143,988	4.5
2050	377,627	5.4	150,882	4.8

---- = No data available

[(a)] Percent growth rate is calculated over the previous decade.

Source: (NHOEP, 2010; USCB, 2011)

Demographic Profile. The demographic profiles of the two-county ROI population are presented in Table 2.2-12 and Table 2.2-13. In 2000, minorities (race and ethnicity combined) comprised 4.1 percent of the total 2-county population. The minority population is largely Hispanic or Latino with a small percentage of Asian residents.

Table 2.2-12. Demographic profile of the population in the Seabrook two-county socioeconomic ROI in 2000

	Rockingham	Strafford	ROI
Total population	277,359	112,233	389,592
Race (percent of total population, not-Hispanic or Latino)			
White	96.1	95.7	95.9
Black or African American	0.5	0.6	0.6
American Indian & Alaska Native	0.2	0.2	0.2
Asian	1.1	1.4	1.2
Native Hawaiian & Other Pacific Islander	0.0	0.0	0.0
Some other race	0.1	0.3	0.1
Two or more races	0.8	1.0	0.9
Ethnicity			
Hispanic or Latino	3,314	1,155	4,469

	Rockingham	Strafford	ROI
Percent of total population	1.2	1.0	1.1
Minority population (including Hispanic or Latino ethnicity)			
Total minority population	8,873	4,160	15,804
Percent minority	3.9	4.3	4.1

Source: (USCB, 2011)

According to American Community Survey 2009 estimates, minority populations in the two-county region (Rockingham and Strafford) increased by approximately 9,500 persons and comprised 6.0 percent of the total two-county population (see Table 2.2-13). Most of this increase was due to an estimated increase of Hispanic or Latinos (over 4,100 persons), an increase in population of 91.9 percent from 2000. The next largest increase in minority population was Asian, an estimated additional 2,400 persons or an increase of 52.1 percent from 2000, followed by Black or African American, an estimated 1,100 persons or an increase of 49.9 percent from 2000 (USCB, 2011).

Table 2.2-13. Demographic profile of the population in the Seabrook two-county socioeconomic ROI in 2009, estimated

	Rockingham	Strafford	ROI
Population	299,276	123,589	422,865
Race (percent of total population, not-Hispanic or Latino)			
White	94.1	93.8	94.0
Black or African American	0.9	0.5	0.8
American Indian & Alaska Native	0.2	0.3	0.2
Asian	1.5	2.0	1.7
Native Hawaiian & Other Pacific Islander	0.0	0.0	0.0
Some other race	0.1	0.1	0.1
Two or more races	1.0	1.7	1.2
Ethnicity			
Hispanic or Latino	6,606	1,968	8,574
Percent of total population	2.2	1.6	2.0
Minority population (including Hispanic or Latino ethnicity)			
Total minority	17,683	7,652	25,335
Percent minority	5.9	6.2	6.0

Source: (USCB, 2011)

Transient Population. Within 50 mi (80 km) of Seabrook, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services. In

2010, there were approximately 309,680 students attending colleges and universities within 50 mi (80 km) of Seabrook (IES, 2011).

In 2000, 5.3 percent of all housing units are considered temporary housing for seasonal, recreational, or occasional use in Rockingham County. By comparison, seasonal housing accounted for 26.7, 42.8, 1.5, 5.1, and 4.0 percent of total housing units in Belknapp, Carroll, Hillsborough, Merrimack, and Strafford counties in New Hampshire, respectively (USCB, 2011). Six counties in the state of Massachusetts are within 50 mi (80 km) of Seabrook; none has seasonal housing units making up more than 5 percent of total housing units in each county. One county in Maine, York County, is located within 50 mi of the plant, where seasonal housing consists of 17.6 of total housing units (USCB, 2011). Table 2.2-14 provides information on seasonal housing for the 13 counties located all, or partly, within 50 mi (80 km) of Seabrook.

Table 2.2-14. Seasonal housing in counties located within 50 mi of Seabrook

County[a]	Housing units	Vacant housing units: for seasonal, recreational, or occasional use	Percent
Maine			
York	94,234	16,597	17.6
Massachusetts			
Essex	287,144	4,255	1.5
Middlesex	576,681	2,823	0.5
Norfolk	255,154	1,161	0.5
Plymouth	181,524	8,594	4.7
Suffolk	292,520	1,725	0.6
Worcester	298,159	3,063	1.0
County subtotal	1,891,182	21,621	1.1
New Hampshire			
Belknap	32,121	8,569	26.7
Carroll	34,750	14,887	42.8
Hillsborough	149,961	2,283	1.5
Merrimack	56,244	2,892	5.1
Rockingham	113,023	6,031	5.3
Strafford	45,539	1,823	4.0
County subtotal	431,638	36,485	8.5
Total	2,417	74,703	3.1

[a] Counties within 50 mi (80 km) of Seabrook with at least one block group located within the 50-mi (80 km) radius

Source: (USCB, 2011)

Migrant Farm Workers. Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers follow the harvesting of crops, particularly fruit, throughout rural areas of the U.S. Others may be permanent residents near Seabrook who travel from farm to farm harvesting crops.

Migrant workers may be members of minority or low-income populations. Because they travel and can spend a significant amount of time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncounted, these workers would be "underrepresented" in U.S. Census Bureau (USCB) minority and low-income population counts.

Information on migrant farm and temporary labor was collected in the 2007 Census of Agriculture. Table 2.2-15 provides information on migrant farm workers and temporary farm labor (less than 150 days) within 50 mi (80 km) of the Seabrook. According to the 2007 Census of Agriculture, approximately 7,104 farm workers were hired to work for less than 150 days and were employed on 1,348 farms within 50 mi (80 km) of the Seabrook. The county with the largest number of temporary farm workers (1,433) on 149 farms was Essex County, MA (USDA, 2009).

In the 2002 Census of Agriculture, farm operators were asked for the first time whether or not they hired migrant workers, defined as a farm worker whose employment required travel that prevented the migrant worker from returning to their permanent place of residence the same day. A total of 535 farms in a 50-mi (80-km) radius of the Seabrook reported hiring migrant workers in the 2007 Census of Agriculture. Middlesex County and Plymouth County reported the most farms (82 in both) with hired migrant workers, followed by Worcester County and Essex County, with 81 and 63 farms, respectively (USDA, 2009).

Table 2.2-15. Migrant farm workers and temporary hired farm labor in counties located within 50 mi of Seabrook

County[(a)]	Number of farms with hired farm labor[(b)]	Number of farms hiring workers for less than 150 days[(b)]	Number of farm workers working for less than 150 days[(b)]	Number of farms reporting migrant farm labor[(b)]
		Maine		
York	160	141	555	9
		Massachusetts		
Essex	171	116	463	15
Middlesex	214	149	1,433	20
Norfolk	70	51	219	7
Plymouth	295	240	894	25
Suffolk	3	3	4	0
Worcester	284	216	1,066	49
County subtotal	1,037	775	4,079	116
		New Hampshire		
Belknap	41	28	166	3
Carroll	42	32	147	2
Hillsborough	124	101	495	13
Merrimack	120	95	554	12

County[a]	Number of farms with hired farm labor[b]	Number of farms hiring workers for less than 150 days[b]	Number of farm workers working for less than 150 days[b]	Number of farms reporting migrant farm labor[b]
Rockingham	150	123	802	14
Strafford	60	53	306	2
County subtotal	537	432	2,470	46
Total	1,734	1,348	7,104	171

[a] Counties within 50 mil (80 km) of Seabrook with at least one block group located within the 50-mi (80 km)radius

[b] Table 7. Hired Farm Labor—Workers and Payroll, 2007

Source: (USDA, 2009)

According to the 2007 Census of Agriculture estimates, 802 temporary farm workers (those working fewer than 150 days per year) were employed on 123 farms in Rockingham County, and 306 temporary farm workers were employed on 53 farms in Strafford County (USDA, 2009).

2.2.9.6 Economy

This section contains a discussion of the economy, including employment, income, unemployment, and taxes.

Employment and Income. From 2000–2009, the civilian labor force in Rockingham County increased 11.8 percent from 155,473 to an estimated 173,847. Strafford County also increased 17.3 percent during that time, from 62,065 to an estimated 72,806 (USCB, 2011).

In 2009, educational services, and health care and social services industry (21.8 percent) represented the largest sector of employment (19.9 percent) in Rockingham County, followed by retail trade (14.5 percent). In Strafford County, the educational services, health care, and social services industry represented the largest employment sector (24.3 percent), followed by manufacturing (14.5 percent). A list of major employers in the two-county area is provided in Table 2.2-16. As shown in the table, the two largest employers in the two-county area are Liberty Mutual Insurance and the University of New Hampshire.

Table 2.2-16. Major employers in the two-county socioeconomic ROI, in 2009

Employer	Number of employees
Liberty Mutual Insurance	4,337
University of New Hampshire	4,268
Insight Technologies	1,300
Columbia Hospital Corporation of America Hospital	1,150
City of Dover	1,139
City of Rochester	1,119
Wentworth-Douglas Hospital	1,048
Exeter Hospital	1,000
NextEra Energy Seabrook, LLC	1,000
City of Portsmouth	937

Employer	Number of employees
U.S. Department of State, National Passport Center	900
Heidelberg-Harris, Inc.	900
Timberlane Regional School District	740
Derry Cooperative School System	690
Rockingham County Home and Jail	690
Frisbie Memorial Hospital	655
Timberland	650
Lonza Biologies	650

Source: (NHELMIB, 2010)

Estimated income information for the Seabrook ROI is presented in Table 2.2-17. According to the American Community Survey 2009 estimates, median household and per capita incomes were above the state average in Rockingham County and lower in Strafford County. An estimated 6.0 and 9.2 percent of individuals in Rockingham County and Strafford County were living below the official poverty level, respectively, while New Hampshire, as a whole, had 8.5 percent. The percentage of families living below the poverty level in Rockingham County and Strafford County was 4.0 and 5.2 percent, respectively. The percentage of families in the New Hampshire as a whole was 5.5 percent (USCB, 2011).

Table 2.2-17. Estimated income information for the Seabrook two-county socioeconomic ROI in 2009, estimated

	Rockingham	Strafford	New Hampshire
Median household income (dollars)[(a)]	70,160	56,463	60,567
Per capita income (dollars)[(a)]	34,315	28,160	30,396
Individuals living below the poverty level (percent)	6.0	9.2	8.5
Families living below the poverty level (percent)	4.0	5.2	5.5

[(a)] In 2009 inflation-adjusted dollars

Source: (USCB, 2011)

Unemployment. According to the American Community Survey 2009 estimates, unemployment rates in Rockingham and Strafford counties were 8.2 and 6.8 percent, respectively, while the unemployment rate for the State of New Hampshire was 7.8 percent (USCB, 2011).

Taxes. NextEra pays annual property taxes to seven local towns and the State of New Hampshire. However, payments to the Town of Seabrook and to the New Hampshire Education Trust Fund are the most significant, with payments in 2009 providing 48.7 percent of net tax commitment in the Town of Seabrook (Table 2.2-18) and 2.0 percent of the Education Trust Fund revenues (Table 2.2-19). Property tax payments made to the Towns of East Kingston, Kingston, Hampton, Hampton Falls, and Newington constituted 1 percent or less of net tax commitment in each jurisdiction in 2008 (NextEra, 2010a).

Table 2.2-18. Net tax commitment in Town of Seabrook, 2004–2008; Seabrook property tax 2004–2008; and Seabrook property tax as a percentage of net tax commitment in Town of Seabrook

Year	Net tax commitment of Town of Seabrook (in millions of dollars, 2009)	Property tax paid by Seabrook (in millions of dollars, 2009) [(a)]	Seabrook property tax as percentage of net tax commitment in Town of Seabrook[(a)]
2004	23.2	8.8	38.1
2005	25.2	8.4	33.5
2006	27.0	10.5	39.0
2007	28.7	11.2	39.1
2008	32.0	15.6	48.7

[(a)] includes property tax payments made by NextEra and Joint Owners

Source: (NextEra, 2010f)

From 2004–2008, property taxes paid by NextEra and the Joint Owners increased from $8.8 million to $15.6 million, while the net tax commitment increased in the Town of Seabrook from $23.2 to $32.0 million (Table 2.2-18). Each year, the Town of Seabrook collects these taxes, retains a portion for operations, and disburses the remainder to the local school system, Rockingham County, and the state of New Hampshire (NextEra, 2010a). Over the same period, property taxes paid by NextEra to the New Hampshire Education Trust Fund increased from $4.0 million to $7.6 million, while total revenues in the Fund increased from $289.1 million to $380.3 million (Table 2.2-19).

Table 2.2-19. New Hampshire education trust fund revenues, 2004–2008; Seabrook property tax, 2004–2008; and Seabrook property tax as a percentage of total New Hampshire education trust fund revenues

Year	Education Trust Fund revenues (in millions of dollars, 2009)	Property tax paid by Seabrook (in millions of dollars, 2009)	Seabrook property tax as percentage of total Education Trust Fund revenues
2004	289.1	4.0	1.4
2005	304.7	4.0	1.3
2006	360.8	4.3	1.2
2007	383.8	5.8	1.5
2008	380.3	7.6	2.0

Source: (NextEra, 2010f)

The State of New Hampshire's electric utility industry is deregulated, and this is not expected to change, meaning that property taxes paid by Seabrook are expected to continue to be primarily based on the market value of the Station property over the license renewal period.

Other Fees and Charitable Contributions. During 2009, Seabrook paid $3.8 million in emergency preparedness fees to the Federal Emergency Management Agency (FEMA) and to the States of Maine, Massachusetts, and New Hampshire. NextEra also made more than

$90,000 in charitable donations to various local and regional organizations as well as a $29,000 donation to other various environmental outreach programs (NextEra, 2010f).

2.2.10 Historic and Archaeological Resources

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

2.2.10.1 Cultural Background

The earliest evidence of people living in New England dates to the Paleo-Indian Cultural Period (10,000 B.C.–8,000 B.C.). Sites containing artifacts associated with this cultural period are found throughout New England, including several locations in New Hampshire. Paleo-Indian sites are found on elevated landforms and contain fluted projectile points (i.e., Clovis spear points), channel flakes, hide scrapers, hammerstones, anvilstones, and abradingstones (Starbuck, 2006). Paleo-indian peoples came into the region as the last major glacial period was ending. The climate being much colder than it is today. Paleo-indian lifestyles followed a nomadic subsistence pattern based on hunting large game but also using smaller game (Starbuck, 2006). During this period, ocean levels rose and landscapes were saturated due to melting glacial ice.

The transition to modern climatic conditions occurred during the next and longest prehistoric cultural period—the Archaic (8,000 B.C.–1,000 B.C.). The Archaic Period was a time of major climatic shifts and the development of new subsistence strategies. The very long Archaic Period (7,000 years) is often divided into early, middle, and late subperiods. The Archaic Period, in general, appears to have been a time of increasing population that required more intensive subsistence strategies. Hallmarks of archaic cultures are an increased reliance on fish and shellfish, the first evidence of continued reliance on plants as a food source, and use of the atlatl (a throwing stick used to increase the range and effectiveness of spears). Archaic settlement patterns suggest a considerable amount of seasonal resource use. The first evidence for horticulture appears at the end of the Archaic Period. Archaic sites are often found near the falls of major rivers and on the ocean shoreline.

The Archaic Period is followed by the Woodland Cultural Period (1000 B.C.–A.D. 1600). The Woodland Period is often divided into early, middle and late periods. The Woodland Period is marked by the appearance of pottery, smoking pipes, more elaborate funerary practices (i.e., burials mounds, funerary items), semi-sedentary villages, and horticulture. In New Hampshire, there is almost no direct evidence of horticulture (Starbuck, 2006). In the Merrimack River Valley of New Hampshire, many sites appear to have gone through cycles of occupation. Some sites were occupied during the early and late Woodland Periods but deserted during the Middle Woodland. In contrast, Woodland Period sites on the Atlantic Coast appear to have been occupied throughout the entire Woodland Period.

The Woodland Period ends with the coming of Europeans around A.D. 1600. This period is often termed the Contact Period. Based on historical sources, the main groups living in New Hampshire prior to the Contact Period were the eastern and western tribes of the Abenaki, the Winnipesaukees, and the Penacooks (Starbuck, 2006). The Penacooks lived in the southeastern portion of the state in the vicinity of the future Seabrook. Most of the Native population in the New England region succumbed to European diseases by the early 1600s.

English and French ships had explored and fished the New England coast for many years prior to the establishment of settlements. The first permanent European settlement in New Hampshire was in 1623 at Odiorne Point near modern day Rye, NH. The lands containing Seabrook were settled in 1638 as part of the town of Hampton. In 1726, the Seabrook area separated and became part of Hampton Falls. The community of Seabrook was incorporated in 1768. The city would reach its modern geographical extent in 1822. The economy in Seabrook was based on fishing and hay farming in the salt marshes as feed for cattle, milling, weaving, and shoemaking (Valimont, 2010). In 1791, a canal was built linking the Hampton River to the Merrimack River. This helped to start a boat building industry in Seabrook. In 1840, the Eastern Railroad connected Seabrook to other major towns along the Atlantic seacoast. The railroad caused the economy and population to grow. Seabrook also became heavily involved in the shoe industry, although fishing continued to be a major part of the local economy. The population of Seabrook peaked around 1880 (Valimont, 2010). The establishment and expansion of the highway system in the 20th century further increased the accessibility of coastal towns like Seabrook. By the late 20th century, tourism had become a major component of the local economy (NHDHR, 2010).

2.2.10.2 Historic and Archaeological Resources

A review of the National Register of Historic Places (NRHP) lists 124 properties in Rockingham County, NH, and 480 properties in Essex County, MA (NPS, 2010). Two NRHP properties, the Governor Meshech Weare House and the Unitarian Church, are located in Hampton Falls. There are nine NRHP properties or historic districts in Hampton. These include the Capt. Jonathan Currier House, the Highland Road Historic District, the Benjamin James House, the Jewell Town District, the Reuben Lamprey Homestead, the Little Boar’s Head District, the Smith’s Corner Historic District, the Town Center Historic District, and the Woodman Road Historic District. There are no listed NRHP properties in the town of Seabrook. However, historic and archaeological resources have been found at the Seabrook.

Seven archaeological sites have been identified on Seabrook property, and more sites are likely to be present; however, these are located outside the areas expected to be affected by station operations (Valimont, 2010). Archaeological surveys conducted in 1973, prior to the construction of the Seabrook, identified archaeological sites (NRC, 1982). Three of the archaeological sites were later combined to form the Rocks Road Site (27RK75). The other two archaeological sites (27RK452 and 27RK453) were determined to be outside the construction footprint. The Rock Roads Site was exhumed, prior to construction, in 1974. The other two sites were not affected by the construction of Seabrook. In 2010, NextEra sponsored additional archaeological investigations to refine the location and extent of existing archaeological sites and resources at the Seabrook.

Table 2.2-20 lists the historic and archaeological resources found on Seabrook property. Most of the historic and archaeological sites on the Seabrook property are associated with prehistoric cultures. The Rocks Road Site, 27RK75, contained evidence of human use beginning in the Late Archaic Period and continuing on to the Late Woodland Period. Human remains were also found at the site. These remains were given to the Abenaki Nation of Missisquoi in 2002 (73 FR 104; May 29, 2008). The remains of a 19th century habitation site was also found at the site. Site 27RK75 was excavated in 1974–1975 by Charles Bolian of the University of New Hampshire, prior to construction of the station. The location of this site was under the Protected Area. Site 27RK162 is the remains of a prehistoric site of unknown age. This site also contained evidence of use during the 19th century. Site 27RK164 is the remains of a prehistoric era site that was occupied from the Late Archaic Period to the Late Woodland Period. Site 27RK165 is the remains of a Late Archaic campsite. Site 27RK170 is the remains of a prehistoric campsite of unknown age. Pottery fragments were found at this site suggesting the Late Archaic to Woodland Period. Sites 27RK452 and 27RK453 both appear to be fishing station and habitation sites; however, one dates to the Middle Woodland Period and one dates to the Middle Archaic Period, respectively.

Table 2.2-20. Historic and archaeological resources found on Seabrook property

Site number	Type	NRHP eligibility	Status
27RK75 (Rocks Road Site)	Prehistoric/Historic	Eligible	Removed prior to construction
27RK162 (Healey's Island)	Prehistoric/Historic	Unevaluated	Outside power block area
27RK164 (Hunts Island)	Prehistoric/Historic	Unevaluated	Outside power block area
27RK165 (Seabrook Marsh)	Prehistoric	Unevaluated	Outside power block area
27RK170 (South Rock Storage Area)	Prehistoric	Unevaluated	Outside power block area
27RK452 (Bolian 2)	Prehistoric	Unevaluated	Partially under power block perimeter fence
27RK453 (Bolian 5)	Prehistoric	Unevaluated	Within power corridor to plant

In addition to the known sites, a recent study suggests that additional archaeological sites are likely to be found on Seabrook property (Valimont, 2010). The recent study identified areas that should be examined for archaeological resources in the event of future activities.

Transmission Lines. Two archaeological sites (27RK168 and 27RK244) have been identified within the transmission line ROW. Both sites contain prehistoric material and have not been assessed for eligibility for listing on the NRHP.

2.3 Related Federal and State Activities

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

The NRC has determined that there are no Federal projects that would make it desirable for another Federal agency to become a cooperating agency in the preparation of the SEIS. Federally owned facilities within 50 mi (80 km) of Seabrook are listed below:

- Pease Air National Guard Base (U.S. Department of Defense)
- Portsmouth Naval Shipyard (U.S. Department of Defense)
- Portsmouth Harbor Coast Guard Station (U.S. Department of Homeland Security)
- Merrimack River Coast Guard Station (U.S. Department of Homeland Security)

The NRC is required, under Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA), as amended, 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 consulted with the NMFS and the USFWS. Federal agency consultation correspondence and comments on the SEIS are presented in Appendix D.

In the U.S., coastal areas are managed through the Coastal Zone Management Act of 1972. The Act, administered by the NOAA Office of Ocean and Coastal Resource Management, provides for management of the nation's coastal resources—including the Great Lakes—and balances economic development with environmental conservation. The Federal Consistency Regulations implemented by NOAA are contained in 15 CFR Part 930. This law authorizes individual states to develop plans that incorporate the strategies and policies they will employ to manage development and use of coastal land and water areas. Each plan must be approved by NOAA. One of the components of an approved plan is "enforceable polices," by which a state exerts control over coastal uses and resources.

The New Hampshire Coastal Management Program was initially approved by NOAA in 1982. The lead agency is the NHDES. The lead agency implements and supervises all the various Coastal Zone Management Programs in the State. Federal consistency requires "federal actions, occurring inside a state's coastal zone, that have a reasonable potential to affect the coastal resources or uses of that state's coastal zone, to be consistent with that state's enforceable coastal policies, to the maximum extent practicable." NHDES completed its review of the Seabrook consistency certification on November 4, 2010, and found that the applicant complies with the enforceable policies of New Hampshire's Coastal Management Program (NHDES, 2010d).

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

Environmental issues associated with refurbishment activities are discussed in NUREG-1437, "*Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants*," Volumes 1 and 2 (NRC, 1996). The GEIS includes a determination of whether or not the analysis of the environmental issues can be applied to all plants and whether or not additional mitigation measures are 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:

- The environmental impacts associated with the issue have been determined to apply to all plants or, for some issues, apply only to plants having a specific type of cooling system or other specified plant or site characteristics.
- A single significance level (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).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis. 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; therefore, an additional plant-specific review of these issues is required.

License renewal actions include refurbishment 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, which were determined to be Category 1 issues, are listed in Table 3.1-1.

Table 3.1-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section(s)
Surface Water Quality, Hydrology, & 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 & Quality	
Impacts of refurbishment on groundwater use & 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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section(s)
Socioeconomics	
Public services: public safety, social services, and tourism & 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 that are inconclusive for all plants, or for specific classes of plants, are Category 2 issues. These are listed, along with other Category 2 issues, in Table 3.1-2.

Table 3.1-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section(s)	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 & 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 & archaeological resources	3.7.7	K
Environmental Justice		
Environmental justice [a]	Not addressed	Not addressed

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

The potential environmental effects of refurbishment actions are identified, and the analysis will be summarized within this section, if such actions are planned. NextEra Energy Seabrook, LLC (NextEra) indicated that it has performed an evaluation of systems, structures, and components (SSCs) pursuant to Section 54.21 of Title 10 of the *Code of Federal Regulations* (10 CFR 54.21) to identify the need to undertake any major refurbishment activities that are necessary to support continued operation of Seabrook Station (Seabrook) during the requested 20-year period of extended operation. Items that are subject to aging and might require refurbishment to support continued operation during the renewal period are listed in Table B.2 of the GEIS.

The results of NextEra's evaluation of SSCs for Seabrook, as required by 10 CFR 54.21, did not identify the need to undertake any major refurbishment or replacement actions associated with license renewal to support the continued operation of Seabrook beyond the end of the existing operating license (NextEra, 2010). Therefore, an assessment of refurbishment activities is not considered in this SEIS.

3.1 References

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

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

NextEra Energy Seabrook, LLC (NextEra), 2010, "License Renewal Application, Seabrook Station," Appendix E, "Applicant's Environmental Report, Operating License Renewal Stage," May 25, 2010, ADAMS Accession Nos. ML101590092 and ML101590089.

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NRC, 1999, "Generic Environmental Impact Statement for License Renewal of Nuclear Plant," NUREG-1437, Office of Nuclear Reactor Regulation, Washington, D.C., Volume 1, Addendum 1, 1999, ADAMS Accession No. ML0400690720.

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

This chapter addresses potential environmental impacts related to the period of extended operation of Seabrook Station (Seabrook). These impacts are grouped and presented according to resource. Generic issues (Category 1) rely on the analysis provided in the generic environmental impact statement (GEIS) (NRC, 1996; NRC, 1999) and are discussed briefly. Site-specific issues (Category 2) have been analyzed for Seabrook and assigned a significance level of SMALL, MODERATE, or LARGE, accordingly. Some remaining issues are not applicable to Seabrook because of site characteristics or plant features. For an explanation of the criteria for Category 1 and Category 2 issues, as well as the definitions of SMALL, MOERATE, and LARGE, refer to Section 1.4.

4.1 Land Use

Onsite land use issues that could be affected by license renewal are listed in Table 4.1–1. As discussed in the GEIS, onsite land use and power line right of way (ROW) conditions are expected to remain unchanged during the license renewal term at all nuclear plants; thus, impacts would be SMALL. These issues were, therefore, classified as Category 1 issues. Section 2.2.1 of this supplemental environmental impact statement (SEIS) describes the land use conditions at Seabrook.

Table 4.1–1. Land use issues

Issues	GEIS section	Category
Onsite land use	4.5.3	1
Power line ROW	4.5.3	1

The Seabrook environmental report (ER), scoping comments, and other available data records on Seabrook were reviewed and evaluated for new and significant information. The review included a data gathering site visit to Seabrook. No new and significant information was identified during this review that would change the conclusions presented in the GEIS. Therefore, for these Category 1 issues, impacts during the renewal term are not expected to exceed those discussed in the GEIS.

4.2 Air Quality

The air quality issue applicable to Seabrook is listed in Table 4.2–1 (also see Table B-1 in Appendix B to Subpart A of Title 10, Part 51 of the *Code of Federal Regulations* (CFR) (10 CFR 51)). There are no applicable Category 2 issues for air quality. The Category 2 issue, “air quality during refurbishment,” is not applicable because NextEra Energy Seabrook, LLC (NextEra) has no plans for refurbishment or other license renewal-related construction activities, as presented in Chapter 3 of this SEIS. Section 2.2.2 of this SEIS describes the meteorological and air quality conditions relative to Seabrook.

Table 4.2–1. Air quality issues

Issue	GEIS section	Category
Air quality effects of transmission lines	4.5.2	1

The area around Seabrook is designated nonattainment for the Federal 8-hour ozone National Ambient Air Quality Standards (NAAQS). Air emissions from current Seabrook operations are regulated by the operating permit conditions that would continue in effect during the license renewal period; thus, no increases in emissions from stationary sources would occur. For the Category 1 issue of air quality effects of transmission lines, the U.S. Nuclear Regulatory Commission (NRC) found that "production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases." NRC staff did not identify any new and significant information based on review of the ER (NextEra, 2010), the public scoping process, or as a result of the environmental site audit that would change the conclusions presented in the GEIS. As a result, it is expected that there would be no impacts related to this Category 1 issue during the period of extended operation beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL.

4.3 Surface Water Resources

The surface water issues applicable to Seabrook are listed in Table 4.3–1 (also see Table B-1 in Appendix B to Subpart A of 10 CFR 51). Surface water use and water quality relative to Seabrook are described in Sections 2.1.7.1 and 2.2.4 of this SEIS, respectively.

Table 4.3–1. Surface water use and quality issues

Issues	GEIS sections	Category
Altered salinity gradient	4.2.1.2.2	1
Scouring caused by discharged cooling water	4.2.1.2.3	1
Discharge of chlorine or other biocides	4.2.1.2.4	1
Discharge of sanitary wastes & minor chemical spills	4.2.1.2.4	1
Discharge of other metals in wastewater	4.2.1.2.4	1
Water use conflicts (plants with once-through cooling systems)	4.2.1.3	1

4.3.1 Generic Surface-Water Issues

NRC staff did not identify any new and significant information based on review of the ER (NextEra, 2010), the public scoping process, or as a result of the environmental site audit. The NRC staff also reviewed other sources of information such as various permits, assorted applicant files, and data reports. As a result, no information or impacts related to these issues were identified that would change the conclusions presented in the GEIS. Therefore, it is expected that there would be no impacts related to these Category 1 issues during the period of extended operation beyond those discussed in the GEIS. For these surface water issues, the GEIS concludes that the impacts are SMALL.

4.3.2 Surface-Water Use Conflicts

No Category 2 surface water issues were found to be applicable to the continued operation of the station, and no further evaluation was performed for Seabrook.

4.4 Groundwater Resources

The groundwater issues applicable to Seabrook are listed in Table 4.4–1 (also see Table B-1 of Appendix B of 10 CFR 51). Groundwater use and water quality relative to Seabrook are described in Sections 2.1.7.2 and 2.2.5 of this SEIS, respectively.

Table 4.4–1. Groundwater use and quality issues

Issues	GEIS sections	Category
Groundwater use conflicts (potable & service water; plants that use <100 gallons per minute (gpm))	4.8.1.1	1
Groundwater quality degradation (saltwater intrusion)	4.8.2.1	1

4.4.1 Generic Groundwater Issues

The combined groundwater withdrawal for Unit 2 dewatering and Unit 1 tritium hydraulic control, as discussed in Section 2.2.5, is much less than 100 gpm (380 liters per minute (L/min)). NRC staff did not identify any new and significant information—based on review of the ER (NextEra, 2010), the public scoping process, or as a result of the environmental site audit—that would change the conclusions presented in the GEIS. Therefore, it is expected that were would be no impacts related to these Category 1 issues during the period of extended operation beyond those discussed in the GEIS. For these groundwater issues, the GEIS concludes that the impacts are SMALL. Additional information on NRC's evaluation of new and significant information relative to groundwater quality at Seabrook is presented in Section 4.10 of this SEIS.

4.4.2 Groundwater Use Conflicts

No Category 2 groundwater issues were found to be applicable to the continued operation of the station, and no further evaluation was performed for Seabrook.

4.5 Aquatic Resources

Section 2.1.6 of this SEIS describes the Seabrook cooling water system, Section 2.2.6 describes the aquatic resources in the vicinity of Seabrook, and Section 2.2.7.1 describes the protected aquatic resources that could occur in the vicinity of Seabrook and associated transmission lines. The Category 1 and Category 2 issues related to aquatic resources applicable to Seabrook are discussed below and listed in Table 4.5–1.

Table 4.5–1. Aquatic resources issues

Issues	GEIS sections	Category
For all plants		
Accumulation of contaminants in sediments or biota	4.2.1.2.4	1
Entrainment of phytoplankton & zooplankton	4.2.2.1.1	1
Cold shock	4.2.2.1.5	1
Thermal plume barrier to migrating fish	4.2.2.1.6	1
Distribution of aquatic organisms	4.2.2.1.6	1
Premature emergence of aquatic insects	4.2.2.1.7	1
Gas supersaturation (gas bubble disease)	4.2.2.1.8	1
Low dissolved oxygen in the discharge	4.2.2.1.9	1
Losses from predation, parasitism, & disease among organisms exposed to sublethal stresses	4.2.2.1.10	1

Stimulation of nuisance organisms	4.2.2.1.11	1
For plants with once-through dissipation systems		
Entrainment of fish & shellfish in early life stages	4.1.2	2
Impingement of fish & shellfish	4.1.3	2
Heat shock	4.1.4	2

4.5.1 Generic Aquatic Ecology Issues

The NRC staff did not identify any new and significant information related to the Category 1 issues listed above during the review of NextEra's ER, the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

4.5.2 Entrainment and Impingement

Entrainment and impingement of aquatic organisms are site-specific (Category 2) issues for assessing impacts of license renewal at plants with once-through cooling systems. Entrainment is the taking in of organisms with the cooling water. The organisms involved are generally of small size, dependent on the screen mesh size, and include phyto- and zooplankton, fish eggs and larvae, shellfish larvae, and many other forms of aquatic life. Impingement is the entrapment of organisms against the cooling water intake screens.

A particular species can be subject to both impingement and entrainment if some individuals are impinged on screens while others pass through and are entrained (EPA, 1977). Section 316(b) of the Clean Water Act (CWA) (33 United States Code (U.S.C.) § 1326(b)) requires the following:

> Any standard established pursuant to section 1311 of this title or section 1316 of this title and applicable to a point source shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

The adverse environmental impacts of cooling water intakes occur through both impingement and entrainment. Heat, physical stress, or chemicals used to clean the cooling system may kill or injure the entrained organisms. Exhaustion, starvation, asphyxiation, descaling, and physical stresses may kill or injure impinged organisms. Due to the length and pressure change associated with the intake and discharge tunnels at Seabrook, NextEra assumes a 100 percent mortality rate for all entrained and impingement organisms.

Because impingement and entrainment are fundamentally linked, the NRC staff determined that effects of each should be assessed using an integrated approach. The NRC staff employed a weights-of-evidence (WOE) approach to evaluate the effects of impingement and entrainment on the aquatic resources in the Gulf of Maine and the Hampton-Seabrook Estuary. NRC employed this approach because the U.S. Environmental Protection Agency (EPA) recommends a WOE approach for ecological risk assessments (EPA, 1998). WOE is a useful tool due to the complex nature of assessing risk (or impact), and NRC has employed this approach in other evaluations of the effects of nuclear power plant cooling systems on aquatic communities (NRC, 2010c).

Menzie et al. (1996) defines WOE as "…the process by which multiple measurement endpoints are related to an assessment endpoint to evaluate whether significant risk of harm is posed to the environment." In this modified WOE approach, NRC staff examined four lines of evidence to determine if operation of the Seabrook cooling system has the potential to cause adverse impacts to fish and shellfish in the vicinity of Seabrook. The first line of evidence is entrainment data provided by NextEra from 1990 through 2009 (NAI, 2010). The second line of evidence is impingement data provided by NextEra from 1994 through 2009 (NAI, 2010). The third line of evidence includes reviews by other regulatory agencies, such as EPA and the New Hampshire Fish and Game Department (NHFGD). EPA's analysis, a Case Study Analysis for the Proposed Section 316(b) Phase II Existing Facilities Rule (EPA, 2002a), includes a comparison of impingement and entrainment data with Pilgrim Nuclear Generating Station (Pilgrim). The fourth line of evidence includes monitoring data of fish and shellfish populations prior to and during operations at a nearfield and farfield site (see Section 4.5.5).

As part of the WOE approach, NRC related the results of the above lines of evidence to NRC's definitions of SMALL, MODERATE, and LARGE, as described in Section 1.2.1. NRC defined the impingement and entrainment impact as SMALL if Seabrook monitoring data (the fourth line of evidence described above) concluded that no significant difference occurred between the preoperational and operational periods or, if there was a change, that it occurred at both the nearfield and farfield sites. In this situation, NRC staff would conclude that impingement and entrainment does not noticeably alter the aquatic resource. NRC defined the impingement and entrainment impact as MODERATE if Seabrook monitoring data indicated that the abundance of a certain species or biological group increased at sites further from the Seabrook cooling system and remained steady near the cooling system. In addition, the NRC staff looked for a strong connection between the Seabrook cooling system and the biological group or species, such as high entrainment and impingement. In this situation, NRC staff would conclude that impingement and entrainment noticeably altered, but does not destabilize, the aquatic resource. NRC defined the impingement and entrainment impact as LARGE if Seabrook monitoring data indicated that the abundance of a certain species or biological group increased or remained steady at sites further from the Seabrook cooling system and decreased near the cooling system or if the abundance of a species or biological group declined at all sites, but the decline was significantly greater closer to the Seabrook cooling system. In addition, NRC staff looked for a strong connection between the Seabrook cooling system and the biological group or species, such as high entrainment and impingement. In this situation, NRC staff would conclude that impingement and entrainment destabilizes the aquatic resource near Seabrook.

Line of Evidence Number 1: Entrainment Studies at Seabrook

NextEra conducted entrainment studies four times per month (NAI, 2010). For bivalve larvae, NextEra collected three replicates per sampling date using a 0.003-in (0.076-mm) mesh. For fish eggs and larvae, prior to 1998, NextEra collected three replicate samples using 0.02-in (0.505-mm) mesh nets. Since 1998, NextEra collected samples using 0.01-in (0.333-mm) mesh sizes throughout a 24-hour period. NextEra estimated entrainment rates by multiplying the density of entrained eggs or larvae within a sample by the volume of water pumped through the plant within the sample period (FPLE, 2008b; NAI, 2010).

<u>Fish Eggs and Larvae</u>. NextEra collected fish egg entrainment samples from 1990–2009 that belong to 24 taxa of eggs and one group of unidentified eggs (NextEra, 2010c; NAI, 2010). Total egg entrainment estimates ranged from 4.8 million in 1994 (8 months of sampling) to 2,104 million in 2000. The annual average total fish egg entrainment was 901 million per year (NAI, 2010) (Table 4.5-2). The most commonly entrained egg species was cunner (*Tautogolabrus adspersus*), which was highest in 2009 at 1,451 million eggs or approximately 69 percent of all entrained eggs in 2009. The annual average entrainment for the most common egg taxa entrained were as follows (Table 4.5–2):

- cunner (387.4 million/year)
- Atlantic mackerel (*Scomber scombrus*) (191.5 million/year)
- silver hake (*Merluccius bilinearis*) (81.1 million/year)
- fourbeard rockling (*Enchelyopus cimbrius*) (51.5 million/year)
- hake (*Urophycis*) (45.7 million/year)
- yellowtail flounder (*Pleuronectes ferruginea*) (42.8 million/year)
- Atlantic cod (*Gadus morhu*) (32.6 million/year)
- windowpane (*Scopthalmus aquosus*) (31.7 million/year)
- American plaice (*Hippoglossoides platessoides*) (25.9 million/year)

For all other species, NextEra observed less than 6 millions eggs entrained per annual average (NAI, 2010). Generally, eggs that are demersal or adhesive are less likely to be entrained since the intake structure is raised above the sea floor. The one exception is lumpfish (*Cyclopterus lumpus*), which have demersal and adhesive eggs. Annual average entrainment of lumpfish eggs from 1990–2009 was 2.6 million eggs per year (NAI, 2010).

NextEra collected fish larvae entrainment samples from 1990–2009 that belong to 52 taxa of larvae and one group of unidentified larvae (NextEra, 2010c; NAI, 2010). Total larval entrainment estimates ranged from 31.2 million in 1994 (8 months of sampling) to 958.5 million in 2004. The annual average fish larvae entrainment was 260.6 million per year (NAI, 2010) (Table 4.5–3). The annual average entrainment for the most common larval taxa entrained were as follows (Table 4.5–3):

- cunner (78.4 million/year)
- rock gunnel (*Pholis gunnellus*) (33.5 million/year)
- Atlantic seasnail (*Liparis atlanticus*) (32 million/year)
- American sand lance (*Ammodytes americanus*) (27.9 million/year)
- silver hake (8.1 million/year)
- fourbeard rockling (22.7 million/year)
- grubby (*Myoxocephalus aenaeus*) (15.3 million/year)
- Atlantic herring (*Clupea harengus*) (9.6 million/year)
- winter flounder (*Pleuronectes americanus*) (9.2 million/year)
- American plaice (4.3 million/year)

In 2009, larval entrainment was highest in June, when cunner and Atlantic mackerel were most abundant (NAI, 2010).

Table 4.5–2. Number of fish eggs entrained (in millions) for most common egg taxa entrained

Taxon	1990[a]	1991[b]	1992[c]	1993[c]	1994[d]	1995[e]	1996[e]	1997[e]	1998[e]	1999[e]	2000[e]	2001[e]
American plaice	2.6	21.0	52.3	19.5	0.4	14.8	78.2	15.6	13.7	24.8	16.7	26.8
Atlantic cod	20.8	74.5	32.0	50.3	0.2	37.0	22.4	6.4	84.3	48.6	30.7	32.1
Atlantic mackerel	518.8	673.1	456.3	112.9	0.0	74.5	305.1	23.1	39.3	44.6	266.9	330.4
Cunner	489.3	147.2	0	58.4	0	18.2	93.9	221.5	63.6	220.3	1,206.7	239.6
Hake	50.1	2.6	0	1.6	0.6	29.3	213.2	71.8	7.5	6.2	295.2	4.4
Fourbeard rockling	108.8	39.5	51.4	32.7	0.2	27.5	38.7	46.6	33.9	27.4	63.6	47.1
Silver hake	11.4	0	0.1	0.4	0.4	22.5	73.6	271.1	18.6	139.9	90.4	48.9
Windowpane	36.4	19.9	22.5	29.1	0.1	17.4	44.2	28.5	17.9	43.2	95.1	33.4
Yellowtail flounder	1.2	569.2	198.6	0	0	0.6	17.9	0.5	1.9	33.8	2.8	8.4
Total (All Taxon)	1,248	1,551	823	316	4.8	256	926	693	287	594	2,104	775

[a] NextEra sampled three months, August–October.

[b] NextEra sampled eight months, January–July, December.

[c] NextEra sampled eight months, January–August.

[d] NextEra sampled seven months, January–March, September–December.

[e] NextEra sampled 12 months per year.

Source: (NextEra, 2010c; NAI, 2010)

Notes: Normandeau Associates, Inc. (NAI) (2010), combined certain groups of species if eggs were morphologically similar and spawning periods overlapped during the sampling period. Groups of species include Atlantic cod/haddock, cunner/yellowtail founder, and hake/fourbeard rockling. NextEra (2010c) estimated entrainment rates for each species by applying the ratio of larval species to the egg species groups.

Table 4.5-2. Number of fish eggs entrained (in millions) for most common egg taxa entrained (cont.)

Taxon	2002[e]	2003[e]	2004[e]	2005[e]	2006[e]	2007[e]	2008[e]	2009[e]	Average
American plaice	22.4	37.8	33.4	11.7	5.3	35.8	48.0	36.7	25.9
Atlantic cod	77.8	15.5	9.3	16.0	15.7	15.1	48.0	15.4	32.6
Atlantic mackerel	56.7	26.4	70.1	37.7	475.6	153.6	82.4	83.5	191.5
Cunner	1,395.7	143.9	518.1	251.2	489.4	295.0	444.5	1,451.2	387.4
Hake	79.7	5.2	5.7	2.8	8.1	15.6	21.7	92.1	45.7
Fourbeard rockling	61.4	44.1	38.2	68.8	36.6	78.2	61.7	123.8	51.5
Silver hake	341.4	235.6	19.8	30.7	9.4	60.8	50.9	196.2	81.1
Windowpane	39.1	15.5	18.2	26.2	24.7	34.7	25.9	61.8	31.7
Yellowtail flounder	3.9	0	0.1	5.0	1.1	7.8	0	4.1	42.8
Total (All Taxon)	2,087	529	724	454	1075	715	791	2,073	901

[a] NextEra sampled three months, August–October.

[b] NextEra sampled eight months, January–July, December.

[c] NextEra sampled eight months, January–August.

[d] NextEra sampled seven months, January–March, September–December.

[e] NextEra sampled 12 months per year.

Source: (NextEra, 2010c; NAI, 2010)

Notes: Normandeau Associates, Inc. (NAI) (2010), combined certain groups of species if eggs were morphologically similar and spawning periods overlapped during the sampling period. Groups of species include Atlantic cod/haddock, cunner/yellowtail founder, and hake/fourbeard rockling. NextEra (2010c) estimated entrainment rates for each species by applying the ratio of larval species to the egg species groups.

Table 4.5-3. Number of fish larvae entrained (in millions) for the most common larval taxa entrained

Taxon	1990 [(a)]	1991 [(b)]	1992 [(c)]	1993 [(c)]	1994[(d)]	1995 [(e)]	1996 [(e)]	1997 [(e)]	1998 [(e)]	1999 [(e)]	2000 [(e)]	2001 [(e)]
American plaice	0.4	1.0	0.8	0.7	0	7.9	8.1	7.0	2.9	4.9	1.6	8.7
American sand lance	0	37.3	18.1	12.0	8.3	9.5	14.0	10.1	10.7	7.8	1.0	5.3
Atlantic herring	0.7	0.5	4.9	9.6	0.1	11.2	4.3	2.1	9.5	8.6	0.2	15.2
Atlantic seasnail	11.6	16.0	31.5	64.4	0.0	26.5	60.6	1.2	38.5	76.5	34.3	19.7
Cunner	42.7	<0.1	0	4.7	0.1	4.4	9.2	203.8	8.4	4.7	111.0	13.6
Fourbeard rockling	37.9	0.5	0.1	2.2	0.0	3.9	11.7	22.4	13.1	21.0	8.2	19.6
Grubby	0	22.4	18.9	13.8	4.9	17.4	18.6	12.8	17.3	6.4	2.2	12.4
Rock gunnel	0	51.1	45.3	5.7	11.0	15.6	33.8	25.1	16.9	18.2	3.5	4.6
Silver hake	7.7	0	0	0.1	0	0.9	16.9	69.0	0.2	0.4	33.2	0.6
Winter flounder	3.2	9.0	6.2	2.9	0	8.0	10.3	2.2	4.7	7.4	14.3	14.3
Total (All Taxon)	121.5	153.8	133.1	126.1	31.2	145.3	215.7	373.4	134.1	171.8	261.2	124.3

[(a)] NextEra sampled three months, August–October.

[(b)] NextEra sampled eight months, January–July, December.

[(c)] NextEra sampled eight months, January–August.

[(d)] NextEra sampled seven months, January–March, September–December.

[(e)] NextEra sampled 12 months per year.

Source: (NAI, 2010)

Table 4.5-3. Number of fish larvae entrained (in millions) for the most common larval taxa entrained (cont.)

Taxon	2002 [e]	2003 [e]	2004 [e]	2005[e]	2006 [e]	2007 [e]	2008 [e]	2009 [e]	Average
American plaice	11.3	9.1	2.6	1.4	0.6	2.6	3.5	11.5	4.3
American sand lance	10.5	27.1	107.1	28.3	14.1	36.6	71.2	128.6	27.9
Atlantic herring	11.7	15.3	8.8	9.7	12.8	11.5	28.2	27.7	9.6
Atlantic seasnail	29.0	43.2	64.2	37.5	20.2	0.0	27.4	37.8	32.0
Cunner	391.1	22.5	451.2	2.5	8.8	97.7	86.2	105.7	78.4
Fourbeard rockling	176.4	19.3	61.4	2.0	4.9	16.4	11.9	20.3	22.7
Grubby	6.6	27.5	51.8	7.8	9.3	15.4	8.3	31.6	15.3
Rock gunnel	12.3	56.0	109.0	54.2	30.3	46.7	48.2	82.9	33.5
Silver hake	5.9	0.5	0.2	0.0	0.1	0.0	17.9	8.2	8.1
Winter flounder	4.5	20.0	34.8	4.9	7.2	15.8	0.1	15.2	9.2
Total (All Taxon)	724.4	268.5	958.5	167	123.2	297.2	333.7	523.2	269.4

[a] NextEra sampled seven months, August–October.

[b] NextEra sampled eight months, January–July, December.

[c] NextEra sampled eight months, January–August.

[d] NextEra sampled eight months, January–March, September–December.

[e] NextEra sampled 12 months per year.

Source: (NAI, 2010)

Entrainment rates for essential fish habitat (EFH) species and their prey are discussed in more detail in Appendix D-1.

Bivalve Larvae. NextEra collected bivalve larvae entrainment samples from 1990–2009 (NAI, 2010). Total larval entrainment estimates ranged from 6,624 x 10^9 in 2004 (among sampling years with at least 6 months of data) to 67,415 x 10^9 in 1999 (Table 4.5–4). The annual average total bivalve larvae was 17,595 x 10^9 per year (NAI, 2010) (Table 4.5–4). On average, prickly jingle (*Heteranomia squamula*) larvae comprised 43 percent of annual bivalve larvae entrainment. Blue mussel (*Mytilus edulis*) larvae comprised 33.5 percent, and the rock borer comprised 12.7 percent of annual bivalve larvae entrainment (NAI, 2010). All other taxa comprised less than 7 percent of annual bivalve larvae entrainment (Table 4.5–4) (NAI, 2010). In 2009, larvae entrainment was highest in August (73 percent) when NAI (2010) detected unusually high numbers of prickly jingle larvae in the nearshore waters. Throughout all years, NAI (2010) detected the highest entrainment rates in summer, which is indicative of when the seasonal depth distribution of bivalve larvae is most likely to be near the depth of the intake structure.

Line of Evidence Number 2: Impingement Studies at Seabrook

NextEra conducted impingement monitoring once or twice per week by cleaning traveling screens and sorting fish and other debris (NAI, 2010). Prior to 1998, NextEra did not sort some collections, and impingement estimates are based on the volume of debris (NAI, 2010). Beginning in 1998, Seabrook staff sorted all collections and identified all impinged fish by species. Beginning in April 2002, NextEra collected two standardized 24-hour samples per week and multiplied by seven to estimate weekly impingement.

The results for 1995–2009 are presented in Table 4.5–5. Prior to October 1994, NextEra determined that some small, impinged fish had been overlooked during separation procedures. NextEra enhanced the impingement monitoring program in the end of 1994 to remedy this issue (NextEra, 2010c).

NextEra collected fish and American lobster (*Homarus americanus*) impingement samples from 1995–2009 that belong to 84 taxa and one group of unidentified fish (NAI, 2010). Total fish and lobster impingement estimates ranged from 7,281 in 2000 to 71,946 million in 2003. The annual average impingement was 20,876 fish and lobster. On average, the most commonly impinged species included Atlantic silverside (*Menidia menidia*) (11.5 percent), rock gunnel (10.5 percent), and winter flounder (10 percent) (Table 4.5–5). Rainbow smelt (*Osmerus mordax*), a National Marine Fisheries Service (NMFS) species of concern, was the sixth most impinged species at Seabrook, with an annual average impingement rate of 1,093 fish per year. The majority of impingement occurred during spring and fall, especially with young-of-the-year (YOY), demersal fish (NAI, 2010).

Table 4.5–4. Number of bivalve larvae entrained (x 10^9) for the most common larval taxa entrained

Taxon	1990[a]	1991[b]	1992[c]	1993[d]	1995	1996	1997	1998	1999	2000
Prickly jingle	1,691	250.8	6.9	3,923	8,906	23,522	2,883	3,827	36,495	7,542
Bivalvia mussels	181.7	38.1	14.5	334.5	797.1	671.4	71.1	64.5	651.3	228.6
Rock borer	876.6	421.3	189.8	2,406	2,598	4,670	923.7	609.7	4,417	1,921
Northern horsemussel	909.7	160.2	0.3	1,284	546.4	5145	614.7	241.7	2,376	2,521
Soft shell clam	8.1	0.6	0.2	22.5	4.3	33.2	53.7	11.4	45.7	23.9
Truncate softshell clam	249.2	6.5	1.1	2.1	27.6	123	0.8	8.3	66	34.9
Blue mussels	3,991	1,688	121.9	10,051	13,231	17,932	1,745	1,493	22,374	10,255
Sea scallop	0.7	0.7	0.1	16.9	6.2	31	0.8	0.8	11.5	9.9
Solenidae clams	61.1	0	75.7	102.5	1,092	241.9	49.5	20.9	773.2	150.4
Surf clam	69	4.4	0	48.5	112.5	171.1	22.5	14.8	175.5	33.6
Shipworm	0.01	15.9	0	0	4.8	7.4	1.7	0.8	29.9	1.5
Total (All taxon)	8,039	2,586	410	18,190	27,327	52,547	6,366	6,293	67,415	22,721

(a) NextEra sampled June–October.

(b) NextEra sampled the last week in April through the first week in August.

(c) NextEra sampled the third week in April through the third week in June.

(d) Number of months that entrainment sampling occurred varied by year. Except as noted, NextEra sampled the third week in April through the fourth week in October. In 1994, NextEra did not conduct bivalve larvae entrainment studies.

(e) NextEra sampled the fourth week in April through the fourth week in October.

(f) NextEra sampled the fourth week in April through the fourth week in September.

Source: (NAI, 2010)

Table 4.5–4. Number of bivalve larvae entrained (x 10^9) for the most common larval taxa entrained (cont.)

Taxon	2001	2002	2003	2004	2005[e]	2006[f]	2007	2008	2009	Average
Prickly jingle	4,129	8,204	3,218.1	2,595	1,217	3,966	3,950	18,452	27,733	8,553.2
Bivalvia mussels	483	1,94.2	73.7	89.6	40.4	73.9	46.2	411.8	74.3	238.94
Rock borer	1,575	567.3	1,203.9	1,024	352.9	604.6	650.7	3,137	2,548	1,615.5
Northern horsemussel	251.6	776.4	240.8	843.2	292.9	715.1	172.5	2,270	1421	1,093.8
Soft shell clam	26.4	60.2	5.1	15.1	9.2	11.1	4.7	45.8	31.8	21.737
Truncate softshell clam	26.3	1.9	13.8	5.2	2.3	0.6	3	6.4	4.8	30.726
Blue mussels	9,621	3,318	2,199	1,526	921.5	1,351	834.4	2,700	3,974	5,754
Sea scallop	8.5	0.8	0	0.7	0.1	0	0.1	0.3	1.2	4.7526
Solenidae clams	922.9	150.8	85.5	113.4	57.9	65.2	156.1	85.1	162.4	229.83
Surf clam	50.8	44.2	3.1	10	14.5	20	2.8	100.7	31.5	48.921
Shipworm	0.3	2.3	0.1	0.6	0.3	0.8	0	1.8	2.3	3.7111
Total (All taxon)	17,095	13,320	7,043	6,223	2,909	6,809	5,820	27,211	35,983	17,595

[a] NextEra sampled June–October.

[b] NextEra sampled the last week in April through the first week in August.

[c] NextEra sampled the third week in April through the third week in June.

[d] Number of months that entrainment sampling occurred varied by year. Except as noted, NextEra sampled the third week in April through the fourth week in October. In 1994, NextEra did not conduct bivalve larvae entrainment studies.

[e] NextEra sampled the fourth week in April through the fourth week in October.

[f] NextEra sampled the fourth week in April through the fourth week in September.

Source: (NAI, 2010)

Table 4.5-5. Number of impinged fish and lobsters at Seabrook from 1994–2009 for commonly impinged species

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Alewife	0	8	1,753	2,797	14	16	4	35	1	9
American sand lance	1,215	1,324	823	182	708	234	423	114	245	3,396
Atlantic menhaden	0	7	97	0	1	957	142	19	1,022	7
Atlantic silverside	5,348	1,621	1,119	210	834	1,335	31	282	1,410	20,507
Atlantic cod	58	119	94	69	38	66	29	30	199	3,091
Cunner	32	342	1,121	233	309	255	324	341	291	554
Grubby	2,678	2,415	1,457	430	3,269	3,953	1,174	549	1,089	2,523
Hakes	2,822	2,188	156	122	4	68	113	523	1,813	166
Northern pipefish	188	579	1,200	243	268	748	370	714	936	2,716
Pollock	1,681	899	1,835	379	536	11,392	534	405	719	499
Rainbow smelt	545	213	4,489	365	535	100	8	65	323	3,531
Red hake	1	16	1,478	371	903	1,120	112	155	52	271
Rock gunnel	494	1,298	1,122	459	2,929	2,308	1,514	2,251	2,066	6,274
Sea raven	78	125	1,015	223	137	132	206	271	166	217
Shorthorn sculpin	14	156	282	123	190	296	923	621	642	7,450
Snailfishes	180	165	1,013	351	856	2,356	690	334	616	451
Threespine stickleback	67	155	320	174	773	506	10	280	34	1,549
Windowpane	980	943	1,164	1,688	772	692	251	161	2,242	4,749
Winter flounder	1,435	1,171	3,231	468	1,143	3,642	102	777	897	10,491
Total (All taxa)	19,212	15,940	26,825	10,648	15,198	31,241	7,281	8,577	18,413	71,946

Source: (NAI, 2010)

Table 4.5-5. Number of impinged fish and lobsters at Seabrook from 1994–2009 for commonly impinged species (cont.)

Species	2004	2005	2006	2007	2008	2009	Total	Percent of Total	Annual Average
Alewife	212	87	255	244	41	0	5,476	1.6	342
American sand lance	665	1,029	213	2,073	758	796	14,198	4.3	887
Atlantic menhaden	361	7,226	94	160	67	39	10,199	3.1	637
Atlantic silverside	877	2,717	788	639	247	525	38,490	11.5	2,406
Atlantic cod	467	454	113	178	73	147	5,225	1.6	327
Cunner	625	893	687	922	731	837	8,497	2.5	531
Grubby	676	531	235	869	3,919	521	26,288	7.9	1,643
Hakes	35	11	6	1,184	3,216	1,427	13,854	4.1	866
Northern pipefish	1,413	1,724	1,288	2,374	1,082	698	16,541	5.0	1,034
Pollock	80	218	73	340	123	657	20,370	6.1	1,273
Rainbow smelt	2,085	3,314	878	572	421	43	17,487	5.2	1,093
Red hake	892	821	546	1,389	14	0	8,141	2.4	509
Rock gunnel	4,137	1,752	3,782	3,174	937	701	35,198	10.5	2,200
Sea raven	129	221	138	164	138	79	3,439	1.0	215
Shorthorn sculpin	876	2,214	1,258	465	1,515	266	17,291	5.2	1,081
Snailfishes	185	442	330	76	233	85	8,363	2.5	523
Threespine stickleback	130	307	139	193	80	118	4,835	1.4	302
Windowpane	936	2,034	572	1,502	1,640	427	20,753	6.2	1,297
Winter flounder	783	1,875	767	3,949	1,920	655	33,306	10.0	2,082
Total (All taxa)	16,696	29,368	12,955	22,472	17,935	9,304	334,011	100.0	20,876

Source: (NAI, 2010)

Impingement rates for EFH species and their prey are discussed in more detail in Appendix D-1.

Line of Evidence Number 3: Related Regulatory Reviews

316(b) Regulations. Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. In its evaluation of the National Pollutant Discharge Elimination System (NPDES) permit, EPA (2002) determined that the following:

"...the Cooling Water Intake System, as presently designed, employs the best technology available for minimizing adverse environmental impact. Therefore, no change in the location, design or capacity of the present system can be made without prior approval of the Regional Administrator and the Director. The present design shall be reviewed for conformity to regulations pursuant to Section 316(b) when such are promulgated."

In March 2011, EPA promulgated new draft regulations pursuant to Section 316(b). As described in Section 2.2.4, Seabrook is currently operating under the NPDES permit from 2002.

EPA Case Study Analysis for the Proposed Section 316(b) Phase II Existing Facilities Rule. In 2002, EPA conducted a case study analysis for a proposed Section 316(b) Phase II existing facilities rule. In the case study, EPA evaluated the economic losses associated with impingement and entrainment at Seabrook and Pilgrim. Pilgrim is located south of Seabrook, in Cape Cod Bay.

EPA (2002a) evaluated entrainment and impingement based on data reported by NextEra in monitoring reports and using the methods outlined in EPA (2002a) to estimate the total number of organisms, age 1 equivalents, yield loss to fisheries, and production foregone due to entrainment and impingement. EPA (2002a) determined that 69 percent of all entrained and impinged species at Seabrook are valued commercially or recreationally. The mostly frequently entrained fishery species were Atlantic mackerel, winter flounder, and red hake. Entrainment of forage fish, species that are prey for fishery species and are important components of the Gulf of Maine food web, was high at Seabrook and Pilgrim and included species such as fourbeard rockling, lumpfish, and rock gunnel at Seabrook. The most frequently impinged fishery species at Seabrook were winter flounder, red hake, and Atlantic silverside (EPA, 2002a).

EPA (2002a) determined that entrainment and impingement for certain species was higher at Pilgrim, whereas entrainment for other species was higher at Seabrook (Table 4.5–6Table 4.5-6 and Table 4.5–7). For example, entrainment of the winter flounder category was nearly an order of magnitude higher at Seabrook (annual mean of 244 million per year) compared to Pilgrim (30.9 million per year). These differences are likely due to differences in the relative abundance of the various species at the two sites and the location of the intake structures (i.e., the Seabrook intake structure is offshore whereas the Pilgrim intake structure is nearshore).

Table 4.5-6. Comparison of annual mean entrainment (in millions of organisms) for selected species at Seabrook and Pilgrim Nuclear Station

Species	Seabrook	Pilgrim
American plaice	27.4	11.3
American sand lance	13.3	138.0
Atlantic cod	10.0	6.3
Atlantic mackerel	245.4	1,035.0
Atlantic menhaden	0.3	81.9
Blue mussel	6,281,453.8	8,073,966.7

Species	Seabrook	Pilgrim
Cunner	35.4	2,714.6
Fourbeard rockling	58.5	94.3
Lumpfish	31.9	6.5
Pollock	0.7	42.8
Radiated shanny	1.7	19.3
Rainbow smelt	0.07	10.1
Red hake	93.2	31.1
Rock gunnel	22.7	34.3
Sculpin spp.	1.6	40.8
Windowpane	25.7	83.5
Winter flounder	244.0	30.9

Notes: Seabrook entrainment data is from 1990–1998. Pilgrim entrainment data is generally from 1990–1999, although for some species selected years from 1974–1990 were included, as described in EPA (2002a) Table G3-14.

Source: (EPA, 2002a), Tables G3-6 and G3-14

As described in EPA (2004), certain species were aggregated in order to limit the number of species groups. Aggregated groups include the following:

- Atlantic cod includes Atlantic cod and haddock.
- Lumpfish includes lumpfish and lumpsucker
- Red hake includes red hake, white hake, and spotted hake.
- Sculpin spp. includes longhorn sculpin, moustache sculpin, sea raven, and shorthorn sculpin.
- Windowpane includes American fourspot flounder, smallmouth flounder, summer flounder, and windowpane.
- Winter flounder includes fourspot flounder, lefteye flounder, righteye flounder, smooth flounder, winter flounder, witch flounder, and yellowtail flounder.

Table 4.5-7. Comparison of annual mean impingement for selected species at Seabrook and Pilgrim Nuclear Station

Species	Seabrook	Pilgrim
Alewife	508	3,250
American sand lance	476	19
Atlantic cod	99	252
Atlantic herring	287	7,593
Atlantic silverside	1,040	11,587
Blueback herring	50	612
Butterfish	28	297
Grubby	1,156	717
Lumpfish	391	198

Species	Seabrook	Pilgrim
Pollock	643	30
Rainbow smelt	701	5,118
Red hake	1,041	178
Sculpin spp.	401	11
Scup	3	97
Tautog	7	183
Windowpane	664	236
Winter flounder	1,032	1,039

Notes: Seabrook impingement data is from 1990–1998. Pilgrim impingement data is generally from 1990–1999, although for some species a few years prior to 1990 were included, as described in EPA (2002a) Table G3-10.

Source: (EPA, 2002a), Tables G3-2 and G3-10

As described in EPA (2004), certain species were aggregated in order to limit the number of species groups. Aggregated groups include the following:

- Atlantic cod includes Atlantic cod and haddock.
- Atlantic herring includes Atlantic herring, hickory shad, and round herring.
- Lumpfish includes lumpfish and lumpsucker.
- Red hake includes red hake, white hake, and spotted hake.
- Sculpin spp. includes longhorn sculpin, moustache sculpin, sea raven, and shorthorn sculpin.
- Windowpane includes American fourspot flounder, smallmouth flounder, summer flounder, and windowpane.
- Winter flounder includes fourspot flounder, lefteye flounder, righteye flounder, smooth flounder, winter flounder, witch flounder, and yellowtail flounder.

The mean impingement and entrainment rate for Seabrook is not necessarily the same for the data provided in NextEra's 2009 monitoring report (NAI, 2010) (Table 4.5–2, Table 4.5–3, and Table 4.5–5) and estimates in EPA (2002a) (Table 4.5–6 and Table 4.5–7). This is due to several reasons. For example, NextEra's 2009 monitoring report provides data from 1990–2009 for entrainment and 1994–2009 for impingement, whereas EPA (2002a) is an earlier document that includes data from 1990–1998. In addition, EPA (2002a) included multiple species within a single species category in order to limit the number of species groups. EPA (2002a) aggregated species for the purpose of conducting benefit transfer analyses that require specific life history data. As requested in NRC's request for additional information (RAIs), NextEra estimated entrainment data per species (NextEra, 2010c). Lastly, EPA (2002a) provides the total entrainment for eggs and larvae, whereas NextEra's entrainment data are separated for eggs and larvae (NAI, 2010).

To estimate economic losses, EPA (2002a) used a variety of benefit transfer methods. For recreational fisheries, EPA used the results from nonmarket valuation studies, whereby recreational fisherman stated the amount they would be willing-to-pay for higher densities of fish. EPA (2002a) evaluated commercial fishery impacts based on commodity prices for the individual species. EPA (2002a) determined the economic value of forage species losses by estimating the replacement cost if fish were restocked with hatchery fish and by considering the foregone biomass production resulting from impingement and entrainment losses.

At Seabrook, EPA valued average entrainment losses at between $139,000–$309,000 per year and average impingement losses at between $3,000–$5,000 per year (in year 2000 dollars). For comparison purposes, EPA determined higher entrainment losses ($513,000 and $744,000 in year 2000 dollars) at Seabrook compared to Pilgrim, but a similar value for impingement losses (EPA, 2002a).

Lastly, EPA (2002a) estimated the benefits of reducing impingement and entrainment at Seabrook. EPA (2002a) determined that the annual benefits for a 70 percent reduction in entrainment at Seabrook range from $97,000–$216,000 and that the annual benefits for a 60 percent reduction in impingement at Seabrook range from $2,000–$3,000.

In the Pilgrim SEIS, NRC staff determined that entrainment at Pilgrim Station was SMALL to MODERATE, depending on the species (NRC, 2007). The NRC staff determined that continued operations would have a MODERATE impact on winter flounder and rainbow smelt—both species were regionally declining in population. In addition, the NRC staff determined that the continued operation of the Pilgrim cooling water system would have MODERATE impacts on the local winter flounder population and the Jones River population of rainbow smelt (NRC, 2007) and SMALL to MODERATE impacts for other species of fish.

New Hampshire Fish and Game. In 2010, NextEra provided NHFGD a copy of "Seabrook Station, 2010 Environmental Monitoring Program Mid-Year Report." In reviewing this report, NHFGD noted that the cooling system impinged over 20,000 fish during the first 6 months of 2010, which was a large increase from the previous year (NextEra, 2010c). NHFGD requested additional data on the fish species impinged and when the impingement occurred (NextEra, 2010c).

In response to this request, NextEra provided additional data on the species impinged broken down by month (NextEra, 2010c). Approximately 77 percent of the impingement occurred in March, and 58 percent of the monthly total occurred during the week of March 14–20, 2010 (NextEra, 2010c). The most commonly impinged species during March included American sand lance (2,294), hake (2,645), and grubby (2,537) (NextEra, 2010c).

NextEra noted that high impingement is often correlated with high wave action. NextEra compared wave height data from a nearby buoy with impingement data and found that the greatest number of fish (1,551) was impinged on March 14–15, when wave heights were highest 19 feet (ft) (5.9 meters (m)) (NextEra, 2010c). Likewise, during a period of low wave height (March 10–11), few fish (45) were impinged (NextEra, 2010c). Based on this data and experience conducting monitoring studies at Seabrook, NextEra (2010c) concluded that the high impingement in March was likely due to high wave action.

Line of Evidence Number 4: Seabrook Monitoring Data

The fourth line of evidence includes monitoring data of fish and shellfish populations prior to and during operations at a nearfield and farfield site. As described in Section 2.2.6, NextEra has conducted monitoring studies for fish and invertebrates since the 1970s. NextEra used a before-after control impact (BACI) design to test for potential impacts from operation of Seabrook. This monitoring design can be used to test the statistical significance of differences in community structure and abundance between the pre-operation and operational period at nearfield and farfield sites. Section 4.5.4 provides the results of these monitoring studies. For the purposes of this WOE approach, a summary of the results is provided below.

NextEra compared the abundance of demersal fish species prior to and during operation at nearfield and farfield sites using an analysis of variance (ANOVA) on a BACI design. As described in Section 2.2.6, at the nearfield sampling station (T2) and at one of the farfield stations (T1), the abundance of fish was significantly higher in the 1970s–1980s (prior to operations) when compared to more recent years that include plant operations (NAI, 2010). In 2009, the combined abundance for all fish species were similar to that found in the mid-1980s at the farfield stations but below preoperational levels at the nearfield station (NAI, 2010). Sosebee et al. (2006) analyzed separate trawl survey data from over 40 years and found similar trends as NAI (2010) at the two farfield stations.

The abundances of the majority of fish species were higher during preoperational monitoring than during operations, although the abundance of some species increased with time (Table 4.5–9). NAI (2010) used a t-test to determine if these differences were statistically significant and if they varied between the nearfield and farfield sampling sites. The abundance of yellowtail flounder, Atlantic cod, and rainbow smelt were significantly higher prior to operations at the nearfield and farfield sampling sites. The decrease in rainbow smelt was significantly greater at the nearfield station compared to the farfield station (see Table 4.5–9). However, NAI (2010) observed a different trend for winter flounder and silver hake. At the nearfield site (T2), the abundance of winter flounder significantly decreased over time from a mean catch per unit effort (CPUE) of 5.5 prior to operations to 2.3 during operations, whereas at both farfield sampling sites (T1 and T3), the mean CPUE significantly increased from 2.8 and 1.4 prior to operations, respectively, to 4.0 and 3.6 during operations. Silver hake abundance also increased at farfield sampling sites and decreased at the nearfield sampling site. NAI (2010) did not test whether the trends for silver hake were statistically significant.

For most fish, changes in species abundance and community structure prior to and during operations occurred at both the nearfield and farfield sampling sites (NAI, 2010). These results suggest that Seabrook operations have not noticeably altered fish populations near Seabrook for most fish species. However, the abundance of winter flounder and rainbow smelt has decreased to a greater and observable extent near Seabrook’s intake and discharge structures compared to 3–4 miles (mi) (5–8 kilometers (km)) away. The local decrease suggests that to the extent local subpopulations exist within 3–4 mi (5–8 km) of Seabrook, they have been destabilized through operation of Seabrook’s cooling water system. There is insufficient data for NRC to make a conclusion for silver hake.

Summary of Entrainment and Impingement Impacts

NRC staff examined four lines of evidence to determine if impingement and entrainment have the potential to cause adverse impacts to fish and shellfish in the vicinity of Seabrook. The first line of evidence is entrainment data provided by NextEra. The second line of evidence is impingement data provided by NextEra. The third line of evidence includes reviews by other regulatory agencies, such as EPA and NHFGD. EPA's (2002a) review also included a comparison of impingement and entrainment data with Pilgrim. The fourth line of evidence includes monitoring data of fish and shellfish populations prior to and during operations at a nearfield and farfield site. Based on this assessment, the NRC concludes that the impacts to the majority of species due to entrainment and impingement would be SMALL, because the NRC staff found that operations of Seabrook have not noticeably altered most fish and shellfish populations. However, the NRC concludes that the impact on winter flounder due to entrainment and impingement is LARGE since winter flounder is regularly entrained and impinged at Seabrook and since monitoring data indicates that the abundance of winter flounder has decreased to a greater and observable extent near Seabrook’s intake and discharge structures compared to 3-4 mi (5-8 km) away. The local decrease suggests that to the extent local subpopulations exist within 3-4 mi (5-8 km) of Seabrook, they have been destabilized through operation of Seabrook's cooling water system.

Winter flounder was the eighth most commonly entrained fish larvae species, with an annual average of 9.2 million entrained larvae per year (NAI, 2010). Winter flounder was the third most commonly impinged species, comprising 10 percent of all impinged fish (NAI, 2010). On average, the Seabrook cooling system impinged 2,083 winter flounder per year (NAI, 2010). Seabrook trawling data indicated that winter flounder significantly decreased at the nearfield sampling site, which is located closest to the intake and discharge structures, but increased or stayed the same at sites 3-4 mi (5-8 km) from the intake and discharge structures. These results suggest that to the extent a local subpopulation of winter flounder exists within 3-4 mi (5-8 km), it has been destabilized through operation of Seabrook's cooling system.

4.5.3 Thermal Shock

For plants with once-through cooling systems and cooling pond heat dissipation systems, NRC's GEIS (1996) lists the effects of heat shock as an issue requiring plant-specific evaluation before license renewal (Category 2). The NRC (1996) made impacts on fish and shellfish resources resulting from heat shock a site-specific issue because of continuing concerns about thermal discharge effects and the possible need to modify thermal discharges in the future in response to changing environmental conditions.

Information considered in this analysis includes the type of cooling system (once-through in this case), Seabrook's NDPES permit, evidence of a CWA Section 316(a) variance documentation, modeling of the thermal plume, Seabrook monitoring of cold-water and warm-water algae species, and other information. To perform this evaluation, the NRC staff reviewed the NextEra's ER (NextEra, 2010) and monitoring data (NAI, 2010), visited the Seabrook site, and reviewed the applicant's NPDES and EPA 316(a) determination.

As described in Section 2.2.4, Seabrook's discharge to the Gulf of Maine is permitted under its NPDES permit (EPA, 2002), which was issued April 1, 2002. The permit allows discharge of 720 mgd (2.7 million m^3/day) on both an average monthly and maximum daily basis. The permit also limits the rise in monthly mean temperature to 5 degrees Fahrenheit in the "near field jet mixing region," or within waters less than 3.3 ft (1 m) from the surface. An EPA online database indicated that Seabrook has had no CWA formal enforcement actions or violations related to discharge temperature in the last 5 years (EPA, 2010a). EPA's Regional Administer determined that NextEra's NPDES permit provides a Section 316(a) variance that satisfies thermal requirements and that "will ensure the protection and propagation of a balanced indigenous community of fish, shellfish, and wildlife in and on Hampton Harbor and the near shore Atlantic Ocean" (EPA, 2002).

The thermal effluent from Seabrook is discharged through 11 riser shafts, spaced approximately 100 ft (30.5 m) apart for a total diffuser length of 1,000 ft (305 m) (NAI, 2001). Each riser shaft terminates in a pair of nozzles that are pointed up at an angle of about 22.5 degrees (NAI, 2001). The nozzles are located about 6.5–10 ft (2–3 m) above the seafloor in depths of approximately 49–59 ft (15–18 m) of water (NAI, 2001).

Padmanabhan and Hecker (1991) conducted a thermal plume modeling and field verification study. This study estimated a temperature rise of approximately 36 to 39 degrees Fahrenheit (20 to 22 degrees Celsius) at the diffusers (Padmanabhan and Hecker, 1991). Field and modeling data indicated that the water rose relatively straight to the surface and spread out within 10–16 ft (3–5 m) of the ocean surface. At the surface, Padmanabhan and Hecker (1991) observed a temperature rise of 3 degrees Fahrenheit (1.7 degrees Celsius) or more within 32 acres (ac) (12.9 hectares (ha)) of the discharge. Padmanabhan and Hecker (1991) did not observe significant increases in surface temperature 1,640 ft (500 m) to the northwest of the discharge structure.

NextEra has conducted monitoring of water temperature at bottom and surface waters near the discharge structure during operations (NAI, 2001; NAI, 2010). NextEra monitored bottom water temperature at a site 656 ft (200 m) from the discharge and at a site 3–4 nautical mi (5–8 km) from the discharge from 1989–1999 (NAI, 2001). NextEra observed a significant difference in the monthly mean bottom water temperature between the two sites. The mean difference was less than 0.9 degrees Fahrenheit (0.5 degrees Celsius) (NAI, 2001). As required by Seabrook's NPDES permit, NextEra conducts continuous surface water monitoring. The mean difference in temperature between a sampling station within 328 ft (100 m) of the discharge and a sampling station 1.5 mi (2.5 km) to the north has not exceeded 5 degrees Fahrenheit (2.8 degrees Celsius), which is the limit identified in the NPDES permit (EPA, 2002; NAI, 2001). For the majority of months between August 1990 and December 2009, the monthly mean increase in surface water temperature was less than 3.6 degrees Fahrenheit (2.0 degrees Celsius).

Based on Seabrook's water quality monitoring and the Padmanabhan and Hecker (1991) study, the habitat most likely affected by the thermal plume would be the upper water column (10–16 ft (3–5 m) of the ocean surface) in the immediate vicinity of the discharge (less than 328 ft (100 m)). Fish may avoid this area; however, the thermal plume would not likely block fish movement since fish could swim around the thermal plume. EFH species likely to avoid this area are discussed in Appendix D-1. Benthic species may also avoid the immediate area surrounding the discharge structures due to higher temperature, velocities, and turbulence. This area is expected to be considerably smaller than the area of increased temperature at the surface.

To examine the potential thermal impacts from plant operations, NAI (2010) compared the abundance of cold water and warm water macroalgae species prior to and during operations at nearfield and farfield sites, as described in Section 2.2.6. Benthic perennial algae are sensitive to changes in water temperature since they are immobile and live more than 2 years. Prior to operations, NAI (2010) collected six uncommon species that were not collected during operations, including the brown macroalga *Petalonia fascia,* which is associated with cold-water habitat. During operations, NAI (2010) collected some typically warm-water taxa for the first time (e.g., the red macroalga *Neosiphonia harveyi*), collected other warm-water taxa less frequently, and collected some cold-water taxa more frequently. NAI (2010) observed 10 species that only occurred during operations, and NAI (2010) reported that these species were within their geographic ranges (NAI, 2010). NAI (2010) concluded that the changes in community composition among cold and warm water species were relatively small, although NAI (2010) did not report the results of any statistical tests to examine the significance in such changes. Since there were no clear patterns of emergent warm-water species, or changes in the abundance of cold-water species, NRC concludes that thermal impacts from Seabrook operations have not noticeably altered aquatic communities near Seabrook.

After reviewing the status of Seabrook's NPDES permit, 316(a) compliance, modeling of the thermal plume, and monitoring of cold water and warm water algae, the NRC concludes that the level of thermal impacts to the aquatic community due to renewing Seabrook's operating license is SMALL.

4.5.4 Mitigation

NextEra prepared a proposal for information collection as a first step to comply with EPA's 2008 proposed Phase II rule of Section 316(b) of CWA (NAI and ARCADIS, 2008). In this document, NextEra identified three types of mitigation that reduce entrainment and impingement (NAI and

ARCADIS, 2008). First, the location of the intake structures is offshore in an area of reduced biological activity as compared to an inshore location. Second, the design of the intake structures includes velocity caps, which fish tend to avoid due to the changes in horizontal flow of water created by the velocity cap. Third, less water is pumped from the Gulf of Maine to Seabrook due to the offshore location, which provides cooler water than an inshore location (NAI and ARCADIS, 2008).

NextEra identified other intake technologies that might mitigate adverse intake effects, such as physical barriers, collection systems, diversion systems, and behavioral deterrent systems. Velocity caps that are installed on Seabrook's intake structures are considered behavioral deterrents. In addition, NextEra installed a seal deterrent system by adding vertical bars on intake structures to prevent seals from getting trapped and drowning (NextEra, 2010c). NextEra did not consider any additional physical barriers, collection, or diversion systems to be practical for Seabrook due to the additional costs associated with designing and constructing these technologies in an open water environment as compared to an inshore environment.

4.5.5 Combined Impacts

As described in Section 2.2.6, NextEra has conducted monitoring studies for plankton, fish, invertebrates, and macroalgae since the 1970s. NextEra used a BACI design to test for potential impacts from operation of Seabrook. This monitoring design can be used to test the statistical significance of differences in community structure and abundance between the preoperation and operational period at nearfield and farfield sites. If a significant difference occurs in the geographical distribution of a population, it could be due to entrainment, impingement, heat shock, or a combination of the cumulative effects from Seabrook operations.

When appropriate, NextEra has tested the significance of the changes in species or biological group abundance, density, or biomass using various statistical tests. A multivariate ANOVA on a BACI design compares preoperational and operational data at the nearfield and farfield sites to test if a significant difference occurred between the preoperational and operational periods and to test if this change was restricted to the nearfield site. When data were inappropriate for an ANOVA test, NextEra used an analysis of similarities (ANOSIM). Using this statistical test, NextEra first tested whether there was a significant difference between sites during the preoperational period. If there was no significant difference, then NextEra separately tested whether each station experienced significant differences prior to and during operations. If there was a significant difference between sites prior to operations, NextEra relied upon hierarchical clustering and nonmetric multi-dimensional scaling (MDS), as described below, to look for changes in species abundance after operations began.

NextEra examined the change in community composition, or relative abundance of various taxa, over time for the biological groups discussed below. NextEra calculated the Bray-Curtis Similarity Index (Boesch, 1977 in NAI, 2010; Clifford and Stephenson, 1975 in NAI, 2010) for all combinations of stations and years by using the mean annual abundance, density, or biomass for each taxon. NextEra evaluated temporal and spatial changes in the similarity indices by using hierarchical clustering and MDS plots. MDS plots resulted in a dendrogram that showed the most similar groups of monitoring sites and years. NextEra then evaluated whether groups were consistent separately by site and monitoring period. For example, an effect on aquatic communities from Seabrook operation could be concluded if MDS plots indicated that the nearfield and farfield sites were similar prior to operations but less similar during operations.

NRC staff related NextEra's monitoring results to NRC's definitions of SMALL, MODERATE, and LARGE, as described in Section 1.2.1. NRC defined the Seabrook cooling system impact as SMALL, if Seabrook monitoring data concluded that no significant difference occurred between the preoperational and operational periods or, if there was a change, that it occurred at both the nearfield and farfield sites. In this situation, NRC staff would conclude that operations of the Seabrook cooling system do not noticeably alter the aquatic resource. NRC defined the Seabrook cooling system impact as MODERATE if Seabrook monitoring data indicated that the abundance of a certain species or biological group increased at farfield sites and remained steady at nearfield sites during operations. In this situation, NRC staff would conclude that operations of the Seabrook cooling system noticeably altered, but does not destabilize, the aquatic resource. NRC defined the Seabrook cooling system impact as LARGE if Seabrook monitoring data indicated that the abundance of a certain species or biological group increased or remained steady at farfield sites and decreased at nearfield sites or if the abundance of a species or biological group declined at all sites, but the decline was significantly greater at nearfield sites. In this situation, NRC staff would conclude that operations of the Seabrook cooling system destabilizes the aquatic resources within 3–4 mi (5–8 km) of Seabrook.

Phytoplankton

As described in Section 2.2.6.3, NextEra examined differences in phytoplankton abundance and chlorophyll *a* concentrations prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design. NAI (1998) found no significant differences in phytoplankton abundance or chlorophyll *a* concentrations between the nearfield and farfield sites, nor was there any significant difference prior to and during operations. NAI (1998) observed minimal changes in species composition prior to and during operations. These results suggest that Seabrook operations have not noticeably altered phytoplankton abundance near Seabrook.

Zooplankton

Holoplankton, Meroplankton, and Hyperbenthos. NextEra compared the density of holoplankton, meroplankton, hyperbenthos taxa prior to and during operation at nearfield and farfield sites using an ANOSIM. NAI (2010) did not find a significant difference in the density of holoplankton or meroplankton taxa prior to and during operations or between the nearfield and farfield sampling sites. These results suggest that Seabrook operations have not noticeably altered holoplankton or meroplankton density near Seabrook.

Since hyperbenthos live closest to the intake structure, this assemblage of species would be most likely to be entrained. NAI (2010) found a significant difference in the density of hyperbenthos taxa between the nearfield and farfield sites. The average density of all hyperbenthos species at the nearfield site was generally an order of magnitude larger than the abundances found at the farfield site both prior to and during operations (NAI, 2010). For *Neomysis American*, a mysid shrimp and the most common species in the hyperbenthos assemblage, NAI (2010) reported significantly higher density at the nearfield site compared to the farfield site. NextEra used MDS plots to examine how the density of hyperbenthos taxa changed over time. NAI (2010) reported relatively consistent density of hyperbenthos taxa at the nearfield site both prior to and during operations. At the farfield site, NAI (2010) reported changes in the density of hyperbenthos taxa after 1996, when the sampling methods were modified in an effort to sample both sites at similar times. Since the density of hyperbenthos taxa generally remained consistent at the nearfield site, these results suggest that Seabrook operations have not noticeably altered hyperbenthos density near Seabrook.

Bivalve Larvae. NextEra compared the density of bivalve larval taxa prior to and during operations at nearfield and farfield sites by using an ANOSIM and MDS plots. NAI (2010) reported three main groups of typical bivalve larvae assemblages in MDS plots, as described in Section 2.2.6. These groups were primarily divided by year, and NAI (2010) reported similar patterns at both the farfield and nearfield sampling sites. At both sampling sites, blue mussels and the rock borer dominated community assemblages of bivalve larvae prior to operations, whereas prickly jingle and blue mussels dominated monitoring samples after 1996. NAI (2010) did not find a significant difference between sampling sites prior to and during operations, when examining total bivalve larvae using an ANOSIM. Since the change in community structure occurred at nearfield and farfield sampling sites, these results suggest that Seabrook operations have not noticeably altered bivalve larval density near Seabrook.

Fish Eggs and Larvae. NextEra compared the density of fish eggs and larvae prior to and during operation at nearfield and farfield sites using an ANOSIM. While there was no significant difference between sampling sites, NAI (2010) reported a significant difference prior to and during operations in the density of fish eggs and larval species. These significant changes over time occurred at both sampling sites. For example, NAI (2010) reported higher average egg density in 1983, 1984, 1986, and 1987 when compared to 1998–2008 for hake, Atlantic cod/haddock (*Melanogrammus aeglefinus*), and fourbeard rockling. NAI (2010) reported the opposite trend for the average egg density of Atlantic mackerel, cunner/yellowtail flounder, hake/fourbeard rockling, windowpane, and silver hake, as shown in Table 4.5–8. NAI (2010) reported higher average larval densities prior to operations when compared to more recent years for Atlantic mackerel, Atlantic herring, winter flounder, and witch flounder (*Glyptocephalus cynoglossus*) and the opposite trend for cunner, American sand lance, fourbeard rockling, rock gunnel, silver hake, and radiated shanny (*Ulvaria subbifurcata*), as shown in Table 4.5-8. Since changes in density prior to and during operations occurred at both the nearfield and farfield sampling sites, these results suggest that Seabrook operations have not noticeably altered fish egg and larval density near Seabrook.

Table 4.5-8. Mean density (No./1000m^3) and upper and lower 95% confidence limits (CL) of the most common fish eggs and larvae from 1982–2009 monitoring data at Seabrook

Taxon	Group 1[(a)]			Group 2[(a)]		
	Lower 95% CL	Mean	Upper 95% CL	Lower 95% CL	Mean	Upper 95% CL
Eggs[(b)]						
Atlantic mackerel	650	1,009	1,369	1,344	1,941	2,538
Cunner/yellowtail flounder	2,764	5,003	7,243	6,577	7,239	8,081
Hakes	235	1,226	2,217	332	488	643
Hake/fourbeard rockling	45	215	386	503	626	749
Atlantic cod/haddock	79	153	226	63	92	120
Windowpane	73	147	221	160	232	304
Fourbeard rockling	168	248	328	34	49	65
Silver hake	45	77	109	149	322	494
Larvae[(c)]						
Cunner	143	425	707	828	1,386	1,945
American sand lance	57	182	307	160	234	308
Atlantic mackerel	28	179	330	65	121	176
Fourbeard rockling	40	68	96	56	78	99
Atlantic herring	37	68	99	23	29	35
Rock gunnel	14	31	49	32	42	52
Winter flounder	18	44	70	8	11	14

Silver hake	14	23	32	35	67	100
Radiated shanny	15	26	36	3	27	50
Witch flounder	9	18	28	3	5	6

(a) NAI (2010) determined groups using a cluster analysis (numerical classification) and non-metric MDS of the annual means (log (x+1)) of each taxon at each station.

(b) Egg Group 1 years = 1983, 1984, 1986, 1987; Group 2 years = 1988–2008

(c) Larvae Group 2 years = 1982–1984, 1986–1989; Group 2 years = 1989–1991, 1993–2009

Source: (NAI, 2010)

Juvenile and Adult Fish

Demersal Fish. NextEra compared the abundance of demersal fish prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design. As described in Section 2.2.6, at the nearfield sampling station (T2) and at one of the farfield stations (T1), the abundance of fish was significantly higher in the 1970s–1980s (prior to operations) when compared to more recent years that include plant operations (NAI, 2010). In 2009, the combined abundance for all fish species was similar to that found in the mid-1980s at the farfield stations but below preoperational levels at the nearfield station (NAI, 2010). Sosebee, et al. (2006) analyzed separate trawl survey data from over 40 years and found similar trends as NAI (2010) at the 2 farfield stations.

NAI (2010) compared abundance by taxon prior to and during operations at the nearfield and farfield sites. The abundances of the majority of species were higher during preoperational monitoring than during operations, although the abundance of some species increased with time (Table 4.5–9). NAI (2010) used a t-test to determine if these differences were statistically significant. The abundance of yellowtail flounder, Atlantic cod, and rainbow smelt were significantly higher prior to operations at the nearfield and farfield sampling sites. The decrease in rainbow smelt was significantly greater at the nearfield station compared to the farfield station (see Table 4.5–9). However, NAI (2010) observed a different trend for winter flounder and silver hake. At the nearfield site (T2), the abundance of winter flounder significantly decreased over time from a mean CPUE of 5.5 prior to operations to 2.3 during operations. However, at both farfield sampling sites (T1 and T3), the mean CPUE increased from 2.8 and 1.4 prior to operations, respectively, to 4.0 and 3.6 during operations. This increase was statistically significant at one of the farfield sites (T3). Silver hake abundance also increased at farfield sampling sites and decreased at the nearfield sampling site. NAI (2010) did not test if these trends were statistically significant.

Table 4.5-9. Geometric mean CPUE (No. per 10-minute tow) and upper and lower 95% CL during preoperational and operational monitoring years for the most abundant species

Species	Sample site	Preoperational monitoring			Operational monitoring		
		Lower 95% CI	Mean	Upper 95% CI	Lower 95% CI	Mean	Upper 95% CI
Yellowtail flounder	Nearfield (T2)	2.7	3.7	5.0	0.1	0.2	0.3
	Farfield (T1)	15.7	20.6	26.9	1.8	2.4	3.1
	Farfield (T3)	6.6	9.2	12.8	1.4	2.1	3.0
Longhorn sculpin	Nearfield (T2)	0.6	1.0	1.5	0.4	0.6	0.8
	Farfield (T1)	2.3	3.2	4.5	2.3	3.1	4.1

Species	Sample site	Preoperational monitoring			Operational monitoring		
		Lower 95% CI	Mean	Upper 95% CI	Lower 95% CI	Mean	Upper 95% CI
	Farfield (T3)	4.2	6.1	8.5	4.8	6.4	8.4
Winter flounder	Nearfield (T2)	3.7	5.5	8.0	1.6	2.3	3.1
	Farfield (T1)	2.1	2.8	3.6	3.0	4.0	5.4
	Farfield (T3)	1.1	1.4	1.9	2.7	3.6	4.8
Hake	Nearfield (T2)	0.6	0.9	1.2	0.3	0.4	0.5
	Farfield (T1)	1.3	1.7	2.0	0.4	0.6	0.8
	Farfield (T3)	0.8	1.1	1.4	0.4	0.9	1.4
Atlantic cod	Nearfield (T2)	0.5	0.8	1.2	0.1	0.2	0.4
	Farfield (T1)	1.7	2.6	3.7	0.2	0.3	0.5
	Farfield (T3)	2.6	4.1	6.2	0.8	1.1	1.5
Raja sp.	Nearfield (T2)	0.4	0.6	0.7	0.4	0.7	0.9
	Farfield (T1)	0.8	1.4	2.3	1.6	2.2	2.9
	Farfield (T3)	2.0	2.6	3.2	2.6	3.5	4.7
Windowpane	Nearfield (T2)	0.8	1.2	1.6	0.7	1.0	1.3
	Farfield (T1)	1.1	1.6	2.3	1.4	1.8	2.2
	Farfield (T3)	0.6	0.9	1.4	1.0	1.7	2.6
Rainbow smelt	Nearfield (T2)	2.2	3.2	4.3	0.3	0.5	0.8
	Farfield (T1)	1.6	2.3	3.1	0.4	0.6	0.9
	Farfield (T3)	0.9	1.6	2.5	0.4	0.6	0.8
Ocean pout	Nearfield (T2)	0.6	0.8	1.0	0.2	0.2	0.3
	Farfield (T1)	0.6	0.7	1.0	0.1	0.1	0.2
	Farfield (T3)	1.4	1.8	2.3	0.1	0.2	0.3
Silver hake	Nearfield (T2)	0.0	0.1	0.1	0.0	0.0	0.1
	Farfield (T1)	0.1	0.2	0.4	0.3	0.6	0.9
	Farfield (T3)	0.1	0.2	0.3	0.1	0.3	0.6

Source: (NAI, 2010)

In addition to the decrease in abundance of species over time, NAI (2010) also reported changes in community composition, or the relative abundance of the most common species, over time. Prior to operations, yellowtail flounder was the most abundance species, followed by longhorn sculpin (*Myoxocephalus octodecimspinosus*) and winter flounder (Table 4.5–9). During operations, winter flounder has been the most abundant species, followed by longhorn sculpin, *Raja* spp., windowpane, and yellowtail flounder. NAI (2010) observed similar changes in community composition at all three sampling sites. Sosebee (2006) classifies yellowtail flounder as overfished.

Except for rainbow smelt, winter flounder, and silver hake, changes in species abundance and community structure, prior to and during operations, occurred at both the nearfield and farfield sampling sites. Therefore, for most species, these results suggest that Seabrook operations have not noticeably altered demersal fish populations near Seabrook. However, the abundance of winter flounder and rainbow smelt has decreased to a greater and observable extent near Seabrook's intake and discharge structures compared to 3–4 mi (5–8 km) away. The local decrease suggests that, to the extent local subpopulations exist within 3–4 mi (5–8 km) of the intake and discharge structures, they have been destabilized through operation of Seabrook's cooling water system. Regarding silver hake, specifically, the NRC does not have sufficient information to make a conclusion for this species because NAI (2010) did not test whether the differences in silver hake abundance at the sampling sites were statistically significant; therefore, the NRC cannot make a species-specific conclusion on silver hake.

Pelagic Fish. As described in Section 2.2.6, the geometric mean CPUE for all pelagic fish species peaked in 1977 and has been declining ever since. NAI (1998) observed this trend at nearfield and farfield sampling sites. The National Oceanic and Atmospheric Administration (NOAA) (2006) reported a different trend for principal pelagic species, which included Atlantic herring and Atlantic mackerel, two of the dominant fish in NAI monitoring surveys. NOAA (2006) reported record low biomass for principal pelagic from 1975–1979, an increase in biomass from the mid-1980s–1990s, and slightly declining biomass since 2000.

NAI (1998) reported a change in the community composition, or the relative abundance of the most common species, in the preoperational monitoring compared to monitoring during operations (Table 4.5–10). Prior to operations, the most abundant species were Atlantic herring (1.1 CPUE), blueback herring (*Alosa aestivalis*) (0.3 CPUE), silver hake (0.3 CPUE), pollock (*Pollachius virens*) (0.3 CPUE), and Atlantic mackerel (0.2 CPUE). During operations, the most common fish species were Atlantic herring (0.3 CPUE), Atlantic mackerel (0.3 CPUE), pollock (0.2 CPUE), and blueback herring (0.2 CPUE) (NAI, 1998). Changes in community composition were similar at nearfield and farfield sampling sites.

Table 4.5-10. Geometric mean CPUE (No. per 24-hr surface and bottom net set) and coefficient of variation (CV) during preoperational (1976–1989) and operational monitoring years (1990–1996)

Species	Sample site	Preoperational monitoring		Operational monitoring	
		Mean	CV	Mean	CV
Atlantic herring	Nearfield (G2)	1.1	20	0.2	33
	Farfield (G1)	1.0	18	0.3	22
	Farfield (G3)	1.2	21	0.4	25
Atlantic mackerel	Nearfield (G2)	0.2	15	0.3	29
	Farfield (G1)	0.2	16	0.3	17
	Farfield (G3)	0.3	16	0.3	15
Pollock	Nearfield (G2)	0.3	10	0.3	16
	Farfield (G1)	0.2	17	0.2	18
	Farfield (G3)	0.3	13	0.2	13
Spiny dogfish	Nearfield (G2)	<0.1	35	0.1	41
	Farfield (G1)	<0.1	45	0.1	69
	Farfield (G3)	<0.1	27	0.2	47

Species	Sample site	Preoperational monitoring		Operational monitoring	
		Mean	CV	Mean	CV
Silver hake	Nearfield (G2)	0.2	35	0.1	60
	Farfield (G1)	0.2	34	0.1	40
	Farfield (G3)	0.3	31	0.1	31
Blueback herring	Nearfield (G2)	0.3	18	0.2	26
	Farfield (G1)	0.2	17	0.2	50
	Farfield (G3)	0.3	24	0.2	32
Alewife	Nearfield (G2)	0.1	14	0.1	21
	Farfield (G1)	0.1	17	0.1	34
	Farfield (G3)	0.1	21	0.1	35
Rainbow smelt	Nearfield (G2)	0.1	21	0.1	29
	Farfield (G1)	<0.1	26	0.1	40
	Farfield (G3)	0.1	21	0.1	39
Atlantic cod	Nearfield (G2)	<0.1	22	<0.1	63
	Farfield (G1)	0.1	18	<0.1	53
	Farfield (G3)	0.1	13	<0.1	63

Source: (NAI, 1998)

The abundance of Atlantic herring decreased the most dramatically at nearfield and farfield sampling sites, with a peak geometric mean CPUE of 6.0 in 1978 and remaining below 1.0 since 1980. Using an ANOVA on a BACI design, NAI (1998) determined that this decrease was statistically significant. NOAA (1995) also reported a precipitous decline in the biomass of Atlantic herring in 1978, which was associated with the collapse of the Georges Bank fishery. In the 1980s, fishing by distant-fleet stopped due to new fishery management regulations. From 1982–1994, the stock continued to increase, so much so that the 1994 stock biomass was larger than the pre-collapse biomass levels in the 1960s (NOAA, 1995). NAI (1998) did not observe a similar recovery of Atlantic herring in its monitoring studies.

The abundance of spiny dogfish (*Squalus acanthias*) increased during operations at the nearfield and farfield sampling sites from a geometric mean CPUE of less than 0.1 prior to operations to a CPUE of 0.1 during operations. Using an ANOVA on a BACI design, NAI (1998) determined that this increase was statistically significant. NOAA (1995) also reported an increase in spiny dogfish from 1968–1994, with biomass peaking in 1989. Link and Garrison (2002) attributed the increase in spiny dogfish abundance to the lower populations of other piscivores species that were heavily targeted by commercial fishery operations, such as Atlantic cod and haddock. Currently, spiny dogfish are one of the dominant fish predators in Georges Bank (Link and Garrison, 2002).

Since changes in species abundance, prior to and during operations, occurred at both the nearfield and farfield sampling sites, these results suggest that Seabrook operations have not noticeably altered pelagic fish populations near Seabrook.

<u>Estuarine (Juvenile) Fish</u>. NextEra compared the abundance of estuarine fish in Hampton-Seabrook Harbor prior and during operation at nearfield and farfield sites using an ANOVA on a BACI design. The abundance of the total number of fish was significantly higher

prior to operations when compared to more recent years at the nearfield and farfield sampling stations (NAI, 2010).

NAI (2010) determined that the abundance of the majority of species was higher during preoperational monitoring than during operations (Table 4.5–11). However, NAI (2010) observed a different trend for American sand lance. At the nearfield sampling station (S2), the abundance of American sand lance decreased over time from a mean CPUE of 0.2 prior to operations to 0.1 during operations. At both farfield sampling sites (S1 and S3), the mean CPUE increased from 0.1 prior to operations, to 0.2 and 0.6, respectively, during operations. NAI (2010) did not test if these trends were statistically significant. NHFGD (2010) conducted seine hauls at four sampling sites within the Hampton-Seabrook Estuary and reported the geometric mean CPUE for juvenile American sand lance to range between 1.49–0.0. At sampling sites in estuaries near the Hampton-Seabrook Estuary, the geometric mean CPUE ranged from 2.0–0.0 (NHFGD, 2010).

Table 4.5–11. Geometric mean CPUE (No. per seine haul) and upper and lower 95% CL during preoperational and operational monitoring years

Species	Sample site	Preoperational monitoring			Operational monitoring		
		Lower 95% CI	Mean	Upper 95% CI	Lower 95% CI	Mean	Upper 95% CI
Atlantic silverside	Nearfield (S2)	5.1	6.8	9.1	2.4	3.1	4.1
	Farfield (S1)	5.1	7.2	10.2	3.6	4.8	6.2
	Farfield (S3)	4.0	6.7	10.7	2.1	2.9	3.9
Winter flounder	Nearfield (S2)	0.6	1.0	1.5	0.1	0.2	0.3
	Farfield (S1)	0.6	0.9	1.2	0.2	0.4	0.5
	Farfield (S3)	2.2	3.2	4.4	0.3	0.5	0.7
Killifishes	Nearfield (S2)	0.6	1.2	2.0	0.1	0.2	0.3
	Farfield (S1)	0.8	1.1	1.5	0.5	0.9	1.3
	Farfield (S3)	<0.1	<0.1	0.1	0.1	<0.1	0.1
Ninespine stickleback	Nearfield (S2)	0.3	0.8	1.6	<0.1	0.1	0.1
	Farfield (S1)	0.4	0.7	1.2	0.1	0.2	0.3
	Farfield (S3)	0.3	0.8	1.4	0.1	0.2	0.3
Rainbow smelt	Nearfield (S2)	<0.1	0.2	0.3	0.1	0.1	0.2
	Farfield (S1)	<0.1	0.1	0.2	<0.1	0.1	0.2
	Farfield (S3)	0.3	0.7	1.2	0.1	0.2	0.4
American sand lance	Nearfield (S2)	0.0	0.2	0.5	0.0	0.1	0.1
	Farfield (S1)	<0.1	0.1	0.2	0.1	0.2	0.3
	Farfield (S3)	<0.1	0.1	0.2	0.3	0.6	0.9
Pollock	Nearfield (S2)	<0.1	0.2	0.3	0.0	<0.1	<0.1
	Farfield (S1)	<0.1	0.1	0.2	<0.1	<0.1	<0.1
	Farfield (S3)	0.1	0.4	0.8	<0.1	0.1	0.1
Blueback herring	Nearfield (S2)	<0.1	0.1	0.1	<0.1	0.1	0.1
	Farfield (S1)	0.1	0.2	0.3	0.1	0.3	0.4

Species	Sample site	Preoperational monitoring			Operational monitoring		
		Lower 95% CI	Mean	Upper 95% CI	Lower 95% CI	Mean	Upper 95% CI
	Farfield (S3)	<0.1	0.1	0.3	<0.1	<0.1	0.1
Atlantic herring	Nearfield (S2)	0.1	0.3	0.5	<0.1	<0.1	0.1
	Farfield (S1)	0.0	0.1	0.5	0.1	0.2	0.3
	Farfield (S3)	0.1	0.1	0.2	<0.1	0.1	0.2
Alewife	Nearfield (S2)	0.0	0.1	0.2	<0.1	<0.1	<0.1
	Farfield (S1)	<0.1	0.1	0.2	0.1	0.2	0.4
	Farfield (S3)	<0.1	0.1	0.1	0.0	0.1	0.2

Source: (NAI, 2010)

Since changes in community composition and the abundance for most species, prior to and during operations, occurred at both the nearfield and farfield sampling sites, these results suggest that Seabrook operations have not noticeably altered estuarine fish populations near Seabrook. Regarding the American sand lance, specifically, the NRC does not have sufficient information to make a conclusion for this species because NAI (2010) did not test whether the differences in American sand lance abundance at the sampling sites were statistically significant; therefore, the NRC cannot make a species-specific conclusion on American sand lance.

Invertebrates

NextEra compared the number of taxa and total density of invertebrates prior and during operation at nearfield and farfield sites using an ANOVA on a BACI design (NAI, 2010). NextEra examined patterns of species richness as an indicator of community stability and total density as an indicator of fluctuations in the abundance of dominant organisms (NAI, 2010). NAI (2010) observed significantly more taxa prior to than during operations at both sampling sites. Species richness was 12–20 percent lower during operational monitoring. NAI (2010) did not observe significant changes in total invertebrate density prior to and during operations or between the nearfield and farfield shallow subtidal sampling sites. At the mid-depth sampling sites, NAI (2010) did not observe significant changes in total number of taxa or invertebrate density prior to and during operations or between the nearfield and farfield shallow subtidal sampling sites.

NAI (2010) used multivariate community analysis techniques, such as MDS plots, to examine changes in community composition, or the relative density of common species, prior to and during operations at the nearfield and farfield sites. MDS plots at the shallow subtidal sampling stations suggest that species composition was relatively similar between the two sites, especially when samples were grouped by date—before or after 1995. Prior to 1995, the herbivorous snail, *Lacuna vincta*, was the most common species, followed by Mytillid spat (the larval stage of mussels) and the isopod *Idotea phosphorea*. After 1995, *L. vincta* was still the most common species, but *I. phosphorea* was more common than Mytilidae spat. NAI (2010) observed this trend at both the nearfield and farfield shallow subtidal sampling stations.

Noncolonial macroinvertebrate community composition was slightly less similar at the mid-depth subtidal samplings stations. NAI (2010) classified monitoring samples into three groups of similar community composition—prior to 1994 at both sampling stations, after 1995 at the nearfield sampling station, and after 1995 at the farfield station (NAI, 2010). In all groups, Mytillid spat was the most common biological group, but the relative abundance of other taxa varied among the three groups. The change in community composition after 1995 may be related to the change in macroalgae biomass over time (NAI, 2010).

NextEra compared the density of selected invertebrate species prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design (NAI, 2010). NAI (2010) did not observe significant differences prior to and during operations or between the nearfield and farfield sampling sites for mytillid spat, northern horse mussels, sea stars, and the green sea urchin.

<u>Crabs</u>. NextEra compared the abundance of rock crab (*Cancer irroratus*) and Jonah crab (*Cancer borealis*) larvae, juveniles, and adults prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design (NAI, 2010). NAI (2010) did not observe significant differences in the abundance of crab larvae or juvenile and adult Jonah crab prior to and during operations or between sampling sites.

<u>Lobsters</u>. NextEra compared the abundance of lobster larvae, juveniles, and adults prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design (NAI, 2010). The geometric mean abundance of lobster larvae, and all lobsters found in traps, was significantly higher during operations compared to prior to operations at all sites. Incze, et al. (2000) also observed an increase in lobster larval in the Gulf of Maine. Fogarty (1988) conjectured that this regional increase might be related to higher water temperatures. Zhang and Chen (2007) built a conceptual model that indicated that increases in the juvenile and adult lobster population might be related to lobster bait as a supplemental food source. In addition, the recent decline in many groundfish species has influenced the increases in crustaceans, such as lobsters and crabs, due to less predation and less competition for prey (Zhang and Chen, 2007).

However, NAI (2010) found that the geometric mean abundance of lobsters of legal-size for commercial harvesting was significantly higher prior to operations. During operations, legal-sized lobsters comprised approximately 3–4 percent of total lobsters caught, whereas prior to operations, legal-sized lobsters comprised approximately 7–8 percent of the total lobsters caught. The legal-size limit for commercial lobsters has changed several times since monitoring began near Seabrook. In 1984, the legal-size carapace length increased from $3\ {}^{1}/_{8}$ inches (in.) (79 millimeters (mm)) to $3\ {}^{3}/_{16}$ in. (81 mm). In 1989, it increased to $3\ {}^{7}/_{32}$ in. (82 mm), and in 1990 (when Seabrook started operations), it increased to $3\ {}^{1}/_{4}$ in. (83 mm). The change in the legal-size to commercially harvest lobsters may, in part, explain the decline in legal-sized lobsters during the operational period. Females comprised between 53–55 percent of the total catch, which remained relatively constant at all sampling stations over time.

NextEra conducted impingement studies for lobsters, as described in Section 4.5.2. Lobster impingement ranged from 0 in 2000 to 77 in 2005 (NAI, 2010). The average annual lobster impingement from 1990–2009 was 15.9 per year (NAI, 2010).

<u>Soft Shell Clams</u>. NextEra compared the abundance of soft shell clam (*Mya arenaria*) larvae; YOY, 1-25 mm; seed clams, 1-12 mm; yearlings, 26-50 mm; and adults, greater than 50 mm (generally at least 2 years of age (Brousseau, 1978)) prior to and during operation using an ANOVA (NAI, 2010). NAI (2010) did not observe significant differences in the abundance of larvae, YOY, or adults prior to and during operations. In the Hampton-Seabrook Estuary, the geometric mean clam density was significantly lower during operations than prior to operations for yearlings (1.0 vs. 3.9) (NAI, 2010).

NAI (2010) compared the density of seed clams in the Hampton-Seabrook Estuary and Plum Island Sound from 1987–2009. NAI (2010) reported no significant difference between site or time periods.

Green crabs, which are an introduced species, are a major source of clam predation (Glude, 1955; Ropes, 1969). NAI (2010) examined the relationship between green crab density and clam density and found that green crab density explained 17 percent of the variation in clam density at one clam flat but did not explain the variation at two other clam flats.

Macroaglae

NextEra compared the number of taxa and total biomass of macroalgae prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design (NAI, 2010). NAI (2010) observed significantly more taxa at the farfield shallow subtidal site (B35) compared to the nearfield shallow subtidal site (B17). However, there was no significant difference prior to and during operations. NAI (2010) did not observe significant changes in biomass prior to and during operations or between the nearfield and farfield shallow subtidal sampling sites.

At the mid-depth sampling sites, NAI (2010) observed significantly more taxa at the farfield site (B31) during operations than prior to operations, whereas there was no significant change at the nearfield site (B19). Algal biomass was significantly greater prior to operations than during operations, but NAI (2010) did not observe a significant difference between the nearfield and farfield sampling sites.

NAI (2010) used multivariate community analysis techniques, such as MDS plots, to determine changes in community composition prior to and during operations at the nearfield and farfield sites. MDS plots indicated high levels of similarity (approximately 75 percent) over time at nearfield and farfield shallow subtidal sampling sites, except for 2 sampling years. MDS plots indicated that samples with the most similar taxa were not consistently grouped by sampling site or year (NAI, 2010). At the mid-depth sampling sites, MDS plots indicated lower levels of similarity (approximately 70 percent). MDS plots indicated that samples with the most similar taxa were grouped by sampling site, although no clear pattern was obvious with preoperational and operational samples (NAI, 2010). This suggests that the community structure differed by site, but, at each site, there was no clear pattern of changing community structure prior to and during operations.

NextEra compared the biomass of selected macroalgae species prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design (NAI, 2010). Irish moss is one of the most common understory, red algae in the vicinity of Seabrook, and it comprised at least half of the biomass in Seabrook monitoring samples in the shallow subtidal. NAI (2010) did not observe significant differences in Irish moss biomass prior to and during operations or between sampling sites.

NAI (2010) observed significant changes in kelp density prior to and during operations (Table 4.5–12). NAI (2010) reported significantly higher *Laminaria digitata* density prior to than during operations. In the shallow and the mid-depth subtidal, the decline at the nearfield sampling site was significantly greater than the decline at the farfield station. In the nearfield mid-depth sampling site (B19), NAI (2010) did not identify *L. digitata* in 2008 or 2009. The density of *Agarum clathratum*, which competes with *L. digitata*, significantly increased over time in the mid-depth sampling stations, and density was significantly higher at the nearfield site (NAI, 2010).

Table 4.5-12. Kelp density (No. per 100 m^2) and upper and lower 95% CL during preoperational and operational monitoring years

Kelp	Sample site	Preoperational monitoring			Operational monitoring		
		Lower 95% CI	Mean	Upper 95% CI	Lower 95% CI	Mean	Upper 95% CI
L. digitata	Nearfield shallow (B17)	140.6	213.9	287.3	5.3	15.2	25.2
	Farfield shallow (B35)	96.5	155.8	215.1	52.3	73.9	95.6
	Nearfield mid-depth (B19)	81.5	139.9	198.3	3.1	7.5	11.9
	Farfield mid-depth (B31)	401.6	500.2	598.7	106.0	157.7	209.5
Sea belt	Nearfield shallow (B17)	270.7	415.1	559.4	66.1	137.9	209.7
	Farfield shallow (B35)	210.9	325.7	440.5	247.8	326.0	404.2
	Nearfield mid-depth (B19)	2.0	59.1	116.3	1.5	10.1	18.7
	Farfield mid-depth (B31)	59.6	95.5	131.5	29.3	48.2	68.2
A. esculenta	Nearfield mid-depth (B19)	0.0	2.4	7.2	0.3	2.3	4.2
	Farfield mid-depth (B31)	19.9	75.2	130.5	20.3	40.0	59.6
A. clathratum	Nearfield mid-depth (B19)	613.5	786.6	959.6	792.2	955.2	1,118.1
	Farfield mid-depth (B31)	280.2	366.4	452.6	407.3	503.6	599.9

Source: (NAI, 2010)

In the shallow subtidal, sea belt (*Saccharina latissima*) density was significantly lower during operations at the nearfield site, but there was no significant change at the farfield site (NAI, 2010). In the mid-depth subtidal, sea belt density significantly decreased at both sampling sites (NAI, 2010). In the mid-depth subtidal, *Alaria esulenta* significantly declined during operations at the farfield site and remained at a low density at the nearfield site prior to and during operations (NAI, 2010). NAI (2010) did not identify *A. esulenta* at the nearfield sampling station over the past 4 years.

Since the decrease in *L. digitata* density was significantly greater at the nearfield sites, and since sea belt density was lower during operations at the nearfield site but not at the farfield site in the shallow subtidal, these results suggest that the local population of *L. digitata* and sea belt has been destabilized through operation of Seabrook's cooling water system.

Summary of Combined Effects

The NRC staff reviewed Seabrook monitoring data to evaluate the impacts from Seabrook cooling water system on aquatic resources. NRC concludes that the impact from operation of the Seabrook cooling water system on phytoplankton, zooplankton, invertebrates, and most fish species is SMALL since monitoring data suggest that operations has not noticeably altered these aquatic communities near Seabrook.

For winter flounder and rainbow smelt, specifically, the NRC staff concludes that the impact is LARGE since the abundance of winter flounder and rainbow smelt has decreased to a greater and observable extent near Seabrook's intake and discharge structures compared to 3–4 mi (5–8 km) away. The local decrease suggests that, to the extent local subpopulations exist within 3–4 mi (5–8 km), they have been destabilized through operation of Seabrook's cooling water system.

For macroalgae, specifically, the NRC staff concludes that the impact from operation of the Seabrook cooling system is LARGE for *L. digitata* and sea belt since the abundance of these species has decreased to a greater and observable extent near Seabrook's intake and discharge structures compared to 3–4 mi (5–8 km) away. The local decrease suggests that, to the extent local subpopulations exist within 3–4 mi (5–8 km), they have been destabilized through operation of Seabrook's cooling water system.

4.6 Terrestrial Resources

The issues related to terrestrial resources applicable to Seabrook are listed in Table 4.6-1. There are no Category 2 issues related to terrestrial resources. The NRC staff did not identify any new and significant information during the review of the applicant's ER (NextEra, 2010), the NRC staff's site audit, the scoping process, or the evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4.6-1. Terrestrial resources issues

Section 2.2.7 provides a description of the terrestrial resources at Seabrook and in the surrounding area.

Issues	GEIS section	Category
Cooling tower impacts on crops & ornamental vegetation	4.3.4	1
Cooling town impacts on native plants	4.3.5.1	1
Bird collisions with cooling towers	4.3.5.2	1
Power line ROW management (cutting herbicide application)	4.5.6.1	1
Bird collisions with power lines	4.5.6.1	1
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3	1
Floodplains & wetland on power line ROW	4.5.7	1

4.7 Protected Species and Habitats

This site-specific, or Category 2 issue, requires consultation with the appropriate agencies to determine if threatened or endangered species are present and if they would be adversely affected by continued operation of Seabrook during the license renewal term. The characteristics and habitats of threatened and endangered species (Table 4.7-1) in the vicinity of the Seabrook site are discussed in Section 2.2.8 of this SEIS.

Protected aquatic species and protected terrestrial species are discussed separately in the following sections.

Table 4.7-1. Threatened or endangered species

Section 2.2.8 describes the threatened or endangered species on or near Seabrook.

Issue	GEIS section	Category
Threatened or endangered species	4.1	2

4.7.1 Protected Aquatic Species

Section 2.2.8 of this document describes the threatened or endangered species on or near Seabrook. The impact to threatened and endangered species is a Category 2 issue, and it is discussed below.

The sections below describe potential impacts to Endangered Species Act (ESA)-listed and proposed species, species protected under the Marine Mammal Protection Act (MMPA), NMFS species of concern, and species of concern for the States of New Hampshire and Massachusetts that may occur along transmission corridors. An assessment of impacts to EFH is provided in Appendix D-1.

ESA-listed and Proposed Species

Three whale species, three sea turtle species, and two fish species, that are protected under the ESA or proposed for listing under the ESA, could occur within the vicinity of Seabrook.

Whales. Northern right whales (*Eubalaena glacialis*), humpback whales (*Megatera novaeangliae*), and fin whales (*Balaenoptera physalus*) are Federally endangered species that inhabit waters off the coast of New Hampshire (NMFS, 2010). These species are not likely to occur in the vicinity of the Seabrook facility or the facility's intake or discharge structures since these species generally inhabit deeper waters (NMFS, 2010). There are no known occurrences of Seabrook operations affecting whales.

Turtles. Three species of sea turtles—loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and leatherback (*Dermochelys coriacea*)—regularly occur in the Gulf of Maine (Thompson, 2010). Under ESA, the leatherback and Kemp's ridley sea turtles are listed as endangered species, and the loggerhead sea turtle is listed as threatened. Leatherback turtles and loggerhead turtles would be most likely to be seasonally present off the coast of New Hampshire and occasionally within the vicinity of Seabrook, including the intake and discharge structures (NMFS, 2010). It is less likely for Kemp's ridley sea turtle to be present in the vicinity of Seabrook (NMFS, 2010). NextEra has not documented any known occurrences of Seabrook operations affecting turtles. In addition, the installment of additional vertical bars on the intake structure as part of the seal deterrent barrier should also help prevent any future incidental takes (NextEra, 2010c).

Fish. NMFS (2010) proposed listing the population of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the Gulf of Maine as a threatened species. Atlantic sturgeon currently occurs in coastal waters off the coast of New Hampshire and is likely to occur within the vicinity of Seabrook (NMFS, 2010). Seabrook monitoring data indicate that operation of the cooling system is not likely to affect Atlantic sturgeon. For example, Seabrook captured a single Atlantic sturgeon during gill-net monitoring studies from 1976–1997 (NextEra, 2010c). Seabrook did not report impingement or entrainment of any Atlantic sturgeon since operations began in 1990 (NextEra, 2010c; NAI, 2010).

The shortnose sturgeon (*Acipenser brevirostrum*) is Federally listed as endangered throughout its range (NMFS, 1998). The shortnose sturgeon has not been observed in New Hampshire since 1971 (NHFGD, 2005). Seabrook has not captured any shortnose sturgeon within monitoring, entrainment, or impingement studies since studies began in 1975 (NextEra, 2010c).

Conclusion for ESA Species. The NRC staff has evaluated the eight Federally listed or proposed species by examining the known distributions and habitat ranges of those species, the potential ecological impacts of the operation of Seabrook on the species, and the studies and mitigation measures that Seabrook employs to protect the species. Seabrook has ongoing ecological studies and monitoring systems in place to evaluate the impact of the facility on

Federally listed aquatic organisms, and it has not observed any takes of any Federally endangered or threatened species. The NRC staff concludes that continued operation of Seabrook during the license renewal term is not likely to adversely affect any Federally listed marine aquatic species. Therefore, NRC did not prepare a biological assessment for any of these species.

Marine Mammal Protection Act

All marine mammals are protected under the MMPA of 1972, as amended. As described above, and in Section 2.2.8, most whales and dolphins are not likely to occur near Seabrook. In addition, there are no known occurrences of Seabrook affecting whales or dolphins (NextEra, 2010).

Seals are likely to occur within the vicinity of Seabrook (NextEra, 2010). From 1993–1998, approximately 55 seals drowned in the intake tunnels. Although NextEra did not observe the drowning, the applicant conjectured that the seals likely swam into the intake structure and became trapped inside (NextEra, 2010c). The downward flow of the water likely transported the seals to the forebay over a period of approximately 80 minutes (NOAA, 2004). Drowned seals were primarily harbor seals (*Phoca vitulina*), although NextEra also discovered the remains of gray seals (*Halichoerus grypus*), harp seals (*P. groenlandica*), and hooded seals (*Cystophora cristata*) (NextEra, 2010).

After NextEra discovered the seal remains, NOAA Fisheries issued an incidental take statement for marine mammals at Seabrook in June 1999 (NOAA, 2004). In August 1999, Seabrook installed a seal deterrent barrier, which included additional vertical barriers on each of the three intake structures. The additional vertical bars reduced the space between bars to less than 5 in. (13 cm) (NOAA, 2004). Since the installment of the seal deterrent barrier, no seals have been trapped at Seabrook (NextEra, 2010).

In May 2004, NOAA Fisheries reviewed Seabrook's application for renewal of NOAA Fisheries regulations governing incidental takes of marine mammals and determined that the cause of the earlier incidental takes had been eliminated and that the potential for injury or mortality had been significantly reduced. Therefore, NOAA Fisheries determined that an incidental take authorization was no longer necessary under the improved operating conditions at Seabrook (NOAA, 2004).

Since the installment of the seal deterrent barrier, there are no known occurrences of Seabrook operations affecting any marine mammals.

NMFS Species of Concern

<u>Rainbow Smelt</u>. NextEra compared the abundance of rainbow smelt prior to and during operation at nearfield and farfield sites using an ANOVA on a BACI design (see Section 4.5.5). NAI (2010) reported a significant decrease over time in the abundance of rainbow smelt at all trawling stations in the Gulf of Maine; however, the decrease was significantly greater at the nearfield trawling station in the Gulf of Maine (T2) (see Table 4.5-9). Rainbow smelt is a cold-water species; therefore, the decrease near the intake and discharge structures could be a combination of impingement and avoidance of thermal effluent.

In the Hampton-Seabrook Estuary, the mean geometric abundance prior to (0.3 CPUE) and during (0.2 CPUE) operations was not significantly different (Table 4.5–11) (NAI, 2010). NHFGD (2010) conducted similar monitoring for juvenile rainbow smelt within the Hampton-Seabrook Estuary and reported a geometric mean CPUE in 2009 of 2.12 at 1 sampling station and 0.0 at 3 other sampling stations. NHFGD (2010) reported similar abundances, between 2.04–0.0 geometric mean CPUE, at 3 other nearby estuaries. From

1997–2009, the abundance of rainbow smelt at the 4 New Hampshire estuaries peaked in 2000 at 1.5 geometric mean CPUE and has been declining ever since (NHFGD, 2010).

NAI (2010) reported entrainment of about 100,000 rainbow smelt eggs in 1996. NextEra did not observe entrainment during any other years. Rainbow smelt spawn in freshwater and eggs are adhesive, which means it is unlikely eggs would travel offshore to the intake structures. The cooling system entrained rainbow smelt larvae during most years, which averaged 460,000 entrained larvae per year.

Rainbow smelt was the sixth most impinged species at Seabrook. On average over years 1990 to 2009, the cooling water system impinged 1,093 rainbow smelt per year (NAI, 2010).

Blueback Herring. NAI (2010) observed relatively stable blueback herring abundance prior to and during operations from pelagic monitoring data in the Gulf of Maine and monitoring data in the Hampton-Seabrook Harbor. NHFGD (2010) conducted similar monitoring for juvenile blueback herring within the Hampton-Seabrook Estuary and did not find any blueback herring in 2009. NHFGD (2010) reported slightly higher abundances, between 2.43–0.0 geometric mean CPUE, at 3 other nearby estuaries. From 1997–2009, the abundance of blueback herring at the four New Hampshire estuaries peaked in 1999 at 0.97 geometric mean CPUE and has been declining ever since (NHFGD, 2010).

NAI (2010) did not observe entrainment of blueback herring eggs or larvae. Blueback herring spawn in freshwater; therefore, eggs and larvae are most likely to occur in fresh or estuarine waters. On average from years 1990 to 2009, the cooling system impinged 129 blueback herring per year.

Alewife. When comparing the abundance of alewife (*Pomolobus pseudoharengus*) prior to and during operations, NAI (2010) reported a slight decrease at the nearfield site (0.1–less than 0.1 CPUE), a slight increase at one of the farfield sites (0.1–0.2 CPUE), and constant levels at the other farfield site (0.1 CPUE). NAI (2010) did not report the significance of these trends. NHFGD (2010) conducted similar monitoring for juvenile alewife within the Hampton-Seabrook Estuary and did not find any alewife in 2009. NHFGD (2010) reported higher abundances, between 0.62–0.0 geometric mean CPUE, at 3 other nearby estuaries. From 1997–2009, the abundance of alewife at the 4 New Hampshire estuaries have varied annually between 0.04–0.34 CPUE (NHFGD, 2010).

NAI (2010) did not observe entrainment of alewife eggs or larvae. Alewife spawn in freshwater; therefore, eggs and larvae are most likely to occur in fresh or estuarine waters. On average, the cooling system impinged 342 alewife per year.

Aquatic Species of Special Concern along Transmission Lines. Along the transmission lines, the banded sunfish (*Enneacanthus obesus*) and redfin pickerel (*Esox americanus americanus*), two species of fish listed as species of special concern by the State of New Hampshire, may occur in Rockingham and Hillsborough Counties, NH (NHNHB, 2009; NHNHB, 2010; NHNHB, 2011). The eastern pond mussel (*Ligumia nasuta*), which is listed as a species of special concern by the States of New Hampshire and Massachusetts, may occur in the vicinity of the transmission lines in Hillsborough and Rockingham Counties, NH, and Amesbury County, MA (MDFW, 2009; MFGD, 2010; NHNHB, 2010; NHNHB, 2011).

As described in Section 2.1.3, within wetlands, Public Service Company of New Hampshire (PSNH) follows the New Hampshire Department of Resources and Economic Development (NHDRED)'s *Best Management Practices Manual for Utility Maintenance In and Adjacent to Wetlands and Waterbodies in New Hampshire* (NHDRED, 2010). Because PSNH does not use herbicides within New Hampshire ROWs or any mechanized vehicles within designated wetlands and wet areas, and because PSNH workers are trained to recognized Federally or

State-protected species (see Section 2.1.3), species within the New Hampshire ROWs are not expected to be adversely affected during the proposed license renewal term.

Because National Grid is prohibited from using herbicides within State-designated priority habitat without prior written approval within the Commonwealth of Massachusetts per 321 CMR 10.14(12), the Massachusetts Department of Fish and Game (MDFG) approves National Grid's yearly operation plan to ensure that vegetative maintenance practices are not adversely affecting sensitive species or wetlands. Additionally, National Grid workers are trained to recognize and avoid impacts to Federally or State-listed species (See Section 2.1.3). NRC staff expects no adverse impacts to species within Massachusetts ROWs during the proposed license renewal term.

Conclusion for Aquatic Species

The NRC staff has evaluated the eight Federally listed or proposed species and six additional species of special concern that could be present in the vicinity of Seabrook or associated transmission lines. In its evaluation, NRC staff examined the known distributions and habitat ranges of those species, the ecological impacts of the operation of Seabrook on the species, and the studies and mitigation measures that NextEra employs to protect the species. NextEra has ongoing ecological studies and monitoring systems in place to evaluate the impact of the facility on aquatic organisms and has not observed any interactions with any Federally endangered or threatened species or species of concern along transmission lines. Since the installment of the seal deterrent barrier, there are no known occurrences of Seabrook operations affecting any marine mammals. Monitoring data for alewife and blueback herring indicate that the operation of Seabrook is not likely to adversely affect these species. Thus, the staff concludes that the impact on protected marine aquatic species from an additional 20 years of operation would be SMALL for most species.

As explained in Section 4.5.2, the NRC staff concludes that the impact on rainbow smelt for an additional 20 years of operations is LARGE due to the relatively high impingement rates and since the abundance of rainbow smelt has decreased to a greater and observable extent near Seabrook's intake and discharge structures compared to further away. The local decrease suggests that, to the extent a local subpopulation exists, it has been destabilized through operation of Seabrook's cooling water system.

4.7.2 Terrestrial Species

In order to identify impacts to terrestrial protected species, the NRC staff contacted applicable Federal and State agencies to gather information, reviewed ecological studies and records of endangered species occurrences near the Seabrook site, and reviewed information provided in the applicant's ER (NextEra, 2010).

Federally Listed Species

The NRC contacted the U.S. Fish and Wildlife Service (USFWS) on July 16, 2010, to request a list of threatened and endangered species that may occur on, or in the vicinity of, the Seabrook site that would have the potential to be affected by the proposed license renewal (NRC, 2010). In response to this request, on September 1, 2010, the USFWS noted that the Federally listed piping plover (*Charadrius melodus*) and roseate tern (*Sterna dougallii*) are known to occur along the Atlantic coast beaches east of the Seabrook site, but their presence on, or in the immediate vicinity of, the Seabrook site is unlikely (USFWS, 2010). These species are described in detail in Section 2.2.8.2. The USFWS concluded that the proposed license renewal of Seabrook is not likely to adversely affect any Federally listed species subject to the USFWS's jurisdiction (USFWS, 2010).

Because no Federally listed threatened or endangered terrestrial species are known to occur on the Seabrook site, operation of Seabrook and its associated transmission lines is not expected to adversely affect any Federally threatened or endangered terrestrial species during the license renewal term.

New Hampshire-Listed Species

Section 2.2.8.2 describes 13 State-listed plant species that are known to occur on the Seabrook site or within the surrounding area. Because no major construction activities or changes to maintenance procedures would occur during the proposed license renewal term, these species would continue to be unaffected by Seabrook operation.

Four bird species—the willet (*Tringa semipalmata*), horned lark (*Eremophila alpestris*), osprey (*Pandion haliaetus*), and common tern (*Sterna hirundo*)—are known to occur on, or in the vicinity of, the Seabrook site (see Section 2.2.8.2). The willet may use the Seabrook site as marginal foraging habitat, but is likely to restrict its use to the mussel beds and mud flats within the salt marshes along the eastern border of the Seabrook site, which would be unaffected by the proposed license renewal. The horned lark and osprey may occasionally pass through the Seabrook site but are not known to nest or winter on the site and are, therefore, unlikely to be affected by the proposed license renewal. The common tern may use the Seabrook site for marginal foraging and breeding habitat, but is more likely to be found along the Atlantic coastline where it would have access to open, bare ground or beach. Like the willet, its use of the Seabrook site would be restricted to the salt marshes along the eastern border of the Seabrook site and would be unaffected by the proposed license renewal.

Concerning State-listed species along the in-scope transmission lines within New Hampshire, because PSNH does not use herbicides within New Hampshire ROWs or any mechanized vehicles within designated wetlands; and wet areas and PSNH workers are trained to recognized Federally or State-protected species, species within the New Hampshire ROWs are not expected to be impacted during the proposed license renewal term.

Massachusetts-Listed Species

Section 2.2.8.2 notes the existence of priority or estimated habitat for bald eagle (*Haliaeetus leucocephalus*), Blanding's turtle (*Emydoidea blandingii*), wood turtle (*Glyptemys insculpta*), blue-spotted salamander (*Ambrystoma laterale*), and five species of dragonflies along the Massachusetts portion of the in-scope transmission line ROWs. Because herbicides are prohibited within State-designated priority habitat without prior written approval within the Commonwealth of Massachusetts per 321 CMR 10.14(12), National Grid's yearly operation plan is approved by the MDFG's Division of Fish and Wildlife to ensure that vegetative maintenance practices are not adversely affecting sensitive species or wetlands; and National Grid workers are trained to recognize and avoid impacts to Federally or State-listed species, no impacts to Massachusetts-listed species are expected during the proposed license renewal term.

Conclusion

The NRC staff concludes that the adverse impacts to threatened and endangered species during the license renewal term would be SMALL. A potential mitigation measure that could further reduce this SMALL impact would be for NextEra to report existence of any Federally or State-listed endangered or threatened species within or near the transmission line ROWs to the NHNHB, NHFGD, MDFG, or USFWS (or all of the above), as applicable, if any such species are identified during the renewal term. In particular, if any evidence of injury or mortality of migratory birds, State-listed species, or Federally listed threatened or endangered species is observed within the corridor during the renewal period, coordination with the appropriate State or Federal agency would minimize impacts to the species and, in the case of Federally listed species, ensure compliance with the ESA.

4.8 Human Health

The human health issues applicable to Seabrook are discussed below and listed in Table 4.8-1 for Category 1, Category 2, and uncategorized issues.

Table 4.8-1. Human health issues

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 contains more information on these issues.

Issues	GEIS section	Category
Radiation exposures to the public during refurbishment	3.8.1[a]	1
Occupational radiation exposures during refurbishment	3.8.2[a]	1
Microbiological organisms (occupational health)	4.3.6	1
Microbiological organisms (public health, for plants using lakes or canals or discharging small rivers)	4.3.6[b]	2
Noise	4.3.7	1
Radiation exposures to public (license renewal term)	4.6.2	1
Occupation radiation exposures (license renewal term)	4.6.3	1
Electromagnetic fields—acute effects (electric shock)	4.5.4.1	2
Electromagnetic fields—chronic effects	4.5.4.2	Uncategorized

[a] Issues apply to refurbishment, an activity that Seabrook does not plan to undertake.

[b] Issue applies to plant features such as cooling lakes or cooling towers that discharge to small rivers. The issue does not apply to Seabrook.

4.8.1 Generic Human Health Issues

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, applicable to Seabrook in regard to radiological impacts, are listed in Table 4.8-2. NextEra stated in its ER (NextEra, 2010) that it was aware of one new radiological issue associated with the renewal of the Seabrook operating license—elevated tritium concentrations in groundwater adjacent to Unit 1. The groundwater monitoring for tritium is discussed later in this section. The NRC staff determined that the issue, while new, is not significant. Section 4.10 contains the discussion of this issue. The NRC staff has not identified any new and significant information, beyond this issue identified by the applicant, during its independent review of NextEra's ER, the site visit, the scoping process, or its evaluation of other available information.

Table 4.8-2. Category 1 issues applicable to radiological impacts of normal operations during the renewal term

Issue—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS section
Human health	
Radiation exposures to public (license renewal term)	4.6.2
Occupational radiation exposures (license renewal term)	4.6.3

According to the GEIS, the impacts to human health are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted (Category 1 issues). These impacts are expected to remain SMALL through the license renewal term.

4.8.1.1 Radiological Impacts of Normal Operations

The NRC staff has not identified any new and significant information, beyond the tritium issue identified by the applicant in its ER, during its independent review of NextEra's ER, the site audit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

Radiation exposures to public (license renewal term). Based on information in the GEIS, the NRC determined that radiation doses to the public will continue at current levels associated with normal operations.

Occupational exposures (license renewal term). Based on information in the GEIS, the NRC determined 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 identified no information that was both new and significant on this issue during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to radiological impacts of routine operations. The information presented below is a discussion of selected radiological programs conducted at Seabrook.

4.8.1.2 Seabrook Radiological Environmental Monitoring Program

Seabrook conducts a Radiological Environmental Monitoring Program (REMP) to assess the radiological impact, if any, to its employees, the public, and the environment around the plant site. An annual radiological environmental operating report is issued with a discussion of the results of the REMP. The report contains data on the monitoring performed for the most recent years and graphs, which show data trends from prior years and, in some cases, provides a comparison to pre-plant operation baseline data. The REMP provides measurements of radiation and of radioactive materials for the exposure pathways and the radionuclides, which lead to the highest potential radiation exposures to the public. The REMP supplements the Radioactive Effluent Monitoring Program by verifying that any measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than those calculated using the radioactive effluent release measurements and transport models.

The objectives of the REMP are as follows:

- to provide an indication of the appearance or accumulation of any radioactive material in the environment caused by the operation of the nuclear power 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
- 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

The REMP provides an independent mechanism for determining the levels of radioactivity in the environment to ensure that any accumulation of radionuclides released into the environment will not become significant as a result of station operations. While in-plant radiation monitoring programs are used to ensure that the dose to members of the public from radioactive effluents are within the dose limits in 10 CFR Part 20 and the As Low As Is Reasonably Achievable (ALARA) design criteria in Appendix I to 10 CFR Part 50, the REMP provides direct verification of any environmental impact that may result from plant effluents.

An annual radiological environmental operating report is issued, which contains numerical data and a discussion of the results of the monitoring program for the past year. The REMP collects samples of environmental media in order to measure the radioactivity levels that may be present. The locations of most monitoring stations have been selected based on an exposure pathway analysis. The exposure pathway analysis considers factors such as weather patterns, anticipated radioactive emissions, likely receptors, and land use in the surrounding areas. Samples collected from monitoring stations located in areas that are likely to be influenced by Seabrook operation are used as indicators. Samples collected from locations that are not likely to be influenced by Seabrook operation serve as controls. Results from indicator monitoring stations are compared to the results from control monitoring stations and results obtained during the previous operational and preoperational years of the program in order to assess the impact Seabrook operation may be having on the environment. The media samples are representative of the radiation exposure pathways that may affect the public. The REMP measures the aquatic, terrestrial, and atmospheric environment for radioactivity, as well as the ambient radiation. Ambient radiation pathways include radiation from radioactive material inside buildings and plant structures and airborne material that may be released from the plant. In addition, the REMP measures background radiation (i.e., cosmic sources, global fallout, and naturally-occurring radioactive material, including radon). Thermoluminescent dosimeters (TLDs) are used to measure ambient radiation. The atmospheric environmental monitoring consists of sampling and analyzing the air for particulates and radioiodine. Terrestrial environmental monitoring consists of analyzing samples of local vegetable crop, groundwater, plant discharge water, storm drain water, sanitary waste water, sediment, vegetation, and milk. The aquatic environmental monitoring consists of analyzing samples of seawater, Irish moss, fish, lobsters, and shellfish. An annual land use census is conducted to determine if the REMP needs to be revised to reflect changes in the environment or population that might alter the radiation exposure pathways. Seabrook has an onsite Groundwater Protection Program designed to monitor the onsite plant environment near the reactor building for early detection of leaks from plant systems and pipes containing radioactive liquid (NextEra, 2010). Additional information on the Groundwater Protection Program is contained later in this section and in the Groundwater Quality section in Chapter 2, section 2.2.4 of this document.

The NRC staff reviewed Seabrook's annual radiological environmental operating reports for 2005–2009 to look for any significant impacts to the environment or any unusual trends in the data (FPLE, 2006a; FPLE, 2007a; FPLE, 2008a; NextEra, 2009b; NextEra, 2010b). A 5-year period provides a representative data set that covers a broad range of activities that occur at a nuclear power plant such as refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities.

Below is a summary of the results reported by NextEra in Seabrook's 2009 annual radiological environmental operating report.

Direct Radiation. Offsite direct radiation monitoring results are consistent with previous years. The 2009 results indicate no measurable dose contribution due to plant operations at locations outside the Seabrook controlled area or any detectable onsite exposures where members of the public are permitted.

Airborne Particulate and Iodine. The Air Particulate Sampling Program observed no offsite dose to the public or impact to the environment from this pathway as a result of plant operations. Results for these locations are within the range observed in previous years and closely follow the trend observed for the control location. Based on these results, there is no evidence of any measurable environmental radiological air quality impact that can be attributed to Seabrook plant operation during 2009.

Surface Water. The quarterly composites and samples showed no indication of tritium. Tritium results for all surface water samples were so low as to be below the detection capability of the analysis method (i.e., less than the lower limit of detection (LLD) of 3,000 pCi/kg for seawater). These results are consistent with preoperational tritium data.

The analysis for gamma radiation emitting material in all surface water samples showed no indication of any gamma-emitting radionuclides related to Seabrook plant operation.

The only radionuclide detected in 2009 was naturally-occurring Potassium-40 (^{40}K). No plant-related nuclides were detected. The present data for gamma emitters in seawater do not indicate any measurable impact from Seabrook plant operation.

Groundwater. Drinking water quality groundwater samples were collected from three offsite locations; the drinking water line supplied by the Town of Seabrook to the Seabrook plant site, an inactive well located approximately 1 km (0.6 mi) north of the plant, and a private well 1.3 km (0.8 mi) north, northwest. This REMP Groundwater Sampling Program is separate from the onsite Groundwater Monitoring Program, which monitors radioactivity from leaks and spills from buried piping and plant systems. The onsite Groundwater Monitoring Program is described in section 2.2.4, Groundwater Resources, of this draft SEIS.

In 2009, a total of 12 REMP groundwater samples were collected. All samples were analyzed for gross-beta activity, gamma-emitters, and tritium. Gross beta activity was detected in 10 of the 12 samples due to naturally-occurring radium and its daughter products. The gross beta activity seen at all three locations are similar to what was seen in the pre-operational program and is consistent with results from previous years of commercial operations. No tritium or gamma emitters were detected in any of the groundwater samples collected during the year. The groundwater sample results do not indicate any measurable impact from Seabrook plant operation.

Milk. Iodine-131 (^{131}I) was not detected in any of the 55 milk samples collected in 2009. Analysis of milk samples did not identify any plant-related gamma-emitting radionuclides above the detection limits of the analysis method. Naturally-occurring ^{40}K was identified in all milk samples. The milk sample results do not indicate any measurable impact from Seabrook plant operation.

Sediment. Analysis of sediment samples for gamma-emitting radionuclides showed the presence of naturally-occurring radionuclides ^{40}K and Thorium-232 (^{232}Th). No plant-related radionuclides were detected. The sediment sample results do not indicate any measurable impact from Seabrook plant operation.

Fish. Bottom dwelling fish species (winter and yellow tail flounder) and fish species that reside in the upper water column (cunner fish) were collected for analysis. Analysis of fish samples collected at both the indicator location and the control location identified the presence of only naturally-occurring radionuclides (^{40}K). The fish sample results do not indicate any measurable impact from Seabrook plant operation.

Lobsters. Analysis of lobster samples collected at both the indicator location near the discharge and the control location within Ipswich Bay identified the presence of only naturally occurring radionuclides (^{40}K). The lobster sample results do not indicate any measurable impact from Seabrook plant operation.

Shellfish. Analysis of mussel samples collected at both the indicator station near the discharge outfall and the control station in Ipswich Bay identified only naturally-occurring radionuclides (^{40}K). The mussel shells were tested for Strontium-90 (^{90}Sr) but no indication of any ^{90}Sr incorporation into the shell was found. The shellfish sample results do not indicate any measurable impact from Seabrook plant operation.

Irish Moss. Analysis of Irish moss (algae) samples, collected at both the indicator station near the plant discharge and a control location in Ipswich Bay, identified only naturally-occurring radionuclides ^{40}K and Beryllium-7 (^{7}Be). One sample taken from the control location detected ^{131}I (31.1 pCi/kg), but a review of effluent discharge records from Seabrook showed no detectable liquid waste release of ^{131}I. It is unlikely that the ^{131}I found in the sample could have originated from Seabrook due to the control station's distance of 10.8 mi (17.4 km) from the plant. The medical industry uses ^{131}I for patient treatment, and it is likely that the ^{131}I detected in the control sample is medically related. The Irish moss sample results do not indicate any measurable impact from Seabrook plant operation.

Vegetable Crop. Analysis for gamma-emitting radionuclides was performed on six vegetable crop samples (green beans and tomatoes) in 2009. Naturally-occurring radionuclide ^{40}K was identified in all samples. The vegetable crop sample results do not indicate any measurable impact from Seabrook plant operation.

Vegetation. Analysis for gamma-emitting radionuclides was performed on five broad leaf vegetation samples from three sites. Naturally-occurring radionuclides—^{40}K, ^{7}Be and ^{232}Th—were detected. The vegetation sample results do not indicate any measurable impact from Seabrook plant operation.

NRC Staff Summary. Based on the review of the radiological environmental monitoring data, the staff found that there were no unusual and adverse trends, and there was no measurable impact to the offsite environment from operations at Seabrook.

4.8.1.3 Seabrook Radioactive Effluent Release Program

All nuclear plants were licensed with the expectation that they would release radioactive material to both the air and water during normal operation. However, NRC regulations require that radioactive gaseous and liquid releases from nuclear power plants must meet radiation dose-based limits, specified in 10 CFR Part 20, and ALARA criteria, defined in Appendix I to 10 CFR Part 50. Regulatory limits are placed on the radiation dose that members of the public can receive from radioactive material released by a nuclear power plant. In addition, nuclear power plants are required to file an annual report to the NRC, which lists the types and quantities of radioactive effluents released into the environment. The radioactive effluent release reports are available for review by the public through the Agencywide Documents Access and Management System (ADAMS) electronic reading room, available through the NRC website.

The NRC staff reviewed the annual radioactive effluent release reports for 2005–2009 (FPLE, 2006; FPLE, 2007; FPLE, 2008; NextEra, 2009a; NextEra, 2010a). The review focused on the calculated doses to a member of the public from radioactive effluents released from Seabrook. The doses were compared to the radiation protection standards in 10 CFR 20.1301 and the ALARA dose design objectives in Appendix I to 10 CFR Part 50.

Dose estimates for members of the public are calculated based on radioactive gaseous and liquid effluent release data and atmospheric and aquatic transport models. The 2009 annual radioactive effluent release report (NextEra, 2010a) contains a detailed presentation of the radioactive discharges and the resultant calculated doses. The following bullets summarize the calculated hypothetical maximum dose to a member of the public located outside the Seabrook site boundary from radioactive gaseous and liquid effluents released during 2009:

- The maximum whole body dose to an offsite member of the public from radioactive liquid effluents was 8.17×10^{4} millirem (mrem) (8.17×10^{6} milllisievert (mSv)), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum organ dose to an offsite member of the public from radioactive liquid effluents was 1.11×10^{3} mrem (1.11×10^{5} mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum air dose at the site boundary from gamma radiation in gaseous effluents was 6.24×10^{5} millirad (mrad) (6.24×10^{7} milligray (mGy)), which is well below the 10 mrad (0.1 mGy) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum air dose at the site boundary from beta radiation in gaseous effluents was 2.47×10^{5} mrad (2.47×10^{7} mGy), which is well below the 20 mrad (0.2 mGy) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum organ (thyroid in any age group) dose to an offsite member of the public at the site boundary from radioactive iodine and radioactive material in particulate form was 2.51×10^{2} mrem (2.51×10^{4} mSv), which is well below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum whole body dose to an offsite member of the public from the combined radioactive releases (i.e., gaseous, liquid, and direct radiation) was 2.58×10^{2} mrem (2.58×10^{4} mSv), which is well below the 25 mrem (0.25 mSv) dose standard in 40 CFR Part 190.

The NRC staff's review of the Seabrook radioactive waste system performance in controlling radioactive effluents found that the radiological doses to members of the public for the years 2005–2009 comply with Federal radiation protection standards, contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190.

Routine plant operational and maintenance activities currently performed will continue during the license renewal term. Based on the past performance of the radioactive waste system to maintain the dose from radioactive effluents to be ALARA, similar performance is expected during the license renewal term.

The radiological impacts from the current operation of Seabrook are not expected to change significantly. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the impacts from radioactive effluents would be SMALL.

4.8.2 Microbiological Organisms

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 lists the effects of thermophilic microbiological organisms on public health as a Category 2 issue that applies to nuclear plants that discharge to cooling ponds, lakes, canals, or small rivers (those with an annual average flow rate of less than 3.15×10^{12} ft^3/year). This issue does not apply to Seabrook because Seabrook withdraws from and discharges to the Atlantic Ocean.

4.8.3 Electromagnetic Fields—Acute Shock

Based on the GEIS, the NRC 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.

The GEIS states that it is not possible to determine the significance of the electric shock potential without a review of the conformance of each nuclear plant's transmission lines with National Electrical Safety Code (NESC) (IEEE, 2007). An 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.

Seabrook electrical output is delivered to the New England electric grid via four substations. The Scobie Pond Substation, located near Derry, NH, is connected to Seabrook via the 345 kilovolt (kV) Scobie Pond Line, which runs approximately 30 mi (48 km). For the first 5 mi, the Scobie Pond Line shares an approximately 250-ft (76-m) corridor with the Tewksbury Line before splitting off into a smaller 170-ft (52-m) wide corridor. The 345 kV Tewksbury Line connects Seabrook first to Ward Hill Substation in Ward Hill, MA, approximately 25 mi (40 km) from the plant, and terminates 15 mi (24 km) past the Ward Hill Substation at Tewksbury Substation. The 345 kV Newington Line connects Seabrook first to the Timber Swamp Substation in Hampton, NH, approximately 4.5 mi (7.2 km) from the plant, and terminates about 13.5 mi (21.7 km) past Timber Swamp Substation at the Newington Generating Station. All three lines are owned and operated by PSNH, while the Massachusetts portion of the Tewksbury Line is owned and operated by National Grid (NextEra, 2010). These three lines connect the plant to the New England electric grid.

As concluded by the NRC staff in Seabrook's final environmental statement for operations, all transmission lines associated with Seabrook were constructed in accordance with NESC and industry guidance in effect at that time (NRC, 1982). Because this conclusion was based on design rather than as-built information, the applicant analyzed the current as-built data on each line in its ER to verify NRC's conclusion that the lines conform to NESC's electric shock provisions. The applicant's analysis determined that there are no locations within the ROW under the transmission lines that have the capacity to induce more than 5 milliamperes (mA) in a vehicle parked beneath the lines. Therefore, the lines meet the NESC 5 mA criterion. The maximum induced current calculated for the power lines was 3.6 mA (NextEra, 2010). Transmission lines and facilities are maintained to ensure continued compliance with current standards. Transmission line procedures include routine ground inspections to identify any ground clearance problems and ensure integrity of the transmission line structures.

The NRC staff has reviewed the available information, including the applicant's evaluation and computational results. Based on this information, the NRC staff concludes that the potential impacts from electric shock during the renewal period would be SMALL.

4.8.4 Electromagnetic Fields—Chronic Effects

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

The potential effects of chronic exposure from these fields continue to be studied and are 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 (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 non-cancer 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, as described below (10 CFR 51 Footnote 5 to Table B-1):

> If in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

The NRC staff considers the GEIS finding of “uncertain” still appropriate and will continue to follow developments on this issue.

4.9 Socioeconomics

The socioeconomic issues applicable to Seabrook are shown in Table 4.9-1 for Category 1, Category 2, and one uncategorized issue (environmental justice). Section 2.2.9 of this SEIS describes the socioeconomic conditions near Seabrook.

Table 4.9-1. Socioeconomics during the renewal term

Issues	GEIS section(s)	Category
Housing impacts	4.7.1	2
Public services: public safety, social services, & tourism & recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6	1
Public services: public utilities	4.7.3.5	2
Public services: education (license renewal term)	4.7.3.1	1
Offsite land use (license renewal term)	4.7.4	2
Public services: transportation	4.7.3.2	2

Historic & archaeological resources	4.7.7	2
Aesthetic impacts (license renewal term)	4.7.6	1
Aesthetic impacts of transmission lines (license renewal term)	4.5.8	1
Environmental justice	Not addressed[(a)]	Uncategorized[(a)]

[(a)] Guidance for implementing Executive Order (EO)12898 and conducting an environmental justice impact analysis was not available prior to the completion of the GEIS. This issue must be addressed in plant-specific reviews.

4.9.1 Generic Socioeconomic Issues

The Seabrook ER, scoping comments, and other available data records for Seabrook were reviewed and evaluated for new and significant information. The review included a data-gathering site visit to Seabrook. No new and significant information was identified during this review that would change the conclusions presented in the GEIS. Therefore, for these Category 1 issues, impacts during the renewal term are not expected to exceed those discussed in the GEIS. For Seabrook, the NRC incorporates the GEIS conclusions by reference. Impacts for Category 2 and the uncategorized issue (environmental justice) are discussed in Sections 4.9.2–4.9.7.

4.9.2 Housing Impacts

Appendix C of the GEIS presents a population characterization method based on two factors, sparseness and proximity (GEIS, Section C.1.4). Sparseness measures population density within 20 mi (32 km) of the site, and proximity measures population density and city size within 50 mi (80 km). Each factor has categories of density and size (GEIS, Table C.1). A matrix is used to rank the population category as low, medium, or high (GEIS, Figure C.1).

According to the 2000 Census, an estimated 448,637 people lived within 20 mi (32 km) of Seabrook, which equates to a population density of 535 persons per square mile (mi^2) (NextEra, 2010). This translates to a Category 4, "least sparse," population density using the GEIS measure of sparseness (greater than or equal to 120 persons per mi^2 within 20 mi). An estimated 4,157,215 people live within 50 mi (80 km) of Seabrook, with a population density of 887 persons per mi^2 (NextEra ,2010). Applying the GEIS proximity measures, Seabrook is classified as proximity Category 4 (greater than or equal to 190 persons per mi^2 within 50 mi). Therefore, according to the sparseness and proximity matrix presented in the GEIS, rankings of sparseness Category 4 and proximity Category 4 result in the conclusion that Seabrook is located in a high-population area.

Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, states that impacts on housing availability are expected to be of small significance in a medium or high-density population area where growth-control measures are not in effect. Since Seabrook is located in a high-population area, and Rockingham County and Strafford County are not subject to growth-control measures that would limit housing development, any changes in employment at Seabrook would have little noticeable effect on housing availability in these counties. Since NextEra has no plans to add non-outage employees during the license renewal period, employment levels at Seabrook would remain relatively constant with no additional demand for permanent housing during the license renewal term. Based on this information, there would be no additional impact on housing during the license renewal term beyond what has already been experienced.

4.9.3 Public Services—Public Utility Impacts

Impacts on public utility services (e.g., water, sewer) are considered SMALL if the public utility has the ability to respond to changes in demand and would have no need to add or modify facilities. Impacts are considered MODERATE if service capabilities are overtaxed during periods of peak demand. Impacts are considered LARGE if additional system capacity is needed to meet ongoing demand.

Analysis of impacts on the public water systems considered both plant demand and plant-related population growth. Section 2.1.7 describes the permitted withdrawal rate and actual use of water for reactor cooling at Seabrook.

Since NextEra has no plans to add non-outage employees during the license renewal period, employment levels at Seabrook would remain relatively unchanged with no additional demand for public water services. Public water systems in the region are adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no additional impact to public water services during the license renewal term beyond what is currently being experienced.

4.9.4 Offsite Land Use—License Renewal Period

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 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 SMALL when there will be little new development and minimal changes to an area's land-use pattern. It is defined as MODERATE when there will be considerable new development and some changes to the land-use pattern. It is defined as LARGE when there will be 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 the size of the plant's tax payments relative to the community's total revenues, the nature of the community's existing land-use pattern, and 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 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 tax payments are 10–20 percent of the community's total revenue, new tax-driven land-use changes would be MODERATE. If tax payments are greater than 20 percent 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.

4.9.4.1 Population-Related Impacts

Since NextEra has no plans to add non-outage employees during the license renewal period, there would be no plant operations-driven population increase in the vicinity of Seabrook. Therefore, there would be no additional population-related offsite land use impacts during the license renewal term beyond those already being experienced.

4.9.4.2 Tax Revenue-Related Impacts

As discussed in Chapter 2, NextEra pays annual real estate taxes to six towns and the State of New Hampshire, including the Town of Seabrook and the New Hampshire Education Trust

Fund. Since NextEra started making payments to local jurisdictions, population levels and land use conditions in both Rockingham County and Strafford County have changed, although there is no evidence that these tax revenues have had any effect on land use activities within the two counties. For the 5-year period from 2004–2008, tax payments to the Town of Seabrook represented between 34–49 percent of the net tax commitment, while payments to the New Hampshire Education Trust Fund were between 1.2–2.0 percent of revenues.

Since NextEra has no plans to add non-outage employees during the license renewal period, employment levels at Seabrook would remain relatively unchanged. There would be no increase in the assessed value of Seabrook, and annual property tax payments would also remain relatively unchanged throughout the license renewal period. Based on this information, there would be no additional tax-revenue-related offsite land use impacts during the license renewal term beyond those already being experienced.

4.9.5 Public Services—Transportation Impacts

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states the following:

> 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.

The regulation in 10 CFR 51.53(c)(3)(ii)(J) requires all applicants 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. Since NextEra has no plans to add non-outage employees during the license renewal period, traffic volume and levels of service on roadways in the vicinity of Seabrook would not change. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

4.9.6 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to take into account the potential effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places (NRHP). The criteria for eligibility include the following (ACHP, 2010):

- association with significant events in history
- association with the lives of persons significant in the past embodiment of distinctive characteristics of type, period, or construction
- association with or potential to yield important information on history or prehistory

The historic preservation review process, mandated by Section 106 of the NHPA, is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800. The issuance of a renewed operating license for a nuclear power plant is a Federal undertaking that could possibly affect either known or potential historic properties located on or near the plant and its associated transmission lines. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effect (APE). If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Officer (SHPO) before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve possible adverse effects of the undertaking.

The NRC contacted the New Hampshire SHPO concerning the proposed action (license renewal of Seabrook) (NRC, 2010b). The NRC also sent letters to the Wampanoag Tribe of Gay Head-Aquinnah, the Abenaki Nation of New Hampshire, the Abenaki Nation of Missisquoi St. Franci/Sokoki Band, and the Cowasuck Band of Pennacook-Abenaki People notifying them of the proposed action and requesting comments and concerns (NRC, 2010a). In a letter dated July 27, 2010, the New Hampshire SHPO acknowledged the NRC staff's letter (NHDHR, 2010). To date, the tribes have not responded.

The APE for the Seabrook license renewal review is the property owned by NextEra for Seabrook. The protected area is the area of greatest activity that could potentially affect historic and archaeological resources. As discussed in Section 2.2.10, there are seven known historic and archaeological resources on the Seabrook property. No resources are known to exist within the APE. Most resources are located well away from the protected area. However, two archaeological sites, 27RK452 and 27RK453, are in the general vicinity of the protected area. Both of these sites contain prehistoric era resources, including the remains of fishing stations and habitation sites. The protected area perimeter fence runs through a portion of 27RK453, and 27RK452 is close by. A recent archaeological survey study conducted on the Seabrook property found there is a very high potential for additional resources to be found on the property (Valimont, 2010). The archaeological study identified additional areas that would need to be surveyed prior to any ground-disturbing activity. Currently, NextEra has no planned activities in or near these areas (NextEra, 2010).

Given the high potential for additional historic archaeological resources to be discovered, NextEra has developed plant procedures that take these resources into consideration. NextEra maintains an Environmental Compliance Manual, which identifies the procedures for considering environmental factors during plant maintenance and operations activities. A component of the manual is a dig safe procedure, which controls any ground disturbing activities. These activities represent the greatest risk to historic and archaeological resources. The dig safe procedure also incorporates the Cultural Resources Protection Plan. This plan ensures that a review of existing historic and archaeological information is completed prior to initiating any ground disturbing activities outside of the protected area. In the event that a known historic and archaeological resource is in the vicinity of planned ground-disturbing activities, the New Hampshire SHPO will be contacted to determine the appropriate measures needed to minimize or avoid any impacts to historic and archaeological resources.

Based on a review of New Hampshire SHPO files for the region, published literature, and information provided by NextEra, the NRC concludes that potential impacts from license renewal of Seabrook on historic and archaeological resources would be SMALL. This conclusion is based on a review of past surveys, the fact that most resources are located away from plant maintenance and operations activities in the protected area, and the Seabrook Cultural Resources Protection Plan and environmental protection procedures.

4.9.7 Environmental Justice

Under EO 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the NRC issued a *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (69 FR 52040), which states, “The Commission is committed to the general goals set forth in EO 12898, and strives to meet those goals as part of its [National Environmental Policy Act] NEPA review process.”

The Council on Environmental Quality (CEQ) provides the following information in *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ, 1997):

> **Disproportionately High and Adverse Human Health Effects.**
>
> Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as employed by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).
>
> **Disproportionately High and Adverse Environmental Effects.**
>
> A disproportionately high environmental impact that is significant (as employed by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as employed by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of Seabrook during the renewal term. In assessing the impacts, the following definitions of minority individuals and populations and low-income population were used (CEQ, 1997):

> Minority individuals. Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races, meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.
>
> Minority populations. Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
>
> Low-income population. Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series P60, on Income and Poverty.

4.9.7.1 Minority Population

According to 2000 Census data, 18.6 percent of the population (approximately 4,148,000 persons) residing within a 50-mi (80-km) radius of Seabrook identified themselves as minority individuals. The largest minority group was Hispanic or Latino (approximately 270,000 persons or 6.5 percent), followed by Black or African American (approximately 268,000 persons or 6.5 percent) (USCB, 2003).

Of the approximately 3,282 census block groups located within the 50-mi (80-km) radius of Seabrook, 612 block groups were determined to have minority race population percentages that exceeded the comparison area (State average) by 20 percent or more. Persons identifying themselves as Hispanic or Latino ethnicity comprised the largest minority race population with 219 block groups. There were 217 block groups where individuals identifying themselves as Black exceeded the comparison area average by 20 percent or more. An additional 107 block groups exceeded the comparison area average by 20 percent or more for individuals identifying themselves as Some Other Race. Block groups with minority populations are concentrated primarily in the Boston Metropolitan Area, with smaller concentrations in Lowell, Methuen, and Fitchburg/Leominster (all in Massachusetts). The minority population nearest to Seabrook is located in Haverhill, MA.

According to American Community Survey 2009 estimates, minority populations in the 2-county region (Rockingham and Strafford) increased by approximately 9,500 persons and comprised 6.0 percent of the total 2-county population (see Table 2.2-13). Most of this increase was due to an estimated increase of Hispanic or Latinos (over 4,100 persons), an increase in population of 91.9 percent from 2000. The next largest increase in minority population was Asian, an estimated additional 2,400 persons or an increase of 52.1 percent from 2000, followed by Black or African American, an estimated 1,100 persons or an increase of 49.9 percent from 2000 (USCB, 2011).

Based on 2000 Census data, Figure 4.9-1 shows minority block groups within a 50-mi (80-km) radius of Seabrook.

4.9.7.2 Low-Income Population

According to 2000 Census data, approximately 62,000 families (6.1 percent) and 356,000 individuals (8.6 percent) residing within a 50-mi (80-km) radius of Seabrook were identified as living below the Federal poverty threshold in 1999 (USCB, 2003). (The 1999 Federal poverty threshold was $17,029 for a family of four). According to the 2000 Census, 7.3 percent of families and 12.6 percent of individuals in Maine, 7.3 percent of families and 10.0 percent of individuals in Massachusetts, and 7.9 percent of families and 7.6 percent of individuals in New Hampshire were living below the Federal poverty threshold in 1999 (USCB, 2010).

Census block groups were considered low-income block groups if the percentage of individuals living below the Federal poverty threshold exceeded the comparison area (State average) by 20 percent or more. Based on 2000 Census data, there were 180 block groups within a 50-mi (80-km) radius of Seabrook that could be considered low-income block groups. The majority of low-income population census block groups were located in the Boston Metropolitan area, with smaller concentrations in Portsmouth, Durham, and Manchester (all in New Hampshire), and in Lowell, Methuen, and Fitchburg/Leominster (all in Massachusetts).

According to American Community Survey 2009 estimates, the median household income for New Hampshire was $60,567, with 8.5 percent of the State population and 5.5 percent of families living below the Federal poverty threshold. Strafford County had a slightly lower median household income average ($56,463) and higher percentages of individuals (9.2 percent) and a slightly lower percentage of families (5.2 percent) living below the poverty level when compared to the State average. Rockingham County had the highest median household income between the two counties ($70,160) and lowest percentages of individuals (6.0 percent) and families (4.0 percent) living below the poverty level when compared to Strafford County and the State (USCB, 2011).

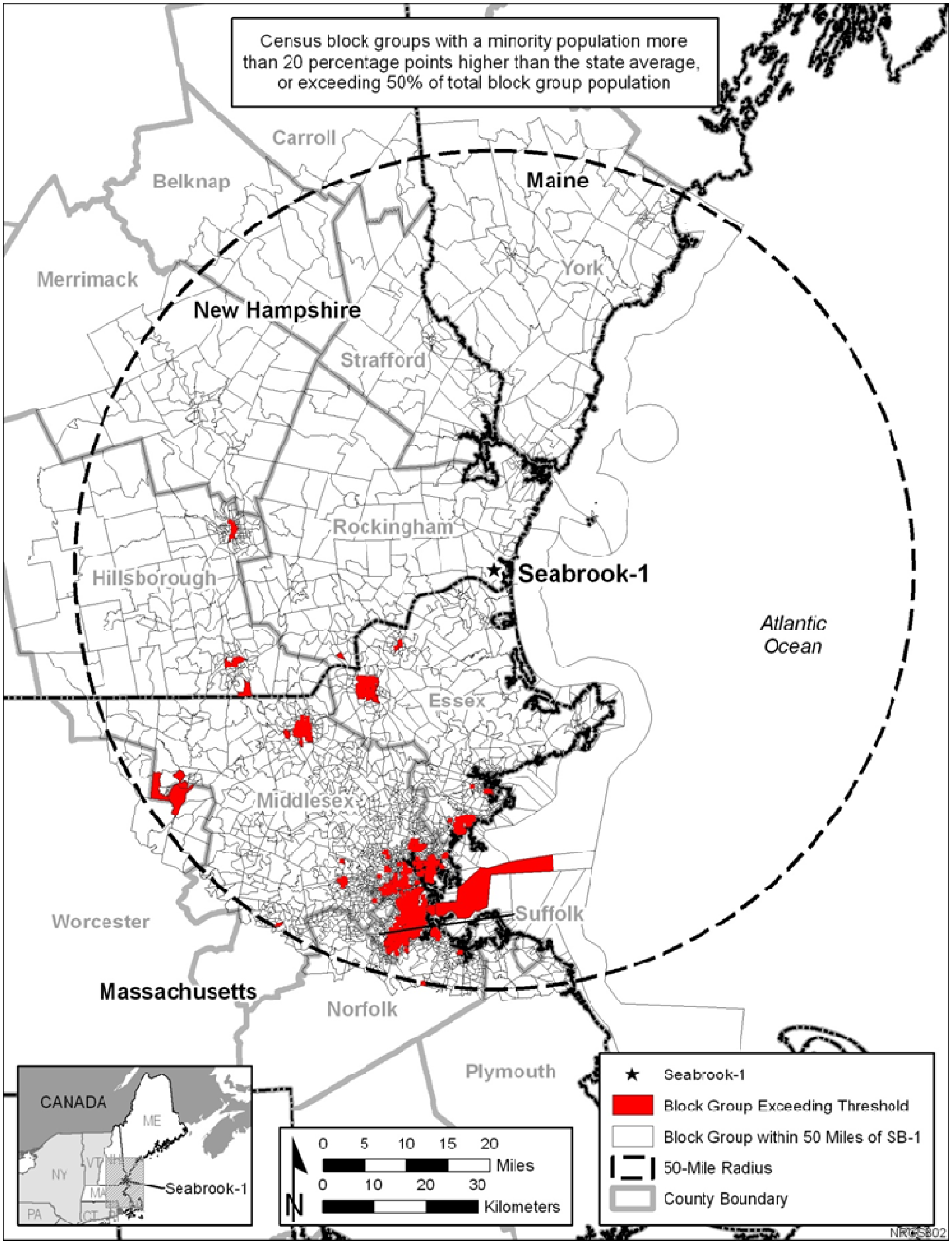

Figure 4.9-1. Census 2000 minority block groups within a 50-mi radius of Seabrook

Source: (NextEra, 2010)

Figure 4.9-2 shows low-income census block groups within a 50-mi (80-km) radius of Seabrook.

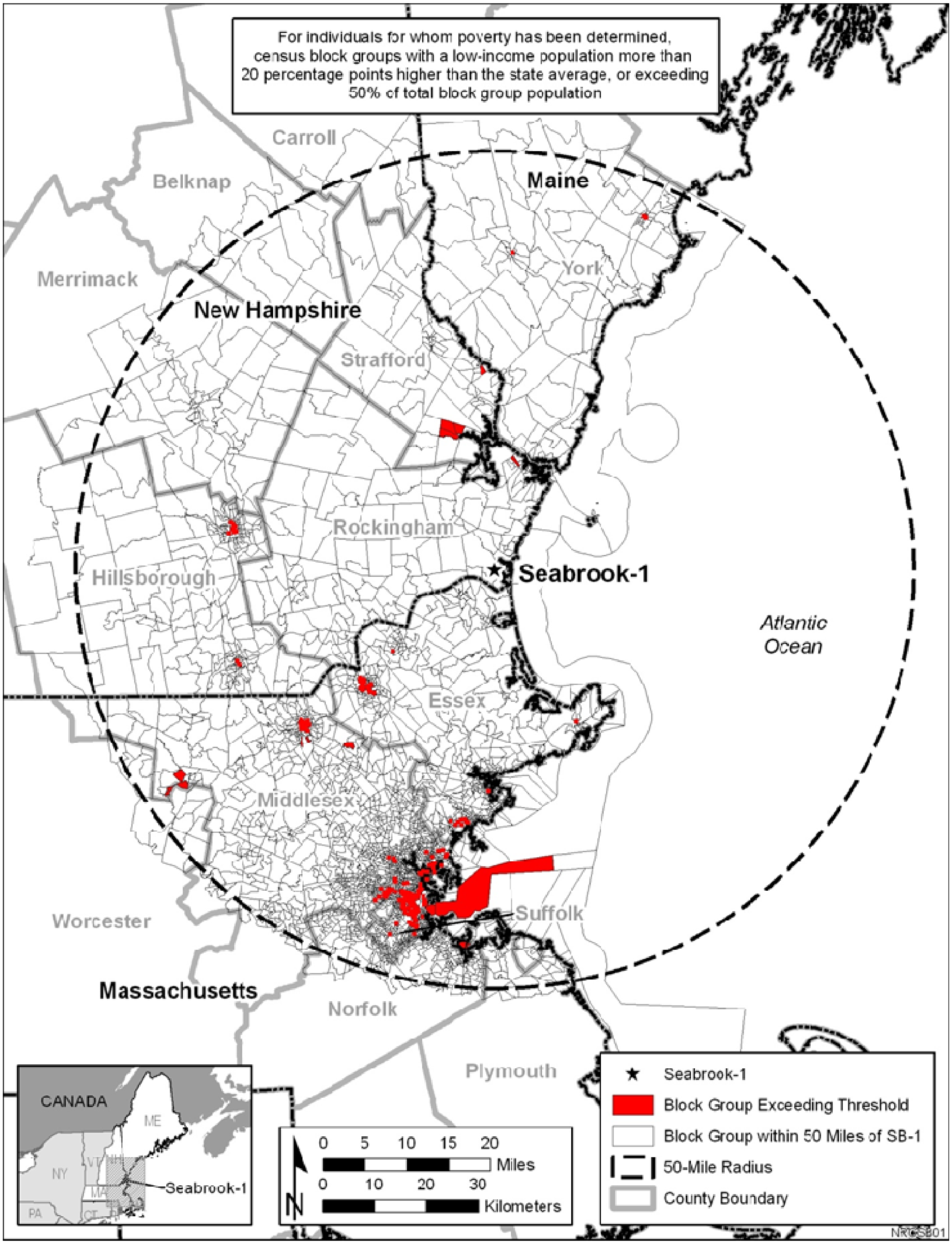

Figure 4.9-2. Census 2000 low-income block groups within a 50-mi radius of Seabrook

Source: (NextEra, 2010)

4.9.7.3 Analysis of Impacts

The NRC addresses environmental justice matters for license renewal through identifying minority and low-income populations that may be affected by the proposed license renewal and examining any potential human health or environmental effects on these populations to determine if these effects may be disproportionately high and adverse.

The discussion and figures above identify the minority and low-income populations residing within a 50-mi (80-km) radius of Seabrook. This area of impact is consistent with the impact analysis for public and occupational health and safety, which also focuses on populations within a 50-mi (80-km) radius of the plant. As previously discussed, for the other resource areas in Chapter 4, the analyses of impacts for all environmental resource areas indicated that the impact from license renewal would be SMALL, except for the impact on aquatic resources, which would be SMALL to LARGE.

Potential impacts to minority and low-income populations would mostly consist of radiological effects; however, radiation doses from continued operations associated with this license renewal are expected to continue at current levels and would remain within regulatory limits. Chapter 5 of this SEIS discusses the environmental impacts from postulated accidents that might occur during the license renewal term, which include design basis accidents. The NRC has generically determined that impacts associated with such accidents are SMALL because the plant was designed to successfully withstand design basis accidents.

Therefore, based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5, it is not likely there would be any disproportionately high and adverse impacts to minority and low-income populations from the continued operation of Seabrook during the license renewal term.

As part of addressing environmental justice concerns associated with license renewal, the NRC assessed the potential radiological risk to special population groups from exposure to radioactive material received through their unique consumption and interaction with the environment patterns. These included subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of airborne radioactive material released from the plant during routine operation. This analysis is presented below.

4.9.7.4 Subsistence Consumption of Fish and Wildlife

The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Section 4-4 of EO 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations that rely principally on fish or wildlife or both for subsistence and to communicate the risks of these consumption patterns to the public. In this SEIS, NRC considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near Seabrook were considered.

The following is a summary discussion of the NRC's evaluation from Section 4.8.1.2 of the REMPs that assess the potential impacts for subsistence consumption of fish and wildlife near the Seabrook site.

NextEra has an ongoing comprehensive REMP at Seabrook to assess the impact of site operations on the environment. To assess the impact of the nuclear power station on the environment, samples of environmental media are collected and analyzed for radioactivity. Two types of samples are taken. The first type, control samples, is collected from areas that are beyond measurable influence of the nuclear plant. These samples are used as reference data. Normal background radiation levels, or radiation present due to causes other than nuclear power generation, can be compared to the environment surrounding the nuclear plant. Indicator samples are the second sample type obtained. These samples show how much radiation or radioactivity is contributed to the environment by the nuclear power plant. Indicator samples are taken from areas close to the station where any contribution will be at the highest concentration. An effect would be indicated if the radioactive material detected in an indicator sample was significantly larger than the background level or control sample.

Samples of environmental media are collected from the aquatic and terrestrial pathways in the vicinity of Seabrook. The aquatic pathways include surface (ocean) water, fish and shellfish (including mussels and lobsters), drinking water supply, shallow well water, sea algae (Irish moss), and sediment. The terrestrial pathways include airborne particulates, milk, food products (green beans and tomatoes), and leafy vegetation. During 2009, analyses performed on samples of environmental media showed no significant or measurable radiological impact above background levels from site operations (NextEra, 2010).

Conclusion

Based on the radiological environmental monitoring data from Seabrook, the NRC finds that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

4.10 Evaluation of New and Potentially-Significant Information

NextEra reported in its ER that it is aware of one potentially new issue related to its license renewal application—elevated tritium concentrations in groundwater adjacent to Unit 1. In September 1999, NextEra discovered elevated tritium levels in groundwater that was seeping into the Unit 1 containment annulus. After investigation, the source of the tritium was found to be a leak from the cask loading area and transfer canal, which is connected to the spent fuel pool. Upon initial discovery, the tritiated water leak had a rate of approximately 0.1 gallons per day (gpd) (0.38 liters (L) per day (L/day)). The leak rate increased over the next 2 years to between 30–40 gpd (110–150 L/day) after the fuel storage building drain collection lines were cleaned and restored.

Tritium concentrations in the primary auxiliary building (PAB) were reported at up to 84,000 pCi/L in 2000. In the containment enclosure ventilation area (CEVA), concentrations were reported up to 3,560,000 pCi/L in 2003. Once a non-metallic liner was applied to the stainless steel liner in the cask loading area and transfer canal in 2004, tritium concentrations in both of these locations dropped significantly, with average tritium levels in 2009 recorded at 4,525 pCi/L in the PAB and 4,745 pCi/L in the containment enclosure area. From 2004–2009, tritium levels in the onsite surficial aquifer were recorded ranging from 617–2,930 pCi/L, all well below the EPA's drinking water standard of 20,000 pCi/L (NextEra, 2010a).

NextEra installed dewatering systems in the fuel building, PAB, and containment area of Unit 1 as part of the tritium mitigation. The Unit 1 groundwater withdrawal system provides the hydraulic containment of the tritium, as well as an additional 32,000 gpd (120 m^3) of groundwater being pumped from the incomplete Unit 2 containment building, which acts to reverse the hydraulic gradient along the southern boundary of the site and slow the flow of groundwater offsite. No offsite migration of tritium in groundwater has been observed.

The applicant reported that groundwater is no longer used at Seabrook, as further discussed in Section 2.1.7.2. To track the progress of the dewatering program, 22 monitoring wells have been installed onsite as part of the plant's groundwater monitoring program. NextEra has indicated that there are no plans to use these former supply wells in the future in any capacity, and it monitors the wells to provide annual updates to the State of New Hampshire Public Utilities Commission (NextEra, 2010a).

The Town of Seabrook's 10 freshwater supply wells are located hydraulically upgradient from Seabrook and at least 2 mi (3.2 km) west of the site. Potential releases of tritiated water from the plant cannot lead to drinking water sources due to the site's hydrogeologic characteristics. Thus, the applicant's analysis concluded that there is no human exposure pathway; therefore, the tritium in groundwater at the site does not present a threat to public or occupational health or safety (NextEra, 2010a).

The NRC staff agrees with NextEra's position that there are no significant impacts associated with tritium in the groundwater at Seabrook. This conclusion is supported by the following information. While onsite tritium remains above EPA's 20,000 pCi/L standard at one location by Unit 1 and is above background at several other onsite locations, the applicant is actively controlling the groundwater with relatively high tritium concentrations. Dewatering operations pump out the groundwater to create a cone of depression that provides hydraulic containment of tritium-impacted groundwater. The tritium-impacted groundwater is sent to the facility's main outfall to the ocean, where it is released in compliance with NPDES and NRC's radiological limits. Groundwater samples from several monitoring wells are well below 20,000 pCi/L and are not expected to impact human or biota receptors. The nearest groundwater users are over 3,000 ft (910 m) from the plant site and are upgradient, as the groundwater flow path beneath the plant site is generally to the east and southeast toward the tidal marsh. The applicant's REMP will monitor the groundwater and continue to report the results in its annual radiological environmental monitoring report. Also, NRC inspectors will periodically review the REMP data for compliance with NRC radiation protection standards.

4.11 <u>Cumulative Impacts</u>

The NRC staff considered potential cumulative impacts in the environmental analysis of continued operation of Seabrook during the 20-year license renewal period. Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with other past, present, and reasonably foreseeable actions. Cumulative impacts can result from 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 cumulative 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.

For the purposes of this cumulative analysis, past actions are those prior to the receipt of the license renewal application. Present actions are those related to the resources at the time of current operation of the power plant, and future actions are those that are reasonably foreseeable through the end of plant operation including the period of extended operation. Therefore, the analysis considers potential impacts through the end of the current license terms as well as the 20-year renewal license term. The geographic area over which past, present, and reasonably foreseeable actions would occur is dependent on the type of action considered and is described below for each resource area.

To evaluate cumulative impacts, the incremental impacts of the proposed action, as described in Sections 4.1–4.9, are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. The NRC staff used the information provided in the ER; responses to RAIs; information from other Federal, State, and local agencies; scoping comments; and information gathered during the visits to the Seabrook site to identify other past, present, and reasonably foreseeable actions. To be considered in the cumulative analysis, the NRC staff determined if the project would occur within the identified geographic areas of interest and within the period of extended operation, if it was reasonably foreseeable, and if there would be potential overlapping effect with the proposed project. For past actions, consideration within the cumulative impacts assessment is resource and project-specific. In general, the effects of past actions are included in the description of the affected environment in Chapter 2, which serves as the baseline for the cumulative impacts analysis. However, past actions that continue to have an overlapping effect on a resource potentially affected by the proposed action are considered in the cumulative analysis.

4.11.1 Cumulative Impacts on Water Resources

Because the station relies on ocean water for cooling purposes, it is not expected to contribute to cumulative impacts on surface water use. The station's discharge from Outfall 001 to the Atlantic Ocean is regulated under its NPDES permit and has not been found to have caused any significant impact on surface water quality.

Groundwater use at the site is limited to the dewatering action at the incomplete Unit 2 and the tritium control dewatering at Unit 1. In combination, this amounts to less than 24 gpm (91 liters per minute (L/min)) of extracted groundwater. The facility purchases an annual average of 80 gpm (300 L/min) of municipal water from a wellfield located over 2 mi (3.2 km) from the plant site. While the overall regional demand for groundwater is expected to grow, the station's water needs are expected to remain steady. Additionally, the station's usage constitutes 14 percent of the Town of Seabrook's total public water demands, and the station's usage is considered in the Town of Seabrook's permitted withdrawals to ensure supply availability (NextEra, 2010).

Tritium has been under investigation at the site since 1999, and monitoring continues at the Unit 1 dewatering system and at shallow and deep monitoring wells across the site, as detailed in Sections 2.2.5 and 4.10 of this SEIS. Tritium levels above the 20,000 pCi/L EPA standard are limited to one dewatering point near the Unit 1 containment. Unit 2 dewatering provides hydraulic control of locations with above background tritium levels. Methyl tertiary butyl ether (MTBE) levels at the vehicle maintenance area have been declining. No receptors are expected to be impacted by groundwater contamination at the station.

Given the available information about surface water use and quality and groundwater use and quality, the cumulative impact of Seabrook operations on water resources during the license renewal term would be SMALL.

4.11.2 Cumulative Impacts on Air Quality

The analysis below considers potential impacts through the end of the current license term as well as the 20-year renewal license term. As described in Section 2.2.2.1, the Town of Seabrook, which encompasses Seabrook, is designated as a nonattainment area for the 8-hour ozone NAAQS. In addition to local emissions, many of the ozone exceedances in New

Hampshire are associated with the transport of ozone and its precursors from the upwind regions by the prevailing winds. The cities of Manchester and Nashua, in neighboring Hillsborough County, are designated as a maintenance area for the carbon monoxide NAAQS.

Currently, Seabrook is operating under a Title V air permit. Annual emissions of criteria pollutants, volatile organic compounds, and hazardous air pollutants at Seabrook vary from year to year but are well below the threshold for a major source (see Table 2.2-1). Rockingham County has experienced frequent exceedances of the 8-hour ozone NAAQS (EPA, 2010). However, as a result of precursor emission controls in upwind regions and New Hampshire, 8-hour ozone concentrations have a downward trend, albeit not a prominent one. Except for ozone, ambient air quality in the Rockingham County is relatively good. As stated by NextEra in the ER (NextEra, 2010), and as confirmed by NRC staff, no refurbishment is planned at Seabrook during the license renewal period. Accordingly, air emissions from continued operation of the plant would not be expected to change during the license renewal period.

Operations at Seabrook release greenhouse gas (GHG) emissions, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Combustion-related GHG emissions (such as CO_2, CH_4, and N_2O) at Seabrook are minor, because Seabrook does not burn fossil fuels to generate electricity. As discussed in Section 2.2.2.1, GHG stationary emission sources at the station include primarily auxiliary boilers, small and large emergency diesel generators, a diesel-powered engine-driven air compressor, and miscellaneous portable equipment. These combustion sources are designed for efficiency and operated using good combustion practices on a limited basis throughout the year (i.e., often only for testing). Other combustion-related GHG emission sources at Seabrook include commuter, visitor, support, and delivery vehicle traffic within, to, and from the plant. In addition, SF_6 is contained in the switchyard breakers and bust ducts at the 345-kV Seabrook transmission substation and is released into the atmosphere during the various stages of the equipment's life cycle. SF_6 is a GHG with a long atmospheric lifetime of 3,200 years, making it the most potent GHG with a global warming potential of 23,900 times that of CO_2. Annual GHG emissions from Seabrook have ranged from approximately 7,893–47,778 tons (7,159–43,336 metric tons) carbon dioxide equivalent (CO_2e), as detailed in Section 2.2.2.1. SF_6 emissions account for a considerable portion of annual total emissions at Seabrook.

Seabrook, through the FPL-New England Division, is participating in the voluntary SF_6 emissions reduction partnership to reduce GHG emissions from its operations via cost-effective technologies and practices (EPA, 1999a). The New Hampshire Department of Environmental Services (NHDES) Air Resources Division is currently administering the Energy and Climate Change Program. This program includes broad incentive-based efforts, such as energy efficiency and conservation and emission reduction trading programs, to address a range of emissions, especially GHGs, across large geographical areas. In addition, the State of New Hampshire has developed a climate action plan to achieve a long-term reduction in GHG emissions, 25 percent by 2025 and 80 percent by 2050, below 1990 levels—a goal similar to those of many other States (NHDES, 2009). To advance the long-term goal and take advantage of the economic opportunity to the State, the plan includes increasing energy efficiency in all sectors, increasing renewable energy sources, and reducing the reliance on automobiles for transportation.

As discussed in Section 2.2.2 of this SEIS, the effects of global climate change are already being felt in the northeastern U.S., including an increase in annual average temperatures since 1970. This warming has resulted in many other climate-related changes, such as more frequent days over 90 degrees Fahrenheit (32 degrees Celsius), increased heavy precipitation, less snow and more rain in winter, reduced snowpack, earlier spring snowmelt, and rising sea temperatures and sea level. The Northeast is projected to face continued warming and more extensive climate-related changes. Extreme heat and declining air quality (notably ozone) would have significant impacts on human health. This warming trend also affects patterns of agricultural production and fisheries in the region, and the projected reduction in snow cover would adversely affect winter recreation and its related industries. Above all, more frequent flooding due to the sea-level rise and heavy downpours have severe impacts on densely populated coastal areas, resulting in storm surges, coastal flooding, erosion, losses of life, property damage, and loss of wetlands (USGCRP, 2009).

As a reference, a brief discussion of the impacts on air quality if fossil-fuel power plant(s) replaced the generating capacity of Seabrook to meet electricity demands in the region is provided below. A more detailed analysis of alternatives and their associated potential impacts are presented in Chapter 8, including a discussion of the power generation technologies and control equipment likely to be used at the time the Seabrook licenses expire.

Nuclear power generation produces less GHG emissions than fossil-fuel power plants, such as coal- or natural gas-fired power plants. GHG emissions at fossil-fuel power plants result primarily from the burning of fossil fuels for power generation.

The amount of CO_2 releases from continued operation of Seabrook can be compared to an equivalent amount of electricity generation from fossil-fuel power plant(s). For 2005, the composite CO_2 emission factor (representing an average of all operating fossil-fuel power plants) is approximately 1,357 pounds per megawatt-hour (lb/MWh) for six New England States (EPA, 2011). Seabrook generates approximately 9,816 gigawatt hours (GWh) per year (assuming a power generating capacity of 1245 MWe and a capacity factor of 90 percent). Thus, Seabrook's generating capacity releases approximately 6.6 million tons (6.0 million metric tons) less CO_2. This is approximately 32 percent of the fossil fuel combustion-related CO_2 emissions of 21 million tons (19 million metric tons) for New Hampshire in 2007 (EPA, 2011a). This also equals about 0.09 percent of total GHG emissions in the U.S., at 7,668 million tons (6,956.8 million metric tons) CO_2e, in 2008 (EPA, 2011b).

Based on all of the above, the NRC staff concludes that combined with the emissions from other past, present, and reasonably foreseeable future actions, cumulative impacts of criteria pollutants (e.g., ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxides, and lead), and hazardous air pollutants on ambient air quality from operations at Seabrook would be SMALL. In addition, continued operation of Seabrook would have net beneficial impacts on global climate change.

4.11.3 Cumulative Impacts on Aquatic Resources

This section addresses the direct and indirect effects of license renewal on aquatic resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The geographic area considered in the cumulative aquatic resources analysis includes the vicinity of Seabrook, including the offshore intake and discharge structures, the Hampton-Seabrook Estuary, and the rivers that drain into the Hampton-Seabrook Harbor.

The benchmark for assessing cumulative impacts on aquatic resources takes into account the preoperational environment as recommended by the EPA (1999), for its review of NEPA documents, as follows:

> Designating existing environmental conditions as a benchmark may focus the environmental impact assessment too narrowly, overlooking cumulative impacts of past and present actions or limiting assessment to the proposed action and future actions. For example, if the current environmental condition were to serve

> as the condition for assessing the impacts of relicensing a dam, the analysis would only identify the marginal environmental changes between the continued operation of the dam and the existing degraded state of the environment. In this hypothetical case, the affected environment has been seriously degraded for more than 50 years with accompanying declines in flows, reductions in fish stocks, habitat loss, and disruption of hydrologic functions. If the assessment took into account the full extent of continued impacts, the significance of the continued operation would more accurately express the state of the environment and thereby better predict the consequences of relicensing the dam.

Sections 2.2.6 and 2.2.8 present an overview of the condition of the Gulf of Maine and the Hampton-Seabrook Estuary and the history and factors that led to its current condition. The direct and indirect impacts from fishing are some of the most influential human activities on the Gulf of Maine ecosystem (Sosebee et al., 2006) (see Section 2.2.6.2). Fishing has resulted in wide-scale changes in fish populations and food web dynamics within the Gulf of Maine (Sosebee, et al. 2006; Steneck, et al., 1994). In the Hampton-Seabrook Estuary, wetland habitat and water flow has been affected by human uses, such as harvesting salt marsh hay (*Spartina patens*) as feed for livestock in the 1700 and 1800s; digging ditches in an attempt to control mosquito populations in the early 1900s; and building roads, jetties, commercial buildings, and residential areas in the 1900 and 2000s (Eberhardt and Burdick, 2009). The increased urbanization in the past 100 years has also led to increased runoff and levels of pollutants within the Hampton-Seabrook Estuary (NHDES, 2004). In the rivers connected to Hampton-Seabrook Estuary, dams block fish migrations and have resulted in the precipitous decline of anadromous fish that move to freshwater to spawn and to marine waters to grow and feed (Eberhardt and Burdick, 2009).

Many natural and anthropogenic activities can influence the current and future aquatic biota in the area surrounding Seabrook. Potential biological stressors include continued entrainment, impingement and potential heat shock from Seabrook (as described in Section 4.5), fishing mortality, climate change, energy development, and urbanization (as described below).

<u>Fishing</u>. Fishing has been a major influence on the population levels of commercially-sought fish species in the Gulf of Maine (Sosebee, et al., 2006). The Hampton-Seabrook Estuary and the Gulf of Maine support significant commercial and recreational fisheries for many of the fish and invertebrate species also affected by Seabrook operations. EPA (2002a) determined that 69 percent of all entrained and impinged fish species at Seabrook are commercially or recreationally fished. From 1990–2000, Atlantic cod comprised 33 percent of the catch in New Hampshire and 25 percent of the revenue. American lobster comprised 14 percent of the catch by weight in New Hampshire and 40 percent of the revenue (EPA, 2002a). Other commercially important species in New Hampshire include spiny dogfish shark, pollock, Atlantic herring, bluefin tuna, American plaice, white hake, yellowtail flounder, and shrimp. Recreationally fished species include American lobster, striped bass, summer flounder, Atlantic cod, scup, and bluefish (EPA, 2002a). Many of these species are managed by Federal, regional, and State agencies, although the biomass of many fish stocks have not rebounded to pre-1960s levels (Sosebee, 2006). Indirect impacts from fishing include habitat alteration as well as indirect effects that propagate throughout the food web, as described in Section 2.2.6.2.

Some of the most productive soft-shell clam flats in New Hampshire are located in the Hampton-Seabrook Estuary. The area hosts a recreational soft-shell clam fishery, although sections of the fishery have been closed for large periods due to health concerns from high bacteria loads in the water (NHDES, 2004). Clam diggers can directly reduce the clam population by harvesting clams or indirectly by leaving clams behind that are eaten by green crabs, gulls, or other predators and by increasing turbidity and sedimentation while digging and disturbing the estuary bottom. Invasive species, such as green crabs, can also directly affect clam populations since green crabs are a major predator on soft-shell clams (Glude, 1955; Ropes, 1969).

For these reasons, the NRC staff concludes that fishing pressure has the potential to continue to influence the aquatic ecosystem, especially food webs, and may continue to contribute to cumulative impacts.

Climate Change. The potential cumulative effects of climate change on the Gulf of Maine and Hampton-Seabrook Estuary could result in a variety of changes that would affect aquatic resources. The environmental factors of significance identified by the U.S. Global Change Research Program (USGCRP) (2009) include temperature increases and sea level rise. Warming sea temperatures may influence the abundance and distribution of species, as well as earlier spawning times. For example, USGCRP (2009) projects that lobster populations will continue to shift northward in response to warming sea temperatures. Atlantic cod, which were subject to intense fishing pressure and other biological stressors, are likely to be adversely affected by the warmer temperatures since this species inhabits cold waters (USGCRP, 2009). USGCRP (2009) projects that the Georges Bank Atlantic cod fishery is likely to be diminished by 2100. NMFS (2009) analyzed fish abundance data from 1968–2007 and determined that the range of several species of fish is moving northward or deeper, likely in response to warming sea temperatures.

Warmer temperatures can also lead to earlier spawning since spawning time is often correlated with a distinct temperature range. Seabrook monitoring studies showed a shift in blue mussel spawning times (NAI, 2010). From 1996–2002, and select years from 2002–2009, the greatest blue mussel larval density occurred in mid-April, whereas the greatest blue mussel larval density occurred in late April in the 1970s, 1980s, and early 1990s.

Sea level rise could result in dramatic effects to nearshore communities, including the reduction or redistribution of kelp, eelgrass, and wetland communities. Aquatic vegetation is particularly susceptible to sea level rise since it is immobile and cannot move to shallower areas. In addition, most species grow within a relatively small range of water depth in order to receive sufficient light to photosynthesize while escaping predation.

The ocean absorbs nearly one-third of the CO_2 released into the atmosphere (NOAA, 2011). As atmospheric CO_2 increases, there is a concurrent increase in CO_2 levels in the ocean (NOAA, 2011). Ocean acidification is the process by which CO_2 is absorbed by the ocean, forming carbonic and carbolic acids that increase the acidity of ocean water. More acidic water can lead to a decrease in calcification (or a softening) of shells for bivalves (e.g., soft shell clams), decreases in growth, and increases in mortality in marine species (Nye, 2010).

The extent and magnitude of climate change impacts to the aquatic resources of the Gulf of Maine and the Hampton-Seabrook Estuary are an important component of the cumulative assessment analyses and could be substantial.

Energy Development. As part of a technical workshop held by NOAA, Johnson, et al. (2008) categorized the largest non-fishing impacts to coastal fishery habitats. Johnson, et al. (2008) determined that the largest known and potential future impacts to marine habitats are primarily from the development of energy infrastructure, including petroleum exploration, production and transportation; liquefied natural gas development; offshore wind development; and cables and pipelines in aquatic ecosystems.

Petroleum explorations and offshore wind development can result in habitat conversion and a loss of benthic habitat as developers dig, blast, or fill biologically productive areas. Petroleum and liquefied natural gas development can impact water quality if there are oil spills or discharges of other contaminants during exploration- or transportation-related activities. Underwater cables and pipelines may block fish and other aquatic organisms from migrating to various habitats (Johnson et al., 2008). Thus, there is a variety of ways in which energy development may contribute to cumulative impacts in the future.

Urbanization. The area surrounding the Hampton-Seabrook Estuary experienced increased residential and commercial development in the 1900s, as the seaside town became a popular tourist destination (Eberhardt and Burdick, 2009). At the beginning of the 21st century, moderate commercial and residential development surrounds the Hampton-Seabrook Estuary (NHNHB, 2009). The town of Hampton's Master Plan calls for continued growth in the area to sustain its attractiveness for tourists (Hampton, 2001).

As described in 2.2.6.2, increased urbanization has led, and will likely continue to lead, to additional stressors on the Hampton-Seabrook Estuary. Run-off from developed and agricultural areas has increased the concentration of nutrients, bacteria, and other pollutants to the estuary. Sections of the Hampton-Seabrook Estuary are listed on New Hampshire's 303(d) list as being impaired due to high concentrations of bacteria (NHDES, 2004). NHDES (2004) also lists the estuary as impaired for fish and shellfish consumption due to polychlorinated biphenyl, dioxin, and mercury concentrations in fish tissue and lobster tomalley. Other activities that may affect marine aquatic resources in Hampton-Seabrook Estuary include periodic maintenance dredging, continued urbanization and development, and construction of new overwater or near-water structures (e.g., docks), and shoreline stabilization measures (e.g., sheet pile walls, rip-rap, or other hard structures).

Future threats to salt marshes in the Hampton-Seabrook Estuary include developmental activities that further hydrological alterations from filling wetlands or other physical changes that alter the flow of tidal waters (NHNHB, 2009; Johnson et al., 2008). Increased nutrients and pollutants in storm runoff are also current threats to the health of this ecosystem (NHNHB, 2009). The NRC staff concludes that the direct and indirect impacts from future urbanization are likely to contribute to cumulative impacts in the Hampton-Seabrook Estuary.

Conclusion. The direct impacts to fish populations, from fishing pressure and alterations of aquatic habitat within the Hampton-Seabrook watershed from past activities, have had a significant effect on aquatic resources in the geographic area near Seabrook. These aquatic ecosystems have been noticeably altered, as evidenced by the low population numbers for several commercially-sought fisheries, the change in food web dynamics, habitat alterations, and the blockage of fish passage within the Hampton-Seabrook watershed. The incremental impacts from Seabrook would be SMALL for most species and LARGE for winter flounder and rainbow smelt because operation of Seabrook would have minimal impacts on most species and entrainment, impingement, and monitoring data indicate that Seabrook operations have destabilized the local abundance of winter flounder and rainbow smelt (see Section 4.5). The cumulative stress from the activities described above, spread across the geographic area of interest, depends on many factors that NRC staff cannot quantify but are likely to noticeably alter or destabilize aquatic resources when all stresses on the aquatic communities are assessed cumulatively. Therefore, the NRC staff concludes that the cumulative impacts from the proposed license renewal and other past, present, and reasonably foreseeable projects would be MODERATE for most species and LARGE for winter flounder, rainbow smelt, and other species that would be adversely affected from climate change, such as lobster and Atlantic cod.

4.11.4 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in adverse cumulative impacts to terrestrial resources, including wildlife populations, invasive species, protected species, and land use. For purposes of this analysis, the geographic area considered in the evaluation includes the Seabrook site and in-scope transmission line ROWs.

Approximately 109 ac (44 ha) of the 780 ac (320 ha) of land on the Seabrook site are developed and maintained for operation of Seabrook (NextEra, 2010). Developed areas with impervious surfaces, such as buildings and parking lots, have increased precipitation runoff and reduced infiltration into the soil, thus reducing groundwater recharge and increasing soil erosion. Before the Seabrook site was constructed, the land was a mixture of mixed hardwood uplands, wetlands, and tidal marsh, similar to the current undeveloped portions of the site.

The transmission lines constructed for the Seabrook site required the clearing of approximately 1,700 ac (690 ha) of land that was previously a combination of developed, residential, forested, open field, and marshland. Subsequent maintenance of the ROWs of the transmission lines for low-growing, shrubby vegetation has resulted in changes to the wildlife and plant species present within the vicinity of these ROWs. Some habitat fragmentation of natural areas may have occurred as a result of initial construction. Habitat fragmentation has likely resulted in increases in invasive species populations, which are typically more aggressive than native species in colonizing disturbed areas. The cumulative effect of ROW maintenance activities, such as mowing, has likely led to localized prevention of the natural successional stages of the surrounding vegetative communities. Oil and fuel from motorized vehicles may have accumulated in certain areas over time. Riparian areas, marshes, and wetlands are especially sensitive to chemical bioaccumulation because they serve as important habitat to wide variety of species, including migratory birds and spawning fish.

Protected terrestrial species, which are discussed in Sections 2.2.8.2 and 4.7.2, are not expected to be adversely affected due to future actions during the renewal term. The numerous marshes and natural areas within the vicinity of the Seabrook site will continue to provide habitat to protected species and other wildlife.

There are no known Federal projects within a 6-mi (10-km) radius of Seabrook. The nearest power generating facility is in Hampton. Foss Manufacturing Company owns a 12-megawatt power plant that burns a combination of natural gas and oil (NextEra, 2010). The following additional power generating facilities are located in Rockingham County and create power from burning wood chips, coal and oil, or natural gas (EIA, 2008):

- Shiller Station—a 171-megawatt facility near Portsmouth
- Newington Station—a 414-megawatt facility in Newington
- Newington Power Facility—a 605-megawatt facility in Newington
- Granite Ridge Power Plant—a 900-megawatt facility near Londonberry

Fossil-fuel power facilities emit GHGs that have been linked to climate change and ozone depletion and other pollutants that result in acid rain, smog, and air pollution.

The East Coast Greenway is a developing trail system that spans nearly 3,000 mi (4,800 km) from Maine to Florida. The trail system makes use of former railway beds, and, within New Hampshire, the trail is proposed to run through the Seabrook site (NextEra, 2010). The New Hampshire portion of the Greenway is currently all on road surface but is planned to be moved to entirely off-road trails from the Massachusetts border to Portsmouth (ECGA, 2010). The New Hampshire portion would use the already-existing Boston and Maine Railroad corridor, so minimal habitat loss or modification would occur (ECGA, 2010). Once completed, the increased bike and foot traffic may alter certain species' behavior and habitat range, but these impacts are not likely to be noticeable.

The NRC staff examined the cumulative effects of the construction of Seabrook, vegetative maintenance, impacts to protected species, and effects of neighboring facilities. The NRC staff concludes that the minimal terrestrial impacts on the continued Seabrook operations would not contribute to the overall decline in the condition of terrestrial resources. The NRC staff believes that the cumulative impacts of other and future actions during the term of license renewal on terrestrial habitat and associated species, when added to past, present, and reasonably foreseeable future actions, would be SMALL.

4.11.5 Cumulative Impacts of Human Health

The radiological dose limits, for protection of the public and workers, have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of Seabrook was included. The REMP conducted by NextEra in the vicinity of the Seabrook site measures radiation and radioactive materials from all sources (i.e., hospitals and other licensed users of radioactive material); therefore, the monitoring program measures cumulative radiological impacts. Within the 50-mi (80-km) radius of the Seabrook site, there are no other nuclear power reactors or uranium fuel cycle facilities. There is a U.S. nuclear submarine fleet maintained at Portsmouth Naval Shipyard, 12 mi from Seabrook, which could be a potential source of a radioactive release to the environment. There are 12 hospitals in Rockingham and Essex Counties that could potentially contribute to radiation discharges to potable waters.

Radioactive effluent and environmental monitoring data for the 5-year period from 2005–2009 were reviewed as part of the cumulative impacts assessment. In Section 4.8.1 of this SEIS, the NRC staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of Seabrook during the renewal term would be SMALL.

The applicant has dry horizontal storage modules for the storage of its radioactive spent fuel. The facility was built to allow for expansion for Seabrook operation through 2050 (NextEra, 2010). The installation and monitoring of this facility is governed by NRC requirements in 10 CFR Part 72, Subpart K, "General License for Storage of Spent Fuel at Power Reactors." Radiation from this facility, as well as from the operation of Seabrook, are required to be within the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 72. The NRC performs periodic inspections to verify compliance with its licensing and regulatory requirements.

The NRC and the State of New Hampshire would regulate any future actions near Seabrook that could contribute to cumulative radiological impacts. The environmental monitoring performed by Seabrook would measure the cumulative impact from any future nuclear operations.

For these reasons, the NRC staff concludes that cumulative radiological impacts would be SMALL, as are the contribution to radiological impacts from continued operation of Seabrook and its associated dry fuel storage facility.

For electromagnetic fields, the NRC staff determined that the Seabrook transmission lines are operating within design specifications and meet current NESC criteria; therefore, the transmission lines do not significantly affect the overall potential for electric shock from induced currents within the analyzed area of interest. With respect to the effects of chronic exposure to ELF-EMF, although the GEIS finding of "not applicable" is appropriate to Seabrook, the transmission lines associated with Seabrook are not likely to significantly contribute to the regional exposure to ELF-EMFs. Therefore, the NRC staff has determined that the cumulative impacts of continued operation of the Seabrook transmission lines and other transmission lines in the affected area would be SMALL.

4.11.6 Cumulative Socioeconomic Impacts

Socioeconomics. This section addresses socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at Seabrook as well as the aggregate effects of other past, present, and reasonably foreseeable future actions. The primary geographic area of interest considered in this cumulative analysis is Rockland and Strafford Counties, where approximately 67 percent of Seabrook employees reside. This area is where the economy, tax base, and infrastructure would most likely be affected since Seabrook employees and their families reside, spend their income, and use their benefits within these counties.

As discussed in Section 4.9 of this SEIS, continued operation of Seabrook during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already experienced. Since NextEra has no plans to hire additional workers during the license renewal term, overall expenditures and employment levels at Seabrook would remain relatively constant with no additional demand for permanent housing and public services. In addition, since employment levels and tax payments would not change, there would be no population or tax revenue-related land use impacts. Based on this, and other information presented in Chapter 4 of this SEIS, there would be no additional contributory effect on socioeconomic conditions in the region from the continued operation of Seabrook during the license renewal term beyond what is currently being experienced.

Historic and Archaeological Resources. Any ground-disturbing activities during the license renewal term could result in the cumulative loss of historic and archaeological resources. Historic and archaeological resources are non-renewable; therefore, the loss of archaeological resources can be cumulative if unique site types are removed. The continued operation of Seabrook during the license renewal term has the potential to impact historic and archaeological resources. The archaeological sites found on the Seabrook site represent the only known Middle Archaic and Woodland Period sites on the New Hampshire coast.

As discussed in Section 4.9.6, continued operation of Seabrook during the license renewal term would have a SMALL impact on historic and archaeological resources. Archaeological sites at Seabrook are located outside of the protected area. Areas that likely contain undiscovered historic and archaeological resources have been identified, and NextEra has established a Cultural Resources Protection Plan to protect historic and archaeological resources at Seabrook.

For the purposes of this cumulative impact assessment, the spatial bounds include the Seabrook site and transmission lines corridors. Cumulative impacts to historic and archaeological resources can result from the incremental loss of unique site types. NextEra has no plans to alter the station site for license renewal. Any ground-disturbing activities would be considered through the corporate Dig Safe and Cultural Resources Protection Plan procedures. Given that the Seabrook property has the potential for unknown resources, the NRC concludes that, when combined with other past, present, and reasonably foreseeable future ground-disturbing activities, the potential cumulative impacts on historic and archaeological resources would be SMALL.

Environmental Justice. The environmental justice cumulative impact analysis assesses the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from past, present, and reasonably foreseeable future actions including Seabrook operations during the renewal term. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impacts, on the natural or physical environment in a minority or low-income community, which are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas presented in Chapter 4 of this SEIS. Minority and low-income populations are subsets of the general public residing in the area, and all would be exposed to the same hazards generated from Seabrook operations. As previously discussed in this chapter, the impact from license renewal for all resource areas (e.g., land, air, water, ecology, and human health) would be SMALL, except in the area of aquatic resources, which would be SMALL to LARGE.

As discussed in Section 4.9.7 of this SEIS, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of Seabrook during the license renewal term. Since NextEra has no plans to hire additional workers during the license renewal term, employment levels at Seabrook would remain relatively constant with no additional demand for housing or increased traffic. Based on this information, and the analysis of human health and environmental impacts presented in Chapters 4 and 5, it is not likely there would be any disproportionately high and adverse contributory effect on minority and low-income populations from the continued operation of Seabrook during the license renewal term.

4.11.7 Summary of Cumulative Impacts

The NRC staff considered the potential impacts resulting from the operation of Seabrook during the period of extended operation and other past, present, and reasonably foreseeable future actions near Seabrook. The preliminary determination is that the potential cumulative impacts would range from SMALL to LARGE, depending on the resource. Table 4.11-1 summarizes the cumulative impact by resource area.

Table 4.11-1. Summary of cumulative impacts on resources areas

Resource area	Summary
Air Quality	Impacts of air emissions over the proposed license renewal term would be SMALL. When combined with other past, present, and reasonably foreseeable future activities, impacts to air resources from Seabrook would constitute a SMALL cumulative impact on air quality. In comparison with the alternative of constructing and operating a comparable gas or coal-fired power plant, license renewal would result in a new cumulative deferral in both GHG and other toxic air emissions, which would otherwise be produced by a fossil-fueled plant, with a net beneficial impact on climate change.
Surface Water	Impacts on surface water from continued cooling water withdrawals and effluent discharges over the proposed license renewal term would be SMALL. When combined with other past, present, and reasonably foreseeable future activities, impacts to surface water from Seabrook facilities would constitute a SMALL cumulative impact.
Groundwater	Groundwater consumption constitutes a SMALL cumulative impact on the resource. When this consumption is added to other past, present, and reasonably foreseeable future withdrawals, cumulative impact on groundwater resources is SMALL. Groundwater contamination is below regulatory limits, is confined to the site, and is being actively controlled. Because contamination would be expected to diminish over time and would

Resource area	Summary
	not foreseeably affect or be used by an offsite user, the cumulative impact on the site's groundwater use and quality would be SMALL.
Aquatic Resources	Fishing pressure and alterations of aquatic habitat within the Hampton-Seabrook Watershed from past activities have had a significant effect on the aquatic ecosystems near Seabrook. These activities are likely to noticeably alter or destabilize aquatic resources when all stresses on the aquatic communities are assessed cumulatively. The cumulative impacts, therefore, would be MODERATE for most species and LARGE for winter flounder, rainbow smelt, and other species that would be adversely affected from climate change, such as lobster and Atlantic cod. The incremental impacts from Seabrook license renewal would be SMALL for most species and LARGE for winter flounder, rainbow smelt and macroalgae.
Terrestrial Resources	Impacts from the continued operation of Seabrook through the license renewal period on terrestrial resources would be SMALL. Combined with other past, present, and future activities at Seabrook, the cumulative impacts on terrestrial resources would be SMALL and would not adversely affect terrestrial resources.
Human Health	The REMP conducted by NextEra in the vicinity of the Seabrook site measures radiation and radioactive materials from all sources (i.e., hospitals and other licensed users of radioactive material); therefore, the monitoring program measures cumulative radiological impacts. In Section 4.8.1 of this draft SEIS, the NRC staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of Seabrook during the renewal term would be SMALL. The NRC and the State of New Hampshire would regulate any future actions near Seabrook that could contribute to cumulative radiological impacts; therefore, the cumulative impacts from continued operation of Seabrook would be SMALL.
Socioeconomics	As discussed in Section 4.9 of this SEIS, continued operation of Seabrook during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already experienced. Since NextEra has no plans to hire additional workers during the license renewal term, overall expenditures and employment levels at Seabrook would remain relatively constant. Combined with other past, present, and future activities, there would be no additional contributory effect on socioeconomic conditions in the future from the continued operation of Seabrook during the license renewal period.
Historic & Archaeological Resources	As discussed in Section 4.9.6, continued operation of Seabrook during the license renewal period would have a SMALL impact on historic and archaeological resources. Combined with other past, present, and reasonably foreseeable future ground-disturbing activities, the potential cumulative impacts on historic and archaeological resources would be SMALL.

4.12 References

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This chapter describes the environmental impacts from postulated accidents that Seabrook Station (Seabrook) might experience during the period of extended operation. A more detailed discussion of the severe accident mitigation alternatives (SAMA) assessment is provided in Appendix F. The term "accident" refers to any unintentional event outside the normal plant operational envelope that results in a release or the potential for release of radioactive materials into the environment. Two classes of postulated accidents are evaluated in the "Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Power Plants" prepared by the U.S. Nuclear Regulatory Commission (NRC) (NRC, 1996), as listed in Table 5.1-1. These two classes include the following:

- design basis accidents (DBAs)
- severe accidents

Table 5.1-1. Issues related to postulated accidents

Two issues related to postulated accidents are evaluated under the National Environmental Policy Act (NEPA) in the license renewal review—DBAs and severe accidents.

Issues	GEIS sections	Category
DBAs	5.3.2; 5.5.1	1
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	2

5.1 Design Basis Accidents

In order to receive 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 prevent and mitigate accidents. The NRC staff reviews the application to determine if the plant design meets the NRC's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. Many 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 preventative and mitigative safety systems of the facility. Title 10 of the *Code of Federal Regulations* (CFR) Part 50 (10 CFR Part 50) and 10 CFR Part 100 describe the acceptance criteria for DBAs.

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 maximum exposed individual. Because of the requirements that continuous acceptability of the consequences and aging management programs (AMPs) 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; therefore, the environmental impacts of those accidents were not examined further in the GEIS.

The NRC 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 (CLB) of the plant. The CLB of the plant is to be maintained by the licensee under its current license; therefore, under the provisions of 10 CFR 54.30, it is not subject to review under license renewal.

No new and significant information related to DBAs was identified during the review of the NextEra Energy Seabrook (NextEra) environmental report (ER), the site visit, the scoping process, or the NRC staff's evaluation of other available information. Therefore, there are no impacts related to DBAs beyond those discussed in the GEIS.

5.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the staff assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and information from various sites to predict the environmental impacts of severe accidents for plants during the renewal period. Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, fires, and sabotage have not traditionally been discussed in quantitative terms in the final environmental impact statements and were not specifically considered for the Seabrook site in the GEIS (NRC, 1996). The GEIS, however, did evaluate existing impact assessments performed by the NRC staff and by the industry at 44 nuclear plants in the U.S. and segregated all sites into six general categories and then estimated that the risk consequences calculated in existing analyses bound the risks for all other plants within each category. The GEIS further concluded that the risk from beyond design-basis earthquakes at existing nuclear power plants is designated as SMALL. The Commission believes that NEPA does not require the NRC to consider the environmental consequences of hypothetical terrorist attacks on NRC-licensed facilities. However, the NRC staff's GEIS for license renewal contains a discretionary analysis of terrorist acts in connection with license renewal. The conclusion in the GEIS is that the core damage and radiological release from such acts would be no worse than the damage and release to be expected from internally-initiated events. In the GEIS, the NRC staff concludes that the risk from sabotage and beyond design-basis earthquakes at existing nuclear power plants is designated as SMALL, and additionally, that the risks from other external events are adequately addressed by a generic consideration of internally-initiated severe accidents (NRC, 1996). Based on information in the GEIS, the staff found the following to be true:

> The generic analysis…applies to all plants and that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water,

> releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants. However, not all plants have performed a site-specific analysis of measures that could mitigate severe accidents. Consequently, severe accidents are a Category 2 issue for plants that have not performed a site-specific consideration of severe accident mitigation and submitted that analysis for Commission review.

The staff identified no new and significant information related to postulated accidents during the review of NextEra's ER, the site audit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to postulated accidents beyond those discussed in the GEIS. In accordance with 10 CFR 51.53(c)(3)(ii)(L), however, the NRC staff has reviewed SAMAs for Seabrook. Review results are discussed in Section 5.3.

5.3 Severe Accident Mitigation Alternatives

Under 10 CFR Section 51.53(c)(3)(ii)(L), license renewal applicants must consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment. The purpose is to ensure that potentially cost-beneficial, aging-related 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 by NextEra, for Seabrook; therefore, the remainder of Section 5.3 addresses those alternatives.

NextEra submitted an assessment of SAMAs for Seabrook as part of the ER (NextEra, 2010), based on the most recently available Seabrook probabilistic risk assessment (PRA), supplemented by a plant-specific offsite consequence analysis performed using the Methods for Estimation of Leakages and Consequences of Releases (MELCOR) Accident Consequence Code System 2 (MACCS2) computer code and insights from the Seabrook individual plant examination (IPE) (NHY, 1991) and individual plant examination of external events (IPEEE) (NAESC, 1992). In identifying and evaluating potential SAMAs, NextEra considered SAMAs that addressed the major contributors to core damage frequency (CDF) and large early release frequency (LERF) at Seabrook, as well as a generic list of severe accident mitigation alternative (SAMA) candidates for pressurized water reactor (PWR) plants identified from other industry studies. NextEra identified 191 potential SAMA candidates. This list was reduced to 74 SAMA candidates by eliminating SAMAs for the following reasons:

- Seabrook having a different design
- the SAMA having already been implemented at Seabrook
- having already met the intent of the SAMA at Seabrook
- combining the SAMA with another SAMA candidate that is similar in nature
- having estimated implementation costs that would exceed the dollar value associated with eliminating all severe accident risk at Seabrook
- being related to a non-risk significant system such that the SAMA would be of very low benefit

NextEra assessed the costs and benefits associated with each of these 74 potential SAMAs and concluded in the ER that several of the candidate SAMAs evaluated are potentially cost-beneficial.

Based on its review, the NRC staff issued requests for additional information (RAIs) to NextEra (NRC, 2010a),(NRC, 2011b). NextEra's responses addressed the NRC staff's concerns and resulted in the identification of additional potentially cost-beneficial SAMAs (NextEra, 2011a; NextEra, 2011b; NRC, 2011a).

5.3.1 Risk Estimates for Seabrook

NextEra combined two distinct analyses to form the basis for the risk estimates used in the SAMA analysis: (1) the Seabrook Level 1 and 2 PRA model, which is an updated version of the IPE (NHY 1991), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis.[1] The SAMA analysis is based on the most recent Seabrook Level 1 and Level 2 PRA models available at the time of the ER, referred to as SSPSS-2006 (the model-of-record used to support SAMA evaluation). The scope of this Seabrook PRA includes both internal and external events.

Table 5.3-1 indicates the Seabrook CDF, based on initiating events, for internal events (plus internal flooding), fires and seismic events (NextEra, 2010; NextEra, 2011a; NextEra, 2011b).

Table 5.3-1. Seabrook CDF for internal and external events

Initiating event	CDF (per year)[(a)]	% Contribution to total CDF[(b)]
Loss of offsite power (LOOP)—due to weather	1.5×10^{-6}	10
Loss of essential alternating current (AC) power 4kV bus	9.5×10^{-7}	6
Reactor trip—condenser available	9.3×10^{-7}	6
LOOP—due to grid-related events	9.0×10^{-7}	6
LOOP—due to hardware or maintenance	8.1×10^{-7}	5
Flood in turbine building	7.3×10^{-7}	5
Steam generator tube rupture (SGTR)	5.9×10^{-7}	4
Loss of primary component cooling system (CS) train	5.3×10^{-7}	4
Loss of essential direct current (DC) power 125V DC bus	3.9×10^{-7}	3
Reactor trip—during shutdown	3.5×10^{-7}	2
Interfacing systems loss-of-coolant accident (ISLOCA)	3.4×10^{-7}	2
Large loss-of-coolant accident (LOCA)	3.4×10^{-7}	2
Medium LOCA	3.3×10^{-7}	2
Excessive LOCA	2.5×10^{-7}	2
Inadvertent safety injection (SI)	2.5×10^{-7}	2

1 The NRC uses Probabilistic Risk Assessment (PRA) to estimate risk by computing real numbers to determine what can go wrong, how likely is it, and what are its consequences. Thus, PRA provides insights into the strengths and weaknesses of the design and operation of a nuclear power plant. For the type of nuclear plant currently operating in the United States, a PRA can estimate three levels of risk. A Level 1 PRA estimates the frequency of accidents that cause damage to the nuclear reactor core. This is commonly called core damage frequency (CDF). A Level 2 PRA, which starts with the Level 1 core damage accidents, estimates the frequency of accidents that release radioactivity from the nuclear power plant. A Level 3 PRA, which starts with the Level 2 radioactivity release accidents, estimates the consequences in terms of injury to the public and damage to the environment. (http://www.nrc.gov/about-nrc/regulatory/risk-informed/pra.html)

Initiating event	CDF (per year)[a]	% Contribution to total CDF[b]
Small LOCA	1.9×10^{-7}	1
Reactor trip with no condenser cooling	1.7×10^{-7}	1
Other internal events[c]	1.0×10^{-6}	7
Total internal events CDF[b]	$\mathbf{1.1\times10^{-5}}$	**70**
Fire Initiating Event		
Fire switchgear (SWGR) room B—loss of bus E6	3.7×10^{-7}	2
Fire SWGR room A—loss of bus E5	3.7×10^{-7}	2
Fire control room—AC power loss	2.1×10^{-7}	1
Fire control room—power-operated relief valve (PORV) LOCA	1.4×10^{-7}	1
Other fire events	2.3×10^{-7}	2
Total fire events CDF[d]	$\mathbf{1.3\times10^{-6}}$	**9**
Seismic Initiating Event		
Seismic 0.7 g transient event	9.2×10^{-7}	6
Seismic 1.0 g transient event	8.7×10^{-7}	6
Seismic 1.4 g transient event	3.6×10^{-7}	2
Seismic 1.0 g anticipated transient without scram (ATWS)	1.1×10^{-7}	1
Seismic 1.4 g large LOCA	1.1×10^{-7}	1
Seismic 0.7 g ATWS	1.0×10^{-7}	1
Seismic 1.0 g large LOCA	8.9×10^{-8}	1
Other seismic events[f]	4.9×10^{-7}	3
Total seismic events CDF[d]	3.1×10^{-6}	21
Total CDF (internal and external events)[g]	$\mathbf{1.5\times10^{-5}}$	**100**

[a] May not total to 100 percent due to round off

[b] Obtained from percentage contribution of internal events provided in response to RAI 1.b.1 (NextEra, 2011a) times the total internal and external events CDF

[c] Obtained by subtracting the sum of the internal initiating event contributors to internal event CDF from the total internal events CDF

[d] Total fire and seismic CDFs provided in response to conference call clarification #2 (NRC, 2011a)

[e] Obtained by subtracting the sum of the fire-initiating event contributors to fire event CDF from the total fire events CDF

[f] Obtained by subtracting the sum of the seismic-initiating event contributors to seismic event CDF from the total seismic events CDF

[g] Provided in response to RAI 1.b.1 (NextEra, 2011a)

The Level 2 Seabrook PRA model that forms the basis for the SAMA evaluation is an updated version of the Level 2 IPE model (NHY, 1991) and IPEEE model (NAESC, 1992), using a single containment event tree (CET) to address both phenomenological and systemic events. The Level 1 core damage sequences are linked directly with the CET, for which the quantified sequences are binned into a set of 14 release categories, which are subsequently grouped into 10 source term categories that provide the input to the Level 3 consequence analysis

(NRC, 2011a; NextEra, 2011a). Source terms were developed for 5 of the 10 release categories using the results of Modular Accident Analysis Program (MAAP), Version 4.0.5 computer code calculations. Source terms for the other five release categories were taken from original analyses to support the Seabrook PRA. The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution within an 80-kilometer (km) (50-mile (mi)) radius for the year 2050, emergency response evacuation planning, and economic parameters. The core radionuclide inventory corresponds to the end-of-cycle values for Seabrook operating at 3,659 megawatts thermal (MWt), which is slightly above the current licensed power level of 3,648 MWt. The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC, 1997a). NextEra estimated the dose to the population within 80 km (50 mi) of the Seabrook site to be approximately 0.107 person-Sievert (Sv) (10.7 person-rem) per year, as shown in Table 5.3-2 (NextEra, 2011a).

Table 5.3-2. Breakdown of population dose by containment release mode

Containment release mode	Population dose (Person-rem[a] per year)	% Contribution
Small early releases	5.3	49
Large early releases	1.6	15
Large late releases	3.8	36
Intact containment	negligible	negligible
Total	**10.7**	**100**

[a] One person-rem = 0.01 person-Sv (Sievert)

5.3.2 Adequacy of Seabrook PRA for SAMA Evaluation

The first Seabrook PRA was completed in December 1983 to provide a baseline risk assessment and an integrated plant and site model for use as a risk management tool. This model was subsequently updated in 1986, 1989, and 1990, with the last update used to support the IPE. Based on its review of the Seabrook IPE, as described in an NRC report dated March 1, 1992 (NRC, 1992), the NRC staff concluded that the IPE submittal met the intent of GL 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities" (NRC, 1988). Although no severe accident vulnerabilities were identified in the Seabrook IPE, 14 potential plant improvements were identified. Four of the improvements have been implemented. Each of the 10 improvements not implemented is addressed by a SAMA in the current evaluation. The internal events CDF value from the 1991 Seabrook IPE (6.1×10^{-5} per year) is near the average of the range of the CDF values reported in the IPEs for Westinghouse four-loop plants, which ranges from about 3×10^{-6} per year to 2×10^{-4} per year, with an average CDF for the group of 6×10^{-5} per year (NRC, 1997b). It is recognized that plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. Based on CDF values reported in the SAMA analyses for license renewal applications, the internal events CDF result for Seabrook used for the SAMA analysis (1.1×10^{-5} per year, including internal flooding) is somewhat lower than that for most other plants of similar vintage and characteristics.

There have been 10 revisions to the IPE model since the 1991 IPE submittal, and three revisions to the PRA model, from the original 1983 PRA model to the 1990 update used to support the IPE submittal. The SSPSA-2006 model was used for the SAMA analysis (a subsequent revision, SSPSA-2009, resulted in a reduction in CDF, but the SAMA analysis was not revised to reflect this revision). NextEra identified the major changes in each revision of the PRA, with the associated change in internal and external event CDF (NextEra, 2010; NextEra, 2011a). A comparison of the internal events CDF between the 1991 IPE and the 2006 PRA model used for the SAMA evaluation indicates a decrease of approximately 82 percent (from 6.1×10^{-5} per year to 1.1×10^{-5} per year), while the external events CDF has increased by approximately 25 percent since the 1993 IPEEE (from 3.6×10^{-5} per year to 4.5×10^{-5} per year).

The Seabrook PRA model is an integrated internal and external events model that has integrated seismic-initiated, fire-initiated, and external flooding-initiated events with internal events since the initial 1983 PRA (NextEra, 2011a). The external events models used in the SAMA evaluation are essentially those used in the IPEEE, with the exception of the seismic PRA model, which underwent a major update for the SSPSA-2005 model. The Seabrook IPEEE was submitted on October 2, 1992 (NAESC, 1992), in response to Supplement 4 of GL 88-20 (NRC, 1991). The submittal used the same PRA as was used for the IPE (i.e., SSPSA-1990) except for updates to the external events. No fundamental weaknesses or vulnerabilities to severe accident risk with regard to external events were identified. Improvements that have already been realized as a result of the IPEEE process minimized the likelihood of there being cost-beneficial enhancements as a result of the SAMA analysis, especially with the inclusion of a multiplier to account for the additional risk of seismic events. In a letter dated May 2, 2001, the NRC staff concluded that the submittal met the intent of Supplement 4 to GL 88-20, and the licensee’s IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC, 2001).

Internal Events CDF

NextEra identified two peer reviews that have been performed on the PRA—a 1999 Westinghouse Owner’s Group (WOG) certification peer review and a 2005 focused peer review against the American Society of Mechanical Engineers (ASME) PRA standard (ASME, 2003; NextEra, 2010). Neither peer review included examination of external flooding, fire, or seismic hazards. The 1999 certification peer review identified 30 Category A and B facts and observations (F&O), and the 2005 focused peer review identified four Category A and B F&Os.[2] NextEra provided the resolution of each of the 34 F&Os and stated that all have been dispositioned and implemented in the PRA model. NextEra also explained that many other internal reviews including vendor-assisted reviews have been performed on specific model updates and that comments from these reviews along with plant changes and potential model enhancements are tracked through a model change database to ensure that the comments are addressed in the periodic update process (NextEra, 2011a). NextEra also noted that a peer review was conducted in late 2009, after the SAMA evaluation, focusing exclusively on internal flooding. NextEra stated that unresolved comments from these reviews primarily reflect model completeness and documentation issues and are not significant to the results and conclusions of the PRA and were judged not to have a significant impact on the SAMA evaluation.

2 Now termed a "Finding," a Category A or B F&Os is an "observation (an issue or discrepancy) that is necessary to address to ensure: [1] the technical adequacy of the PRA ... [2] the capability/robustness of the PRA update process, or [3] the process for evaluating the necessary capability of the PRA technical elements (to support applications)." (NEI 05-04, "Process for Performing Internal Events PRA Peer Reviews Using the ASME/ANS PRA Standard, " Rev. 2, 2008)

NextEra stated that there have been no major plant changes since PRA model SSPSS-2006 was issued and identified the specific plant and model changes made to the PRA model that resulted in the 2009 periodic update of the model, referred to as PRA model SPSS-2009 (NextEra, 2011a). NextEra explained that the model changes resulted in a total CDF decrease of about 19 percent (i.e., from 1.5×10^{-5} per year for SSPSS-2006 to 1.2×10^{-5} per year for SPSS-2009) and resulted in no significant shift in the relative importance of initiating events or components. Based on these results, NextEra judged that changes incorporated into the SSPSA-2009 model would not have a significant impact on the overall SAMA results. NextEra also explained that the SSPSS-2010 model scheduled to be issued in 2011 is being upgraded to meet the internal flooding requirements in the ASME PRA standard (ASME, 2009), and insights from this upgrade indicate that control building flooding scenarios will dominate the risk of internal flooding. Based on this, NextEra identified and evaluated a new SAMA, "install a globe valve or flow limiting orifice upstream in the fire protection system," to mitigate the risk of control building flooding. Based on the reduction in the total CDF since revision SSPSS-2006 of the Seabrook PRA model used for the SAMA analysis and essentially no change in the relative importance of initiating events and plant components in revision SSPSS-2009 of the PRA model, the NRC staff concludes that PRA model and plant changes made since SSPSA-2006, other than changes made to the internal flooding model (for which a new SAMA has been identified and evaluated), are not likely to impact the results of the SAMA analysis.

Consistent with the requirements of the ASME 2009 PRA standard (ASME, 2009), NextEra maintains PRA quality control at Seabrook via an existing administrative procedure that defines the quality control process for PRA updates and ensures that the PRA model accurately reflects the current Seabrook plant design, operation, and performance (NextEra, 2011a). The quality control process includes monitoring PRA inputs for new information, recording new applicable information, assessing significance of new information, performing PRA revisions, and controlling computer codes and models. NextEra also stated that the PRA training qualification is performed as part of the Engineering Support Personnel Training Program. Given that the Seabrook internal events PRA model has been peer-reviewed and the peer review findings were all addressed, and that NextEra has satisfactorily addressed NRC staff questions regarding the PRA, the NRC staff concludes that the internal events Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

Seismic CDF

The Seabrook IPEEE seismic analysis used a seismic PRA following NRC guidance (NRC, 1991). The seismic PRA included the following:

- a seismic hazard analysis (based on the Electric Power Research Institute (EPRI) (EPRI, 1988) and the Lawrence Livermore National Laboratory (LLNL) (NRC, 1994) hazard curves)
- a seismic fragility assessment
- seismic quantification to yield initiating event frequencies and conditional system failure probabilities
- plant model assembly to integrate seismic initiators and seismic-initiated component failures with random hardware failures and maintenance unavailabilities

The seismic CDF resulting from the Seabrook IPEEE was calculated to be 1.2×10^{-5} per year using a site-specific seismic hazard curve, with sensitivity analyses yielding 1.3×10^{-4} per year using the LLNL seismic hazard curve and 6.1×10^{-6} per year using the EPRI seismic hazard curve. The Seabrook IPEEE did not identify any vulnerability due to seismic events but did identify two plant improvements to reduce seismic risk. Neither of the two improvements has been implemented. Each of the two improvements is addressed by a SAMA in the current evaluation.

Subsequent to the IPEEE, NextEra updated the seismic PRA analysis. These updates included expanding fragility analysis, with additional components; using the more current EPRI uniform hazard spectrum (UHS); and improving modeling and documentation of credited operator actions. NextEra compared the dominant contributors to the seismic CDF from the IPEEE PRA model to the dominant contributors from the current seismic PRA analysis or SSPSA-2009 model, as presented in Table 5.3-3. NextEra stated that the seismic CDF for the SSPSA-2009 model is essentially the same as that for the SSPSA-2006 PRA model used in the SAMA evaluation (NRC, 2011a).

Table 5.3-3. Dominant contributors to seismic CDF

Seismic initiating event group	% Contribution to seismic CDF	
	IPEEE	SSPSA-2009[a]
Seismic transient total	78	65
Seismic ATWS total	11	24
Seismic LOCA total	10	11
Other seismic groups	1	1
Total seismic CDF	**1.2×10^{-5}/yr**	**3.1×10^{-6}/yr**

[a] The seismic CDF for PRA model SSPSA-2009 (3.1×10^{-6} per year) is essentially unchanged from the seismic CDF for PRA model SSPSA-2006 model (3.1×10^{-6} per year) used in the SAMA evaluation.

NextEra stated that extensive internal technical reviews of the seismic PRA analysis were performed for the original 1983 PRA and again when the seismic analysis was revised for the IPEEE and when the seismic analysis was revised for the SSPSA-2005 PRA model update. No significant comments were documented from these reviews, and no formal peer reviews have been conducted on the seismic PRA model (NextEra, 2011a). In response to an NRC staff request to assess the impact on the SAMA evaluation of updated seismic hazard curves developed by the U.S. Geological Survey (USGS) in 2008 (USGS 2008), NextEra provided a revised SAMA evaluation using a multiplier of 2.1 to account for the maximum estimated seismic CDF for the Seabrook of 2.2×10^{-5} per year, as noted in the attachments to NRC Information Notice 2010-18, Generic Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants" (NRC, 2010a; NRC, 2010b; NextEra, 2011a; NextEra, 2011b). Note that, in the process of estimating an appropriate multiplier, NextEra considered that the estimated seismic CDF of 2.2×10^{-5} per year did not credit the installation of the supplemental electrical power system (SEPS) diesel generators (DGs) in 2004, which, based on a subsequent PRA estimate, reduced seismic CDF by 26 percent. Therefore, in estimating the multiplier, NextEra first reduced the 2.2×10^{-5} per year estimate for seismic CDF by 26 percent to 1.6×10^{-5} per year.

The NRC staff concludes that the seismic PRA model in combination with the use of a seismic events multiplier provides an acceptable basis for identifying and evaluating the benefits of SAMAs. This conclusion is based on the fact that the Seabrook seismic PRA model is integrated with the internal events PRA, the seismic PRA has been updated to include additional components and to extend the fragility screening threshold, the SAMA evaluation was updated using a multiplier to account for a potentially higher seismic CDF, and NextEra has satisfactorily addressed NRC staff RAIs regarding the seismic PRA.

Fire CDF

The Seabrook IPEEE fire analysis employed EPRI's fire-induced vulnerability evaluation (FIVE) methodology (EPRI, 1992) based on definitions of Appendix R fire areas for Seabrook. Qualitative and quantitative screening was performed to determine that 13 of the 73 fire areas contained important equipment (pumps, valves, and cabling, etc.). These were further assessed. Final quantification used the Seabrook IPE PRA model to calculate a fire-induced CDF of 1.2×10^{-5} per year. While no physical plant changes were found to be necessary as a result of the IPEEE fire analysis, potential plant improvements to reduce fire risk were identified, of which four have been implemented. The one improvement not implemented is addressed by a SAMA in the current evaluation.

NextEra updated the fire PRA, subsequent to the IPEEE, in support of the SSPSA-2004 PRA update. NextEra stated that the fire analysis methodology used was essentially the same, with some variations, as that described previously for the IPEEE fire analysis (NextEra, 2011a). NextEra also compared the dominant contributors to the fire CDF from the IPEEE PRA model to the dominant contributors from the current fire PRA analysis or SSPSA-2009 model, which is presented in Table 5.3-4. NextEra stated that the fire CDF for the SSPSA-2009 model is somewhat higher than the SSPSA-2006 PRA model fire CDF of 1.3×10^{-6} per year used in the SAMA evaluation (NRC, 2011a), but there was no significant shift in the relative importance of initiating events or components. The dominant fire zone areas in these fire analyses are the control room, essential switchgear rooms, turbine building, and primary auxiliary building.

Table 5.3-4. Dominant contributors to fire CDF

Fire location	% Contribution to fire CDF	
	IPEEE	**SSPSA-2009[(a)]**
Control room	34	52
Essential switchgear rooms	18	41
Turbine building	13	5
Primary auxiliary building	26	2
Ocean service water (SW) pumphouse	9	1
Electrical tunnels	<1	<1
Total fire CDF (all fire areas)	**1.2×10^{-5}/yr**	**1.7×10^{-6}/yr**

[(a)] The fire CDF for PRA model SSPSA-2009 (1.7×10^{-6} per year) is somewhat higher than the fire CDF for PRA model SSPSA-2006 model (1.3×10^{-6} per year) used in the SAMA evaluation. However, the total CDF for the SSPSS-2009 PRA model (1.2×10^{-5} per year), which includes the increased fire CDF of 1.7×10^{-6} per year, is lower than the total CDF from the SSPSS-2006 PRA model (1.5×10^{-5} per year) used in the SAMA analysis. Since the benefits are based on the total potential risk reduction, not just from fire events, the higher, more conservative total value from the SSPSS-2006 PRA model was deemed appropriate for the SAMA analysis, even though it incorporated the somewhat lower total fire CDF. Additional justification for using the SSPSS-2006 value is provided in the text.

NextEra stated that extensive internal technical reviews of the fire PRA analysis were performed for the original 1983 PRA and again when the fire analysis was revised for the IPEEE and when the fire analysis was revised for the SSPSA-2005 PRA model update. No significant comments were documented from these reviews, and no formal peer reviews have been conducted on the fire PRA model (NextEra, 2011a). Considering that the Seabrook fire PRA model is integrated with the internal events PRA, that the fire PRA has been updated to include more current data, and that NextEra has satisfactorily addressed NRC staff RAIs regarding the fire PRA, the NRC staff concludes that the fire PRA model provides an acceptable basis for identifying and evaluating the benefits of SAMAs.

"Other" External Event CDF

The Seabrook IPEEE analysis of "other" external events included high winds, external floods, transportation accidents, etc. (HFO events), and it followed the screening and evaluation approaches specified in Supplement 4 to GL 88-20 (NRC, 1991), concluding that Seabrook met the 1975 Standard Review Plan (SRP) criteria (NRC, 1975b). The following external event frequencies exceeded the 1.0×10^{-6} per year screening criterion (NAESC, 1992):

- flooding resulting from a storm surge caused by a hurricane, which is modeled in the PRA (NextEra, 2010) and reported to contribute 2×10^{-8} per year to the total Seabrook CDF
- a truck crash into the SF6 transmission lines, which has been mitigated by the installation of jersey barriers and guard rails and that, as a result, has been screened from the PRA model (NextEra, 2011a)

While no physical plant changes were found to be necessary as a result of the IPEEE HFO analysis, one plant improvement based on HFO analysis was recommended, but this has already been implemented (NextEra, 2011a). The Seabrook IPEEE submittal also stated that, as a result of the Seabrook IPE, cost-benefit analyses were being performed for many potential plant improvements, which may also collaterally reduce external event risk. Four of these five potential plant improvements have been implemented, and the fifth is addressed by a SAMA in the current evaluation.

Level 2 and LERF

To translate the results of the Level 1 PRA into containment releases, as well as the results of the Level 2 analysis, NextEra significantly revised the 2005 PRA update (i.e., PRA model SSPSA-2005) from that used in the IPE to reflect the Seabrook plant as designed and operated as of 2006. NextEra explained that the quantification of the Level 1 and Level 2 models is done using a linked event tree method approach that does not employ plant damage states (NextEra, 2011a). Therefore, all Level 1 sequences are evaluated by the CET. The Level 2 model is a single CET and evaluates the phenomenological progression of all the Level 1 sequences including internal, fire, and seismically-initiated events. It has 37 branching events, for each of which the split fraction is determined based on the type of event. End states resulting from the combinations of the branches are then assigned to one of 16 release categories based on characteristics that determine the timing and magnitude of the release, whether or not the containment remains intact, and isotopic composition of the released material. The quantified CET sequences are subsequently grouped into 10 source term categories by grouping those that occur due to different phenomena, but for which the consequence is essentially the same. These 10 provide the input to the Level 3 consequence analysis.

Source terms were developed for each of the source term categories. The release fractions and timing for 5 of the 10 source term categories are based on the results of plant-specific calculations using the MAAP Version 4.0.5 in conjunction with WASH-1400 (NRC, 1975a) and the Industry Degraded Core Rule-Making (IDCOR) Program MAAP analysis for the Zion plant. The release fractions and timing for the other five source term categories are based on analyses performed for the original 1983 Seabrook PRA. NextEra generally selected the representative MAAP case based on that which resulted in the most realistic timing and source term release.

The current Seabrook Level 2 PRA model is an update of that used in the IPE, which did not identify any severe accident vulnerabilities associated with containment performance. The NRC staff review of the IPE back-end (i.e., Level 2) model concluded that it appeared to have addressed the severe accident phenomena normally associated with large dry containments, that it met the IPE requirements, and that there were no obvious or significant problems or errors. The LERF model was included in the 1999 industry peer review. All F&Os from this review have been dispositioned and implemented in the PRA model. NextEra explained that the apparently very low LERF for Seabrook (1.2×10^{-7} per year in the SSPSS-2006 model, which is less than 1 percent of the CDF) results from the very large-volume and strong containment building in comparison to most other nuclear power plant containment designs (NextEra, 2011a), such that there are no conceivable severe accident progression scenarios that result in catastrophic failure early in the accident sequence. The NRC staff considers NextEra's explanation reasonable. Based on the NRC staff's review of the Level 2 methodology, the NRC staff concludes that NextEra has adequately addressed NRC staff RAIs, that the LERF model was reviewed in more detail as part of the 1999 WOG certification peer review, and that all F&Os have been resolved. Therefore, the NRC staff concludes that the Level 2 PRA provides an acceptable basis for evaluating the benefits associated with various SAMAs.

Level 3—Population Dose

NextEra extended the containment performance (Level 2) portion of the PRA to assess offsite consequences (essentially a Level 3 PRA) via version 1.13.1 of the MACCS2 code, including consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses (NRC, 1998). Plant-specific input to the code included the following:

- the source terms for each release category
- the reactor core radionuclide inventory
- site-specific meteorological data for the year 2005
- projected population distribution within an 80-km (50-mi) radius for the year 2050, based on year 2000 census data from SECPOP2000 (NRC, 2003)
- emergency evacuation planning, using only 95 percent of the population (conservative relative to NUREG-1150, which assumed 99.5 percent (NRC, 1990))
- economic parameters including agricultural production

Multiple sensitivity cases were run, including the following:

- releases at ground level and 25 percent, 50 percent, and 75 percent of the containment building height (baseline is release at the top of containment)

- release plumes with 1 and 10 MW heat release
- factor-of-two scaling of containment building wake effects
- annual meteorological data from 2004–2008
- variations in evacuation parameters, such as percent of population, evacuation speed and delay time

NextEra's results showed only minor variations from the baseline for these sensitivities, which is consistent with previous SAMA analyses. The NRC staff concludes that the methodology used by NextEra to estimate the offsite consequences for Seabrook provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDF and offsite doses reported by NextEra.

5.3.3 Potential Plant Improvements

NextEra's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of the most significant basic events from the 2006 plant-specific PRA, which was the most current PRA model at the time the SAMA evaluation was performed
- review of potential plant improvements identified in the Seabrook IPE and IPEEE
- review of other industry documentation discussing potential plant improvements
- insights from Seabrook personnel

Based on this process, an initial set of 191 candidate "Phase I" SAMAs was identified, for which NextEra performed a qualitative screening to eliminate ones from further consideration using the following criteria:

- The SAMA is not applicable to Seabrook due to design differences (19 SAMAs screened).
- The SAMA has already been implemented at Seabrook or the Seabrook meets the intent of the SAMA (87 SAMAs screened).
- The SAMA is similar to another SAMA under consideration (11 SAMAs screened).
- The SAMA has estimated implementation costs that would exceed the dollar value associated with eliminating all severe accident risk at Seabrook (no SAMA screened).
- The SAMA was determined to provide very low benefit (no SAMA screened).

Based on this screening, 117 SAMAs were eliminated, leaving 74 for detailed evaluation in Phase II. In Phase II, NextEra performed an additional qualitative screening to eliminate 13 SAMAs that had estimated implementation costs that would exceed the dollar value associated with eliminating all severe accident risk at Seabrook. Also in Phase II, a detailed evaluation was performed for each of the then remaining 61 SAMA candidates. NextEra accounted for the potential risk reduction benefits associated with each SAMA by quantifying the benefits using the integrated internal and external events PRA model.

The NRC staff reviewed NextEra's process for identifying and screening potential SAMA candidates, as well as the methods for quantifying the benefits associated with potential risk reduction. This included reviewing insights from the plant-specific risk studies and reviewing plant improvements considered in previous SAMA analyses. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for fire risks and the absence of external event vulnerabilities constituted reasonable justification for examining primarily the internal events risk results for this purpose. The NRC staff concludes that NextEra used a systematic and comprehensive process for identifying potential plant improvements for Seabrook, and the set of SAMAs evaluated in the ER, together with those evaluated in response to NRC staff inquiries, is reasonably comprehensive and, therefore, acceptable.

5.3.3.1 Risk Reduction

NextEra evaluated the risk-reduction potential of the 61 SAMAs retained for the Phase II evaluation that were not screened for excessive cost. NextEra used model re-quantification to determine the potential benefits based on the SSPSS-2006 PRA model. The majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to eliminate the risk associated with the proposed enhancement. On balance, such calculations overestimate the benefit and are conservative. The NRC staff reviewed NextEra's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on NextEra's risk reduction estimates.

5.3.3.2 Cost Impacts

NextEra developed plant-specific costs of implementing the 61 Phase II candidate SAMAs using an expert panel—composed of senior plant staff from the PRA group, the design group, operations, and license renewal—with experience in developing and implementing modifications at Seabrook. In most cases, detailed cost estimates were not developed because of the large margin between the estimated SAMA benefits and the estimated implementation costs (NextEra, 2011a). The cost estimates conservatively did not specifically account for inflation, contingencies, implementation obstacles, or replacement power costs. The NRC staff reviewed the bases for the applicant's cost estimates and, for certain improvements, 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 concludes that the cost estimates provided by NextEra are sufficient and appropriate for use in the SAMA evaluation.

5.3.3.3 Cost-Benefit Comparison

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

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

where:

APE = present value of averted public exposure ($)

AOC = present value of averted offsite property damage costs ($)

AOE = present value of averted occupational exposure costs ($)

AOSC = present value of averted onsite costs ($)

COE = cost of enhancement ($)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA, and it is not considered cost beneficial. Present values for both a 3 percent and 7 percent discount rate were considered. Using the NUREG/BR-0184 methods, NextEra estimated the total present dollar value equivalent associated with eliminating severe accidents from internal and external events at Seabrook to be about $819,000, also referred to as the maximum averted cost risk (MACR).

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was considered not to be cost beneficial. In the baseline analysis (using a 7 percent discount rate), NextEra identified one potentially cost-beneficial SAMA (SAMA 165, see Table 5.3-5). Based on the consideration of analysis uncertainties, NextEra identified one additional potentially cost-beneficial SAMA (SAMA 157, see Table 5.3-5). In response to NRC staff RAIs regarding the SAMA identification process and updates to the PRA model, two additional potentially cost-beneficial SAMAs were identified (SAMAs 192 and 193, see Table 5.3-5). In addition, in response to NRC staff RAIs, NextEra provided the results of revised baseline and uncertainty analyses, in both of which a multiplier was used to account for additional SAMA benefits in external events due to a potentially larger seismic CDF (NextEra, 2011a; NextEra, 2011b). No additional potentially cost-beneficial SAMAs were identified.

The four potentially cost-beneficial SAMAs are discussed in Section 5.3.4. The NRC staff notes that these are included within the set of SAMAs that NextEra plans to enter into the Seabrook long-range plan development process for further implementation consideration. The NRC staff concludes that, with the exception of the four potentially cost-beneficial SAMAs, the costs of the other SAMAs evaluated would be higher than the associated benefits.

5.3.4 Cost-Beneficial SAMAs

Highlighted in ***bold italics*** in Table 5.3-5 are the four potentially cost-beneficial SAMAs (157, 165, 192 and 193).

Table 5.3-5. SAMA cost-benefit Phase-II analysis for Seabrook

Analysis case & applicable SAMAs (where multiples, only number & minimum cost are listed)	Modeling assumptions	% Risk reduction		Total benefit ($)		Cost ($)
				Baseline (with 2.1 multiplier)		
		CDF	Pop. dose	Internal + External	with uncertainty	
No SBO: Five SAMAs analyzed	Eliminate failure of the emergency diesel generators (EDGs)	27	12	160K (330K)	300K (620K)	>1.0M (minimum of six)
No LOOP: Five SAMAs analyzed	Eliminate LOOP events	42	36	340K (700K)	640K (1.3M)	>2.4M (minimum of three)

Analysis case & applicable SAMAs (where multiples, only number & minimum cost are listed)	Modeling assumptions	% Risk reduction		Total benefit ($)		Cost ($)
				Baseline (with 2.1 multiplier)		
		CDF	Pop. dose	Internal + External	with uncertainty	
No loss of 4 kilovolt (kV) in-feed breakers: #21—Develop procedures to repair or replace failed 4 kV breakers	Eliminate failure of the 4KV bus in-feed breakers	1	<1	8K (17K)	15K (32K)	Screened
No loss of high pressure injection: Three SAMAs analyzed	Eliminate failure of the high pressure injection system	68	52	470K (980K)	890K (1.9M)	>5.0M (minimum of three)
No loss of low pressure injection: #28—Add a diverse low pressure injection system	Eliminate failure of the low pressure injection system	11	29	160K (340K)	300K (640K)	>1.0M
No depletion of reactor water storage tank (RWST): Two SAMAs analyzed	Eliminate RWST running out of water	28	12	160K (330K)	300K (630K)	>1.0M (minimum of both)
No small LOCAs: #41—Create a reactor coolant depressurization system	Eliminate all small LOCA events	7	2	33K (70K)	63K (130K)	>1.0M
No DC dependence for SW: #43—Add redundant DC control power for SW pumps	Eliminate the dependence of the SW pumps on DC power	1	1	10K (21K)	19K (40K)	>100K
No loss of component cooling water (CCW): Two SAMAs analyzed	Eliminate failure of the CCW pumps	25	23	180K (380K)	350K (730K)	>1.0M (minimum of both)
No reactor coolant pump (RCP) seal LOCAs: Seven SAMAs analyzed	Eliminate all RCP seal LOCA events	11	12	92K (170K)	180K (370K)	>500K (minimum of seven)
No loss of feedwater: #79—Install bigger pilot operated relief valve so only one is required	Eliminate all loss of feedwater events	12	7	73K (150K)	140K (290K)	>1.0M
No heating, ventilation, and air conditioning (HVAC) dependence for CS, SI, RH, & containment building spray (CBS): #80—Provide a redundant train or means of ventilation	Eliminate the dependence of CS, SI, residual heat removal (RHR), & CBS pumps on HVAC	8	1	32K (67K)	61K (130K)	>500K
No HVAC dependence for EFW: #84—Switch for emergency feedwater (EFW) room fan power supply to station batteries	Eliminate loss of EFW ventilation	<1	<1	<1K (<1K)	<1K (<2K)	>250K

Analysis case & applicable SAMAs (where multiples, only number & minimum cost are listed)	Modeling assumptions	% Risk reduction		Total benefit ($)		Cost ($)
				Baseline (with 2.1 multiplier)		
		CDF	Pop. dose	Internal + External	with uncertainty	
No containment failure due to overpressure: Four SAMAs analyzed	Eliminate all containment failures due to overpressure	0	36	160K (340K)	310K (650K)	>3.0M (minimum of six)
No hydrogen burns or detonations: Three SAMAs analyzed	Eliminate all hydrogen ignition/burns	0	0	<1K (<1K)	<1K (<1K)	>100K (minimum of three)
No failure of operator action to transfer to long-term recirculation following large LOCA: #105—Delay containment spray actuation after a large LOCA	Eliminate the human failure to complete/ ensure the RHR/low head safety injection (LHSI) transfer to long term recirculation during large LOCA events	2	<1	7.2K (15K)	14K (29K)	>100K
Reduce failure to isolate containment by half: Two SAMAs analyzed	Reduce risk from all containment isolation failures by 50%	0	19	100K (220K)	200K (420K)	>500K (minimum of both)
Reduce ISLOCA risk by half	Reduce ISLOCA event risk by 50%	1	3	14K (30K)	27K (60K)	>100K
No ISLOCAs: Two SAMAs analyzed	Eliminate all ISLOCAs	2	7	28K (60K)	53K (110K)	>190K (minimum of both)
No STGRs: Five SAMAs analyzed	Eliminate all SGTR events	3	17	86K (180K)	160K (345K)	>500K (minimum of five)
No ATWSs: Four SAMAs analyzed	Eliminate all ATWS events	3	11	70K (150K)	130K (280K)	>500K (minimum of four)
No piping system LOCAs: #147—Install digital large break LOCA protection system	Eliminate all piping failure LOCAs	10	12	100K (220K)	200K (410K)	>500K
No secondary side depressurization from stem line break upstream of MSIVs: #153—Install secondary side guard pipes up to the main steam isolation valves	Eliminate all steam line break events	0	<1	3K (7K)	6K (13K)	>500K

Analysis case & applicable SAMAs (where multiples, only number & minimum cost are listed)	Modeling assumptions	% Risk reduction		Total benefit ($)		Cost ($)
				Baseline (with 2.1 multiplier)		
		CDF	Pop. dose	Internal + External	with uncertainty	
No operator error when aligning & loading SEPS DGs: #154—Modify SEPS design to accommodate: (a) automatic bus loading, (b) automatic bus alignment	Eliminate failure of all operator actions to align & load the SEPS DGs	NP*	NP	33K (68K)	62K (130K)	>750K
Provide independent AC power to battery chargers: ***#157—Provide independent AC power source for battery chargers; for example, provide portable generator to charge station battery***	***Eliminate failure of operator action to shed DC loads to extend batteries to 12 hours & eliminate failure to recover offsite power for plant-related, grid-related, & weather-related LOOP events***	***4***	***2***	***23K (48K)***	***45K (95K)***	***30K***
#159—Install additional batteries						>1.0M
No depletion of condensate storage: Two SAMAs analyzed	Eliminate CST running out of water	1	1	9K (18K)	16K (34K)	>40K (minimum of both)
No loss of turbine-driven auxiliary feedwater (TDAFW): #163—Install third EFW pump (steam-driven)	Eliminate failure of the TDAFW train	19	9	100K (210K)	190K (400K)	>2.0M
Guaranteed success of RWST long-term makeup without recirculation: ***#165—RWST fill from firewater during containment injection—Modify 6" RWST Flush Flange to have a 2½-inch female fire hose adapter with isolation valve***	***Guaranteed success of RWST makeup for long term sequences where recirculation is not available***	***10***	***8***	***75K (160K)***	***120K (300K)***	***50K***
No fire in turbine building at west wall or relay room: #175—Improve fire detection in turbine building relay room	This SAMA has been implemented (NextEra 2011b)					
No LOCA via PORV due to control room fire: #179—Fire induced LOCA response procedure from alternate shutdown panel	Eliminate control room fire causing opening of the PORV & a LOCA	1	<1	4K (8K)	7K (15K)	>20K

Analysis case & applicable SAMAs (where multiples, only number & minimum cost are listed)	Modeling assumptions	% Risk reduction		Total benefit ($)		Cost ($)
		CDF	Pop. dose	Baseline (with 2.1 multiplier)		
				Internal + External	with uncertainty	
No failures due to seismic relay chatter: #181—Improve relay chatter fragility	Eliminate all seismic relay chatter failures	9	12	100K (210K)	200K (410K)	>600K
No seismic-induced loss of DGs or TDEFW: #182—Improve seismic capacity of EDGs & steam-driven EFW pump	Eliminate all seismic failures of EDGs or turbine-driven EFW	0	0	<1K (<1K)	<1K (<1K)	>500K
Containment purge valves are always closed: #184—Control/reduce time that the containment purge valves are in open position	Eliminate possibility of containment purge valves being open at the time of an event	0	≈0	<1K (<1K)	<1K (<1K)	>20K
No CDF contribution from pre-existing containment leakage: #186—Install containment leakage monitoring system	Eliminate all CDF contribution from pre-existing containment leakage	NP	NP	11K (23K)	20K (43K)	>500K
Benefits of SEPS success criteria change, from 2 of 2 SEPS DGs to 1 of 2 SEPS DGs: #189—Modify or analyze SEPS capability; 1 of 2 SEPS for LOSP non-SI loads, 2 of 2 for LOSP SI loads	Modify fault tree so that one of two SEPS DGs are required rather than both SEPS DGs being required	7	1	30K (60K)	60K (120K)	>300K
No inadvertent failures of redundant temperature logic during loss of primary component cooling water (PCCW): #191—Remove the 135ºF temperature trip of the PCCW pumps	Eliminate inadvertent failure of the redundant temperature element/logic of the associated primary component cooling (PCC) division for both loss of PCCW initiating events & loss of PCCW mitigative function	<1	<1	<1K (<1K)	<1K (<1K)	>100K
No flooding in control building due to fire protection system actuation: ***#192—Install a globe valve or flow limiting orifice upstream in the fire protection system***	***Eliminate control building fire protection flooding initiators***	***25***	***6***	***160K (340K)***	***310K (640K)***	***200K***

Analysis case & applicable SAMAs (where multiples, only number & minimum cost are listed)	Modeling assumptions	% Risk reduction		Total benefit ($)		Cost ($)
				Baseline (with 2.1 multiplier)		
		CDF	Pop. dose	Internal + External	with uncertainty	
No AC dependence for containment isolation valve CS-V-167: ***#193—Hardware change to eliminate MOV AC power dependency***	***Eliminate MOV AC power dependency by replacing the MOV with a fail-closed air-operated valve (AOV)***	*0*	*35*	*190K (400K)*	*365K (770K)*	*300K*

* NP = Not Provided

5.3.5 Conclusions

NextEra compiled a list of 191 SAMAs based on a review of the most significant basic events from the plant-specific PRA, insights from the plant-specific IPE and IPEEE, review of other industry documentation, and insights from Seabrook personnel. Of these, 117 SAMAs were eliminated qualitatively, leaving 74 candidate SAMAs for evaluation. An additional 13 SAMAs were eliminated due to having estimated implementation costs that would exceed the dollar value associated with eliminating all severe accident risk at Seabrook, leaving 61 candidate SAMAs for evaluation. These underwent more detailed design and cost estimates to show that two were potentially cost-beneficial in the baseline analysis (SAMAs 157 and 165). NextEra also performed additional analyses to evaluate the impact of parameter choices and uncertainties, resulting in the addition of no potentially cost-beneficial SAMAs. However, in response to NRC staff RAIs, NextEra further identified two additional SAMAs (SAMAs 192 and 193) as being potentially cost beneficial. NextEra has indicated that all four potentially cost-beneficial SAMAs will be entered into the Seabrook long-range plan development process for further implementation consideration.

The NRC staff reviewed the NextEra analysis and concludes that the methods used and their implementation were acceptable. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by NextEra are reasonable and sufficient for the license renewal submittal. The level of treatment of SAMAs for external events was deemed sufficient to support the conclusion that 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 inclusion of a multiplier to account for the additional risk of seismic events. Therefore, the NRC staff concurs with NextEra's identification of potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of SAMAs 157, 165, 192, and 193 by NextEra through its long-range planning process is appropriate. As stated by the applicant, the four potentially cost-beneficial SAMAs are not aging-related. The staff reviewed SAMAs 157, 165, 192, and 193. These mitigative alternatives do not involve aging management of passive, long-lived systems, structures, or components during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54.

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6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE, SOLID WASTE MANAGEMENT, AND GREENHOUSE GAS

6.1 The Uranium Fuel Cycle

This section addresses issues related to the uranium fuel cycle and solid waste management during the period of extended operation (listed in Table 6.1-1). The uranium cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The generic potential impacts of the radiological and non-radiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the Generic Environmental Impact Statement (GEIS) (NRC 1996, 1999). They are based, in part, on the generic impacts provided in Title 10, Part 51.51(b) of the *Code of Federal Regulations* (10 CFR 51.51(b)), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor."

Table 6.1-1. Issues related to the uranium fuel cycle and solid waste management.

There are nine generic issues related to the fuel cycle and waste management. There are no site-specific issues.

Issues	GEIS Sections	Category
Offsite radiological impacts (individual effects from other than the disposal of spent fuel & high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6	1
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
Offsite radiological impacts (spent fuel & high-level waste disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
Non-radiological 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	1
Low-level waste storage & 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	1
Mixed waste storage & 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	1
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	1
Non-radiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6	1
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1	1

The staff of the U.S. Nuclear Regulatory Commission (NRC) did not identify any new and significant information related to the uranium fuel cycle during its review of the Seabrook Station (Seabrook) environmental report (ER) (NextEra 2010), the site visit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS.

For these Category 1 issues, the GEIS concludes that the impacts are SMALL except for the offsite radiological collective impacts from the fuel cycle and from high-level waste and spent fuel disposal, which the Commission concludes are acceptable.

6.2 Greenhouse Gas Emissions

This section discusses the potential impacts from greenhouse gases (GHGs) emitted from the nuclear fuel cycle. The GEIS does not directly address these emissions, and its discussion is limited to an inference that substantial carbon dioxide (CO_2) emissions may occur if coal- or oil-fired alternatives to license renewal are carried out.

6.2.1 Existing Studies

Since the development of the GEIS, the relative volumes of GHGs emitted by nuclear and other electricity-generating methods have been widely studied. However, estimates and projections of the carbon footprint of the nuclear power lifecycle vary depending on the type of study done. Additionally, considerable debate exists among researchers regarding the relative effects of nuclear and other forms of electricity generation on GHG emissions. Existing studies on GHG emissions from nuclear power plants generally take one of the following forms:

- qualitative discussions of the potential to use nuclear power to reduce GHG emissions and mitigate global warming
- technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle or entire nuclear power plant life cycle and comparisons to the operational or life cycle emissions from other energy generation alternatives

6.2.1.1 Qualitative Studies

The qualitative studies consist primarily of broad, large-scale public policy or investment evaluations on whether an expansion of nuclear power is likely to be a technically, economically, or politically workable means of achieving global GHG reductions. Studies found by the NRC staff during the subsequent literature search include the following:

- Evaluations determined if investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider, 2000; IAEA, 2000; NEA, 2002). Ultimately, the parties to the Kyoto Protocol did not approve nuclear power as a component under the Clean Development Mechanism (CDM) due to safety and waste disposal concerns (NEA, 2002).
- Analyses were developed to assist governments, including the U.S. Government, in making long-term investment and public policy decisions in nuclear power (Keepin, 1988; Hagen, et al., 2001; MIT, 2003).

Although the qualitative studies sometimes reference and analyze the existing quantitative estimates of GHGs produced by the nuclear fuel cycle or life cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are typically not directly applicable to an evaluation of GHG emissions associated with the proposed license renewal for a given nuclear power plant.

6.2.1.2 Quantitative Studies

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature and were useful to the NRC staff's efforts to address relative GHG emission levels. Examples of these studies include—but are not limited to—Mortimer (1990), Andseta, et. al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), Parliamentary Office of Science and Technology (POST) (2006), Atomic Energy Authority (AEA) (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparing these studies, and others like them, is difficult because the assumptions and components of the lifecycles that the authors evaluate vary widely. Examples of areas in which differing assumptions make comparing the studies difficult include the following:

- energy sources that may be used to mine uranium deposits in the future
- reprocessing or disposal of spent nuclear fuel
- current and potential future processes to enrich uranium and the energy sources that will power them
- estimated grades and quantities of recoverable uranium resources
- estimated grades and quantities of recoverable fossil fuel resources
- estimated GHG emissions other than CO_2, including the conversion to CO_2 equivalents per unit of electric energy produced
- performance of future fossil fuel power systems
- projected capacity factors for alternatives means of generation
- current and potential future reactor technologies

In addition, studies may vary with respect to whether all or parts of a power plant's lifecycle are analyzed. For example, a full lifecycle analysis will typically address plant construction, operations, resource extraction (for fuel and construction materials), and decommissioning. A partial lifecycle analysis primarily focuses on operational differences.

In the case of license renewal, a GHG analysis for that portion of the plant's lifecycle (operation for an additional 20 years) would not involve GHG emissions associated with construction because construction activities have already been completed at the time of relicensing. In addition, the proposed action of license renewal would also not involve additional GHG emissions associated with facility decommissioning because that decommissioning must occur whether the facility is relicensed or not. However, in some of the above-mentioned studies, the specific contribution of GHG emissions from construction, decommissioning, or other portions of a plant's lifecycle cannot be clearly separated from one another. In such cases, an analysis of GHG emissions would overestimate the GHG emissions attributed to a specific portion of a plant's lifecycle. Nonetheless, these studies supply some meaningful information with respect to the relative magnitude of the emissions among nuclear power plants and other forms of electric generation, as discussed in the following sections.

In Tables 6.2-1, 6.2-2, and 6.2-3, the NRC staff presents the results of the above-mentioned quantitative studies to supply a weight-of-evidence evaluation of the relative GHG emissions that may result from the proposed license renewal as compared to the potential alternative use of coal-fired, natural gas-fired, and renewable generation. Most studies from Mortimer (1990) onward suggest that uranium ore grades and uranium enrichment processes are leading determinants in the ultimate GHG emissions attributable to nuclear power generation. These studies show that the relatively lower order of magnitude of GHG emissions from nuclear power, when compared to fossil-fueled alternatives (especially natural gas), could potentially disappear if available uranium ore grades drop sufficiently while enrichment processes continued to rely on the same technologies.

6.2.1.3 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Considering that coal fuels the largest share of electricity generation in the U.S., and that its burning results in the largest emissions of GHGs for any of the likely alternatives to nuclear power generation (including Seabrook), most of the available quantitative studies focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle—and, in some cases, the nuclear lifecycle—as compared to an equivalent coal-fired plant, are presented in Table 6.2-1. This table does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-1. Nuclear greenhouse gas emissions compared to coal

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta et al. (1998)	Nuclear energy produces 1.4% of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Coal—264–357 g C_{eq}/kWh
Storm van Leeuwen & Smith (2005)	Authors did not evaluate nuclear versus coal.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Coal—950 g C_{eq}/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g C_{eq}/kWh Coal—>1000 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would increase nuclear to 6.8 g C_{eq}/kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90%.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Coal—950–1250 g C_{eq}/kWh
Fthenakis & Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones (2007)	Author did not evaluate nuclear versus coal.

6.2.1.4 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle—and, in some cases, the nuclear lifecycle—as compared to an equivalent natural gas-fired plant, are presented in Table 6.2-2. This table does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-2. Nuclear greenhouse gas emissions compared to natural gas

Source	GHG Emission Results
Mortimer (1990)	Author did not evaluate nuclear versus natural gas.
Andseta et al. (1998)	Author did not evaluate nuclear versus natural gas.
Spadaro (2000)	Nuclear—2.5–5.7 g Ceq/kWh Natural Gas—120–188 g Ceq/kWh
Storm van Leeuwen & Smith (2005)	Nuclear fuel cycle produces 20–33% of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g Ceq/kWh Cogeneration Combined Cycle Natural Gas—150 g Ceq/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g Ceq/kWh Natural Gas—500 g Ceq/kWh Note: Decrease of uranium ore grade to 0.03% would increase nuclear to 6.8 g Ceq/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90%.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8–24 g Ceq/kWh Natural Gas—440–780 g Ceq/kWh
Fthenakis & Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones (2007)	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15–27% of the GHG emissions of natural gas.

6.2.1.5 Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6.2-3. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because of the large variation in efficiencies due to their different sources and locations. For example, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved (if used at all). Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources. As noted in Section 6.2.1.2, the following table does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-3. Nuclear greenhouse gas emissions compared to renewable energy sources

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta et al. (1998)	Author did not evaluate nuclear versus renewable energy sources.
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Solar Photovoltaic (PV)—27.3–76.4 g C_{eq}/kWh Hydroelectric—1.1–64.6 g C_{eq}/kWh Biomass—8.4–16.6 g C_{eq}/kWh Wind—2.5–13.1 g C_{eq}/kWh
Storm van Leeuwen & Smith (2005)	Author did not evaluate nuclear versus renewable energy sources.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Solar PV—125 g C_{eq}/kWh Hydroelectric—50 g C_{eq}/kWh Wind—20 g C_{eq}/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g C_{eq}/kWh Biomass—25–93 g C_{eq}/kWh Solar PV—35–58 g C_{eq}/kWh Wave/Tidal—25–50 g C_{eq}/kWh Hydroelectric—5–30 g C_{eq}/kWh Wind—4.64–5.25 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would increase nuclear to 6.8 g C_{eq}/kWh.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Solar PV—43–73 g C_{eq}/kWh Hydroelectric—1–34 g C_{eq}/kWh Biomass—35–99 g C_{eq}/kWh Wind—8–30 g C_{eq}/kWh
Fthenakis & Kim (2007)	Nuclear—16–55 g C_{eq}/kWh Solar PV—17–49 g C_{eq}/kWh
Dones (2007)	Author did not evaluate nuclear versus renewable energy sources.

6.2.2 Conclusions: Relative Greenhouse Gas Emissions

The sampling of data presented in Tables 6.2-1, 6.2-2, and 6.2-3 demonstrates the challenges of any attempt to determine the specific amount of GHG emission attributable to nuclear energy production sources, as different assumptions and calculation methods will yield differing results. The differences and complexities in these assumptions and analyses will further increase when they are used to project future GHG emissions. Nevertheless, several conclusions can be drawn from the information presented.

First, the various studies show a general consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation. The GHG emissions from a complete nuclear fuel cycle currently range from 2.5–55 grams of Carbon equivalent per Kilowatt hour (g C_{eq}/kWh), as compared to the use of coal plants (264–1250 g C_{eq}/kWh) and natural gas plants (120–780 g C_{eq}/kWh). The studies also give estimates of GHG emissions from five renewable energy sources based on current technology. These estimates included solar-photovoltaic (17–125 g C_{eq}/kWh), hydroelectric (1–64.6 g C_{eq}/kWh), biomass (8.4–99 g C_{eq}/kWh), wind (2.5–30 g C_{eq}/kWh), and tidal (25–50 g C_{eq}/kWh). The range of these estimates is wide, but the general conclusion is that current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as from these renewable energy sources.

Second, the studies show no consensus regarding future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors about the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors to include changes in technology. Similar disagreement exists about future GHG emissions associated with coal and natural gas for electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources and is expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed Seabrook relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The NRC staff bases this conclusion on the following rationale:

- As shown in Table 6.2-1and Table 6.2-2, the current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.
- License renewal of a nuclear power plant like Seabrook will involve continued GHG emissions due to uranium mining, processing, and enrichment, but it will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not).
- Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the Seabrook periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements could extend this timeframe.

With respect to comparison of GHG emissions among the proposed Seabrook license renewal action and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, and constructing facilities of all types. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same order of magnitude. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power—and because most renewable energy sources lack a fuel component—it is likely that GHG emissions from renewable energy sources would be lower than those associated with Seabrook at some point during the period of extended operation.

The NRC staff also supplies an additional discussion about the contribution of GHG to cumulative air quality impacts in Section 4.11.2 of this supplemental environmental impact statement (SEIS).

6.3 References

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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 on 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—notes a range of impacts for each environmental issue.

Additionally, 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; NRC, 1999).[1] 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 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:

- 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 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).
- 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; therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

7.1 Decommissioning

Table 7.1-1 lists the Category 1 issues from Table B-1 of Title 10 of the *Code of Federal Regulations* (CFR) Part 51, Subpart A, Appendix B that are applicable to Seabrook Station (Seabrook) decommissioning following the renewal term.

Table 7.1-1. Issues Related to Decommissioning

Issue	GEIS Section(s)	Category
Radiation doses	7.3.1; 7.4	1
Waste management	7.3.2; 7.4	1

[1] 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.

Issue	GEIS Section(s)	Category
Air quality	7.3.3; 7.4	1
Water quality	7.3.4; 7.4	1
Ecological resources	7.3.5; 7.4	1
Socioeconomic impacts	7.3.7; 7.4	1

Decommissioning would occur whether Seabrook shuts down at the end of its current operating license or at the end of the period of extended operation. There are no site-specific issues related to decommissioning.

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

Radiation doses. Based on information in the GEIS, the NRC noted that "[d]oses 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 person-rem (1 person-mSv) caused by buildup of long-lived radionuclides during the license renewal term."

Waste management. Based on information in the GEIS, the NRC noted that "[d]ecommissioning 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."

Air quality. Based on information in the GEIS, the NRC noted that "[a]ir 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."

Water quality. Based on information in the GEIS, the NRC noted that "[t]he 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."

Ecological resources. Based on information in the GEIS, the NRC noted that "[d]ecommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts."

Socioeconomic Impacts. Based on information in the GEIS, the NRC noted that "[d]ecommissioning 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."

NextEra Energy Seabrook, LLC (NextEra) stated in its Environmental Report (ER) that it is not aware of any new and significant information on the environmental impacts of Seabrook license renewal (NextEra, 2010). The NRC staff has not found any new and significant information during its independent review of the NextEra ER, the site visit, the scoping process, or 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. For all of 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 be warranted.

7.2 References

NextEra Energy Seabrook, LLC (NextEra), 2010, "License Renewal Application, Seabrook Station," Appendix E, "Applicant's Environmental Report, Operating License Renewal Stage," May 25, 2010, Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML101590092 and ML101590089.

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8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The National Environmental Policy Act (NEPA) requires the consideration of a range of reasonable alternatives to the proposed action in an environmental impact statement (EIS). In this case, the proposed action is whether to issue a renewed license for the Seabrook Station (Seabrook), which will allow the plant to operate for 20 years beyond its current license expiration date. A license is just one of a number of authorizations that a licensee must obtain in order to operate its nuclear plant. Energy-planning decision makers and the owners of the nuclear power plant ultimately decide if the plant will operate, and economic and environmental considerations play a primary role in this decision. The U.S. Nuclear Regulatory Commission's (NRC's) responsibility is to ensure the safe operation of nuclear power facilities and not to formulate energy policy or encourage or discourage the development of alternative power generation.

The license renewal process is designed to assure safe operation of the nuclear power plant during the license renewal term. Under the NRC's environmental protection regulations in Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), which implement Section 102(2) of NEPA, renewal of a nuclear power plant operating license requires the preparation of an EIS.

To support the preparation of these EISs, the NRC prepared the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)," NUREG-1437, in 1996. The 1996 GEIS for license renewal was prepared to assess the environmental impacts associated with the continued operation of nuclear power plants during the license renewal term. The intent was to determine which environmental impacts would result in essentially the same impact at all nuclear power plants and which ones could result in different levels of impacts at different plants and would require a plant-specific analysis to determine the impacts. For those issues that could not be generically addressed, the NRC develops a plant-specific supplemental environmental impact statement (SEIS) to the GEIS.

NRC regulations 10 CFR 51.71(d) implementing NEPA for license renewal require that a SEIS consider the following:

> Consider and weigh the environmental effects of the proposed action [license renewal]; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental effects and consideration of the economic, technical, and other benefits and costs of the proposed action.

In this chapter, the potential environmental impacts of alternatives to license renewal for Seabrook are examined as well as alternatives that may reduce or avoid adverse environmental impacts from license renewal, when and where these alternatives are applicable.

While the 1996 GEIS reached generic conclusions regarding many environmental issues associated with license renewal, it did not determine which alternatives are reasonable or reach conclusions about site-specific environmental impact levels. As such, the NRC must evaluate environmental impacts of alternatives on a site-specific basis.

As stated in Chapter 1 of this document, alternatives to the proposed action of license renewal for Seabrook must meet the purpose and need for issuing a renewed license. They must "provide an option that allows for baseload power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning decision-makers, such as State, utility, and, where authorized, Federal agencies (other than NRC)."

Alternatives Evaluated In-Depth:

- Natural-gas-fired combined-cycle (NGCC)
- New nuclear
- Combination alternative (NGCC and Wind)

Other Alternatives Considered:

- Wind power
- Solar power
- Wood waste
- Conventional hydroelectric power
- Ocean wave and current energy
- Geothermal power
- Municipal solid waste (MSW)
- Biofuels
- Oil-fired power
- Fuel cells
- Coal-fired power
- Energy conservation and energy efficiency
- Purchased power

The NRC ultimately makes no decision about which alternative (or the proposed action) to carry out because that decision falls to utility, State, or other Federal officials to decide. Comparing the environmental effects of these alternatives will help the NRC decide whether the adverse environmental impacts of license renewal are great enough to deny the option of license renewal for energy-planning decision makers (10 CFR 51.95(c)(4)). If the NRC acts to issue a renewed license, all of the alternatives, including the proposed action, will be available to energy planning decision makers. If NRC decides not to renew the license (or takes no action at all), then energy-planning decision makers may no longer elect to continue operating Seabrook and will have to resort another alternative—which may or may not be one of the alternatives we consider in this section—to meet their energy needs now being satisfied by Seabrook.

In evaluating alternatives to license renewal, energy technologies or options currently in commercial operation are considered, as well as some technologies not currently in commercial operation but likely to be commercially available by the time the current Seabrook operating license expires. The current operating license for the reactor at Seabrook will expire on March 15, 2030. Our analysis assumes that an alternative must be available (constructed, permitted, and connected to the grid) by the time the current Seabrook license expires.

Alternatives that cannot meet future system needs by providing amounts of baseload power equivalent to Seabrook's current generating capacity and whose costs or benefits do not justify inclusion in the range of reasonable alternatives were eliminated from detailed study. The remaining alternatives were evaluated and are discussed in-depth in this section. Each alternative eliminated from detailed study is briefly discussed, and a basis for its removal is provided at the end of this section. In total, 16 energy technology options and alternatives to the proposed action were considered (see text box) and then narrowed to the 3 alternatives considered in Sections 8.1–8.3.

The 1996 GEIS presents an overview of some energy technologies but does not reach any conclusions about which alternatives are most appropriate. Since 1996, many energy technologies have evolved significantly in capability and cost, while regulatory structures have changed to either promote or impede development of particular alternatives.

As a result, the analyses include updated information from the following sources:

- Energy Information Administration (EIA)
- other offices within the Department of Energy (DOE)
- U.S. Environmental Protection Agency (EPA)
- New England's Independent System Operator (ISO-NE)
- industry sources and publications

- information submitted by the applicant in the NextEra Energy Seabrook, LLC's (NextEra) Environmental Report (ER)

The evaluation of each alternative considers the environmental impacts across seven impact categories: (1) air quality, (2) groundwater use and quality, (3) surface water use and quality, (4) ecology, (5) human health, (6) socioeconomics, and (7) waste management. A three-level standard of significance—SMALL, MODERATE, or LARGE—is used to indicate the intensity of environmental effects for each alternative undergoing in-depth evaluation. The order of presentation is not meant to imply increasing or decreasing level of impact. Nor does it imply that an energy-planning decision maker would select one or another alternative.

For each alternative where it is feasible to do so, the NRC considers the environmental effects of locating the alternative at the existing Seabrook site, as well as at an alternate site. Selecting the existing plant site allows for the maximum use of existing transmission and cooling system infrastructures and minimizes the overall environmental impact. However, in the case of Seabrook, there may not be sufficient land available to site some of the alternatives evaluated here while, at the same time, allowing the continued operation of the reactor until its license expiration date.

The ISO-NE provides electric service to the six states comprising northern New England: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. To ensure that the alternatives analysis was consistent with State or regional energy policies, the NRC reviewed energy related statutes, regulations, and policies within the ISO-NE states. The current generation capacity mix and electricity production data within the ISO-NE service area was also considered. New Hampshire's total generating capacity of 4,100 megawatts (MW), approximately one-third of which comes from nuclear, represents 13 percent of the total capacity in the ISO-NE service area. However, New Hampshire accounts for only 9 percent of the region's total consumption, making New Hampshire a net exporting area for electricity (ISO-NE, 2010b). The NRC concludes that, because a loss of power from the Seabrook reactor would potentially impact electricity consumers throughout the ISO-NE service area, the evaluation of alternatives should consider alternatives located throughout the entire ISO-NE service area, not just New Hampshire.

Sections 8.1–8.5 describe the environmental impacts of alternatives to license renewal. These include an NGCC in 8.1, new nuclear generation in 8.2, and a combination alternative of NGCC and wind in Section 8.3. In Section 8.4, alternatives considered but eliminated from detailed study are briefly discussed. Finally, the environmental effects that may occur if NRC takes no action and does not issue a renewed license for Seabrook are described in Section 8.5. Section 8.6 summarizes, in detail, the impacts of each of the alternatives considered.

8.1 Natural-Gas-Fired Combined-Cycle Alternative

This section presents the environmental impacts of an NGCC generation at the Seabrook site.

Natural gas accounted for 42.4 percent of all electricity generation in the ISO-NE service area in 2009, accounting for the greatest share of electrical power (ISO-NE, 2010a). Development of new natural gas-fired plants may be affected by future regulations that may limit greenhouse gas (GHG) emissions. A gas-fired power plant, however, produces markedly fewer GHGs per unit of electrical output than a coal-fired plant of the same electrical output. Natural gas-fired power plants are feasible, commercially available options for providing electric-generating capacity beyond Seabrook's current license expiration.

Combined-cycle power plants differ significantly from coal-fired and existing nuclear power plants. Combined-cycle plants derive the majority of their electrical output from a gas-turbine and then generate additional power—without burning any additional fuel—through a second, steam-turbine cycle. The exhaust gas from the gas turbine is still hot enough to boil water to steam. Ducts carry the hot exhaust to a heat-recovery steam generator, which produces steam to drive a steam turbine and produce additional electrical power. The combined-cycle approach is significantly more efficient than any one cycle on its own; thermal efficiency can exceed 60 percent. Because the natural gas-fired alternative derives much of its power from a gas turbine cycle, and because it wastes less heat than the existing Seabrook plant, it requires significantly less cooling water.

To replace the 1,245 megawatt electric (MW(e)) power that Seabrook generates, and to compensate for differences in the 92 percent capacity factor of a nuclear reactor and the expected 85 percent capacity factor of a typical NGCC plant, the NRC staff assumes power equivalency would require an NGCC facility with a nameplate capacity of 1,348 MW(e). Typical power trains for large-scale combined cycle power generation would involve one, two, or three combined-cycle units, available in a variety of standard sizes. To complete the assessment of an NGCC alternative, the NRC staff presumes that appropriately sized units could be assembled to annually produce electrical power in amounts equivalent to the Seabrook reactor. The combined-cycle units are presumed to each be Advanced F-Class design, equipped with water or steam injection as a pre-combustion control to suppress nitrogen oxide (NO_x) formation and selective catalytic reduction (SCR) of the exhaust with ammonia for post-combustion control of NO_x emissions.

As noted above, the gas-fired alternative would require much less cooling water than Seabrook because it operates at a higher thermal efficiency (nearly 60 percent) and because it requires much less water for steam cycle condenser cooling. The existing once-through cooling system now supporting the reactor would be able to support a natural gas alternative on the Seabrook site without any increase in its current capacity. However, in recognition of the mounting concerns for the potential adverse impacts to aquatic ecosystems from once-through cooling systems and to ensure a conservative evaluation, NRC assumes that the NGCC alternative would not use the existing once-through cooling system. Instead, it would be supported by a closed loop cooling system, using seawater recovered from the existing cooling water intake and discharging blowdown water through the existing cooling system discharge pipe. Under such a configuration, the rate of withdrawal of seawater to support steam cycle cooling would be dramatically reduced.

This gas-fired alternative would produce relatively little waste, primarily in the form of spent catalysts used for control of NO_x emissions. The NRC staff presumes that the SCR technology employed would involve introducing ammonia into the exhaust ducts of the cooling towers where it combines with NO_x in a nickel catalyst bed to form zero-valent nitrogen and water. Based on data provided by the Institute of Clean Air Companies, EPA acknowledges that typical SCR devices can demonstrate removal efficiencies of between 70 and 90 percent (EPA, 2000a).

The NRC staff presumes that buildable land of sufficient acreage and appropriate location would be available to support an onsite natural gas combined cycle plant and its new closed loop cooling system. Environmental impacts from construction of the gas-fired alternative will include the release of criteria pollutants and GHGs from the operation of construction equipment and construction vehicles, the generation of fugitive dust from ground disturbing activities, construction noise, and terrestrial habitat fragmentation. Site crews will clear vegetation from the site, prepare the site surface relocating existing facilities, if necessary, and begin excavations for foundations and buried utilities before other crews begin actual construction on the plant and any associated infrastructure. Offsite impacts will also occur as a result of construction of a natural gas pipeline connecting the site to existing infrastructure. Modifications to existing electricity transmission infrastructure are expected to be minimal and will have only minimal environmental impacts. Modifications and rejuvenation of a rail spur connecting to Seabrook may also create some short-term impacts, including criteria pollutant releases and noise. Construction related impacts will all be of relatively short duration.

Environmental impacts from the NGCC alternative are summarized in Table 8.1-1.

Table 8.1-1. Environmental impacts of NGCC alternative

	New NGCC at the Seabrook Site
Air Quality	SMALL to MODERATE
Groundwater	SMALL
Surface Water	SMALL
Aquatic & Terrestrial Resources	SMALL
Human Health	SMALL
Socioeconomics	SMALL to MODERATE
Historic and Archaeological	SMALL to MODERATE
Waste Management	SMALL

8.1.1 Air Quality

Various Federal and State regulations aimed at controlling air pollution would impact a fossil fuel-fired power plant, including the NGCC alternative, located anywhere within the ISO-NE service area. Seabrook is located in Rockingham County, which is part of the Merrimack Valley Southern New Hampshire Interstate Air Quality Control Region. The portion of this control region, containing Seabrook, is currently a non-attainment area for 8-hour ozone. A new, gas-fired 1,348 MW(e) net generating plant developed at the Seabrook site would qualify as a new major source of criteria pollutants and require a New Source Review (NSR) and Prevention of Significant Deterioration of Air Quality Review. The natural, gas-fired plant would need to comply with the standards of performance for stationary gas turbines set forth in 40 CFR Part 60, Subpart GG.

Section 169A of the CAA (42 U.S.C. 7401) establishes a national goal of preventing future, and remedying existing, impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. The Regional Haze Rule, promulgated by EPA in 1999 and last amended in October 2006 (71 FR 60631), requires states to demonstrate reasonable progress towards the national visibility goal established in 1977 to prevent future impairment of visibility due to man-made pollution in Class I areas. The visibility protection regulatory requirements are contained in 40 CFR Part 51, Subpart P, including the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Federal Class I area. If a gas-fired alternative were located close to a mandatory Class I area, additional air pollution control requirements would potentially apply; however, there are no Class I areas within 50 miles of the Seabrook site.

In response to the Consolidated Appropriations Action of 2008 (Public Law 110-161), EPA recently promulgated final mandatory GHG reporting regulations for major sources (emitting more than 25,000 tons per year of all GHGs), effective in December 2009 (EPA, 2010a). This new NGCC plant would be subject to those reporting regulations. Future regulations may require control of CO_2 emissions.

Under the Federal Acid Rain Program, a new natural gas–fired plant would have to comply with Title IV of the CAA reduction requirements for SO_2 and NO_x, which are the main precursors of acid rain and the major cause of reduced visibility. Title IV establishes maximum SO_2 and NO_x emission rates from the existing plants and a system of the SO_2 emission allowances that can be used, sold, or saved for future use by new plants.

The Clean Air Interstate Rule (CAIR) was first promulgated by EPA in 2005, permanently capping SO_2 and NO_x emissions from stationary sources located in 28 states, including two ISO-NE states (Connecticut and Massachusetts). A new fossil fuel-fired source constructed in either of those states would be subject to revised emission limits for SO_2 and $NO_{x,}$ promulgated under CAIR. However, the Federal rule was vacated by the D.C. Circuit Court on February 8, 2008. In December 2008, the U.S. Court of Appeals for the D.C. Circuit reinstated the rule, allowing it to remain in effect but also requiring EPA to revise the rule and its implementation plan. On July 6, 2010, EPA proposed replacing CAIR with the Transport Rule for control of SO_2 and NO_x emissions that cross state lines, the regulations of which would be implemented in 2011 and finalized in 2012. It is expected that SO_2 emission allowances allocated to stationary sources under the Acid Rain Program would be used to meet SO_2 emission limits under CAIR. NO_x emission allowances would be allocated to sources, based on each impacted state's budget, under the Model NO_x Trading Program being formulated by EPA (EPA, 2011).

Finally, although there are no Federal rules requiring control of GHG emissions currently in effect, the New Hampshire Climate Change Action Plan (NHDES, 2009) sets a statewide goal of reducing GHG emissions by 80 percent of 1990 levels by 2050. Reaching that goal may ultimately involve establishment of state emission limits of GHG emissions from major stationary sources, and a new fossil fuel-fired facility located in New Hampshire would likely be subject to those controls. On a regional level, the Governors of all six of the ISO-NE states, together with Governors from Delaware, Maryland, New Jersey, and New York are signatories to the Regional Greenhouse Gas Initiative (RGGI) Memorandum of Understanding, executed initially on December 20, 2005, and since amended twice (RGGI, 2005; RGGI, 2006; RGGI, 2007). The RGGI establishes a regional cap on CO_2 emissions from the power sector and requires each power generator using fossil fuels to possess tradable CO_2 allowances for each ton of CO_2 they emit. It states subsequently promulgated regulations that establish budget trading programs for CO_2 allowances. Any fossil fuel-fired facility located within the ISO-NE states would be subject to that State's budget trading program and would be required to either install control equipment to reduce CO_2 emissions or trade for CO_2 allowances with other CO_2 sources to stay within its CO_2 emission allowance.

Using data and algorithms published by EPA and EIA, and performance guarantees provided by pollution control equipment vendors, the NRC staff projects the following emissions for an NGCC alternative to the Seabrook reactor:

- Sulfur oxides (SO_x)—104 tons (94 metric tons (MT)) per year
- NO_x—398 tons (361 MT) per year
- Carbon monoxide (CO)—918 tons (832 MT) per year
- Particulate matter less than or equal to 10 μm (PM_{10})—202 tons (183 MT) per year
- CO_2—3,364,526 tons (3,052,298 MT) per year

8.1.1.1 Sulfur and Nitrogen Oxides

As stated above, the new natural gas-fired alternative would produce 104 tons (94 MT) per year of SO_x and 398 tons (361 MT) per year of NO_x, based on the use of the dry low NO_x combustion technology and use of the SCR, in order to significantly reduce NO_x emissions.

The new plant would be subjected to the continuous monitoring requirements of SO_2, NO_x, and CO_2 specified in 40 CFR Part 75. The natural gas-fired plant would emit approximately 3.36 million tons (approximately 3.05 million MT) per year of (currently) unregulated CO_2 emissions.

8.1.1.2 Particulates

The new, natural gas-fired alternative would produce 202 tons (183 MT) per year of particulates, all of which would be emitted as PM_{10}. Small amounts of particulate would be released as drift from the newly installed closed loop cooling system's cooling tower (regardless of whether it involves a natural draft or mechanical draft tower). Particulate control would likely not be required, and this drift would not present a new impact to extant vegetation, which already experiences sea spray during some weather conditions.

8.1.1.3 Carbon Monoxide

Based on EPA emission factors (EPA, 1998), the NRC staff estimates that the total CO emissions would be approximately 918 tons (832 MT) per year.

8.1.1.4 Hazardous Air Pollutants

In December 2000, the EPA issued regulatory findings (EPA, 2000b) on emissions of hazardous air pollutants (HAPs) from electric utility steam-generating units. These findings indicated that natural gas-fired plants emit HAPs such as arsenic, formaldehyde and nickel and stated that "[t]he impacts due to hazardous air pollutants (HAP) emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary."

Impacts to air quality from the operation of the NGCC alternative would be the same at an alternative site or the Seabrook site. However, given the extant ambient air quality at an alternative site, regulatory authorities may introduce additional pollution control requirements, including derating the unit.

8.1.1.5 Construction Impacts

Activities associated with the construction of the new, natural gas-fired plant at the Seabrook site would cause some additional air impacts as a result of emissions from construction equipment and fugitive dust from operation of the earth-moving and material handling equipment. Impacts to climate change from the construction of an NGCC alternative would result primarily from the consumption of fossil fuels in reciprocating internal combustion engines (RICE) of construction vehicles and equipment, workforce vehicles used in commuting to and from the work site, and delivery vehicles. Analogous impacts would occur in association with offsite pipeline construction. All such impacts would be temporary. Workers' vehicles and motorized construction equipment would generate temporary criteria pollutant emissions. Dust control practices would reduce fugitive dust, which would be temporary in nature. Given the expected, relatively small workforces and a relatively short construction period for both the NGCC facility and the pipeline, the NRC staff concludes that the impact of vehicle exhaust emissions and fugitive dust from operation of earth-moving and material handling equipment would be SMALL.

The overall air quality impacts associated with construction of a new natural gas-fired plant located at the Seabrook site and with construction of a natural gas pipeline at offsite areas would be SMALL.

8.1.1.6 Additional Operating Impacts

In addition to the air quality impacts associated with operation of the NGCC facility, additional air quality impacts would result from vehicles used by the commuting operating workforce. However, the NGCC workforce is substantially smaller than the current operating workforce for the reactor, so a change to an NGCC alternative will result in substantial reductions in commuting-related air emissions. The impacts to air quality from ancillary activities during operation of an NGCC alternative would be SMALL.

EPA reported that, in 2008, the total amount of carbon dioxide equivalent (CO_2-e) emissions related to electricity production was 2,397.2 teragrams (2,363.5 million metric tons (MMT)) (EPA, 2010b). EIA reports that, in 2008, electricity production in New Hampshire was responsible for 6,777 thousand MTs (6.8 MMT), or 0.29 percent of the national total (EIA, 2010d). The NRC staff estimates that uncontrolled emissions of CO_2-e from operation of the NGCC alternative would amount to 3.36 MT per year (MT/y) (3.05 MMT per year (MMT/y)). This amount represents 0.12 percent and 41.5 percent, respectively, of 2008 U.S. and New Hampshire CO_2-e emissions. Although natural gas combustion in the combustion turbines would be the primary source, other miscellaneous ancillary sources—such as truck and rail deliveries of materials to the site and commuting of the workforce—would make minor contributions.

The National Energy Technology Laboratory (NETL) estimates that carbon capture and storage (CCS) technologies will capture and remove as much as 90 percent of the CO_2 from the exhausts of combustion turbines. However, NETL estimates that such equipment imposes a significant parasitic load that will result in a power production capacity decrease of approximately 14 percent, a reduction in net overall thermal efficiency of the combustion turbines studied from 50.8 percent to 43.7 percent, and a potential increase in the levelized cost of electricity produced in NGCC units so equipped by as much as 30 percent (NETL, 2007). Further, permanent sequestering of the CO_2 would involve removing impurities (including water), pressurizing it to meet pipeline specifications, and transferring it by pipeline to acceptable geologic formations. Even when opportunities exist to use the CO_2 for enhanced oil recovery (rather than simply dispose of the CO_2 in geologic formations), permanent disposal costs could be substantial, especially if the gas-fired units are far removed from acceptable geologic formations. With CCS in place, the gas-fired alternative would release 0.28 MMT/yr of CO_2. If future regulations require the capture and sequestration of CO_2 from gas-fired facilities, the impact on climate change from this alternative would be further reduced.

A report by the Global Change Research Program predicts continued warming and more extensive climate-related changes for the Northeast region, including increased temperatures and shortened winters, more frequent days with temperatures about 100 degrees Fahrenheit, increased frequency of severe storms, coastal flooding, erosion, and loss of wetlands (Karl et al., 2009).

Based on this information, the overall air quality impacts of a new natural gas-fired plant located at the Seabrook site would be SMALL to MODERATE.

8.1.2 Groundwater Use and Quality

The use of groundwater is not expected in the construction or operation of the NGCC alternative. Some foundation excavations may intrude on the brackish groundwater zone or lower freshwater aquifers. Open excavations will create a potential pathway for groundwater contamination and may also establish communications between aquifers. All open excavations will require dewatering that can impact surface waters. With the application of best management practices and the controls established in a General Stormwater Permit, no impacts on groundwater quality are expected. The impact of construction and operation of the NGCC alternative at Seabrook on groundwater use and quality would be SMALL.

8.1.3 Surface Water Use and Quality

The use of minimal amounts of surface water (freshwater) is expected in the construction of the NGCC, primarily for fugitive dust control and concrete mixing. Some impacts to surface water quality may result in increased sediment loading to stormwater run-off from active construction zones; however, the NRC staff expects that a Stormwater Pollution Prevention General Permit would require best management practices that would prevent, or significantly mitigate, such impacts.

The NGCC alternative at the Seabrook site is expected to use a new, closed loop cooling system, but it will still use the existing seawater water withdrawal and discharge structures. Throughout the operating period of the NGCC facility, conversion to a closed loop system will result in greatly reduced withdrawal rates of seawater (to replace water lost to evaporation and drift from the cooling tower) than are now occurring in the once-through system. Cooling tower blowdown waters discharged to the ocean would have similar thermal profiles to the discharges now occurring, but they would also contain various chemicals used to treat the water in the closed loop system to maintain cooling tower performance. Discharges would be controlled by a revised National Pollutant Discharge Elimination System (NPDES) permit. The NRC staff concludes that the impact on surface water quality and use from the construction and operation of the NGCC alternative at the Seabrook site would be SMALL.

8.1.4 Aquatic and Terrestrial Ecology

8.1.4.1 Aquatic Ecology

Minimal impacts to aquatic ecology are anticipated throughout the construction phase of an NGCC alternative. Seawater would continue to be used to support the operation of the new closed loop cooling system. However, withdrawal rates would be substantially reduced from those now occurring in the once-through system supporting the Seabrook reactor. The NRC staff concludes that impacts to aquatic ecology would be SMALL.

8.1.4.2 Terrestrial Ecology

As indicated in previous sections, the NRC staff presumes that an NGCC alternative could be constructed on the existing Seabrook property. While much of the plant is likely to be located on previously disturbed, industrialized portions of the site, some fallow areas may also be involved. Terrestrial ecology in these fallow areas will be affected, primarily resulting in habitat fragmentation and loss of food sources. Offsite impacts will occur at the locations impacted by the construction of the natural gas pipeline connecting the site to existing infrastructure. However, impacts to terrestrial resources on the site will be minimal since existing activities on the site will likely have already caused indigenous terrestrial resources to relocate from the site.

Operation of the cooling tower would cause some deposition of dissolved solids (including salt) on surrounding vegetation and soil from cooling tower drift; however, since the potentially impacted areas are already subject to sea spray or other natural mechanisms of salt deposition, the impacts from cooling tower drift would be incremental and probably insignificant to the existing plant community. Impacts to terrestrial resources from the construction and operation of the NGCC alternative on the Seabrook site would be SMALL.

8.1.5 Human Health

Impacts to human health from construction of the NGCC alternative would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules would control those impacts to workers to acceptable levels. Impacts from construction on the general public would be minimal since limiting active construction area access to authorized individuals is expected. Human health effects of gas-fired generation are generally low, although in Table 8-2 of the GEIS (NRC, 1996), the NRC staff identified both cancer and emphysema as potential health risks from gas-fired plants. NO_x emissions contribute to ozone formation, which, in turn, contributes to human health risks. Emission controls on the NGCC alternative can be expected to maintain NO_x emissions well below air quality standards established for the purposes of protecting human health, and emissions trading or offset requirements mean that overall NO_x releases in the region will not increase. Health risks to workers may also result from handling spent catalysts, used for NO_x control, which may contain heavy metals.

Overall, human health risks to occupational workers and to members of the public from the construction and operation of the NGCC alternative at Seabrook would be SMALL.

8.1.6 Socioeconomics

8.1.6.1 Land Use

The GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site (NRC, 1996). The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a natural gas-fired combined-cycle power plant at the Seabrook site.

A new NGCC plant would require approximately 44 acres (ac) (18 hectares (ha)) of land to support a natural gas-fired alternative to replace the Seabrook reactor. Ancillary support activities for the reactor may need to be relocated to provide sufficient land area for an NGCC plant, and some fallow areas may need to be used in addition to land areas in the previously disturbed industrial footprint of the site. Nevertheless, onsite land use impacts from construction and operation of the NGCC alternative on Seabrook would be SMALL.

In addition to onsite land requirements, new areas of offsite land would be affected by construction of the gas pipeline. In addition to onsite land requirements, land would be required offsite for natural gas wells and collection stations. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside the U.S. and be delivered as liquefied gas. Some natural gas could also come from outside of the U.S. and be delivered as liquefied gas to a seaport.

The elimination of uranium fuel for the Seabrook reactor could partially offset offsite land requirements by reducing land needed for mining of uranium ore. The NGCC alternative and its necessary support equipment (including an alternative closed loop cooling system) could be constructed largely within the existing developed industrial footprint of the Seabrook site and therefore overall land use impacts would be SMALL.

8.1.6.2 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new NGCC power plant could affect regional employment, income, and expenditures. Two types of jobs would be created by this alternative: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the NGCC power plant alternative were evaluated in order to measure their possible effects on current socioeconomic conditions.

NextEra estimates an average construction workforce of 548, with a peak construction workforce of 991. During construction of the NGCC, the communities surrounding the power plant site would experience increased demand for rental housing and public services. The relative economic effect of construction workers on the local economy and tax base would vary over time.

The majority of the impacts from these two workforces would occur within the town of Seabrook and neighboring towns. Other construction jobs would be created to support construction of the pipeline. However, given the relatively short duration of the construction periods for both the NGCC facility and the pipeline, impacts to most social services from construction will be SMALL.

After construction, local communities could be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. Since Seabrook is located near the Boston metropolitan area, these effects would be smaller because workers are likely to commute to the site instead of relocating to be closer to the construction site. Because of Seabrook's proximity to large population centers, the impact of construction on socioeconomic conditions would be SMALL.

NextEra estimates an operations workforce of 47. The NextEra estimate appears to be reasonable and is consistent with trends toward lowering labor costs by reducing the size of power plant operations workforces. The amount of taxes paid under the NGCC alternative may increase if additional land is required offsite to support this alternative. Operational impacts would be SMALL.

8.1.6.3 Transportation

Transportation impacts associated with construction and operation of the NGCC alternative would consist of commuting workers and truck deliveries of construction materials and equipment to the Seabrook site. During periods of peak construction activity, 991 workers would be commuting to the site increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Some plant components would be delivered by train via the existing but currently unused rail spur serving the Seabrook site. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact on local transportation. Traffic-related transportation impacts during construction would likely range from SMALL to MODERATE depending on the time of day.

During plant operations, traffic-related transportation impacts would almost disappear. According to NextEra, approximately 47 workers would be needed to operate the NGCC power plant. Since fuel is transported by pipeline, the transportation infrastructure would experience little to no increased traffic from plant operations. Overall, the NGCC alternative transportation impacts would be SMALL during power plant operations.

8.1.6.4 Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the natural gas-fired alternative and the surrounding landscape and the visibility of the natural gas-fired plant.

The power block of the NGCC alternative would look very similar to the Seabrook power block. The addition of mechanical draft or natural draft cooling towers and associated condensate plumes would add to the visual impact. The NGCC units could have exhaust stacks higher and more prominent than the existing off-gas stack of the nuclear plant.

Mechanical draft cooling towers would generate operational noise. Noise during power plant operations would be limited to industrial processes and communications. Pipelines delivering natural gas fuel could be audible offsite near gas compressor stations.

In general, aesthetic impacts would be limited to the immediate vicinity of the Seabrook site and would likely be similar to those associated with the currently operating Seabrook reactor. Impacts would be SMALL.

8.1.6.5 Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape, as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the U.S., they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground-disturbing activities.

Based on a review of the Seabrook Cultural Resources Protection Plan, New Hampshire State Historic Preservation Officer (SHPO) files for the region, published literature, and additional information provided by NextEra, the potential impacts of constructing and operating an NGCC alternative at the Seabrook Site on historic and archaeological resources could be SMALL to MODERATE. This impact is based on the results of archaeological surveys. There is a high potential for additional archaeological sites and resource materials to be discovered during construction, including a high potential for encountering human remains. NextEra could mitigate MODERATE impacts by following the Seabrook Cultural Resources Protection Plan to ensure that any adverse impacts to archaeological resources at the Seabrook site are avoided.

8.1.6.6 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new NGCC plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing in the vicinity of the Seabrook site, and all are exposed to the same hazards generated from constructing and operating a new NGCC power plant. Section 4.9.7, Environmental Justice, provides socioeconomic data regarding the analysis of environmental justice issues.

Potential impacts to minority and low-income populations from the construction and operation of a new NGCC power plant at the Seabrook site would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of Seabrook could affect low-income populations. Given the proximity of Seabrook to the Boston metropolitan area, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a new NGCC power plant would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of the Seabrook site.

8.1.7 Waste Management

During the construction stage of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed of onsite, or shipped to an offsite waste disposal facility. Because the NGCC would most likely be constructed on the previously disturbed portions of the Seabrook site, the amounts of wastes produced during land clearing would be minimal.

During the operational stage, spent SCR catalysts used to control NOx emissions would make up the majority of the industrial waste generated by this alternative. Because the specific NOx emission control equipment cannot be specified at this time, the amount of spent catalysts that would be generated during each year of operation of the NGCC alternative also cannot be calculated with precision. However, the amount would be modest. Domestic and sanitary wastes would be expected to decrease from amounts now generated during the operation of the reactors due to a greatly reduced operating workforce for the NGCC alternative. According to the 1996 GEIS a natural gas-fired plant would generate minimal waste; therefore, waste impacts would be SMALL for an NGCC alternative located at the Seabrook site.

8.2 New Nuclear Alternative

This section presents the environmental impacts of new nuclear generation at the Seabrook site.

In evaluating the new nuclear alternative in its ER, NextEra presumed that a replacement reactor would be installed on the Seabrook site, allowing for the maximum use of existing ancillary facilities such as the cooling system and transmission infrastructure. Although the Seabrook site contains the containment building for a second reactor that was never built, NextEra did not presume to use that containment structure for the replacement reactor.

In conducting its own evaluation of the nuclear alternative, the NRC staff presumes that the replacement reactor would be a pressurized water reactor of the Areva U.S. Evolutionary Power Reactor (EPR) Design, similar to the reactor recently proposed by Constellation Energy for installation as Unit 3 at the Calvert Cliffs Power Plant in Maryland. That reactor is rated at a core thermal power of 4,590 MWt and a net electrical output of 1,562 MW(e). The parameters of that reactor and conditions of the Calvert Cliff site are sufficiently similar to conditions at the Seabrook site. Additionally, the NRC's assessment of the impacts of construction and operation of the Calvert Cliffs Unit 3 reactor—as represented in a recently issued Draft SEIS (NRC, 2010)—are generally representative of impacts that could be anticipated from construction and operation of a reactor of similar design and capacity at Seabrook. Unless otherwise noted, the evaluation presented in the following sections was derived from the Calvert Cliffs Unit 3 Draft SEIS to the appropriate extent.

As with the NGCC alternative, NRC staff presumes that the alternative reactor would not use once-through cooling, but would use closed cycle cooling using either a mechanical draft or natural draft-cooling tower. However, the cooling system would use seawater, and the existing intake and discharge structures at Seabrook would continue in service with little to no structural modifications. The existing electrical switchyard and substation on Seabrook, and the transmission lines leaving the site, are expected to serve the replacement reactor with little to no modifications required. Finally, although Seabrook is in a coastal area, NRC staff presumes that barges would not be used to bring materials and equipment to the site.

Environmental impacts from the new nuclear alternative at the Seabrook site are summarized in Table 8.2-1.

Table 8.2-1. Environmental impacts of new nuclear alternative

	New nuclear at the Seabrook Site
Air Quality	SMALL
Groundwater	SMALL
Surface Water	SMALL
Aquatic & Terrestrial Resources	SMALL
Human Health	SMALL
Socioeconomics	MODERATE to LARGE
Historic and Archaeological	MODERATE to LARGE
Waste Management	SMALL

8.2.1 Air Quality

8.2.1.1 Construction Impacts

During construction, air quality would be affected by the release of criteria pollutants from construction vehicles and equipment, workforce commuting vehicles, and material delivery vehicles. Releases of volatile organic compounds (VOCs) can be expected from onsite vehicle and equipment fueling activities and from the use of cleaning agents and corrosion control coatings. Finally, although the new reactor would be located primarily on previously disturbed land areas within the industrial footprint of the Seabrook, some virgin areas may also be impacted. Ground disturbances—such as ground clearing and cut and fill activities, movement of construction vehicles on unpaved and disturbed land surfaces, and delivery and stockpiling of natural materials used in construction (e.g., sand and gravel)—would all still occur and would increase fugitive dust releases. NextEra would be expected to apply best management practices to control such air quality impacts to acceptable levels. Climate impacts during construction of the alternative reactor would result primarily from the operation of construction vehicles and equipment using RICEs and from the operation of delivery vehicles and vehicles used by the commuting workforce. Those impacts will be short-lived and are expected to be SMALL.

Overall, air impacts during construction would be of relatively short duration and would be SMALL.

8.2.1.2 Additional Operating Impacts

During operation, air quality impacts would include release of criteria pollutants from vehicles of the commuting operating workforce and those delivering supplies and equipment to the site (primarily trucks). The expected operation of diesel-fuel emergency generators for preventative maintenance purposes or during refueling operations would represent additional sources of criteria pollutants during operation. Finally, operation of the cooling tower would result in the release of particulates in the form of drift. Overall, impacts to air quality during operation would be SMALL.

Operation of a new nuclear alternative would have essentially identical effects on climate change as operating the current Seabrook reactor. Operation of the reactor itself does not result in the release of GHG that could impact climate. However, GHG emissions do result from some ancillary support activities such as the periodic preventative maintenance operation of diesel-fuel emergency generators, the onsite travel of vehicles, and commuting of the operating workforce. Because operating parameters of an alternative reactor would be essentially the same as the existing reactor and the operating workforce would be of the same approximate size as the current workforce, impacts on climate from an alternative reactor at Seabrook can be expected to be essentially the same as climate impacts of the current reactor—SMALL. Those impacts are discussed in detail and quantified in Section 4.2.

Climate-related changes for the Northeast region that could affect an alternative reactor at the Seabrook site include coastal flooding, erosion, and loss of wetlands (Karl et al., 2009).

8.2.2 Groundwater Use and Quality

Groundwater sources may be accessed to support construction activities, especially fugitive dust control and onsite concrete production, and could total as much as 100,000 gallons per day (gpd). Withdrawal permits issued by state authorities would be the primary control mechanisms for avoiding adverse impacts to groundwater by specifying groundwater well construction, use, and abandonment standards and procedures and limiting water withdrawals. In addition to wells that might be installed to access groundwater to support construction, excavation of the containment structure, extending to as much as 40 ft (12.2 m) below grade, would very likely encounter both brackish groundwater at shallow depths and deeper fresh groundwater at lower depths, creating a potential pathway for groundwater contamination and communication between aquifers. Given the site's proximity to the ocean, open excavations might require continuous dewatering until construction is completed. Best management practices and conditions of a Stormwater General Permit would be used to prevent groundwater contamination through open excavations. Groundwater would not be required to support reactor operation. Impacts to groundwater use and quality at the Seabrook site would be SMALL.

8.2.3 Surface Water Use and Quality

Construction would result in minor impacts to surface water due to altered drainage patterns and the potential for increased sediment and construction-related pollutants in run-off from the active construction site. However, because the existing cooling system intake and discharge structures would continue in service, major impacts to surface water that could result during construction of new intake and discharge components would be avoided. Best management practices, as well as conditions and constraints of a required General Stormwater Permit, would further limit impacts to surface water during construction. During operation, the closed loop cooling system of the alternative reactor would represent the greatest impacting activity; however, the system would withdraw seawater at a substantially reduced rate than the current once-through system. Actual rates of use would be dependent on power levels of the reactor as well as meteorological conditions, but the design basis for the cooling system would involve withdrawals at a rate of 44,320 gallons per minute (gpm), a water consumption rate (evaporation and drift from the cooling tower) of 22,199 gpm, and a blowdown discharge rate of 22,121 gpm. The discharge from the closed loop system is expected to have similar thermal characteristics to the current discharge; however, the discharge water will now contain some chemicals used to treat the water to ensure continued performance of the closed loop system. A new NPDES permit, issued by State authorities, would guarantee acceptable thermal and chemical complexion of the discharged cooling water. Impacts to surface water quality and use from construction and operation of a new reactor at the Seabrook site would be SMALL.

8.2.4 Aquatic and Terrestrial Ecology

8.2.4.1 Aquatic Ecology

Because of the reduced rate of water withdrawal for cooling, impingement, and entrainment, impacts to aquatic ecosystems can be expected to be less than is currently occurring with the once-through cooling system. However, blowdown from the newly installed closed loop cooling system would represent a new impact to aquatic ecosystems. The limitations imposed in a revised NPDES permit, issued by the New Hampshire Department of Environmental Services (NHDES), would control adverse impacts to aquatic ecosystems from cooling system discharges. The NRC staff concludes that impacts to aquatic ecology would be SMALL at the Seabrook site.

8.2.4.2 Terrestrial Ecology

As noted in previous sections, the NRC staff presumes that a new nuclear alternative could be constructed on the existing Seabrook property. While much of the plant is likely to be located on previously disturbed industrialized portions of the site, some fallow areas may also be involved, and some wetland areas may experience temporary impacts during the construction phase. Impacts to wetland would be controlled by conditions (including mitigations, where appropriate) in a necessary U.S. Army Corps of Engineers (USACE)-issued permit. The terrestrial ecosystem on Seabrook has already adjusted to the presence of an operating nuclear reactor. Some increased human presence will occur during construction, and some additional habitat fragmentation will result from the application of additional acreages to industrial use, but impacts to terrestrial ecosystems during operation are expected to be essentially equivalent to those now occurring from the operating reactor. Construction is expected to impact approximately 460 ac (186 ha). Once construction is complete, laydown and assembly areas and vehicle and equipment staging and maintenance areas will be returned to their natural state, and the amount of permanently impacted land area would be reduced to approximately 320 ac (130 ha). Some additional acreage may be affected if existing ancillary facilities need to be relocated. The operation of a closed loop cooling system will result in drift and salt deposition on vegetation in the immediate vicinity of the newly installed closed loop cooling tower (regardless of whether a mechanical draft or natural draft tower is selected). However, given the proximity of the Seabrook site to the Atlantic Ocean and the presence of wetland marshes throughout the site, the extant vegetation can be expected to be salt-tolerant, and additional impacts from cooling tower drift would be incremental. Overall, the NRC concludes that impacts to terrestrial ecology will be SMALL.

8.2.5 Human Health

Human health effects of a new nuclear power plant would be similar to those of the existing Seabrook reactor. Human health issues related to construction would be equivalent to those associated with the construction of any major complex industrial facility and would be controlled to acceptable levels through the application of best management practices and NextEra's compliance with applicable Federal and State worker protection regulations. Both continuous and impulse noise impacts can be expected at offsite locations, including at the closest residences during construction. NRC estimates peak noise levels of 83–108 decibels (dBa) at the point of noise generation, with noise levels of 70–102 dBA at a distance of 50 ft (15.2 m). The following actions can be expected to control noise impacts to acceptable levels:

- confining noise-producing activities to core hours of the day (7:00 a.m.–5:00 p.m.)
- suspending the use of any explosives during certain meteorological conditions (primarily inversion conditions and heavy cloud cover, or both, that allows sound to propagate long distances without appreciable attenuation)
- notifying potentially affected parties beforehand of such events can be expected to control noise impacts to acceptable levels

Heavily wooded areas on the site would also serve to reduce offsite noise impacts. If the rail spur leading to the site were to be put into service to bring materials and equipment to the site during construction, noise from rail operations would impact individuals in the residential area that now abuts the rail line. Human health impacts from operation of the nuclear alternative would be equivalent to those associated with continued operation of the existing reactor under license renewal. Noise impacts from facility operation would be much reduced from that occurring during construction. NRC staff expects that operational human health effects would be SMALL. Overall, human health impacts from construction and operation would be SMALL.

8.2.6 Socioeconomics

8.2.6.1 Land Use

As discussed in Section 8.1.6, the GEIS generically evaluates the impacts of nuclear power plant operations on land use, both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a new nuclear power plant at the Seabrook site.

Approximately 460 ac (186 ha) of land would be needed to support a new nuclear power plant to replace the Seabrook reactor. There is sufficient buildable land available on the Seabrook site for a replacement reactor. However, some wetlands may be affected during construction. Onsite land use impacts from construction would be SMALL at the Seabrook site.

Land use impacts would be greater at an alternate site where no supporting infrastructure exists, including offsite impacts from the construction of transmission lines.

Offsite impacts associated with uranium mining and fuel fabrication to support the new nuclear alternative would generally be no different from those occurring in support of the existing

Seabrook reactor, although land would be required for mining the additional uranium. Overall land use impacts from a new nuclear power plant would range from SMALL to MODERATE.

8.2.6.2 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new nuclear power plant could affect regional employment, income, and expenditures. Two types of job creation would result: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts.

A peak construction workforce of 4,000 workers would be required. During construction of a new nuclear power plant, the communities surrounding the construction site would experience increased demand for rental housing and public services. The relative economic effect of construction workers on the local economy and tax base would vary over time.

After construction, local communities might could be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. Since Seabrook is located near the Boston metropolitan area, these effects would be smaller because workers are likely to commute to the site instead of relocating to be closer to the construction site. Because of Seabrook's proximity to large population centers, the impact of construction on socioeconomic conditions could range from SMALL to MODERATE.

The number of operations workers could have a noticeable effect on socioeconomic conditions in the region. The permanent relocation of operations workers and their families would create additional job opportunities in the region and could strain social services in surrounding communities. Several tax revenue categories would be affected to include taxes on wages and salaries, sales and use taxes on purchases, workforce expenditures, property taxes on the new reactor, and personal property taxes on owned real property. Socioeconomic impacts associated with the operation of a new nuclear power plant at the Seabrook site would range from SMALL to MODERATE.

8.2.6.3 Transportation

During periods of peak construction activity, as many as 4,000 workers could be commuting daily to the site. In addition to commuting workers, trucks would be transporting construction materials and equipment to the worksite, increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Some plant components are likely to be delivered by train via the existing rail spur. Since the town of Seabrook already experiences high traffic volumes during certain times of the day, transportation impacts could range from MODERATE to LARGE.

Transportation traffic-related impacts would be greatly reduced after construction but would not disappear during plant operations. Transportation impacts would include daily commuting by the operating workforce, equipment and materials deliveries, and removal of waste material to offsite disposal or recycling facilities by truck. Traffic-related transportation impacts would be similar to those experienced during the operation of the existing Seabrook reactor. Overall, the new nuclear alternative would have a SMALL to MODERATE impact on transportation conditions in the region around the Seabrook site.

8.2.6.4 Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the new nuclear alternative and the surrounding landscape and the visibility of the new nuclear plant.

The appearance of the power block for the new nuclear power plant would be virtually identical to the existing Seabrook power block. The addition of mechanical draft or natural draft cooling towers and associated condensate plumes would add to the visual impact.

Mechanical draft cooling towers would generate more operational noise. Noise during power plant operations would primarily be limited to industrial processes and communications.

In general, aesthetic impacts would be limited to the immediate vicinity of the Seabrook site and would likely be similar to those associated with the currently operating Seabrook reactor. Aesthetic impacts would be SMALL.

8.2.6.5 Historic and Archaeological Resources

The same considerations, discussed in Section 8.1.6.5, for the impact of the construction of a gas-fired plant on historic and archaeological resources apply to the construction activities that would occur on the Seabrook site for a new nuclear reactor.

As previously noted, the potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities.

Based on a review of the Seabrook Cultural Resources Protection Plan, New Hampshire SHPO files for the region, published literature, and additional information provided by NextEra, the potential impacts of constructing and operating a new nuclear power plant at the Seabrook Site on historic and archaeological resources could be SMALL to MODERATE. This impact is based on the results of archaeological surveys. There is a high potential for additional archaeological sites and resource materials to be discovered during construction, including a high potential for encountering human remains. NextEra could mitigate MODERATE impacts by following the Seabrook Cultural Resources Protection Plan to ensure that any adverse impacts to archaeological resources at the Seabrook site are avoided.

8.2.6.6 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new nuclear power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts, or risk of impact, on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around the Seabrook site, and all are exposed to the same hazards generated from constructing and operating a new nuclear power plant.

Potential impacts to minority and low-income populations from the construction and operation of a new nuclear power plant at Seabrook would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of the Seabrook site could affect low-income populations. Given the close proximity to the Boston metropolitan area, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a new nuclear power plant would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of Seabrook.

8.2.7 Waste Management

During the construction stage of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed onsite, or shipped to an offsite waste disposal facility. Construction related wastes would be solid, liquid, or gaseous, and some would require management, treatment, and disposal as hazardous. Various permits, issued by State or local authorities, would control the disposition of all construction-related wastes. Permits issued by USACE would control disposition of dredged spoils from wetland areas. Because the alternative would be constructed on the previously disturbed Seabrook site, the amounts of wastes produced during land clearing would be minimal.

Wastes associated with construction will be similar in nature and amount to wastes from similar industrial construction endeavors and should be easily managed in area landfills and waste treatment facilities. Operating impacts of the replacement reactors with respect to waste generation can also be expected to be virtually equivalent to impacts from the continued operation of the existing reactors. Overall, waste impacts of new reactors at the Seabrook would be SMALL.

8.3 Combination Alternative of Natural-Gas-Fired Combined-Cycle and Wind

This section presents the environmental impacts of a combination alternative to the continued operation of the Seabrook reactor consisting of an NGCC facility constructed at the Seabrook site and operating in conjunction with wind farms located in various locations within the ISO-NE service territory.

To serve as an effective baseload power alternative to the Seabrook reactor, this combination alternative must be capable of providing an equivalent amount of baseload power. For the purpose of this evaluation, half of the annual power producing potential of the Seabrook reactor—5,018,604 megawatt hours (MWh)—would come from an NGCC facility and the other half from wind farms. To produce its required share of power, the NGCC portion, operating at an expected capacity factor of 85 percent, would need to have a nameplate rating of 674 MW(e) (net). Design features and operating parameters of the NGCC portion of this combination alternative are presumed to be the same as those used to describe the discrete NGCC alternative in Section 8.1. The NGCC portion would use the existing electrical switchyards, substations, and transmission lines that now connect Seabrook to the ISO-NE grid. Existing intake and discharge structures of the existing cooling system would continue in service but would be connected to a new closed cycle cooling system using either a mechanical draft or natural draft cooling tower.

The remainder of the power from this combination alternative would come from at least five wind farms, four of which are located on land somewhere within the ISO-NE service territory, with the last wind farm located offshore, in the Outer Continental Shelf (OCS) opposite the New Hampshire or Massachusetts coasts. To produce their share of the power—5,018,604 MWh annually—the five wind farms, operating at capacity factors of 35 percent each, would need a collective nameplate capacity rating of 1,636.86 MW, or an average individual nameplate rating of 327.37 MW.

Wind energy's intermittency affects its viability and value as a baseload power source; however, strategic and tactical options are under development to address this shortcoming. By using a combination of both onshore and offshore wind farms, producing a nameplate capacity of 1,636.86 MW is more reasonable than expecting a similar capacity to be produced on a wind farm in only one location. Having multiple locations (both onshore and offshore) ensures that the wind turbines experience varied wind conditions at each site rather than being subject to wind capacities at only one specific location. As a result, power is more likely to be produced at least some of the facilities at any given time, reducing the variability of wind-generated electricity. This variability can be lessened further if the proposed four onshore and one offshore wind farms are located at considerable distance from one another and allowed to operate as an aggregate, controlled from a central point. Because the energy produced from wind will service the entire ISO-NE area, the combination of sitting wind farms at large distances from one another and developing both inland and offshore facilities would ensure a more constant source of energy. Energy storage is another possible way to overcome intermittency. Besides pumped-storage hydroelectricity, compressed air energy storage (CAES) is the technology most suited for storage of large amounts of energy; however, as noted earlier, no combination of wind and CAES has yet been proposed at the utility scale (EAC, 2008). The American Wind Energy Association (AWEA) reports that more than 35,600 MW of wind energy capacity was operational at the end of 2009 nationwide, with 10,010 MW installed just in 2009 (AWEA, 2010a). Installed capacity in ISO-NE states totals about 250 MW (AWEA, 2010c). As is the case with other renewables, the feasibility of wind resources serving as alternative baseload power in the ISO-NE service area is dependent on the location, value, accessibility, and constancy of the resource. Wind energy must be converted to electricity at, or near, the point where it is extracted and there are limited energy storage opportunities available to overcome the intermittency and variability of wind resource availability. The highest wind-resource areas in the ISO-NE service territory are in remote locations, primarily along mountain ridgelines or in offshore areas. The Seabrook site would not be an appropriate location for the wind portion of this combination alternative, but, instead, each of the five wind farms will be located in remote or rural areas somewhere within the ISO-NE service territory or in an offshore location adjacent to the coasts of New Hampshire, Massachusetts, Rhode Island, or Maine. Thus, each wind farm will require a build-out of transmission lines to deliver its output to the nearest segment of the ISO-NE high-voltage grid.

At the current stage of wind energy technology development, wind resources of Category 3 (wind has a power density of 300–400 W/m^2 with wind speeds of 15.7–16.8 mph (7.0–7.5 m/s)) or better are required to produce utility-scale amounts of electricity. Land-based wind turbines have individual capacities as high as 3 MW, with the 1.67-MW turbine being the most popular size to have been installed in 2008. Offshore wind turbines being considered for commercial deployment have capacities between 3 MW and 5 MW (NREL, 2008). In the analysis, it was assumed that 1.67-MW turbines would be used onshore and 3.6-MW turbines offshore. The capacity factors of wind farms are primarily dependent on the constancy of the wind resource and, while off-shore wind farms can have relatively high capacity factors due to high-quality winds throughout much of the day (resulting primarily from differential heating of land and sea areas), land–based wind farms typically have capacity factors less than 40 percent. Many hundreds of turbines would be required to meet the baseload capacity of the Seabrook reactor. Further, to avoid inter-turbine interferences to wind flow through the wind farm, turbines must be separated from each other, resulting in utility-scale wind farms requiring substantial amounts of land.

A study performed by the National Renewable Energy Laboratory (NREL) assessed offshore wind energy potential in the U.S.; the results show that New England has some of the best wind resources available (NREL, 2010b). Analysis from the regional transmission operator in its renewable scenario development analysis (RSDA) report also suggests wind energy is a viable alternative for the New England area (ISO-NE, 2009).

The anticipated environmental impacts of a combination alternative involving an NGCC facility on the Seabrook site operating in conjunction with four onshore and one offshore wind farms are summarized in Table 8.3-1.

Table 8.3-1. Environmental impacts of NGCC and wind combination alternative

	NGCC portion of the combination alternative at the Seabrook Site	Wind portion of the combination alternative at various onshore & offshore sites
Air quality	SMALL	SMALL
Groundwater	SMALL	SMALL
Surface water	SMALL	SMALL
Aquatic & terrestrial resources	SMALL	SMALL
Human health	SMALL	SMALL
Socioeconomics	SMALL	SMALL to LARGE
Historic & archaeological	SMALL to MODERATE	SMALL to MODERATE
Waste management	SMALL	SMALL

The types of environmental impacts of the NGCC portion of this combination alternative will be the same as those discussed in Section 8.1 for the discrete NGCC alternative. However, the smaller facility described here will have a proportionally reduced impact on air quality during operation. Construction-related impacts will be less due to a shorter construction period and a smaller construction workforce. In other respects, differences in impacts are incremental. Only those impacts thought to be significantly different from impacts associated with the NGCC alternative, discussed in Section 8.1, are discussed in the following sections.

Under the hypothetical alternative scenario described in Section 8.3, the 5 wind farms would need an average individual nameplate rating of 327.37 MW to replace half of the power expected to be produced by the Seabrook reactor. Assuming 1.67-MW turbines, each of the 4 onshore wind farms will require 196 turbines; the offshore wind farm will require 66 turbines, assuming 5-MW turbines. The onshore wind farms would likely be placed atop ridgelines where the wind potential is high, but such locations will result in greater visual impacts than if the wind farms were sited at lower elevations.

Although evidence of environmental impacts from land-based wind farms is extensive, there is very little empirical evidence of the impacts offshore wind farms along the Atlantic coast would have. However, extensive studies have been conducted on offshore wind farms in Europe and, together with an EIS recently published by Minerals Managements Services (MMS) (MMS, 2009), these studies provide the basis for some of the conclusions below. The evaluation presented in the following sections for the onshore wind alternative was derived to the appropriate extent from impacts identified in the Wind Energy Programmatic EIS (BLM, 2005).

While specific locations cannot be determined at this time, utility-scale wind farms extend over large land areas, although wind farm components will occupy only a small portion of that area. Nevertheless, it would not be feasible to locate any of the wind farms at the Seabrook site. NRC staff believes that it is likely that the offshore wind farm would be developed off the coasts of New Hampshire, Massachusetts, Rhode Island, or Maine, in the OCS.

The anticipated environmental impacts of a combination alternative involving an NGCC facility on the Seabrook site operating in conjunction with four on-shore and one off-shore wind farms are discussed in the following sections.

8.3.1 Air Quality

Section 8.1.1 discusses the various State and Federal regulations that would control the construction and operation of an NGCC facility. Although the NGCC facility of this alternative has one-half the rated capacity of the discrete NGCC alternative discussed in Section 8.1, the same regulatory controls would apply to pollutant releases.

Using data and algorithms published by EPA and EIA, and performance guarantees provided by pollution control equipment vendors, the NRC staff projects the following emissions for an NGCC alternative to the Seabrook reactor:

- SO_x—52 tons (47 MT) per year
- NO_x—199 tons (180 MT) per year
- CO—459 tons (416 MT) per year
- PM_{10}—101 tons (92 MT) per year
- CO_2—1,682,263 tons (1,526,149 MT) per year

8.3.1.1 Construction Impacts

Air quality impacts from construction of the NGCC portion would be similar to those resulting from construction of the discrete NGCC discussed in Section 8.1. However, this smaller facility will have a somewhat smaller footprint than the facility discussed in Section 8.1. As a result, relocation of existing facilities may not be required or may be required to a lesser extent. Likewise, the construction period for the NGCC facility of the combination alternative should be less, although the construction workforce could essentially be the same as for the larger facility discussed in Section 8.1.

GHGs will be produced during construction of the NGCC alternative, but the expected shorter time frame suggests that amounts of GHG will be less than the amount anticipated from the construction of the much larger NGCC facility discussed in Section 8.1. Because detailed construction schedules are not currently available, it is difficult to quantify the GHG emissions that would result. During operation, the primary source of GHGs will be the commuting workforce, which is expected to be slightly smaller than the workforce for the discrete NGCC alternative. NRC estimates that the 674 MW NGCC facility, operating at a capacity factor of

85 percent, would generate 1,682,263 tons of CO_2-e per year (1,526,149 MMT/y). Assuming, as suggested by NETL (2007), that CCS can remove 90 percent of the CO_2 in the exhaust, this NGCC facility would release 0.15MMT/yr of CO_2-e if CCS controls were required in the future.

For the onshore wind farm portion, construction activities that could impact air quality include vehicle traffic from workers and equipment; construction of access roads; removal of vegetative cover; construction of lay-down areas, staging areas, and pads; and concrete pouring for buildings and tower foundations. Construction activities would also generate fugitive dust from vehicle travel, movement, transport and stockpiling of soils, concrete batching, drilling, and pile driving. Worker and delivery vehicles and the operation of ancillary construction equipment would generate emissions. Construction of onsite buildings, electrical substations, and installation of electrical interconnections among turbines would also produce emissions. The above activities would be temporary and would cease once construction is complete. Most construction activities would occur during the day; therefore, nighttime noise levels probably would drop to background levels of the project area, and their potential impacts would be temporary and intermittent in nature.

For the offshore wind farm portion, construction activities would be different, in some respects, from those for onshore wind energy development projects. Air emissions would result from onshore activities of workforce commuting and delivery of components to staging areas, but the relatively small footprints of the land-based components of an offshore wind farm (cable landing and substation) suggest that little to no fugitive dust from ground disturbing activities would be associated with their construction. Air emissions unique to offshore wind farms would include exhaust gases from marine vessels and helicopters (if applicable) that would be used during construction. During the construction period, noise impacts could occur from vessels carrying equipment and construction crews to and from the offshore site. In the immediate vicinity of each turbine, noise could disrupt marine mammals, fish, and sea turtles. Vessels and barges involved with pile driving or the use of explosives to install foundations would create underwater noise and vibrations; whether or not it can be heard from shore would depend on distance and other factors such as meteorological conditions. Noise from pile driving of the turbine monopiles would be the principal noise impacts during construction. There would also be increased noise at the docks and onshore support facilities, as well as increased noise levels from helicopters, if used.

GHGs will be produced during the construction of both the onshore and offshore wind alternatives assumed in this analysis. Without a detailed construction plan, however, it is difficult to quantify total emissions. The emissions would come mainly from the exhausts of equipment and vehicles used by the commuting workforces and for delivery of construction materials and components, including vessels and work barges used in offshore facility construction or helicopters used in either onshore or offshore facility construction. Emissions from offshore construction may be slightly higher since both land- and water-based vehicles would be used. EPA estimates that CO_2 emissions from combustion of gasoline and diesel fuel would be 8.8 kg/gal (19.4 lb/gal) and 10.1 kg/gal (22.2 lb/gal), respectively (EPA, 2005).

The overall air quality impacts associated with construction of an onshore and offshore wind alternative would be SMALL.

8.3.1.2 Additional Operating Impacts

EPA reported that, in 2008, the total amount of CO_2-e emissions related to electricity production was 2,397.2 teragrams (2,363.5 MMT) (EPA, 2010b). EIA reports that, in 2008, electricity production in New Hampshire was responsible for 6,777 thousand MTs (6.8 MMT), or 0.29 percent of the national total (EIA, 2010d). The NRC staff estimates that uncontrolled emissions of CO_2-e from operation of the NGCC portion of this combination alternative would amount to 1.68 MT/y (1.53 MMT/y). This amount represents 0.06 percent and 22.5 percent, respectively, of 2008 U.S. and New Hampshire CO_2-e emissions. Although natural gas combustion in the combustion turbines would be the primary source of GHGs during operation, other miscellaneous ancillary sources—such as truck and rail deliveries of materials to the site and commuting of the workforce—would make minor contributions. During operation of an onshore wind alternative, noise sources would be mechanical and aerodynamic noise from wind turbines; transformer and switchgear noise from substations; corona noise from transmission lines; and vehicular traffic noise. Improvements in the design of large wind turbines have resulted in significantly reduced mechanical noise. As a result, aerodynamic noise (the flow of air over the blades) is the dominant noise source from modern wind turbines.

Impacts to air quality from the operation of the onshore wind turbines themselves are insignificant. There could be minor VOC emissions during routine changes of lubricating fluids and greases. Fugitive dust from road travel, vehicular exhaust, and brush clearing, in addition to the tailpipe emissions associated with vehicle travel, would occur during operations. However, all these activities would have limited scope and should have no significant air quality impact. The overall air quality impacts associated with the operation of an onshore wind alternative would be SMALL.

During operation of an offshore wind alternative, minimal noise impacts to recreational boaters from wind turbines are expected, but vibrations transmitted down the tower could be disruptive to fish and aquatic mammals. The operation of wind turbines would not be audible from land; however, for navigation safety, the turbines closest to established shipping lanes could be equipped with foghorns that would be audible to ships during periods of fog. During operation, only emissions from the maintenance vessels are expected. The overall air quality impacts associated with the operation of an offshore wind alternative would be SMALL.

No GHG emissions are released during operation of a wind turbine, regardless of whether it were onshore or offshore; however, negligible amounts would be released from the vehicles used to transport maintenance personnel throughout the operating lives of either facility. Therefore, negligible impacts to climate are expected.

8.3.2 Groundwater Use and Quality

Impacts to groundwater discussed in Section 8.1.2 would also occur for the NGCC portion of this alternative. The impact of the natural gas-fired portion of the combination alternative on groundwater use and quality at the Seabrook site would be SMALL.

For the onshore wind farm portion, construction activities affecting water include water used for dust control during construction of access roads, vegetative clearing, and grading. Water would be used for concrete used in the foundations of wind towers, substations, control buildings, and other support facilities, as well as potable water for onsite workers. The level of impact on groundwater will depend on the extent to which it is used to support these activities. Given the relatively short duration of construction, installation of new groundwater wells is unlikely. Water is more likely to be trucked in from offsite or obtained from local groundwater wells or surface water bodies near the facility. Construction activities are expected to have minimal, or no, impact on groundwater. No impacts to groundwater are expected during wind farm operation. Overall, impacts to groundwater are expected to be SMALL. Very little water would be used during operation, as no water is required for cooling purposes. Activities that could affect water quality include improper pesticide use or vehicle traffic. Impacts to groundwater use and quality from the construction and operation of an onshore wind alternative would be SMALL.

Impacts to groundwater use and quality would be minimal for an offshore wind alternative. Construction of access roads, transmission lines, or other onshore construction activities has little potential to impact groundwater quality. Overall, impacts to groundwater use and quality from the construction and operation of an offshore wind alternative would be SMALL.

8.3.3 Surface Water Use and Quality

The impacts to surface water use and quality of the NGCC alternative, discussed in Section 8.1.3, will also occur for this facility. Construction-related use and quality impacts will be of the same types, although the construction period will be shorter. During operation, lesser amounts of ocean water will be withdrawn to support steam cycle cooling. Impacts to surface water use and quality from construction and operation of the NGCC portion of this alternative at the Seabrook site will be SMALL.

Surface water bodies near the onshore wind farm portion could provide water to support construction activities and would be accessed under appropriate water withdrawal permits. Construction impacts on surface water quality could include increased sediment in stormwater flowing across or from active construction areas and the incidental release various fuels and chemicals. A General Stormwater Permit can provide adequate controls to preempt adverse impacts. Impacts to surface water use and quality from the construction and operation of an onshore wind alternative would be SMALL.

For the offshore wind portion, impacts to water quality include ballast water discharge from vessels transporting crew and materials to the offshore site and other water discharges from vessels (deck drainage, greywater discharge), as well as impacts resulting from installation of monopiles and undersea cables. The only discharges during operations would be those associated with vessels performing maintenance activities. Impacts to surface water use and quality from the construction and operation of an offshore wind alternative would be SMALL.

8.3.4 Aquatic and Terrestrial Ecology

8.3.4.1 Aquatic Ecology

Withdrawal rates for seawater used to cool the steam cycle of this smaller NGCC facility would be less than for the discrete NGCC facility discussed in Section 8.1.4. The NRC staff concludes that impacts to aquatic ecology would be SMALL.

For the onshore wind portion, construction activities could adversely affect wetlands and aquatic biota through habitat disturbance, mortality or injury of biota, erosion and runoff, exposure to contaminants, and interference with migratory movements. Construction within wetlands or other aquatic habitats would be largely prohibited, thus limiting potential direct impacts to aquatic ecology. Indirect impacts could occur as a result of surface water quality degradation or impacts from soil erosion. Aquatic ecology impacts for an onshore wind alternative would be SMALL.

Impacts to aquatic ecology could be more significant for offshore wind energy development. Construction activities will introduce noise sources that could be disruptive to aquatic and mammal populations in the area. Vessels bringing wind turbine components from overseas or other U.S. ports could lead to the introduction of invasive species to local waters. Construction activities could also disrupt fishing. However, while most construction related impacts—such as noise, seafloor disturbance, and increased amounts of suspended sediment—would be temporary, permanent alteration of habitat during construction could also occur. The presence of monopile turbine foundations may act as fish attracting devices, which could potentially benefit aquatic communities. During operations, noise from maintenance vessels and vibration noise transmitted through the towers would continue to provide minimal impacts to the aquatic ecosystems. A recent report by the National Wildlife Federation (NWF) notes that studies performed in Europe have concluded that the ecological risks from offshore wind do not result in long-term or large-scale impacts. Mitigation measures to reduce noise and impact to aquatic habitats would be needed as well as additional studies to evaluate the effect of wind development on aquatic resources (NWF, 2010). Impacts to aquatic ecology from an offshore wind alternative would be SMALL.

8.3.4.2 Terrestrial Ecology

Given the shorter construction period and the small footprint of the NGCC portion of this combination alternative, compared to the discrete NGCC alternative discussed in Section 8.1.4, terrestrial ecology impacts from construction and operation at the Seabrook site would be SMALL.

Terrestrial species may be affected by an onshore wind energy project operations through electrocution from transmission lines; noise; collision with turbines, meteorological towers, and transmission lines; site maintenance activities; disturbance associated with activities of the project workforce; and interference with migratory behavior. Bat, raptor, and migratory bird mortality from turbine collisions is a concern for operating wind farms; however, recent developments in turbine design have reduced the potential for bird and bat strikes. Impacts to terrestrial ecology from the construction and operation of an onshore wind alternative would be SMALL.

For the offshore wind portion, construction activities that could affect terrestrial ecology include vegetative clearing for, and construction of, the marine cable landing facility and substation and construction of the transmission line connecting to the existing grid. Impacts from these facilities and components during operations would be minimal, and areas disturbed during construction would be re-vegetated. Potential impacts to avian species include disturbances due to human and boating activities, operation of construction equipment, displacement due to habitat loss, and collision risk to birds during construction. During operations, similar impacts are possible, including loss or modification of habitat, creation of barriers to the flight paths for migrating birds from operating turbines, and collision risk to birds. Oil spills (from turbine transmissions and yaw control gear boxes), although unlikely, would adversely affect birds. The report by NWF acknowledges that offshore wind farms have significant environmental benefits over fossil fuel technologies, but it further notes that some data gaps still exist with respect to predicting impacts to ecosystems from offshore wind farms of the Atlantic coast (NWF, 2010). Impacts to terrestrial ecology from the construction and operation of an offshore wind alternative would be SMALL.

8.3.5 Human Health

Human health impacts of this smaller NGCC facility will be proportionally the same as those for the NGCC facility discussed in Section 8.1.5 and would be SMALL.

Construction impacts to human health would resemble impacts from a typical construction project and include mostly work-related accidents and injury.

There are concerns that operation of onshore wind turbines could affect the health of individuals living near a wind development project. Possible impacts include low-frequency noise, turbine blade shadowing, and blade flicker. The extent of these impacts on human health has not been verified by clinical studies; however, since most wind farms would be expected to be located in remote areas and since all such impacts would be expected to significantly decline with distance, very few members of the general population, if any, would be impacted. Turbines also could cause safety hazards to nearby airports and may cause interferences to radar operation. Overall, health risks to workers and members of the public from the construction and operation of an onshore wind alternative would be SMALL.

Although improbable, the following impacts to human health from the operation of offshore wind turbines are possible—blade throws (turbine blades becoming loose and flying off due to centripetal force) and, under specific weather conditions, ice could form on blades and release onto nearby boaters. As with onshore wind farms in remote areas, the number of individuals expected to be in the vicinity of a wind turbine at any given time is quite small, as is the likelihood of adverse impact to those individuals. Overall, health risks to workers and the public from the construction and operation of an offshore wind alternative would be SMALL.

8.3.6 Socioeconomics

8.3.6.1 Land Use

The footprint of the NGCC portion of the combination alternative will be somewhat smaller than the NGCC alternative discussed in Section 8.1.6. Onsite land use impacts from the construction and operation of the NGCC portion of this alternative will be SMALL. Offsite impacts will result from construction of a supporting pipeline and are also expected to be SMALL.

Because onshore wind turbines require ample spacing between one another to avoid inter-turbine air turbulence, the footprint of utility-scale wind farms could be quite large. Delivering heavy or oversized components to remote rugged areas along ridgelines are challenging and may require extensive road infrastructure modifications and construction of access roads that take circuitous routes to their destination. However, once construction is completed, many access roads can be reclaimed and replaced with more direct access to the wind farm for maintenance purposes. Likewise, land used for equipment laydown and turbine component assembly and erection would be returned to its original state. During operations, only 5–10 percent of the total acreage within the footprint is actually occupied by turbines, access roads, support buildings, and associated infrastructure while the remaining land areas can be put to other compatible uses, including agriculture. Overall, land use impacts from an onshore wind alternative would be SMALL to MODERATE.

Offshore wind turbines would be constructed in a grid pattern, with minimum spacing of 0.39 miles by 0.63 miles. The Cape Wind final EIS estimates a footprint of 25 square miles to generate a maximum of 454 MW (MMS, 2009). A proportionally smaller, but comparable area requirement would be needed for the 327 MW offshore wind farm proposed in this SEIS. Marine cables would be installed on, or below, the seafloor interconnecting the turbines with a centrally located electrical service platform and connecting that service platform with an onshore cable landing facility and substation. Cable installation would result in only brief impacts to the seafloor. In addition, a small amount of land would be required for the cable landing and substation. Overall, land use impacts from an offshore wind alternative would be SMALL.

8.3.6.2 Socioeconomics

As previously discussed, socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of the NGCC power plant and wind farm could affect regional employment, income, and expenditures. Two types of jobs are created by this alternative: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements of power plant construction and operations for the combination alternative were determined in order to measure their possible effect on current socioeconomic conditions.

Socioeconomic impacts would be less than those anticipated for the NGCC alternative discussed in Section 8.1.6, due primarily to the smaller construction workforce, the shorter construction period, and the smaller operating workforce. Socioeconomic impacts from the construction and operation of the NGCC portion of this alternative on the Seabrook site would be SMALL.

After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. However, these effects would likely be spread over a larger area, as the wind farms may be constructed in more than one location. The combined effects of these two construction activities would be SMALL.

Job creation is the most prominent socioeconomic impact for both the onshore and offshore wind portion of this combination alternative. Many jobs would be created in the short term during the construction period. Fewer, but more long-term, jobs would be created during operations. Because the workforce for wind energy development projects is generally low, it is expected that impacts would be minor. The Cape Wind FEIS estimates that 391 full time jobs would be created during the 27-month construction period, and 50 workers would be required for operation; workforce numbers would be similar for an onshore wind alternative. Socioeconomic impacts would be SMALL for both the onshore and offshore portions of this combination alternative.

8.3.6.3 Transportation

Transportation impacts during the construction and operation of the NGCC portion of this alternative would be less than the impacts expected for the NGCC alternative, discussed in Section 8.1, because of a smaller construction workforce and smaller volume of materials and equipment would be needed to be transported to the site.

Construction and operation of a natural-gas-fired power plant and wind farm would increase the number of vehicles on the roads near these facilities. During construction, cars and trucks would deliver workers, materials, and equipment to the worksites. The increase in vehicular traffic would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Transporting components of wind turbines could have a noticeable impact, but is likely to be spread over a large area. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact. Traffic-related transportation impacts during construction could range from SMALL to MODERATE, depending on the location of the wind farm site, current road capacities, and average daily traffic volumes.

During plant operations, transportation impacts would not be noticeable. Given the small numbers of operations workers at these facilities, the levels of service traffic impacts on local roads from the operation of the gas-fired power plant at the Seabrook site and at the wind farm would be SMALL. Transportation impacts at the wind farm site or sites would also depend on current road capacities and average daily traffic volumes but are likely to be SMALL given the low number of workers employed by that component of the alternative.

8.3.6.4 Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the surrounding landscape and the visibility of the power plant. In general, aesthetic changes would be limited to the immediate vicinity of the Seabrook site and the wind farm facilities.

Aesthetic impacts from the gas-fired power plant component of the combination alternative would be essentially the same as those described for the gas-fired alternative discussed in Section 8.1.6. Given the industrial character of the Seabrook site, the only new visual impact of an NGCC alternative would be the cooling tower and condensate plume. Power plant infrastructure would be generally smaller and less noticeable than the Seabrook containment and turbine buildings. Cooling towers would generate condensate plumes and operational noise. Noise during power plant operations would be limited to industrial processes and communications. In addition to the power plant structures, construction of natural gas pipelines would have a short-term impact. Noise from the pipelines could be audible offsite near compressors. In general, aesthetic changes would be limited to the immediate vicinity of the Seabrook site and would be SMALL.

The wind farms would have the greatest visual impact. The onshore wind turbines, which are over 300 ft (100 m) tall and spread across multiple sites, would dominate the view and would likely become the major focus of attention. Because onshore wind farms will be located in rural or remote areas, the introduction of wind turbines will be in sharp contrast to the visual appearance of the surrounding environment. The wind farms would likely be located along ridgelines, maximizing their visibility (BLM, 2005). Impacts of construction and operation of an onshore wind alternative could be MODERATE to LARGE.

During construction of an offshore wind farm, visual impacts might result from nighttime work lighting. The impact from lighting is dependent on the distance of the observer and intensity of the lighting. During operations, flashing lights could be visible for approximately 2.5 miles. Wind farms located more than 4 miles from shore would appear small on the horizon from the shoreline (MMS, 2009). Impacts of construction and operation from an offshore wind alternative on aesthetics could be MODERATE to LARGE.

8.3.6.5 Historic and Archaeological Resources

The same considerations, discussed in Section 8.1.6.5, for the impact of the construction of a NGCC plant on historic and archaeological resources apply to the construction activities that would occur on the Seabrook site for the NGCC portion of the combination alternative. As previously noted, the potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities.

Based on a review of the Seabrook Cultural Resources Protection Plan, New Hampshire SHPO files for the region, published literature, and additional information provided by NextEra, the potential impacts of constructing and operating a new NGCC power plant at the Seabrook Site on historic and archaeological resources could be SMALL to MODERATE. This impact is based on the results of archaeological surveys. There is a high potential for additional archaeological sites and resource materials to be discovered during construction, including a high potential for encountering human remains. NextEra could mitigate MODERATE impacts by following the Seabrook Cultural Resources Protection Plan to ensure that any adverse impacts to archaeological resources at the Seabrook site are avoided.

Surveys would be needed to identify evaluate and address mitigation of potential impacts prior to the construction of any new wind farm. Studies would be needed for all areas of potential disturbance (e.g., roads, transmission corridors, or other right-of-ways (ROWs)). Areas with the greatest sensitivity should be avoided.

Construction activities of an onshore wind farm that have potential to impact cultural resources include earthmoving activities (e.g., grading and digging) and pedestrian and vehicular traffic.

Visual impacts on significant cultural resources—such as viewsheds from other types of historic properties—may also occur.

Impacts to historic and archaeological resources for offshore wind development would be proportional to the land areas and seafloor areas disturbed during construction and would be based on whether or not those areas had been previously surveyed. Importantly, coastal and near-shore areas could have high concentrations of historic and archaeological resources.

Depending on the resource richness of the site chosen for the wind farms and associated infrastructure, the impacts could range between SMALL to MODERATE. Therefore, the overall impacts on historic and archaeological resources from the combination alternative could range from SMALL to MODERATE.

8.3.6.6 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new NGCC power plant at the Seabrook site and wind farms. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceeds the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around the power plant, and all are exposed to the same hazards generated from constructing and operating a gas-fired power plant or the wind farms.

Potential impacts to minority and low-income populations from the construction and operation of an NGCC power plant at Seabrook and wind farm would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of the Seabrook Site and wind farms could affect low-income populations. Given the close proximity to the Boston metropolitan area, most construction workers would likely commute to construction sites, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a NGCC power plant and wind farms (depending on location) would not have a disproportionately high and adverse human health and environmental effects on minority and low-income populations.

8.3.7 Waste Management

Wastes from the construction of the NGCC facility in this alternative will be less than construction wastes for the NGCC alternative discussed in Section 8.1.7. Operational wastes will also be less. Waste impacts from the construction and operation of the NGCC facility in this alternative will be SMALL.

In general, onshore wind farm waste management impacts could occur from the improper management or inadvertent release of hazardous materials—including fuels, lubricants, pesticides, and dielectric fluids in substation electrical equipment and from routine maintenance activities that would generate spent lubricating and hydraulic fluids and water-based coolants. Land clearing and other construction activities would generate waste that can be disposed of onsite or transported to a waste disposal site. During operation, generation of waste would be minimal and would fall under the control of various State and Federal regulations, depending on the nature of the waste. Waste impacts from an onshore wind alternative would be SMALL.

Waste types and impacts for an offshore wind farm would be similar to those for an onshore wind alternative; all waste would be expected to be brought back to shore for disposal. During construction, impacts could occur from mismanagement or improper disposal of oils and fluids, corrosion control coatings, or other chemicals used in construction. Since most components would be assembled elsewhere at onshore locations, waste-related impacts to the ocean would be confined to trash and debris accidently falling overboard from marine vessels or the electrical service platforms, which would wash up on shore, be carried out to the open ocean, or sink to the ocean floor. During operation, the generation of waste would be limited to wastes lubricating fluids resulting from routine maintenance. Waste impacts from an offshore wind alternative would be SMALL.

8.4 Alternatives Considered but Dismissed

Alternatives to Seabrook license renewal that were considered and eliminated from detailed study are presented in this section. The order of presentation does not imply a priority. Wind is considered in combination with an NGCC facility in Section 8.3. The evaluation of wind technology appearing in this section is as a discrete alternative.

8.4.1 Wind

As with other intermittent renewable energy sources such as solar power, the feasibility of wind as a baseload power relies on the availability, accessibility, and constancy of the wind resource within the region of interest. Unlike solar thermal facilities that can capture and store relatively large amounts of solar energy as heat for delayed production of electricity to match the temporal profiles of electricity loads in their service areas, wind energy must be converted to electricity at, or near, the point where it is extracted and there are limited energy storage opportunities available to overcome the intermittency and variability of wind resource availability.

At the current stage of wind energy technology development, wind resources of Category 3 (wind has a power density of 300–400 W/m^2 with wind speeds of 15.7–16.8 mph (7.0–7.5 m/s)) or better are required to produce utility-scale amounts of electricity. The capacity factors of wind farms are primarily dependent on the constancy of the wind resource and, while off-shore wind farms can have relatively high capacity factors due to high-quality winds throughout much of the day (resulting primarily from differential heating of land and sea areas), land–based wind farms typically have capacity factors less than 40 percent. Many hundreds of turbines would be required to meet the baseload capacity of the Seabrook reactor, and each wind farm would require a build-out of transmission lines to deliver its output to the nearest segment of the ISO-NE high-voltage grid. Further, to avoid inter-turbine interferences to wind flow through the wind farm, turbines must be separated from each other, resulting in utility-scale wind farms requiring substantial amounts of land.

Wind energy's intermittency affects its viability and value as a baseload power source; however, strategic and tactical options are under development to address this shortcoming. Although research is ongoing (much of it Federally funded) to couple wind farms with advanced energy storage technologies such as batteries and compressed air storage, the targets of those initiatives involve the storage of relatively minor amounts of power. Besides pumped hydro, compressed air energy storage (CAES) is the technology most suited for storage of large amounts of energy; however, as noted earlier, no combination of wind and CAES has yet been proposed at the utility scale (EAC, 2008).

In 2009, the average nameplate capacity of individual wind turbines was 1.74 MW while the average rotor diameter was almost 82 meters, increases of 40 percent and 69 percent, respectively, of those parameters from 1999-vintage wind turbines. Meanwhile, the average capacity of wind farms installed in 2009 was 91 MW, a decrease from the 121 MW capacity of wind farms installed in 2008. Land-based wind turbines have individual capacities as high as 3 MW, with the 1.67-MW turbine being the most popular size to have been installed in 2008. Offshore wind turbines being considered for commercial deployment have capacities between 3 MW and 5 MW (NREL, 2008). While turbine size increases and other technological advancements (especially in wind forecasting) have generally improved the value and reliability of wind as a baseload power source, DOE's Office of Energy Efficiency and Renewable Energy (EERE) reports that among 260 wind farms built from 1999–2008, cumulative annual capacity factors generally increased over the period, varying from 24 percent in 1999 to a high of nearly 34 percent in 2008 (falling off to 30 percent in 2009) (DOE/EERE, 2010). DOE further notes that some factors have slowed the increase in wind farm capacity factors, including forced curtailments of wind-generated power from Texas wind farms and installation of wind farms in wind resource areas of lesser quality. Wind energy market penetrations have increased dramatically in recent years; 9,994 MW of capacity was installed in 2009, a 40 percent increase from 2008, bringing the cumulative nationwide installed wind capacity to more than 35,000 MW (DOE/ERE, 2010).

Despite the relatively high reliability demonstrated by modern turbines, the recent technological advancements in turbine design and wind farm operation, and wind energy's dramatic market penetrations of recent years, empirical data on wind farm capacity factors and wind energy's limited ability to store power for delayed production of electricity cause the NRC staff to conclude that wind energy—on shore, off shore, or a combination thereof—could not serve as a discrete alternative to the baseload power supplied by the Seabrook reactor. However, NRC also concludes that, when used in combination with other technologies with inherently higher capacity factors, wind energy can provide a viable alternative. NRC evaluated such a possible combination in Section 8.3.

8.4.2 Solar Power

Solar technologies, photovoltaic (PV) and solar thermal (also known as CSP) use the sun's energy to produce electricity at a utility scale. In PV systems, the energy contained in photons of sunlight incident on special PV materials results in the production of direct current (DC) electricity, which is aggregated, converted to alternating current (AC), and connected to the high-voltage transmission grid. CSP technologies produce electricity by capturing the sun's heat energy. Two types of CSP technology that have enjoyed the greatest utility-scale applications are the parabolic trough and the power tower; both involve capturing the sun's heat and converting it to steam, which powers a conventional Rankine cycle STG. Although relatively benign in many respects, solar technology requires substantial land areas, and CSP technologies require roughly the same amount of water for cooling of the steam cycle as many other thermoelectric technologies. Establishing adequate cooling for CSP facilities is often problematic since geographic areas with the highest-value direct normal insolation (DNI) required for CSP are often in remote desert areas with limited, or no, water availability.

As with other forms of renewable energy, the potential of solar technologies to serve as reliable baseload power alternatives to the Seabrook reactor depends on the value, constancy, and accessibility of the solar resource. Both PV and CSP are enjoying explosive growth worldwide, especially for various off-grid applications or to augment grid-provided power at the point of consumption; however, discrete baseload applications still have technological limitations. Although thermal storage can markedly increase the value of CSP-derived power for baseload applications by providing energy storage capabilities, low energy conversion efficiencies and the inherent weather-dependent intermittency of solar power limit its application as baseload power in all but geographic locations with the highest solar energy values.

Solar energy qualifies as a Class-I resource under New Hampshire's Renewable Portfolio Standard (RPS). Under that standard, investor-owned utilities and competitive power suppliers must obtain 11 percent of their power portfolio from Class-I renewables by 2020 and 16 percent by 2025. EIA reports the total solar generating capacity (solar thermal and solar PV) in the U.S. in 2008 was 536 MW, 0.005 percent of the total nationwide generating capacity of 1,010,171 MW. Solar power produced 864 MWh of power in 2008, 0.002 percent of the nationwide production of 4,119,388 MWh (EIA, 2010A). In New Hampshire, in 2008, all renewables excluding hydroelectric were responsible for 1,174,984 MWh, 5.1 percent of the State's total generation of 22,876,992 MWh. In August 2010, the ISO-NE states generated 723,000 MWh of power (Connecticut—65, Massachusetts—108, Maine—395, New Hampshire—110, Rhode Island—13, and Vermont—32), approximately 5.6 percent of the nationwide total of 13,034 thousand MWh for that period (EIA, 2010f).

DOE's NREL reports that all of the ISO-NE service territory has average solar insolation useful for PV applications on the order of 4.0 kWh/m^2/day and DNI suitable for use in CSP applications averaging 3.5 kWh/m^2/day (NREL, 2010a). Both of these solar insolation values are well below the ideal for efficient and cost effective application of PV and CSP technologies. The modest levels of solar energy available throughout the ISO-NE service territory, the weather-dependent intermittency of solar power, and the inefficiency of solar technologies at their current stage (and for the foreseeable future) of technological development all argue against selecting solar power as a discrete alternative to the Seabrook reactor's baseload power. The relatively minor contributions of solar and other renewable technologies (excluding hydroelectric and pumped storage) to statewide power generation in New Hampshire, and most other ISO-NE states, are consistent with this conclusion.

8.4.3 Wood Waste

As noted in the GEIS (NRC, 1996), the use of wood waste to generate utility scale baseload power is limited to those locations where wood waste is plentiful. Wastes from pulp, paper, and paperboard industries, and from forest management activities, can be expected to provide sufficient, reliable supplies of wood waste as feedstocks to external combustion sources for energy generation. Beside the fuel source, the technological aspects of a wood-fired generation facility are virtually identical to those of a coal-fired alternative; combustion in an external combustion unit such as a boiler to produce steam to drive a conventional STG. Given constancy of the fuel source, wood waste facilities can be expected to operate at equivalent efficiencies and reliabilities. Costs of operation would depend significantly on processing and delivery costs. Wood waste combustors would be sources of criteria pollutants and GHG, and pollution control requirements would be similar to those for coal plants, except that there is no potential for the release of HAPs such as mercury. Co-firing of wood waste with coal is also technically feasible. Processing the wood waste into pellets can improve the overall efficiency of such co-fired units. Although co-fired units can have capacity factors similar to baseload coal-fired units, such levels of performance are dependent on the continuous availability of the wood waste fuel. Among the ISO-NE states, 2008 electricity generating capacity from wood waste ranged from 26 MW (Massachusetts) to 76 MW (Vermont), to 140 MW (New Hampshire) to 612 MW (Maine) with zero generating capacity in Connecticut and Rhode Island; the largest amount of electricity generated from wood waste in 2008 occurred in Maine (EIA, 2010g-l). Given the limited capacity and modest actual electricity production, the NRC staff has determined that production of electricity from wood waste at levels equivalent to the Seabrook reactor would not be a feasible alternative to Seabrook license renewal.

8.4.4 Conventional Hydroelectric Power

Three technology variants of hydroelectric power exist—dam and release (also known as impoundment), run-of-the-river (also known as diversion), and pumped storage. In each variant, flowing water spins impellers of turbines of different designs to drive a generator to produce electricity. Dam and release facilities affect large amounts of land behind the dam to create reservoirs but can provide substantial amounts of power at capacity factors greater than 90 percent. Power generating capacities of run-of-the-river dams fluctuate with the flow of water in the river and the operation of such dams is typically constrained (and stopped entirely during certain periods) so as not to create undue stress on the aquatic ecosystems present. Pumped storage facilities use grid power to pump water from flowing water courses to higher elevations during off-peak load periods in order to release the water during peak load periods through turbines to generate electricity. Capacities of pumped storage facilities are dependent on the configuration and capacity of the elevated storage facility.

A comprehensive survey of hydropower resources in ISO-NE states was completed in 1997 by DOE's Idaho National Environmental Engineering Laboratory. All ISO-NE states had only modest hydroelectric potential, with Maine having the greatest capacity at 1042 MW (INEEL, 1998). At the time of the study, the total hydroelectric generating potential for each of the ISO-NE states were as follows:

- Connecticut—44 MW
- Massachusetts—132 MW
- Maine—1,042 MW
- New Hampshire—32 MW
- Rhode Island—11 MW
- Vermont—174 MW

More recently, EIA reports that, in 2008, conventional hydroelectric power (excluding pumped storage) was the principal electricity generation source among renewable sources in four of the ISO-NE states—Massachusetts, Maine, New Hampshire, and Vermont (EIA, 2010g-l). Nevertheless, only 5.9 gigawatthours (GWh) of hydroelectric power were generated in the ISO-NE states from January–July 2010, 3.3 percent of the nationwide total of 179.5 GWh (EIA, 2010m). As noted earlier, as of April 1, 2010, 1224 MW of new hydroelectric capacity was represented in the ISO-NE interconnection queue (ISO-NE, 2010b). However, experience has shown that not all of the MW capacity represented in the Interconnection Queue materializes in power actually introduced into the grid. For planning purposes, ISO-NE expects attrition of projects on the Interconnection Queue to be as high as 40 percent (ISO-NE, 2010a). If that were to be the case, the collective capacities of all hydroelectric facilities on the Queue that would ultimately inject electricity into the grid would fall well below the amount necessary to serve as a discrete technology replacement to Seabrook's reactor. Although hydroelectric facilities can demonstrate relatively high capacity factors, the relatively modest capacities and actual recent power generation of hydroelectric facilities in ISO-NE states, combined with the diminishing public support for large hydroelectric facilities because of their potential for adverse environmental impact, supports NRC's conclusion that hydroelectric power is not a feasible alternative to the Seabrook reactor.

8.4.5 Ocean Wave and Current Energy

Differential heating of the earth's water and land surfaces results in wind, which acts on the ocean's surface to create waves. The gravitational pull of the moon also helps to create waves. Ocean waves, currents, and tides represent kinetic and potential energies. The total annual average wave energy off the U.S. coastlines, at a water depth of 197 ft (60 m), is estimated at 2100 terawatt-hours (TWh) (MMS, 2006). Wave currents and tides are often predictable and reliable; ocean currents flow consistently, while tides can be predicted months and years in advance with well-known behavior in most coastal areas. Four principal wave energy conversion (WEC) technologies have been developed to date to capture the potential or kinetic energy of waves: point absorbers, attenuators, overtopping devices, and terminators. All have similar approaches to electricity generation but differ in size, anchoring method, spacing, interconnection, array patterns, and water depth limitations. Point absorbers and attenuators both allow waves to interact with a floating buoy, subsequently converting its motion into mechanical energy to drive a generator. Overtopping devices and terminators are also similar in their function. Overtopping devices trap some portion of the incident wave at a higher elevation than the average height of the surrounding sea surface, thus giving it higher potential energy, which is then transferred to power generators. Terminators allow waves to enter a tube, compressing air trapped at the top of the tube, which is then used to drive a generator.

Capacities of point absorbers range from 80–250 kW, with capacity factors as high as 40 percent; attenuator facilities have capacities of as high as 750 kW. Overtopping devices have design capacities as high as 4 MW, while terminators have design capacities ranging from 500 kW–2 MW and capacity factors as high as 50 percent (MMS, 2007).

The most advanced technology for capturing tidal and ocean current energy is the submerged turbine. Underwater turbines share many design features and functions with wind turbines but because of the greater density of water compared to air, have substantially greater power generating potential than wind turbines of comparable size blades. Only a small number of prototypes and demonstration units have been deployed to date, however. Underwater turbine "farms" are projected to have capacities of 2–3 MW, with capacity factors directly related to the constancy of the current with which they interact.

The environmental impacts of WEC technologies are still largely undefined and, while expected to be generally benign, could vary substantially with site-specific circumstances. Also, large-scale deployment of WEC technologies could compete with other activities already occurring in offshore locations, including commercial and recreational fishing and commercial shipping. Although real-world examples are limited, the potential cost of commercial-scale WEC-derived power is estimated to range from $0.09–$0.11 per kilowatt-hour (MMS, 2006). The relatively modest power capacities and relatively high costs of resulting power, coupled with the fact that all WEC technologies are in their infancy, support the NRC staff's conclusion that WEC technologies are not feasible substitutes for the Seabrook reactor.

8.4.6 Geothermal Power

Geothermal technologies extract the heat contained in geologic formations to produce steam to drive a conventional STG. The following variants of the heat exchanging mechanism have been developed:

- Hot geothermal fluids contained under pressure in a geological formation are brought to the surface where the release of pressure allows them to flash into steam (the most common of geothermal technologies applied to electricity production).
- Hot geothermal fluids are brought to the surface in a closed loop system and directed to a heat exchanger where they convert water in a secondary loop into steam.
- Hot dry rock technologies involve fracturing a formation and extracting heat through injection of a heat transfer fluid.

Facilities producing electricity from geothermal energy can routinely demonstrate capacity factors of 95 percent or greater, making geothermal energy clearly eligible as a source of baseload electric power. However, as with other renewable energy technologies, the ultimate feasibility of geothermal energy serving as a baseload power replacement for the Seabrook reactor is dependent on the quality and accessibility of geothermal resources within or proximate to the region of interest—in this case, the ISO-NE service territory. As of October 2009, the U.S. had a total installed geothermal electricity production capacity of 3,153 MW, originating from geothermal facilities in nine states: Alaska, California, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah, and Wyoming. Additional geothermal facilities are being considered for Colorado, Florida, Louisiana, Mississippi, and Oregon. None of the ISO-NE states has adequate geothermal resources to support utility-scale electricity production (GEA, 2010). NRC concludes, therefore, that geothermal energy does not represent a feasible alternative to the Seabrook reactor.

8.4.7 Municipal Solid Waste

MSW combustors use three types of technologies—mass burn, modular, and refuse-derived fuel. Mass burning is currently the method used most frequently in the U.S. and involves no (or little) sorting, shredding, or separation. Consequently, toxic or hazardous components present in the waste stream are combusted, and toxic constituents are exhausted to the air or become part of the resulting solid wastes. Currently, approximately 86 waste-to-energy plants operate in 24 states, processing 97,000 tons of MSW per day. Latest estimates are that 26 million tons of trash was processed in 2008 by waste-to-energy facilities. With a reliable supply of waste fuel, waste-to-energy plants have an aggregate capacity of 2,572 MW and can operate at capacity factors greater than 90 percent (ERC, 2010). Currently, 19 waste-to-energy facilities are operating in the ISO-NE states with an aggregate capacity of 543.7 MW. The number of facilities in each state, statewide amounts of MSW processed in tons per day, and aggregate nameplate capacities include the following:

- Connecticut—6 facilities, 6,537 T/d, 194 MW
- Massachusetts—7 facilities, 9,450 T/d, 265.9 MW
- Maine—4 facilities, 2,800 T/d, 65.3 MW
- New Hampshire—2 facilities, 700 T/d, 18.5 MW

EPA estimates that, on average, air impacts from MSW-to-energy plants are 3,685 lb/MWh of CO_2, 1.2 lb/MWh of SO_2, and 6.7 lb/MWh of NO_x. Depending on the composition of the municipal waste stream, air emissions can vary greatly and the ash produced may exhibit hazardous character and require special treatment and handling (EPA, 2010d).

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant would be approximately the same as that for a coal-fired power plant. Additionally, waste-fired plants have the same, or greater, operational impacts than coal-fired technologies (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at coal-fired facilities or at wood-waste facilities because of the need for specialized waste separation and handling equipment (NRC, 1996).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term as energy prices increase (and especially since such landfills, of sufficient size and maturity, can be sources of easily recoverable CH_4 fuel); however, it is possible that municipal waste combustion facilities may become attractive again.

Regulatory structures that once supported MSW incineration no longer exist. For example, the Tax Reform Act of 1986 made capital-intensive projects such as municipal waste combustion facilities more expensive relative to less capital-intensive waste disposal alternatives such as landfills. Also, the 1994 Supreme Court decision C&A Carbone, Inc. *v.* Town of Clarkstown, NY, 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. In addition, environmental regulations have increased the capital cost necessary to construct and maintain municipal waste combustion facilities.

As expected, the operating waste-to-energy plants in New England are located near population centers. The NRC staff interprets the current array of operating facilities as representative what the current market and other counterbalancing factors will support. To meet the power equivalency of the Seabrook reactor, the aggregate capacity of waste-to-energy facilities in New England would need to expand nearly 230 percent from current activity levels. Given the small average installed size of MSW plants, additional stable streams of MSW are not likely to be available to support numerous new facilities. In addition, based on the increasingly unfavorable regulatory environment, especially with respect to expanding pollution control regulations, the NRC staff does not consider MSW combustion to be a reasonable alternative to Seabrook license renewal.

8.4.8 Biomass Fuels

When used here, “biomass fuels” include crop residues, switchgrass grown specifically for electricity production, forest residues, CH_4 from landfills, CH_4 from animal manure management, primary wood mill residues, secondary wood mill residues, urban wood wastes, and CH_4 from domestic wastewater treatment. The feasibility of the use of biomass fuels for baseload power is dependent on their geographic distribution, available quantities, constancy of supply, and energy content. A variety of technical approaches has been developed for biomass-fired electric generators, including direct burning, conversion to liquid biofuels, and biomass gasification. In a study completed in December 2005, Milbrandt of NREL documented the geographic distribution of biomass fuels within the U.S., reporting the results in MTs available (dry basis) per year (NREL, 2005). Very limited amounts of potential biomass fuels are available in the ISO-NE states. Amounts of biomass fuels produced in the ISO-NE states range from a low of 174 MT/y in Rhode Island to a high of 3,489 MT/y in Maine, with a regional average of 1,374 MT/y. Power generating capacity from biomass fuels is very limited in the ISO-NE states, ranging from 3 MW in Vermont to 272 MW in Massachusetts (EIA, 2010g-l). Landfill gas is the only biomass fuel from which power is being derived in ISO-NE states in any appreciable amount, ranging from a high of 1,128 MWh in 2008 in Massachusetts to a low of 155 MWh in New Hampshire, with none being produced in Vermont. As of April 2010, of the total 3,515 MW represented in the ISO-NE Interconnection Queue, only 380 MW was for biomass-produced electricity (ISO-NE, 2010a).

In the GEIS, the NRC staff indicated that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as Seabrook. After re-evaluating current technologies, and after reviewing existing state-wide capacities and the extent to which biomass is currently being used to produce electricity in the ISO-NE states (and the apparent limited supporting delivery infrastructures), the NRC staff finds biomass-fired alternatives are unable for the foreseeable future to reliably replace the Seabrook capacity and are not considered feasible alternatives to Seabrook license renewal.

8.4.9 Oil-Fired Power

Oil of various qualities, resulting from the refining of conventional crude oils or unconventional sources such as oil sands or tar sands, is combusted in a boiler where the steam thus produced is used to drive a conventional STG. Although oil has historically been used extensively in the northeast for comfort heating, EIA projects that oil-fired plants will account for very little of the new generation capacity constructed in the U.S. during the 2008–2030 time period. Further, EIA does not project that oil-fired power will account for any significant additions to capacity (EIA, 2009f).

The variable costs of oil-fired generation tend to be greater than those of the nuclear or coal-fired operations, and oil-fired generation tends to have greater environmental impacts than natural gas-fired generation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive (EIA, 2009f). The high cost of oil has prompted a steady decline in its use for electricity generation. Thus, the NRC staff does not consider oil-fired generation as a reasonable alternative to Seabrook license renewal.

8.4.10 Fuel Cells

Fuel cells oxidize fuels without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air (or oxygen) over a cathode and separating the two by an electrolyte. The only byproducts (depending on fuel characteristics) are heat, water, and CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam reforming under pressure. Natural gas is typically used as the source of hydrogen.

Currently, fuel cells are not economically or technologically competitive with other alternatives for electricity generation. EIA projects that fuel cells may cost $5,478 per installed kW (total overnight costs, 2008 dollars) (EIA, 2010n), substantially greater than coal ($2,223), advanced (natural gas) combustion turbines ($648), onshore wind ($1,966), or offshore wind ($3,937), but cost competitive with solar PV ($6,171) or CSP solar ($5,132). More importantly, fuel cell units are likely to be small in size (the EIA reference plant is 10 MW(e)). While it may be possible to use a distributed array of fuel cells to provide an alternative to Seabrook, it would be extremely costly to do so and would require many units and wholesale modifications to the existing transmission system. Accordingly, the NRC staff does not consider fuel cells to be a reasonable alternative to Seabrook license renewal.

8.4.11 New Coal-Fired Capacity

Coal-fired generation accounts for a greater share of U.S. electrical power generation than any other fuel. Furthermore, the EIA projects that new coal-fired power plants will account for the greatest share of capacity additions through 2030—more than natural gas, nuclear, or renewable generation options. Integrated-gasification combined-cycle (IGCC) technology is an emerging coal option that uses coal gasification technology and is substantially cleaner than before combustion. While coal-fired power plants are widely used and likely to remain widely used, the NRC acknowledges that future additions to coal capacity may be affected by perceived or actual efforts to limit GHG emissions.

Only a few IGCC plants are operating at utility scale. Although coal-fired generation is technically feasible and can supply baseload capacity similar to that supplied by Seabrook, to date, IGCC technologies have had limited application and have been plagued with operational problems such that their effective, long-term capacity factors are often not high enough for them to reliably serve as baseload units. For these reasons, the NRC does not consider the construction of a large, baseload coal-fired power plant as a reasonable alternative to continued Seabrook operation.

8.4.12 Energy Conservation and Energy Efficiency

Though often used interchangeable, energy conservation and energy efficiency are different concepts. Energy efficiency typically means deriving a similar level of service by using less energy, while energy conservation simply indicates a reduction in energy consumption. Both fall into a larger category known as DSM. DSM measures—unlike the energy supply alternatives discussed in previous sections—address energy end uses. DSM can include measures that do the following:

- shift energy consumption to different times of the day to reduce peak loads
- interrupt certain large customers during periods of high demand
- interrupt certain appliances during high demand periods
- replace older, less efficient appliances, lighting, or control systems
- encourage customers to switch from gas to electricity for water heating and other similar measures that utilities use to boost sales

Unlike other alternatives to license renewal, the GEIS notes that conservation is not a discrete power-generating source; it represents an option that States and utilities may use to reduce their need for power generation capability (NRC, 1996).

In a 2008 staff report, the Federal Energy Regulatory Commission (FERC) outlined the results of the 2008 FERC Demand Response (DR) and Advanced Metering Survey (FERC, 2008). Nationwide, approximately 8 percent of retail electricity customers are enrolled in some type of DR program. The potential DR resource contribution from all U.S. DR programs is estimated to be close to 41,000 MW, or about 5.8 percent of U.S. peak demand. A national assessment of DR potential, required of FERC by Section 529 of the Energy Independence and Security Act of 2007, evaluated potential energy savings in 5- and 10-year horizons for 4 development scenarios—Business As Usual, Expanded Business As Usual, Achievable Participation, and Full Participation. Each of these scenarios represents successively greater DR program opportunities and proportionally increasing levels of customer participation (FERC, 2009). The greatest savings would be realized under the Full Participation scenario, with peak demand reductions of 188 gigawatts (GW) by the year 2019, a 20 percent reduction of the anticipated peak load that would result without any DR programs in place. Under the Achievable Participation scenario, reflecting a more realizable voluntary participation level of 60 percent of eligible customers, peak demand would be reduced by 14 percent (138 GW) by 2019.

In New England, DR opportunities are offered in the wholesale electricity market (under provisions of ISO-NE’s Forward Capacity Market (ISO, 2010a)) and to retail electricity customers by load-serving utilities in the region. Thus, in its modeled Business as Usual scenario, FERC estimates that DR programs in the NE states could be among the most prolific in the country, capable of reducing peak load by as much as 10 percent overall. FERC also believes that the potential for peak reductions through DR is already largely realized in the NE states where DR programs are already collectively within 12 percent of meeting the peak demand reductions projections in FERC's Full Participation scenario (FERC, 2009).

FERC's State-specific analyses for the NE states (FERC, 2010a) indicates that by the year 2019, the Full Participation scenario would yield peak demand reductions ranging from 13.2–28.9 percent of statewide electricity consumption, from a 163 MW reduction in Vermont to a 2,458 MW reduction in Connecticut and a total reduction for all NE states of 6524 MW. If the potentials for DR reductions have already been largely realized, the Business as Usual scenario is a more realistic projection. Under that scenario, DR programs would yield an ISO-NE-wide reduction of 3,200 MW by 2019, ranging from 89 MW in Vermont (7.2 percent of the state's projected peak demand) to 1,369 MW in Connecticut (16 percent of the state's projected peak demand).

ISO-NE reports that, currently, 1,900 MW of DR programs are in place, and the largest reduction in a summer peak demand occurred in 2009 when DR programs provided a reduction of 682 MW from the peak of 28,770 MW (ISO-NE, 2010a). However, in the latest Forward Capacity Auction completed by ISO-NE, 2,867 MW of DR was accepted and will count toward satisfying the Installed Capacity Requirement (ICR) for the period 2012–2013. The 2,867 MW of accepted DR resources were composed of 1,072 MW of passive demand resources and 1,794 MW of active demand resources. ISO-NE determined that this amount of DR resources would be sufficient to satisfy the ICR but only if current generation resources, including the Seabrook reactor, remained in operation. Although NRC agrees that active DR programs will effectively serve to reduce peak demand, passive DR programs provide for continuous reductions in electricity consumption and, thus, offer a better measure of the feasibility of DR programs as a baseload power replacement. The 1,072 MW of passive DR resources most recently accepted by ISO-NE for interconnection, together with the FERC analysis that suggests only minor potential remains for significant DR program expansions in the NE states, allows the NRC staff to conclude that passive DR programs are not a feasible baseload power alternative to Seabrook.

8.4.13 Purchased Power

Under the purchased power alternative, no new generating capacity would necessarily be built and operated by NextEra but, instead, an equivalent amount to the electricity now being supplied by the Seabrook reactor would be purchased from other generators. Those generators could be located anywhere within or outside the ISO-NE service territory, although far-distant sources may not be immediately available to serve ISO-NE load centers without substantial transmission system build-outs.

Although wind energy development is expected to expand greatly in the New England states and neighboring areas in Canada, reliable schedules of development for those resources have not been announced nor has the proportion of power that would be exported to the load centers currently served by the Seabrook reactor. Further, regardless of the source of purchased power, substantial costs would be incurred in necessary expansions to the transmission infrastructure.

There is no guarantee that a sufficient amount of power from yet-to-be-developed renewable and other resources within, and outside of, the ISO-NE service territory would ultimately be available for purchase. Further, NextEra would be competing for those resources that do become available with generators subject to RPS or RGGI requirements or both. Incorporation of new generation sources from locations that are remote or distant from load centers would likely involve significant expenditures in transmission infrastructure expansions. NRC, therefore, concludes that a purchased power option is not a viable discrete alternative to extending the Seabrook reactor license.

8.5 No-Action Alternative

This section examines the environmental effects that would occur if NRC took no action. No action in this case means that NRC does not issue a renewed the operating license for Seabrook, and the license expires at the end of the current license term, on March 15, 2030. If NRC takes no action, the plant will shutdown at, or before, the end of the current license. After shutdown, plant operators will initiate decommissioning in accordance with 10 CFR 50.82.

No-action is the only alternative that is considered in-depth that does not satisfy the purpose and need for this SEIS, as it does not provide power generation capacity nor would it meet the needs currently met by the Seabrook reactor or that the alternatives evaluated in Sections 8.1–8.5 would satisfy. Assuming that a need currently exists for the power generated by the Seabrook reactor, the no-action alternative would require the appropriate energy planning decision makers to rely on an alternative to replace the capacity of the Seabrook reactor or reduce the need for power.

This section addresses only those impacts that arise directly as a result of plant shutdown. The environmental impacts from decommissioning and related activities have already been addressed in several other documents, including the "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, Supplement 1 (NRC, 2002); the license renewal GEIS (Chapter 7; NRC, 1996); and Chapter 7 of this SEIS. These analyses either directly address or bound the environmental impacts of decommissioning whenever NextEra ceases to operate Seabrook.

Even with a renewed operating license, Seabrook will eventually shut down, and the environmental effects addressed in this section will occur at that time. Because these effects have not otherwise been addressed in this SEIS, the impacts are addressed in this section. As with decommissioning effects, shutdown effects are expected to be similar whether they occur at the end of the current license or at the end of a renewed license. Table 8.5-1 provides a summary of the environmental impacts of the no-action alternative.

Table 8.5-1. Environmental impacts of no-action alternative

	No-action alternative
Air quality	SMALL
Groundwater	SMALL
Surface water	SMALL
Aquatic & terrestrial resources	SMALL
Human health	SMALL
Socioeconomics	SMALL to MODERATE
Historic & archaeological	SMALL
Waste management	SMALL

8.5.1 Air Quality

When the plant stops operating, there will be a reduction in air quality impacts; specifically, emissions of pollutants related to operation of the plant and emissions of criteria pollutants associated with commuting of the operating workforce will cease. Since it was determined that emissions during the renewal term would have a SMALL impact on air quality, if emissions decrease, the impacts to air quality from the no-action alternative will be SMALL.

8.5.2 Groundwater Use and Quality

Chapter 4 discusses the impact to groundwater that is currently occurring as a result of operation of the Seabrook reactor. Groundwater wells installed onsite originally supplied a fraction of the fresh water used for sanitary and nonsafety-related purposes. However, those uses were discontinued in 1986, and no groundwater is currently used to support operation of the plant. Tritium contamination is known to exist in groundwater beneath the Seabrook site and remediation and mitigation activities are ongoing. Once operation of the reactor ceases, the potential for additional releases of tritium to the groundwater is expected to diminish. However, releases of tritium may not totally cease until decommissioning is completed. Remediation activities are expected to continue after reactor operation ceases. NRC concludes that impacts to groundwater from the no-action alternative will be SMALL.

8.5.3 Surface Water Use and Quality

Chapter 4 discusses the impacts to surface water from plant operation. Operational impacts include withdrawals and discharges of seawater in association with operation of the once-through cooling system. Impacts also include stormwater runoff from industrial areas of the plant, controlled through provisions of a Stormwater General Permit. Once reactor operation stops, impacts associated with seawater withdrawals and discharges will cease; however, stormwater discharges from industrialized portions of the site will continue largely unchanged until decommissioning activities commence. The current Stormwater General Permit would continue in effect after reactor operation stops and would be replaced by an amended permit once decommissioning actions commence. NRC concludes that impacts to surface water from the no-action alternative will be SMALL.

8.5.4 Aquatic and Terrestrial Resources

Chapter 4 discusses the impacts to aquatic and terrestrial resources from plant operation. Withdrawals and discharges of seawater associated with operation of the once-through cooling system will cease once reactor operation stops, thus eliminating the most significant impacting factors for aquatic resources. Impacts to terrestrial resources are expected to change slightly from the reduced human presence on the site once operations cease. Potentially new impacts to aquatic and terrestrial resources may be created once decommissioning commences. NRC concludes that impacts to aquatic and terrestrial resources from the no-action alternative will be SMALL.

8.5.5 Human Health

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on human health are SMALL. After cessation of plant operations, the amounts of radioactive material released to the environment in gaseous and liquid forms, all of which are currently within respective regulatory limits, would be reduced or eliminated. Therefore, the NRC staff concludes that the impact of plant shutdown on human health would also be SMALL. In addition, the potential for a variety of accidents will also be reduced to only those associated specifically with shutdown activities and fuel handling. In Chapter 5 of this SEIS, the NRC staff concluded that impacts of accidents during operation are SMALL. Impacts to human health from a reduced suite of potential accidents after reactor operation ceases would also be

SMALL. Therefore, the NRC staff concludes that impacts to human health from the no-action alternative will be SMALL.

8.5.6 Socioeconomics

8.5.6.1 Land Use

Plant shutdown would not affect onsite land use. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines connected to Seabrook would remain in service after the plant stops operating. Maintenance of most existing transmission lines would continue as before. The transmission lines could be used to deliver the output of any new power generating capacity additions made on the Seabrook site. Impacts on land use from plant shutdown would be SMALL.

8.5.6.2 Socioeconomics

Plant shutdown would have an impact on socioeconomic conditions in the region around Seabrook. Should the plant shut down, there would be immediate socioeconomic impacts from loss of jobs (some, though not all, of the approximately 1,100 employees would begin to leave), and tax payments may be reduced. These impacts, however, would not be considered significant on a regional basis given the close proximity to the Boston metropolitan area and because plant workers' residences are not concentrated in a single community or county. Revenue losses from Seabrook operations would directly affect Rockingham County and other local taxing districts and communities closest to, and most reliant on, the plant's tax revenue. The socioeconomic impacts of plant shutdown would, depending on the jurisdiction, range from SMALL to MODERATE. See Appendix J to NUREG 0596, Supplement 1 (NRC, 2002) for an additional discussion of the potential socioeconomic impacts of plant decommissioning.

8.5.6.3 Transportation

Traffic volumes on the roads near the Seabrook site would be greatly reduced after plant shutdown due to the loss of jobs at the facilities. Deliveries of materials and equipment to Seabrook would also be reduced until decommissioning. Transportation impacts from the termination of plant operations would be SMALL.

8.5.6.4 Aesthetics

Plant structures and other facilities would likely remain in place until decommissioning. Noise caused by plant operation would cease. Aesthetic impacts of plant closure would be SMALL.

8.5.6.5 Historic and Archaeological Resources

Impacts from the no-action alternative on historic and archaeological resources would be SMALL. A separate environmental review would be conducted for decommissioning. That assessment would address the protection of historic and archaeological resources.

8.5.6.6 Environmental Justice

Impacts to minority and low-income populations when Seabrook ceases operations would depend on the number of jobs and the amount of tax revenues lost by the communities in the immediate vicinity of the power plant. Closure of Seabrook would reduce the overall number of jobs (there are currently 1,100 employed at the facility) and tax revenue for social services attributed to plant operations. Minority and low-income populations in the township vicinity of Seabrook could experience some socioeconomic effects from plant shutdown, but these effects would not likely be high and adverse.

8.5.7 Waste Management

The impacts of waste generated by continued plant operation are discussed in Chapter 6 of this SEIS. The impacts of low-level and mixed waste from plant operation are characterized as SMALL. Once the Seabrook reactor stops operating, generation of high-level waste will cease and generation of low-level and mixed wastes will be diminished, limited only to those wastes associated with reactor shutdown and fuel handling activities. Therefore, the NRC staff concludes that the impacts of waste generation after shutdown will be SMALL.

8.6 Alternatives Summary

In this SEIS, NRC has considered alternative actions to license renewal of the Seabrook reactor, including in-depth evaluations of new generation alternatives (Sections 8.1–8.3), alternatives that the staff dismissed from detailed evaluation as infeasible or inappropriate (Section 8.4), and the no-action alternative in which the operating license is not renewed (Section 8.6). Impacts of all alternatives considered in detail are summarized in Table 8.6-1.

Table 8.6-1. Environmental impacts of proposed action and alternatives

Alternative	Air quality	Groundwater	Surface water	Aquatic & terrestrial resources	Human health	Socioeconomics & historic & archaeological	Waste management
License renewal	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL	SMALL	SMALL
Natural gas-fired	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
New nuclear	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL
Combination NGCC & wind	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL
No action	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

The environmental impacts of the proposed action (issuing renewed Seabrook operating license) would be SMALL for all impact categories, except for aquatic resources where the impact level would be SMALL to LARGE. Based on the above evaluations, the gas-fired alternative is not an environmentally favorable alternative due to air quality impacts from NO_x, SO_x, PM_{10}, CO, and CO_2 (and their corresponding human health effects). NRC notes that while substantial quantities of high-value wind resources exist within, and near, the ISO-NE service territory, for intermittent renewable energy sources, such as wind, to serve as a reliable baseload alternative, they would need to be pursued in combination with conventional technologies. Such a combination was evaluated in depth and found to have less environmental impacts in most respects than would have resulted from pursuit of the conventional technology portion alone. Finally, the NRC concluded that under the no-action alternative, the act of shutting down the Seabrook reactor on or before its license expiration date, would have only SMALL impact in all categories except socioeconomics where it could have a MODERATE impact in areas immediately adjacent to Seabrook.

In conclusion, there is no clear, environmentally-preferred alternative in this case. All alternatives capable of meeting the needs currently served by Seabrook entail impacts greater than or equal to the proposed action of Seabrook license renewal. Because the no-action alternative necessitates the implementation of one or a combination of alternatives, the no-action alternative would have environmental impacts greater than or equal to the proposed license renewal action.

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9.0 CONCLUSION

This draft supplemental environmental impact statement (SEIS) contains the environmental review of the NextEra Energy Seabrook, LLC (NextEra) application for a renewed operating license for Seabrook Station (Seabrook), as required by the *Code of Federal Regulations* (CFR), Part 51 of Title 10 (10 CFR Part 51) and the U.S. Nuclear Regulatory Commission's (NRC) regulations that implement the National Environmental Policy Act (NEPA). This chapter section presents conclusions and recommendations from the site-specific environmental review of Seabrook and summarizes site-specific environmental issues of license renewal that were identified during the review. The environmental impacts of license renewal are summarized in Section 9.1; a comparison of the environmental impacts of license renewal and energy alternatives is presented in Section 9.2; unavoidable impacts of license renewal, energy alternatives, and resource commitments are discussed in Section 9.3; and conclusions and NRC staff recommendations are presented in Section 9.4.

9.1 Environmental Impacts of License Renewal

The NRC staff's review of site-specific environmental issues in this SEIS leads to the conclusion that, with two exceptions, issuing a renewed license would have SMALL impacts for the Category 2 issues applicable to license renewal at Seabrook, as well as environmental justice and chronic effects of electromagnetic fields (EMF). In the area of aquatic resources, the NRC staff concluded that the impacts of license renewal at Seabrook would be SMALL for phytoplankton, zooplankton, invertebrates and most fish species. However, the impact on winter flounder, rainbow smelt, and some kelp species is LARGE since the abundance of these species has decreased to a greater and observable extent near Seabrook's intake and discharge structures as compared to 3–4 miles (mi) (5–8 kilometers (km)) away. Similarly, in the Category 2 issue of protected species, the NRC staff concluded that the impacts of the license renewal at Seabrook would be SMALL for terrestrial and most aquatic species. However, the impact for the rainbow smelt, listed as a Species of Concern by the National Marine Fisheries Service (NMFS), would be LARGE due to the relatively high impingement rates and since the abundance of rainbow smelt has decreased to a greater and observable extent near Seabrook's intake and discharge structures as compared to further away.

Mitigation measures were considered for each Category 2 issue, as applicable. The NRC staff identified one potential measure that could mitigate potential impacts to threatened or endangered species. This measure would be for NextEra to report existence of any Federally- or State-listed endangered or threatened species within or near the transmission line rights-of-way (ROWs) to the New Hampshire Natural Heritage Bureau, Massachusetts Fish and Game Department, or U.S. Fish and Wildlife Service (USFWS) if any such species are identified during the renewal term. In particular, if any evidence of injury or mortality of migratory birds, State-listed species, or Federally-listed threatened or endangered species is observed within the corridor during the renewal period, coordination with the appropriate State or Federal agency would minimize impacts to the species and, in the case of Federally-listed species, ensure compliance with the Endangered Species Act (ESA).

The NRC staff also considered cumulative impacts of past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes them. The NRC staff concluded that cumulative impacts of Seabrook's license renewal would be SMALL for all areas except aquatic resources. For aquatic resources, the NRC staff concluded that the cumulative impacts would be MODERATE for most species and LARGE for winter flounder, rainbow smelt, and other species that would be adversely affected from climate change, such as lobster and Atlantic cod. The incremental impacts from Seabrook license renewal would be SMALL for most species and LARGE for winter flounder and rainbow smelt.

9.2 Comparison of Environmental Impacts of License Renewal and Alternatives

In the conclusion to Chapter 8, the NRC staff determined that the impacts from license renewal would generally be equal to or less than the impacts to alternatives to license renewal. In comparing likely environmental impacts from natural-gas-fired combined-cycle generation, new nuclear generation, a combination alternative consisting of a natural-gas-fired combined-cycle component and a wind component, and the environmental impacts of license renewal, it was found that there is no clear environmentally-preferred alternative to license renewal. All alternatives capable of meeting the needs currently served by Seabrook entail impacts greater than or equal to the proposed action of Seabrook license renewal. Additionally, because the no-action alternative necessitates the implementation of one or a combination of alternatives, the no-action alternative would have environmental impacts greater than or equal to the proposed license renewal action. Based on the analysis of alternatives to license renewal, the NRC staff has determined that the impacts of license renewal are reasonable when taken in the context of alternatives to the renewal of the Seabrook license.

9.3 Resource Commitments

9.3.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all feasible mitigation measures. Implementing any of the energy alternatives considered in this SEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with U.S. Environmental Protection Agency (EPA) emissions standards, though the alternative of operating a fossil-fueled power plant in some areas may worsen existing attainment issues. Chemical and radiological emissions would not exceed the National Emission Standards for hazardous air pollutants (HAPs).

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to radiation and hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the general public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste would also be unavoidable. In comparison, hazardous and nonhazardous wastes would also be generated at non-nuclear power generating facilities. Wastes generated from plant operations during the renewal term would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable

Federal and State regulations. Due to the costs of handling these materials, power plant operators would be expected to conduct all activities and optimize all operations in a way that generates the smallest amount of waste possible.

9.3.2 The Relationship between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment as described in Chapters 4, 5, 6, 7, and 8. "Short-term" is the period of time that continued power generating activities take place.

Power plant operations require short-term use of the environment and commitment of resources, and they commit certain resources (e.g., land and energy) indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including license renewal, than under the no-action alternative because of the continued generation of electrical power and the continued use of generating sites and associated infrastructure. During operations, all energy alternatives require similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from nuclear power plant operations introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but they are not expected to impact air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired.

Continued employment, expenditures, and tax revenues generated during power plant operations directly benefit local, regional, and State economies over the short term. Local Governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste requires an increase in energy and consumes space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities are committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

9.3.3 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitment of resources that have been identified in this SEIS. Resources are irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitment of resources for electrical power generation include the commitment of land, water, energy, raw materials, and other natural and man-made resources required for power plant operations. In general, the commitment of capital, energy, labor, and material resources are also irreversible.

The implementation of any of the energy alternatives considered in this SEIS would entail the irreversible and irretrievable commitment of energy, water, chemicals, and in some cases, fossil fuels. These resources would be committed during the license renewal term and over the entire life cycle of the power plant and would be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and power plant operations and electricity for equipment and facility operations. Electricity and fuel would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are readily available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

9.4 Recommendations

The NRC's preliminary recommendation is that the adverse environmental impacts of license renewal for Seabrook are not great enough to deny the option of license renewal for energy-planning decision makers. This recommendation is based on the following:

- analysis and findings in the generic environmental impact statement (GEIS)
- environmental report (ER) submitted by NextEra
- consultation with Federal, State, and local agencies
- NRC staff's own independent review
- consideration of public comments received during the scoping process

10.0 LIST OF PREPARERS

This draft supplemental environmental impact statement (SEIS) was prepared by members of the Office of Nuclear Reactor Regulation (NRR) with assistance from other U.S. Nuclear Regulatory Commission (NRC) organizations and with contract support from Argonne National Laboratory (ANL) and Pacific Northwest National Laboratory (PNNL).

Table 10-1 provides a list of NRC staff that participated in the development of the draft SEIS. ANL provided contract support for alternatives, socioeconomics, environmental justice, land use, historic and archaeological resources, air quality, and hydrology—presented primarily in Chapters 2, 4, and 8. PNNL provided contractor support for the severe accident mitigation alternatives (SAMAs) analysis, presented primarily in Chapter 5 and Appendix F.

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[a]ANL is operated by UChicago Argonne, LLC for the U.S. Department of Energy

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11.0 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THE SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT ARE SENT

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Kevin Fleming Commenter	
Debbie Grinnell Commenter	C-10 Research & Education Foundation
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Paul Gunter Commenter	Beyond Nuclear
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Joyce Kemp Commenter	
Mary Lampert Commenter	
Robert McDowell Commenter	
Scott Medford Commenter	
Tim Noonis Commenter	Hampton Area Chamber of Commerce

Name & Title	Company & Address
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Russell Prescott New Hampshire State Senator, District 23	
Robin Read New Hampshire State Representative, District 16	
Michael Schidlovsky Commenter	Exeter Area Chamber of Commerce
Peter Somssich Commenter	
Dennis Wagner Commenter	
Cathy Wolff Commenter	

12.0 INDEX

APPENDIX A
COMMENTS RECEIVED ON THE SEABROOK STATION ENVIRONMENTAL REVIEW

A COMMENTS RECEIVED ON THE SEABROOK STATION ENVIRONMENTAL REVIEW

A.1 Comments Received During Scoping

The scoping process began on July 20, 2010, with the publication of the U.S. Nuclear Regulatory Commission's (NRC's) Notice of Intent to conduct scoping in the *Federal Register* (75 FR 42168). The scoping process included two public meetings held at the Galley Hatch Conference Center in Hampton, NH on August 19, 2010. Approximately 82 members of the public attended the meetings. After the NRC's prepared statements pertaining to the license renewal process, the meetings were open for public comments. Attendees provided oral statements that were recorded and transcribed by a certified court reporter. Any written statements submitted at the public meeting were appended to the transcript. Transcripts of the entire meeting were provided as an attachment to the Scoping Meeting Summary dated September 20, 2010 (NRC, 2010a). In addition to the comments received during the public meetings, comments were also received through mail and email.

Each commenter was given a unique identifier, so every comment could be traced back to its author. Table A-1 identifies the individuals who provided comments applicable to the environmental review and the Commenter ID associated with each person's set of comments. The individuals are listed in alphabetical order, by last name. To maintain consistency with the Scoping Summary Report, dated March 1, 2011 (NRC, 2011), the unique identifier used in that report for each set of comments is retained in this appendix.

Table A-1. Individuals providing comments during the scoping comment period

Commenter	Affiliation (if stated)	Comment source	Commenter ID	ADAMS accession number
Backus, Robert		Afternoon Scoping Meeting	I	ML102520183
Bamberger, Paul		Evening Scoping Meeting	P	ML102520207
Blanch, Paul		Afternoon Scoping Meeting Evening Scoping Meeting	K	ML102520183 ML102520207
Bogen, Doug	Seacoast Anti Pollution League	Afternoon Scoping Meeting www.regulations.gov	E	ML102520183 ML102670048
Brown, Gilbert		Evening Scoping Meeting	V	ML102520207
Casey, Joe	New Hampshire Building & Construction Trades Council	Afternoon Scoping Meeting	G	ML102520183
Fahey, Joseph	Town of Amesbury, Office of Community & Economic Development	Letter	X	ML102650486
Fleming, Kevin		Afternoon Scoping Meeting	M	ML102520183
Grinnell, Debbie	C-10 Research & Education Foundation	Evening Scoping Meeting	R	ML102520207
Guen, Janet	United Way of the Greater Seacoast	Afternoon Scoping Meeting	F	ML102520183
Gunter, Paul	Beyond Nuclear	Afternoon Scoping Meeting Evening Scoping Meeting	D	ML102520183 ML102520207

Commenter	Affiliation (if stated)	Comment source	Commenter ID	ADAMS accession number
Harris, William		Evening Scoping Meeting E-mails	T	ML102520207 ML102500271 ML102420043
Hassan, Maggie	New Hampshire State Senator, District 23	Evening Scoping Meeting Letter	N	ML102520207 ML102420037
Kemp, Joyce		www.regulations.gov	Z	ML102640371
Lampert, Mary	Speaking for C-10 Research & Education Foundation	Afternoon Scoping Meeting Evening Scoping Meeting	A	ML102520183 ML102520207
McDowell, Robert		Afternoon Scoping Meeting	C	ML102520183
Medford, Scott		Evening Scoping Meeting	U	ML102520207
Noonis, Tim	Hampton Area Chamber of Commerce	Afternoon Scoping Meeting Evening Scoping Meeting	H	ML102520183 ML102520207
Nord, Chris		Evening Scoping Meeting	O	ML102520207
Port, Andrew	City of Newburyport, Office of Planning & Development	Letter	W	ML102660331
Read, Robin	New Hampshire House of Representatives, District 16	Afternoon Scoping Meeting	B	ML102520183
Schidlovsky, Michael	Exeter Area Chamber of Commerce	Afternoon Scoping Meeting	J	ML102520183
Somssich, Peter		Evening Scoping Meeting & Submittal	Q	ML102520207
Vining, Geordie		www.regulations.gov	Y	ML102450525
Wagner, Dennis		Afternoon Scoping Meeting	L	ML102520183
Wolff, Cathy		Evening Scoping Meeting	S	ML102520207

The NRC staff categorized and consolidated specific comments by topic. Comments with similar specific objectives were combined to capture the common essential issues raised by participants. Comments fall into one of the following general groups:

- Specific comments that address environmental issues within the scope of the NRC environmental regulations related to license renewal. These comments address Category 1 (generic) or Category 2 (site-specific) issues or issues not addressed in the generic environmental impact statement (GEIS). They also address alternatives to license renewal and related Federal actions.
- Comments that are general in nature, including comments in support of, or opposed to, nuclear power or license renewal or regarding the renewal process, the NRC's regulations, and the regulatory process. These comments may or may not be specifically related to the Seabrook license renewal application.
- Comments that address issues that do not to fall within or are specifically excluded from the scope of the NRC environmental regulations related to license renewal. These comments typically address issues such as the need for power, emergency

- preparedness, security, current operational safety issues, and safety issues related to operation during the renewal period.

During the Seabrook scoping process, comments that address environmental issues within the scope of the environmental review are presented in Section A.1.1 below, along with the NRC response. While they are presented as direct quotes, the formatting of the comment in the source document may not necessarily be preserved. The comments that are general in nature, or outside the scope of the environmental review for Seabrook, are not included here but can be found in the Scoping Summary Report (NRC, 2011).

The in-scope comments are grouped in the following categories:

- Alternatives to License Renewal
- Socioeconomic Impacts of Seabrook
- Aquatic Ecology
- Effects of Climate Change
- Radioactive Releases to the Environment
- Hydrology and Groundwater
- Severe Accident Mitigation Alternatives (SAMA) Analysis

A.1.1 Alternatives to License Renewal

Comment B-01-ALT: I was at a conference of legislators from all over the Northeast in Maine on Monday, where Gordon Van Welie, who's the [independent system operator] ISO -- the president of ISO New England, which runs the grid in New England, said that there are 3,000 megawatts of wind power currently in the pipeline in New England. 12,000 megawatts is available.

Maine in 2008 passed the Maine Wind Energy Act, which calls on Maine to produce 3,000 megawatts of wind by 2020. New Hampshire, we now have renewable portfolio standard, which calls on the state to have 25 percent of its energy produced from renewable sources by 2025.

I seriously question the need for Seabrook, and I still don't understand how we can be doing this process, looking at what the environmental and renewable energy situation and energy efficiency improvements 20 years and 40 years down the road.

I think it's way premature to be doing this process now. I agree with the petitioners, who say that ten years would be a much better time period to look at. There have been huge advances in renewable energy and energy efficiency. There have been huge advantages in storing alternative energy through battery technology.

There was a recent article in the *New York Times* about storing wind power. I think that this is just way premature, and I think that the NRC should look seriously at the petitioners' proposal, and look at the alternatives seriously.

Comment E-04-ALT: I mean I think that we really need to be looking more broadly and look at, you know, really the current and future power systems and power policy in the Northeast, and right now New Hampshire has, I think, 3,500 megawatts of capacity. That's like three times our stage usage of power. We are essentially an energy colony for the rest of the Northeast.

Now that's okay. Obviously some areas are going to be better at producing power, you know, and we fully expect other states will jump in and be major power producers. It was mentioned, I think earlier, the offshore potential for wind power.

The state of Maine in particular has looked into this. They did a report. It came out last December, which said that there was the potential of large scale offshore wind power to produce 149 gigawatts of power. That's about 120 Seabrooks just off the coast of Maine.

I'm sure some of you have seen this map, but this is the Department of Energy map that Mr. Gunter referred to later. In this map, the color code is bright red there. That's not "warning, get out of here"; that is the highest potential, excellent potential, outstanding is the word they use, the Department of Energy, and that's off the coast of Maine, off the coast of New Hampshire and on down the coast.

We need to be looking very carefully at these alternative power sources, and also the economic impact of that. I mean just think of all the many thousands of jobs that would be created if we were to convert some of our coastal facilities to the production of wind power.

I think of the Portsmouth Naval Shipyard, the Bath [Iron Works]. All up and down the coast we have facilities that could be producing very useful technology for the future of our energy system in this region, and we need to be looking at the potential huge public benefit of developing those resources, instead of relying on old, obsolete, potentially unsafe resources like the Seabrook reactor.

Comment E-08-ALT: On the subject of "reasonable alternatives energy sources" relative to re-licensing of this plant, which you claim to want input on, we strongly urge you to make a good-faith effort to examine current projections of renewable energy potential in the New England coastal region. This is a huge topic, but we offer one such study produced at the University of Maine last year and summarized in an AP report from December 15th. Researchers estimated that "within 50 miles of its coast, Maine has the potential wind energy of 149 gigawatts, roughly the equivalent power of 149 nuclear plants." Further, the state has already set a goal to have 5 gigawatts of wind power (4 times that of the Seabrook plant) developed by 2030, the very same year at which Seabrook is currently slated to be retired. Please also see the attached map from the U.S. Dept. of Energy's National Renewable Energy Laboratory depicting the "outstanding" wind power potential offshore of New England.

There are of course many other renewable energy technologies in the offing over the next few decades to be potentially developed in the New England coastal region, from wave power and tidal power to photovoltaic systems on existing residential and commercial rooftops. These technologies are inherently cleaner, safer, more secure and resilient, as well as increasingly more cost-effective and job-producing than continued reliance on nuclear power. If you do not make some effort in your "alternatives" analysis to explore these technologies' potential, your [environmental impact statement] EIS will be highly deficient and will not pass the "laugh test" with the region's residents or public officials. Again, future generations will have to live with the decisions, good or bad, that you make in this current process, and you owe them the respect of making an honest and justifiable effort to examine the reasonable alternatives as well as the environmental impacts of maintaining the status quo in the face or a rapidly changing energy production as well as geophysical climate.

Comment T-04-ALT: So, one other aspect I think that you should consider in a relicensing application is alternative nuclear energy systems where there are scale economies to be on the same site because you already have a site with all the infrastructure and the security systems that are now likely to be much less vulnerable. Some of the Babcock and Wilcox -- I may not have the name right -- plants that are underwater at all times, so that even if an aircraft were to come at just the right angle -- and I've supervised modeling of aircraft attacking nuclear power plants and LNG plants and these plants were not designed for direct attack by aircraft that are purposely trying to take out the plant.

But these plants do have some redundant features -- under many conditions they would survive an aircraft attacking a nuclear plant -- but a safer option is to have plants that are always protected, so even if an aircraft came at just the right angle with just the right amount of energy that you would have a safer outcome. So, I believe that when you're considering relicensing for this long period of time, one ought to consider alternative nuclear plants at the same site as an option to consider in lieu of just automatically extending a license for a plant that simply was not designed for an era of terrorism.

Comment T-07-ALT: Finally, the environmental review should consider the consequences of continued availability of Seabrook Station No. 1, its degradation as a base-load generator, or its total loss if its license is not to be renewed. The life cycle costs per kilowatt hour [kWH] of electric power for rate payers of southern New Hampshire and rate payers of northern Massachusetts should be projected. As of the present writing, it appears that the cost per kWH of electric production at Seabrook Station No. 1 is substantially lower than the recently projected costs of Cape Wind electric power (including downtime for disrupted production) derived from projected offshore wind turbine systems.

For Massachusetts electric rate payers, wind energy is either a projected financial burden for electric ratepayers, or perhaps an acceptable experimental beginning (at higher per unit costs, for now) that is ameliorated by the concurrent delivery of lower cost electric power from the Seabrook Station No. 1 facility. Without concurrent availability of the Seabrook Station No. 1 for baseline load generation, some of the renewable energy alternatives might be assessed as too expensive to add to the grid costs passed on to ratepayers. And disruption costs, when wind and solar systems produce little or no net electric power, could cause system-wide outages if the baseload power of Seabrook is to become unavailable. Seabrook's role in reducing average electric costs and reducing incidents of ISO New England system outages should be included within any environmental assessment.

Response: *These comments refer to the alternatives to license renewal, including the alternative of not renewing the operating license for Seabrook, also known as the "no action" alternative. In Chapter 8 of this supplemental environmental impact statement (SEIS), the staff evaluated the following alternatives to Seabrook license renewal: natural-gas-fired combined cycle; new nuclear; and a combination alternative consisting of a natural-gas-fired combined cycle component and a wind component. Additionally, the staff evaluated the alternative of not renewing the Seabrook operating license in Section 8.5.*

Although many wind projects are planned, wind power alone is not a technically feasible and commercially viable alternative, because of the intermittent nature of the energy source. The feasibility of wind as a baseload power relies on the availability, accessibility, and constancy of the wind resource. Research is ongoing (much of it Federally funded) to couple wind farms with advanced energy storage technologies such as batteries and compressed air storage; the targets of those initiatives, however, involve the storage of relatively minor amounts of power.

Comments B-01-ALT and T-07-ALT raise the issue of need for power; the need for power is considered to be outside the scope of license renewal (10 CFR 51.95 (c)(2)). The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for baseload power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning decision-makers, such as State, utility, and, where authorized, Federal agencies (other than NRC). These portions of the comments are outside the scope of the license renewal review and were not considered in the development of this SEIS.

Comment T-04-ALT touches on security issues at nuclear facilities. While malevolent acts are beyond the scope of a National Environmental Policy Act (NEPA) review, the NRC routinely assesses threats and other information provided by other Federal agencies and sources, while also ensuring that licensees meet appropriate security-level requirements. The NRC continues to focus on the deterrence, detection, and prevention of terrorist acts or sabotage or both at NRC-licensed facilities and routinely assesses threat information and other information from a variety of Federal agencies and sources. The issue of security and risk from terrorist acts or sabotage or both at nuclear power reactor facilities is not unique to those facilities that have requested a renewal of their licenses. This portion of the comment is not within the scope of this environmental review and was not evaluated further in development of this SEIS.

Comment B-01-ALT raises the timing of the submittal of the Seabrook license renewal application (LRA); that portion of the comment is considered outside the scope of license renewal. On August 18, 2010, Earth Day Commitment/Friends of the Coast, Beyond Nuclear, Seacoast Anti-Pollution League, C-10 Research and Education Foundation, Pilgrim Watch, and New England Coalition jointly filed a petition for rulemaking requesting a change to 10 CFR 54.17 to permit an application for license renewal no sooner than 10 years before the expiration of the current license. This petition is currently under review; however, under the current regulations, an applicant is allowed to submit an application 20 years prior to the expiration of its current license. More information on the status of the petition for rulemaking can be found under Docket ID NRC-2010-0291 on the website www.regulations.gov. This portion of the comment was not evaluated further in development of this SEIS.

A.1.2 Socioeconomic Impacts of Seabrook

Comment F-01-SOC: I'd simply ask that in a definition of environment, it be looked at in the broadest possible context, to review not just the traditional definitions of environment, but also environment as it relates to the quality of life that we all experience in our communities, and in particular the health and human service needs of the people who live in our local area.

I would ask that the scope include looking at the role that Nextera plays in helping to provide for the health and human service needs in our area, the large number of jobs it provides that pay a living wage, the taxes it pays to its local communities, and the role that it plays a good citizen in working with local health and human service and other non-profit agencies, the leadership its employees provide on boards and other committees, the financial support that it provides, not just to United Way but other organizations, and the volunteer time and energy that it puts back into the community. Thank you.

Comment U-02-SOC: Will you conduct or will you ensure the applicant conducts an equitable review of taxes paid and contributions made to various states, towns, residences impacted by the siting and continued operation of the plant? Perhaps on a per megawatt basis, per area impacted basis or other comparable metric within the industry or within the region?

Response: *These comments deal with the socioeconomic impacts of Seabrook on local and regional communities, including related issues such as taxes, employment, and public services. The socioeconomic impacts of renewing the Seabrook operating license are discussed in Sections 2.2.9 and 4.9 of this SEIS. This includes a discussion of annual property tax payments to seven local jurisdictions and the State of New Hampshire's Education Trust Fund; however, the State and local jurisdictions ultimately decide how to tax utility companies, assess power plant value, and distribute tax money.*

A.1.3 Aquatic Ecology

Comment I-03-ECO: On environmental impacts, you know, one of the big issues when this plant was going through its original licensing was the operation of the once-through cooling system, which is a total mortality system with a total loss of all entrained organisms in the plant. Will we be able to have baseline data to know whether that plant is having an adverse effect on the environment? How will that be looked at? I assume that that will be covered.

Response: *This comment deals with the operation of Seabrook's once-through cooling system and its effects on the surrounding ecosystem. The design, operation, and ecological effects of Seabrook's once-through cooling system on the surrounding environment are discussed in Sections 2.1.6, 2.2.6, and 4.5 of this SEIS. The NRC found that the impacts from operation of Seabrook's once-through cooling system on phytoplankton, zooplankton, invertebrates, and most fish species to be SMALL; however, the impact on winter flounder, rainbow smelt, and some kelp species would be LARGE.*

A.1.4 Effects of Climate Change

Comment E-02-CLI: Now I recognize that the purpose of this meeting is to identify environmental impacts of this plant. But we're more concerned actually right now I'd like to talk about the plant impacts from the environment. We know now that our environment is changing. I think most everybody and certainly the science is in on this, and to others it should be obvious from recent calamities occurring across the globe as well as in the region, that the climate is changing, that we know now the environmental parameters we have today are not going to be in effect 20, 40, 50, 100 years from now.

Just look at a few of these, sea level in particular. Sea level is going up. It has been going up for decades. But it's going to accelerate. We know this. The question is how quickly will it accelerate? How many meters higher will it be in 50 or 100 years? The current best estimate, without dramatic reductions in carbon emissions, which we certainly aren't seeing in our country, according to recent events, that estimate is that by the end of this century, sea level will rise upwards of a meter. That will affect the, obviously the coastline, the ground water levels, the salinity of the ground water. It will have dramatic effects on our sea coast environment.

Now another organization that I've worked with in the past, Clean Air Cool Planet out of Portsmouth, has put together a map of what the Hampton-Seabrook Harbor will look like with a one meter sea level rise. I'm sorry, I don't have a blow-up of this. I just pulled it out of my files this morning. But if you can see the area in blue, it's essentially all the salt marsh and much of the low-lying coastal area will be under water with a one meter sea level rise. The Seabrook plant is on this little peninsula right in the middle here. It will be almost surrounded by water. Most of the routes out of the plant, out of Seabrook and Hampton will be under water. Route 1, Route 1A, Route 101, they will not be accessible if this sea level rise continues, as is predicted now. We have to take this into account. We'll have a much better picture 10 or 20 years from now. But we certainly can't say right now that everything's going to be fine and that the current water regime is going to be the same.

Now looking at groundwater, this is a very important concern. I've mentioned the issues with tritium, but we're also concerned about all the underground infrastructure specifically at this plant, and what effects this groundwater change will have on that, on those systems. The salinity increases certainly will affect the corrosion levels, the amount of damage going on to these critical infrastructure, and it will affect the coastal area in many other ways. There are studies that have already been done.

The United States Geological Survey did a report on sea coast water resources. They have determined that there will be much greater reliance on groundwater, more extraction of groundwater in our seacoast area in coming decades, and that will also affect the salinity levels of groundwater. We know this on the sea coast. When you pump water out of the ground, you draw in more of the ocean water, the saline water and certainly with sea level rising, that makes it all the much worse.

One other key issue we've heard a little bit about, especially down in the Gulf Coast, is violent storms. We haven't had a significant hurricane up on this region, a really big one since, I think, 1938. But it is predicted that there will be much more and more frequent violent storms in this area. Again, looking at this map here, one of the things that it shows with the one meter sea level rise is that Hampton Beach will be largely under water. Seabrook Beach will be under water.

Those are the barrier beaches that we rely on to protect our salt marsh area and our inland coastal areas. And with those barrier beaches gone, it's much more likely that you're going to see damage. I don't know exactly how high Seabrook plant is above sea level or the spent fuel pools or the dry cast storage area. But I know it's not that high. I know with the 20 foot sea level rise, the whole place will be under water.

So I do hope that you will be, if you don't have on staff, you'll be hiring a climatologist to look at the latest research on this, and a hydrogeologist to look at the impacts on groundwater and the impacts of a changing water regime, because we need to know this information. This could be vitally important to the integrity of the plant in coming decades.

Comment E-07-CLI: As we project into the future, which is what this re-licensing process seems to be all about, we recognize your current scoping is meant to identify future environmental impacts of plant operations, but we're more concerned about environmental impacts to the plant itself, namely, from a changing climate. If you expect to take a "business as usual" [BAU] approach to re-licensing this plant, then it behooves you to adopt a BAU perspective on future climate impacts. The science is in and it should be obvious to most that our climate is changing—what we know is that environmental parameters now will clearly not be the case 50 -100 years from now.

What this means in the current context is that you ought to be planning for significant changes to sea level, groundwater and surface water hydrology, and violent storm/storm surge potential as it will likely affect the plant infrastructure and operations. The "best science" now tells us that without significant and rapid carbon emission reductions, sea level could rise approximately 1 meter by the end of this century. This may seem like a long way off, but considering the ongoing debacle of efforts to implement a long-term storage solution to spent fuel and that your recent actions allow for "temporary" waste storage on-site for up to 60 years after plant closure, it appears that Seabrook's waste storage site as well as the plant itself will likely be underwater before the waste problem is finally resolved.

Please take a look at the attached map of Hampton-Seabrook Harbor with a 1 meter sea level rise, produced recently by Clean Air-Cool Planet, a regional climate action organization with offices in Portsmouth, NH. With magnification, you can see that the plant site is mostly covered by blue, representing sea water under the best estimate scenario at the end of the century. Currently surrounding land, including adjacent saltmarsh and equally important barrier beach are also underwater in this scenario. This eventuality is probably more significant than the overall sea level change projected, in that the plant site will be much more subject to violent storm and coastal flooding damage, even if not underwater itself. Other likely impacts to the region's transportation system, groundwater and surface water regimes, and emergency planning are hard to predict, but clearly can not be assumed to be minimal. Current projections of significant population increases in the Seacoast region will further complicate this picture, and make it all the more important that assurance of plant infrastructure integrity be maintained under this radically different hydro-geological regime.

Therefore, we urge you to address likely future climate and coastal impact issues as you develop your EIS. Without reference to currently projected climate changes, your analysis will be inherently simplistic and deficient, and it will represent a gross dis-service to future generations who will have to live with the decisions you make in this process.

Response: *These comments relate to climate change and its impact on the environmental characteristics of the Seabrook site, such as change in weather patterns and sea level. Climate change and its related impacts are discussed in Sections 2.2.2 and 4.11.2 of this SEIS. Implications of global climate change—including implications for severe weather and storm intensity—are important to coastal communities and to critical infrastructure such as Seabrook. While there is great uncertainty, scientists have predicted that sea levels are expected to rise between 3–4 feet (ft) (0.9–1.2 meters (m)) by the end of this century. Changes in sea level, at any one coastal location, depend not only on the increase in the global average sea level but on various regional geomorphic, meteorological, and hydrological factors (USGCRP, 2009). At Seabrook, all critical structures are located at a finished grade elevation of 20 ft (6.1 m) above mean sea level (MSL) (FPLE, 2008), which is well beyond the expected sea level rise.*

Where the comments address the management of underground infrastructure, such as buried piping and inaccessible components, those portions of the comment are considered out of scope for the environmental review and were not evaluated in the development of this SEIS; however, aging management of plant systems is evaluated as part of the Seabrook LRA safety review. The results of the staff's safety review of the LRA will be documented in the staff's safety evaluation report (SER).

A.1.5 Radioactive Releases to the Environment

Comment E-01-RAD: We are very concerned about the ongoing air and water emissions from these plants. You've heard some from others and probably will hear more on that.

One in particular that hasn't been mentioned is the radioactive water, otherwise known as tritium, which we have seen leakage from the plant already, and is a problem throughout the industry. We've most recently heard about the problems at Vermont Yankee.

We're just amazed that in all these years and all the time we've known about the security and leakage problem, that the NRC does not require the power plant owners to have a maintenance plan to report that information. It's a voluntary program.

I just find this appalling that for all this time we've known about this problem, and for all the problems it's caused in particular with the relicensing of Vermont Yankee, that this is still an issue, and that we do not have public access to this information. It just isn't available.

Comment E-06-RAD: Among other issues, [Seacoast Anti-Pollution League] SAPL is generally concerned about ongoing air/water radioactive emissions from the Seabrook plant. Our initial perusal of available NRC documents concerning these emissions found that some years' reports did not appear to be available, and that in any case these annual summaries do not necessarily provide a complete picture of routine emissions. Regarding tritium emissions in particular, it's our understanding that there no requirements for the plant owner to report these leaks except to the extent that they are detected in the surrounding environment. Likewise, the plant owner is not required to have a maintenance plan, though there appears to be a voluntary effort on the part of the industry to address this ongoing problem, which is likely to grow in future years as the plant ages. What we have been able to glean from available sources seems to present conflicting figures about the quantity of tritium released earlier in the decade at Seabrook, as well as the extent of the contamination and efforts to address it at the time. Any EIS ought to provide a better picture of the situation with tritium and other common radioactive emissions, as well as the likelihood of future problems of this sort as the plant ages.

Comment O-03-RAD: Tritium -- tritium and pipe degradation. Almost 20-years ago, again, in a different part of New England -- the Deerfield River Valley of western Massachusetts -- exposure to tritium was linked to Down syndrome -- statistical significance -- for Down syndrome and assorted other health maladies. The study was signed-off on by the State of Massachusetts. The study is available. If you needed the study and don't have it, I can give you the study because I've got it at home. So, tritium is a known evil quantity and the linkage was made 20-years ago to the Yankee Atomic reactor in Rowe, Massachusetts. Yankee Atomic was closed in the early 90s due to concerns around pipe embrittlement. Is it possible that pipe embrittlement caused the release of all of that tritium?

You know, I am not a technician. We've got gentlemen like Paul Blanch here who hopefully will get a chance to speak tonight, but if we've got pipes that are inaccessible and can't be monitored, then that certainly falls within the scope of the upcoming license extension hearings. That stuff has to be looked at because we cannot have tritium flowing into the groundwater and coming right across the marsh into Hampton. I mean, Winnacunnet Road is right on the marsh. I have friends that live on Winnacunnet Road. So, is it true that Florida Power and Light is digging test wells because they're trying to track tritium? I mean, these are hugely important concerns and should be included within the scope of these hearings.

Response: *These comments deal with radioactive releases, including tritium, during the operation of Seabrook and their consequences to human health. The evaluation of radiological impacts of Seabrook operation, as well as the goals of the Radiological Environmental Monitoring Program (REMP), are discussed in Section 4.8 of this SEIS. As discussed in Section 4.8, the objectives of the REMP are as follows:*

- *to provide an indication of the appearance or accumulation of any radioactive material in the environment caused by the operation of the nuclear power 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*
- *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*

The NRC staff reviewed Seabrook's annual radiological environmental operating reports for 2005–2009 to look for any significant impacts to the environment or any unusual trends in the data. A 5-year period provides a representative data set that covers a broad range of activities that occur at a nuclear power plant such as refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities. Based on the review of the radiological environmental monitoring data, the staff found that there were no unusual and adverse trends, and there was no measurable impact to the offsite environment from operations at Seabrook.

With respect to tritium releases, the NRC finds that there are no significant impacts associated with tritium in the groundwater at Seabrook. While onsite tritium remains above EPA's 20,000 pCi/L standard at one location by Unit 1 and is above background at several other onsite *locations, the applicant is actively controlling the groundwater with relatively high tritium concentrations. Dewatering operations pump out the groundwater to create a cone of depression that provides hydraulic containment of tritium-impacted groundwater. The tritium-impacted groundwater is sent to the facility's main outfall to the ocean, where it is released in compliance with NPDES and NRC's radiological limits. Groundwater samples from several monitoring wells are well below 20,000 pCi/L and are not expected to impact human or biota receptors (NextEra, 2010). The nearest groundwater users are over 3,000 ft (910 m) from the plant site and are upgradient, as the groundwater flow path beneath the plant site is generally to the east and southeast toward the tidal marsh.*

Comment O-03-RAD also raises the management of buried piping; that portion of the comment is considered out of scope for the environmental review and was not evaluated in the development of this SEIS; however, aging management of plant systems is evaluated as part of the Seabrook LRA safety review. The results of the staff's safety review of the LRA will be documented in the staff's SER.

A.1.6 Hydrology and Groundwater

Comment A-02-HYD: Currently, there seems to be a legal debate on whether consideration will be given to the leaking of radioactive liquids or other toxics unmonitored off site. The issue seems to be that currently only what will be accepted will be the dysfunction, if you will, of those components as it affects safety systems. However logically, I'd like to bring to your attention the potential of bringing it under the environmental umbrella, because it seems clear if the aging management program has not been found to be sufficient to monitor potential leaks going unmonitored off site, then in fact it would be a violation of regulation and a negative impact on the environment. That also should go for components that are buried, if we figure out how that's defined, that contain fuel from the diesel fuel tanks. I think that would be another way of getting at it, if you will. But the exam question is what you should be doing in your review of the SEIS.

So I would suggest that you fill in the blanks, provide a map, a list first of all the components within scope that are submerged, buried, what have you. Second, provide a map of where they are on the site. Provide to us in the SEIS information regarding the age of those components, the history of repairs, the results of sampling, the material that they're made of, specifics such as their contours, their elbows, etcetera, that would affect corrosion.

Also very important, provide to us, and you should be looking at this yourselves actually, what hydro geo studies have been done to determine where the monitoring wells are currently being placed, and provide those hydro geo studies that have done subsurface investigation to the public in your report, and the date at which those were done. So were the monitoring wells, in other words, put in helter skelter, or have there been very recent hydro geo studies performed?

Response: *This comment deals with the aging management of Seabrook components and the use of monitoring wells to track groundwater quality issues related to the operation of Seabrook. Insomuch as this comment deals with aging management of buried piping at the plant, those portions of the comment are considered out of scope for the environmental review and were not evaluated in the development of this SEIS; however, aging management of plant systems is evaluated as part of the Seabrook LRA safety review. The results of the staff's safety review of the LRA will be documented in the staff's SER.*

Groundwater resources at Seabrook and the effects of plant operations on groundwater hydrology and quality are presented in Sections 2.2.4 and 4.3 of the SEIS. Specifically, Section 2.2.4 summarizes the results of NRC's review of Seabrook's Groundwater Protection Program, including the placement of site groundwater monitoring wells. As part of this *evaluation, the NRC staff specifically reviewed the conceptual groundwater model prepared for Seabrook in 2008 and 2009. All studies reviewed by the NRC staff are cited in Section 2.2.4 and listed in Section 2.4 of the SEIS.*

A.1.7 Severe Accident Mitigation Alternatives Analysis

Comment A-01-SAMA: I'd like to direct my questions and comments solely to severe accidents. There is a requirement of the applicant to do a severe accident mitigation analysis. It can be found in their application. In reading it, it's akin to reading a fairy tale. There is absolutely nothing in it that has a commonality of what one would expect of a severe accident from a nuclear reactor. It is NRC's job in the SEIS to not just describe what the applicant did, and summarize it in a chapter, as has been done at other licensees. It is rather to do, and we expect a detailed analysis of this issue. A SAMA, that's the shorthand, they're required to analyze. It's a cost-benefit analysis, the consequences of off-site of an accident, and then weigh that against costs for mitigative measures that would help reduce risk.

So this is very, very important. The applicant used a computer code called the MAC [sic] code, [MELCOR Accident Consequence Code Systems 2 (MACCS2)]. My question is I think it's necessary to justify the use of that code. First, it is not -- it was not held to the same quality assurance requirements of the American Society of Mechanical Engineering QA Program, requirements for nuclear facilities. So therefore there is a very important question. It was designed solely for research. There is a paper on this by the author of the code. It was not designed for licensing. So therefore the question is why is it being used? Also in the code, if you read it, go through it, there's no explanation of exactly how it works, which is a problem and your responsibility to explain to the public. The problem, there are many problems with this code, and it's not appropriate for use. As it was used by Seabrook in this application to determine off-site consequences. Why? It's important, when you're looking at consequences, to understand atmospheric dispersion and deposition. The code has embedded in it a module called ATMOS, and relevant for you, that uses the straight-line Gaussian plume model, which assumes that wind blows like a beam of a flashlight. NRC, DOE, the public, the world, meteorologists know that is not how the wind blows in a coastal location. Therefore, it is very important when you are doing your review, that you do site-specific analysis, analyses of plume distribution, meteorology in this area. There have been numerous studies ignored by the applicant, but they cannot be ignored by NRC, of how the meteorology is on the coast of Massachusetts, New Hampshire and Maine, specifically discussing the sea breeze effect, which occurs here, increases deposition, number one, and also when it looks like the wind's blowing offshore, it's brought in sometimes 20 to 40 miles. Very significant, ignored by the applicants in their application.

Also ignored is the fact of how plumes travel over water, where they because of lack of turbulence, they remain concentrated, and as a result you can find, when there are northeast winds, deposition blowing down to the dense urban areas, such as a Boston, where you'd expect to find hot spots, or conversely up the New Hampshire coast, to densely populated areas such as Portsmouth and Portland. This is ignored by the licensee. It cannot be ignored. Nor can it be ignored that they got their meteorological data from one source, the on-site meteorological tower, which simply will tell how wind is blowing on site, but not what happens to it off site. So the data they used is essentially worthless. We expect and demand NRC to do more. The economic costs were also grossly underestimated, particularly the cleanup costs. The MAC-S2 models bases its assumptions on clean up, on WASH 1400. Therefore, the DF factor, decommissioning factor, decontamination rather factor, is 15.

We want you to look at that. What is the DF factor that Seabrook has assumed? More importantly, what level of cleanup? They never talk about the level of cleanup. Would it be required to go [U.S. Environmental Protection Agency] EPA, 15 millirem a year? Are we going to 25? Are we going to 50? Are we going to 500? Because what is allowable greatly affects the cost of cleanup. A GOE report has reported that in fact there's no agreement between EPA and NRC. The public here wants to know. The public wants to know some other factors that were ignored. Where's the waste going to go? How much waste? What is the volume that is expected in a severe accident?

While you're looking for a place, how is it going to be safeguarded? That's a cost that's not accounted for. Are they going to put lead blankets over it? How is resuspension going to be covered? What about workers? Whereas WASH 1400 and the MAC-S2 code that they use for their cost calculations assume and was based on a weapons event, cleaning up; it was during the Cold War, of a weapons event. That is the fundamental underpinning of the code, cleanup cost factors. However, there is a vast difference between cleaning up on a weapons event than cleaning up from a reactor event. A weapons event has larger particles, larger mass loading. They assumed, as the MAC-S2 code assumes, the buildings will be hosed down and fueled to be plowed under. This will not be allowed by the public, by [Comprehensive Environmental Response, Compensation, and Liability Act of 1980] CERCLA, by EPA. So let's get some real cost here, real cost. You don't have real cost.

Also underestimated are the health costs. Look at, and we want to know. This has to be site-specific. We cannot have the health costs that are assumed in the code, that go back to understandings of the 1960's, at best early 70's. We've had [Biological Effects of Ionizing Radiation] BEIR-7. BEIR-7 is not conservative enough, because it does not include the Techna River studies. It does not include the studies by Cardis, which show far greater damage from lower doses than BEIR-7. So therefore the health costs. Health itself is taken off the table as a Category 1 issue. But the costs of health belong in the SAMA.

Next, and I'm almost finished, what is missing is consideration of a spent fuel pool accident. I think obviously this is important, because there's far more radioactivity in a spent fuel pool, and you can have migration from a reactor accident to a spent fuel pool accident, so you get a double whammy, or it can move the other way. The argument for not considering this holds no water. They go to the GEIS and look at Section 6, which takes spent fuel and low level waste for that matter off the table for adjudication, but the first paragraph says "Normal operations." Section 5 of the GEIS, which this process is under, describes and gives a definition of severe accidents, and it defines it in terms of consequence, not in terms of the origin of the accident. Therefore, consideration of the spent fuel pool accident in a severe accident mitigation analysis, must be considered.

Last in the application, they talk about evacuation time estimates, which are required, because how long it takes and how many people will get out of dodge will affect -- in time will affect health costs. However, when you read the application, the only reference is to Seabrook's radiological emergency plan. There is no reference, no information of evacuation time estimates, no provision if they used [KLD Associates] KLD, whether these time estimates were performed during peak commuter hours, during bad weather in peak commuter hours, during holidays, during high beach season. There's no information whatsoever. Just a mere "other" reference to NUREG-1150, which has absolutely nothing to do with this, that was an analysis of consequence at five reactors, not Seabrook included in 1991. So it is really irrelevant. So that has to be updated. Last, they do a sensitivity analysis to show that we put in more numbers to make a severe accident look a little worse, and see it didn't make enough of a difference.

But what they did was use the same code, the same assumptions, the same processes, so repeating the same mistake one, two, three, four times, that never will give you the right answer. And so these are the questions. We will send these questions to the NRC, because we will not accept, and nor will you -- we're sure you would like to do a good job -- simply to read what they did and then briefly describe it in Reader's Digest form. We expect analyses, and we're very willing to help you with this process.

Comment A-03-SAMA: I spent most of my time on the Severe Accident Mitigation Analysis, which is within scope. And focused mainly on the fact that the computational tool -- the computer code -- that they are using, the MACCS2, is an antiquated code. It is not properly Q/A'd for licensing. It was done for research and it very much underestimates impact by having embedded in it the straight-line Gaussian plume model, which is inappropriate for this coastal site for largely underestimating clean-up because it was based upon WASH 1400, which in turn was based upon cleanup after a weapons event. But there is not a comparability -- as WASH pointed out and also some of the NRC staff reviewer's of 1150 pointed out -- between a weapons event with large particles and large mass loadings to a reactor accident. So, I won't go into it.

There was also underestimating by a very large measure health costs and also underestimating Evacuation Time Estimates [ETEs] because it's apparent from at least reading the application they did not quote any ETEs for us to even question what the assumptions -- if they used KLD -- whether they considered peak traffic times, holidays, beach traffic, etc., etc. and also ignoring spent-fuel pool accidents, which seem to be in scope because of Section 5 of the GEIS.

But I would say, for something different, that my comments on the MACCS2 particularly in regard to clean-up and the gross underestimation of cost that result from it -- even the author of the code, David Shannon, has written to the fact that if you are interested in economic costs, don't use this code. And who should know better than the person who wrote it. That seems obvious. But, you should bring it in to your discussion of alternatives because in comparing alternative energies, you should be having a chart on economics. The only fair way to do it is not as suggested by a previous speaker that all you look at is the running costs because if that were the case, then a lot of people's houses would be real cheap if somebody else paid their mortgages, if someone else paid their insurance, et cetera, et cetera. That seems to be the case with the nuclear industry.

So, when you compare costs -- when you have to do your alternatives comparison -- I ask you to take the economics -- what the difference in subsidies for each are and then to tie in the MACCS2 code when you're talking about liability and insurance because the MACCS2 -- it was MACCS, actually -- which is the same in every respect to the MACCS2 -- is the underpinning, also the Price Anderson Act. So, the amount of insurance that is provided through the Price Anderson Act that the industry is responsible for rests upon this inadequate code estimation of costs. So, that too should be factored in.

Now, I'm not trying to screw the industry. What I'm trying to do is get an honest assessment of what the costs are, so in fact then we can have an honest appraisal and also then come up with a fair accounting of mitigations as they are offset by the cost. So, thank you for that thought -- or listening to that thought.

Response: *These comments address several aspects of the applicant's SAMA analysis. MACCS2 is the primary radiological dose code in the U.S., and is funded by the NRC and the Department of Energy (DOE). Traditionally, the NRC radiological consequence analyses have been conducted to evaluate potential effects of severe nuclear power plant accidents. The MACCS2 code was developed to support offsite consequence estimates for Level 3 probabilistic risk assessments of severe accidents at light water reactors. Such assessments have long* *served as the foundation for NRC regulatory decisions, which include analyses of health and safety, land contamination, and economic consequences (NRC, 2009). A description of MACCS2 Version 1.13.1 that was used to perform the calculations of the offsite consequences of a severe accident for Seabrook can be found in NUREG/CR-6613, “Code Manual for MACCS2: Volumes 1 and 2” (NRC, 1998). It is beyond the scope of the environmental report (ER) and the SEIS to describe in detail the code’s analytical process. However, a description of the application of the MACCS2 code for the Seabrook analysis has been provided in the relevant portions in Appendix F of this SEIS.*

While arguments can be made that there are individual models more recent than those employed in MACCS2 to estimate cleanup costs, none of these have been integrated into a comprehensive package such as MACCS2. It is important that, when analyzing multiple aspects such as the various capabilities listed above for MACCS2, the various individual models be structured to account for assumptions, simplifications, interfaces, etc. This is the main reason why one cannot simply replace individual modules in an overall code, such as MACCS2, with other individual modules. Essentially, a new code would have to be developed. Until either MACCS2 undergoes a comprehensive update or a new integrated code is developed, it is not practical to “cherry-pick” from the various modules within MACCS2. The Sandia Site Restoration Study has previously been cited as an alternative to the MACCS2 decontamination costs because these costs are not based on fallout from the explosion of nuclear weapons that produce large particle sizes and high mass loadings. However, the Site Restoration Study only indicates that decontamination data may not be applicable to a plutonium dispersal accident (the subject of the Site Restoration Study) and makes no such assertion with respect to a reactor accident. In fact, it specifically indicates that there is applicable data pertaining to reactor accidents.

The use of a straight-line Gaussian model in the ATMOS module of MACCS2 is entirely consistent with the use of similar straight-line models (e.g., XOQDOQ, which implements guidance in Regulatory Guide 1.111) used to evaluate the consequences of routine releases at all new nuclear power plants and to determine compliance with regulations at existing power plants. The MACCS2 code implicitly models the sea breeze effect because it uses all the meteorological conditions to determine the transport and dispersion of radionuclides, including conditions during sea breeze events. The MACCS2 code will treat any recorded wind that blows inland as continuing inland. That some plumes may initially head out to sea and then be drawn back would simply mean that there would be more time for dispersion before the plume moves inland. Moreover, for every change in direction associated with a sea breeze (winds blowing on shore during the day when the land becomes warmer than the water), there will also be an opposite change in direction associated with a land breeze (winds blowing offshore during the night). The deposition patterns determined by the ATMOS module of MACCS2 are cigar shaped, extending outward 50 miles from the release source in the initial model transport direction. This treatment of the sea breeze is realistic for the use to which the code output is being applied and the atmospheric model in MACCS2. As the ER indicates, the Seabrook meteorological data included 8,760 hourly recordings of wind direction, wind speed, atmospheric stability, and accumulated precipitation over a year. NextEra examined 5 years of meteorological data (2004–2008), including a sensitivity analysis of the MACCS2 inputs that varied the annual meteorological data set (NextEra, 2010). As a result, NextEra chose to use, in its baseline analysis, the meteorological data set that resulted in the maximum dose and cost *risk, namely the data from 2005, thus adding to the conservatism of the analysis. Sea breezes are adequately accounted for in the meteorological data used in the Seabrook analysis.*[1]

Furthermore, the modeling of "hot spots" (small, localized volume elements where the radiation level is higher than average) is not essential to the evaluation of SAMAs and is unlikely to affect the identification of potentially cost-beneficial SAMAs. A hot spot is a relatively small area compared to the modeled domain, and the magnitude of hot spots would be small. Consequently the effect of the hot spot on the two spatially and temporally integrated parameters (population dose and economic cost) used in the SAMA analysis is small when a hot spot exists. Further, considering the frequency of conditions that might lead to a hot spot, the effect of hot spots on the climatological mean parameter values is even smaller.

With respect to spent fuel pool accidents, onsite storage of spent fuel is considered a Category 1 issue, which was evaluated in the GEIS; therefore, accidents would be encompassed by the analysis of the Category 1 issue of onsite spent fuel storage. As such, the need for mitigation alternatives within the context of renewal has been considered, and the Commission concludes that its regulatory requirements already in place provide adequate mitigation incentives for onsite storage of spent fuel. No discussion of mitigation alternatives is needed in an LRA because the Commission has generically concluded that additional site-specific mitigation alternatives are unlikely to be beneficial (NRC, 1996). In addition, the NRC staff did not find any new and significant information that would call the analysis of the Category 1 issue into question.

NRC does not reproduce the licensee's SAMA assessment in detail. Calculations are verified for accuracy at a high-level (e.g., using the reported output from the MACCS2 runs), but detailed analysis—such as rerunning the MACCS2 code, or reviewing all inputs—is beyond the scope of the review. If the licensee reports results atypical from what would be anticipated from a SAMA assessment that could also affect the cost-beneficialty determination, the NRC process is to request additional information and justification, including any inputs used, for these analyses. While the NRC reserves the right to require justification of any calculation, this is usually reserved for cases where reanalysis has the potential to affect the cost-beneficiality determination of particular SAMAs. Much of the concern regarding absolute accuracy is addressed via the requirement for various types of sensitivity analyses, designed to bound potential underestimates or analytical simplifications that could affect the cost-beneficiality determinations.

In response to an RAI, NextEra provided site-specific information regarding assumptions for evacuation of the local population, including evacuation time estimates (NextEra, 2011). The staff has reviewed the information supplied by the applicant and has determined that no sensitivity analyses are required. Emergency planning decisions would be based on the site Emergency Plan. Pursuant to 10 CFR Part 50.47, the Emergency Plan is required to provide adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition. The Seabrook Emergency Plan, including meteorological and dose projection capabilities, has been reviewed by the NRC and found to meet all regulatory requirements.

With respect to health costs and the BEIR VII Report, the National Research Council of the National Academies published "Health Risks from Exposure to Low Levels of Ionizing Radiation, BEIR VII Phase 2" in spring 2006. The major conclusion of the report is that current scientific evidence is consistent with the hypothesis that there is a linear, no-threshold dose response

1 Sensitivity to sea breeze effect was estimated by NextEra to be, at most, an increase in offsite economic cost risk by seven percent. There is no currently non-cost-beneficial SAMA where the maximum benefit, including uncertainty, lies within seven percent of the minimum estimated implementation cost.

relationship between exposure to ionizing radiation and the development of cancer in humans. This conclusion is consistent with the system of radiological protection that the NRC uses to develop its regulations. Moreover, the BEIR VII Report does not say that there is no safe level of exposure to radiation; it does not address "safe versus not safe." It does continue to support the conclusion that there is some amount of cancer risk associated with any amount of radiation exposure and that the risk increases with exposure and exposure rate. It does conclude that the risk of cancer induction at the dose levels in the NRC's and EPA's radiation standards is very small. Similar conclusions have been made in all of the associated BEIR reports since 1972 (BEIR I, III, and V).

The results of the NRC staff's review of the SAMA analysis are presented in Chapter 5 and Appendix F of this SEIS.

A.2 References

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APPENDIX B
NATIONAL ENVIRONMENTAL POLICY ACT ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

B NATIONAL ENVIRONMENTAL POLICY ACT ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (referred to as the GEIS), documents the results of the U.S. Nuclear Regulatory Commission (NRC) staff's systematic approach to evaluating the environmental impacts of renewing the licenses of individual nuclear power plants. Of the 92 total environmental issues that the NRC staff identified in the GEIS, the staff determined that 69 are generic to all plants (Category 1), while 21 issues must be discussed on a site-specific basis (Category 2). Two other issues, environmental justice and the chronic effects of electromagnetic fields, are uncategorized and must be evaluated on a site-specific basis.

The table below is a listing of all 92 environmental issues, including the possible environmental significance (SMALL, MODERATE, LARGE, or uncategorized) as appropriate. This table, provided in Section 9 of the GEIS, is codified in the NRC regulations as Table B-1 in Appendix B, Subpart A, to Title 10 of the *Code of Federal Regulations* (CFR) Part 51, and is provided here for convenience.

Table B-1. Summary of Findings on National Environmental Protection Agency (NEPA) Issues for License Renewal of Nuclear Power Plants

Issue	Category	Findings
Surface Water Quality, Hydrology, and Use (for all plants)		
Impacts of refurbishment on surface water quality	Generic	SMALL. Impacts are expected to be negligible during refurbishment because best management practices are expected to be employed to control soil erosion and spills.
Impacts of refurbishment on surface water use	Generic	SMALL. Water use during refurbishment will not increase appreciably or will be reduced during plant outage.
Altered current patterns at intake and discharge structures.	Generic	SMALL. 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.
Altered salinity gradients	Generic	SMALL. Salinity gradients 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.
Altered thermal stratification of lakes	Generic	SMALL. Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Temperature effects on sediment transport capacity	Generic	SMALL. 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.
Scouring caused by discharged cooling water	Generic	SMALL. 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.
Eutrophication	Generic	SMALL. 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.
Discharge of chlorine or other biocides	Generic	SMALL. Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.

Issue	Category	Findings
Discharge of sanitary wastes and minor chemical spills	Generic	SMALL. Effects are readily controlled through [National Pollutant Discharge Elimination System] NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term
Discharge of other metals in waste water	Generic	SMALL. 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.
Water use conflicts (plants with once-through cooling systems)	Generic	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	Site-specific	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).
		Aquatic Ecology (for all plants)
Refurbishment	Generic	SMALL. During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.
Accumulation of contaminants in sediments or biota	Generic	SMALL. 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.
Entrainment of phytoplankton and zooplankton	Generic	SMALL. 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.
Cold shock	Generic	SMALL. 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.
Thermal plume barrier to migrating fish	Generic	SMALL. 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.
Distribution of aquatic organisms	Generic	SMALL. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.
Premature emergence of aquatic insects	Generic	SMALL. 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.
Gas supersaturation (gas bubble disease)	Generic	SMALL. 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.

Issue	Category	Findings
Low dissolved oxygen in the discharge	Generic	SMALL. 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.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	Generic	SMALL. 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.
Stimulation of nuisance organisms (e.g., shipworms)	Generic	SMALL. 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.
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See § 51.53(c)(3)(ii)(B).
Impingement of fish and shellfish	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See § 51.53(c)(3)(ii)(B).
Heat shock	Site-specific	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See § 51.53(c)(3)(ii)(B).
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Generic	SMALL. 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.
Impingement of fish and shellfish	Generic	SMALL. The impingement 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.
Heat shock	Generic	SMALL. 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.
Ground-water Use and Quality		
Impacts of refurbishment on ground-water use and quality	Generic	SMALL. Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.

Issue	Category	Findings
Ground-water use conflicts (potable and service water; plants that use <100 [gallons per minute] gpm)	Generic	SMALL. Plants using less than 100 gpm are not expected to cause any ground-water use conflicts.
Ground-water use conflicts (potable and service water, and dewatering; plants that use >100 gpm)	Site-specific	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gpm may cause ground-water use conflicts with nearby ground-water users. See § 51.53(c)(3)(ii)(C).
Ground-water use conflicts (plants using cooling towers withdrawing make-up water from a small river)	Site-specific	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground-water or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).
Ground-water use conflicts (Ranney wells)	Site-specific	SMALL, MODERATE, OR LARGE. Ranney wells can result in potential ground-water depression beyond the site boundary. Impacts of large ground-water withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See § 51.53(c)(3)(ii)(C).
Ground-water quality degradation (Ranney wells)	Generic	SMALL. Ground-water quality at river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of reactor cooling water. However, the lower quality infiltrating water would not preclude the current uses of ground water and is not expected to be a problem during the license renewal term.
Ground-water quality degradation (saltwater intrusion)	Generic	SMALL. Nuclear power plants do not contribute significantly to saltwater intrusion) intrusion.
Ground-water quality degradation (cooling ponds in salt marshes)	Generic	SMALL. Sites with closed-cycle cooling ponds may degrade ground-water quality. Because water in salt marshes is brackish, this is not a concern for plants located in salt marshes.
Ground-water quality degradation (cooling ponds at inland sites)	Site-specific	SMALL, MODERATE, OR LARGE. Sites with closed-cycle cooling ponds may degrade ground-water quality. For plants located inland, the quality of the ground water in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See § 51.53(c)(3)(ii)(D).
		Terrestrial Resources
Refurbishment impacts	Site-specific	SMALL, MODERATE, OR LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See § 51.53(c)(3)(ii)(E).
Cooling tower impacts on crops and ornamental vegetation	Generic	SMALL. 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.

Issue	Category	Findings
Cooling tower impacts on native plants	Generic	SMALL. 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.
Bird collisions with cooling towers	Generic	SMALL. These collisions 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.
Cooling pond impacts on terrestrial resources	Generic	SMALL. Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.
Power line right-of-way management (cutting and herbicide application)	Generic	SMALL. The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.
Bird collision with power lines	Generic	SMALL. Impacts are expected to be of small significance at all sites.
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	Generic	SMALL. 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.
Floodplains and wetland on power line right of way	Generic	SMALL. Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.
Threatened or Endangered Species (for all plants)		
Threatened or endangered species	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See § 51.53(c)(3)(ii)(E).
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	Site-specific	SMALL, MODERATE, OR LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage. See § 51.53(c)(3)(ii)(F).
Air quality effects of transmission lines	Generic	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
Land Use		
Onsite land use	Generic	SMALL. Projected onsite land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.

Issue	Category	Findings
Power line right of way	Generic	SMALL. Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.
Human Health		
Radiation exposures to the public during refurbishment	Generic	SMALL. During refurbishment, the gaseous effluents would result in doses that are similar to those from current operation. Applicable regulatory dose limits to the public are not expected to be exceeded.
Occupational radiation exposures during refurbishment	Generic	SMALL. Occupational doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risk from all causes including radiation is in the mid-range for industrial settings.
Microbiological organisms (occupational health)	Generic	SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.
Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Site-specific	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).
Noise	Generic	SMALL. 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.
Electromagnetic fields, acute effects (electric shock)	Site-specific	SMALL, MODERATE, OR LARGE. Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are 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 at the site. See § 51.53(c)(3)(ii)(H).
Electromagnetic fields, chronic effects	Uncategorized	UNCERTAIN. Biological and physical studies of 60 - Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a consensus scientific view has not been reached.[(1)]
Radiation exposures to public (license renewal term)	Generic	SMALL. Radiation doses to the public will continue at current levels associated with normal operations.
Occupational radiation exposures (license renewal term)	Generic	SMALL. 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.
Socioeconomics		
Housing impacts	Site-specific	SMALL, MODERATE, OR LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See § 51.53(c)(3)(ii)(I).

Issue	Category	Findings
Public services: public safety, social services, and tourism and recreation	Generic	SMALL. Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
Public services: public utilities	Site-specific	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See § 51.53(c)(3)(ii)(I).
Public services, education (refurbishment)	Site-specific	SMALL, MODERATE, OR LARGE. Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors.
Public services, education (license renewal term)	Generic	SMALL. Only impacts of small significance are expected.
Offsite land use (refurbishment)	Site-specific	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See § 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term)	Site-specific	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See § 51.53(c)(3)(ii)(I).
Public services, Transportation	Site-specific	SMALL, MODERATE, OR LARGE. Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the license renewal are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).
Historic and archaeological resources	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See § 51.53(c)(3)(ii)(K).
Aesthetic impacts (refurbishment)	Generic	SMALL. No significant impacts are expected during refurbishment.
Aesthetic impacts (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Aesthetic impacts of transmission lines (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
		Postulated Accidents
Design basis accidents	Generic	SMALL. The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.
Severe accidents	Site-specific	SMALL. The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See § 51.53(c)(3)(ii)(L).

Issue	Category	Findings
		Uranium Fuel Cycle and Waste Management
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste	Generic	SMALL. Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S - 3 of this part [10 CFR Part 54]. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.
Offsite radiological impacts (collective effects)	Generic	The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of ears are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations. Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.
Offsite radiological impacts (spent fuel and high level waste disposal)	Generic	For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem per year. The lifetime individual risk from 100 millirem annual dose limit is about 3×10^{-3}. Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood an 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. The evaluation estimated the 70-year whole-body dose commitment

Issue	Category	Findings
		to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, [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 of between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths worldwide for a 100,000 metric tonne [of heavy metal] (MTHM) repository. Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts pf spent fuel and high level waste disposal, this issue is considered in Category 1.
Non-radiological impacts of the uranium fuel cycle	Generic	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.
Low-level waste storage and disposal	Generic	SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

Issue	Category	Findings
Mixed waste storage and disposal	Generic	SMALL. 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.
On-site spent fuel	Generic	SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.
Nonradiological waste	Generic	SMALL. 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.
Transportation	Generic	SMALL. The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 [megawatt days per metric ton uranium] MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S–4—Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water- Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.
		Decommissioning
Radiation doses	Generic	SMALL. 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.
Waste management	Generic	SMALL. 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.
Air quality	Generic	SMALL. 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.
Water quality	Generic	SMALL. 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.
Ecological resources	Generic	SMALL. Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	Generic	SMALL. 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.

Issue	Category	Findings
		Environmental Justice
Environmental justice	Uncategorized	NONE. The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

(1) If, in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

APPENDIX C
APPLICABLE REGULATIONS, LAWS, AND AGREEMENTS

C APPLICABLE REGULATIONS, LAWS, AND AGREEMENTS

The Atomic Energy Act (42 USC § 2021) authorizes the U.S. Nuclear Regulatory Commission (NRC) to enter into agreement with any State to assume regulatory authority for certain activities. For example, through the Agreement State Program, New Hampshire assumed regulatory responsibility over certain byproduct, source, and quantities of special nuclear materials not sufficient to form a critical mass. The New Hampshire State Agreement Program is administered by the Radiological Health Section, Division of Public Health Services, New Hampshire Department of Health and Human Services.

In addition to implementing some Federal programs, State legislatures develop their own laws. State statutes supplement, as well as implement, Federal laws for protection of air, water quality, and groundwater. State legislation may address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

The Clean Water Act (CWA) allows for primary enforcement and administration through State agencies, provided the State program is at least as stringent as the Federal program. The State program must conform to the CWA and to the delegation of authority for the Federal National Pollutant Discharge Elimination System (NPDES) Program from the U.S. Environmental Protection Agency (EPA) to the State. The primary mechanism to control water pollution is the requirement for direct dischargers to obtain an NPDES permit or, in the case of States where the authority has been delegated from the EPA, a State Pollutant Discharge Elimination Systems permit, pursuant to the CWA. In New Hampshire, the EPA issues and enforces NPDES permits.

One important difference between Federal regulations and certain State regulations is the definition of water regulated by the State. Certain State regulations may include underground waters while the CWA only regulates surface waters.

C.1 State Environmental Requirements

Certain environmental requirements, including some discussed earlier, may have been delegated to State authorities for implementation, enforcement, or oversight. Table C-1 provides a list of representative State environmental requirements that may affect license renewal applications for nuclear power plants.

Table C-1. State Environmental Requirements.

Seabrook is subject to State requirements regarding its environmental program. Those requirements are briefly described below. See SEIS Section 1.9 for Seabrook's compliance status with these requirements.

Law/Regulation	Requirements
	Air Quality Protection
Federal Clean Air Act (42 USC 7401 et seq.), New Hampshire Revised Statutes Annotated (RSA), Chapter 125-C, *Air Pollution Control*	An operating permit is required for air emissions and is issued by the New Hampshire Department of Environmental Services (NHDES). RSA Chapter 125-C establishes the policies by which the state administers the Title V permit program under the *Clean Air Act*.
Federal Clean Air Act (42 USC 7401 et seq.), New Hampshire Code of Administrative Rules (CAR), Part ENV-A 610, *General State Permits and General Permits Under Title V*	A general permit is required for air emissions and is issued NHDES. CAR ENV-A 610 establishes permit procedures by which the state administers the Title V permit program under the *Clean Air Act*.

Law/Regulation	Requirements
New Hampshire CAR, Part ENV-A 1205, *Prevention, Abatement, and Control of Stationary Source Air Pollution*	This law regulates emissions of volatile organic compounds (VOCs) from gasoline storage tanks, gasoline dispensing facilities, bulk gasoline plants, and cargo trucks in accordance with Sections 182(b)(3) and 184 of the *Clean Air Act*.
Waste Management and Pollution Prevention	
New Hampshire CAR, Part ENV-WM 300, *Permits*	This law establishes the procedures and requirements used in permitting hazardous waste management facilities. It requires facilities to obtain a permit prior to constructing, modifying, or operating a facility.
New Hampshire CAR, Part ENV-WM 1400, *Petroleum Storage Facilities*	This law establishes the procedures and requirements for facilities that use petroleum storage tanks. It requires facility owners to register all petroleum storage facilities.

C.2 Operating Permits and Other Requirements

Several operating permit applications may be prepared and submitted, and regulator approval, permits or both would be received prior to license renewal approval by the NRC. Table C-2 lists representative Federal, State, and local permits.

Table C-2. Federal, State, and Local Permits and Other Requirements.

Seabrook is subject to other requirements regarding various aspects of their environmental program. Those requirements are briefly described below. See SEIS Section 1.9 for Seabrook's compliance status with these requirements.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Water Resources Protection			
NPDES Permit: Industrial Facility Storm Water	EPA	CWA (33 USC 1251 et seq.); 40 CFR Part 122	Storm water would be discharged from the nuclear power plants during operations. Storm water would discharge through existing outfalls covered by a permit.
NPDES Permit: Process Water Discharge	EPA	CWA (33 USC 1251 et seq.); 40 CFR Part 122	Process industrial wastewater would be discharged through existing outfalls covered by the permit.
Waste Management and Pollution Prevention			
Registration for transportation of radioactive material in Virginia	Virginia Department of Emergency Management	Title 44, Code of Virginia, Chapter 3.3, Section 44-146.30	Commonwealth of Virginia requires shippers of hazardous radioactive materials to register with the Virginia Department of Emergency Management.
License to deliver radioactive material to a processing facility in Tennessee	Tennessee Department of Environment and Conservation	Tennessee Code Annotated 68-202-206	Seabrook radioactive material is delivered to a processing facility in Tennessee.
Permit to deliver radioactive material to a disposal facility in Utah	Utah Department of Environmental Quality	Utah Rule 313-26	Seabrook radioactive material is shipped to a disposal facility in Utah.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
		Emergency Planning and Response	
Transportation of hazardous material registration	U.S. Department of Transportation	*Hazardous Material Transportation Act* (49 USC 1501 et seq.); 49 CFR Part 107	Seabrook hazardous materials shipments comply with U.S. Department of Transportation packaging, labeling, and routing requirements.
		Biotic Resource Protection	
Threatened and endangered species consultation	U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS)	*Endangered Species Act of 1973*, as amended (16 USC 1531 et seq.)	NRC consults with USFWS and NMFS regarding the impact of license renewal on threatened or endangered species or their critical habitat.
Coastal zone management certification	NHDES	*Coastal Zone Management Act* (16 USC 1451)	An applicant is required to provide certification to the Federal agency that license renewal would be consistent with the Federally-approved state coastal zone management plan.
Permit to display finfish and invertebrates	New Hampshire Fish and Game Department	New Hampshire RSA 214:29	An applicant is required to obtain a permit to display finfish and invertebrates at the Seabrook Science and Nature Center.
		Cultural Resources Protection	
Archaeological and historical resources consultation	State Historic Preservation Officer	*National Historic Preservation Act* of 1966, as amended (16 USC 470 et seq.)	NRC consults with the State Historic Preservation Officers regarding the impacts of license renewal and the results of archaeological and architectural surveys of nuclear power plant sites.